2 Tth ASIAN-PACIFIC WEED SCIENCE SOCIETY CONFERENCE 2019

"WEED SCIENCE FOR SUSTAINABLE AGRICULTURE AND ENVIRONMENT"

PROGRAM AND ABSTRACTS

RIVERSIDE MAJESTIC HOTEL, KUCHING, SARAWAK, MALAYSIA 3-6 SEPTEMBER 2019

Organisers





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Corteva Agriscience™ begins business as an independent agriculture company.

CORTEVA 2018

Corteva Agriscience name announced.

2017

0



The Dow Chemical Company and DuPont merged, combining Dow AgroSciences, DuPont Crop Protection and Pioneer to form Corteva Agriscience.

OUPINT 2015 Dow

DowDuPont merger announced.



DuPont acquired 100% ownership of Pioneer Hi-Bred International.



Dow AgroSciences

QUPONT

The Dow Chemical Company purchased the full agricultural business and created Dow AgroSciences.

1989 Dow





Dow

The Dow Chemical Company established a separate agricultural business.



Henry A. Wallace founded the Hi-Bred Corn company in Iowa, and in 1935 Wallace added the name Pioneer to distinguish it from other companies.





H.H. Dow founded The Dow Chemical Company in Midland, MI.

QUPOND 1802

E.I. du Pont established the DuPont Company in Wilmington, DE.

A brief look at our history...

WELCOME MESSAGE



It is a great pleasure to extend my warm welcome to all distinguished speakers and participants of the 27th Asian-Pacific Weed Society International Conference 2019. I would like to take this opportunity to congratulate Malaysian Plant Protection Society (MAPPS) and Asian-Pacific Weed Society (APWSS) for jointly organising this conference in Kuching, Sarawak.

The global challenge to increase agricultural production to ensure food security and food safety to meet the demand of increasing world population is an issue that needs to be addressed. Sustainable crop production is threatened by

various factors such as climate change, land degradation, water crisis and weeds infestation. Weeds are a major problem in crop production, reducing yield and quality and increasing production cost. The noxious weeds are also detrimental to our native plants, competing with and invading them, and certain species are harmful to livestocks and human health.

Effective and sustainable management of weeds requires an integrated approach in view of cost and labour constraints, environmental degradation, health hazard and development of herbicide-resistance weeds. Integrated weed management is crucial for sustainable agriculture and environmental protection. The approach consists of a suit of options including improved cultural practices, thermal treatment, use of bioherbicides and allelopathy crops to reduce environmental degradation and emergence of herbicide-resistance weeds. Precision weed management is now made possible by the advent of digital technology through use of remote sensing, drones and robots.

This conference with the theme 'Weed Science for Sustainable Agriculture and Environment' is timely and serves as a good platform to share information, knowledge and experiences among researchers, practitioners, entrepreneurs, investors and policy makers to bring forth new ideas, technologies and strategies to address the challenges of managing weeds in the context of sustainable agriculture and environmental protection.

Lastly, I wish all participants a fruitful conference and a memorable stay in this beautiful city of Kuching, Sarawak.

Thank you.

Yang Berhormat Datuk Amar Douglas Uggah Anak Embas Deputy Chief Minister of Sarawak Second Minister for Finance and Minister of Modernisation of Agriculture, Native Land and Regional Development Sarawak

WELCOME MESSAGE



It gives me great pleasure to welcome all of you to beautiful multi-cultural Kuching, Sarawak, Malaysia and to this 27th APWSS Conference. We are indeed very proud to host this very important event. As a representative of the Asian-Pacific Weed Science Society (APWSS), and a chairperson of the organizing committee, it gives me immense pleasure to pen a few words to embrace all participants and delegates of this conference.

APWSS is a society that was established 52 years ago

to gather weed researchers and practitioners from all over the world to express views on all issues relating to weeds and their management through the promotion of research, education and extension outreach activities.

This Conference provide a platform for useful exchange of scientific and technical information, experiences and of innovative ideas. It also serves to strengthen linkages among the industry, academicians, scientist and policy makers locally and internationally. I am obliged to all experts who have come to share their knowledge in this conference. I am absolutely sure that you will have a fruitful and rewarding exchanges in the next few days of the event.

Congratulations to all of you, the local and international delegates who made it to this workshop, I welcome you to Malaysia and wish you have a delightful stay.

The Organizing Committee would also like to acknowledge CORTEVA Agriscience, Business Events Serawak, Universiti Putra Malaysia and Universiti Teknologi Mara for their support of this event.

My sincere thank also goes to the local and international organizing committees and all our partners who worked hard in the preparation of the conference.

Last but not least, I wish all the participants a successful conference and fruitful discussion.

Thank you.

Prof Dr. Abdul Shukor Juraimi

President, Asian-Pacific Weed Science Society (APWSS) Chairperson, 27th APWSS Conference

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LIST OF INVITED SPEAKERS

Keynote Speaker



Prof. Dr. Stephen Powles

The University of Western Australia

Herbicide Resistance and its Management in Asian Pacific: Challenges and Opportunities

Plenary Speakers



Emeritus Prof. Dr Robert Zimdahl

Colorado State University, USA

Weed Science for a Sustainable Agriculture and Environment – An Ethical Perspective

Prof. Dr. Stephen William Adkins

The University of Queensland, Australia

The Global Threat from Biological Invasions under a Changing Climate: An Example of a Notorious Invader, Parthenium Weed

Prof Dr. Do-Soon Kim

Seoul National University, South Korea

Plant Image Science (Plant Phenomics) as a New Tool for Weed Research



3- 6th September 2019



Syngenta, UK

Evolution and Non-Target Site Resistance Mechanism in Weeds





Dr. Michael D. Day

Department of Agriculture and Fisheries, Australia

Weed Biological Control: Challenges and Opportunities

Dr A.N. Rao

International Crops Research Institute for the Semi-Arid Tropics, India

The Progress and Future of Weed Science Research in Asian-Pacific Region

Prof Dr. Samunder Singh

Chaudhary Charan Singh Haryana Agricultural University, India

Ecobiology and Management of *Phalaris minor*



OPENING CEREMONY

27TH APWSS CONFERENCE TUESDAY (3rd September 2019) VENUE : SARAWAK CHAMBER BALLROOM

0800	Arrival of Guests
0815	Arrival of YB Datuk Amar Douglas Uggah Embas Deputy Chief Minister of Sarawak, Second Minister for Finance, Minister for Modernisation of Agriculture, Native Land & Regional Development
0830	Welcoming Speech Prof. Dr. Abdul Shukor Juraimi Chairman of Organising Committee
	Opening Speech by YB Datuk Amar Douglas Uggah Embas
	Multimedia Presentation
	Launching of APWSS Journal and MAPPS Book
0915	Refreshment

SCIENTIFIC PROGRAM

2 SEPT 2019 (Monday)	Time
Paper Writing Workshop	8.30 - 10.00 am
Venue: Deer & Lady Suite, Level 3	
APWSS Young Scientists 'Meet And Greet' Meeting	2.00 – 4.00 pm
Venue: Deer & Lady Suite, Level 3	
APWSS Executive Board Meeting	4.30 – 7.00 pm
Venue: Deer & Lady Suite, Level 3	
PRE-REGISTRATION & POSTER MOUNTING	4.30 - 6.00 pm
Venue: Level 3 Foyer	
3 SEPT 2019 (Tuesday)	
Registration	7.15 – 8.30 am
Venue: Level 3 Foyer	
Opening Ceremony	8.30 - 9.15 am
Morning break	9.15 – 9.45 am
Keynote	9.45 – 10.30 am
Prof. Dr. Stephen Powles	
Herbicide Resistance and its Management in Asian Pacific: Challenges and Opportunities	
Venue : Sarawak Chamber Ballroom 2 & 3	
Chairperson: Shukor Juraimi	
Plenary 1	10.30- 11.00 am
Dr. Shiv Shankhar Kaundun	
Evolution and Non-Target Site Resistance Mechanism in Weeds	
Venue : Sarawak Chamber Ballroom 2 & 3	
Chairperson: Samunder Singh	

Session 1A	Session 1B	Session 1C	Session 1D	11.00-12.30 pm
Herbicide resistant weed	Herbicide formulation and	Utilization of weeds for value-	Herbicide behaviour in	
and herbicide tolerant	application technology	added products	soil and water	
crop	Weed risk assessment and	Venue : Deer & Lady Suite,	Venue : Wind Suite, level	
Venue : Sarawak Chamber	management	level 3	3	
Ballroom 2 & 3, level 3	Education and extension in	Chairperson: Sushilkumar	Chairperson: Norida	
Chairperson: Edison Purba	weed science		Mazlan	
	Venue : Windows on Kuching 1			
	& 2, level 18			
	Chairperson: Michael Widderick			
1 0 1	101	101	101	11.00 11.15 am
IAI Registeres Mechanism to	IBI Towarda Increasing the Efficiency	ICI Inspecticidal Branartian of	IDI Dotato Iniuny from	11.00 - 11.15 am
Resistance Mechanism to	of Chemical Spraving Lloing	Selected Weeds Against Disc	Polato Injury Iron	
(ALS) Horbicido and	Unmanned Aprial System (LAS)	Moovil Sitophilus oruzzo I	Its Management	
Alternative Herbicide	in Rice Cultivation	Nurul Hazwani Mohamed*	Strategies	
Options in Polypogan fugax	Siti Amni Ismail	Narai nazwani monameu	Chun Zhang*	
Xiaovue Yu*				
1A2	1B2	1C2	1D2	11.15-11.30 am
Molecular Basis of	Effectiveness of Potassium	Weeds in Our Midst: Their	Residues of Imidazolinone	
Resistance to ALS-	Glyphosate 660 g/L Herbicide on	Nutritional Contents and	Herbicide in Irrigated Rice	
Inhibiting Herbicides in	the Time Interval of Rainfastness	Medicinal Properties	Fields of Sg Leman,	
Amaranthus retroflexus L.	After Application on Weeds	Maclin Dayod*	Selangor	
from China	Uum Umiyat*		Engku Ahmad Khairi	
Zhaofeng Huang*			Engku Ariff*	
1A3	1B3	1C3	1D3	11.30-11.45 am
Molecular and Biochemical	The Effect of Rainfastness of	Weeds as an Alternative Feed	Soil Based Pre-	
Basis of ACCase Inhibitor	Herbicide Potassium Glyphosate	Resource for Small Holders'	Emergence Herbicide	
Tolerance In Roegneria	to Control Weeds of Oil Palm	Livestock Farming	Dose Recommendation: A	
kamoji Ohwi from China	Denny Kurniadie*	Vennila Chandran*	Way Forward to Precision	
Wei Tang*			Agriculture	
			Selvakumar, S.*	

1A4 Metabolic Herbicide Resistance Gene Discovery in Wild Oat Qiong Peng *	1B4 Climate Niche Models – The Perils of Restricted-Range Parameterisation Data <i>Graeme Bourdôt</i> *	1C4 Biomass Production and Carbon Sequestration of Perennial Grass <i>Miscanthus</i> Yeon-Ho Park *	1D4 Evaluation of Herbicide Residues Under the Long- Term Conservation Agriculture Experiments Shobha Sondhia *	11.45-12.00 pm
1A5 The Metabolic Resistance And Essential Genes Involved in ALS Inhibitors- Resistant <i>Myosoton</i> <i>aquaticum</i> L. <i>Weitang Liu</i> *	1B5 The Need for Farm Biosecurity: Herbarium Records of Major Weeds Explained by Human Assisted Dispersal <i>Trevor K. James</i> *			12.00-12.15 pm
1A6 Multiple Resistance to Penoxsulam, Metamifop and Quinclorac Without Mutations in the Target Enzymes in <i>Echinochloa</i> <i>oryzicola</i> (Vasing.) Vasing <i>Mingshan Ji</i> *	1B6 Current Practices and Challenges for Education and Extension in Weed Science in Fiji <i>Aradhana Devi Deesh</i> *			12.15-12.30 pm
1A7 Herbicide Resistance in Weeds of Wheat in Khyber Pakhtunkwa-Pakistan				
Saima Hashim*				
	Lunc	ch		12.30 - 2.00 pm

Weed Sci	Plenar Emeritus Prof. Dr ence for a Sustainable Agriculture a Venue : Sarawak Char Chairperson: N	r y 2 Robert Zimdahl nd Environmental – An Ethical Per nber Ballroom 2 & 3 lilda Burgos	spective	2.00 -2.30 pm
Session 2A Herbicide resistant weed and herbicide tolerant crop Venue : Sarawak Chamber Ballroom 2 & 3 Chairperson: A.N. Rao	Session 2B Novel herbicide and herbicide mode of action Venue : Windows on Kuching 1 & 2, level 18 Chairperson: Yoshiharu Fujii	Session 2C Weed management in other crops Venue : Deer & Lady Suite, level 3 Chairperson: Denny Kurniadie	Session 2D Weed management in rice Venue : Wind Suite, level 3 Chairperson: Do-Soon Kim	2.30 -4.00 pm
2A1 Identification of Several Diuron-Resistant Weed Species in Pineapple Plantation in Lampung Province, Indonesia Resti Puspa Kartika Sari *	2B1 The Discovery of Herbicide Safeners From Nature Products <i>Xile Deng</i> *	2C1 Weed Management in Grain Legumes: Issues and Strategies <i>Narendra Kumar</i> *	2D1 Lead speaker Prof. Dr. Nilda Roma- Burgos Sustainable Agriculture is Intergration of Tools and Mindset Overhaul	2.30 -2.45 pm
2A2 Bensulfuron-Methyl- Resistant <i>Ammannia</i> <i>auriculata</i> and Its Competition with Rice Paddy <i>Jinwen Zhu</i> *	2B2 Bioefficacy Evaluation of Pelargonic Acid, Alternative Herbicides and Herbicide Combinations for the Control of Volunteer Oil Palm Seedlings in Immature Oil Palm Meor Badli Shah Ahmad Rafie *	2C2 Weed Management Options for Strip Tillage Maize in Bangladesh <i>Ilias Hossain</i>	2D2 Safening S-Metolachlor in Rice Via Extract from <i>Ligusticum</i> <i>Jingbo Li</i> *	2.45-3.00 pm
2A3	283	203	203	3.00-3.15 pm

Identification of Several Weed Species That Have Evolved Resistance to Glyphosate Herbicide in Oil Palm Plantation in Lampung Province, Indonesia Nanik Sriyani *	Baseline Sensitivity of Echinochloa Species to Rinskor™ Active in Korea Jee-hwan Yi*	Weed Management for Reduced Use of Paraquat in Cassava Production Yurawan Anatanamanee *	Genetic Diversity, and Origins of Weedy Red Rice and the Use of Phylogeographical Structures to Control its Seed-mediated Contamination in Taiwan Dong-Hong Wu *	
2A4 Rapid Diagnosis of Herbicidal Activity Using Spectral Image Analysis <i>Tae-Kyeong Noh</i> *	2B4 Baseline Sensitivity of <i>Echinochloa crus-galli</i> to Florpyrauxifen-Benzyl in Korea <i>Harim Kim</i> *	2C4 Weed Suppression Effect of African Tulip Woodchips (<i>Spathodea campanulata</i>) as Different Thickness Mulch in Vegetable and Root Crop Production <i>Makereta Ranadi</i> *	2D4 Performance of Bensulfuron-methyl 1.1% + Metsulfuron-methyl 0.2% + Acetochlor 14% WP Against Wide Range of Weed Control in Transplanted Rice of Bangladesh <i>Md. Khairul Alam</i> <i>Bhuiyan</i> *	3.15-3.30 pm
2A5 Baseline Sensitivity of <i>Echinochloa</i> Species to Triafamone Assessed Using a Multi-Pot Tray Assay <i>Jang-Ho Boo</i> *	2B5 Synergistic Effect of Hydrolized Corn Gluten Meal on Acetochlor Bo Tao *	2C5 Efficacy of Herbicides on Weed Control in Mungbean Cultivation in Bangladesh <i>Md. Omar Ali</i> *	2D5 Weed-Competitive Rice: An Eco Friendly Approach Towards Minimizing Usage of Herbicides in Sri Lanka <i>R.M.U.S. Bandara</i> *	3.30-3.45 pm
2A6 Potential Escape Mechanisms for Weedy Rice (<i>Oryza sativa</i>) from	2B6 Bixlozone: A New Isoxazolidinone Herbicide for A Wide Range of Major Crops		2D6 Effects of Imidazolinone Formulation, Application Rate and Application	3.45-4.00 pm

3- 6th September 2019

Imidazolinone	Herbicide	Anandakrishnan Balaraman*		Timing on Control of	
Application				Weedy Rice and Selected	
Muhamad	Shakirin			Weed Species in	
Mispan*				Clearfield [®] Rice System	
				Dilipkumar Masilamany*	
Tea break					4.00 – 4.30 pm
		APWSS Annual G	Seneral Meeting		4.30 – 5.30 pm
		4 SEPT 2019 (Wednesday)		
		Plena	ry 3		9.00 - 9.30 am
		Prof Dr. Samu	Inder Singh		
		Ecobiology and Manager	ment of <i>Phalaris minor</i>		
		Venue : Sarawak Chambe	r Ballroom 2 & 3, level 3		
		Chairperson: De	eirdre Lemerle		
Plenary 4				9.30 - 10.00 am	
		Prof Dr. Do-	Soon Kim		
	Pla	nt Image Science (Plant Phenomics) as a New Tool for Weed Resear	ch	
		Venue : Sarawak Chambe	r Ballroom 2 & 3, level 3		
		Chairperson: De	eirdre Lemerle		
		Morning	break		10.00 -10.30 am
Session 3	3A	Session 3B	Session 3C	Session 3D	10.30 12.15 pm
Weed biolog	y and	Allelopathy and allelochemical	Weed management in other	Weed management in	
physiology and	l ecology	in weed management	crops	rice	
Venue : Sarawak	Chamber	Venue : Windows on Kuching 1	Venue : Deer & Lady Suite,	Venue : Wind Suite, level	
Ballroom 2 & 3	, level 3	& 2, level 18	level 3	3	
Chairperson: S. I	M. Rezaul	Chairperson: Baki Bakar	Chairperson: Meor Badli Shah	Chairperson: Udai Pratap	
Karim			Ahmad Rafie	Singh	
3A1		3B1	3C1	3D1	10.30-10.45 am
Effect of Therma	al Time on	Lead speaker	Effect of Different Ground Cover	Major Weeds and Weed	
Growth And Fee	cundity of	Prof. Dr. Yoshiharu Fujii	Management Systems on	Management: Perceptions	
			Population Changing Pattern of		

Redroot Pigweed (<i>Amaranthus retroflexus</i>) Asad M. Khan *	Allelopathy and Its Utilization for Weed Control and Robustness of Soil Rhizosphere	Pennisetum polystachion in Coconut Plantations of Sri Lanka S. S. Udumann *	of Farmers Growing Rice Under Different Stratum of Irrigation Systems of Isabela and Nueva Ecija Provinces, Philippines Dindo King Donayr	
3A2 Distribution Patterns of Weedy Rice Populations in Vavunia District, Northern Province of Sri Lanka <i>Shyama Ranjani</i> <i>Weerakoon</i> *	3B2 Isolation of Phytotoxic Substances from Kiwifruit Leaves and the Soil under Kiwifruit Trees <i>Shun Okada</i> *	3C2 Weed Dynamics and Onion Yield as Influenced by Pre-Mix Clodinafop-Propargyl 12.25% + Sodium Oxyfluorfen 14.7% EC <i>Ramesh K. Singh</i> *	3D2 Efficacy of Novixid TM (Rinskor TM Active+ Penoxsulam) Against Broad-Spectrum Weed Control in Wet Direct Seeded Rice of Central India <i>Sunil Kumar</i> *	10.45-11.00 am
3A3 Phenology, Fecundity and Dormancy of <i>Avena sterilis</i> <i>ssp. ludoviciana</i> from Plants Grown Under Late Season Soil Water Stress Mohammad Ali *	3B3 Selectivity to Rice and Phytotoxicity to Selected Weeds of Potential Bioherbicide from Aqueous Leaf Extract of <i>Ludwigia</i> <i>hyssopifolia</i> (G. Don) Exell <i>Arnoldus M. Mangao</i> *	3C3 Three Tier Management Practices for Effective Organic Weed Management in Sweet Corn Roshan Choudhary *	3D3 Integrated Weed Management for Direct- Seeded Rice in Cambodia <i>Virender Kumar</i> *	11.00-11.15 am
3A4 Hidden-in-Plain-Sight: Distribution Pattern and Phenotypic Variation of	3B4 Identification of Previously- Published Allelochemicals in OM	3C4 Field Study of Rinskor™ Active and ALS Inhibitor Herbicides on	3D4 Response of Rice and Weeds to Early	11.15-11.30 am

Weedy Rice in Peninsular Malaysia <i>Intan Filzah Mahmod</i> *	Rice Varieties with Cloud-Based Metabolomics Platform <i>Ho Le Thi</i> *	Parthenocarpy Effect in Oil Palm <i>Edison Purba</i> *	Submergence in Direct- Seeded Rice in Sri Lanka <i>Swarna Herath</i> *	
	3B5 Development of Pre-Emergence Bio-Herbicide From Purple Nutsedge (<i>Cyperus rotundus</i> L.) for Controlling Broad-Leaf Weeds <i>Ferdhi Isnan Nuryana</i> *	3C5 Effect of Sequential And Tank Mix Herbicides On Weed Dynamics and Yield of Rainfed Maize <i>Anil Kumar</i> *	3D5 Effect of Weed Control and Poultry Manure on Growth And Yield of Upland Rice in Sudan Savannah of Nigeria <i>Danmaigoro</i> <i>Olanrewaju</i> *	11.30-11.45 am
	3B6 Allelopathic Potential of the Aqueous Methanol Extracts of <i>Elephantopus scaber</i> and Its Inhibitoy Substance <i>Sutjaritpan Boonmee</i> *	3C6 Growth and Yield Response of Some Striga Tolerant Maize (<i>Zea mays</i> L.) Varieties to Weed Management Practices and Sowing Times at Minna, Nigeria <i>Musa Gimba Matthew Kolo</i> *	3D6 Rinskor™ Active, the Newest Arylpicolinate Auxinic Herbicide for Effective and Sustainable Weed Management in Rice <i>Mauricio Morell</i> *	11.45-12.00 pm
	3B7 Involvement of Autotoxicity in Asparagus Decline and Its Effective Treatment <i>Hisashi Kato-Noguchi</i> *			12.00-12.15 pm
	Lunc	ch		12.30 – 2.00 pm

3- 6th September 2019

The	Plena Dr A.N. Progress and Future of Weed Scie Venue : Sarawak Chambe Chairperson: Stephe	r y 5 Rao nce Research in Asian-Pacific regi r Ballroom 2 & 3, level 3 en William Adkins	ion	2.00 – 2.30 pm
	Plenar Dr. Michae Biological Weed Control: Ch Venue : Sarawak Chambe Chairperson: Stephe	r y 6 I D. Day allenges and Opportunity r Ballroom 2 & 3, level 3 en William Adkins		2.30 – 3.00 pm
Session 4A Biological weed control Venue : Sarawak Chamber Ballroom 2 & 3, level 3 Chairperson: Tjitrosemito Soekisman	Session 4B Allelopathy and allelochemical in weed Venue : Windows on Kuching 1 & 2, level 18 Chairperson: Hisashi Kato- Noguchi	Session 4C Weed management in other crops Venue : Deer & Lady Suite, level 3 Chairperson: Shiv Shankhar	Session 4D Weed biology and physiology and ecology (4) Venue : Wind Suite, level 3 Chairperson: Muhamad Shakirin Mispan	3.00 – 4.30 pm
4A1 Lead speaker Dr. Sushilkumar Current Status of Classical Biological Control of Weed and Its Future Prospects in India	4B1 The Possible Role of Allelopathy in Invasive Succession of <i>Papaver</i> <i>dubium</i> L. <i>Masataka Izumi</i> *	4C1 Lead speaker Prof. Dr. Per Kudsk IWMPRAISE – A Multi-National European Research and Innovation Project on Integrated Weed Management	4D1 Genetic Regulation of Seed Dormancy and Germination in <i>Solanum</i> <i>rostratum</i> <i>Shouhui Wei</i> *	3.00-3.15 pm
4A2 Release and Establishment of Leaf-Feedng Lady Beetle	4B2 Carnosic Acid: A Phytotoxic Compound in the Leaves of <i>Rosmarinus officinalis</i> L.	4C2 Energy Budgeting in Weed and Tillage Management under Conservation Tillage	4D2 Effect of Fulvic Acid on Barnyard Grass Seeding Growth: Metabolomic and	3.15-3.30 pm

<i>Mada polluta</i> on <i>Tecoma</i> <i>stans</i> in South Africa <i>Lulama Gracious Madire</i> *	Kwame Sarpong Appiah*	Sheela Barla*	Transcriptomic Analyses of the Phytohormone Biosynthetic Pathway <i>Lifeng Wang</i> *	
4A3 Biological Control Initiatives Against Poisonous South American Ink Berries (<i>Cestrum</i> Spesies) in South Africa David Simelane *	4B3 Ascertainment of Allelopathy: Screening of Allelopathic Prospective Species from South Asian Country, Bangladesh <i>Kohinoor Begum</i> *	4C3 Herbicides Hotspots in Bangladesh <i>Md. Hazrat Ali</i> *	4D3 Genetic Structure and Diversity of Weedy Rice Populations in Sri Lanka <i>Disna Ratnasekera</i> *	3.30-3.45 pm
4A4 An Update on Prickly Acacia (<i>Vachellia nilotica</i> ssp. <i>Indica</i>) Biological Control Research in Queensland, Australia Boyang Shi *	4B4 Inhibitory Activity of Aqueous Extracts from <i>Samanea saman</i> on Barnyard-grass <i>Do Tan Khang</i> *	4C4 Performance of Strip-Planted Wheat with Post-Emergence Weed Control by Herbicides Taslima Zahan *	4D4 Investigation of Seed and Plant Growth Physiological Characters of Parthenium Weed (<i>Parthenium</i> <i>hysterophorus</i> Linn.) in Taiwan <i>Hsieh Ching-Hsiang</i> *	3.45-4.00 pm
4A5 Testing Alternative Host <i>Opuntia</i> sp. As Potential Target for Biocontrol Agents (<i>Dactylopius sp.</i>) Previously Established in Queensland Shamli, S .*	4B5 Allelopathic Effect of the Leaf Litter Leachates of <i>Ulex</i> <i>europaeus</i> to the Other Species and to the Seed Germination of <i>Ulex europaeus</i> Itself <i>Mika Hozawa</i> *	4C5 Influence of Weed Control Methods on the Growth and Yield of Soybean (<i>Glycine max</i> L.) Varieties <i>A.K.M. Ruhul Amin</i> *		4.00-4.15 pm
	4B6	4C6		4.15-4.30 pm

	Phytotoxic Effect and Identification of Potential Allelochemicals from <i>Turnera</i> <i>subulata</i>	Growing of the Competitive Crops Can Suppress Weeds in Subtropical Australia <i>Michael Widderick</i> *		
	Norhafiza Yaakob*			
	4B7			4.30 -4.45 pm
	Allelopathic Effect of Parthenium			
	and Crowth of Some Important			
	Crops and Woods of Khyber			
	Pakhtunkhwa Province of			
	Pakistan			
	Haroon ur Rashid*			
	Tea br	eak		4.30 – 5.00 pm
	Conference	e dinner		7.00 – 9.30 pm
	5 SEPT 2019	(Thursday)		
APWSS Young Scientist Forum				8.30 – 10.00 am
Venue : Sarawak Chamber Ballroom 2 & 3, level 3				
Chairperson: Muhamad Shakirin Mispan				
	Chairperson: Muhama	ad Shakirin Mispan		
Metabolism Profiling of C	Chairperson: Muhama Cytochrome P450 CYP81a Subfamily	ad Shakirin Mispan y to Disclose the Pattern of Herbici	de Cross-Resistance in	8.30-8.45 am
Metabolism Profiling of C	Chairperson: Muhama Cytochrome P450 CYP81a Subfamily Echinochloa phyllop	ad Shakirin Mispan y to Disclose the Pattern of Herbici ogon (Stapf) Koss	de Cross-Resistance in	8.30-8.45 am
Metabolism Profiling of C	Chairperson: Muhama Cytochrome P450 CYP81a Subfamily <i>Echinochloa phyllop</i> Niña Gracel	ad Shakirin Mispan y to Disclose the Pattern of Herbici ogon (Stapf) Koss Dimaano *	de Cross-Resistance in	8.30-8.45 am
Metabolism Profiling of C	Chairperson: Muhama Cytochrome P450 CYP81a Subfamily <i>Echinochloa phyllop</i> Niña Gracel ple Herbicide Resistance in Winter (ad Shakirin Mispan y to Disclose the Pattern of Herbici ogon (Stapf) Koss Dimaano * Grass (<i>Poa annua</i>) across South-E	de Cross-Resistance in Eastern Australia	8.30-8.45 am 8.45-9.00 am
Metabolism Profiling of C Incidence of Multi	Chairperson: Muhama Cytochrome P450 CYP81a Subfamily <i>Echinochloa phyllop</i> Niña Gracel iple Herbicide Resistance in Winter (Rajesh E	ad Shakirin Mispan y to Disclose the Pattern of Herbici ogon (Stapf) Koss Dimaano * Grass (<i>Poa annua</i>) across South-E Barua*	de Cross-Resistance in Eastern Australia	8.30-8.45 am 8.45-9.00 am
Metabolism Profiling of C Incidence of Multi Ecology and Phenolog	Chairperson: Muhama Cytochrome P450 CYP81a Subfamily <i>Echinochloa phyllop</i> Niña Gracel ple Herbicide Resistance in Winter (Rajesh E gy of Achillea millefolium- A Fast Em Mustageem	ad Shakirin Mispan y to Disclose the Pattern of Herbici ogon (Stapf) Koss Dimaano * Grass (<i>Poa annua</i>) across South-E Barua* erging Invasive Weed in the Highe a Ahmad*	de Cross-Resistance in Eastern Australia er Himalayan Ranges	8.30-8.45 am 8.45-9.00 am 9.00-9.15 am
Metabolism Profiling of C Incidence of Multi Ecology and Phenolog Evalu	Chairperson: Muhama Cytochrome P450 CYP81a Subfamily <i>Echinochloa phyllop</i> Niña Gracel ple Herbicide Resistance in Winter (Rajesh E gy of Achillea millefolium- A Fast Em Mustaqeem Jation of the Degree of Seed Dorma	ad Shakirin Mispan y to Disclose the Pattern of Herbici ogon (Stapf) Koss Dimaano * Grass (<i>Poa annua</i>) across South-E Barua* erging Invasive Weed in the Highe Ahmad* ncy in Weedy Rice Seeds in Malay	de Cross-Resistance in Eastern Australia er Himalayan Ranges	8.30-8.45 am 8.45-9.00 am 9.00-9.15 am 9.15-9.30 am
Metabolism Profiling of C Incidence of Multi Ecology and Phenolog Evalu	Chairperson: Muhama Cytochrome P450 CYP81a Subfamily <i>Echinochloa phyllop</i> iple Herbicide Resistance in Winter (Rajesh E gy of Achillea millefolium- A Fast Em <u>Mustaqeem</u> uation of the Degree of Seed Dorma Amalia Qistina	ad Shakirin Mispan y to Disclose the Pattern of Herbici ogon (Stapf) Koss Dimaano * Grass (<i>Poa annua</i>) across South-E Barua* erging Invasive Weed in the Highe Ahmad* ncy in Weedy Rice Seeds in Malay a Zulrushdi*	de Cross-Resistance in Eastern Australia er Himalayan Ranges ysia	8.30-8.45 am 8.45-9.00 am 9.00-9.15 am 9.15-9.30 am
Metabolism Profiling of C Incidence of Multi Ecology and Phenolog Evalu Resopnse of Wee	Chairperson: Muhama Cytochrome P450 CYP81a Subfamily <i>Echinochloa phyllope</i> Niña Gracel iple Herbicide Resistance in Winter (Rajesh E gy of Achillea millefolium- A Fast Em Mustaqeem Juation of the Degree of Seed Dorma Amalia Qistina d Species under Different Atmosphe	ad Shakirin Mispan y to Disclose the Pattern of Herbici ogon (Stapf) Koss Dimaano * Grass (<i>Poa annua</i>) across South-E Barua * erging Invasive Weed in the Highe Ahmad * ncy in Weedy Rice Seeds in Malay a Zulrushdi * ere CO ₂ : Impact on Biology and Gly	de Cross-Resistance in Eastern Australia er Himalayan Ranges ysıa	8.30-8.45 am 8.45-9.00 am 9.00-9.15 am 9.15-9.30 am 9.30-9.45 am
Metabolism Profiling of C Incidence of Multi Ecology and Phenolog Evalu Resopnse of Wee	Chairperson: Muhama Cytochrome P450 CYP81a Subfamily <i>Echinochloa phyllop</i> Niña Gracel ple Herbicide Resistance in Winter (Rajesh E gy of Achillea millefolium- A Fast Em Mustaqeem Jation of the Degree of Seed Dorma Amalia Qistina d Species under Different Atmosphe Arslan Masoo	ad Shakirin Mispan y to Disclose the Pattern of Herbici ogon (Stapf) Koss Dimaano* Grass (<i>Poa annua</i>) across South-E Barua* erging Invasive Weed in the Highe Ahmad* ncy in Weedy Rice Seeds in Malay a Zulrushdi* ere CO ₂ : Impact on Biology and Gly d Peerzada*	de Cross-Resistance in Eastern Australia er Himalayan Ranges ysıa yphosate Efficacy	8.30-8.45 am 8.45-9.00 am 9.00-9.15 am 9.15-9.30 am 9.30-9.45 am
Metabolism Profiling of C Incidence of Multi Ecology and Phenolog Evalu Resopnse of Week Screening and Evaluatio	Chairperson: Muhama Cytochrome P450 CYP81a Subfamily <i>Echinochloa phyllop</i> <i>Niña Gracel</i> iple Herbicide Resistance in Winter (<i>Rajesh E</i> gy of <i>Achillea millefolium</i> - A Fast Em <i>Mustaqeem</i> uation of the Degree of Seed Dorma <i>Amalia Qistina</i> d Species under Different Atmosphe <i>Arslan Masoo</i> on of Fungal Pathogens Associated	ad Shakirin Mispan y to Disclose the Pattern of Herbici ogon (Stapf) Koss Dimaano* Grass (<i>Poa annua</i>) across South-E Barua* erging Invasive Weed in the Highe Ahmad* ncy in Weedy Rice Seeds in Malay a Zulrushdi* ere CO ₂ : Impact on Biology and Gly d Peerzada* with Parthenium hysterophorus L.	de Cross-Resistance in Eastern Australia er Himalayan Ranges ysia yphosate Efficacy in Peninsular Malaysia	8.30-8.45 am 8.45-9.00 am 9.00-9.15 am 9.15-9.30 am 9.30-9.45 am 9.45-10.00 an

3- 6th September 2019

Morning break	10.00 -10.30 am

Plenary 7 Prof. Dr. Stephen William Adkins The Global Threat from Biological Invasions under A Changing Climate: An Example of A Notorious Invader, Parthenium				
	Venue : Sarawak Chamber Chairperson: Ro	Ballroom 2 & 3, level 3 bert Zimdahl		
Session 5A Invasive weed management Venue : Sarawak Chamber Ballroom 2 & 3, level 3 Chairperson: Per Kudsk	Session 5B Biological weed control Venue : Windows on Kuching 1 & 2, level 18 Chairperson: Michael Day	Session 5C Weed management in other crops Venue : Deer & Lady Suite, level 3 Chairperson: Hsieh Ching- Hsiang	Session 5D Weed management in rice Venue : Wind Suite, level 3 Chairperson: Hiroshi Matsumoto	11.00-12.30 pm
5A1 Lead speaker Prof. Dr. S. M. Rezaul Karim Management of Parthenium Hazards Using Biocontrol Methods in Malaysia	5B1 Characteristics of Fungi Potential Biocontrol Agents Against <i>Eleocharis kuroguwai</i> <i>Kenichi Yamaguchi</i> *	5C1 Lead speaker Prof. Dr. Zahid Ata Cheema Application of Allelopathy for Weed Management and Enhancement in Crop Growth and Yield	5D1 Herbicides Combination for Management of <i>Vaucheria</i> <i>species</i> Yellow Green Algae in Transplanted Rice under Coastal Situation of Karnataka <i>Naveen Neralgundi</i> <i>Eshwarappa</i> *	11.00-11.15 am
5A2 Efficacy of Chemical Herbicides Using a Novel Encapsulated Delivery Mechanism for Stem Injection on Mimosa Bush <i>Amelia Limbongan</i> *	5B2 Host Specifity Testing of <i>Chiasmia</i> <i>assimilis</i> (Warren) (Lepidoptera: Geometridae) as Biocontrol Agents for <i>Vachellia nilotica</i> in Baluran National Park, East Java, Indonesia <i>Saiful Bachri</i> *	5C2 Rinskor [™] Active, A New Herbicide for Managing Water Hyacinth (<i>Eichhornia crassipes</i>) in Water Ways of Vietnam and Thailand Duy Le *	5D2 Developing Weed Management for Direct- Seeded Rice Systems in The Lao PDR Deirdre Lemerle *	11.15-11.30 am

5A3 Management of <i>Ambrosia</i> <i>psilostachya</i> - A Quarantine Weed First Time Reported in Karnataka, India <i>Grama Nanjappa</i> <i>Dhanapal</i> *	5B3 Isolation and Biological Characteristics of <i>Colletotrichum</i> <i>eleusines</i> , a Potential Mycoherbicide Candidate for Control of Goosegrass (<i>Eleusine</i> <i>indica</i> (L.) Gaertn.) <i>Qiongnan Gu</i> *	5C3 Economic Feasibility of Weed Management and Tillage in Maize – Wheat Sequence under Conservation Agriculture <i>R. R. Upasani</i> *	5D3 Working with Smallholder Farmers to Adapt a Weed Management Strategy for Best Management Practices (BMPS) in Rice Production in Myanmar <i>Madonna C. Casimero</i> *	11.30-11.45 am
5A4 Control and Eradication of <i>Chimonobambusa</i> <i>quadrangularis</i> in Gunung Gede Pangrango National Park <i>Indah Wahyuni</i>	5B4 Development of Weed Control Techniques for Organic Rice Production In China <i>Sheng Qiang</i> *	5C4 Weed Management in Rice- Wheat System in Indo- Gangetic Plains of India <i>U P Singh</i> *	5D4 Rinskor™ Active New Herbicidal Tool for Weed Control In Rice in China <i>Chunhe Qu</i> *	11.45-12.00 pm
5A5 The Development of Invasive Alien Plant Species Management for the Rehabilitation of Invaded Ecosystems SoekismanTjitrosemito *	5B5 Impact of the Gall Fly, <i>Urophora</i> <i>stylata</i> , on Seed Production of <i>Cirsium vulgare</i> in New Zealand <i>Michael Cripps</i> *	5C5 Weed Management In Rice- Wheat-Greengram Cropping System Under Conservation Agriculture <i>Ramphool Puniya</i> *	5D5 Continuous Herbicides Application on Dynamics Of Weed Flora, Weed Control and Soil Properties in Transplanted Lowland Rice- Rice Cropping System under Clay Loam Soil <i>Murali Arthanari</i> <i>Palanisamy</i> *	12.00-12.15 pm

5A6 Floral Invasion: Threat to Ecology, Biodiversity and Agriculture in Pakistan <i>Khan Bahadar Marwat</i> *		5C6 Weed Control Through Sequential and Tank Mix Application of Herbicides in Onion (<i>Allium cepa</i> L.) <i>Rajvir Sharma</i> *		12.15-12.30 pm
Lunch 12.30 - 2.00			12.30 - 2.00 pm	
Closing ceremony		2.30 – 3.30 pm		
6 SEPT 2019 (Friday)				
Post-conference Tour (Optional) 8.30 –2.00			8.30 –2.00 pm	

LIST OF POSTERS

Code	Authors	Title of Poster
	Alleopathy and allelochemical in w	veed management
P1	Akari Hashimoto	INVESTIGATION ON AN ACTIVE ALLELOPATHIC SUBSTANCE IN PRUNED-BRANCHES OF KIWI FRUITS
P2	Bo Lyu	ALLELOPATHIC EFFECT AND MECHANISM of Solidago canadensis L ON WHEAT (<i>Triticum aestivum</i>)
P3	Kaisei Tsunaki	INSECT ANTI-FEEDANTS IN AERIAL PARTS OF <i>Physalis angulata</i> var. <i>augulata</i>
P4	Nornasuha Yusoff	POTENTIAL ALLELOPATHIC EFFECT OF Passiflora foetida ON Brassica chinensis AND Zea mays
P5	Ryuhei Saitoh	ACTION MECHANISMS OF <i>S</i> -(+)-CARVONE ON CELL WALL OF RICE AND ARABIDOPSIS ROOTS
P6	Yuri Hamada	INVESTIGATION OF AN ALLELOPATHIC SUBSTANCE IN Osmanthus × fortunei Carrière LEAVES
P7	Murali Arthanari Palanisamy	BIOMULCHING AN ENVIRONMENT FRIENDLY OPTION TO CHANGE NUTRIENTS UPTAKE AND REMOVAL PATTERN IN SUNFLOWER (<i>Helianthus annus</i> L.)

P8	Abdul Shukor Juraimi	ALLELOPATHIC EFFECT OF SELECTED INVASIVE WEED SPECIES ON GERMINATION AND SEEDLING GROWTH OF WEEDY RICE (<i>Oryza sativa</i>)
P66	Haroon Ur Rashid	INHIBITORY EFFECT OF ALLELOPATHIC PLANTS' WATER EXTRACTS FOR WEED MANAGEMENT IN MAIZE
	Biological weed control	
P9	Chuah Tse Seng	COMPATIBILITY OF SELECTED ADJUVANTS AND HERBICIDES WITH FUNGAL PATHOGENS, <i>Bipolaris</i> spp. FOR INTEGRATED MANAGEMENT OF GOOSEGRASS (<i>Eleusine indica</i> (L.) Gaertn.)
P10	Young Kwan Ko	HERBICIDAL ACTIVITY OF <i>Streptomyces</i> sp. KRA18-249 ISOLATED FROM SOIL
P11	Jianping Zhang	MOLECULAR CLONING OF GENES INVOLVED IN OPHIOBOLIN A BIOSYNTHESIS PATHWAY FROM BIOHERBICIDAL FUNGUS
P12	Jung Sub Choi	CHARACTERISTICS AND STRUCTURAL IDENTIFICATION OF POTENTIAL NOVEL HERBICIDAL SUBSTANCE FROM <i>Streptomyces</i> sp. KRA17-580
P13	Kouki Oyama	THE POSSIBILITY OF DEVELOPMENT FOR WEED MANAGEMENT BY USING MARIGOLD (<i>Tagetes</i> spp.)
P14	Shihai Chu	HOST RANGE OF Herpetogramma basalis, A BIOLOGICAL CONTROL AGENT FOR THE INVASIVE WEED, Alternanthera philoxeroides IN CHINA

	Invasive weed management	
P15	Song Zhen	EFFECTS OF <i>Flaveria bidentis</i> INVASION ON THE DIVERSITY OF FUNCTIONAL BACTERIA IN RHIZOSPHERE SOIL
P16	Fu Weidong	EFFECT OF Agasicles hygrophila RELEASE ON THE CONTROL OF Alternanthera
P17	Zhang Guoliang	GENETIC DIVERSITY ANALYSIS OF DIFFERENT POPULATIONS OF Cenchrus spinifex IN NORTHERN CHINA
P18	Jung Sup Choi	EFFECT OF ENVIRONMENTAL FACTORS ON GERMINATION AND EMERGENCE OF <i>Erodium cicutarium</i> L.: AN EXOTIC WEED IN KOREA
P19	Mohd Hefni Rusli	BIOSECURITY AWARENESS ON POTENTIAL INVASIVE WEED SPECIES IN OIL PALM PLANTATION IN MALAYSIA
P20	Grama Nanjappa Dhanapal	MANAGEMENT OF LORANTHUS (Dendrophthoe falcata) IN SAPOTA
P21	Muhammad Saiful Ahmad Hamdani	EVALUATION ON CONTROL EFFICACY OF <i>Parthenium hysterophorus</i> L. THROUGH CHEMICAL APPROACHES
	Herbicide resistant weeds and herb	picide tolerant crops
P22	Jiapeng Fang	TARGET SITE-BASED PENOXSULAM RESISTANCE IN BARNYARDGRASS (<i>Echinochloa crus-galli</i> (L.) P. Beauv.) FROM CHINA
P23	Jun Li	RESEARCHES ON THE RESISTANCE MECHANISM OF QUINCLORAC IN Echinochloa cruss-galli var. zelayensis

P24	Mongkol Sripeangchan	RINSKOR [™] ACTIVE CONTROLS ALS-RESISTANT <i>Echinochloa crus-galli</i> (L.) IN DIRECT SEEDED RICE IN THAILAND
P25	Shigenori Okawa	DEVELOPMENT OF RESISTANCE TO NOVEL ALS INHIBITORS IN Schoenoplectiella juncoides IN THE PADDY FIELDS OF MIYAGI
P26	Susan Knight	SUPPORTING FARMERS WITH THE <u>R</u> ESISTANCE <u>IN-S</u> EASON <u>Q</u> UICK TEST FOR <i>Phalaris minor</i> IN WHEAT FIELDS OF NORTHERN INDIA AND PAKISTAN
P27	Xiaoling Song	POTENTIAL WEEDINESS OF STACKED TRANSGENIC RICE LINE T2A-1 WITH CRY2A*/BAR GENE
P28	Hailan Cui	THE RESISTANCE OF <i>Cyperus difformis</i> TO ACETOHYDROXYACID SYNTHASE INHIBITORS IN CHINA PADDY FIELD
P29	Xiwu Zhu	THE STUDIES ON EXPRESSING BAR GENE USING ATTENUATED VIRUS-BASED VECTOR TO ENHANCE THE RESISTANCE OF TOBACCO PLANT TO GLUFOSINATE
P30	Goh Sou Sheng	PRELIMINARY SURVEY ON HERBICIDE-RESISTANT WEEDS AT RUBBER CULTIVATION AREAS IN THE SOUTHERN REGION OF PENINSULAR MALAYSIA
	Herbicide behavior in soil and wate	r
P31	Liang-Yu Yang	STUDY ON BIODEGRADATION OF BUTACHLOR BY ANAEROBIC MICROBIAL COMMUNITY

P32	Tosapon Pornprom	RESIDUES OF BROMACIL AND DIURON FOR WEED CONTROL IN PINEAPPLE FIELDS
P33	Yasuhiro Yogo	EFFECT OF TEMPERATURE ON SOIL ADSORPTION AND DURATION OF ACTIVITY OF THREE AMIDE HERBICIDES UNDER SUBMERGED CONDITION
P34	Yen-JR, Chen	MICROBIAL DEGRADATION OF HERBICIDES AMETRYN AND DIURON BY DISSIMILATORY METAL REDUCING BACTERIA Shewanella spp. KR12
	Weed biology, physiology and eco	logy
P35	R.M.U.S. Bandara	DAYS TO GERMINATION AND FLOWERING OF DIFFERENT WEED SPECIES IN SRI LANKA RICE CULTIVATION
P36	Chong Tet Vun	ANATOMICAL CHARACTERISTIC COMPARISON BETWEEN MALAYSIAN WEEDY RICE VARIANTS AND CULTIVATED RICE
P37	Gao Xingxiang	ADAPTABILITY OF Aegilops tauschii, Alpecurus myosuroides AND Lolium multiflorum IN DIFFERENT TYPES OF SOIL
P38	Hala Eltahir Alloub	COMPOSITION AND DISTRIBUTION OF WEED SEED BANK IN SOILS OF FOUR SUGARCANE (Saccharum officinarum L.) FARMS, SUDAN
P39	Liyao Dong	NA+/K+ BALANCE AND TRANSPORT REGULATORY MECHANISMS IN WEEDY AND CULTIVATED RICE (<i>Oryza sativa</i> L.) UNDER SALT STRESS

P40	Lamei Wu	STUDY ON SEED GERMINATION AND GROWTH OF QUINCLORAC- RESISTANT <i>Echinochloa crusgalli</i> UNDER SALINITY STRESS
P41	Mei Li	SEEDLING EMERGENCE OF THREE GRASS IN WHEAT FIELD AT DIFFERENT SOIL DEPTHS
P42	Mitsuhiro Matsuo	GROWTH AND SEED PRODUCTION OF CAROLINA DAYFLOWER (<i>Commelina caroliniana</i> Walter) AND THE EMERGENCE CHARACTERISTICS IN FOLLOWING YEAR
P43	Ruhai Li	WEED DIVERSITY AND CHARACTERISTICS OF WEED COMMUNITIES IN PEANUT FIELDS OF MAIN GROWING REGIONS IN HUBEI PROVINCE, CHINA
P44	Yung-Fen Huang	EXPLORE RICE WEEDY TRAIT GENETICS USING RICE 3K DATABASE
P45	Dindo King Donayre	PLASTICITY OF LOWLAND ECOTYPE <i>Cyperus rotundus</i> L. IN RESPONSE TO FLOODING, BURYINGAND CLIPPING INTERVENTIONS
P65	Maizatul-Suriza	NOXIOUS WEEDS IN THE MALAYSIAN OIL PALM PLANTATIONS
	Novel herbicides and herbicide mo	de of action
P46	Jinxin Wang	EVALUATION OF WEED CONTROL EFFICACY AND CROP SAFETY OF THE NEW HPPD-INHIBITING HERBICIDE-QYR301

3- 6th September 2019

Precision and advances in weed control technology

P47	Tosapon Pornprom	EVALUATING THE EFFECTS OF CHEMICAL RIPENING ON ITS
		COMPONENTS AND QUALITY TRAITS OF SUGARCANE USING YAMAHA
		UNMANNED HELICOPTER
P48	Masitah Ab Jalil	GENETIC EVALUATION OF NEW WEED COMPETITIVE AND DROUGHT
		TOLERANCE RICE LINES
	Chunhong lia	HERBICIDE APPLICATION AT REDUCED DOSE LISING INTELLIGENT

P49 Chunhong Jia HERBICIDE APPLICATION AT REDUCED DOSE USING INTELLIGENT PLANT PROTECTION MACHINE IN WINTER WHEAT FIELD IN NORTH CHINA PLAIN

Herbicide formulation and application technology

P50 Idris Abu Seman INFLUENCE OF HERBICIDES APPLICATION ON THE INCIDENCE OF BASAL STEM ROT DISEASE CAUSED BY *Ganoderma boninense* IN OIL PALM

P51 Liu Xiu THE COMBINED TOXICITY OF BISPYRIBAC-SODIUM AND CYHALOFOP-BUTYL TO BARNYARD GRASS

3- 6th September 2019

	Weed management in non-cropped	d areas and aquatic system
P52	In-Yong Lee	DISTRIBUTION AND CONTROL OF Lactuca scariola IN KOREA
P53	Hiroki Iwamoto	SEQUENTIAL EVALUATION OF SPREAD OF KUDZU COMMUNITY BY AERIAL IMAGE PROCESSING
	Weed management in cropped are	as
P54	Chikako Miura	NOVEL PRECISION RICE WEED MANAGEMENT SYSTEM IN TOHOKU AREA BY A NEW WAY OF WATER INLET APPLICATION OF 3-WAY 1KG GRANULE HERBICIDE, "PYRIFTALID, MESOTRIONE AND METAZOSULFURON" AFTER MIDSEASON DRAINAGE IN JAPAN
P55	Edison Purba	EVALUATING HERBICIDES FOR GLYPHOSATE-RESISTANT GOOSEGRASS (<i>Eleusine indica</i>) CONTROL IN OIL PALM
P56	Madonna C Casimero	DEVELOPING AND ADAPTING BEST WEED MANAGEMENT PRACTICES FOR HIGHER PRODUCTIVITY IN DIRECT SEEDED RICE IN RAINFED LOWLAND AREAS IN CENTRAL PHILIPPINES
P57	Gregory Wells	HERBICIDE SEQUENCES WITH AGIXA [™] HERBICIDE GIVE BEST WEED CONTROL IN AUSTRALIAN DRILL SOWN RICE, GROWN WITH DELAYED PERMANENT WATER
P58	Hiroshi Kikugawa	PERFORMANCE OF TOLPYRALETE IN THAI, INDONESIAN, AND VIETNAMESE CORN FIELDS

3- 6th September 2019

P59	Hiroyuki Okamoto	PURPLE NUTSEDGE (<i>Cyperus rotundus</i>) CONTROL WITH FLAZASULFURON
P60	Kye-Hwan Lee	HERBICIDAL ACTIVITY OF POST-EMERGENCE NEW HERBICIDE, FLORPYRAUXIFEN-BENZYL EC (LOYANT EC), AGAINST ANNUAL WEEDS IN PADDY FIELD
P61	Edwin Capili Martin	INTERFERENCE OF WEEDY RICE ON YIELD AND YIELD COMPONENTS OF CULTIVATED RICE IN THE PHILIPPINES
P62	Phatphitcha Rujirapongchai	TANK MIXTURE OF POST AND PRE-EMERGENCE HERBICIDES FOR BROAD SPECTRUM WEED CONTROL IN DIRECT-SEEDED RICE
P63	Norazua Zakaria	FIELD EFFICACY AND CROP TOLERANCE OF LOYANT (FLORPYRAUXIFEN-BENZYL) FOR CONTROL OF SELECTED WEEDS SPECIES IN MALAYSIAN RICE FIELD
P64	Yoshiki Kawano	COMBINATION OF HERBICIDES AND INTERTILLAGE FOR CONTROL OF CAROLINA DAYFLOWER (<i>Commelina caroliniana</i> Walter) INVADED IN SOYBEAN FIELDS
P67	Chenzhong Jin	SURVEY OF WILD PLANTS AND CHEMICAL CONTROL IN Camellia oleifer abel FOREST IN HUNAN PROVINCE

KEYNOTE

HERBICIDE RESISTANCE AND MANAGEMENT IN ASIA-PACIFIC: CHALLENGES AND OPPORTUNITIES

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Abstract

Global food production must meet the challenge of increasing food supply for the everincreasing global human population. Global food supply is especially reliant on high and sustained productivity of the great global grain field crops of rice, wheat, soybean, maize etc. In turn, sustainable high crop yields are very dependent on efficient control of crop-infesting weed species. In many parts of the world, herbicides have and continue to deliver effective weed control that positively contributes to global food production and food security. However, the evolution of herbicide resistant crop weed populations in many parts of the world threatens the sustainability of herbicide weed control and thus global food production. Herbicides have been used for 60 years to control crop-infesting weeds and 50 years ago the first examples of herbicide resistant weed evolution became evident in those western nations that first adopted herbicides for weed control. Then, 25 years ago, transgenic glyphosate resistant crops were enthusiastically adopted in some western nations, especially where resistance to other herbicides was a major problem. Over-use of glyphosate, without diversity, guickly led to major glyphosate resistance weed evolution. Currently, and logically, herbicide resistance weed problems are greatest in western nations and glyphosate resistant weeds are greatest where glyphosate resistant crops have been widely and persistently grown without diversity in weed control tools and strategies. Many parts of Asia-Pacific have thus-far not experienced the herbicide resistance problems of the west. Yet, in some major food-producing regions of Asia the traditional agricultural diversity is reducing and herbicide use is increasing in a nonsustainable manner. Asia-Pacific has the opportunity to not repeat the high herbicide relianceminimum diversity practices that led to the herbicide resistant weed problems in some western nations. Asia-Pacific can learn from western nation herbicide resistance experience so as to avoid major resistance problems. This presentation will strongly emphasise that herbicide resistance is an entirely manageable problem. Through diversity in agriculture, and diversity in herbicide and non-herbicide weed control tools, the efficacy of herbicides can be sustained to the benefit of food production. This presentation will contrast the resistance issues in some western nations in comparison to some Asian-Pacific situations. This presentation will highlight strategies and tactics that can be used to help achieve herbicide sustainability and minimise resistance to the benefit of global food production.

Keywords: Diversity, glyphosate, herbicide, resistance, sustainability

PLENARY 1

EVOLUTION OF NON-TARGET SITE RESISTANCE MECHANISM IN WEEDS

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Abstract

The evolution of weed resistance to herbicides, often due to a lack of diversity in weed management practices, is a growing problem threatening food production in many agrosystems worldwide. Several examples of problematic herbicide-resistant weeds abound, including Amaranthus palmeri (USA), Digitaria insularis (Brazil), Alopecurus myosuroides (United Kingdom), *Eleusine indica* (Malaysia) and *Lolium rigidum* (Australia), to name but a few. Resistance is generally classified into target-site and non-target-site mechanisms. Non-Target-Site Resistance (NTSR) consists of the degradation of herbicides into non-toxic entities or the compartmentalisation of xenobiotics away from its target. Herbicide detoxification generally occurs in a two-step process whereby the molecule is activated in phase I prior to conjugation in phase II, although some metabolism-based resistances happen directly via phase II. Phase I activation largely involves cytochrome p450 mono-oxygenases whereas phase II is accomplished by glutathione-S-transferases or glycosyltransferases. Compartmentalisation through reduced translocation or vacuolar sequestration tends to implicate specific transporters of non or poorly metabolisable herbicides such as paraguat and glyphosate as well as some auxinic herbicides. NTSR is increasingly recognised as being more widespread than target-site resistance but is more difficult to identify. This is because the precise NTSR genes involved and the associated fitness costs are yet to be determined in most instances. In the majority of cases NTSR appears to be polygenic and complex with resistance levels being highly dependent on herbicide rates, plant growth stages and environmental conditions. NTSR is concerning because it can be accumulated upon repetitive selection with reduced herbicide rates, an unfortunately common practice, and especially because it can endow resistance to unrelated herbicide modes of action. The advent of recent genomic technologies combined with carefully built mapping populations offer the prospect of identifying the precise contribution of genes involved in NTSR. Computer-based models that can accommodate cross-resistance patterns between different herbicide modes of action will be useful for designing sustainable weed management strategies that can mitigate against the growing risks associated with NTSR.

Keywords: Herbicide, non-target-site resistance, metabolism, compartmentalisation

PLENARY 2
WEED SCIENCE FOR A SUSTAINABLE AGRICULTURE AND ENVIRONMENT -AN ETHICAL PERSPECTIVE

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Abstract

We live in an era of scientific achievement and technological progress unequaled in human history. Agriculture's dominant focus is feeding the human population. From an ethical perspective, this is clearly very positive, but it does not absolve agriculture from critical, ethical examination of the totality of agriculture's effects. The public in most countries is concerned about the negative human and environmental effects of agricultural technology. In spite of agriculture's great productive success, agriculture's practitioners do not automatically have societal ethical acceptability. We have been seduced into thinking that as long as we increased food availability we were exempt from seeking societal approval for employing the technology that modern agriculture requires. We need to begin the difficult task of conducting an ethical analysis of agriculture, our science, and its results. It is important that we discuss and debate how we practice agriculture and how we determine whether or not what we choose to do is the right thing to do. To earn the public's ongoing support, agriculture must examine its full range of effects and be sure they align with the highest ethical values. Agriculture's record is enviable in the science and technology associated with its primary ethical concern - feeding the world, but we need to do far more to assure that we address the broader ethical issues that are the public's increasing concern. Those engaged in agriculture are certain about the goodness of the agricultural enterprise. However, the moral confidence that pervades agriculture is potentially harmful because it is unexamined. It is necessary that those engaged in agriculture analyze what it is about agriculture that favors, inhibits or limits agriculture. All should strive to nourish and strengthen the aspects of agriculture that are beneficial and change those that are not. To do this all must be confident to study ourselves, our institutions, and be dedicated to the task of modifying the values and goals of both.

Keywords: Confidence, environment, ethics, sustainability, weed management.

PLENARY 3

ECOBIOLOGY AND MANAGEMENT OF Phalaris minor

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Abstract

Littleseed canarygrass (Phalaris minor Retz.) is a pervasive weed in Asian countries interfering winter season crops. Yield losses of 15-50% inflicted by *P. minor* are very common. Its abundant seed production, light seed weight with hard seed coat, its preference for higher soil moisture and fertility conditions for growth and early season crop mimicry makes it most troublesome weed of wheat in India, Iran, Mexico, Pakistan, Nepal, Australia and Israel. Its evolved resistance to several herbicides of ACCase, PSII and ALS inhibitors defy management using herbicides alone. Under these circumstances integration of eco-biological knowledge of *P. minor* would be pivotal in its sustainable management. Studies have revealed that *P. minor* inclination to flourish under good soils of high fertility and moisture content; poor guality ground water used for irrigation decreased its preponderance. Freshly harvested seed were dormant, though dormancy was broken by the next growing season; seed longevity was more under anaerobic than aerobic conditions in the soil. Seed stored under laboratory conditions were viable for 6 years, though viability lost under field conditions in less than 1 and 2 years under aerobic and anaerobic conditions, respectively. Application of 8t/ha straw decreased its emergence and growth and straw burning of 6-12 t/ha in situ, charred P. minor seed at surface but had no effect on germinability at 2 cm and deeper depths. P. minor seed could tolerate 65°C temperature for two weeks in an oven under dry conditions without losing viability. Maximum seedling emergence and plumule length was recorded from surface and 2 cm soil depth and decreased significantly with increasing depths. It could tolerate continuous flooding for 20 days with no adverse effect on emergence and required >80 days flooding to lose viability. An osmotic potential of -0.4 MPa had no significant decrease in germination of P. minor as it required -1.2 MPa for loss of viability. Germination was similar in dark and light conditions with little effect of pH under wheat growing conditions. Churning of soil (puddling for rice transplanting) distributed P. minor seed to top 15 cm soil, though maximum being in 0-5 cm soil layer. Continuous zero tillage for five years resulted in minimum seed in different soil horizons compared to conventional tillage in both rice and wheat under rotation, but minimum tillage resulted in higher seed in different soil layers over zero tillage. Emergence of P. minor was more under delayed sowing of wheat in India (decreased temperature) than early sowing of October. Double pre-sowing irrigation stimulated emergence and control by field preparation or non-selective herbicides under zero tillage. Increased seed rate (wheat) and cross-row sowing method provided competitive edge to wheat, but increased fertilizer was more beneficial to *P. minor* in the absence of any control measures. Similarly, selection of competitive (early vigour and canopy cover) varieties smothered P. minor. Thus the agronomical, edaphic and biological knowledge of *P. minor* can effectively be integrated with chemical/mechanical control measures for sustainable management with lower environmental load of herbicides and delayed evolution of resistance to herbicides on new sites of action.

Keywords: Germination, littleseed canarygrass, viability, rice, wheat PLENARY 4

PLANT IMAGE SCIENCE (PLANT PHENOMICS) AS A NEW TOOL FOR WEED RESEARCH

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Abstract

Plant image science is a branch of science which utilizes image science comprising techniques and processes to acquire, process and analyze plant images for plant research (Noh & Kim, 2018). Recent remarkable development of image sensing and processing techniques and big data analysis has enabled us to visualize invisible spectral plant responses and rapidly diagnose plant responses to biotic and abiotic stresses. Plant image analysis can also assess phenotypic traits including morphological and quantitative traits nondestructively and more accurately. In plant phenomics, an area of science concerned with measuring plant phenomes, plant image science now plays a key role, enabling high throughput plant phenotyping and screening. Many recent efforts revealed that plant spectral images acquired at various wave lengths, particularly chlorophyll fluorescence (CF) and infrared (IR) thermal images. Plant spectral images contain biologically meaningful information and thus can be used to detect herbicidal activity of unknown compounds much earlier than the conventional method, which requires substantial amounts of time, effort and cost, making herbicide study and development very expensive and time-consuming. Plant spectral image analysis may also allow us to identify weeds and to diagnose herbicide resistant weeds more rapidly and accurately. Therefore, in this presentation, plant image science will be introduced and its potential application for weed research will also be presented, particularly in the aspects of weed identification, herbicide bioassay, and herbicide resistance diagnosis. For weed identification. RGB camera-based platform has already commercially been available and its identification accuracy has continuously been improved particularly by incorporating RGB images into deep-learning algorithm. In the area of herbicide bioassay and resistance diagnosis, CF and IR thermal image analyses have widely been applied. Our own research with these two spectral images also revealed that herbicidal activity of various herbicides with different modes of action could be assessed much earlier than the conventional assay even when no visual symptom appears. CF and IR thermal image analyses could also distinguish between herbicide resistant and susceptible weeds more rapidly than other quick assays. Our results showed that the timing when the first spectral response and the type of spectral response depends on herbicide mode of action, suggesting the potential application of plant image science to estimate/predict potential modes of action of a new compound and to diagnose herbicide resistance. In conclusion, plant image science will become an essential part of weed research, particularly weed identification for weed mapping and smart weed control, high throughput screening (HTS) in herbicide development, and rapid diagnosis of herbicide resistant weeds in the near future.

Keywords: Herbicide assay, image analysis, plant image science, plant phenomics

PLENARY 5

THE PROGRESS AND FUTURE OF WEED SCIENCE RESEARCH IN THE ASIAN-PACIFIC REGION

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Abstract

Reducing poverty and ensuring future food and nutritional security are major concerns of the Asian-Pacific region (the region) which is characterized by rapid population growth, food crises and climate change. Efforts to increase crop productivity and reduce existing crop yield gaps, by identifying constraints such as weeds and alleviating them, are essential to meet the targeted food and nutritional security goals in the region. The Asian-Pacific Weed Science Society (APWSS)'s prime objective of promoting weed science in the region, by pooling and exchanging information has been done primarily through its biennial conferences and publications. In this review, an effort is made to assess the extent of achievement of APWSS prime objective by analyzing the APWSS publications. The research work reported and published on weeds and their weed management, methods adoption by farmers, shifts in weeds and farmer's needs, is synthesized and the future weed management research needs of the region are suggested. The discovery of 2, 4-D has led to intensified herbicides based weed management research and publications in both developed and developing countries of the region. Herbicide use became major weed management tool in developed countries and is increasing gradually in developing nations. Currently, herbicides became an indispensable input of agriculture in most countries in the region. However, herbicide resistant weeds, the shifts in weed population and emergence of invasive weeds like weedy rice and climate change became major weed management challenges. Around \$250 million investment with ten years or more time for new herbicide molecule development has slowed down new herbicides introduction. Genetically modified Herbicide Tolerant Crops (HTC) was introduced in certain countries as a component of Integrated Weed Management (IWM). Herbicide tolerant weeds emergence due to gene flow and non-adoption of stewardship guidelines. health and environmental concerns and lack of trained personnel are limiting HTC introduction and adoption. Thus, IWM, better understanding weed ecology, biology and best weed management practices became major areas recent research and publications of weed management in the region. Genetic engineering, automation and artificial intelligence, better understanding of weed biology and ecology as influenced by climate change may provide innovative options to generate creative sustainable weed management approaches to efficiently, economically and ecologically manage weeds in the region. The decision making tools and location specific efficient weed management technologies popularizing extension methodologies are essential. APWSS will continue to play key role in strengthening Weed Science and sustainable weed management in the Asian-Pacific region.

Keywords: Asian-Pacific region, weed management, weed ecology, herbicide resistant weeds, herbicide tolerant crops

PLENARY 6

WEED BIOLOGICAL CONTROL: CHALLENGES AND OPPORTUNITIES

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Abstract

Biological control of weed programmes have been conducted since 1902, resulting in over 500 biological control agents being deliberately released against nearly 200 weed species in over 90 countries. Collectively, fifteen countries in Asia and 17 of the 22 countries and territories in the Pacific region have deliberately released over 80 biological control agents to help manage over 30 of their most invasive weeds. Many of these programmes, e.g. Chromolaena odorata and Mimosa diplotricha, have been highly successful, with the complete control of the target weed, and with no adverse impacts to non-target species, the environment or people. In fact, globally, over a third of all weed biological control programmes have resulted in the complete control of the target weed, resulting in huge benefit: cost ratios of up to 4,000:1. In addition, there have been no unpredicted sustained non-target impacts on native or economic plants by weed biological control agents. This is because biological control agents are thoroughly tested, sometimes against up to 280 plant species, prior to being released. Moreover, many biological control agents that have proved to be successful in one country have now been released in over 30 countries and have been out in the field for over 40 years. Any impacts to non-target species would have been detected by now. Yet, despite these successes and no reports of non-target impacts, many countries are still reluctant to implement weed biological control. Even countries which have had tremendous successes with weed biological control in the past, have shied away from implementing biological control in recent times, stating that it is unsafe, risky or doesn't does not work. Statements such as "agents could evolve or mutate to attack other plant species" are often used to justify not implementing biological control, without any understanding of biological control theory and host specificity testing. In the meantime, farmers are spending millions of dollars and hours, as well as pumping thousands of kilograms of chemicals into the environment, in an unsustainable effort to control these weeds. The challenge therefore, is to educate scientists, regulators and funding bodies to acknowledge the huge benefits and the low-risk of weed biological control. There are numerous opportunities to introduce highly specific and very effective biological control agents from countries where they are being utilized into other countries where the target weed is problematic.

Keywords: Benefit: cost ratios, host specificity, low-risk, sustainable alternative

PLENARY 7

THE GLOBAL THREAT FROM BIOLOGICAL INVASIONS UNDER A CHANGING CLIMATE: AN EXAMPLE OF A NOTORIOUS INVADER, PARTHENIUM WEED

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Abstract

The exclusion or management of weeds has been a continuous struggle throughout the history of agriculture and native ecosystem protection in the Asian-Pacific region and the rapidly changing climate is doing little to help this. Aided by increased globalization, this rapidly changing climate has facilitated the spread of invasive plant species and is making their management difficult. This review provides insights into the impacts of some major climate change elements on weed biology and management. We will use parthenium weed (Parthenium hysterophorus L.) as an example, a well-known noxious invasive species, to describe how its biology, spread and management will continue to be affected by changes in ambient temperature, moisture availability and atmospheric carbon dioxide concentration. In recent times, perhaps already driven by climate change, this weed has invaded diverse climatic and biogeographic regions in more than 50 countries across five continents. Efforts are under way to minimize the multifarious impacts of this weed, however, rapid evolutionary adaptations are giving an advantage to this prolific pest. Therefore, its invasion mechanism, spread and management under a changing climate has become the focus of recent studies. Some important observations indicate that under increased atmospheric temperature and carbon dioxide concentration, and a changed rainfall pattern, as predicted for future: (1) its C3 photosynthetic pathway will dramatically increase plant growth and stature, thus enhancing its competitiveness, (2) its greater stature and larger root network will increase its allelopathic capacity against native and agricultural plants (3) its unique reproductive biology will be enhanced providing for further propagule production (4) its tolerance to abiotic stresses and ability to grow in wide range of edaphic conditions, including extreme weather events and floods will aid its spread, (5) however, the presently released biological control agents will retain their effectiveness, (6) as will the chemical approaches to its management. Such an understanding of these phenomena regulating this weeds ability to respond to climate change has pragmatic implications for the present and long-term management of this weed. A better understanding of the interaction of physiological processes, ecological functions, and genetic makeup, within a range of environments will help to devise appropriate management strategies for this and other weeds.

Keywords: Invasive plant, climate change, carbon dioxide, weed management, parthenium weed.

1A1 RESISTANCE MECHANISM TO AN ACETOLACTATE SYNTHASE (ALS) HERBICIDE AND ALTERNATIVE HERBICIDE OPTIONS IN *Polypogan fugax*

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Abstract

Polypogon fugax is a common winter weed in China and other Asia countries. We have previously found a *P. fugax* biotype, which has evolved resistance to ACCase herbicides as a result of an Ile-2041-Asn substitution in the target gene. A total of 19 herbicides were evaluated for their effects on this ACCase-resistant (AR) biotype in comparison with a susceptible (AS) biotype. Most of the pre-emergence (PRE) and post-emergence (POST) herbicides effectively controlled the AR biotype except for some ALS herbicides. The AR biotype exhibited low to intermediate level of resistance to some ALS inhibitors, such as flucarbazone-Na (2-fold), metsulfuron-methyl (6-fold) and chlorsulfuron (2-fold). Sequence analysis of ALS gene revealed that two ALS genes were existed in the AS biotype but only one in the AR biotype. The ploidy level of the AS and AR biotypes were equal, indicating that copy number variation was existed among P. fugax biotypes. No substitution associated with ALS resistance mechanism was found in ALS genes, but the activity of ALS enzyme isolated from the AR bitype was inherently higher and less sensitive to metsulfuron-methyl compared to the AS biotype. In addition, GST activity was also less sensitive to metsulfuron-methyl in the AR biotype than the AS biotype. Malathion had much greater synergy effect with metsulfuronmethyl on the AR biotype than the AS biotype, and three CYP family genes were regulated at different levels in the AR biotype after treatment, suggesting that CYP might contribute to the resistance to ALS herbicides. Taken together, the resistance mechanism to ALS herbicides of the studied *P. fugax* biotype was related to the insensitivity of ALS enzyme and GST activity, and the CYP-mediated enhancement of herbicide metabolism.

Keywords: Cytochrome P450, glutathione S-transferases, metsulfuron-methyl, non-target resistance (NTSR), target-site resistance (TSR)

1A2 MOLECULAR BASIS OF RESISTANCE TO ALS-INHIBITING HERBICIDES IN Amaranthus retroflexus L. FROM CHINA

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Abstract

Amaranthus retroflexus L, is a problematic weed in agricultural fields. It could produce large number of seeds and is considered as a strong competitor with crops. As a highly competitive C4 species, A. retroflexus may cause substantial crop yield loss. In China, repeated use of acetolactate synthase (ALS) inhibiting herbicides has led to the evolution of many A. retroflexus resistant populations. The study was conducted to investigate the basis for resistance to ALS-inhibiting herbicides in A. retroflexus. Sequence analysis of the ALS revealed that TGG was replaced by TTG at ALS amino acid position 574, which resulted in the Trp to Leu substitution (Trp-574-Leu) with two nucleotides change of GGT to TAT, resulting in the Gly to Tyr substitution at 654 (Gly-654-Tyr) in the resistant population. Purified R-Tyr654 sub-population was generated and characterized in response to different classes of ALSinhibiting herbicides. The whole-plant response experiments revealed that the R-Tyr654 population exhibited highly resistant to imidazolinone and sulfonylamino-carbonyltriazolinone, and moderately resistant to sulfonylurea, triazolopyrimidine, but susceptible to pyrimidinylthiobenzoate herbicides. In vitro ALS activity assay showed ALS with Gly-654-Tyr substitution was resistant to all the tested ALS-inhibiting herbicides. Malathion pretreatment assay indicated herbicide metabolism is not likely play a role in the R-Tyr654 population. The molecular basis of ALS-inhibiting herbicide resistance in A. retroflexus was identified to be due to Trp-574-Leu and Gly-654-Tyr substitutions in the ALS. This is the first report of Gly-654-Tyr substitution in ALS conferring broad resistance to ALS-inhibiting herbicides. Herbicides with other site of action should be employed to control this resistant A. retroflexus population. This work is funded by the National Science Foundation of China (31871985).

Keywords: ALS enzyme, Amaranthus retroflexus, herbicide, resistance

1A3 MOLECULAR AND BIOCHEMICAL BASIS OF ACCase INHIBITOR TOLERANCE IN Roegneria kamoji Ohwi FROM CHINA

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Abstract

Acetyl coenzyme-A carboxylase (ACCase) inhibiting herbicides are widely used for grass weed control in China. Roegneria kamoji used to be an unimportant weed in cropping areas, had recently found spread in wheat fields in some regions of China and could not be effectively controlled by ACCase inhibitors. In this study, two populations of R. kamoji from ACCase inhibitors failed control wheat fields, and two populations from uncultivated areas that had never been treated with herbicide were collected as the plant material. The resistance profile and to characterise the molecular basis of tolerance to ACCase inhibitors in R. kamoji were determined. Both *R. kamoji* populations from wheat field and non-cultivated area were highly tolerant ($GR_{50} > 16 \times$ labeled field rates, LFR) to the aryloxyphenoxypropionate (APP) herbicides (i.e. fenoxaprop-*p*-ethyl and clodinafop- propargyl), and phenylpyrazolin (DEN) herbicide, which is pinoxaden. However, these populations were susceptible to APP herbicides such as haloxyfop-R-methyl and quizalofop-p-ethyl (GR₅₀ < 1/4× LFR) and cyclohexanedione (CHD) herbicides, viz. clethodim and sethoxydim ($GR_{50} < 1/2 \times LFR$). Gene sequencing revealed that the four *R. kamoji* populations had no reported resistance-related substitutions present in the ACCase gene, and has 99% identity to wheat (Triticum aestivum). The use of the known metabolic inhibitor (i.e. malathion and 4-chloro-7-nitro-benzoxadiazole) in combination with fenoxaprop-p-ethyl did not enhance the activity of this herbicide. As a conclusion, this study documented cross-resistance to ACCase inhibitors and this is the first case of ACCase inhibitor tolerance in R. kamoji. It is inferred that no reported resistancerelated substitution and the highly similarity to wheat in the ACCase gene may result in an insensitive target enzyme to ACCase inhibitors in R. kamoji. Based on the current studies, it is unlikely that CYTP450 or GST were involved in the ACCase inhibitors tolerance in R. kamoji plants.

Keywords: ACCase gene, ACCase mutation, common roegneria, malation, target enzyme

1A4 METABOLIC HERBICIDE RESISTANCE GENE DISCOVERY IN WILD OAT

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Abstract

Weedy plant species that have evolved resistance to herbicides due to enhanced metabolic capacity to detoxify herbicides are a major issue threatening herbicide sustainability and global crop production. Metabolism-based herbicide resistance (referred to as metabolic resistance) in weeds has not been well characterized at the genetic level. Diclofop-methyl-resistant (R) wild oat lines only possessing metabolic resistance were isolated and used for RNA-Seq transcriptome analysis for metabolic resistance gene discovery. Forty contig genes that showed constitutive expression differences between the R and susceptible (S) samples were selected for validation, and these include 22 CYP P450 genes, 9 Glycosyl transferase genes and 9 GST genes related to herbicide metabolism. After validation with RNA-seg samples, the candidate genes were reduced to 31 including 17 CYP P450, 8 Glycosyl transferase family genes, and 6 GST genes. The 31 contigs were then evaluated using additional samples from the R and S lines, and from a single wild oat line segregating R at 4,000 or 6,000 g ha⁻¹ and S at 1,000 g ha⁻¹ of diclofop-methyl. Next, a physiological validation experiment was conducted, in which 2,4-D pre-treatment was used to induce gene expression providing diclofop protection in S individuals due to increased metabolism. With this method only two candidate genes (CYP450) were significantly induced in the S samples. Therefore, these two CYP450 genes (CYP 72A15 and CYP 86A2) are very likely associated with metabolic resistance to diclofop-methyl in the R wild oat line and are prioritized for further characterization using rice genetic transformation.

Keywords: CYP450, diclofop, metabolic resistance, RNA-sequencing, wild oat

1A5 THE METABOLIC RESISTANCE AND ESSENTIAL GENES INVOLVED IN ALS INHIBITORS-RESISTANT Myosoton aquaticum L.

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Abstract

Previous studies have demonstrated that multiple herbicide resistance was found in many populations of Myosoton aquaticum L., a noxious weed in wheat fields. It is suggested that the resistance to ALS inhibitor tribenuron-methyl (TBM) may cause by enhanced activities of herbicide-metabolizing enzymes. Here, we investigate TBM metabolism in the resistant (R) and susceptible (S) plants of *M. aquaticum*. It was confirmed that the R plants metabolized TBM more rapidly than the S plants in which the R plants had significantly higher rates than the S plants (by 1.51 and 5.21-times at 7 and 9 days after treatment (DAT), respectively). Moreover, malathion pretreatment increased herbicide residues in both R or S plants, although the effect was more obvious in the former population, with a 2.02- and 2.07-fold increase at 7 and 9 DAT, respectively, versus a 1.33- and 1.39-fold increase for the latter. Besides, GST activity was higher in resistant than susceptible individuals. Based on the RNA-seg analysis and two rounds of gRT-PCR validation, we successfully isolated and analyzed three genes, i.e. CYP86A2-1, GST-DHAR2-1, and Peroxidase70-1. These genes were constitutively upregulated in resistant individuals. This further supports that enhanced herbicide metabolism drives tribenuron-methyl resistance in M. aquaticum. Transgenic Arabidopsis (Arabidopsis thaliana) that expressing the CYP86A2-1 or GST-DHAR2-1 gene survived in media containing TBM and florasulam at levels at which the wild type stopped growing. Our results confirmed that enhanced herbicide metabolism has driven TBM resistance in M. aquaticum. Overexpression of the CYP86A2-1 or GST-DHAR2-1 gene confers resistance to two classes of ALS inhibitors in A. thaliana.

Keywords : GSTs, herbicide resistance, Myosoton aquaticum L., P450s, resistance gene

1A6 MULTIPLE RESISTANCE TO PENOXSULAM, METAMIFOP AND QUINCLORAC WITHOUT MUTATIONS IN THE TARGET ENZYMES IN *Echinochloa oryzicola* (Vasing.) Vasing

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Abstract

Echinochloa oryzicola (Vasing.) Vasing is one of the most competitive weeds in rice fields that resulted in reduced rice growth and yield in North-eastern region (Liaoning, Jilin and Heilongjiang Provinces), one of the main rice producing areas of China. Penoxsulam, metamifop and guinclorac are three major herbicides used to control E. oryzicola with different mechanisms of action (acetolactate synthase inhibitors [ALS], acetylCoA carboxylase inhibitors [ACCase], and synthetic auxins respectively). Recently, resistance has evolved in *E*, *oryzicola* under continuous selective pressure from herbicides. The objectives of this study were to determine the multiple resistance of 32 E. oryzicola populations from North-eastern of China and to explore the target-site based resistance mechanisms in these populations. Whole-plant dose-reponse experiments showed that 3 out of 32 E. oryzicola populations (i.e. HLJ4, LN1 and LN24) exhibited multiple resistance to penoxsulam, metamifop and guinclorac. These three resistant populations have high level of resistance to guinclorac, with resistance indexes of 65.89, 145.31 and 269.77, respectively. And, HLJ4 showed low level of resistance to penoxsulam, and high level resistance to metamifop, with resistance indexes of 3.64 and 10.64, respectively; LN1 showed high level resistance to both penoxsulam and metamifop, with resistance indexes of 25.67 and 23.59, respectively; LN24 showed moderate resistance to penoxsulam and metamifop, with resistance indexes of 8.66 and 9.86, respectively. Targetsite resistance was considered to be the major cause of herbicide resistance to ALS and ACCase inhibiting herbicides, whereas DNA sequencing of target enzyme genes revealed that there was no resistance endowing amino acid substitutions in those resistance populations when compared with sensitive population (LN12).

Keywords: Herbicide resistance, multiple resistance, targeted enzyme sequencing

1A7

HERBICIDE RESISTANCE IN WEEDS OF WHEAT IN KHYBER PAKHTUNKWA-PAKISTAN

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Abstract

Herbicide-resistant weed species have become widespread in recent years due to nonjudicious use of herbicides. In this study wheat field surveys were conducted in two divisions of Khyber Pakhtunkhwa (Peshawar and Dera Ismail Khan) during January -December, 2017. Questionnaire method was used to collect data from wheat growers. Alongside, seeds of prevalent weeds were collected from wheat fields for bioassays studies. Data analysis revealed that *Phalaris minor* L. (Little seed canary grass) is a major weed of winter cereal crop followed by Avena fatua L. in Khyber Pakhtunkhwa. Three aryloxyphenoxy propionate herbicides like, clodinafop-propargyl, fenoxaprop-P-ethyl and diclofop-methyl were used to control Phalaris minor L. and Avena fatua L. Data analysis revealed that the higher yield of wheat was associated with continuous use of the above mentioned herbicides however, this exercise resulted in the development of herbicide resistance. Bioassays studies conducted in laboratory showed that increase in dose of herbicide as well as exposure time significantly affected the fresh weight of weed biotypes. The value of GR50 for Avena fatua biotype from Dera Ismail Khan was 2 fold (0.855 kg a.i.ha⁻¹) against clodinafop (Topik 15 WP) and 0.5 fold (1.53 kg a.i ha⁻¹) against fenoxaprop-p-ethyl (Puma Super 75EW). While Phalaris minor biotype from Peshawar confirmed 2 fold (0.592 kg a.i. ha⁻¹) GR50 against clodinafop propargyl (Topik 15 WP). This study predicts that herbicide resistance in *Phalaris minor* and *Avena fatua* biotypes is present against two very effective herbicides used in wheat. Hence, to overcome herbicide resistance and efficiently control weeds in both Divisions, herbicides from different chemical families and with different mode of action are suggested to be suitable weed management option.

Keywords: Herbicide resistance, wheat, Phalaris minor, Khyber Pakhtunkhwa -Pakistan

1B1

TOWARDS INCREASING THE EFFICIENCY OF CHEMICAL SPRAYING USING UNMANNED AERIAL SYSTEM (UAS) IN RICE CULTIVATION

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Abstract

Due to increase in Malaysia population of 1.9% per annum, about 2.91 million metric tons (MT) of rice is needed by 2020, with an average rice yield needs to be increased to 5MT per hectare. However, up to date, only about 84% from the total rice cultivation area has reached the target. Low production of rice has been identified that caused by few factors namely i) lack of advanced technologies ii) low mechanization index (MI) of average 0.59 with lowest in chemical spraying, fertilizing and seeding operations (MI of 0.19,0.17 and 0.25 respectively) iii) low field capacity (ha/hr) with 0.72-1.25 ha/hr for current practices of spraying using knapsack and iv) low work quality in accordance to Good Agricultural Practices (GAP). Due to these factors, the utilization of Unmanned Aerial System (UAS) has been seen as a prospect in replacing the current practices especially in chemical spraying due to its proven ability in increasing the field capacity (ha/hr), precision in application and quality of work. However, like any other spraying applicator, the utilization of UAS in chemical spraying should also meet the spraying aim and increase the spraying efficiency which greatly affected by its aerodynamic effect produced during the rotation of blades. This research outlines the development of indoor testing facility to evaluate the performance of the UAS in spraying application and initial attempt in modifying the pesticide to suit the UAS application. The research is expected to find an optimum important parameter for UAS in chemical spraying to increase the spraying efficiency.

Keywords: Aerial spraying, agricultural mechanization, chemical spraying, rice cultivation, Unmanned Aerial System.

1B2

EFFECTIVENESS OF POTASSIUM GLYPHOSATE 660 G/L HERBICIDE ON THE TIME INTERVAL OF RAINFASTNESS AFTER APPLICATION ON WEEDS

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Abstract

Rainfall after herbicide application can affect weed control. Not just precipitation but the intervals between the application of herbicides and fall of rain, the amount of precipitation, as well as a itensitas herbicide formulation, the formulation as well as the concentrations of the herbicide could affect the level of absorption, translocation and efficiency controlling weeds. Absorption is limited by the number of herbicide active ingredients pass through the cuticle of leaves, and is influenced by environmental conditions, by species of weeds and the characteristics of herbicides. The fall in the rain as soon as the application provide a consequence will be reduced absorption and consequently lowers the efficiency of herbicide. The objective of this study was to evaluate the effect of rainfall on the effectiveness of herbicides applied on the weeds, namely Paspalum conjugatum and Imperata cylindrica. The experiment was carried out under greenhouse conditions and the experimental design was completely randomized design with four replications, with treatments in a 7x8 factorial arrangement (one herbicides treatments and six rain intervals) and control. The herbicides used was of Potassium Glyphosate 660 g/l (powermax). The rain simulation occurred at intervals of 0, 1, 2, 3, 4 hour and no rain, and control (no herbicide treatment and no simulation rainfall). Herbicide Potassium Glyphosate 660 g/l effectively controls Paspalum conjugatum, Imperata cylindrica at a dose of 1.11 / ha. The time interval 0 - 4 hours after application does not affect the effectiveness of the herbicide Potassium Glyphosate 660 g/l in controlling weeds. Period of 1-4 hours without rain is required by the herbicide Potassium Glyphosate 660 SL to provide effective weed control. herbicides will work properly, need not have happened rain at least 3 hours after application Herbicide Potassium Glyphosate 660 g./l.

Keywords: Herbicide, weed, rainfastness

THE EFFECT OF RAINFASTNESS OF HERBICIDE POTASSIUM GLYPHOSATE TO CONTROL WEEDS OF OIL PALM

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Abstract

The objective of this study was to evaluate the rainfastness of herbicide Potassium glyphosate 440 g/l in controlling dominant weeds of oil palm plantations. The experiment was carried out under the green house conditions in Bandung Indonesia. The experiment was carried out in December 2017 until January 2018. The weeds at the same fresh weight and have 2-3 leaves were planted in a plastic pots with a capacity of 2.5 litters of soil and kept in the green house for one month, then move out into plot size of 4 x 4 m and the herbicide was applied with the following rainfall interval: a) 4 hours b) 3 hours, c) 2 hours, d) 1 hour before rainfall applying, e) directly rainfall applied after herbicide application, f) apply herbicide without any rainfall, g) without application of herbicide and without rainfall. The weeds are : Ageratum conyzoides, Borreria alata, Paspalum conjugatum and Imperata cylindrica. The experimental design used was Randomized Block Design with 7 treatments and each treatment was replicated 4 times. Weed dry mass was determined at 3 weeks after herbicide application. The results of this experiment showed that the interval needed between herbicide application and rainfall was different among weed species. Broad leaf weeds species, such as Ageratum conyzoides require rain free period 0-1 hour, whereas Borreria alata require rain-free period of 2 hours. Weed grass species: Imperata cylindrica and Paspalum conyugatum required rain-free period of 3 hours.

Keywords: Rain-free period, herbicide efficacy, *Ageratum conyzoides, Imperata cylindrica*, Roundup Transrob

CLIMATE NICHE MODELS – THE PERILS OF RESTRICTED-RANGE PARAMETERISATION DATA

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Abstract

Failure to include occurrences throughout invasive species' global ranges can lead to poor parameterisation of climate niche models. The consequences for species' projected potential distributions and risk assessments have rarely been demonstrated in the published literature. Our study with Abutilon theophrasti, in which we compared the projections of a CLIMEX model for the species published in 2000 and applied to California, with a new CLIMEX model that we constructed in 2019 for application in New Zealand, provides an example. In this case, the exclusion of many hundreds of occurrences of the species in its invaded range in Northern Europe contributed to the earlier model fitting only 54% of the global occurrences of the species. In New Zealand, the lack of fit resulted in the model substantially underestimating the potential distribution of the species as compared to the new model for which all available overseas occurrences were used for parameterisation. The use of the earlier model by biosecurity decision-makers in New Zealand would have led to substantial underestimation of the potential national economic effects of the weed and to an inadequate national biosecurity response. Fortuitously, both models lead to similar potential distributions in California. Our study highlights the importance of including all known occurrences in the parameterisation of climate niche models and the need to be cautious when projecting published models onto potential novel ranges.

Keywords: Biosecurity, climate niche models, parameterisation, weed potential distributions, weed risk analysis

THE NEED FOR FARM BIOSECURITY: HERBARIUM RECORDS OF MAJOR WEEDS EXPLAINED BY HUMAN ASSISTED DISPERSAL

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Abstract

New Zealand has only been colonised for less than 200 years yet most of our major weeds, which are all introduced from elsewhere, were widespread within the country within a short period. This cannot be explained by their own natural spread rates which in most instances are slow. The introduction and early spread of weeds were determined from the dates and spatial locations of their herbarium records. These records generally show rapid dispersal within and between the North and South Islands of New Zealand. This strongly suggests that they must have been moved by an agricultural or other human assisted pathway. This dispersal was probably unintentional, but intentional movement cannot be ruled out, particularly to get from one island to the other. If improved internal biosecurity practices are not adopted then we could expect new weeds arriving into New Zealand to spread at a rate faster than their natural spread would determine. Currently New Zealand has many pro-active mechanisms in place to stop some of the pathways, for example, roadside dumping is illegal, machine hygiene is promoted, some plants are banned from trade (e.g. NPPA) and there are rules that are in place to restrict movement of Unwanted Organisms. But is this enough? Have we got all the pathways covered? Although the weeds discussed here were largely spread before biosecurity was recognised as a priority, two relatively recent incursions, vellow bristle grass (Setaria pumila) and velvetleaf (Abutilon theophrasti), moved very quickly across the country, indicating that we could still do better.

Keywords: Biosecurity, incursion weeds, pathways, weed dispersal.

CURRENT PRACTICES AND CHALLENGES FOR EDUCATION AND EXTENSION IN WEED SCIENCE IN FIJI

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Abstract

As the mainstay of Fiji's economy, agriculture contributes around 28% to total employment in the formal sector and indirectly employing many more. It is the third largest sector and contributes about \$451 million (9%) annually to the nation's Gross Domestic Product. Due to government assistance and subsidy programmes for farmers, herbicides are now heavily used for weed control in commercial agriculture. Consequently, over-reliance on herbicides to control weeds has led to issues of weeds becoming resistant to herbicides. In this regard, the Crop Research Division in Ministry of Agriculture plays vital role in conducting research and developing economical, efficient and cost effective packages of agricultural practices using combination of weed management techniques. For educational awareness programs, the researched information are summarised as resource materials targeting farmers, technical/extension staffs, other researchers, students, stakeholders and general public. Unfortunately, the main challenge lies in terms of accessibility to farmers in rural and maritime zone, funding for training, unpredictable weather conditions, cultural/traditional practices and lack of trained weed scientists. To improve the effectiveness of such education programmes, effective linkages between farmers and weed researchers will be necessary to facilitate the adoption of good weed management practices. To achieve this, it is suggested that the Extension section of the Ministry be continuously up skilled with latest researched techniques of weed management. In order to build this capacity, mobilising additional funding for both weed research and weed management education is essential for the Ministry.

Keywords: Agriculture, education, extension, weed management, weed science.

INSECTICIDAL PROPERTIES OF SELECTED WEEDS AGAINST RICE WEEVIL, Sitophilus oryzae L.

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Abstract

Insects, particularly pest insects have been affecting humans in numerous ways that include foraging on all kinds of plants and infesting food or any other stored products. This has caused a large amount of loss and deterioration of food quality as insects fill up about two-thirds of the identified animal species all over the world. The major and most widespread and destructive pest insect in stored grains is Sitophilus oryzae L. (Coleoptera: Curculionidae) or also known as rice weevil. This insect is known to cause damage to stored rice grains by chewing and feeding on rice kernels. The use of synthetic insecticides has been a major preference for control attacks by rice weevil. However, the excessive use of insecticides could serve as a catalyst for current and future ecological crises such as insecticide resistance and contamination in food. Therefore, a big step is needed to develop an environmental friendly bio-insecticide to control rice weevil from damaging stored grains. Weed of six species was collected, washed, dried and ground to powder. A total of 100 g of weed powder were soaked in 1000 ml of methanol (1:10) for three days before evaporated by using the rotary evaporator. Extraction shows that there were highly significant differences between methanol and hexane where methanol recorded higher yield with a mean of 10.96% while 1.01% of yield from hexane extraction. Toxicity test shows that Macaranga tanarius produced LC₅₀ value at 3463 ppm followed by Ageratum convzoides and Chromonaela odorata at 7365 ppm and 97426 ppm respectively after 72 hours of treatment. The chemical composition of extract from Macaranga tanarius were identified by using gas chromatography-mass spectrometry (GC-MS). The highest compound found in the leaf extract was thunbergol ($C_{20}H_{34}O$), which comes from group diterpene that reportedly has insecticidal properties. Pseudo-ternary phase diagrams were designed by including active ingredient (Macaranga tanarius), termul, poe and water. Isotropic region was formed and formulation was selected with the priority of isotropic, one-phase and stability of physical at an ambient temperature. Formulation was then tested on the insect and the mortality shows at 9254.5ppm. The result revealed insecticidal properties of *M. tanarius* towards rice weevil.

Keywords: Sitophilus oryzae, Macaranga tanarius, bio-insecticide

WEEDS IN OUR MIDST: THEIR NUTRITIONAL CONTENTS AND MEDICINAL PROPERTIES

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Abstract

Weeds are plants unwanted in human-controlled settings such as plantations, gardens and parks. While a significant number of weeds had been proven to possess medicinal properties, information on their nutritional contents is still limited. In this study, 12 plant species were selected based on their documented medicinal properties. Eight and 4 plant species were collected for quantification of nutritional contents in their shoots and roots, respectively. These samples were collected before 10:00 am, chopped into smaller pieces, oven dried at 70°C to constant weight, ground and then digested based on published methods prior to quantification of their nutritional contents. We found that plant species with the highest content of nutrition in their shoots were Ageratum conyzoides (26.1% protein, 4.2% nitrogen, 2.7% calcium, 0.7% magnesium, 0.6% phosphorus, 225 mg/kg manganese, 50 mg/kg boron and 23 mg/kg copper), Passifloria feotida (4.0% potassium and 105 mg/kg zinc), Hedyotis corymbosa (12.9% ash), *Phyllanthus niruri* (2.6% fat) and *Mimosa pudica* (551 mg/kg iron). In the roots, plant species with the highest content of nutrition were Eleusine indica (32.9% ash, 6.8% protein, 1.1% nitrogen, 0.6% calcium, 0.2% phosphorus, 0.2% magnesium, 30,969 mg/kg iron, 166 mg/kg zinc, 150 mg/kg manganese and 38 mg/kg copper), Ageratum conyzoides (1.1% potassium) and Stachytarpheta jamaicensis (6 mg/kg boron). We also observed that ash, fat, protein, nitrogen, phosphorus, potassium, calcium, magnesium and boron are preferentially accumulated in shoots whereas iron in roots. The results of this study suggest that some weeds are capable of accumulating a substantial amount of macro- and micronutrients. Hence, apart from their medicinal properties, these weeds could be exploited as raw materials for making compost.

Keywords: Compost, medicinal plants, nutritional, weeds

WEEDS AS AN ALTERNATIVE FEED RESOURCE FOR SMALL HOLDERS' LIVESTOCK FARMING

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Abstract

India is predominantly with small holders' farms and offers a vast and diverse livestock and poultry population, contributes 27% the agricultural GDP. Although there has been considerable increase in production of animals, the productivity per unit animal is much lower compared to that in many developed and developing countries. Efficient management of feed resource is of prime importance for optimizing livestock production. The animals are mostly fed with crop residues, green fodder and concentrate feeds. Crop residues and concentrates are obtained from the agricultural crops cultivated for food and other purposes. Apart from these, the major source of feed for animals includes greens especially from weeds of cropped area, forests and uncultivable lands. Even though aggressive growth of weed species with high invasion potential pose problem during cultivation of agricultural and vegetable crops such as mustard, maize, pigeon pea, mungbean, potato, onion, cotton, soyabean, pearl millet and sugar cane, weeds are beneficial as fodder in small holders farming. The commonly available dicot weeds in field crops includes Achyranthus aspera, Amaranthus lividus, Amaranthus spinosus, Ammannia baccifera, Anagalis arvensis, Boerhavia diffusa, Celosia argentea. Chenopodium album. Chloris barbata. Digera muricata. Euphorbia hirta. Ipomoea pes-tigridis, Leucas aspera, Ludwigia perennis, Meliotus indica, Physalis minima, Portulaca oleracea, Trianthema portulacastrum, Tribulus terrestris, Tridex procumbensetc. The monocot weeds include Commelina benghalensis. Cynodon dactylon. Cyperus compressus. Cyperus difformis. Cyperus esculentus. Cyperus iria. Cyperus rotundus. Dactyloctenium aegyptium. Echinochola colonum, Eragrostis ciliaris, Phalaris minor, Setaria tomentosa, etc. The vegetational diversity is rich in nutritional availability equivalent to the fodder crops and the guantity of weed biomass obtained contributes considerably to the quantity of green biomass fed to the animals. The total weed available in our country contributes to 15 lakh tonnes per year of total green fodder availability (approximately 3% of the total available green biomass). Such weeds are highly suitable for value addition as feed blocks, silage making and hay making for feeding animals during scarcity periods. Weeds are especially beneficial for feeding livestock during dry periods or maintenance. Weeds have diversified benefits such as medicinal properties, used as human food, helps in prevention of soil erosion, carbon sequestration etc, but as a forage, it contributes to the livestock economy by reducing the cost of production of livestock.

Keywords: Feed block, livestock, preservation, scarce period, weeds

BIOMASS PRODUCTION AND CARBON SEQUESTRATION OF PERENNIAL GRASS Miscanthus x giganteus

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Abstract

Miscanthus is a perennial grass which inhabits a wide range of climates and has long been considered as an invasive weed in East Asia. However, it is now being considered as a potential biomass crop due to its high environmental adaptability and biomass productivity. Among various favorable traits, its ability to sequestrate carbon in above-ground (shoot) and below-ground (roots) makes it a special crop particularly in the context of a carbon neutral biomass production. The carbon sequestration ability of Miscanthus derives from its rhizomatous growth trait as well as its high biomass. Therefore, this study was conducted to quantify the biomass production and carbon sequestration by *Miscanthus* x giganteus (2n=3X) grown under different nitrogen fertilizer levels ranging from 0 to 240 N kg⁻¹ ha⁻¹ year⁻¹ for 6 years after its planting. Above-ground biomass yield was assessed every year and belowground biomass including rhizomes and roots were harvested and assessed in the 6th year. Soil was also sampled in the 6th year and total carbon content in soil was analyzed. Aboveground biomass increased with increasing nitrogen fertilizer to reach its maximum yield of 2,771 g m⁻² in 240 N kg⁻¹ ha⁻¹. Below-ground biomass increased with increasing nitrogen fertilizer level up to 60 kg N ha⁻¹ year⁻¹ to reach its maximum yield of 25.95 g m⁻², and thereafter decreased with increasing nitrogen fertilizer level. Nitrogen fertilizer did not significantly affect soil total carbon. Overall, our study revealed that Miscanthus significantly fixed CO₂ into biomass in both above-ground and below-ground parts, suggesting that Miscanthus cultivation can sequestrate significant amount of CO2. This work was carried out with the support of "Next-Generation BioGreen21 Program for Agriculture & Technology Development (Project No. PJ01324501)", Rural Development Administration, Korea.

Keywords: Bioenergy crop, biomass, carbon sequestration, *Miscanthus*, soil carbon

1D1

POTATO INJURY FROM RESIDUAL QUINCLORAC AND ITS MANAGEMENT STRATEGIES

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Abstract

Quinclorac is a commonly used herbicide in paddy fields. Its residues in the soil can highly affect the growth of step-crop, causing adverse consequences leading to the stunted plant, growth malformations and retardation, especially on the vegetables in the nightshade family, such as potato (Solanum tuberosum), chili (Capsicum annuum) and eggplant (Solanum melongena). Rice-potato rotation is one of the main cultivation modes in South China. Using large areas of idle paddy fields to plant potato in winter can bring huge economic benefits to farmers. However, the growth of potato is usually affected by soil guinclorac residues. This paper studied the typical phytotoxic symptoms of injury potato plants from residual quinclorac and gave a sight for the management strategies. Field experiment was conducted in ricepotato rotation field in Guangzhou between 2015 and 2017. All results were repeated three times. Quinclorac residue amount in the soil less than 1.9 µg/kg had no effect on the growth of the potato plant. When the amount of quinclorac residue was between 1.9 and 3.75 µg/kg, the growth of potato plants was significantly inhibited. The plant height and fresh weight decreased, while the leaf shape was normal, compared to the normal potato plants. If the soil quinclorac residue content was higher than 7.5 µg/kg, the potato plants showed serious injury, yellowing, deformity, crinkled leaf surface and short roots and the fresh weight inhibition rate was more than 60%, resulting in the potato yield and quality decreased massively. Solanum nigrum is annual herb nightshade, its phytotoxic symptoms caused by quinclorac residue were consistent with those potato plants and could be used as an indicator plant. Planting S. nigrum before sowing potatoes can simply determine whether the field is suitable for potato plantation. Furthermore, if the residue injury has already occurred on the potato, the foliage application of plant growth regulators (brassinolide, chitosan, naproxen, and sodium nitrophenate), fertilizers and microbial agents can alleviate the symptoms of potato injury. Those strategies are also applicable to the chilli and eggplant injured by the soil quinclorac residues and have been widely used in South China. The above management strategies which studied in this paper can timely and effectively prevent the occurrence of guinclorac residues injury and bring great economic benefits to farmers.

Keywords: Quinclorac residue, injury, indicator plant

1D2

RESIDUES OF IMIDAZOLINONE HERBICIDE IN IRRIGATED RICE FIELDS OF SG LEMAN, SELANGOR

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Abstract

The imidazolinone-resistant rice production system (IRRP) is a system that is designed to control weeds, especially weedy rice. The system starts by planting the imidazolinone (IMI) resistant rice and use the said herbicide to control the weeds while giving no negative impact on the rice. However, the continuous use of the imidazolinone resistant rice has caused the weedy rice to become resistant to IMI and raises the concern of IMI residues in their water around the rice fields. A survey was conducted on 115 farmers in Sg Leman, Sekinchan to get the information on the farmer's herbicide used to control weedy rice. Another study was also carried out to determine residues of IMI in the water around the rice fields. This study shows that about one third of farmers in this area has started using alternative herbicide to IMI. The second study also shows not only residues of IMI have been found in the said area, but the concentration increases as the end of the season approached. This result is unexpected as many studies have shown that the photolysis of IMI occurred rapidly in aqueous solution under sunlight condition. This result raises concern on whether this residue has any effect on aquatic fauna in the vicinity of the rice fields.

Keywords: Herbicides, imidazolinone residues, weeds,

1D3

SOIL BASED PRE-EMERGENCE HERBICIDE DOSE RECOMMENDATION: A WAY FORWARD TO PRECISION AGRICULTURE

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Abstract

Adsorption and desorption of pre-emergence herbicide in soils are among of the most important processes, that influence the effect of pre-emergence herbicide availability to kill the germinating weeds. Generally, the blanket recommendation is used in India for weed control in various crops. Herbicides applied on clay or organic rich soil type, absorb more resulting in lowering the availability in soil solution become sub lethal to kill the weeds. Desorption of herbicide is also critical in determining the herbicide availability to the target species. Effective weed control could be achieved by studying the sorption and desorption property of the soil. Therefore, a laboratory experiment was conducted at the Department of Agronomy, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai to study the optimum level of the pre-emergence herbicide pendimethalin and oxyfluorfen concentrations. The study on sorption and desorption was carried out with that herbicide concentration of 1, 2, 3, 4, 5 ppm in five different soils viz., sandy loam, sandy clay loam, clayey, sandy clay, sandy clay loam with high organic matter soil. Based on the results obtained, the sorption of pre-emergence herbicide oxyfluorfen varied from 98.53 to 77.96 % and pendimethalin was varied from 98.11 to 94.07% in different soils. The highest sorption of 98.53 % (oxyfluorfen) and 98.11 % (pendimethalin) was observed with clayey soils followed by sandy clay loam soils with high organic matter content (96.97 for oxyfluorfen and 95.975% for pendimethalin). Lowest sorption (77.96% for oxyfluorfen and 94.07% for pendimethalin) was recorded with sandy loam soils. Highest desorption of (57.44% for oxyfluorfen and 24.04% for pendimethalin) was recorded with sandy loam soil and the lowest desorption percentage (13.18% for oxyfluorfen and 6.65% for pendimethalin) was obtained with sandy clay loam soil with higher organic matter. Based on the analytical results of sorption and desorption, oxyfluorfen and pendimethalin dose was optimized as 0.51, 3.55 kg ha⁻¹ for sandy clay loam soils with high organic matter, 0.33, 2.26 kg ha⁻¹ for clay soil, 0.27, 2.04 kg ha⁻¹ for sandy clay, 0.19, 1.07 kg ha⁻¹ for sandy clay loam soil and 0.10, 1.06 kg ha⁻¹ for sandy loam soils respectively. In conclusion, the clay and organic matter rich soil required more quantity of oxyfluorfen and pendimethalin compared to other types of soil for effective management of weeds under irrigated condition.

Keywords: Pendimethalin, oxyfluorfen, sorption, desorption, herbicide dose

1D4

EVALUATION OF HERBICIDE RESIDUES UNDER THE LONG-TERM CONSERVATION AGRICULTURE EXPERIMENTS

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Abstract

Long term experiment on weed management in conservation agriculture system having various tillage systems was initiated in a network mode under All India Coordinated Research Project on Weed Management under rice based and non-rice based cropping systems such as rice-wheat, maize-wheat, rice-maize-green gram, pearl millet - mustard cropping and ricemustard since 2012 in different agro-ecological conditions of India. Treatments consisted of different tillage practice and application of recommended herbicides at recommended doses and remained unchanged for five consecutive years. Effect of herbicides on soil physicochemical properties as well as the fate of herbicides in the soil and plant under these cropping systems were evaluated. Degradation of herbicide residues was determined in the soil samples which were taken from the initial days of spraying to till harvest of the crop, and terminal residues in the crop samples were determined at the time of harvesting in each year. The application of herbicides under various tillage systems for five consecutive years did not show any significant effect on soil Bulk Density, pH, and organic carbon content. Dissipation of herbicides was found to follow first order reaction kinetics (R2 > 0.90) irrespective of tillage practices and cropping systems. The higher half-life of pendimethalin and atrazine were found to be about 14.8 – 20.0 days and 16.6 - 24.9, respectively in the soil of the maize crop. In one location, pendimethalin residues in the soil, rice grain and straw were detected within the range of 0.01 to 0.043 μ g/g, which were below the maximum residue limit (0.05 μ g/g). In general, residues of pretilachlor, bispyribac sodium, pyrazosulfuron, fenoxaprop-p-ethyl, anilofos, and pendimethalin applied in rice crop were not detected in the soil, grain and straw at harvest in the rice-wheat cropping system. Addition of organic matter decreased residues rapidly in ricemaize-cowpea. Similarly, residues of clodinafop-propargyl, isoproturon, and metribuzin in wheat; pendimethalin in a sunflower; atrazine in maize; pendimethalin and oxyfluorfen in mustard, atrazine and 2, 4-D in pearl millet were found below the detectable limits in the soil and plant samples at the time of harvest. Different tillage practices under rice and non-rice based cropping system could not significantly affect the persistence of herbicides in the soil.

Keywords: Conservation agriculture, herbicide; residues, tillage practices, cropping systems

IDENTIFICATION OF SEVERAL DIURON-RESISTANT WEED SPECIES IN PINEAPPLE PLANTATION IN LAMPUNG PROVINCE, INDONESIA

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Abstract

Weeds such as Dactyloctenium aegyptium, Eleusine indica, and Praxelis clematidea are dominant weeds that are difficult to control in pineapple plantation in Lampung Province, Sumatera, Indonesia. The main weed control method in the pineapple plantation is chemical control using herbicides, one of which is diuron. Diuron has been used in the pineapple plantation for more than 35 years. The use of herbicides with the same mechanism of action intensively over a long period of time can accelerate the occurrence of herbicide-resistant weeds that cannot be controlled at the recommended dosages. The study was conducted to determine whether D. aegyptium, E. indica, and P. clematidea from pineapple plantation have evolved resistance to diuron herbicide and to examine whether the resistance correlate with the weed physiological activities. The study was conducted at the University of Lampung, Bandar Lampung, Indonesia, from September 2018 to March 2019. The study consisted of two stages, i.e. Stage 1: Weed resistance test, and Stage 2: Physiological activity test on resistant weeds. In the present study, a split-plot design was used with 6 replications in Stage 1 and 3 replications in Stage 2. The first factor was the origins of weeds, viz, herbicide-exposed weeds and non-exposed weeds. The second factor is the dose of diuron with 0, 600, 1,200, 2,400, 4,800, and 9,600 g ha⁻¹. In Stage 1, observations on the percent of mortality and weed dry weight were conducted. Data were analyzed to determine (lethal time at 50% mortality), ED₅₀ (effective dose at 50% mortality), and RI (resistance index). In Stage 2 physiological activities which include the rate of carbon assimilation, stomatal conductance, and the rate of transpiration were analyzed. The results showed that: (1) Weed exposed to diuron needed a longer time to be damaged with LT₅₀ values of 44.53, 17.70, and 5.93 days for *D. aegyptium*, *E. indica*, and *P. clematidea*, respectively at the dose of 4,800 g ha⁻¹, while the LT_{50} values for the respective untreated weeds were 4.70, 9.64, and 5.25 days, respectively; (2) RI value for D. aegyptium that treated with diuron was 16.70 and thus it is classified as high resistance level. Meanwhile RI for E. indica and P. clematidea were 1.46 and 1.74 respectively, which indicated the absence of resistance; (3) The physiological activities of *D. aegyptium*, which has a high level of diuron resistance exhibited higher carbon assimilation, stomatal conductance, and transpiration than that of the sensitive *D. aegyptium*.

Keywords: *Dactyloctenium aegyptium, Eleusine indica,* gas exchange, *Praxelis clematidea,* weed resistance

2A2

BENSULFURON-METHYL-RESISTANT Ammannia auriculata AND ITS COMPETITION WITH RICE PADDY

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Abstract

Ammannia auriculata Willd. (commonly known as redstem) has been becoming one of the most harmful weeds in paddy fields in China in recent years. The objectives of the study were to detect the sensitivity of the weed to bensulfuron-methyl (BSM), and to compare the competitive ability between resistant (RB, NB143) and susceptible (SB, HZ001) biotypes to rice. Among the 140 tested biotypes, 96.4% of them were resistant to BSM, and the average resistance index of biotypes from Zhejiang, Jiangsu, and Anhui provinces and Shanghai city were 31.3, 20.7, 6.9 and 16.8, respectively. The seeds of the two biotypes were sown simultaneously with rice in a separate basin in the field, and the weed seedlings were thinned to 58 plants/m². The results showed that the emergence dynamic of the RB seeds were similar to that of the SB seeds with two peaks at 2-6 and 10-12 days after seeding (DAS), respectively. Redstem grew slowly within 15 DAS but tremendously fast in the subsequent growing period. Both biotypes were shorter than rice plant before 45 DAS but they became much higher than rice plant after 55 DAS. The RB biotype was 14.7% lower than the SB biotype in term of height at the end of the study, and the rice yield was decreased by 50.8% under competition with the RB biotype and 73.1% with the SB biotype, respectively. The results indicate that the BSMresistant redstem is widely distributed in China, and the interference of the BSM-resistant redstem to rice is reduced to some extent because of the fitness cost in height compared to the SB biotype. Nevertheless, the BSM-resistant redstem is still a noxious weed in the rice paddies. This information is helpful for the risk evaluation and strategic management of BSMresistant redstem in the rice fields (The work was funded by National Key Research and Development Program of China (2017YFD0200307) and National Natural Science Foundation of China (No.31171863)).

Keywords: Ammannia auriculata, bensulfuron-methyl, competition, Oriza sativa, resistance

IDENTIFICATION OF SEVERAL WEED SPECIES THAT HAVE EVOLVED RESISTANCE TO GLYPHOSATE HERBICIDE IN OIL PALM PLANTATION IN LAMPUNG PROVINCE, INDONESIA

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Abstract

The presence of weeds in oil palm plantation in Indonesia is a serious threat because it can significantly reduce crop productivity. Asystasia gangetica and Eleusine indica are dominant weeds that are difficult to control in oil palm plantation in Lampung Province, in the island of Sumatera. Glyphosate is one of the most widely used herbicides to control weeds chemically in the oil palm plantation for the last 35 years. It has been realized that the use of herbicides with the same mechanism of action intensively can speed up the evolution of resistant weeds over a long period of time. Resistant weeds can survive and reproduce with exposure to herbicides with doses that are generally lethal to the weeds. The study was conducted to determine whether A. gangetica and E. indica from oil palm plantations have evolved resistance to glyphosate and to confirm whether the respective resistance correlated with weed physiological activity. The study was conducted at the University of Lampung, Bandar Lampung, Indonesia, from September 2018 to March 2019. The study consisted of two stages, i.e. Phase 1: Weed resistance test, and Phase 2: Physiological activity test on resistant weeds. The study was arranged in a split-plot design with 6 replications in Phase 1 and 3 replications in Phase 2. The first factor was the origins of weeds, which are herbicide-exposed weeds and weeds without any herbicide application. The second factor is the dose of glyphosate, i.e. 0, 480, 960, 1,920, 3,840 and 7,680 g ae ha⁻¹. In Phase 1, recorded observations were the percent of mortality and dry weights. Data were analyzed to determine LT_{50} (lethal time at 50%) mortality), ED₅₀ (effective dose at 50% mortality), and RI (resistance index). In Phase 2, observations of physiological activities included the rate of carbon assimilation, stomatal conductance, and transpiration rate. The results showed that A. gangetica and E. indica have evolved resistant to glyphosate as indicated by: (1) The values of LT₅₀, viz. 14.85 and 29.98 days, respectively at the dose of 1,920 g ae ha⁻¹ in A. gangetica and E. indica that exposed to glyphosate, while untreated weeds were 8.54 and 6.42 days for both weeds, respectively; (2) RI values of A. gangetica and E. indica that exposed to glyphosate were 2.87 and 2.32 and hence they can be classified as having a low resistance level; (3) The physiological activities (carbon assimilation, stomatal conductance, and transpiration) of A. gangetica and E. indica, which have low level of resistance to glyphosate, are not different from those of unexposed (sensitive) A. gangetica and E. indica in general.

Keywords: Asystasia gangetica, Eleusine indica, gas exchange, glyphosate, weed resistance

2A4 RAPID DIAGNOSIS OF HERBICIDAL ACTIVITY USING SPECTRAL IMAGE ANALYSIS

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Abstract

Herbicide screening and dose-response study require substantial amount of time, effort and cost, making a new herbicide discovery very expensive and time-consuming. If herbicidal activity can be diagnosed at very earlier timings after herbicide application, we can significantly save time, effort and cost, and facilitate discovery of new herbicides. Various rapid diagnostic methods have been developed, but most of them are destructive and require significant time and efforts for identifying herbicidal activity. Therefore, this study was conducted to apply spectral image analysis for rapid diagnosis of herbicidal activity. Infrared (IR) thermal, chlorophyll fluorescence (CF) and visual RGB images were acquired after treating herbicides with different herbicide modes to a model plant, oilseed rape (Brassica napus) and analyzed acquired plant spectral images using MATLAB 2017 to quantify plant body temperature, photosystem (PS) II quantum yield (Fv/Fm), and color values, respectively. Spectral parameters were monitored every day and the fresh weight of plants was finally determined at 18 days after treatment. Spectral image analyses showed that PS II quantum yield decreased and plant body temperature increased over time. The timing when the first spectral response appears and the type of spectral responses differed according to herbicide modes of action. PSI, PSII, PPO inhibitors and glufosinate show distinctive spectral responses in IR thermal and CF at very early timing within 1 day after herbicide treatment. Other herbicides needed more days to fully view the changes. Thus, we concluded that herbicidal efficacy of herbicides with different modes of action can be detected by analyzing spectral responses. suggesting the possibility of rapid screening of herbicidal compounds and rapid diagnosis of herbicide resistant weeds.

Keywords: Herbicide resistance, herbicide screening, image analysis, rapid diagnosis

2A5 BASELINE SENSITIVITY OF *Echinochloa* SPECIES TO TRIAFAMONE ASSESSED USING A MULTI-POT TRAY ASSAY

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Abstract

Echinochloa species have threatening rice production due to their high competitiveness and herbicide resistance, particularly to acetolactate synthase (ALS) and acetyl-CoA carboxylase (ACCase) inhibitors. Alternative herbicides with different modes of action can control herbicide resistant weeds but may also eventually result in resistance to these herbicides. Earlier estimation of potential risk of resistance to an herbicide may help maintain sustainability of the herbicide by delaying resistance development. Therefore, this study was conducted to estimate baseline sensitivities of two Echinochloa species (E. crus-galli and E. oryzicola) to a new ALS inhibiting herbicide, triafamone, using a multi-pot tray assay we developed. Pregerminated E. crus-galli and E. oryzicola accessions collected in northern part (Gyeonggi and Gangwon provinces) of South Korea were planted in multi-pot trays placed in a plastic box. At the 4 leaf stage, *Echinochloa* plants were submerged by flooded water and triafamone was applied directly to the flooded water at a range of doses. For *E. crus-galli*, the GR₅₀ values ranged from 5.8 to 779.5 g a.i. ha⁻¹ with the mean of 37.3 g a.i. ha⁻¹, resulting in the baseline sensitivity of 133.4. For *E. oryzicola*, the GR_{50} values ranged from 6.25 to 2045.0 g a.i. ha⁻¹ with the mean of 37.76 g a.i. ha⁻¹, resulting in the baseline sensitivity of 327.2. Our findings thus suggest that triafamone has a high potential risk of herbicide resistance development in Echinochloa spp. This may be due to a long-term use of other ALS inhibitors for Echinochloa control in paddy rice fields of Korea.

Keywords: Baseline sensitivity, Echinochloa spp., multi-pot tray assay, triafamone

2A6 POTENTIAL ESCAPE MECHANISMS FOR WEEDY RICE (*Oryza sativa*) FROM IMIDAZOLINONE HERBICIDE APPLICATION

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Abstract

Weedy rice (Oryza sativa L.) is a notorious weed species in rice growing areas in Malaysia. Clearfield® Rice Production System (CPS), an herbicide-tolerant rice cultivar, was introduced in Malaysia in the year 2010 as the current best solution to combat weedy rice especially in a direct-seeding system. The use of imidazolinone (IMI), the active ingredient in the OnDuty® herbicide, in CPS has successfully controlled weedy rice infestation. However, the evolution of weedy rice with various levels of resistance towards IMI herbicide has been reported in Malaysia. Therefore, this study was aimed to evaluate the association of weedy rice adaptive traits as potential escape mechanisms from IMI-herbicide treatment. A total of 96 random weedy rice samples with unknown resistant status towards OnDuty® herbicide were collected from various rice fields in Kedah and Selangor. The seed dormancy status was determined using standard germination test. Traits including pericarp and hull colour, shattering percentage, and presence of awn were recorded after growing the seeds in glasshouse. Determination of degree of resistant of collected weedy rice seed samples was carried out by soaking the seeds with a single-dose herbicide application. Seedlings germinability and viability were determined after 14d of soaking. Phenotypic data showed that collected weedy rice samples were 57.3% red pericarp colour (42.7% white), 59.3% straw-hulled colour (0.05% black; 35.4% furrow), 74% showed high shattering capability and 76% displayed no awn. Germination test showed that 96.7% of weedy rice populations had less than 50% germination rate indicating strong seed dormancy imposed in these weedy rice populations. However, high germination rate was observed after IMI-herbicide treatment, indicating the herbicide has no effect to seed germinability. Seed bioassay displayed that a total of 76.6% of weedy rice samples showed >50% germination rate with 16.7% displaying >50% viability rate indicating weedy rice already developed certain degrees of resistance towards Imidazolinone, while the remaining 23.4% still retain their susceptibility to the herbicide. Correlation analysis showed that weedy rice with weak dormancy (r = 0.256) and straw hull colour (r = 0.411) developed high susceptibility to IMI-herbicide. This study demonstrated that weedy rice populations in Malaysia displayed strong degree of seed dormancy which leads to high IMI-resistant potential. Pigmentation in the seed coat might provide extra defence mechanism of weedy rice to avoid herbicide injuries during seed development. Therefore, this might suggest that weedy rice escape to become resistant towards imidazolinone application could be from dormancy and hull.

Keywords: Adaptation, Clearfield® rice production system, herbicide resistant, imidazolinone, weedy rice.

2B1 THE DISCOVERY OF HERBICIDE SAFENERS FROM NATURE PRODUCTS

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Abstract

Herbicides are often used for the control of weeds in an effort to both make sure the adequate production of food crops and to meet the increasing production requirements on the globe. However, when used in field conditions, herbicides usually exhibit a very negative effect on the growth and yields of food crops such as corn, cereal, rice, barley, sorghum, soybean, wheat, etc. Herbicide safeners are chemicals that reduce the phytotoxicity of herbicides to crop plants without compromising weed-control efficacy and applying herbicide safeners is the most direct and cost-effective method to reduce the toxicity and improve the selectivity of herbicides. However, some of these commercially available herbicide safeners have been found to be toxic to both aquatic organisms and mammals for example, benoxacor, which is proved to be highly toxicity to the aquatic antotrophs (the acute LC_{50} for freshwater algae is 0.53 mg/L), and it led to an increased search for high-efficiency, high-activity, and relatively environmentally friendly herbicide safeners. Natural products were usually used as crop protection agents in green pest management and organic agriculture for their relative environmental safety. Hence, this report will mainly describe the discovery of nature product herbicide safeners (sanshools, Z-ligusticide and furocoumarin), which were extracted from the traditional Chinese medicinal materials-Chinese red pepper, Rhizoma et Radix Notopterygii and Ligusticum chuanxiong, respectively. These nature products have quite different structures from that of commercial herbicide safeners, and also showed similar herbicide safener activities compared to those commercial ones. Even more, in this report, we will further describe the optimization of sanshools that were chose as the herbicide safener lead. Three series of N-alkylamide derivatives were synthesized via one-spot process by shortening the unsaturated long-chain alkyl groups from the lead sanshools. The herbicide safener activity of these compounds to protect rice from metolachlor injury was tested and the structure-activity relationship (SAR) was also discussed. Most of these N-alkylamide derivatives showed moderate to good herbicide safener activities. In particular, after the combined treatment of 0.25 µM of metolachlor and 5 mg/L of 2k, one of the N-alkylamide derivatives, the recovery rates of the injured rice seedlings were 86.31%, 92.02% and 78.31% of the non-treated control values in shoot height, root length and fresh biomass, respectively. The latter were superior to the recovery rates upon using the commercial agent dichloroacetamide. This report will both provide lead compounds for designing novel herbicide safeners and give useful guidance to discover novel safeners from nature products.

Keywords: Herbicide safeners, Rhizoma et Radix Notopterygii, *Ligusticum chuanxiong,* weed management.

BIOEFFICACY EVALUATION OF PELARGONIC ACID, ALTERNATIVE HERBICIDES AND HERBICIDE COMBINATIONS FOR THE CONTROL OF VOLUNTEER OIL PALM SEEDLINGS IN IMMATURE OIL PALM

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Abstract

Volunteer oil palm seedlings (VOPS) has become a serious problem in replanting and immature area of oil palm caused by uncollected loose fruits and oil palm fruitlets that were buried during land clearing and land preparation. These viable seeds germinate voluntarily in the newly replant area in high numbers. Use of systemic or translocative herbicides is prohibited in immature palms due since it is harmful and cause phytotoxicity to the palms. A new contact non-selective herbicide, pelargonic acid, a fatty acid derived from natural sources was recently introduced. A research trial was conducted at an immature oil palm field to evaluate this new herbicide and several other herbicides to determine its effectiveness in controlling volunteer oil palm seedlings. Results showed that for volunteer oil palm seedlings with the height above 30 cm, pelargonic acid 80% w/w at 22.5 litre per ha combined with glufosinate ammonium 13.5% at 1.5 litre per ha, glufosinate ammonium at 3.3 litre per ha combined with sodium chlorate 99%, glufosinate ammonium at 1.5 litre per ha combined with MSMA 47% w/w at 3.0 litre per ha, glufosinate ammonium 13.5% w/w at 1.5 litre per ha combined with premix formulation of MSMA 39.5% + Diuron 7.8% w/w at 3.0 liter per ha was equally effective in causing 100% mortality of volunteer oil palm seedlings at 84 Davs After Treatment (DAT) which is equally effective with glyphosate isopropylamine 41% w/w at 11.25 litre per ha and glyphosate monoammonium 33.6% w/w at 5 litre per ha. For volunteer oil palm seedlings below 30 cm height, pelargonic acid 80% w/w was as effective with other herbicide in causing 100% mortality at 84 DAT.

Keywords: Contact herbicides, pelargonic acid, glufosinate ammonium, sodium chlorate, glyphosate.

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Abstract

Echinochloa species is one of the most important weeds and the wide spread of herbicide resistant Echinochloa species, particularly to acetyl CoA carboxylase (ACCase) and acetolactate synthase (ALS) inhibitors, is now threatening rice cultivation in many countries. Herbicides with alternative modes of action are urgently required for herbicide resistant Echinochloa management. A new herbicide Rinskor[™] Active (florpyrauxifen-benzyl ester) belonging to Group O (HRAC) / Class 4 (WSSA) was registered in Korea since 2017 and has shown effective activity against Echinochloa species including ACCase and ALS inhibitor resistance populations at 4 to 5 leaf stages by foliar application. However, continuous use of Rinskor could eventually select for resistant *Echinochloa* to Rinskor. Therefore, a baseline sensitivity of Echinochloa species to Rinskor was investigated to evaluate the potential risk of the evolution of resistance in Echinochloa species to this new herbicide on 70 samples of Echinochloa crus-galli and E. oryzicola that were collected nationwide paddy fields in Korea. Samples were grown in plastic pots up to the 5 leaf stage and Rinskor was applied postemergence at 0, 2.1875, 4.375, 8.75, 17.5, 35, and 70 g a.i. ha⁻¹ using a spray booth equipped with 8002 flat fan nozzle adjusted to deliver 600 L ha⁻¹. Mean and median GR_{50} values of Rinskor were 11.42 and 11.31 g a.i. ha⁻¹, respectively, for *E. crus-galli* and 8.4 and 6.9 g a.i. ha⁻¹ for *E. oryzicola*. The baseline sensitivity index was 2.4 (16.4 / 6.9 g a.i. ha⁻¹) and 6.9 (25.4 / 3.7 g a.i. ha⁻¹) for E. crus-galli and E. oryzicola, respectively. Therefore, results suggest that E. oryzicola has a potentially greater risk of resistance development to Rinskor than E. crus-galli. For the sustainability of Rinskor for Echinochloa management in paddy fields, a strategic rotational use of Rinskor with other herbicides with different modes of action may be preferred, particularly for E. oryzicola, and a regular monitoring of resistance to Rinskor is also essential as a part of a resistance management strategy.

Keywords: Rinskor, florpyrauxifen, resistance, baseline study, *Echinochloa*.

2B4 BASELINE SENSITIVITY OF *Echinochloa crus-galli* TO FLORPYRAUXIFEN-BENZYL IN KOREA
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Abstract

Echinochloa crus-galli (barnyardgrass) is one of the most noxious weeds in rice cultivation because of its high competitiveness against rice and resistance to aceotolactate synthase (ALS) and acetyl CoA carboxylase (ACCase) inhibiting herbicides in many countries including Korea. Alternative herbicides with different modes of action can be considered as a solution to manage resistant *E. crus-galli*. Florpyrauxifen-benzyl ester (Rinskor™ Active, HRAC Group O / WSSA Class 4) was newly introduced in Korea due to its new mode of action and effective activity against Echinochloa species including ACCase and ALS inhibitor resistant *Echinochloa* species even at the 5 leaf stage. However, repeated use of florpyrauxifen-benzyl may lead to Florpyrauxifen-benzyl resistance in *E. crus-galli*. Therefore, this study was conducted to estimate the baseline sensitivity of *E. crus-galli* to florpyrauxifen-benzyl. Seventy accessions of Echinochloa crus-galli collected nationwide in paddy fields of Korea were grown in plastic pots up to the 5 leaf stage and florpyrauxifen-benzyl was applied to the foliage of Echinochloa crus-galli at a range of doses (0, 2.1875, 4.375, 8.75, 17.5, 35, and 70 g a.i. ha ¹) using a track sprayer equipped with 8002 flat fan nozzle adjusted to deliver 600 L ha⁻¹. Mean and median GR_{50} values of florpyrauxifen-benzyl was 11.42 g and 11.31 g a.i. ha⁻¹, respectively, and the highest and the lowest GR₅₀ values were 16.4 g and 6.9 g a.i. ha⁻¹, respectively, resulting in the baseline sensitivity index of 2.4. Our results thus suggest that Echinochloa crus-galli has a potentially low risk of resistance development to florpyrauxifenbenzyl. Therefore, it is expected that proper rotation of the florpyrauxifen-benzyl with herbicides with different mode of action in the paddy field will maintain adequate levels of control over *E. crus-galli* for a considerable period of time.

Keywords: Baseline sensitivity, *Echinochloa crus-galli*, florpyrauxifen, herbicide resistance.

2B5 SYNERGISTIC EFFECT OF HYDROLIZED CORN GLUTEN MEAL ON ACETOCHLOR

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Abstract

Bioassay method, High performance liquid chromatography (HPLC) and field trials were used to investigate the synergistic mechanism of hydrolized corn gluten meal adding to acetochlor and its effect on crop growth and development. Hydrolized corn gluten meal (H-CGM) synergists improved the activity of acetochlor EC and the the stability of acetochlor's efficacy. The separate acetochlor pre-treatment germination inhibition rate was 9.34%, and the fresh weight inhibitory rate was 8.26% at dosage as low as 25 ga.i.hm⁻². After the H-CGM synergist was added, the control effect increased to 45.82% and 49.34%, which is more than 4-fold; similarly, high concentrations approximately doubled the effect. The effect of post-emergence was still greater than that without the added synergist, and the difference was significant. In addition, as the addition dosage of H-CGM increased, the surface tension, viscosity and drying duration of the acetochlor solution increased. When the addition dosage of H-CGM was within a certain range, the maximum retention of the acetochlor solution increases with the addition dosage. When the addition dosage exceeds 7.5%, the maximum retention was discreased. The H-CGM synergist promoted the absorption of acetochlor by barnyard grass seeds. In summary, H-CGM could increase the activity of acetochlor, significantly. The H-CGM synergist also improved maize safety, promoted maize growth and development.

Keywords: Biological synergist; hydrolized corn gluten meal; acetochlor; synergistic effect; synergistic mechanism

2B6 BIXLOZONE: A NEW ISOXAZOLIDINONE HERBICIDE FOR A WIDE RANGE OF MAJOR CROPS

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Abstract

Bixlozone is a new herbicide from the isoxazolidinone family discovered and developed by FMC's research and development organization. It provides a new and unique selective residual weed control solution in a wide range of crops including, cereals, corn, legumes, oilseed rape, rice and sugarcane, and will offer a new mode of action herbicide solution for many of these crops. Bixlozone provides both systemic and contact activity, with residual control and can be applied pre-emergence, early post-emergence or incorporated by sowing, across a wide range of agronomic environments. It controls major problem grass weeds including ryegrass and blackgrass, and several key broadleaf weeds by inhibiting 1-deoxy-Dxylulose 5-phosphate synthase resulting in the disruption of plastid isoprenoid biosynthesis. Bixlozone is proposed to be classified as an HRAC Group F4 and will offer a new rotational product tool for resistance management. It will be an ideal complementary mixing partner for broadleaved herbicides as it can extend the utility of existing molecules by expanding the weed spectrum in many cases at reduced use rates. It will also be safe to a wide variety of rotational crops seeded after initial crop planting. Bixlozone is expected to be first launched in Australia in 2021 in cereals and rapeseed with subsequent launches planned in Asia Pacific, Latin America, and Europe.

Keywords: Bixlozone, isoxazolidinone, blackgrass, ryegrass

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Abstract

Grain legumes are the second most important group of crops after cereals and remained integral part of Indian agriculture since time immemorial. They are among the ancient food crops with evidence of their cultivation for over 8,000 years. Grain legumes are valued for their importance in nutritional security, soil amelioration and sustainable crop production. They also play an important role in protecting the environment from the risk associated with present day high input agriculture. Over a dozen pulse crops including chickpea, pigeonpea, urdbean, mungbean, lentil, cowpea, lathyrus, frenchbean, horsegram, field pea, moth bean, etc. are being grown in one or the other part of the country throughout the year. The total production of grain legumes (2017-18) in the country is 25.23 million tonnes from an area of 31.11 million hectares with productivity of 811 kg/ha. The productivity of grain legumes, however, continues to be low as they are generally grown in rainfed areas (85%) under poor management condition and face various kinds of biotic and abiotic stresses. Weeds are the principal biotic constraints to grain legume production. It is estimated that out of total annual losses of grain legumes from various pests, weeds alone account more than 30%. Manual weeding is generally being done but due to higher operational cost and also difficulties in carrying of the operation during rainy season, the option for use of herbicides was explored since long. Till date. only few herbicides are registered for the use in grain legumes and that too for preemergence or pre-plant application. Therefore, most of the earlier recommendations in grain legumes are combination of pre-emergence herbicide and manual weeding. Thus, an integrated approach should be followed which include cropping systems, crop husbandry, plant type, mechanical weeding, herbicides, herbicide resistant cultivars, allelochemicals, etc. Weed smothering efficiency of different crops in intercropping is already reported by many workers. Similarly, the effect of previous crop and their management practices also showed effect on weeds in succeeding crops in cropping system. The reduction in overall weed population and Cyperus infestation is reported under green manuring with dhaincha and summer mungbean. Some of the post-emergence herbicides like imazethapyr (rainy season grain legumes) and guizalofop-p-ethyl (in winter grain legumes) were found effective in controlling weeds. Progress is also made in development of herbicides resistant cultivars of grain legumes. The presentation will include glimpse of all such possible strategies of weed management in grain legumes.

Keywords: Cropping system, grain legumes, herbicide, stress, weeds

2C2 WEED MANAGEMENT OPTIONS FOR STRIP TILLAGE MAIZE IN BANGLADESH

Weed Science for Sustainable Agriculture and Environment

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Abstract

Field study was conducted at the Regional Wheat Research Centre, Bangladesh Agricultural Research Institute, Rajshahi, Bangladesh (24°3'N, 88°41E, 18 m above sea level). The site has a subtropical climate and is located in Agro Ecological Zone 25 (Old Himalayan Piedmont Plains) on flood-free high land, with course-textured and highly permeable soil. The objectives of the study were to find out the most effective weed control method in maize and to compare the effects of different pre and post emergence herbicides on said crop. The average yield of maize (7.18 t ha) in the country is comparatively low compared to other maize producing countries of the world. Low yield of maize in Bangladesh is largely due to poor weed management practices. Yield loss of maize crop was about 21-25% only due to the weed infestation. The farmers are usually reluctant to control the weed in maize field. However, sometimes they use hand-weeding, which proves uneconomical due to the increasing of labor wages and shortage of labor. Herbicides were most economical and, saving time and labor for controlling weed in maize field. Non-selective herbicide like glyphosate with pre and post emergence herbicides were used in 25-30 days after sowing in maize field. Pre-emergence herbicides were pendimethalin and atrazine and post-emergence herbicides were atrazine. tembotrione (Laudis), Halosulfuron methyl (Sempra), tembotrione (Laudis) + atrazine & halosulfuronmethyl (Sempra) + atrazine. The population and dry weight of weeds were less significantly when applied with pre-emergence of atrazine and atrazine+Laudis as the post emergence herbicides treated plot over control plot. In addition, the weed control efficiency was significantly higher in pre-emergence Atrazine and atrazine+Laudis as the post emergence herbicides treated plot over control treatment. Grain and stover yield were significantly higher in pre-emergence atrazine and post emergence atrazine+Laudis herbicides treatment over control plot. Significantly yield loss was less in pre-emergence Atrazine and post emergence atrazine+Laudis herbicides treatment plot over control plot. Overall performance of the herbicides experiment showed that atrazine as the pre-emergence and atrazine+Laudis as the post emergence herbicide for best controlling weeds spices in strip tillage maize cultivation in Bangladesh. Besides, atrazine as the pre-emergence and atrazine+Laudis as the post emergence herbicides were economically beneficial for the effective control of maize weeds compatibly with less cost. Thus, atrazine as the preemergence herbicide and atrazine+Laudis as the post emergence herbicide may be the best options for controlling weeds in strip tillage maize cultivation in Bangladesh.

Keywords: Maize crop, pre and post emergence herbicides, weed species, yield loss, weed control efficiency

2C3

WEED MANAGEMENT FOR REDUCED USE OF PARAQUAT IN CASSAVA PRODUCTION

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Abstract

In Thailand, cassava is mainly grown in sandy and sandy loam soil under rainfed condition. As the labor was shortage and expensive, herbicides became an alternative weed control among farmers. In general, paraquat, the most popular post-emergence herbicide, was applied 2-4 times/crop. However, crop injury was often found resulting in yield reduction. This study aimed to use pre-emergence herbicides to minimize use of paraquat in cassava production. Three weed managements were evaluated in farmer's field with plot size of 1.5 ha during May2017-April 2018. Firstly, a tank mixture of acetochlor 50% EC and flumioxazin 50% WP at the rate of 1.5 kg + 0.0625 g ai ha⁻¹ was applied at one day after planting followed by one application of paraguat at 60 days after planting. Secondly, alachlor 48% EC at 2.0 kg ai ha⁻¹ was applied immediately after planting followed by two applications of paraguat at 30 and 60 days and mechanical control at 90 days after planting. Thirdly, flumioxazin 50% WP at 0.0625 g ai ha⁻¹ was applied immediately after planting followed by two applications of paraguat at 30 and 60 days and mechanical control at 90 days after planting. The results exhibited that a tank mixture of acetochlor 50% EC and flumioxazin 50% WP gave an excellent weed control for 60 days and only a single application of paraguat was required. In contrast, a single herbicide application, either alachlor or flumioxazin, did not give a broad spectrum of weed control so that paraguat and mechanical control were needed. It was noted that first weed management gave better weed control and higher yield than the others. Later, cassava farmers' adoption was observed in 65 farmers. About 70% of total farmers preferred a tank mixture of acetochlor 50% EC and flumioxazin 50% WP at the rate of 1.5 kg + 0.0625 g ai ha⁻ ¹ at one day after planting followed by one shot of paraguat at 60 days. It only reduced the use of paraguat but minimized cost of cassava production by 60%. Hence, good weed control at 1-2 months after planting played an important role on the reduction of paraguat use in cassava.

Keywords: Acetochlor, alachlor, cassava, flumioxazin, paraquat, weed management

WEED SUPPRESSION EFFECT OF AFRICAN TULIP WOODCHIPS (Spathodea campanulata) AT DIFFERENT THICKNESS MULCH IN VEGETABLE AND ROOT CROP PRODUCTION

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Abstract

Spathodea campanulata (P.Beauv), commonly known as African tulip tree is regarded as an invasive plant in most countries. S.campanulata was introduced into Fiji in 1936 (Parham, 1964) and has rapidly spread throughout the country. S campanulata has become invasive and occupies agricultural farming area and native forest (Larrue, Daehler, & Bufford, 2014). Its negative impact to the environment outweighs its potential uses. Using S. campanulata woodchips as mulching were not known in Fiji. Therefore, a study was conducted at Crop Research farm in Koronivia Research Station, to examine the effects of using African tulip (Spathodea campanulata) woodchips as mulch for weed suppression in eggplant (Solanum melongena) field and taro (Colocasia esculentum) Linn. (Schott and Endl) production. The trials consisted of three different depths of shredded S. campanulata stems (2.5cm, 7.6cm, and 12.7cm) and no mulch as control plots. The result indicates that S. campanulata woodchips suppresses weeds. The weight of eggplant fruit and taro corms was higher in 7.6cm depth than other three treatments (2.5cm, 12.7cm and no mulch). There were greater number of weeds controlled in depths of 7.6cm and 12.7cm as compared to the depth of 2.5cm and plot with no S. campanulata wood chips. There was no significant difference between S. campanulata woodchips depth of 7.6cm and 12.7cm in the number of weeds controlled and vield of eqgplant and taro. The 7.6cm depth would require less volume of S. campanulata chips than 12.7cm depth to cover a given area of land. Therefore, the 7.6cm depth of S. campanulata woodchips is recommended.

Keywords: African tulip, Fiji, mulch of different depth, *Spathodea campanulata*, weed suppression, woodchips.

EFFICACY OF HERBICIDES ON WEED CONTROL IN MUNGBEAN CULTIVATION IN BANGLADESH

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Abstract

Mungbean (Vigna radiata L.) is one of the important pulse crop in cereal-based cropping systems of Bangladesh due to short duration (60-65 days). But the farmers grow it without or almost with less care. Whereas, weed is one of the negative factor for successful crop production which causing crop losses 50-70% in mungbean. There are different weed control methods like- manual, mechanical and herbicide application etc. but manual and mechanical weeding are laborious, time consuming and costly. In many countries herbicides are being used for controlling weed but yet in Bangladesh it is not identified that which herbicide is suitable for weed control. Under the above circumstances it is necessary to know that which is the proper herbicide for controlling weeds in mungbean cultivation. Considering the above demand, a field experiment was conducted at two locations Ishurdi and Gazipur under Bangladesh Agricultural Research Institute, Bangladesh during Kharif-I season of 2015 and 2016 to find out the suitable and economically viable herbicide for controlling weed in mungbean cultivation. There were nine weed management options like pre and post sowing application of Whipsuper (Fenoxyprop-P-ethyl), Release (Fenoxyprop-P-ethyl), Tyzalo super (Quizalofop-P-ethyl)) @ 1.3ml/L water for all, Hand weeding at 20 DAE, Weed free plot and Control. From the two years pooled results it was found that post-sowing whipsuper showed the highest weed control efficiency (79.92% and 82.22%), and less intensity of weed infestation (1) for Ishurdi and Gazipur, respectively. Weed free plot produced the highest seed yield (1413 kg ha⁻¹ and 1510 kg ha⁻¹) of mungbean followed by post-sowing whipsuper (1240 kg ha⁻¹ and 1335kg ha⁻¹) and the lowest seed yield (631 kg ha⁻¹ and 626 kg ha⁻¹) was recorded in control at Ishurdi and Gazipur, respectively. The highest net return (Tk 47035 ha⁻¹ and Tk 50285 ha⁻¹), and MBCR (20.45 and 21.86) were found in post-sowing whipsuper and the lowest net return (Tk 16160 ha⁻¹ and Tk 19085 ha⁻¹) and MBCR (7.03 and 8.30) were found in pre-sowing release for Ishurdi and Gazipur, respectively. According to cost analysis the lowest MBCR (1.24 and 1.45) was found in weed free plot due to higher labor cost. Among the herbicides, post-sowing whipsuper performed better for reducing the number of weeds which also produced statistically higher seed yield. It is also identified through crop response study that there was no residual effect of herbicide and this technology is performing better in the farmer's field.

Keywords: Efficacy, herbicide, mungbean, weed

SUSTAINABLE AGRICULTURE IS INTERGRATION OF TOOLS AND MINDSET OVERHAUL

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Abstract

Modern agriculture is replete with tools - classical and technologically advanced. Agricultural innovations are ramping up rapidly in many areas of science and technology. Modern tools fall into broad categories such as fertilizer technology, pesticide technology (for diseases, insects, weeds, nematodes), irrigation technology, improved crop varieties, tillage and cultivation implements. Many of these tools are products of overarching technological advances in the fields of crop biotechnology, molecular biology, molecular breeding, nanotechnology, 'OMICS' and bioinformatics, remote sensing and drone technology, and robotics. Resistance to herbicides and climate change are driving agricultural innovations in weed management. Contemporary weed populations are adapting to chemical management tools almost as fast as, or faster than, scientists can produce new ones. Indications are that climate change accelerates weed adaptation to herbicides and will tip the competition scale more in favor of weeds than crops. Attaining sustainable food production and conserving the environment are becoming ever more difficult. Sustainable agriculture means sustaining food production and ecological health and conserving natural resources. The tools we have, by themselves, cannot help us attain sustainable agriculture. We have to use these tools holistically, in full integration. Wise integration of tools requires collective action across all sectors of the private industry, academia, government, farmers and general consumers. Appropriate integration of tools necessitates intensive education across the board - from technology generators, farm input providers, technology advisors, government institutions and policy makers, to farmers and consumers. For example, policies and programs supportive of farmers, the agriculture industry in general, and environmental conservation cannot be made by legislators who do not have a comprehensive understanding of the issues we face. Without support, and without understanding of sustainable farming practices, adoption of sustainable practices will be limited and ineffective. Fully integrated crop production is complex and often costly; these are major deterrents of technology adoption. To practice sustainable agriculture is to acquire a new mindset and a new conviction for all – that agriculture cannot remain just as a means to survive through one year, but as a means to preserve mankind. Sustainability can only be achieved if we ascribe to a common goal and work as a collective.

Keywords: Climate change, integrated weed management, modern farming tools, sustainable food production, weed resistance

2D2 SAFENING S-METOLACHLOR IN RICE VIA EXTRACT Ligusticum chuanxiong

Weed Science for Sustainable Agriculture and Environment

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Abstract

Ligusticum chuanxiong oil was extracted through CO₂-Supercritical Fluid Extraction method and endowed predominant alleviation of injury to rice from S-metolachlor. However, its mechanism is poorly understood. To our knowledge, most herbicide safeners function through enhancement of herbicide metabolism in crops. Plant xenome refers to such as glutathione transferases (GSTs), cytochrome P450 (CYPs) and glycosyltransferases (UGTs) and plays an important role in herbicide metabolism. Hence, expression of xenome was compared following treatment with *Ligusticum chuanxiong* oil, using RNA-Seq. Results revealed significant upregulation of 15 GSTs, 14 CYPs and 11 UGTs, compared with the untreated control. Moreover, the activities of GSTs and CYPs enzymes were investigated. Following treatment with extract, GSTs enzyme activity evidently elevated up to 36%, and CYPs activity slightly increased, but less than 8% with no significance. Therefore, we believe induction of these genes, especially GSTs, is likely to enhance S-metolachlor metabolism and thus lead to rice protection. Subsequent qPCR experiment is underway to quantify the expression level of these upregulated genes. Furthermore, we will focus on the validation of crucial genes for safening effect on rice, using gene overexpression in rice calli and plant.

Keywords: Herbicide safener, Ligusticum chuanxiong, transcriptomics, overexpression

2D3

GENETIC DIVERSITY, AND ORIGINS OF WEEDY RED RICE AND THE USE OF PHYLOGEOGRAPHICAL STRUCTURES TO CONTROL ITS SEED-MEDIATED CONTAMINATION IN TAIWAN

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Abstract

Weedy red rice (WRR) possesses traits, including seed dormancy and shattering, that facilitate its infestation in rice fields from one crop season to the next. These plants are not only the potential source of pollen-mediated gene flow and hosts for diseases or other pests, but also are competitors for fertilizer due to their vigorous growth. In addition to increase production costs to control this weed, the red pericarp and undesirable eating qualities of WRR lead to reduce product value, consequently putting production constraints on the global rice industry. The rice production system in Taiwan relies on transplanting which is recommended for effective control of weeds in rice fields during the seedling stage. However, the infestation of WRR in rice fields has become increasingly severe in the past few years in Taiwan. Although WRR occurs at a rate of only 0.5 to 1% in contaminated fields, it can be spread easily through the use of shared field equipment among rice fields. Ratoon cropping or tillage immediately after harvest increases the population densities of WRR, resulting in future yield losses. Effective control strategies for WRR should meet the balance between economic benefit, efficiency, and feasibility. The recommended WRR control measures under a transplanting system begin with irrigating the paddy field after harvest to induce the sprouting of shattered seed, followed by plowing the WRR seedlings into the soil. Herbicide is applied three times in succession every seven days to kill emerging WRR. The final step is the manual removal of the remaining WRR.

Keywords: Weedy red rice, phylogeographical structures, seed-mediated contamination, weed management

PERFORMANCE OF BENSULFURON-METHYL 1.1% + METSULFURON-METHYL 0.2% + ACETOCHLOR 14% WP AGAINST WIDE RANGE OF WEED CONTROL IN TRANSPLANTED RICE OF BANGLADESH

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Abstract

Weeds cause major problem in rice production, which compete with crop yield and also impair guality of rice. Manual weeding is costly and laborious, one of the alternate options is use of herbicide. Bensulfuron-methyl 1.1% + Metsulfuron-methyl 0.2% + Acetochlor 14% is a new pre-emergence and early post emergence herbicide in Bangladesh. It controls annual and perennial weeds and sedges through inhibition of the enzyme acetolactate synthase (ALS) which leads to the rapid cessation of cell division and subsequent growth processes in plants. Field trials were conducted at Bangladesh Rice Research Institute (BRRI), Gazipur during Aman (wet season), 2016 and Boro (dry season), 2016-17 to evaluate the efficacy of Bensulfuron-methyl 1.1% + Metsulfuron-methyl 0.2% + Acetochlor 14% on a wide range of weed suppression and performance of transplanted rice. Bensulfuron-methyl1.1% + Metsulfuron-methyl 0.2%+ Acetochlor 14% WP @ 75, 90 and 105 g ha⁻¹ were applied along with Bensulfuran methyl 14%+ Acetochlor 14% WP @ 750 g ha⁻¹, weed free and unweeded control was used for assessment. Visual assessment indicated that this herbicide possesses high selectivity and not toxic to rice plants. The results revealed that the major weed flora associated with the transplanted rice was mainly comprised of two grasses, two sedges and four broadleaves in Aman (wet season), 2016 and two grasses, two sedges and two broad leaves in Boro (dry season), 2016-17. The most dominant weeds were Cyperus difformis, Echinochloa crus-galli, Scirpus maritimus and Monochoria vaginalis in both the growing seasons. Application of Bensulfuron-methyl 1.1% + Metsulfuron-methyl 0.2%+ Acetochlor 14% WP @ 90 g ha⁻¹ was most effective to suppress weed emergence and biomass in both the seasons resulting increased grain yield more than 50% as compared to unweeded control. Therefore, Bensulfuron methyl 1.1% + Metsulfuron-methyl 0.2% + Acetochlor 14% WP @ 90 g ha⁻¹ should be applied at one-to two-leaf stage of weed for effective control of weeds in transplanted rice.

Keywords: Bensulfuron-methyl 1.1% + metsulfuron-methyl 0.2%+ acetochlor 14% WP, grain yield, transplanted rice, weed control efficiency.

WEED-COMPETITIVE RICE: AN ECO FRIENDLY APPROACH TOWARDS MINIMIZING USAGE OF HERBICIDES IN SRI LANKA

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Abstract

Crop competitiveness against weed can be defined as the ability to maintain higher yields under weedy conditions. Weed management in lowland rice production is a major constraint leading to low yields. Identification and development of competitive rice varieties may be effective in weed suppression and be a valuble component in integrated weed management. Three rice varieties namely; At 306 and Bg352(new improved) and Suwandel (traditional), and seven rice lines, At 10-1240, Bw11-3403 and At 10-1327 (local) and AERON 9-3, AERON 10-26, IR09N247 and Zhonghua (from IRRI, Philippines) were evaluated for their weed competitiveness during two cultivating seasons namely; Yala (Minor Season; March-September) 2015 and Maha (Major Season: October-February) 2015/2016. Further another set of three imported rice lines from IRRI at the Philippines, namely; IRDTN 07-11, AERON 9-3 and QR IRO 10A 107 and two locally developed rice lines, namely: QR 15-520 and QR 16-2022 were evaluated for their weed competitiveness during Maha 2017/2018 and Yala 2018. Both field experiments were done at the Rice Research and Development Institute (RRDI) at Batalagoda, Sri Lanka. The % vield reduction for each rice variety/line was calculated by standard formulae. Weed-competitiveness was calculated according to formulae of S. S. Harding and A. B. Jalloh, 2013. Data were analyzed using SAS software employing GLM procedure. The local lines Bw11-3403 and At10-1327 were very highly weed-competitive (VHC). AERON9-3, AERON10-26, At10-1240, Zhonghua and IRDTN 07-11 were highly weed competitive (HC). Bg352, QR 15-520 and QR IRO 10A 107 were competitive (C). IR09N247, Suwandal and QR 16-2022 were moderately weed-competitive (MC). These varieties/lines showed a faster conopy closure over the time compared to other tested lines used in preliminary studies, which is a favourable character for weed suppression that can be used in future breeding programs. Faster canopy closure capacity, less than 15% of yield reduction due to weed competition could be considered as criteria for identifying rice varieties/lines that are weed competitive. Weed competitive rice cultivars can effectively be incorporated into integrated weed management package and will also help in minimizing usage of chemical herbicides.

Keywords: Canopy closure, rice varieties/lines, weed competitiveness, yield reduction

EFFECTS OF IMIDAZOLINONE FORMULATION, APPLICATION RATE AND APPLICATION TIMING ON CONTROL OF WEEDY RICE AND SELECTED WEED SPECIES IN CLEARFIELD® RICE SYSTEM

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Abstract

Two field studies were conducted at main-season 2017 and off-season 2018 in the rice field of MARDI Seberang Perai, Malaysia to determine the influences of Onduty[®] and Kifix[®] application rate and application timing on weedy rice and other weed species control. The herbicide treatments were: (i) Onduty® 75 g ai/ha was sprayed at 5 days after rice sowing (DAS); (ii) Onduty[®] 150 g ai/ha was sprayed at 5 DAS; (iii) Kifix[®] 75 g ai/ha was sprayed at 14 DAS; (iv) Kifix[®] 150 g ai/ha was sprayed at 14 DAS; (v) Onduty[®] 75 g ai/ha was sprayed at 5 DAS followed by (fb.) Kifix[®] 75 g ai/ha was sprayed at 14 DAS; (vi) Onduty[®] 75 g ai/ha was sprayed at 5 DAS fb. Kifix[®] 150 g ai/ha was sprayed at 14 DAS; (vii) Onduty[®] 150 g ai/ha was sprayed at 5 DAS fb. Kifix[®] 75 g ai/ha was sprayed at 14 DAS; (viii) Onduty[®] 150 g ai/ha was spraved at 5 DAS fb. Kifix[®] 150 g ai/ha was spraved at 14 DAS: and (ix) weedy check plot. The emergence and growth of weedy rice were completely inhibited in the plots treated with Onduty[®] 150 g ai/ha at 5 DAS, Onduty[®] 150 g ai/ha at 5 DAS fb. Kifix[®] 75 g ai/ha at 14 DAS, and Onduty[®] 150 g ai/ha at 5 DAS fb. Kifix[®] 150 g ai/ha at 14 DAS. This result indicated single spray of Onduty[®] 150 g ai/ha at 5 DAS is sufficient to control weedy rice in Clearfield[®] rice system. Single spray of Kifix[®] 150 g ai/ha at 14 DAS, had reduced weedy rice density and dry weight up to 60 and 65%, respectively, when compared to the untreated plot. Besides, single application of Onduty[®] 150 g ai/ha at 5 DAS reduced dry weight of *Fimbristylis miliacea* (38 to 100%), Leptochloa chinensis (100%), Limnocharis flava (78%), and Monochoria vaginalis (92 to 100%) as compared to those observed in the plots treated with Kifix[®] 150 g ai/ha at 14 DAS. Results of the study revealed that, though Onduty[®] and Kifix[®] are sharing the same active ingredients (imazapic and imazapyr), but differences in chemical proportion in the product formulation, the application rate and timing play an important role in achieving effective weed control.

Keywords: Weedy rice, Clearfield[®] rice, imidazolinone herbicide, Onduty[®], Kifix[®]

EFFECT OF THERMAL TIME ON GROWTH AND FECUNDITY OF REDROOT PIGWEED (Amaranthus retroflexus)

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Abstract

Amaranthus retroflexus is a problematic weed encountered in Cotton (*Gossypium hirsutum* L.) growing regions of Australia. This research investigates the influence of thermal time and biotypes (Goondiwindi and Gatton) on growth and reproduction of *A. retroflexus*. An infield pot experiment was conducted in in 2017- 2018. Both the biotypes of *A. retroflexus* were planted in pots in early, mid, late, very late season at research facility of University of Queensland, Gatton. Maximum plant height of 91 cm was achieved by early planting biotypes of *A. retroflexus*. A. *retroflexus* achieved the height of 45 cm when planted in late very late season. Early season planted *A. retroflexus* plants reach 50% height in height in 15-18 day earlier than late season. Both the populations produced less than 100,000 seeds plant⁻¹. None of the planting date plants could achieve above ground biomass of 560 g plant⁻¹ and the very late planted plants exhibits lowest quantum of above ground biomass. It was also observed that *A. retroflexus* collected from both locations can vary biologically, plants exhibited environmental plasticity and could complete their life cycle and contribute to spreading populations.

Keywords: Phenology, thermal time, weed, Amaranthus

DISTRIBUTION PATTERNS OF WEEDY RICE POPULATIONS IN VAVUNIA DISTRICT, NORTHERN PROVINCE OF SRI LANKA

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Abstract

Weedy rice (Oryza sativa f. spontanea) is a challenging threat to worldwide rice production. Radiative adaptive capability of weedy rice (WR) to wide environmental stresses enables them to successfully compete with cultivated rice varieties causing considerable loss in yield. Emergence of WR in Vavuniya District is reported recently and provide an opportunity to study the distribution pattern of WR in new habitats. Limited studies are available on occurrence and spatial distribution patterns of WR populations in Northern Province. Present study was carried out to assess the spatial distribution and variation of agro-morphological characteristics of WR populations in Vavuniya District in Northern Province of Sri Lanka. Seeds of different WR populations were collected from eight different locations in Vavunia District representing three agro-ecological sub-regions: DL1b and DL1e (900mm, moderately dry) and DL1f (> 800mm, dry). The collected seeds of cultivated rice varieties and presumed WR accessions were sown in plastic trays and transplanted to pots filled with respective paddy soils. The pots were arranged in CRD in a plant house at the School of Agriculture. Paranthan, Sri Lanka and 31 agro-morphological characters were measure/observed. A total of thirteen (5 parametric and 8 non-parametric) agro-morphological characters of WR populations vary significantly across agro-ecological sub-regions indicating ecological provenance in distribution. The populations in drier areas (DL1f) are well-separated from the populations in moderately dry (DL1b and DL1e) areas. Variation of agro-morphological characters across the agro-ecological regions also suggest that WR accessions are adapting to a diverse habitat condition in Vavuniya District. The association between the occurrence of WR and cultivated rice was stronger in Bg rice series over other cultivated rice series (Bw and At series). An in-depth study needs to be carried out to confirm present findings.

Keywords: Agro-morphology, ecological provenance, *Oryza sativa* f. *spontanea*, Sri Lanka, Vavunia District.

PHENOLOGY, FECUNDITY AND DORMANCY OF Avena sterilis ssp. ludoviciana FROM PLANTS GROWN UNDER LATE SEASON SOIL WATER STRESS

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Abstract

Wheat (Triticum aestivum L.) is the main winter crop in the northeastern grain region (NGR) of Australia, cultivated following no-till or minimum till coupled with stubble retention i.e. conservation agriculture (CA). On the other hand wild oat (Avena sterilis ssp. ludoviciana (Durieu) Nyman) is considered the most difficult-to-control winter weed in NGR particularly after adoption of no-till CA. A variety of survival mechanisms (for example seed dormancy) are responsible for its persistence. Environmental stress, such as drought at late season is known to reduce wild oat (especially Avena fatua L.) seed dormancy status. We hypothesize that a dry period during the seed development stage, will not only promote early shedding of seed but also reduce dormancy. These two traits would enable A. sterilis ssp. ludoviciana to be more persistent in no-till CA in NGR. To test this hypothesis we conducted a soil water stress experiment in a greenhouse (~23/14°C day/night) with five levels of soil moisture (100, 80, 60, 40 and 20% of soil water holding capacity of a black Vertosol soil – 71% clay) during July to November 2018 in a completely randomized design with six replications. Four biotypes of A. sterilis ssp. ludoviciana coming from the NGR viz. Biloela 1: -24.35471 °S. 150.49773 °E: Biloela 2: -24.35048 °S, 150.497 °E, Toobeah: -28.36792 °S, 149.52197 °E and Jandowae: -26.66727 °S, 151.0246 °E were used in this experiment. The soil moisture stress treatments were applied at panicle initiation stage that continued until harvest. It was found that plants suffered with severe soil water stress matured 18 days earlier and produced less filled (30% less) and smaller (39% smaller) seeds compared with control plants. The biotypes coming from the northern NGR matured four to seven days earlier than the biotypes from the southern NGR. The germination test (conducted at constant 9°C under 12/12 hour light/dark condition for 42 days in an incubator) showed that 99% of primary seeds of the control plants were dormant compared with 67% of those that matured earlier than the control plants. Thus it is evident that the increasing frequency of dry period at seed development stage in the NGR is responsible for production of less dormant A. sterilis ssp. ludoviciana seeds where no-till CA is helping to retain these seeds on the top soil. Under favourable germination conditions in the following autumn/winter season these less dormant seeds will immediately be available to re-infest the wheat crop.

Keywords: Climate variability, fecundity, no-tillage conservation agriculture, wheat, wild oat survival

HIDDEN-IN-PLAIN-SIGHT: DISTRIBUTION PATTERN AND PHENOTYPIC VARIATION OF WEEDY RICE IN PENINSULAR MALAYSIA

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Abstract

Weedy rice (Oryza sativa) is a notorious weed that infests paddy fields worldwide. The changes agricultural practices from transplanting to direct seeding gave negative impact on rice farming in Malaysia which reduce rice production and grain quality. Surveys conducted in 2017 revealed that the distribution pattern of weedy rice was recorded to be random in Kedah. Perlis, Perak and Kelantan; uniform in Selangor (Sungai Besar) and Penang; and clumped in Terengganu and Selangor (Sawah Sempadan) based on VMR values. While the patchiness of weedy rice dispersion showed that Perlis, Pulau Pinang, Perak, Selangor (Sungai Besar), and Terengganu have more than 50% of surveyed field blocks displayed uniform weedy rice distribution while Kedah (Alor Setar) and Kelantan have majority of the fields displayed cluster distribution. The variation in distribution patterns suggested that farmers in Peninsular Malaysia practising different weedy rice management in every granary and low awareness on this notorious weed among farmers. Based on PCA, Malaysian weedy rice had diverse morphological characteristics and dispersed all over the Peninsular. Observation on weedy rice infestation pattern via spatial distribution suggested that weed management need to be properly orchestrated among farmers to ensure the degree of infestation is under a sustainable level.

Keywords: Morphology, spatial distribution, weedy rice (*Oryza sativa*)

ALLELOPATHY AND ITS UTILIZATION FOR WEED CONTROL AND ROBUSTNESS OF SOIL RHIZOSPHERE

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Abstract

Robustness of soils is an important element in the establishment of sustainable food production. We studied the use of allelopathic cover crops for weed management and their contribution for stable crop and vegetable productions. We have established specific bioassay and separation methods for allelopathy and screened allelopathic plants and their allelochemicals. In the same vein, it is important to know the roles and contribution of allelopathy and allelochemicals in the fields. Recently we have established "Soil Rhizosphere Method" to evaluate allelopathy under natural field condition. This method was developed to ascertain allelopathic activities in the soil rhizosphere. Accordingly, we found hairy vetch (Vicia villosa) as the best cover crop for weed control in Japan. Subsequently, we initiated new trials to identify metabolites and micro-organisms in the soil rhizosphere by metabolomic and genetic methods. We grew hairy vetch in winter season, and with sovbean as successive crop. Metabolites in rhizosphere were analyzed by LC-MS/MS or GC-MS to ascertain active allelochemicals in the soils. We found canavanine, a non-proteinogenic amino acid, was exudated from hairy vetch roots and weed control in soybean crop was attributed principally to this metabolite. Other amino acids rich in amino-group could also contribute for the allelopathic activity of hairy vetch. Canavanine, possibly a precursor of cyanamide, both being allelochemicals, have been reported earlier. The allelopathic activities of canavanine and other amino-group in rich amino acids were short and did not lead to any deleterious effects to the soil following hairy vetch cultivation. We also found several potential allelochemicals in the soil rhizosphere in the presence of hairy vetch, as well as from the soil rhizosphere of soybean after hairy vetch. We established a long-term field cultivation of hairy vetch with soybean crops in the research field of Ibaraki University. Metabolites from soil rhizospheres were analyzed. We concluded that hairy vetch inhibited weeds growth by the allelochemicals exudated from roots. Those allelochemicals disappeared following incorporation into soils and served as nitrogen source which promoted growth of the next crop. There is a possibility of other metabolites probably synthesized by micro-organisms existing in hairy vetch, hence contributed to the robustness of soils. We hope our project clarify the roles of allelochemicals in rhizosphere and their contribution in the robustness of soil after hairy vetch cultivation. aligned with weed control in crops, thereby contributed for the stable food production. This research was supported by the JST CREST Project, Grant Number JPMJCR1702.

Keywords: Allelopathy, canavanine, cyanamide, hairy vetch, soil rhizosphere.

3B2

Weed Science for Sustainable Agriculture and Environment

ISOLATION OF PHYTOTOXIC SUBSTANCES FROM KIWIFRUIT LEAVES AND THE SOIL UNDER KIWIFRUIT TREES

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Abstract

Kiwifruit plants had been cultivated over 20 years, but the declining of the vine and reduction of the fruit productivity often occurs. In addition, the young plants replanted to the old planting site do not grow well even after soil disinfection. The symptom is typical of replanting problems reported in several fruit trees. Phytotoxic substances released from the plants may play a role in the replanting problems. However, little is known about the phytotoxic substances in the kiwifruit leaves and the soil under kiwifruit plants. This study investigated the phytotoxic activity of kiwifruit leaf and soil extracts, and identified the phytotoxic substances contained. Dried kiwifruit leaves were extracted with 70% aqueous methanol for 48 h and re-extracted with methanol for 48 h. The filtrates were mixed and subjected to bioassay. The extracts inhibited the growth of seven test plant species including kiwifruit with the extract-concentration dependently. The result indicates that kiwifruit leaves possess phytotoxic substances, which may influence the growth of young kiwifruit replanted. The leaf extracts were then concentrated to obtain aqueous solution and partitioned with ethyl acetate. The obtained ethyl acetate phase was separated with bioassay-guided chromatography steps such as silica gel. sephadex LH-20, C₁₈ cartridge, and HPLC. Two phytotoxic substances were finally isolated from the leaf extracts and identified as quercitrin and (-)-epicatechin. These isolated substances inhibited the cress growth with concentration dependently. The soil collected under aged kiwifruit plants was extracted as described above. The soil extracts also inhibited the growth of cress. The isolation of the phytotoxic substances in the soil extracts is underway. Quercitrin and (-)-epicatechin may contribute to the phytotoxic activity of kiwifruit leaf extracts and may be involved in the decline of young kiwifruit growth through their accumulation in the cultivated soil.

Keywords: Actinidia deliciosa, allelopathy, replant problem

SELECTIVITY TO RICE AND PHYTOTOXICITY TO SELECTED WEEDS OF POTENTIAL BIOHERBICIDE FROM AQUEOUS LEAF EXTRACT OF *Ludwigia hyssopifolia* (G. DON) EXELL

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Abstract

Ludwigia spp., known to be invasive especially in aquatic areas, is suspected of allelopathic activities. Their tissues contain group of compounds known to be involved in allelopathy which is taken advantage for weed management in agriculture. Because of this, one of its members, Ludwigia hyssopifolia (G. Don) Exell, was studied to determine its allelopathic potential based on the effects of aqueous extracts of its tissues (leaves, roots and stem) on the seed germination and seedling growth. Ludwigia hyssopifolia has potential allelopathic activity as its leaf aqueous extract showed the highest phytotoxic activity. There were significant inhibition of its leaf aqueous extract on lettuce (Lactuca sativa) germination and radicle growth. significant inhibition on shoot growth and biomass accumulation of weeds (Amaranthus spinosus, Dactyloctenium aegyptium and Cyperus iria) were observed while maintaining less adverse effects on rice (the crop) compared to other aqueous extracts of roots and stem. Phytochemical screening revealed that phenols, tannins, flavonoids, terpenoids, saponins and coumarins are found in the leaf aqueous extract. Folin-Ciocalteu method revealed that its leaves contain 26.66 ± 0.30 mg GAE/g. The extract was then acid-hydrolyzed to liberate the phenolics from glycosidic- and ester-linkages which yielded a rate of 2.5 %. Two-dimensional chromatography showed that coumarin, biflavones, glucosyl flavone, isoflavone, flavonoid and cinnamic ester compose its phenolic profile. After development in thin-layer chromatography, the major compound was eluted and characterized. The compound had maximum UV absorbance at 272 nm. Based on FT-IR spectroscopy, it has phenol, carboxylic acid and ether functionalities. These observations, coupled with chromatographic mobility using twodimensional paper chromatography and thin layer chromatography, proved that the possible identity of the compound is syringic acid.

Keywords: Allelopathy, bioherbicide, Ludwigia hyssopifolia (G. Don) Exell, phenolics, syringic acid

IDENTIFICATION OF PREVIOUSLY-PUBLISHED ALLELOCHEMICALS IN OM RICE VARIETIES WITH CLOUD-BASED METABOLOMICS PLATFORM

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Abstract

The methanol extracts of nine OM rice varieties (2395, 5451, 6976, 380, 5930, 4498, 3536, N406 and 7347) were used to explore their allelopathic potential on the banyardgrass, an invasive weed seriously threathening the rice production in Asian countries. The following study aimed to detect the previously-known allelochemicals in these rice varieties using a cloud-based metabolomics platform. The UPLC-HRMS and metabolomics software platform. XCMS Online, were used for peak detection, peak grouping, spectra extraction, and retention time correction/alignment of allelochemicals. At the concentration of 1.0 g/ml⁻¹ (rice weight equivalent to 1 ml of methanol extract), three OM rice varieties (5930, 4498, and 6976) correlatively possessed the greatest allelopathic activities on the growth of banyardgrass shoot (98.77%, 90.75% and 87.17%) and root (99.39%, 92.83% and 86.56 %), respectively. Twenty allelochemicals previously-known to exert allelopathic effects in rice were putatively identified in these nine rice varieties including 4-Dihydroxybenzaldehyde; 2.6-Dimethoxybenzoic acid; 3,4-Dihydroxybenzoic acid; 3,4-Dihydroxyphenylacetic acid; 3-Hydroxybenzoic acid; 4-Hydroxybenzoic acid; 5-Methoxysalicylic acid; 7 -Oxostigmasterol; Benzoic acid; Benzoic acid, 2,4-dimethoxy-; Benzoic acid, 2,5-dihydroxy-; Benzoic acid, 3,4dimethoxy-; Benzoic acid, 3,5-dihydroxy-; Benzoic acid, 3,5-dimethoxy-; Cinnamic acid; Coumarin; Ergosterol peroxide; p-Hydroxycinnamic acid; Salicylic acid and Vanillic acid. Four OM rice varieties (4498, 3536, 5930 and N406) contain more than 50% in total numbers of identified allelochemicals; followed by OM (2395, 5451, 6976, 380 (35%-45%)) and OM7347 (20%). OM5930 possessed the highest number and concentration of allelochemicals and so, indicate the greatest allelopathic activity. These results facilitate the orientation and potential of OM 5930, OM 4498 and OM 3536 as promising rice varieties in biological control of weed towards economic efficacy, safe and environmental friendliness.

Keywords: Allelochemicals, OM rice varieties, XCMS.

DEVELOPMENT OF PRE-EMERGENCE BIO-HERBICIDE FROM PURPLE NUTSEDGE (Cyperus rotundus L.) FOR CONTROLLING BROAD-LEAF WEEDS

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Abstract

Results from previous study state that the purple nutsedge had potential to be used as the bio herbicide. Thus, several studies had been carried out in analyzing the bioactive content of purple nutsedge, the factors that influence the availability of bioactive content, the effect of laboratory bioassays as well as the efficacy of formulation of purple nutsedge as the bioherbicides on the seed germination of various species of plants. Results showed that purple nutsedge contained 21 phenolic compounds and one allelopathic compound had been identified which is α-cyperone. Whole parts of the purple nutsedge contained phenolic compounds, but the largest amount of phenolic compounds available in the tuber. Whilst, the highest amount of α -cyperone was in the flesh of the tuber, followed by the whole tuber and the tuber peel. The amounts of phenolic compounds were influenced by the habitat (which is the accession number) of purple nutsedge. Bioassay in the laboratory showed that the extracts (water and methanol) and macerates significantly reduced the germination of broad-leaf seeds such as Asystasia sp., Boreria sp. and Lactuca sativa by more than 75% compared to control but less effective in suppressing the germination of Oryza sativa seeds. The extracts and macerates also caused abnormal germination sprouts in the L. sativa and O. sativa. Efficacy trials that currently ongoing in the greenhouse and field indicated that the use of purple nutsedge extracts is not as effective as in the laboratory bioassay. The efficacy can be increased through the use of surfactants. Experiments in the greenhouse also indicated that the granule of purple nutsedge powder had prospective to be applied in controlling weeds.

Keywords: Allelopathy, phenolic, pre-emergence, α-cyperone, surfactant.

3B6

ALLELOPATHIC POTENTIAL OF THE AQUEOUS METHANOL EXTRACTS OF Elephantopus scaber AND ITS INHIBITOY SUBSTANCE

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Abstract

Elephantopus scaber Linn. is a tropical perennial herb that has been traditionally utilized as folk medicine in many Asian countries. Elephantopus scaber has been extensively studied on their biological activities such as anticancer, anti-inflammatory, anticoagulant, antidiabetic, and hepatoprotective activities. However, there is no information available on the allelopathic properties of *E. scaber*. This study, therefore, aimed to investigate the allelopathic effects of the *E. scaber* on the growth of the test plants and to isolate potent allelopathic substances. The whole plant of *E. scaber* was extracted with 70% acueous methanol and determined the biological activity. The E. scaber extracts exhibited inhibitory effects on the shoot and root growth of cress, lettuce, alfalfa, barnyard grass, Italian ryegrass and foxtail fescue. The inhibition rate was proportional to E. scaber extract and increased with exposure to higher concentrations. These results suggest that the *E. scaber* may possess allelopathic activity. The extracts were partitioned with ethyl acetate, and the ethyl acetate fraction was then purified through a series of chromatography including a column of silica gel, Sephadex LH-20, C₁₈ cartridge, and reverse-phase HPLC, respectively. Bioassay-directed fractionations of *E*. scaber extracts resulted in the isolation of a growth inhibitory substance ESW-1. The ESW-1. isolated from 1.2 g dry weight equivalent extract/mL, inhibited the shoot and root growth of cress by 1.5 and 5.9% that of control, respectively. The present results indicate that the extracts of *E. scaber* have allelopathic activity and ESW-1 may contribute to the allelopathic effect of *E. scaber*. The whole plant of *E. scaber* and an isolated substance EWS-1 may play an important source in the development of alternative strategies for weed management.

Keywords: Allelopathic activity, *Elephantopus scaber*, inhibitory substance

INVOLVEMENT OF AUTOTOXICITY IN ASPARAGUS DECLINE AND ITS EFFECTIVE TREATMENT

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Abstract

Asparagus (Asparagus officinalis L.) is a widely cultivated perennial vegetable and can be harvested several years. However, the crop quality and yield decline after a few years' cultivation, which is called "asparagus decline". One of the possible reasons for "asparagus decline" is thought to be the infection by soil-borne pathogenic fungi, such as *Fusarium* spp. However, several fungicide treatments on asparagus fields did not improve significantly the quality and productivity of asparagus. The objective of this study was therefore to clarify the "asparagus decline" and to identify the effective treatments to recover from "asparagus decline". When the asparagus seedlings were grown with 10-year-asparagus-cultivated soils, the growth of the seedlings were inhibited by 60% compared to control seedlings. The result confirmed that the asparagus soils have autotoxic activity. An aqueous methanol extract of the 10-year-asparagus-cultivated soils was then purified by several chromatographs with monitoring the inhibitory activity and a potent growth inhibitory substance was isolated. The chemical structure of the compound was determined by spectral data to be trans-cinnamic acid. trans-Cinnamic acid inhibited the growth of asparagus seedlings at concentrations greater than 10 µM. The concentrations required for 50 % growth inhibition of asparagus were 24.1 µM. trans-Cinnamic acid accumulated 174 µM in the 10-year-asparagus-cultivated soils. Therefore, considering the concentration of *trans*-cinnamic acid in the soil and growth inhibitory activity of it, trans-cinnamic acid can cause the growth inhibition on asparagus or "asparagus decline". After several trials to find out the effective treatments to recover from "asparagus decline", it was found that, when the asparagus seedlings were grown in 10-yearasparagus-cultivated soils with commercial soil additive product TetsuRiki™-Aqua (Aichi Steel Co., Aichi, Japan), the growth of the seedlings were 1.4-fold greater than that of the seedlings grown in the asparagus-cultivated soils without TetsuRiki[™]-Agua. This result indicates that the treatment of the soil additive product TetsuRiki[™]-Aqua may work to reduce "asparagus decline".

Keywords: Allelopathy, asparagus, autotoxicity, cinnamic acid, growth inhibition

EFFECT OF DIFFERENT GROUND COVER MANAGEMENT SYSTEMS ON POPULATION CHANGING PATTERN OF *PENNISETUM POLYSTACHION* IN COCONUT PLANTATIONS OF SRI LANKA

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Abstract

Pennisetum polystachion is a major monocotyledonous weed species in intermediate zone coconut plantations in Sri Lanka and a perennial problem in coconut plantations as it causes significant losses in terms of nut yield. The occurrence of this weed also causes difficulties in its eradication. The influence of different management systems was evaluated in terms of their impact on P. polystachion seedling emergence patterns in coconut plantations in Sri Lanka. Treatments imposed were application of glyphosate (N-(phosphonomethyl)-glycine) (T1), cover cropping with Pueraria phaseoloides (T2), tractor harrowing (T3), tractor slashing (T4) and tractor ploughing (T5). All the treatments were applied twice a year except T2. Based on the reduction in weed biomass, application of glyphosate (T1) and cover cropping (T2) practices were very efficient methods to reduce the *P. polystachion* population. Chemical weeding and cover cropping were the best methods to reduce *P. polystachion* seedling emergence density in the field. The effectiveness of slashing in reducing weed seedling emergence density was lower than cover cropping and chemical weeding methods. The weed seedling emergence densities were almost similar in ploughed and harrowed plots. The seed depth of emerged seedling was very high in harrowed and ploughed treatments when compared to other treatments. This indicated that loosening the soil creates more favorable environment for the germination of weed seeds buried in soil. Therefore, it can be argued that the elimination of weed seeds in the top 2cm or 4cm in the soil seed bank by any means is likely to reduce the level of weed infestation by about 60% to 95%. The results indicated that burying rhizomes in ploughing and harrowing treatment plots at the depths below 30 - 40 cm would be effective in controlling germination of this weed species. The investigations of the experiments also suggested that keeping rhizomes on the soil surface without burying for durations of 5 – 15 days would produce weak plants with poor development of leaf areas and shoot dry weights of *P. polystachion*.

Keywords: Coconut plantations, Pennisetum polystachion, seedling emergence pattern

WEED DYNAMICS AND ONION YIELD AS INFLUENCED BY PRE-MIX CLODINAFOP-PROPARGYL 12.25% + SODIUM OXYFLUORFEN 14.7%EC

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Abstract

Onion (Allium cepa var. aggregatum L.) is one of the important bulbous vegetable crops and widely cultivated in the Asian continent including India and also in Europe. The crop is valued for its bulbs having characteristic odor, flavor, and pungency. Being a highly export oriented crop; it earns substantial foreign exchange for the India. Onion plants are poor competitor of weeds in early stages due to lack of adequate foliage to withstand competition from weeds. Additionally, onion cylindrical upright leaves do not shade the soil to suppress weed growth. Uncontrolled weed severely reduces the onion bulb yield and the profitability to onion growers. Manual and mechanical weeding is often limited by lower economic returns and mechanical damage to onion bulbs. Individual herbicides have narrow spectrum and continued use may lead to selection of resistant biotype in onion. Field study was conducted during post-rainy season to evaluate the effect on weeds in onion and onion bulb yield of pre-mix formulation of clodinafop -propargyl 12.25% + sodium oxyfluorfen 14.7%EC at 93.75+112.5, 125+150, 156.25+187.5 ga.i./ha, propaguizafop + oxylourfen at 43.75+105 g a.i./ha and individual herbicide clodinafop -propargyl at 125 g a.i./ha, oxyflourfen at 200 ga.i./ha The major monocots weeds were Cyperus rotundus L. and Cynodon dactylon (L)Pers. Dominant broad leaf weeds (BLW) includes Chenopodium album L., Melilotus sp. Trianthema portulacastrumL., and Rumex dentatus L Post-emergence application of clodinafop- propargyl + sodium oxyflourfen at 93.75+112.5 to 125+150, g a.i./ha recorded lower population and dry matter accumulation of all the weed species. Onion yield was maximum clodinafop -propargyl + sodium oxyflourfen at 125+150, g a.i./ha as POST and was comparable to clodinafop propargyl + sodium oxyflourfen at 93.75+112.5 g a.i./ha. Post emergence treatment with clodinafop -propargyl + sodium oxyflourfen at 125+150, g a.i./ha recorded highest profit in onion.

Keywords: Onion yield, clodinafop -propargyl + sodium oxyflourfen, profit, weed dynamics

THREE TIER MANAGEMENT PRACTICES FOR EFFECTIVE ORGANIC WEED MANAGEMENT IN SWEET CORN

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Abstract

Field experiment was conducted to determine the effect of different organic weed management practices on the weed population and productivity of sweet corn. The experiment was done at the Agronomy Farm, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan, India with 12 treatments in randomized block design and replicated thrice. Season long weed control could be achieved by using three tier weed management practices before sowing, after sowing and in standing crop viz combination of summer ploughing, soil solarisation, stale seed bed with plastic mulch, straw mulch and hand weeding. The major broadleaf weeds in the experimental fields were Digera arvenris (3.26), Trianthema portulacstrum (15.00) and Commelina bengalensis (14.2). The grassy weeds were Echinochloa colona (36.88) and Dinebra retroflexa (5.00). Application of plastic mulch (25 micron) in corn field significantly increased sweet corn yield by 18.82 % and 84.41 % over atrazine 500 g fb straw mulching (10 t/ha) at 20 DAS and control, respectively. Weed density of grassy and broad leaf weeds were recorded significantly lower in plastic mulch either with summer ploughing, sowing after stale seed bed preparation or soil solarization. Plastic mulch with soil solarization proved the most effective and recorded 90.6% and 90.70 % reduction in total weed dry matter at 60 DAS and at harvest, respectively in comparison to weedy check at 60 DAS (43.99 g/m2) and at harvest (57.14 g/m²). Research has shown that use of plastic mulch is an effective method for reducing weed problem in organic sweet corn in the water scarcity regions of India.

Keywords: Plastic mulch, soil solarisation, sweet corn, weed management

FIELD STUDY OF RINSKOR™ ACTIVE AND ALS INHIBITOR HERBICIDES ON PARTHENOCARPY EFFECT IN OIL PALM

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Abstract

Exogenous growth substances have been reported inducing parthenocarpy in oil palm. Producers do not favour parthenocarpic fruits in oil palm because these possess a lower oil content. Rinskor[™] active (florpyrauxifen-benzyl) (is a new arylpicolinate synthetic auxin herbicide classified as Group O, based on Herbicide Resistance Action Committee classification). Rinskor has commonly been used for weed control in rice, and its use as the herbicide in oil palm crop is currently being explored. A field experiment was carried out to investigate the effect caused by auxin and ALS herbicides sprayed around circle weeding on oil palm fruits. Eight treatments comprising of Rinskor™ active (Loyant 25 EC) at 25, 50, 100, 200 g a.i. ha⁻¹, diclosulam (Strongarm 840 WG) at 320 g a.i. ha⁻¹, penoxsulam (Clipper 250D) at 100 g a.i. ha⁻¹, picloram + 2,4-D (Tordon 450SL 60+240 g/L) at 240+960 g a.i. ha⁻¹ and manual weeding as untreated control. Herbicides were applied two times with three-month interval, and manual weeding was carried out at same timings as untreated check. Each treatment consisted of three palm trees with three replicates applied at the base, in a circle with an approximate diameter of 2.5 m. Fruit bunches on the palm trees were assessed two times (three months after each herbicide application). Results showed that all rates of Rinskor, diclosulam, and penoxsulam were safe not causing any parthenocarpy in treated palms and being significantly different to picloram + 2,4-D treatment which resulted in high percentage of parthenocarpy to fruits (83,1% and 92.3% three months after first and second application respectively). Results demonstrated that Rinskor did not induce parthenocarpy in oil palm when used as the herbicide for managing weeds in this crop.

Keywords: Auxin, florpyrauxifen-benzyl, oil palm, parthenocarpy, Rinskor™ active

EFFECT OF SEQUENTIAL AND TANK MIX HERBICIDES ON WEED DYNAMICS AND YIELD OF RAINFED MAIZE

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Abstract

Field experiment was conducted in SKUAST-Jammu during the years from 2016 to 2017 and from 2017 to 2018, to study the efficacy of sequential and/or tank mix herbicides for weed management in rainfed maize. The experiment was laid out in randomized complete block design with three replications and treatments consisting of combinations of tembotrione. halosulfuron, atrazine, 2, 4-D and mertibuzin as the sequential or tank mix herbicides which were tested for comparison. The soil of the site was sandy loam in texture, slightly acidic in reaction, low in organic carbon and available nitrogen but medium in available phosphorus and potassium. Major weed flora registered in maize crop culture were found to be Digiteria sanguinalis, Acrachne racemosa, Eragrostis tenella,, Physalis minima, Phyllanthus nururi, Solanum nigrum, Cynodon dactylon, Amaranthus viridis, Echinochloa colonum, Eleusine aegyptium, Digitaria sanguinalis, Cyperus rotundus and Cyperus iria. Significantly highest maize grain yield, weed control efficiency, lowest weed density and weed biomass were recorded with the application of tembotrione 100g/ha + atrazine 750g/ha at 15-20 DAS which was statistically at par with tembotrione 100g/ha + atrazine 500g/ha, atrazine 1000g/ha followed by tembotrione 100g/ha, tembotrione 100g/ha + halosulfuron 67.5g/ha, tembotrione 100g/h + halosulfuron 52.5g/ha and atrazine 1000g/ha followed by mertibuzin 250g/ha. However, the highest benefit cost (B:C) ratio was recorded with the application of tembotrione 100g/ha + atrazine 500g/ha which was closely followed by that of tembotrione 100g/ha + atrazine 750g/ha. Hence, the study revealed that tembotrione 100g/ha + atrazine 500g/ha at 15-20 DAS provides better herbicidal weed management options and also proved itself economically superior to all other weed management practices in rainfed maize. Besides, this treatment also provides a viable option of post-emergence herbicidal weed control in subtropical foot-hill plains of Jammu and Kashmir State of India.

Keywords: Rainfed maize, sequential herbicides, tank mix herbicides, weed control efficiency, yield

GROWTH AND YIELD RESPONSE OF SOME STRIGA TOLERANT MAIZE (Zea mays L.) VARIETIES TO WEED MANAGEMENT PRACTICES AND SOWING TIMES AT MINNA, NIGERIA

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Abstract

The growth and yield response of some Striga tolerant maize (Zea mays L.) varieties to weed management practices and sowing times in a naturally infested Striga field at Minna, Nigeria were studied in 2017 and 2018 rainy seasons. The treatments consisted of four medium maturing Striga tolerant maize varieties: SAMMAZ 15, 17, 37 and 40, weed management practices: weedy check, pre-emergence (PE) Atrazine at 3 kg a.i ha⁻¹ + Hoe weeding (HW) at six weeks after sowing (WAS), PE Atrazine at 3 kg a.i ha⁻¹ + Post-emergence (POE) Nicosulfuron at 1.5 kg a.i ha⁻¹ at 6 WAS, 2 HW at 3 and 6 WAS and sowing times: early, midand late season arranged in a split plot in RCBD with three replications. Maize varieties and weed management practices were factorially combined and assigned to the main plot while sowing times was the sub plot. Days to first Striga shoot emergence were similar in SAMMAZ 15 and 40, but significantly longer than in the other varieties, except SAMMAZ 40 in 2017. The Striga shoot density was lower in SAMMAZ 15 compared to other varieties, except in SAMMAZ 40 at 8 and 10 WAS in 2018. Striga shoot emergence was delayed most with the application of Atrazine + POE Nicosulfuron, but at par with 2 HW. However, Striga shoot density was the lowest with the application of Atrazine + POE Nicosulfuron throughout the sampling periods in the two years. Early sowing of maize delayed Striga shoot emergence most and consistently had the least shoot density. Generally, mid-season sown maize produced taller plants and the highest grain yield in both years. In terms of varietal maize grain vield, SAMMAZ 17 and 40 were the highest with application of Atrazine + Nicosulfuron and when sown mid-season. It is concluded that SAMMAZ 15 be sown early and SAMMAZ 17 and 40 be sown in mid-season with application of Atrazine + Nicosulfuron for Striga management, provides better crop growth and grain yield in southern Guinea agro-ecology of Nigeria.

Keywords: Maize varieties, sowing times, Striga, weed management, yield response

MAJOR WEEDS AND WEED MANAGEMENT: PERCEPTIONS OF FARMERS GROWING RICE UNDER DIFFERENT STRATUM OF IRRIGATION SYSTEMS OF ISABELA AND NUEVA ECIJA PROVINCES, PHILIPPINES

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Abstract

Knowing the existing farmers' weed management practices is one of the most important requirements when choosing, designing, and implementing effective weed control strategies in wider scale. A study was conducted in two major rice producing provinces of the Philippines (Isabela and Nueva Ecija) to determine the perceptions of rice farmers on major weeds and weed management practices in irrigated lowland rice fields. Irrigators associations and rice farmers whose rice fields were located at the upstream and downstream strata of the national irrigation system were randomly selected as respondents for the interviews using a guided guestionnaire. Further random selections were done to separate rice farmers whose rice fields were located at the head, middle, and tail-end parts of each stratum. Items of the interviews were the profiles of farmers, crop production practices and harvests, common weeds encountered, and perceptions on commonly used weed management techniques. Data from interviews were collected, encoded and analyzed. Most of the respondents were male between 41 to 70 years old, farm owners in size of 1 ha, and had mean harvests of 5 to 6 tons/ha (Isabela) and 7-8 tons/ha (Nueva Ecija). Most of them acquired seeds from seed growers, did land preparation within 14 to 21 days, and used manual transplanting for crop establishment. Many of the respondents considered weeds as problem to their rice cultivation causing yield reduction of 5 to 10%, and that Echinochloa crus-galli was the most dominant weed. Seeds carried by irrigation, brought by animals, and from previous cropping were the most perceived sources of weed seeds. Most of them believed that thorough land preparation, use of pre-and post-emergence herbicides, water management and manual weeding are the most effective weed management techniques to combat weeds of irrigated lowland rice. Analysis of the data showed no differences on perceptions of farmers in terms major weeds and weed management practices between provinces, stratum (upstream vs. downstream) and sub-stratum (head, middle and tail-end part) of irrigation system. Results of the survey suggest that interventions, awareness and campaigns are needed to guide rice farmers in combating weeds of irrigated lowland rice. Results further suggest that any identified weed management strategies can be implemented across provinces and strata of irrigation system.

Keywords: Irrigation system, farmer perceptions, major weeds, weed management

EFFICACY OF NOVIXID[™] (RINSKOR[™] ACTIVE+ PENOXSULAM) AGAINST BROAD-SPECTRUM WEED CONTROL IN WET DIRECT SEEDED RICE OF CENTRAL INDIA

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Abstract

Novixid[™] 3.25 % OD, a pre-mix combination of Rinskor[™] active and Penoxsulam, is a postemergence broad-spectrum rice herbicide being developed for rice growers in India. It was evaluated in field trials conducted during 2016 and 2017 seasons in Chhattishgarh province of central India. The objective of these studies was to evaluate the bio-efficacy and dose response of Novixid[™] for broad-spectrum weed control in wet Direct Seeded Rice (puddled DSR). Field study treatments included three dose rates of Novixid (32.5, 40.64 and 48.8 g a.i./ha); bispyribac-sodium 10 % SC at 25 g a.i. /ha as a standard treatment, and an untreated control. Post-emergence foliar application targeting 3 to 5 grass weeds leaf stage was done using a backpack knapsack spraver fitted with flood jet nozzles. Treatments were arranged in a randomised block design with three replications. Treatments were assessed based on percent visual weed control at 15 and 30 DAA and weed count at 30 DAA. Crop response was also evaluated based on a scale of 0-10. Novixid at 40.64 g a.i./ha provided effective control (>90 % visual weed control) of Echinochloa colona, Echinochloa crus-galli, Cyperus difformis, Scirpus sp. Monochoria vaginalis and Ludwigia sp. at 30 DAA. Efficacy of Novixid at 40.64 g a.i/ha was either equivalent or better than the standard bispyribac-sodium treatment against evaluated weeds. All the tested dose rates of Novixid were found to be safe to the rice crop. Novixid[™] herbicide containing Rinskor[™] active, demonstrated effective control of the key rice weeds, with adequate crop safety, and will be a potential herbicide management tool for rice growers in India.

Keywords: Central India, Novixid[™] herbicide, direct seeded rice, Rinskor[™] Active, Rinskor[™] + penoxsulam

INTEGRATED WEED MANAGEMENT FOR DIRECT-SEEDED RICE IN CAMBODIA

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Abstract

Recently, Cambodian farmers rapidly shifted from puddle transplanted rice to direct seeded rice (DSR) and from hand weeding to herbicide-based weed control in rice to cope with the rising scarcity of agricultural labor in the country. The changes in rice farming system can have a strong implication for weed management practices. Therefore, the study was conducted with the following objectives: (1) characterize farmer's weed management practices and identifying their knowledge gaps, (2) quantify the extent of weed seed contamination in farmers saved paddy seed lots, and (3) to develop profitable and sustainable weed management options for wet-DSR. To achieve these objectives a survey study and onfarm adaptive trials were conducted. In a survey study, one-hundred farmers from lowland rice systems of Battambang province in Cambodia were surveyed in 2017 using a structured guestionnaire. Also, from each surveyed farmer, a 1-kg seed sample was collected to assess the extent of weed seed contamination. Adaptive trials were conducted in three provinces (Battambang, Kampong Thom, and Prey Veng) with four treatments: best management practices (BMPs) + herbicide program-1; BMPs + herbicide program-2; conventional practice (the average practice of 40 surveyed farmer including weed management); conventional practice + herbicide program-1. Survey results showed that all surveyed farmers practice broadcast DSR with an average seed rate of 181 kg ha⁻¹ using their own-saved seeds or brought from their neighbor (82%). All the paddy seed samples were contaminated with weed seeds of 34 species - weedy rice being the major contaminant, with an average of 1070 weed seeds kg⁻¹ of paddy seed. About 93% of farmers reported that weeds are a major problem in their field with 70% indicated a yield loss of >20% due to weeds. All farmers used postemergence (POST) based herbicide program with no use of pre-emergence (PRE). Input dealers were the major source of information for farmers in the selection and use of herbicide (72%). Adaptive on-farm trials showed that IWM [BMPs + herbicide program-1 or 2 (pretilachlor as PRE followed by POST application of bispyribac-sodium (program-1) or fenoxaprop+ethoxysulfuron (program-2) yielded 11-21% higher in Battambang and 11-17% in Prey Veng province compared to conventional practice. These results suggest that IWM options using clean seed, application of appropriate PRE and POST herbicide at the right time, amount and accurate application technique can improve weed control and hence the rice yield in Cambodia.

Keywords: Cambodia, farmers' practice, weed seed contamination, weedy rice, directseeded rice

RESPONSE OF RICE AND WEEDS TO EARLY SUBMERGENCE IN DIRECT-SEEDED RICE IN SRI LANKA

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Abstract

The wide spread introduction of direct seeding has led to aggravated weed problems and reliance on herbicides. Early submergence of rice is a key component in weed management, but it hinders germination, growth and establishment of crop in direct-seeded rice (DSR). Combining early submergence with tolerant rice genotypes would help in achieving improved crop establishment and weed management in DSR. This research was aimed at determining the effect of submergence on growth and yield of different rice (Oryza sativa L) varieties and weeds. The submergence-tolerance ability of 15 rice varieties; Bg 300, Bg 94/1, Bg 379/2, Bg 455. H4. Ba 352. Ba 360. BW 364. BW 367. BW 372. Ld 368. Ld 371. At 307. At 308. At 36 of different age classes, and their traits that may confer such attributes were investigated under saturated and continuous submerged conditions (5 cm water depth) under field conditions. Seeds soaked for 48 h and incubated for 24 h were sown in the field. The results indicated that the weed density was significantly reduced with submergence. Reduction of grass and sedges weed density was 70% and 60%, respectively. The 5 cm submergence depth gave a weed control index (WCI) of 50% at 6 weeks after sowing (WAS) compared to the saturated plots (P<0.05). Results showed that Bw 367and At 362(3.5 month age class) and Bq 455 had highest seedling density under submerge condition. The grain yield was the highest in At 362(4.3t/ha) followed by Bw 367, At 308 and At 307(3 months), and Bg 455 In submerged condition. In saturated condition, grain yield was negatively correlated with the density of sedges (r=-0.556***), and grasses (r=-0.629***) at 6 WAS. In submerged condition, grain yield had significant positive correlation with the rice plant count (r =0.336*), whereas, a negative significant correlation with the density of broadleaf weeds ($r = -0.323^*$). The study suggests that, submergence could play an important role in management of weeds when submergence tolerance varieties are used.

Keywords: Direct seeding, submergence, rice, weeds, yield

EFFECT OF WEED CONTROL AND POULTRY MANURE ON GROWTH AND YIELD OF UPLAND RICE IN SUDAN SAVANNAH OF NIGERIA

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Abstract

Field trials were conducted in the research farm of Federal University Dutse (Lat. 11° 46 39" N; Long. 09°20, 30'E) in the Sudan savannah ecological zone of Nigeria. Objective of this study was to evaluate performance of upland rice varieties affected by herbicide and poultry manure. Field trial locations were in Sudan savanna ecological zone with a mean annual rainfall of 600mm distributed between May and October. The treatments consisted of three rates of poultry manure (0, 5 and 10t /ha) and five weed control treatments (orizoplus, pendimentaline, pendimentaline + one hoe weeding at 6 weeks after sowing (WAS), hoe weeding and weedy check) factorially combined in the main plot while two upland varieties of rice (Nerica and Faro 48) in the sub-plot given a total of 30 treatments. The treatments were laid out in a split-plot design with three replications. Application of pendimentaline+one hoe weeding at 6WAS produced significantly greater plant height, leaf area, leaf area index, panicle length, panicle weight per plant, biological yield and the grain yield of rice than the other rates comparable with the hoe weeded control while the weedy check had the least. The application of 10t/ha of poultry manure gave significantly greater plant height, leaf area, leaf area index, panicle lenght, number of grain per panicle, harvest index and the grain yield of rice than the lowest rates (0 and 5t/ha). Faro 48 resulted in most significant increase growth and vield parameters such as plant height, length of panicle, and the grain vield of rice in both years. In conclusion, the combination of 10t/ha of manure and pendimentaline+one weeding control at 6 weeks after sowing gave better weed control, growth and yield of Faro 48 rice variety than the Nerica variety.

Keywords: Rice, poultry manure, variety, herbicide and grain yield.
3D6

RINSKOR™ ACTIVE, THE NEWEST ARYLPICOLINATE AUXINIC HERBICIDE FOR EFFECTIVE AND SUSTAINABLE WEED MANAGEMENT IN RICE Mauricio Morell¹*, Duy Le²

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Abstract

Effective weed management in rice is a key factor to ensure healthy crops and expected vields. Food supply, the most basic human need today and in the future, strongly depends on a comprehensive integrated pest management. Weeds are the major problem in rice, exacerbated by scarcity of labor, water security and rapidly growing herbicide resistance issues. Uncontrolled weeds can lead to yield losses as high as 80%, therefore effective weed management is critical to rice production. Over time, weeds can develop resistance to an herbicide and become less sensitive to that means of control. In many cases, herbicides that worked in the past no longer achieve the expected results when used following label recommendations. Herbicides with differentiated or new modes of action can help mitigate the development of weed resistance. Corteva Agriscience[™], discovered and developed a novel herbicide, Rinskor™ active (florpyrauxifen-benzyl), the latest member of the arylpicolinate family of chemistry, a unique and new class of synthetic auxins within the Herbicide Resistance Action Committee Group O. Chemical substitutions yielded a new compound with increased herbicidal potency, paving the way for a new generation of lower-dose-rate synthetic auxin herbicides. Rinskor has desirable attributes such as high herbicidal activity in a broad and differentiated spectrum of weeds in rice and other crops, including important grasses, broad leaf weeds and sedges affecting farmers' yields. The product is applied postemergence, mainly absorbed by foliage and translocated to growing points where it exerts its herbicidal action. Rinskor binds with specific auxin receptors, demonstrating stronger affinity to AFB5 and lower affinity to TIR1, differentiating it from other known auxin chemistries, offering an enhanced spectrum of control, and activity on important susceptible and target-site resistant weeds in rice. Rinskor is applied at very low rates and rapidly degrades in the environment, with favorable toxicology, ecotoxicology and environmental fate profiles. Thousands of greenhouse and field trials carried out by Corteva scientists and university researchers around the world during its development, demonstrated Rinskor's efficacy and crop safety. Product registrations and commercial uses are underway in several countries worldwide. Subsequent launches are set to occur soon. Globally registrations are expected in more than 40 countries in total. Because of its multiple agronomic and environmental benefits, Rinskor will be a pivotal tool, helping rice farmers manage resistant and tough-tocontrol weeds, and will contribute to food security by sustaining rice production in an environmentally responsible way for years to come.

Keywords: Herbicides, rice, Rinskor[™] active, weeds

4A1

CURRENT STATUS OF CLASSICAL BIOLOGICAL CONTROL OF WEED AND ITS FUTURE PROSPECTS IN INDIA

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Abstract

An introduction of specific natural enemies of the origin area to new habitat from another country that provided self-sustaining control of targeted weed is called classical biological control. This method has been found very successful on large infestation of a single weed species, which usually take place in the wasteland, range lands or in water bodies. Biological weed control has been found not very successful to control weeds in the crop, instead in some specific situations, this approach may be the cause of harm to the crop. Heavy uses of herbicides and emerging evidences caused by herbicide application led to suggestion of classical biological control of weeds are relevant. In India, weeds like *Eichhornia carassipes*. Salvinia molesta, Hydrilla verticillata, Pistia stratiotes, Ipomoea aquatica etc. are problematic aquatic weed. In north-east and Kerala, water hyacinth problem is the most severe. Floating weed Salvinia molesta was not seen a problematic weed part of the northern state of the country, but its recent invasion in Madhya Pradesh gives an indication of its increasing threats in the new location. Terrestrial weed Parthenium hysterophorus has invaded about 35 million hectares of land in India. It has been considered a biggest threat for loss of crop productivity, biodiversity and many health problems in human beings. Lantana camara, Chromolaena odorata and Mikania micrantha are problematic weeds of forests. Currently in India, about 31 exotic biological control agents have been introduced against weeds, of which six could not be released in the field, 3 could not be recovered after release while 22 were recovered and established. Based on established result of biological control agents, 7 are providing excellent control, 4 substantial control and 9 partial control. Maximum degree of success by classical biological control agents in India has been recorded in aguatic weeds (55.5%) followed by homopterous pests (46.7%) of crop pests and terrestrial weeds (23.8%). There are many biological control agents which have shown varying degrees of success through combined effects. Such successful biological control agents need to be introduced in India to control of the problem weeds like P. hysterophorus, E. carassipes, P. stratiotes, Alternanthera philoxeroides etc.

Keywords: Aquatic weed, current status, classical biological control, terrestrial weed

4A2

RELEASE AND ESTABLISHMENT OF LEAF-FEEDNG LADY BEETLE Mada polluta ON Tecoma stans IN SOUTH AFRICA

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Abstract

Tecoma stans (L.) Juss ex Kunth var stans (Bignoniaceae), also known as yellow bells, is an evergreen tree or a shrub in South Africa and has become an aggressive invader throughout the country. A leaf-feeding lady beetle Mada polluta (Coleoptera: Coccinellidae), originally from Mexico, was introduced in South Africa and subsequently developed as biological control agent for T. stans. Release of 100 to 400 M. polluta adults at 24 sites in six South African provinces (Gauteng, North West, Limpopo, Mpumalanga, KwaZulu-Natal (KZN) and Eastern Cape) since 2013. The aim of the study was to assess the establishment, plant damage, initial dispersal rate and the optimum release size of *M. polluta* at selected release sites. Initial establishment, which was measured during the six months of release, was reported at almost all the sites in the afore-said provinces. However, full establishment was reported after the beetle had successfully overwintered at four sites in the Eastern Cape and KZN provinces. Among the four established sites, two were selected to assess the initial dispersal rate and the plant damage. The lady beetle dispersed at a rate of approximately 100 over a twelvemonths period. At the same release sites, the fruit production was reduced from 90 to 100% while leaf density was reduced from 82 to 86%. The optimum release size of the lady beetles per site was 100 adults. Although *M. polluta* is a slow disperser, the preliminary damage assessment at the release sites suggested that the beetle could reduce the invasiveness of T. stans in the country.

Keywords: Biological control, release, Mada polluta, yellow bells

4A3

BIOLOGICAL CONTROL INITIATIVES AGAINST POISONOUS SOUTH AMERICAN INK BERRIES (*Cestrum SPESIES*) IN SOUTH AFRICA

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Abstract

Three Cestrum sp (Solanaceae), namely; Cestrum laevigatum Schltdl., Cestrum pargui L'Hér and Cestrum aurantiacum Lindl. native in Central and South America were declared invasive weed in South Africa. Two (i.e, C. laevigatum and C. parqui L'Hér) of these have become highly invasive in the country, C. laevigatum being highly abundant along the coastal regions of KwaZulu-Natal and the Eastern Cape while C. parqui is predominantly found in inland provinces of Gauteng, North West, Free State and Mpumalanga. The third species, C. aurantiacum, is localized at few sites in KwaZulu-Natal and Gauteng provinces. Cestrum species are generally toxic to animals including cattle, sheep, horse, pigs, poultry and humans. In particular, naturally occurring cases of poisoning of cattle by C. parqui are characterised by depression, convulsions and death. Hence the rapid spread of *C. pargui* in inland provinces such as Gauteng and the North West poses a serious threat to the livestock industry in these regions. The Plant Health and Protection unit of the Agricultural Research Council has commenced a biological control programme of the invasive *Cestrum* spp., with surveys and search for potential biological control agents initiated in the native region in 2012. Among several natural enemies found in the native range was a leaf-mining flea beetle Epitrix sp. (Chrysomelidae) which has since been introduced to guarantine in South Africa for further host-specificity testing. Preliminary findings and some biological attributes of Epitrix sp. suggest that the beetle is suitable for release against *Cestrum* spp. in South Africa. The flea beetle is sufficiently host-specific to Cestrum spp., and that both immature and adult stages cause significant defoliation to the plants. Epitrix sp. has a short generation period with a rapid population growth rates. Plans are underway to determine the full identity of *Epitrix* sp. and then apply for permission to release the beetle species in South Africa. However, due to severity of invasion by Cestrum spp. in South Africa, Epitrix sp. alone is unlikely to effectively control these species. Therefore, further exploratory attempts, focusing on seed-, stem- and root-feeding agents, should be made in order to complement *Epitrix* sp.

Keywords: Biological control, *Cestrum aurantiacum, Cestrum laevigatum, Cestrum parqui, Epitrix* sp, Invasive weeds.

4A4

AN UPDATE ON PRICKLY ACACIA (Vachellia Nilotica ssp. indica) BIOLOGICAL CONTROL RESEARCH IN QUEENSLAND, AUSTRALIA

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Abstract

Prickly acacia (Vachellia nilotica subsp. indica), a Weed of National Significance, has serious detrimental impacts on pasture production, resulting in economic loss, and on biodiversity. Biological control is one of the most important approaches for management of exotic invasive weeds, involving introducing their natural enemies to reduce their growth and reproductive capacity or even kill them. Three agents for prickly acacia were prioritised from India for host specificity tests including a scale insect (Anomalococcus indicus), a green leaf-webber (Phycita sp.) and a leaf weevil (Dereodus denticollis). The scale insect is highly damaging to prickly acacia, but developed and fed on many non-target, native plants in guarantine, and so may not be regarded as sufficiently host specific for release in Australia. Host testing of the green leaf-webber and leaf weevil was abandoned due to continued difficulties in rearing them in guarantine. Attention then turned to Africa. Surveys in Ethiopia have identified a gall thrips (Acaciothrips ebneri) and three gall mites (Aceria spp.) as potential biological control agents. The gall thrips has been imported into guarantine in Australia and host specificity tests are in progress. To date over 50 test plant species have been screened and the gall thrips have only induced galls and reproduced on prickly acacia. One of the gall mites (Aceria sp.) from Ethiopia has been exported into a quarantine facility in South Africa where host specificity tests are being undertaken. Surveys in Senegal identified a tephritid gall fly (Notomma *mutilum*) as a prospective biocontrol agent. Future surveys are planned in countries in North Africa, such as Egypt, which are unexplored for prickly acacia agents.

Keywords: Prickly acacia, biological control, host specific, prospective biological agent

TESTING ALTERNATIVE HOST *Opuntia* sp. AS POTENTIAL TARGET FOR BIOCONTROL AGENTS (*Dactylopius sp.*) PREVIOUSLY ESTABLISHED IN QUEENSLAND.

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Abstract

Introductions of cactus in Australia have been occurring since the late 1700's. Some species were brought in for commercial cultivation and others as ornamental plants. Since then, many species have become invasive, with 27 opuntioid cacti now listed as Weeds of National Significance (WoNS). Cacti in Australia can form dense thickets that impact on Agriculture by reduce grazing activities, as well as reducing habitat for native species. Biological control of invasive cactus has been on-going in Australia since the 1920s, resulting in the release of insect agents targeting numerous cactus species. However, there are several cactus species currently present in Australia that have not been studied as potential targets for biocontrol. Some of these species are major threats in the State of Queensland where they are not currently established - with an increase in the number of confiscations of these restricted cacti made by Biosecurity Queensland officers over the last few years. In Queensland, Cochineal bug (Dactylopius sp., Dactylopiidae, Hemiptera) have been successfully used to control invasive Opuntia species. The aim of this study was to test alternative hosts for Dactylopius opuntiae, which is currently used in Queensland as a biological control agent for Opuntia stricta and O. tomentosa. In no choice host tests, development of D. opuntiae on cladodes of Opuntia microdasys, O. rufida, O. robusta and O. puberula were compared with development on the target host for this species, O. tomentosa. Initial result indicated that D. opuntiae may be effective as a biocontrol of some of our test species, however efficacy trials on whole plants will need to be completed. This research will allow an assessment of whether biological control agents currently released in Queensland may be effective in preventing establishment of additional opuntioid cactus species, and provide information to other states about potential biological control for species naturalized outside Queensland.

Keywords: Cochineal, Dactylopius, Opuntia stricta, Opuntia tomentosa, Opuntia microdasys

THE POSSIBLE ROLE OF ALLELOPATHY IN INVASIVE SUCCESSION OF Papaver dubium L.

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Abstract

Papaver dubium L. is an annual alien species in Japan which was first found in Tokyo in 1961. Since then, it has been widely spread across Japan. However, its mechanism of expansion has not been well investigated yet. Since allelopathy is one of the key mechanisms of plants invasion, it is essential to investigate the allelopathic potential of P. dubium as a possible strategy for its succession in Japan. Therefore, in order to determine the possible role of allelopathy in the invasion of P. dubium, Sandwich method (SW), Dish Pack Method (DP), Plant Box method (PB) and soil incorporation test were performed. Then, the growth-inhibitory effects on the lettuce seedlings were measured. Fresh leaves were extracted with aqueous methanol to determine its growth-inhibitory effect on the lettuce seedlings. The HPLC analysis was conducted to investigate the chemical composition in the aqueous methanol extract and the contribution of the main active compound to its inhibitory activity was calculated. Papaver dubium showed strong growth-inhibitory activity in SW (82%), PB (74%) and the soil incorporation test. The extracts of fresh leaves showed dose-dependent growth-inhibitory effect (EC50: 30 mg/mL). The HPLC analysis revealed that the fresh leaves contain high concentration of berberine (9.4 µg/mg). The pure berberine showed inhibitory activity in a dose-dependent way (EC50: 20 µg/mL). Finally, the total activity of berberine was estimated at 0.47. Based on the present results, it is possible that allelopathy plays some roles in an invasive succession of *P. dubium* and the main active compound may be berberine.

Keywords: Allelopathy, alien species, growth inhibitory activity, Berberine

4B2

CARNOSIC ACID: A PHYTOTOXIC COMPOUND IN THE LEAVES OF Rosmarinus officinalis L.

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Abstract

Weeds contribute significantly to the yield loss of field crops, and there is the need to manage the threats of weeds using sustainable weed control strategies. Allelochemicals and allelopathic species can be explored as an alternative weed control measure in sustainable agriculture. In this study, we aimed to evaluate the phytotoxicity of rosemary (Rosmarinus officinalis L.) and identify the compound(s) responsible for the plant growth inhibitory effects. Also, the seasonal variations in the plant growth inhibitory activity of rosemary were evaluated. The phytotoxicity of rosemary (leaves, roots, inflorescences, and stems) was tested on the radicle and hypocotyl growth elongations of lettuce (Lactuca sativa L.). The phytotoxicity and content of allelochemical in rosemary leaves collected during the growing season at two different locations (Matmata and Fars) in Tunisia were evaluated. The results showed that the leaves of rosemary had the highest inhibitory activity on lettuce radicle and hypocotyl growth elongations. The leaves contained the highest content of polyphenols (caffeic, ferulic, gallic, rosmarinic, carnosic, and chlorogenic acids) when analysed by reversed-phase highperformance liquid chromatography (HPLC). Among these polyphenols, carnosic acid was the main compound detected in the leaves of rosemary and had a strong specific activity (EC₅₀) of 25 µg/mL when tested on the radicle elongation of lettuce. By the total activity evaluation, carnosic acid was estimated to be the compound responsible for the phytotoxicity of rosemary leaves. Further to this, the phytotoxic effect of R. officinalis leaves on the lettuce growth elongation also varied during the growing season and also between the two sites. The variations in the phytotoxicity of rosemary leaves were due to the changes in the carnosic acid levels in the leaves of rosemary.

Keywords: Carnosic acid, inhibition, phytotoxicity, *Rosmarinus officinalis*.

ASCERTAINMENT OF ALLELOPATHY: SCREENING OF ALLELOPATHIC PROSPECTIVE SPECIES FROM SOUTH ASIAN COUNTRY, BANGLADESH

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Abstract

Weed management is one of the significant challenges in field crop cultivation since weed poses a considerable threat in reducing the crop production annually in South Asian countries, including Bangladesh. Allelopathy, a phenomenon where secondary metabolites are produced and released by one plant species, influence the growth and development of other species, can be exploited to manage weeds sustainably. The focus of this study, is to evaluate the plants as a potential allelopathic plant species, which can be explored as new natural herbicides as a part of integrated weed management in sustainable agriculture. Two hundred fifty-two plant samples from 70 families were collected from Bangladesh and evaluated with the sandwich method. About 31% of the samples showed significant allelopathic potential on the lettuce radicle elongation. Fruits of Couroupita guianensis, Phyllanthus emblica and Acacia concinna showed the highest and similar inhibition by 95.4% compared to control on the radicle. Conversely, one hundred three plant samples from 40 different plant families have been manipulated by the dish pack method, for screening the volatile allelopathic species. About 25.2% of plant samples showed the inhibition potentialities by releasing the volatile allelochemicals. The result stated that the pericarp of Sapindus mukorossi showed 97% inhibition compared to the control, which was followed by the leaf of Cassia nodosa (65.6% inhibition of control), and the root of Kaempferia galangal (56.6% inhibition compared to control) respectively. This result suggested that the significant plant growth-inhibiting plant species may play a vital role as an alternative to synthetic herbicide for sustainable weed management in agricultural land.

Keywords: Allelopathy; dish pack method, sandwich method; sustainability, weed management.

INHIBITORY ACTIVITY OF AQUEOUS EXTRACTS FROM Samanea saman ON BARNYARD-GRASS

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Abstract

Samanea saman is a woody tree belonging to legumes and mostly found in tropical and subtropical regions. Naturally, there are few or even no weeds grown surrounding saman trees. The phenomenon supposes that the falling leaves contain allelochemicals phytochemicals that can inhibit or stimulate the growth and development of other plants. Therefore, the study was conducted to evaluate the allelopathic effect of aqueous extracts from leaves, stems and seeds of saman trees. The evaluated concentrations were 0.1 g/mL, 0.05 g/mL and 0.025 g/mL, and the tested plants consisted of lettuce (Lactuca sativa) and barnyard-grass (Echinochloa crusgalli). The bioassay of inhibitory effect was conducted using petri dish with 20 seeds in each dish with four replicates. After one week of treatment, the germination rate, shoot height, root length and fresh weight of plants were recorded. Total content of phenolics, flavonoids and mimosine were measured using spectrophotometical methods. The results showed that at the concentration of 0.05 g/mL, the inhibitory activity was over 50% on evaluated parameters. Particularly, seed extract inhibited 50% of germination rate, 70.9% of shoot height, 97.3% of root length and 70.9% of fresh weight compared to control. The phytochemical estimation also indicated the high content of mimosine in seeds of saman tree with 10.63 ± 0.21 mM, significantly different from other aerial parts of the tree. The highest total flavonoid and phenolic contents was found in the leaves with 1.27 ± 0.02 and 2.91 ± 0.14 mg/g dried weight, respectively. The findings confirmed the allelopathic potential of aqueous extracts from aerial parts of saman tree in the nature.

Keywords: Inhibitory activity, mimosine, Samanea saman, weed.

4B5

ALLELOPATHIC EFFECT OF THE LEAF LITTER LEACHATES OF Ulex europaeus TO THE OTHER SPECIES AND TO THE SEED GERMINATION OF Ulex europaeus ITSELF

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Abstract

Ulex europaeus is listed as one of the world 100 most noxious species by International Union for Conservation of Nature. Once it starts to propagate in an introduced site, it often occupies a huge land and hinders the growth of the native species. It causes negative effects to the agriculture and ecosystem such as in the Hawaii Island of USA and New Zealand. Some of the very effective strategies for adaptation must inhere in U. europaeus and this study had been focused on allelopathy as one the adaptation strategies of this species. The objectives of this study were to assess the allelopathic effects of the leaf litter of U. europaeus to the other plant species by sandwich method, (which the growth of lettuce seeds were used as the indicator for the magnitude of allelopathy), and to the seed germination of this species itself. Leaf samples were obtained from seven different locations, which were in USA (Hawaii Island, Maui Island, San Mateo, Bandon and Coos Bay) and New Zealand (North Island and South Island) during the period from July 2016 to March 2018, and the results were compared to those of Abutilon theophrasti that has been reported to have strong allelopathy examined by the same method. As the result, the allelopathy of U. europaeus leaves to the radicle growth of the lettuce seeds was significantly stronger than A. theophrasti. When the magnitude of the allelopathy of U. europaeus leaves from ten different habitats in seven locations was compared, it was divided to three significantly different groups. It inferred that the magnitude of the allelopathy of U. europaeus leaves differed significantly according to the vegetation of the habitat. The strong magnitude and variability of the allelopathy of U. europaeus leaves were suggested from the results tested by the sandwich method. Furthermore, the leaf litter leachates of U. europaeus hindered the germination of the seeds of themselves from other mother trees significantly at the concentrations of 10% and 1% and even from the same mother tree significantly at the same concentrations. The productive matured mother trees of U. europaeus were supposed to be protected from competition with other new mother trees by using the allelopathy of the leaves. The strong allelopathic effect of the leaf litters of U. europaeus seemed to be used to compete with other species and to keep the effective propagation.

Keywords: Adaptation strategy, different habitats, invasive species, magnitude of allelopathy, managerial control

PHYTOTOXIC EFFECT AND IDENTIFICATION OF POTENTIAL ALLELOCHEMICALS FROM *Turnera subulata*

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Abstract

Allelopathy application in agricultural management can reduce issues related to the use of synthetic herbicides such as environmental pollution and herbicide resistance development. *Turnera subulata* is a perennial shrub belonging to family Turneraceae, widely used as natural insect control in the oil palm plantation and paddy field. The plant may be potentially useful for weed suppressing agent when used as a companion plant with crop plants. Given this context, the study attempted to evaluate potential allelopathic of T. subulata and to identify potential allelochemicals in T. subulata. Laboratory bioassays of sandwich method and dish pack method were respectively used to evaluate the allelopathic potential of T. subulata with Lactuca sativa (lettuce), Brassica chinensis (pak choi) and Oryza sativa var sativa (weedy rice) as the receptor plants. High-Performance Thin-Layer Chromatography (HPTLC) screening method was developed to identify the potential allelochemicals of T. subulata. Substantial inhibition on the growth of tested receptor plants was recorded. Sandwich method revealed inhibitory of T. subulata on hypocotyl of weedy rice (44.08%), B. chinensis (38.23%) and L. sativa (36.26%) at 50 mg well⁻¹ respectively. Meanwhile, the radicle growth of B. chinensis (77.35%) weedy rice (68.21%) and L. sativa (72.97%) were reduced tremendously. In the dish pack bioassay, the inhibition percentage at 41 mm distance from well donor source for the radicle of L. sativa, B. chinensis and weedy rice were 62.64%, 2.90%, 25.52% when compared to control, respectively. Based on HPTLC fractionation, two potential compounds (rutin and naringin) were elucidated from the methanolic extract of *T. subulata* leaves. These compounds were fractionated using ethyl acetate: ethanol: formic acid: water (28:2.4:4.8:4.8) and validated according to their Rf values with the corresponding spot of standards. Laboratory bioassays and HPTLC screening method suggest that *T. subulata* is a promising allelopathic candidate species for weed control strategy.

Keywords: Allelopathy, allelochemicals, HPTLC, Turnera subulata

GROWTH OF SOME IMPORTANT CROPS AND WEEDS OF KHYBER PAKHTUNKHWA PROVINCE OF PAKISTAN

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Abstract

Parthenium hysterophorus L. being a declared invasive weed is threatening the biodiversity of Pakistan. To study its allelopathic potential, the laboratory and pots-based studies were undertaken to investigate the allelopathic effect of *Parthenium* on selected important crops (which were Triticum aestivum, Cicer arietinum and Brassica campestris) and weeds (which were Avena fatua, Asphodelus tenuifolius and Lolium rigidum). The fresh leaves of P. hysterophorus were dried in shade and grinded. The powder was prepared into different concentrations, which were 25 g L⁻¹, 50 g L⁻¹ and 75 g L⁻¹. Five seeds of each species were placed in the petri dishes and pots, and then the extracts were applied when needed. Control (0 g L⁻¹) was also included for comparison. The experiments were conducted in completely randomized design (CRD) with four replications. Since the statistical differences between the runs were non- significant the data were pooled before subjecting it to ANOVA and mean separation. The differences among the species tested and the rates of *Parthenium* extracts were different statistically for all the traits tested in each of the experiments, while for the species x *Parthenium* concentration interaction, the differences were only significant (p<0.05) for plant height in the pot experiment. The results showed that with the increasing concentration of P. hysterophorus, all the parameters studied in the six species tested were significantly decreased. Hence, the present study suggests that *P. hysterophorus* affects the agro ecosystem and needs to be properly managed. Moreover, its autotoxicity and allelopathic effect on weeds is an encouraging finding for the weed managers in achieving sustainable management of weeds.

Keywords: Allelopathy, *Parthenium*, crops, weeds.

IWMPRAISE – A MULTI-NATIONAL EUROPEAN RESEARCH AND INNOVATION PROJECT ON INTEGRATED WEED MANAGEMENT

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Abstract

IWMPRAISE is a new five-year EU Horizon 2020 project on integrated weed management (IWM) with 37 partners (research institutes, advisory services and SMEs) in eight European countries. The objective of IWMPRAISE is to demonstrate that adoption of IWM will support cropping systems that are agronomically and environmentally more sustainable and more resilient without jeopardizing profitability or the steady supply of food, feed and biomaterials. IWMPRAISE develops, test and assesses management strategies delivered across cropping systems for four crop groups: narrow-row annual crops, wide row annual crops, perennial herbaceous crops and perennial woody crops. The specific objectives are to i) quantify and address current socio-economic and agronomic barriers to the uptake of IWM ii) design, evaluate and optimize novel alternative weed control methods and create a 'tool box' of validated IWM methods iii) assess the short- and long-term agronomic performance and environmental and economic sustainability of IWM strategies and iv) make results available to end users. One work package is devoted to understanding end users' perception of IWM and barriers to uptake of new knowledge while another will focus on the interface between weed management and tillage. Novel IWM strategies for each of the four crop groups are being developed within national clusters where all stakeholders are represented. The development of IWM strategies are supported by research activities delivering practical knowledge and novel tools for weed control as well as tools for assessing and disseminating the novel strategies. IWMPRAISE will provide advances beyond the state-of-the-art within several research areas ensuring that the overall goal of the project, to provide practical solutions to the end users, will be fulfilled. IWMPRAISE combines research and development activities that provide the tools for developing novel IWM strategies with activities that adopt the "interaction innovation model" involving end-users in a partnership with public research institutes and private SMEs. The outputs of the first two years are presented.

Keywords: Integrated weed management, non-chemical weed control, mental modelling, interactive innovation model

ENERGY BUDGETING IN WEED AND TILLAGE MANAGEMENT UNDER CONSERVATION TILLAGE

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Abstract

A field experiment was conducted at Birsa Agricultural University Farm, Ranchi during the rainy and winter seasons of 2015-16 and 2016-17. The experiment was conducted in split plot design with three replications. The treatment comprised of five tillage practices in main plots i.e. conventional tillage - conventional tillage (CT - CT); Conventional tillage - zero tillage (CT -ZT; zero tillage-zero tillage (ZT – ZT); zero tillage - zero tillage crop residue (ZT – ZT+R); zero tillage+ crop residue - zero tillage+ crop residue (ZT+R - ZT+R) in maize and wheat, respectively. Similarly, weed control methods in sub plots involved atrazine@ 1 kg/ha PE for maize - isoproturon @ 0.75 kg/ha + 2,4 -D @ 0.5 kg/ha post emergence; pendimethalin @ 1kg/ha + intercrop black gram for maize isoproturon @ 0.75 kg/ha + 2.4 –D @ 0.5 kg/ha post emergence+ mechanical weeding at 40 DAS and weedy check - weedy check in maize-wheat sequence. CT – CT sequence recorded 64.19, 73.78 and 56.38% higher gross energy output. net energy output (MJ/ha) and energy use efficiency compared to ZT -ZT sequence i.e. 180379, 151652 MJ/ha and 5.25, respectively. ZT+R - ZT+R being similar to CT - CT sequence recorded 26.12 per cent reduced specific energy (MJ/t) compared to sequence. ZT -ZT i.e 5952 MJ/t. Among weed control methods, IWM recorded 70.58, 82.79 and 69.59 percent higher gross energy output, net energy output and energy use efficiency compared to weedy check i.e. 179685, 150495 MJ/ha and 5.13. IWM recorded 35.93 percent reduced specific energy (MJ/t) compared to maximum under weedy check i.e. 6295 MJ/t. Interaction effect of tillage sequences and weed control methods on gross energy output, net energy output and energy use efficiency revealed that combination of CT – CT along with IWM similar to ZT+R - ZT+R along with IWM being significantly higher over rest of the treatment combinations recorded 173.67 and 209.94% higher gross energy output and net energy output compared with minimum recorded under ZT – ZT under weedy check i.e. 142814 and 115228 MJ/ha. ZT+R – ZT+R along with IWM being similar to CT – CT along with IWM being significantly higher over rest of the treatment combinations recorded 166.51 percent higher energy use efficiency and 53.74 percent reduced specific energy compared with ZT - ZT under weedy check i.e. 4.18 and . 7041.20 MJ/t

Keywords: Energy use efficiency, maize-wheat sequence, specific energy, zero tillage

4C3 HERBICIDE HOTSPOTS IN BANGLADESH

Weed Science for Sustainable Agriculture and Environment

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Abstract

Weed competes with crops for light, nutrients and water thereby resulting yield loss of field crops up to 80-90 percent in worst cases. In the absence of specific or broad-scale weed surveys in Bangladesh, about 350 species have been incidentally recorded as important weeds of cultivated fields. In Bangladesh improper weeding causes yield loss that range in between 40 to 50 percent in rice, 24 to 58 percent in wheat, almost 49 percent in maize, 43 percent in potato, 20 percent in sugarcane, 75-80 percent in jute, nine percent in tea and 25 to 60 percent in other crops. In current practice farmers usually do weeding by hand, hoe, mechanical weeder and chemical weeding with herbicide. Hand weeding and mechanical weed control in field crops is costly, need more money and time consuming. In case of hand weeding it needs 120 to 220 USD per hectare depending on crops. Estimates indicate that about 30% of rice farmers are losing about 500 kilograms per hectare of rice, due to poor weed control. Now farmers are more interested in chemical weed control with herbicide which adoption is increasing day by day due to its quick effectiveness and low cost. Presently, farmer's net income can be increased by 100% with the use of herbicides. In Bangladesh, no census of herbicide-resistant weeds has been reported while there are some unconfirmed reports that already a few biotypes of broadleaf weeds like Chenopodium album, are resistant to carfentrazone-ethyl plus isoproturon in some areas of the North-western region of the country. As detailed, dis-aggregated, information on herbicide use is not currently available. the findings of this report attempt to cast some light on the overall extent of herbicide use in Bangladesh, as well as, highlight areas where particularly toxic herbicides are concentrated.

Keywords: Weed Management, herbicide, herbicide resistant weed, Bangladesh

4C4 PERFORMANCE OF STRIP-PLANTED WHEAT WITH POST-EMERGENCE WEED CONTROL BY HERBICIDES

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Abstract

Strip planting technique is getting more popular in the wheat cultivation rather than the conventional tillage practice because of having environmental and cost effective benefits of reduced tillage. It has also evident that strip-planted wheat gives better yield and economic return than under the conventional system; however, weed management has an important role in obtaining the target yield. Post-emergence weed control by herbicide has a great impact on the growth as well as the yield of wheat. Therefore, three available post-emergence herbicides (ethoxysulfuron, carfentrazone-ethyl plus isoproturon and carfentrazone-ethyl) were tested at their label rate and double than that during the winter season of 2017 to 2018 and 2018 to 2019 to evaluate the performance of strip-planted wheat cv. BARI Gom-30. The field was mostly infested by grass weeds (73% and 97% of the total infested weeds during 2017 to 2018 and 2018 to 2019, respectively) and the most dominant weed species was Echinochloa colona during both the year. Application of ethoxysulfuron at label rate and double of the label rate was effective for grass weeds, but not for broadleaf weeds. Application of carfentrazone-ethyl plus isoproturon found the most effective for controlling all types of weeds at both label rate and double of the label rate (71-73% and 64-68% of total weed biomass during 2017 to 2018 and 2018 to 2019, respectively). BARI Gom-30 gave the highest grain and straw yields at label rate of carfentrazone-ethyl plus isoproturon; however, the similar results were also obtained from the double rate application but it had some adverse effect on the wheat leaves and took longer time to recover compared to the label rate application of carfentrazone-ethyl plus isoproturon.

Keywords: Reduced tillage, strip planting, weed, wheat.

4C5 INFLUENCE OF WEED CONTROL METHODS ON THE GROWTH AND YIELD OF SOYBEAN (*Glycine max* L.) VARIETIES

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Abstract

One of the most widespread agricultural problems in the arid and semiarid regions is weed, which renders crop productivity. The experiment was conducted at the farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh in order to study the influence of weed control methods on the growth and yield of soybean. The experiment comprised of two factors- Factor A: soybean variety (three varieties): Sohag, BARI soybean 6, and BINA soybean 1; Factor B: weed control methods (four levels): no weeding, hand weeding at 20 and 40 DAS (days after sowing), chemical control by whip super 9EC (Fenoxaprop-p-Ethyl) herbicide application at 20 DAS and Siam weed (Chromolaena odorata) aqueous extract. The experiment was laid out in Split plot design with three replications. Results of the experiment showed that at 30, 45, 60 and 75 DAS, the maximum number of weed population (25.00, 31.22, 25.22 and 20.44, respectively) was observed in control plots while the minimum number (11.78, 14.67, 14.44 and 14.11, respectively) in herbicide treated plots. At 30, 45, 60, and 75 DAS and at harvest, the tallest plant (18.56, 35.51, 56.80, 61.99 and 68.17 cm, respectively) was observed in herbicide treated plots, whereas the shortest plant (15.04, 25.95, 38.70, 45.30 and 52.46 cm, respectively) from weedy check plots. The highest seed yield (2.01 t ha⁻¹) was observed in the herbicide treatments, whereas the lowest seed yield (1.41 t ha⁻¹) from the control plots. Combination effect of varieties and weed control methods showed that at 30, 45, 60, and 75 DAS and at harvest, the tallest plant (19.86, 38,65, 61.66, 66.45 and 73.10 cm, respectively) was found in BARI soybean 6 in combination with chemical control by whip super 9EC herbicide application at 20 DAS while the shortest plant (14.51, 24.55, 36.58, 44.06 and 46.69 cm, respectively) from the combination of variety Sohag under no weed control. The highest seed yield (2.23 t ha⁻¹) was recorded in BARI soybean 6 combination with chemical control by whip super 9EC herbicide application at 20 DAS while the lowest seed yield (1.26t ha⁻¹) from the combination of variety Sohag under no weeding. However, Siam aqueous extract also found as a weed suppressive. Therefore, additional research is necessary in order to isolate and identify of potent allelochemical(s) from this species.

Keywords: Soyabean, yield, whip super 9EC (Fenoxaprop-p-Ethyl) herbicide, siam weed (*Chromolaena odorata*), weed management

4C6 GROWING OF THE COMPETITIVE CROPS CAN SUPPRESS WEEDS IN SUBTROPICAL AUSTRALIA

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Abstract

Herbicide resistance is a key constraint in effective and sustainable control of weeds in Australian cropping systems. At June 2019, there were 50 weed species in Australia confirmed resistant to herbicides. In response, there is a current focus on identifying agronomic and nonchemical tactics for weed control in cropping systems. One such tactic is growing a competitive crop. Research in the subtropical northern grain region of Australia is focusing on improving competitiveness of summer crops sorghum and mung bean. Sorghum is commonly grown at wide (100 cm or wider) row spacing and pulse crops, including mung bean, are known to be poor competitors. Summer grass weeds Echinochloa colona (awnless barnyard grass) and Chloris virgata (feathertop Rhodes grass) have both been confirmed glyphosate resistant in the region and both are common and difficult to control in summer cropping. Field experimentation has measured the impact of row spacing and crop density (2017) and row spacing and crop cultivar (2018) on growth and seed production of these weeds and crop yield. In sorghum, an increased crop density from 3 to 16 plants/m² significantly reduced both E. colona and C. virgata seed production, but there was no impact of row spacing in 2017. In 2018, a reduction in row spacing from 100 to 50 cm significantly reduced seed production of E. colona by up to 66% and C. virgata by 56% and reduced biomass of both weed species. There was no impact of cultivar. In both years, growing a competitive crop did not impact the crop vield. For mung bean in 2017, narrowing row spacing from 50 to 25 cm decreased E. colona and C. virgata biomass, compared with 75 cm rows and a greater mung bean yield was measured at narrow row spacing (25 cm). There was no effect of mung bean density on weed biomass, seed production or crop yield. In 2018, there was a strong cultivar effect on weed growth and crop yield, but no row spacing effect. A competitive crop can suppress incrop weeds without jeopardizing, and in some cases increasing the crop yield. However, crop competitive effects can differ across environment and season. Growing a competitive crop for weed control reduces selection pressure for herbicide resistance development and can prolong the useful life of herbicides. Current research is also evaluating crop competition in chickpea and faba beans against Sonchus oleraceus (common sowthistle).

Keywords: Crop competition, herbicide resistance, mung bean, sorghum, summer grass weeds

4D1 GENETIC REGULATION OF SEED DORMANCY AND GERMINATION IN Solanum rostratum

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Abstract

Buffalobur (Solanum rostratum Dunal) is a worldwide noxious invasive weed and is listed as one of the top ten invasive species in China. The seed is the primary source of weed infestation and dispersal. Regulation of seed dormancy and germination would be an important approach for sustainable management of this species. By RNA-Seg of GA and ABA-treated seeds, differential expressed genes related to seed dormancy and germination were screened, and their regulating pathway was clarified. We obtained the suitable reference genes for qPCR normalization in buffalobur using geNorm, NormFinder, BestKeeper and RefFinder statistical algorithms. For GA, ABA and water-treated seeds, the best genes were eIF, SAND and ACT, respectively. But for total seed samples of multiple treatments, PP2Acs was the most stable gene. Based on Illumina Hiseg 2500 platform, 336057 unigenes were achieved with an average length of 363 bp. 63579 unigenes were annotated to 129 pathways in KEGG, and 28874 genes were differentially expressed. We further identified 11 genes which associated with seed dormancy and germination. Among them, 4 genes related to GA signaling pathway (GID1B, GAI, GA3ox1 and GA2ox2), 3 genes related to ABA signaling pathway (PYL2, NCED6) and CYP707A). The expression of these genes in buffalobur seeds treated with exogenous hormones were verified by gPCR, and the regulating pathway of seed dormancy and dermination of buffalobur was elucidated. This study will help to explore the mechanism of seed dormancy and germination of buffalobur and will provide a basis for application of the suicidal germination strategy.

Keywords: Solanum rostratum, seed dormancy, transcriptome analysis, gene expression, regulatory pathway

4D2 EFFECT OF FULVIC ACID ON BARNYARD GRASS SEEDING GROWTH: METABOLOMIC AND TRANSCRIPTOMIC ANALYSES OF THE PHYTOHORMONE BIOSYNTHETIC PATHWAY

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Abstract

Barnyard grass (Echinochloa crus-galli L.) is a major weed in rice field. Flooding is an effective method to control the occurrence and damage of barnyard grass. Our previous study found that the growth of barnyard grass seedlings can be affected by the addition of fulvic acid under flooding condition. Compared with the blank control group (CK), the inhibitory rates of the application of fulvic acid with the concentration of 0.8 g/L for barnyard grass shoot length, root length and fresh weight were 32.12%, 92.34% and 42.24%, respectively. However, the shoot length of barnyard grass seedlings increased by 22.88% with the application of very lowconcentration fulvic acid (LF, 0.02g /L), while the root length and fresh weight have little change. Suitable application of fulvic acid and water retention could inhibit the growth of barnyard grass seedlings so as to control barnyard grass in paddy field. Moreover, the analyses of metabolomic and transcriptomic demonstrated that fulvic acid regulated barngrass seedling growth mainly through affecting the synthesis of plant hormones including auxin, cytokinin, ethylene and salicylic acid, and the synthesis of flavonoids and flavonol. Compared with CK, 5-methoxyindole-3-carbaldehyde, methoxyindoleacetic acid, indole and 3indoleacetonitrile were upreculated by 11.82, 5.08, 4.35 and 4.15-fold respectively in HF, most indole derivatives are slightly down-regulated in LF.

Keywords: Barnyard grass, fulvic acid, growth inhibition, metabolomic, transcriptomic

4D3 GENETIC STRUCTURE AND DIVERSITY OF WEEDY RICE POPULATIONS IN SRI LANKA

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Abstract

Weedy rice (Oryza sativa f. spontanea) are weedy crop relatives of rice which aggressively outcompete crops and reduce harvests. To design effective methods to control such weedy rice populations, the knowledge of genetic diversity, population genetic structure and the origins and dispersal patterns in a given region are important. Thirty-three simple sequence repeat (SSR) markers were used to estimate genetic parameters of 20weedy rice populations (W-1W20 (from Sri Lanka, each containing about 25individuals of weedy rice. All 33loci displayed polymorphism among the 20populations with a total of 534alleles identified. The most variable locus RM 426had 69alleles, while RM 414showed only two alleles across the populations, with an average of 26.7 alleles per population. As measured by expected heterozygosity, the highest genetic diversity was found for W3 population (H_E = while ,(0.603) the W10 population recorded lowest (H_E = (0.390 diversity. Out of the total genetic variance found. %19and %62are structured among and within populations, respectively. The UPGMA tree illustrated that all 20populations were genetically structured into two well-separated major groups as was confirmed by the structure analysis. Further clusterization can also be supported by ΔK peaks at K= 9and K= 12with the admixed genetic background for individuals in some populations. W4 and W6 populations were recorded a high number of private alleles and separated from other populations, showing unique genetic background. Conclusively, these results indicated that a high level of within-population variance than among population variance in Sri Lankan weedy rice populations. Recent alterations in agronomic practices and weed management strategies affect the re-emergence and divergence of weedy rice in Sri Lanka.

Keywords: Genetic diversity, *Oryza sativa* f. spontanea, population Genetics, SSR markers, weedy crop relatives.

4D4 INVESTIGATION OF SEED AND PLANT GROWTH PHYSIOLOGICAL CHARACTERS OF PARTHENIUM WEED (PARTHENIUM HYSTEROPHORUS LINN.) IN TAIWAN

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Abstract

Parthenium weed (Parthenium hysterophorus L.) is one of the Asteraceae herbaceous plants. the rapid growth and reproduction has made it become a wide spread naturalized invasive plant in southern Taiwan. This study showed that Parthenium seeds stored at 5, 10, 15, 25°C and 7, 14, 21 days had the germination rate ranged from 25 to 40%. Using sand as medium the germination rate will be greater than 70%. At 0.5cm sowing depth seed germination rate dropped significantly to less than 50% of the 0cm depth treatment. The deeper the sowing depth the lower the germination rates. Significant impact on reducing seed germination when Day / night temperature difference above 10°C occurred. The germination rate for Day / night temperature 20/10, 30/20, 30/22°C were 29.3%, 18.7%, 12%, respectively. Water logging for long days can delay seed germination of Parthenium weed more than 52%. Field survey study showed that Parthenium weed can reach about 40~115cm in height. Lower temperatures (<15°C) significantly restricted the plant growth after five weeks of treatment. 70% or above shading increased number of leaves and leaf area. However, the plant height did not show significant differences. Water logging or heavy rain season will shapely decrease seed germination and inhibit plant growth. It is estimated that the field grown Parthenium can produce around 3,000 seeds per plant.

Keywords: Germination, parthenium weed, shading, sowing depth, temperature

5A1 MANAGEMENT OF PARTHENIUM HAZARDS USING BIOCONTROL METHODS IN MALAYSIA

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Abstract

Parthenium hazard occurred by parthenium weed (Parthenium hysterophorus L.) is a new and alarming issue in Malaysia which was first innovated in 2013. Parthenium hazards are the negative impacts caused by the weed to human health, animal health, crop production, biodiversity and the environment. The people in contact with this plant suffer from severe allergic diseases such as dermatitis, hay fever and asthma. The plant is toxic to cattle, and affects the meat and milk quality. It invades grazing lands, disturbed areas, roadsides and cultivated lands which spread very fast just like wild fire. Some people in Kedah and Johor were found infected with parthenium allergy in Malaysia. A huge amount of weed seeds (3.18 million/ha) in the soil seed bank is posing threats to the inhabitants indicating future infestation and invasion. This invasive alien species have been spread to ten states of the country including Sabah. The control of this invasive species using biocontrol method is a sustainable approach. This research was, therefore, done to isolate the disease-causing fungus from parthenium leaf and to extract mycotoxin from the cell filtrate of the isolated fungus for parthenium control. The diseased parthenium leaf was sampled and cultured in potato dextrose agar, the fungus was identified and tested for its pathogenicity on fresh parthenium leaf in the Universiti Malaysia Kelantan (UMK) laboratory. A fungal isolate, UMKRSPL1 (Rhizoctonia solani) was isolated which caused disease symptoms on the fresh parthenium leaf. In another experiment, the isolate was grown in potato dextrose broth, then collected the cell filtrate and purified the cell filtrate by activated charcoal. The purified cell filtrate at 10% concentration applied for eight days was enough to get more than 90% killing effect of the parthenium leaf. A technological model, "BioKill-Tech" was proposed for commercial production of bioherbicide from the mycotoxin in the industry.

Keywords: BioKill-Tech, invasive alien species, mycotoxin, *Parthenium hysterophorus*, UMKRSL1 isolate

5A2 EFFICACY OF CHEMICAL HERBICIDES USING A NOVEL ENCAPSULATED DELIVERY MECHANISM FOR STEM INJECTION ON MIMOSA BUSH

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Abstract

Mimosa bush (Vachellia farnesiana) is an introduced species which is widely distributed across northern Australia. At low densities, mimosa bush can be beneficial as an alternative forage during the dry season. However, dense infestations hinder access to water points and make mustering of animals more difficult, particularly due to the damage caused by its spines. Mimosa bush is generally controlled by application of chemical herbicides using foliar, basal bark or cut stump techniques. To minimise the risk of spray drift and potential non-target damage a novel stem injection technique using application of encapsulated herbicide has been developed by Bioherbicides Australia. This method was used to evaluate the efficacy of six encapsulated herbicides stem injected into intact stems of mimosa bush growing in a naturalised population near Moree, New South Wales. Granular forms of glyphosate, aminopyralid/metsulfuron-methyl, hexazinone, clopyralid, triclopyr/picloram, and metsulfuronmethyl were tested and compared against the conventional basal bark application of triclopyr/picloram mixed with diesel and an untreated control. A randomized complete block design was utilised with canopy death estimation as the response variable. Eight months after the implementation of treatments, canopy death in the aminopyralid/metsulfuron-methyl (87%), metsulfuron-methyl (84%) and hexazinone (80%) stem injection treatments was not significantly different (P > 0.05) to the currently recommended basal bark application of triclopyr/picloram (90%). Moderate levels of canopy death (60%) occurred in the clopyralid treatment, but both glyphosate (45%) and granular triclopy/picloram (41%) treatments These preliminary results suggest that from an efficacy recorded limited canopy death. perspective, stem injection of several encapsulated herbicides can provide comparable control to currently recommended options. Minimal risk of spray drift and potential non-target damage make this an alternative option for situations where land managers need to reduce associated risks. However, further refinement and testing is required and choice of herbicide and ease of application would need to be considered for each situation before control is initiated.

Keywords: Efficacy, herbicide, mimosa bush, stem injection

5A3 MANAGEMENT OF Ambrosia psilostachya - A QUARANTINE WEED FIRST TIME REPORTED IN KARNATAKA, INDIA

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Abstract

Western Ragweed-Ambrosia psilostachya DC is a new quarantine weed, belongs to Asteraceae family was reported for the first time in the year 2012 in India in M. Bevinahally, Sreerampura, Gottikere Pura, Aralikere of Turuvekere taluk, Tumkur district, and Karnataka. It has spread to the neighboring areas/villages in about 150 hectares in cropped, non-cropped areas, road sides, forestry, plantations, wasteland and all along the irrigation canals in recent years. This perennial weed has extensive vegetative reproduction through horizontally spreading underground rhizomatous plenty of stoloniferous roots spreading up to 1.0 m laterally and giving raise to new shoots covering the ground area completely. This has led to total elimination of other plants and grasses in the infested fields. Thus, ovines and bovines do not have grasses to eat on grazing lands/ waste lands. The AICRP on weed management, University of Agricultural Sciences, Bengaluru has recommended a herbicide technology consisting of repeated spraying of Glyphosate 41 SL (10 ml/litre of water + 20 g urea + 2-3 drops lime juice, three times a year at every four months interval has resulted in significant reduction (70-80%) of Ambrosia weed in cropped and non-cropped situations. Further, biological control by using Zygogramma beetles and fast growing species like Sunhemp, Crotalaria spp, Fodder Cowpea, Cassia spp also controlled Ambrosia weed to an extent of 20-30 per cent in twelve villages, infested with Ambrosia. It has shown that systematic approach, regular monitoring and periodic herbicide spray can check the further spread of Ambrosia weed to other places.

Keywords: Ambrosia psilostachya, biological control, herbicide, quarantine weed.

5A4 CONTROL AND ERADICATION OF *Chimonobambusa quadrangularis* IN GUNUNG GEDE PANGRANGO NATIONAL PARK

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Abstract

Indonesia has signed Convention on Biological Diversity (CBD), and integrated CBD into the law no. 5 /1994 and in 2016, the Minister of Environment and Forestry has also issued the ministerial decree no P.94/MENLHK/SETJEN/KUM.1/12/2016 on invasive alien species. CBD adopted 20 formulated targets from 2011 – 2020, called Aichi Biodiversity Target. Target no. 9 states that by 2020, invasive alien species and pathways are identified and prioritized. priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment. Research works were conducted to response the target no. 9. A vegetation analysis using nested sampling method was conducted and a risk assessment method of Virtue (2010) was adopted. The results recommended that the bambu kirisik Chimonobambusa quadrangularis should be eradicated. Bambu kirisik grew vegetatively by rhizomes. It grew up to about 6.00 m height, at densities around $10.42 / m^2$. with its rhizome reached 31.00 m / m² long carrying more than 700 living buds. The growth was very rapid during the wet season, allocated a considerable resources for leaves, culm and branches but slowed down during the dry season, and allocated less resoucres for above around part, more of its resources was in the rhizome. Control experiment in the field indicated that slashing the culms by leaving only one node reduced more regrowth than that when slashed leaving 3 nodes. When brushed with 10% triclopyr as Garlon diluted in diesel oil, reduced more regrowth. Slashing all culms 4 months after treatment and the regrowth were measured 2 months later the regrowths were considerable, and there was no different, except those under triclopyr treatment. However it was not satisfactory for the eradication. Greenhouse experiment was performed at SEAMEO BIOTROP by using extract of Mikania micrantha, glyphosate, and glufosinate. Glyphosate killed rhizome significantly up to 95-100 %. However the growth of bamboo at the SEAMEO BIOTROP green house is abnormal, rendering the results inapplicable when applied in the field. The work is still going on to study its biology before designing its eradication.

Keywords: Invasive alien plant species, risk analysis for management, eradication, *Chimonobambusa quadrangularis*

5A5 THE DEVELOPMENT OF INVASIVE ALIEN PLANT SPECIES MANAGEMENT FOR THE REHABILITATION OF INVADED ECOSYSTEMS

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Abstract

Baluran National Park (BNP) covers a set of ecosystems from coastal area with mangrove. an extensive savana, to lowland tropical moonson forests, up to motane moonson forests of Baluran mountain (inactive, with a summit of 1247 m above sea level), covering a total area of 25,000 ha, located at the northorn tip East Java, Indonesia. It is unique because its climate is so dry creating an extensive savana supporting the life of banteng (Bos javanicus) an endogenous herbivore, the ancestral of current domesticated Bali cattles. This BNP is heavily invaded by Acacia nilotica an inavsive alien plant species originated from India. It invaded more than 6000 ha of BNP in 2013 and kept on spreading, as the spread was facilitated by herbivores living in the park. The herbivores consumed dropped mature pods, during dry season, but their digestive tract did not harm the seeds, and the viable seeds were excreted in feces everywhere, distributing seeds in BNP. A.nilotica shaded out grasses facilitated the domination of broadleaved weeds reducing herbage as well as the population of banteng, and other herbivores, threatening the integrity of the ecosystems. Experimental works have been carried out since 1980's, including mechanical chemical and lately also biological control, but the invasion is still spreading. An integrated approach of A.nilotica control management was discussed to halt the spread and rehabilitate the savanna to reestablish the habitat of herbivores especially banteng. The integrated control management begins by controlling broadleaved weeds, including young A.nilotica with foliar spray of triclopyr as GARLON 670EC at 2.00 lt/ha diluted in water mixed with 0.2% surfactant and sprayed in 400lt/ha during wet season under intact A.nilotica shade. Following the dry season trees of A.nilotica was cut mechanically using chainsaw and soon be brushed with triclopyr as 10% GARLON 670EC dissolved in diesel oil. The cutting of trees are carried out by villagers around BNP in the framework of people empowerment and allowing them to take A.nilotica timber out of the park for themelves. The threat of emerging seeds are controlled biologically using Chiasmia assimilis. It is expected the problems of A.nilotica is solved.

Keywords . Baluran National Park, *Acacia nilotica*, invasive alien plant species, triclopyr, *Chiasmia assimilis*

5B1 CHARACTERISTICS OF FUNGI POTENTIAL BIOCONTROL AGENTS AGAINST Eleocharis kuroguwai

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Abstract

Kuroguwai (*Eleocharis kuroguwai* Ohwi) belonging to Cyperaceae is one of the noxious paddy weeds in Japan. It has been reported that the hyphomycetes fungus (not identified yet) infected and caused spotted lesions on stem of flower in Kuroguwai naturally emerging in Tohoku. Diseased Kuroguwai caused by these fungal could produce less number of tubers in wet soil hence those fungal isolated might take a part as potential biocontrol agents. In year 2014 until 2018, we had been isolated the fungi from diseased Kuroguwai seedlings which were collected in three districts of Japan (the northern, the middle and the southern parts). The hyphomycetes fungi showed pathogenicity to Kuroguwai seedlings isolated from Tohoku and also in Kanto and Kyushu. However, no fungal were successfully isolated in summer season from Kuroguwai seedlings even in Tohoku. The typical nematode-shaped conidia found infected only Kuroguwai seedling but not rice or other Cyperacea plants. These hyphomycetes fungi could be divided to several phenotypic groups based on their characteristics on Potato dextrose agar (mycelial color, growth speed, and conidia frequency). The tentative groups also seemed to have a correlation with the sequences in rDNA ITS region. Our results showed there are several groups of the indigenous hyphomycetes fungi which could be infected Kuroguwai seedlings and reduce a formation of tubers.

Keywords: Biological control, *Eleocharis kuroguwai*, hyphomycetes fungi

5B2 HOST SPECIFITY TESTING OF *Chiasmia assimilis* (WARREN) (LEPIDOPTERA: GEOMETRIDAE) AS BIOCONTROL AGENTS FOR *Vachellia nilotica* IN BALURAN NATIONAL PARK, EAST JAVA, INDONESIA

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Abstract

Research work was conducted in insect guarantine SEAMEO BIOTROP from September to December 2017 to study the host specificity of C. assimilis, a biocontrol agent of V. nilotica. Two tests, i.e. choice and no choice were carried out in sequences. The centrifugal taxonomy selection of plants produced 61 species. The choices test was done using cut foliage of test plants in trays size 28 cm length x 20.5 cm width x 7 cm thick. The tray was covered with a lid that was holed at 6 x 13.5 cm² and covered with plastic gauze to facilitate exchange of air. This tray was lined with 1.5 cm thick moistened rockwool to provide enough moisture for the cut foliage and covered with thin plastic layer. The cut foliage of tested plants were arranged in a circle to be equal distance from the site of release from the larva. Nine tests were carried out. The first 6 tests of cut foliage from 10 different plant species and the three more tests of cut foliage from 5 different species were chosen included V. nilotica as the control in three replications. Five larva of 5 days old of C. assimilis were released into the center of the circle. The evaluation was carried out in 6 days after the release to see how severe the leaf damage on the test plant compared to V. nilotica. From the choice test there were Calliandra calothyrsus Meisn, Parkia speciosa Hassk., Sterculia foetida L., Syzygium polyantum (Wight) Walp. and Psidium guajava L. the cut foliage of which showed an indication of damage eaten by the larva of C. assimilis. Those 5 plants species were subjected to host specificity testing without choice, with V.nillotica as the control plant. Each pot wrapped tightly with stiff transparent plastic forming a tube at a height suited to the young test plants, this arrangement was replicated 4x, Five 3 days old larvas C. assimilis were released on each tube. After one week, those 3 days old larva of C. assimilis were found dead on C. calothyrsus Meisn, P.speciosa Hassk, S. foetida L., S. polyantum (Wight) Walp, and P.guajava L. while under V. nilotica as the control, 64.49 % become imago. It seems that the range of host plant of C. assimilis is very narrow, in fact according to this test C. assimilis was able to complete its life cycle only on V. nilotica.

Keywords: Biocontrol agent, Chiasmia assimilis, Vachellia nilotica

5B3 ISOLATION AND BIOLOGICAL CHARACTERISTICS OF Collectotrichum eleusines, A POTENTIAL MYCOHERBICIDE CANDIDATE FOR CONTROL OF GOOSEGRASS (Eleusine indica (L.) Gaertn.)

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Abstract

Goosegrass (Eleusine indica (L.) Gaertn.) is one of the world's most noxious annual weed species. In search of a potential mycoherbicide against the goosegrass, an indigenous fungi was isolated from diseased goosegrass collected from Hubei Province, China. The fungi caused severe greyish-white lesions with brown margins on leaves, under laboratory and field conditions. Though slow initiator, it caused 72% disease by 7 day after inoculation and complete mortality of the plants by 15th day of application under greenhouse conditions. Hence, as potential biocontrol agent, the fungus was subjected to morphological identification and then molecular characterization by amplification of 18S RNA gene fragment from genomic DNA using 18S gene universal primers. Subsequently with sequencing, GenBank database comparisons and phylogenetic analysis, the fungus was determined as Colletotrichum eleusines. The growth of the colonies of C. eleusines was higher at 25 to 30 °C, the best pH for mycelial growth is 6-9, acetic environment is good for sporulation. There was no interference of the photoperiod on mycelial growth and sporulation. The best carbon source for *C. eleusines* growth is starch, for sporulation is maltose. The best nitrogen source for *C.* eleusines growth is yeast extract, for sporulation is NaNO₃. The disease severity increased as the fungal inoculum increased from 1×10^5 to 1×10^7 conidia/ml when sprayed till run-off. This C. eleusines isolate showed no pathogenicity to corn, rice (Oryza sativa spp. indica, O. sativa spp. *japonica* and an O. sativa hybrid), wheat or any dicot crop species. We conclude that C. eleusines, with high efficacy against goosegrass and demonstrated safety to crop, is a promising mycoherbicide candidate worthy of further evaluation and development for control of goosegrass.

Keywords: Biological characteristics, Colletotrichum eleusines, goosegrass, mycoherbicide,

5B4 DEVELOPMENT OF WEED CONTROL TECHNIQUES FOR ORGANIC RICE PRODUCTION IN CHINA

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Abstract

Organic rice production is rapidly growing in China. However, labour-dependent weed control is still constraining its development as labour cost has increased recently. Integrated rice-duck farming, as the primary course of organic rice farming, has been widely adopted in China. An 18-years' observation on weed effects showed that the farming could effectively control major weeds except *Echinochloa* through reduction of weed seed bank. A new granular mycoherbicide made from *Sclerotium rolfsii* was evaluated to control weeds in organic rice farming. The mycoherbicide demonstrated good control of broad leaf weeds and sedges without affecting rice. Vinegar-sludge alone and vinegar-sludge in combination with the mycoherbicide gave 85.6 and 88.75% control effects, respectively. Combining the above methods with removing weed seeds from irrigation water could effectively control weeds including *Echinochloa* and significantly reduce weed seed bank.

Keywords: Bioherbicide, cleaning irrigation water; mycoherbicide; organic rice; *Sclerotium rolfsii*

5B5

IMPACT OF THE GALL FLY, Urophora stylata, ON SEED PRODUCTION OF Cirsium vulgare IN NEW ZEALAND

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Abstract

The gall fly, Urophora stylata, was released in 1998 as a biological control agent for the thistle weed, Cirsium vulgare (spear thistle, bull thistle, Scotch thistle), in New Zealand. In the summer of 2018, a survey was conducted to assess the frequency and intensity of attack by the gall fly on seedheads of the weed. A stratified random selection of 20 populations of the weed was undertaken to ensure 10 populations on each of the North and South Islands of the country, and that all selected populations were on land designated as sheep and beef pasture, where the weed is most problematic. The gall fly was found at 14 of the 20 thistle populations and was absent from the populations surveyed in the southern and western regions of the South Island. Surveyed plants (typically 30 per population) were grouped into three attack frequency categories according to the proportion of seedheads attacked per plant: 'no attack', 'partial attack', and 'complete attack'. Compared to plants with no attack, partial attack resulted in 14% fewer seeds, and complete attack (all seedheads per plant attacked) resulted in 47% fewer seeds. Similar reductions were recorded for seed weight, and seed germination rates. indicating that the biocontrol agent not only reduced the number of seeds, but also the quality of seeds. Intensity of attack was measured as the proportion of the seedhead that was galled. There was a significant relationship indicating that seed production decreased with increasing attack intensity. A model results indicated (based on attack intensity and seedhead size) that the gall fly reduced seed production of C. vulgare populations by 11 to 61%. This research represents the first assessment of U. stylata in New Zealand and indicates that it can have a significant impact on the weed.

Keywords: Cardueae, herbivory, Tephritidae, seed predator

5C1

APPLICATION OF ALLELOPATHY FOR WEED MANAGEMENT AND ENHANCEMENT IN CROP GROWTH AND YEILD

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Abstract

Allelopathy existed since centuries as a natural phenomenon in the eco-system. It has emerged as a new science in the recent few decades. Many plants are allelopathic in nature. The plants produce secondary metabolites which are highly water soluble and added to the environment by decomposition of plant residues, volatilization, leaching by rain and root exudation. Plants vary in their allelopathic potential, some are very strong allelopathic and some are less. Their varieties also differ in the number and quantity of allelochemicals. These allelopathic compounds influence the germination and growth of other plants. The allelopathic compounds are species specific and inhibit growth at higher concentration and promote at lower concentration. Allelopathy can be manipulated in agricultural systems as crop rotation, intercropping, residue mulching and water extracts for weed control, herbicide dose reduction and growth promotion. We have conducted series of laboratory and field experiments at department of Agronomy, University of Agriculture, Faisalabad. Potent allelopathic plants as Sorghum, Sunflower, Brassica, Rice Maize, Eucalyptus, Mulberry, Garlic, Brinial and Moringa were selected for the present studies. Mature dry herbage of these plants was used as mulch or for the preparation of water extract except Moringa where its fresh leaves were used. The mature sundried stalks or straw or leaves were chopped into 2 cm pieces for spreading as the mulch just after sowing the wheat or after crops. For water extract preparation the chopped herbage was soaked in water in ratio of 1:10 (one Kg of the residue in 10 liters of water) for 24 hours at room temperature then filtered. For controlling weeds, this extract was either used as such or boiled to reduce volume by 20 times. The water extracts were foliar applied at 20 until 30 days after sowing crops for weed control. For herbicide dose reduction, these were tank mixed before spray. For growth promotion the water extracts were foliar applied in low concentration (3%) at tillering and earing in wheat and rice, while at 30 cm height and tasseling in Maize. Sorghum ev JS-263 appeared the most effective therefore we used its herbage in most of our studies while other plants were used occasionally. Results revealed that allelopathic plants residues as mulches significantly inhibited weed population. Allelopathic plant water extracts as foliar sprays suppressed weed dry mass up to 80 %. Allelopathic water extracts used in combination with herbicides reduced the dose more than 50 %. Application of allelopathic extracts as the foliar sprays enhanced growth of crops and yield by 10 to 25 %. This indicates use of allelopathy in agriculture.

Keywords: Allelopathic plants, crop growth, sorghum, weed control

RINSKOR[™] ACTIVE, A NEW HERBICIDE FOR MANAGING WATER HYACINTH (*Eichhornia crassipes*) IN WATER WAYS OF VIETNAM AND THAILAND

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Abstract

Water hyacinth (Eichhornia crassipes) is an invasive plant in many countries of Asia Pacific region. The plant's rapid vegetative reproduction in tropical climate areas and the high mobility in freshwater ways cause several weed problems. The huge infestation of water hyacinth creates a dense mat of vegetation on the water surface and can clog streams and trouble the water transportation. The high population of this floating weed also causes water loss in the irrigation system through a high evapotranspiration. Governments in many Asia countries are spending a significant amount of money to manage water hyacinth. Glyphosate and 2,4-D are commonly used for controlling this troublesome weed in Vietnam and Thailand. However, government restrictions are limiting the use of these herbicides for aquatic weed control. Therefore, an alternative herbicide is needed to manage this aquatic weed. Rinskor[™] Active is a new auxinic herbicide developed by Corteva AgriscienceTM and was evaluated for water hyacinth control in Vietnam and Thailand in 2018. Three field efficacy experiments were conducted in controlled facilities, and Rinskor at 10-15 g a.i. ha⁻¹ applied on top of foliage exhibited 95% to 100% control of mature water hyacinth at 14 days after application. Rinskor provided greater control of target weed over the glyphosate at 960 g a.i. ha⁻¹ (70% to 90%) and 2,4 D at 680 g a.i. ha⁻¹ (80% to 90 %), and no plant regrowth was observed in Rinskor plots at 40 days after application. As a low used dose and environmental friendly herbicide, Rinskor is an important candidate for managing water hyacinth in Vietnam and Thailand.

Keywords: Aquatic weed, Rinskor[™] Active, water hyacinth

ECONOMIC FEASIBILITY OF WEED MANAGEMENT AND TILLAGE IN MAIZE – WHEAT SEQUENCE UNDER CONSERVATION AGRICULTURE

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Abstract

The experiment was conducted at Birsa Agricultural University, Ranchi, Jharkhand during 2015-16 and 2016-17. The experiment was laid out in strip plot design with five tillage sequences in main plots, viz. conventional-conventional (CT – CT), conventional – zero (CT – ZT), zero – zero (ZT – ZT), zero – zero with crop residue (ZT – ZT+R) and zero tillage along with crop residues in both the seasons (ZT+R - ZT+R) while three weed control methods in sub plots viz, recommended herbicides in maize (atrazine @ 1 kg/ha preemergence) and wheat (isoproturon @ 0.75 kg/ha +2,4-D @ 0.5 kg/ha post emergence), IWM in maize (pendimethaline @1 kg/ha + intercrop black gram) and in wheat (isoproturon @ 0.75 kg/ha +2.4-D @ 0.5 kg/ha post emergence + mechanical weeding at 40 DAS) and weedy check, respectively. The pool data of interaction effect of tillage sequences and weed control methods revealed that combination of CT - CT along with IWM recorded significantly higher maize equivalent yield to the extent of 163.14% compared with minimum ZT – ZT under weedy check i.e. 39.45 g/ha. Similarly, the combination of CT – CT along with IWM recorded significantly higher net return, and B:C ratio by maize-wheat system to the extent of 91109 \heta compared with ZT - ZT under weedy check i.e. 15924`/ha and B:C ratio to the extent of 387.80 percent compared with ZT - ZT under weedy check i.e. 0.41.

Keywords: Economics, maize - wheat system, zero tillage, conventional tillage
WEED MANAGEMENT IN RICE-WHEAT SYSTEM IN INDO-GANGETIC PLAINS OF INDIA

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Abstract

Rice -wheat (RW) cropping system is the prevalent system which covers about 13.5 million hectare in Indo-Gangetic plain (IGP) of India, Bangladesh, Pakistan and Nepal. This system contributes 40 per cent of the rice and wheat production in the India and predominant in Uttar Pradesh, Punjab, Haryana, Bihar and West Bengal. The productivity of RW has stagnated or decreased due to weed infestation, soil health deterioration, inappropriate crop establishment, water and resource use. Furthermore, excessive tillage, use of poor quality seed, weed contaminated seeds, labour unavailability, inappropriate selection and application of herbicides, continuous use of same herbicide and cropping system leading to weed shift and herbicide resistance which ultimately aggravating weed problems in RW system of IGP. Echninochloa spp, Phalaris minor wild/volunteer rice are the major weeds infesting the RW system. Zero tillage (ZT) combined with retention of crop residue is a potential tool for effective weed management in RW system in IGP. Conservation Agriculture (CA) based practices i.e. permanent no-till residue managed beds and double no-till (ZT direct seeded rice- ZT wheat) helped in minimizing weed infestation in rice-based cropping systems due to less weed seed bank disturbance in soil and proper cover of soil by the residue. In permanent no-till residue retained systems, less seasonal weed infestation (Echninochloa and Phalaris minor) was observed, however, some increase infestation of perennial weed were also observed. ZT DSR with anchored residue was effective in minimizing weed density, dry weight and nutrient depletion by weeds. ZT with residue provided advantages in weed suppression and yield increase in wheat. Sulfosulfuron + metsulfuron was effective in controlling weeds in wheat. ZT rice-ZT wheat observed lower weed infestation, higher yield and net return due to higher weed control efficiency and better crop establishment over conventional tilled (CT) rice-CT wheat. Use of bispyribac 25g ha⁻¹ + pyrazosulfuron 20 g ha⁻¹ in rice and clodinofop 60g ha⁻¹+ carfentrazone 20g ha⁻¹ in wheat under ZT Rice - ZT Wheat system provided efficient weed management, higher yield, system productivity and profitability in RW system. Need based interventions in tillage system, planting systems, and other management strategies can alter the soil environment and helpful in managing weeds. Appropriate crop establishment with CA based practices, need based stale seed bed, use of cover crops/crop residues, crop diversification with sensible use of herbicides should be integrated for managing weeds of RW system on sustainable basis in IGP.

Keywords: Rice-Wheat, weed management, zero tillage

WEED MANAGEMENT IN RICE-WHEAT-GREENGRAM CROPPING SYSTEM UNDER CONSERVATION AGRICULTURE

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Abstract

A field experiment was conducted at Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu from 2016 to 2019 to study the weed dynamics and crop productivity of rice-wheat-greengram cropping system under conservation agriculture. The experiment was laid out in split plot design with 3 replications. The tillage and residue management treatments (TR-CTW, TR-ZTW-ZTG, CTDSR-CTW-ZTG, ZTDSR-ZTW+residue-ZTG and ZTDSR+residue-ZTW+residue-ZTG were kept in main plots and weed management treatments (herbicidal, integrated and unweeded) in sub-plots. In direct seeded rice (DSR), pendimethalin 1 kg/ha as PRE *fb* bispyribac-sodium 25 g/ha at 25 days after sowing (DAS) and in transplanted rice (TR), bispyribac-sodium 25 g/ha at 25 days after transplanting (DAT) was taken as herbicidal treatments. In integrated weed management (IWM) treatments one hand weeding at 45 DAS/DAT was additionally given beside herbicidal treatment. In wheat, sulfosulfuron + metsulfuron (30+2 g/ha) at 30 DAS and sulfosulfuron + metsulfuron (30+2 g/ha) at 30 DAS fb one hand weeding were taken for herbicidal and IWM treatment, respectively. After harvesting of wheat, zero-tillage greengram (ZTG) crop was sown. The Alternanthera philoxeroide and Caesulia axilaris were significantly higher in TR as compared to DSR either under zero tillage (ZT) and conventional tillage (CT), however, density of Phyllanthus niruri and Physalis minima were significantly higher in DSR either under ZT and CT as compared to TR. Transplanted rice produced significantly higher grain yield with lowest density and biomass of weeds than ZT-DSR+residue, ZT-DSR and CT-DSR. The IWM gave significantly highest grain yield with lowest weed biomass as compared to unweeded check and alone application of herbicides. Amongst all the tillage, residue and weed management combinations, highest net returns and B:C ratio were recorded in ZT-DSR+residue and IWM treatment combinations. In wheat, the density of Phalaris minor, Ranunculus arvensis and Anagalis arvensis were decreased in ZT-wheat+residue than CT-Wheat and ZT-wheat as compared to initial weed density. However, density of *Medicago spp.* increased in ZT-wheat than CT-wheat as compared to initial weed density. Lowest weed density and weed biomass were recorded in ZT-wheat+residue as compared to CT-wheat and ZT-wheat. Among the weed management treatments, IWM recorded significantly lowest density and biomass of weeds with highest grain yield and B: C ratio as compared to herbicidal treatments. Thus ZTDSR+residue-ZTW+residue-ZTG along with integrated weed management has been found in conservation agriculture.

Keywords: Conservation agriculture, rice-wheat-greengram, residue, tillage, weeds

WEED CONTROL THROUGH SEQUENTIAL AND TANK MIX APPLICATION OF HERBICIDES IN ONION (*Allium cepa* L.)

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Abstract

Onion (Allium cepa L.) being the highest foreign exchange earner, is extremely important commercial crop in India. Poor competitive ability with slow growth and poor foliage canopy makes onion crop weak competitor against weeds. Weeds cause reduction in bulb yield to an extent of 40-80 percent. Manual weeding is more tedious, expensive and time consuming, and pre-emergent herbicides could not able to control the successive flushes of weeds which further hinder bulb development and create problem during bulb uprooting operation. Therefore the need for sequential application of herbicides and post-emergence application of tank mixed herbicides was applied for broad spectrum control of weeds in onion. Field experiment was conducted during rabi season of 2012-13 and 2013-14 at the ICAR-Indian Agricultural Research Institute, New Delhi. Sandy loam (Ustochrept), slightly alkaline (pH 7.7) with electric conductivity of 0.31 ds/m, low in organic carbon (0.37 %) was used, medium in available potassium (260 kg/ha) and low in available phosphorus (9.5 kg/ha) and available nitrogen (251 kg/ha). Two month old seedlings of variety "Pusa Ridhi" were transplanted. The field experiment had ten weed control treatments including 0.75 kg./ha pendimetnalin for preemergence, 0.75 kg./ha pendimetnalin for pre-emergence followed by a hand weeding (HW) (30 DATP), 1.0 kg/ha pendimethalin for pre-emergence followed by 1.0 kg/ha pendimethalin for sand mix application at 30 DATP, 0.5kg/ha oxyflurofen for pre-emergence, 0.25 kg/ha oxyflurofen followed by a hand weeding (30 DATP), 0.25 kg/ha oxyflurofen followed by sequential application of 0.25 kg/ha oxyflurofen as sand mix application (30 DATP), tank mix post-emergence application of guizalofop and oxyflurofen with ratio of 2:3 and 3:2, weed free check and weedy check. Results revealed that all weed control treatments caused significant reduction in total weed density (213.33 m⁻²) as compared to weedy check(269.33/m2) due to better control of weeds. Integration of 0.75kg/ha pendimetnalin for pre-emergence supplemented with one HW at 30DATP (23.72 tha⁻¹ bulb yield), sequential application of 0.75 kg/ha pendimethalin for pre-emergence followed by sand mix application (as broad cast) of 0.75 kg/ha pendimethalin and tank mix post emergence application of guizalofop and oxyflurofen at 30 DATP were found statistically at par in increasing the bulb yield of onion owing the better control of weeds.

Keywords: Herbicides, onion, oxyflurofen, pendimethalin, quizalofop

HERBICIDES COMBINATION FOR MANAGEMENT OF *Vaucehria* sp. YELLOW GREEN ALGAE IN TRANSPLANTED RICE UNDER COASTAL SITUATION OF KARNATAKA

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Abstract

Low land rice ecosystem in coastal Karnataka is infested with complex of weed flora including semi aquatic and aquatic weeds. In 2013, Vaucehria sp. belongs to family Vaucheriaceae, phylum xanthophyta commonly known as yellow green algae was first noticed in coastal region of Karnataka during kharif season. This weed competes for the nutrients, water and sunlight with the rice crop and forms the thick yellow green mat in the field. It won't allow the paddy crop to produce tillers which will directly affect on the yield loss up to 40 to 50 per cent. At present in the coastal region the spread of this weed area is more than 2000 ha. A study was conducted on "Effect of herbicides and herbicides combination in transplanted rice with special reference to vaucehria species of yellow green algae under coastal Karnataka". A field experiment was conducted in Kharif season 2017 and Kharif season 2018 at farmers' field of kota hobli, Udupi District with objective is to find out the effective herbicides and their combinations against yellow green algae. From the data, among the different weed management treatments, significantly lower weed density (fresh and dry weight) of Vaucehria species At 15, 30 and 45 DAT (Days after transplanting) was observed in pre-emergent application of pendimethalin 38.7 CS at 750 g a.i. ha⁻¹ at 3 DAT followed by post emergent application of penoxsulam 24 % CS at 22.5 g a.i. ha-1 at 25-30 DAT recorded fresh weight $(32.92, 25.88 \text{ and } 13.28 \text{ g per m}^2 \text{ respectively})$ and dry weight (6.12, 5.48 and 4.76 g per m² respectively) with highest weed control efficiency 92.37 %. This treatment was also recorded significantly highest plant height (95.18 cm), higher number of tillers per hill (25.75), grain yield (5326 kg/ha) and this treatment was followed by application of pre-emergent herbicide pendimethalin 38.7 CS at 750 g a.i. ha⁻¹ at 3 DAT followed by early post emergent application of Bispyribac sodium 10 SC (25 g a.i ha⁻¹) 15 to 20 DAT.

Keywords: Dry weight, fresh weight, herbicide combinations, pendimethalin, Vaucehria,

LAO PDR

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Abstract

Lowland, small-holder farmers in the Lao PDR are moving from wet-season, transplanted rice (Oryza sativa L.) to direct-seeded rice (DSR) to save labour and time, and to respond to risks due to climate change. However, there is considerable evidence in South East Asia that when farmers transition to DSR, weeds are a major constraint to adoption. DSR is in the early stages of development in Laos and farmers urgently need information on best management practices to reduce impacts of weeds on rice yield and weed seedbanks. In August/September 2018 during the wet season, we combined field observations and a questionnaire of farmers to determine the most common weed species, densities and farmers' current weed control practices in DSR systems in Savannakhet Province of the Lao PDR. The study found that farmers' understanding of the impact of weeds on rice yields is limited. The most prevalent weeds were sedges, Fimbristylis miliacea, Cyperus iria, C. difformis and C. rotundus, and grasses, Echinochloa ssp. and Leptochloa chinensis. Weed densities of more than 50 plants/m² were observed prior to hand-weeding in 21 of the 35 fields (60%). We found that 83% of farmers use hand-weeding, 11% do nothing, and 6% use some herbicide. The study identified a significant need for supporting farmers and advisors in developing tools for: a) weed management, and b) weed recognition. In 2019, we began a program to examine integrated weed management techniques in DSR with small-holder farmers and their advisors. Techniques investigated include: placement of fertilizer at sowing compared to broadcast 14 days after sowing, to increase rice emergence and vigor; early interrow cultivation; crop/weed cutting and removal before weed seed set; and late-season, needs-based hand-weeding, to prevent weed-seed set. This is a collaboration between the Crawford Fund of Australia, the Australian Volunteers Program and the Provincial Agriculture and Forestry Office of Savannakhet. The long-term aims are to observe changes in weed spectrum over time, build the capacity of farmers and advisors to control weeds in DSR, to reduce weed seedbanks, and to maximize profits and environmental outcomes.

Keywords: Capacity building, competition, direct-seeded rice, hand-weeding, mechanical control

WORKING WITH SMALLHOLDER FARMERS TO ADAPT A WEED MANAGEMENT STRATEGY FOR BEST MANAGEMENT PRACTICES (BMPS) IN RICE PRODUCTION IN MYANMAR

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Abstract

A series of field studies were conducted in five project sites representing five rice eco-zones in Myanmar. Bogale and Htan Ta Bin represent the flood prone area. Pyapone and Myaungmya and Mrauk U represent the flood prone and salinity prone area. Yamethin is a drought prone area. Aside from the environmental stress, weeds and limited knowledge of farmers on weed management also contribute to low rice yields in these areas. Yield loss trials were conducted in 2016 and 2017 summer seasons to determine the impact of weeds to rice growth. Field evaluation of herbicides was also conducted to identify the most effective in controlling weeds. In summer 2017, the best herbicide in each site was integrated with the best fertilizer management practice (80-28-38 kg NPK/ha) and the best stress tolerant variety and compared with current farmer practices. Yield loss ranged from 0 to 18% in summer season 2016 an 0 to 22% in summer season 2017. Weed weights were higher in Mrauk U at harvest compared to Pyapon. Fenoxaprop ethyl + ethoxysulfuron, bensulfuron and 2,4-D controlled weeds better than bispyribac sodium at 45 days after planting. In Pyapon, weed arowth was lesser that weed control was similar regardless of herbicide used. Across all sites. fenoxaprop ethyl controlled weeds better until harvest compared to other herbicides. Yields were highest in plots treated with bispyribac sodium, and with fenoxaprop-ethyl + ethoxysulfuron in Myaungmya, with 2,4-D in Pyapone, with fenoxapropethyl-ethoxysulfuron in Mrauk U and bensulfuron methyl in Thantabin. Across all sites, fenoxaprop ethyl + ethoxysulfuron had the highest mean yield (3.3 t/ha). The suite of best management practices improved rice yields. The rice eco-zones with highest increase were Htan Ta Bin (28%), Mrauk U (25%), Yamethin (22%), Bogale (17%) and lowest was observed in Myaungmya (9%).

Keywords: Best management practices in rice production, Myanmar, smallholder farmers, weed management strategy

RINSKOR™ ACTIVE NEW HERBICIDAL TOOL FOR WEED CONTROL IN RICE IN CHINA

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Abstract

Rinskor[™] active (florpyrauxifen-benzyl), a new arylpicolinate synthetic auxin herbicide from Corteva Agriscience[™], Agriculture Division of DowDuPont, has global utility in seeded and transplanted rice, along with utility in several other cropping and aquatic systems. Rinskor straight formulation Royant[®] 25EC herbicide and its premixes with cyhalofop-butyl (Novlect™ 120EC herbicide, Rinskor 20 + cyhalofop-butyl 100 g ai/l) and penoxsulam (Novixid™ 32.5OD herbicide, Rinskor 12.5 + penoxsulam 20 g ai/l) have been developed to cover different requirements of weed control and weed resistance management in China and around the world. Royant[®] at 22.5 to 30 g ai/ha in tank mix with cyhalofop at 225 to 300 g ai/ha achieved more than 95% control of Echinochloa crus-galli and Leptochloa chinensis, while applied at 15 to 30 g ai/ha it provided almost complete control (98 ~ 100%) of Sagittaria trifolia, Alisma plantago-aquatica, Monochoria spp., Ammannia auriculata, Eclipta alba, Lindernia pyxidaria, Ludwigia octovalvis, Murdannia triguetra and Cyperus difformis. Rinskor and its premixes offer a broad post-emergence application window, ranging from 2 leaves to tillering stage of grass weeds, a broad weed control spectrum in paddy rice, and a favorable crop safety profile. Its importance as part of a weed resistance management program, due to its differentiated mode of action (binding site on auxinic receptor), makes it a robust tool for weed management in rice for the Asian rice farmers. Furthermore, its premixes with herbicides of alternative modes of action (ALS and ACCase) enhance its role in weed control and resistance management.

Keywords: Pest management, Rinskor™ active, weed management

CONTINUOUS HERBICIDES APPLICATION ON DYNAMICS OF WEED FLORA, WEED CONTROL AND SOIL PROPERTIES IN TRANSPLANTED LOWLAND RICE-RICE CROPPING SYSTEM UNDER CLAY LOAM SOIL

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Abstract

Field experiment were conducted to study the influence of weed management on weed shift. productivity and economics in transplanted rice-rice cropping system, assess the persistent and residue (soil, grain and straw) of herbicides and estimate the effect of weed management on microbial population and enzyme activity in long term rice - rice cropping system during rabi 2017-18 (December, 2017–May, 2018) and kharif, 2018 (June – October, 2018) in Tamil Nadu Agricultural University, Coimbatore, India. The experiment was laid out in a randomized block design without replication. The rice varieties ADT 37 for rabi and CO(R) 51 for kharif season were used for the trial. There are about six treatments viz., PE pyrasosulfuron ethyl (10% WP) fb hand weeding for both the seasons, PE pyrasosulfuron ethyl (10% WP) fb hand weeding + PE bensulfuron methyl (0.6%) + pretilachlor (6.6%) fb hand weeding, PE pyrasosulfuron ethyl (10% WP) fb POE bispyribac sodium (10% EC), PE pyrasosulfuron ethyl (10% WP) fb POE bispyribac sodium (10% EC) + PE bensulfuron methyl (0.6%) + pretilachlor (6.6%) fb POE bispyribac sodium (10% EC). Hand weeding twice and Unweeded check. During rabi, 2017-18, the relative density of grasses was more in PE pyrazosulfuron ethyl 20g/ha fb hand weeding at 30 DAT and PE pyrazosulfuron ethyl 20g/ha PoE bispyribac sodium 25 g/ha and significantly higher grain yield of 6731 kg/ha was recorded with PE pyrazosulfuron ethyl 20g/ha fb hand weeding at 30 DAT followed by PE pyrasosulfuron ethyl (10% WP) fb POE bispyribac sodium (10% EC). During kharif. 2018, the relative density of grasses and broad leaved weeds were dominant in all the treatments at 60 DAT. The relative density of sedges was more in PE pyrasosulfuron ethyl (10% WP) fb POE bispyribac sodium (10% EC) + PE bensulfuron methyl (0.6%) + pretilachlor (6.6%) fb POE bispyribac sodium (10% EC) at 25 g/ha significantly higher grain yield of 7483 kg/ha was recorded with hand weeding which was on par with PE pyrasosulfuron ethyl (10% WP) fb POE bispyribac sodium (10% EC). Higher grain yield and income was obtained with PE bensulfuron methyl (0.6%) + pretilachlor (6.6%) fb hand weeding during rabi 2017-18 and PE pyrasosulfuron ethyl (10% WP) fb hand weeding during kharif 2018. Residues are below the detection limit of 0.01 mg/kg and soil nutrients status was also unaffected significantly by the herbicidal weed management practices.

Keywords: Continuous herbicide application, weed flora, rice-rice cropping system

FLORAL INVASION: THREAT TO ECOLOGY, BIODIVERSITY AND AGRICULTURE IN PAKISTAN

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Abstract

Pakistan has unique topography, having vegetation from see level in the South to Alpine & snow line in the North; therefore has unique plant diversity spread all over the country. Angiopermic invasion was studied by our group from Peshawar in early 1990s and published extensively. However, after severe earthquake in 2005 followed by unprecedented floods in 2010 and resultant climate change posed new threats and ultimately the extent of the invasion took new dimensions. In this article, efforts have been made to compare the new trends in weed invasion with the published work already published for a simple way to work.

Keywords: Angiopermic invasion, Peshawar, climate change

P1

INVESTIGATION ON AN ACTIVE ALLELOPATHIC SUBSTANCE IN PRUNED-BRANCHES OF KIWI FRUITS

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Abstract

Kiwi fruit branches need to be pruned twice a year because of their rapid clonal growth. These pruned-branches entail an added economic disposal costs, hence a problem to the producers. The development of the effective use of pruned-branches of kiwi fruit is one of the solutions. It has been reported that the incorporation of the kiwi fruit pruned-branch chips into the soil inhibited the growth of other plants, which suggests that the kiwifruit pruned-branches may contain allelopathic substances. However, the allelopathic substances in the pruned-branches have not been identified. Therefore, we aimed to evaluate the allelopathic activity and to isolate a possible active allelopathic substance in the pruned-branches. The pruned-branches were extracted with 70% aqueous methanol and methanol. The two extracts were combined and evaluated their allelopathic activity. The extracts inhibited the shoot and root growths of test plants (cress, lettuce, alfalfa, barnyard grass, foxtail fescue and Italian ryegrass) and were concentration-dependent. The concentrations required for 50% growth inhibition of all the test plants were 65.9-446 mg and 27.0-169 mg D.W. equivalent extract/mL for the shoots and roots, respectively. The extract was then separated by several chromatographic runs. During the chromatographic separations, allelopathic activities of all fractions were determined by a bioassay, and the active fractions were further purified. An allelopathic active substance was finally isolated by HPLC at the retention time of 30-36 min. The present results suggest that the pruned-branches of kiwifruit may have allelopathic activity due to the presence of an active allelopathic substance. Therefore, the kiwi fruit pruned-branches can be applied to crop fields as a natural herbicide.

Keywords: Agricultural residue, allelopathic activity, kiwifruit

P2

ALLELOPATHIC EFFECT AND MECHANISM of Solidago canadensis L ON WHEAT (*Triticum aestivum*)

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Abstract

Canadian goldenrod (*Solidago canadensis L*) has become a serious weed and an allelopathic weed to many crops and weeds in China since the 1980s. In this study, *S. canadensis L*. as a donor and Wheat (*Triticum aestivum*) as a recipient plant were used to study the main allelopathic pathways. The inhibition of germination, root length and shoot length in wheat were 15.6, 67.2 and 34% obtained from the leachates of stems and leaves (0.1 g mL⁻¹) respectively. However, the inhibition data were up to 21.2, 82.0 and 67.7% from the saprophytic part of the *S. canadensis L*. at the concentration of 0.05 g mL⁻¹. The result suggests that leaching and decomposition of its residue are confirmed as the main allelopathic pathways. Then the compound n-hexadecanoic acid was isolated from *Solidago canadensis L* through extracting from organic solvent and its inhibition to the seeding growth of wheat was clarified.

Keywords: Allelopathic effect, Canadian goldenrod, mechanism

P3

INSECT ANTI-FEEDANTS IN AERIAL PARTS OF Physalis angulata var. augulata

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Abstract

Recently, the alien Solanaceae weed, Physalis angulata var. angulata is widely distributed in Japan. The weed inflicted damages onto various crops, leading to decrease in the harvesting yields, especially in beans cultivation, where the weed species are serious problems. In the field this weed does not show any apparent damage from phytophagous insects. Additionally, there were few reports on the strong insect anti-feedant triterpenolide (withanolides) produced by *Physalis* spp. We presumed that this plant used these triterpenolides as one of the chemical defense system in its habitat. The objective of this study is the elucidation of insect feeding tolerance mechanism of this weed from the point of view of chemical ecology. Physalis angulata var. angulata were collected from red beans farm located in Kyoto Prefecture in 2018. The fresh aerial parts were extracted by hexane and acetone, respectively. The hexane extract showed both of insect toxicity and insect anti-feedant activity against common cutworms, Spodptera litura. These extracts were fractionated by silica gel flash column chromatography eluted by hexane/ethyl acetate solvent system. The major constituent of both extracts was linolenic acid, while the triterpenoid was isolated from the residue after removing linolenic acid. The structures of isolated natural products were elucidated by spectroscopic analyses. Consequential evaluations of these extracts on their insect anti-feedant activity were done by dual choice-type feeding test against common cutworms.

Keywords: Insect anti-feedant, Physalis angulata, solanaceae, triterpene

POTENTIAL ALLELOPATHIC EFFECT OF Passiflora foetida ON Brassica chinensis AND Zea mays

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Abstract

Interest in developing effective biological weed management system increased because of the awareness of problems associated with the intensive use of herbicides. Thus, allelopathy has been suggested to be one of the possible alternatives for achieving sustainable weed management. Passiflora foetida is a terrestrial perennial herbaceous vine weed and its common name in Malaysia is 'leletup'. Passiflora foetida is the serious weed for several crops and has medicinal value. Previous study had found that *P. foetida* exhibited high allelopathic activity among 15 weed species that had been tested using sandwich and dish pack method. However, there is limited information about the allelopathic activity of P. foetida under soil condition. Thus, this study was carried out to investigate the regulatory role of dry leaf litter and leaf litter aqueous extract of P. foetida on two crop species, which were Brassica chinensis and Zea mays under soil condition. The dry leaf litters were mixed with soil in three concentrations (i.e; 2.5%, 5% and 10%) and leaf litter aqueous extract were prepared and dilutions into 2.5%, 5% and 10% along with control (have no leaf litter) in three replicates. The hypocotyl length, radicle length, chlorophyll content, leaf area, biomass of shoot and biomass of root were recorded after three weeks of experiment. Soil samples were taken from pot culture bioassay and were analyzed for pH, salinity, nitrogen (N), phosphorus (P) and potassium (K). Results showed that the effect of leaf litter was more severe on these plant parameters of both tested species compared to leaf litter extract. There was complete 100% growth inhibition of *B. chinensis* when applied with 10% of *P. foetida* leaf litter. The highest concentration of leaf litter reduced the highest hypocotyl and radicle length, and the lowest concentration reduced the smallest. The total chlorophyll content of both species reduced significantly when applied with leaf litter. However, the salinity increased as the concentration of both treatments increased. Besides, N, P and K were also higher in both treatments compared to control. These results suggested that P. foetida have allelopathic activity and further studies need to be carried out to identify the allelochemicals involved in these inhibitory activities.

Keywords: Allelopathy, crop, growth, soil condition, weed.

P5

ACTION MECHANISMS OF S-(+)-CARVONE ON CELL WALL OF RICE AND ARABIDOPSIS ROOTS

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Abstract

Allelochemicals are one of the attractive sources for discovering lead compounds to develop novel herbicides with new mode of action. S-(+)-carvone ((S)-(+)-2-methyl-5-(1methylethenyl)-2-cyclohexenone), a volatile allelochemical found in the leaves of Aloysia polystachya shows phytotoxic activity. In our previous studies, S-(+)-carvone induced shoot and root growth inhibition, decrease of the chlorophyll content, and overproduction of the reactive oxygen species in Arabidopsis seedlings. In addition, the characteristic of cracks were observed in S-(+)-carvone-treated rice roots. It is known that aluminum stress induces the cracks on roots and affects cell wall constituents such as pectin, lignin, and xyloglucan endotransglucosylase/hydrolase (XTH) gene expression. However, phytotoxic mechanism of S-(+)-carvone is not well-understood yet. In this study, pectin methylation levels and lignin content were investigated in the rice roots and expression of several XTH genes in Arabidopsis roots to understand the phytotoxic mechanisms of S-(+)-carvone. S-(+)-Carvone inhibited shoot and root growth of rice seedlings in the concentration-dependent manner ($\geq 114 \mu mol/L$). At 703 µmol/L, the cracks on the rice root surface were observed. Pectin methylation levels decreased in the rice roots at 24 h after treatment with ≦228 µmol/L of S-(+)-carvone whereas they increased when treated with 703 µmol/L. In addition, S-(+)-carvone increased lignin content in rice roots 24 h after treatment at 114 µmol/L or more. Expression levels of genes encoding XTH, which modifies xyloglucan sugar chain in primary cell walls during cell proliferation and elongation, were determined by qRT-PCR using Arabidopsis. S-(+)-Carvone (250 µmol/L) decreased expression levels of AtXTH17. 20. 26. and 31 genes 24 h after treatment. These results suggest that S-(+)-carvone may directly affect various cell wall constituents in both rice and Arabidopsis roots.

Keywords: Allelochemical, cell wall, phytotoxic activity, S-(+)-carvone

P6

INVESTIGATION OF AN ALLELOPATHIC SUBSTANCE IN Osmanthus × fortunei Carrière LEAVES

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Abstract

Osmanthus × fortunei Carrière (Oleaceae) is a natural hybrid of O. heterophyllus (G.Don) P.S. Green and O. fragrans Lour. The plant has been reported to contain various secondary metabolites. Therefore, there is a possibility that O. × fortunei produce substances with allelopathic activity. However, there is no report regarding allelopathy of O. × fortunei. Hence, the objectives of this research were to evaluate allelopathic activity and to isolate and identify the allelopathic substances from O. × fortunei leaves. Osmanthus × fortunei leaves were extracted with 80% aqueous methanol and methanol. Those extracts were combined and evaluated for their allelopathic activity. The extracts showed the growth inhibitory activity on six tested plants (which were cress, lettuce, alfalfa, barnyard grass, foxtail fescue and Italian ryegrass), which were concentration-dependent. The extracts were partitioned with an equal volume of ethyl acetate. The ethyl acetate fraction was purified by silica gel column, sephadex LH-20 column, flash chromatography and reverse phase HPLC and the biological activities of each purification steps were monitored using cress bioassay. An active substance was finally isolated and identified as (+)-pinoresinol by polarimeter, HRESIMS and ¹H NMR. (+)-Pinoresinol inhibited the growth of cress and Italian ryegrass. The concentration that requires for 50% growth inhibition of (+)-pinoresinol for cress shoots and roots were 1.9 mM and 2.5 mM, respectively, and those for Italian ryegrass shoots and roots were 2.0 mM and 0.73 mM, respectively. The results of this study suggested that the extracts of O. × fortunei leaves have allelopathic activity and (+)-pinoresinol is the allelopathic substance in O. × fortunei leaves.

Keywords: Allelopathy, Osmanthus × fortunei Carrière, (+)-Pinoresinol

Ρ7

BIOMULCHING AN ENVIRONMENT FRIENDLY OPTION TO CHANGE NUTRIENTS UPTAKE AND REMOVAL PATTERN IN SUNFLOWER (*Helianthus annus* L.)

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Abstract

The diverse group of nonchemical weed management practices has currently outpaced the fundamental research on weeds especially the nutrient properties such as the nutrient uptake by crop and the nutrient removal by weeds. This is guite essential to know the best weed management practices and their impact on the nutrient recycling pattern. This study under present investigation aimed at to study the nutrient uptake and removal pattern by crop and weeds through application of biomulches. The treatments consisted of different kind of biomulches viz., live mulching with Sunhemp @ 40 kg ha⁻¹ and incorporation at 30 DAS, live mulching with multi varietal Crops (Navathaniyam) @ 50 kg ha⁻¹incorporation at 30 DAS, application of Terminalia chebula powder @ 400 kg ha⁻¹; mango leaves @ 4 t/ha, Tamarind leaf mulch @ 4 t ha⁻¹, Eucalyptus leaves @ 7 tha⁻¹, mustard seed powder @ 160 kgha⁻¹, neem leaves @ 2.5 tha⁻¹, hand weeding at 30 and 45 DAS, and unweeded control (unmulched). The treatments were conducted in randomized block design with three replications. All the biomulches were applied at 3 DAS. Results revealed that higher nutrient uptake of 5.3, 2.4 and 12.0 kg ha⁻¹ of N, P₂O₅ and K₂O at 30 DAS produced 2297 kg ha⁻¹ of sunflower yields which was subjected to biomulching with Eucalyptus leaves @ 7 tha⁻¹ on 3 DAS. Mango leaves @ 4 t/ha was the next best treatment which was effective in release of nutrients to the crop with an uptake of 4.9, 2.15 and 11.0 kg ha⁻¹ of N, P₂O₅ and K₂O. Nutrient removal by weeds $(1.0, 0.33 \text{ and } 1.8 \text{ kg ha}^{-1})$ was significantly lower in *Eucalyptus* leaves @ 7 t ha^{-1} treated plot. Crop yields were positively correlated with nutrient uptake whereas negative correlated with nutrient removal by weeds. Hence, application of *Eucalyptus* leaves @ 7 t ha⁻¹ is a viable strategy in for effective weed control and increased the nutrient uptake of sunflower which leads to improved sunflower yields in a sustainable manner.

Keywords: Biomulches, nutrient uptake by crop, sunflower, weed removal

ALLELOPATHIC EFFECT OF SELECTED INVASIVE WEED SPECIES ON GERMINATION AND SEEDLING GROWTH OF WEEDY RICE (*Oryza sativa*)

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Abstract

Weed management in the crop production system is accomplished mainly by the use of chemical herbicides. Management of invasive weed species in Malaysian agro-ecosystems is very much herbicide-based. It is recognized that the overuse of chemical herbicides causes the pollution of ground water and the herbicidal resistance among weeds. Recently, there has been focused on the utilization of allelochemicals as sources of the new herbicides and novel mechanism of action. The aim of this study was to identify and screen the allelopathic activity of invasive broadleaf weed species in Malaysia. Ten broadleaf invasive weed species (Amaranthus lividus, Asystasia gangetica, Borreria alata, Croton hirtus, Euphorbia hirta, Xanthium indicum. Parthenium hysterophorus. Lindernia crustacea. Hyptis capitata. Cleome rutidosperma) were collected from their wild population near Universiti Putra Malaysia (UPM). Fresh leaves, roots and shoots (whole plant) of the weed species was shade-dried under ambient conditions. The weed extract was prepared and thirty seeds of weedy rice (Oryzae sativa) were placed in petri dish and treated with the extract solution with five replication. Distilled water was used as control. The methanol extracts of different weed species were significantly influenced the germination percentage, shoot length and root length of weedy rice (O. sativa). At all concentration, all weed extracts showed above 50% germination except P. hysterophorus. Parthenium hysterophorus showed 1% seed germination in 50 gL¹ concentrations and there was no seed germination in 100 gL⁻¹ concentrations. Shoot length of O. sativa (weedy rice) was found to be lowest in P. hysterophorus (1.79 cm) and C. rutidosperma (1.93 cm) followed by 2.54 cm in B. alata (2.54 cm) in all concentrations. While the effect of methanol weed extracts of P. hysterophorus on O. sativa (weedy rice) root length ranged from 0 to 0.80 cm and 2.13 cm at 100 to 6.25 gL⁻¹ and control (without extracts). Parthenium hysterophorus has the potential to be exploited for potent allelochemicals. Based on the results, it is suggested that *P. hysterophorus* have strong potential for development as natural herbicides in weed management.

Keywords: Allelopathy, germination, invasive broadleaf weed species, seedling growth, weedy rice.

P9

COMPATIBILITY OF SELECTED ADJUVANTS AND HERBICIDES WITH FUNGAL PATHOGENS, *Bipolaris* spp. FOR INTEGRATED MANAGEMENT OF GOOSEGRASS (*Eleusine indica* (L.) Gaertn.)

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Abstract

There are several studies on potential use of fungal pathogens for biological control of goosegrass but there is still a limited study on compatibility of adjuvant and synthetic herbicide with fungal pathogen for goosegrass control. Thus, this study aimed to investigate the tolerance level of isolated pathogenic fungi in response to selected adjuvants and herbicides under laboratory conditions. The fungi were isolated from goosegrass plants in corn fields and then cultured in potato dextrose agar to obtain pure culture. Through spore observation, three Bipolaris spp. were successfully identified. These isolated fungi were mixed with three types of adjuvants, Tween 80, Tween 20 and dimethyl sulfate (DMSO) at a series of concentrations ranged from 0 to 1% (v/v), respectively. Sterilized distilled water acted as the negative control. It was found that, all the fungi were compatible to the tested adjuvants at 0.1 to 0.8 % in which no inhibition of fungi was noted 48 hours after incubation period. These fungi were also treated with four herbicides registered in oil palm, namely topramezone, diuron, oxyfluorfon and imazethapyr at their respective recommended rates. The results revealed that oxyfluorfon gave the highest fungal growth inhibition that was 90% while imazethapyr and topromezone provided fungal growth inhibition of 50 and 20%, respectively. In contrast, diuron did not show any inhibitory effect on the fungi. These findings suggest that Tween 20, Tween 80 and DMSO are potential adjuvants to be mixed with the fungi. Diuron is the most compatible herbicide with the isolated fungi for integrated management of goosegrass.

Keywords: Bipolaris spp., herbicides, biological control, integrated weed management.

P10

HERBICIDAL ACTIVITY OF Streptomyces sp. KRA18-249 ISOLATED FROM SOIL

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Abstract

Investigation of phytotoxic compounds from various biological sources offers useful clues in searching new candidates of natural herbicides with useful properties that could be more safe and specific than the synthetic weedicides. Streptomyces are considered as important biosynthetic factory for their bioactive metabolites production and exhibiting interesting bioactivities like antibacterial, cytotoxic and herbicidal properties. Screening of Streptomyces for potent secondary metabolites against weeds has been one of the most interested areas in weed management research. The strain KRA18-249 isolated from forest soil of Kangwondo Jeongseon of South Korea showed significant phytotoxic activity against Digitaria ciliaris. In the foliar application study, the culture filtrate of the KRA18-249 showed strong herbicidal activity for D. ciliaris, Solanum nigrum, Aeschynomene indica, Calystegia japonica and had phytotoxic symptoms of wilting and meristem damage in broadleaves species within 24 hours after treatment. An active compound of KRA18-249 obtained from the culture filtrate was separated by ethyl acetate extraction and purified by silica, C₁₈ column chromatography and Sephadex LH20. The structure of active metabolite, 249-Y1, was identified as polyketides of molecular formula C₂₀H₁₆O₆ (m/z=375 [M+Na]) by electrospray ionization mass spectra (ESI-MS) and ¹H-, ¹³C- NMR and 2D-NMR spectral data analyses. Herbicidal activity of 249-Y1 at 500 µg mL⁻¹ against D. ciliaris, S. nigrum, A. indica, C. japonica was 100%, 100%, 80% and 100%, respectively. The phytotoxic symptoms of 249-Y1 shown was wilting or burn-down of leaves and finally plant death. These results suggest that the herbicidal metabolite producing Streptomyces sp. KRA18-249 may be a new bio-herbicide candidate and/or may provide a new lead molecule for a more efficient herbicide.

Keywords: Herbicidal activity, phytotoxic, Streptomyces

P11

MOLECULAR CLONING OF GENES INVOLVED IN OPHIOBOLIN A BIOSYNTHESIS PATHWAY FROM BIOHERBICIDAL FUNGUS

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Abstract

Ophiobolins are sesterterpenoid-type phytotoxins produced by fungi. They are active on a broad spectrum of organisms including plants, fungi, bacteria, nematodes and tumor cells, and have a potential for development of new crop-protection and pharmaceutical product. However, due to the low content of bioactive in ophiobolin-producing fungi, the commercial applications of ophiobolins were restricted. To significantly increase yields of ophiobolin, from an ophiobolin-producing fungus, *Biopolaris eleusines* (Be), transcriptome sequencing was used to produce a substantial expressed sequence tags (EST) dataset from Be. Based on the analysis of EST, molecular cloning by RACE technology and analysis of related key genes involved in ophiobolin A biosynthesis pathway was conducted. *BeHMGR*, *BeIPPI*, *BeFPPS* and *BeGGPPS* of four key enzymes involved in ophiobolin A biosynthesis pathway was isolated from ophiobolin A-producing fungus strain Be for the first time. This information might be helpful not only for theoretical research of further defining the mechanism of ophiobolin A biosynthesis, but also supply more clues of target enzymes to modulate the production of ophiobolin A for practical application.

Keywords: Bipolaris eleusines; Ophiobolin, 3-hydroxy-3-methylglutaryl-CoA reductase gene

P12

CHARACTERISTICS AND STRUCTURAL IDENTIFICATION OF POTENTIAL NOVEL HERBICIDAL SUBSTANCE FROM *Streptomyces* sp. KRA17-580

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Abstract

Weed has been recognized as one of the most serious agricultural and environmental problem. Approaches to the biological weed control in arable crops and integration of biological weed control with other weed management methods have been broadly made. Bio herbicidal metabolites produced by Streptomyces sp. are being studied as possible herbicides or herbicidal adjuvants to develop biological agents that are easily degradable and environment friendly. Also, isolation and structural identification of natural herbicide active compounds from soil Streptomyces has been proposed as one of effective approaches for novel lead discovery of bio-herbicides. A screening of bio herbicidal agent managed to isolate the strain KRA17-580 that had a significant herbicidal activity against a grass weed Digitaria *ciliaris*. Based on the result from 16S rRNA sequence in comparison with the close strains, the isolate KRA17-580 was identified as Streptomyces olivocromogenes. An optimizing culture was done on the basis of pH, agitation, temperature and culture time. The KRA17-580 showed a strong herbicidal activity and high cell mass at pH 5.5~8.5, 150~200 rpm, 25~30°C and culture period of 7~9 days. Two herbicidal compounds isolated from the culture filtrate were purified by solvent partition, C_{18} , Sephadex LH20 column chromatography and high performance liquid chromatography. By 1D-, 2D-NMR and ESI-MS analysis, the 580-H1 and 580-H2 were identified as a cinnoline-4-carboxamide (MW, 173.0490; C9H7N3O) and cinnoline-4-carboxylic acid (MW, 174.3.0503; C₉H₆N₂O₂), respectively. In the foliar application study, two herbicidal compounds showed strong herbicidal activity against D. ciliaris among 12 monocot and 5 dicot weed species. Result from 580-H1 showed that phytotoxic symptoms from foliar application were bleaching and stunting and phytotoxicity of desiccation and burndown or bleaching of leaves appeared and finally died. These results suggested that the Streptomyces sp. KRA17-580 producing herbicidal metabolites may be a new bio-herbicide candidate and/or may provide a new lead molecule for a more efficient herbicide.

Keywords: Bioherbicide, secondary metabolite, *Streptomyces*

P13

THE POSSIBILITY OF DEVELOPMENT FOR WEED MANAGEMENT BY USING MARIGOLD (*Tagetes* spp.)

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Abstract

It was known that marigolds (*Tagetes* spp.) had a potential for weed suppression. However, the evaluation for the potential had performed separately for african marigold (T. erecta) or french marigold (*T. patula*) species. Furthermore, there was no evaluation of comparison with its potential of each species under the same condition. In this study, both field and bioassay experiments were conducted to identify marigold species that could be utilized to control weeds under the cultivation of sweet potato (Ipomoea batatas). On field experiment, the seeds of two french marigold and one african marigold were sown in set standard quantity (0.5kg/10a), half quantity (0.25kg/10a) and twice quantity (1.0kg/10a) after transplanting of sweet potato in each plot at 1.5*2.0m including the ridge of sweet potato on May in 2018. After sowing, the height and cover degree (%) of marigold and weed species infested naturally in 30*30cm quadrat set randomly in each plot were measured every week. The tuberous roots of high quality (over 50g per individuals) were selected and counted in the number and weighed, after harvesting all tuberous roots of sweet potato plants at 150 days after transplanting. All tests were replicated thrice. The marigold plants of three species were reduced cover degree of all weed species infested naturally compare with that in non-marigold plot. In particular, the plants of 'kosei-dairin mix' seeded twice quantity were reduced by 30 to 40% of cover degree in weed species. The number and weight on tuberous roots of high guality in sweet potato plants in all of marigold plots became the more and the bigger than those in non-marigold plot. Six french marigold species, two african marigold species and T. tenuifolia were prepared by sand culture for bioassay evaluation. Lettuce (Lactuca sativa cv. Great Lakes 366) and barnyard grass (Echinochloa crus-galli) were used as receiver plants. After sowing, they were incubated set at 25 °C under 12h light period. After 5 days, root length of their plants were measured. The exudation from the roots of 2 african varieties affected to initial root elongations of lettuce and barnyard grass seedlings. From these results, it was demonstrated to have higher allelopathic potential for weed suppression in the plants of 'kosei-dairin mix' (african marigold).

Keywords: Allelopathic potential, intercropping, marigold, sweet potato, varietal difference

P14

HOST RANGE OF Herpetogramma basalis, A BIOLOGICAL CONTROL AGENT FOR THE INVASIVE WEED, Alternanthera philoxeroides IN CHINA

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Abstract

Alternanthera philoxeroides (Mart.) Griseb. an herbaceous amphibious weed, is one of the worst invasive alien weed species. It has caused serious economic and ecological problems in China. Although biological control with insects has been successful in aquatic habitats, there is a need for other biological agents to control the terrestrial type of A. philoxeroides. A local pyralid moth, Herpetogramma basalis (Lepidoptera: Crambidae) was discovered feeding on A. philoxeroides through field surveys in Hubei Province, China. To determine the host range, non-target impacts of H. basalis and evaluate its potential for control of A. philoxeroides the no-choice and multiple-choice tests were conducted. Under no-choice conditions, feeding damage occurred on target weeds and 29 non-target plant species. However, H. basalis completed development on only nine of them. Survival to adulthood was highest on A. philoxeroides and several other Amaranthaceae species. In multiple-choice studies, H. basalis showed a strong oviposition preference for A. philoxeroides over A. tricolor. The present results indicate that *H. basalis* is an oligophagous herbivore with a preference for the target weed A. philoxeroides and inferior preference of its closely related species. Although the only crop species A. tricolor. supported completed development and inferior oviposition, considering the controllable risks, we cautiously recommend *H. basalis* for the biological control of A. philoxeroides.

Keywords: Alternanthera philoxeroides, biological weed control, Herpetogramma basalis, host specificity.

P15

EFFECTS OF Flaveria bidentis INVASION ON THE DIVERSITY OF FUNCTIONAL BACTERIA IN RHIZOSPHERE SOIL

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Abstract

Flaveria bidentis is an invasive plant found in large areas of northern China. This study conducted a separation and screening of the main functional bacteria in the soil of *F. bidentis* and investigated the change in the community structure. A variety of functional microbes were isolated using selective media and rep-PCR clustering, and a diversity analysis was carried out. In addition, the dominant populations of various functional bacteria were identified using 16S rRNA sequence alignment. The results showed that F. bidentis increased the contents of the major available nutrients in the soil, and the levels of azotobacteria, organic phosphorus bacteria, inorganic phosphorus bacteria, and silicate bacteria in the soil of F. bidentis were significantly higher than those of the native plant Tagetes erecta and control. Rep-PCR analysis indicated that the structure of the four functional bacterial microfloras in the soil of F. bidentis was significantly different from those of the native plant and control. The diversity analysis demonstrated that the diversity of functional microorganisms in the soil of F. bidentis was richer, the community structure was more complex, the predominant microflora comprised a greater proportion of the total population, and the ecological diversity was higher. This was further evidenced by identification of the main functional isolates from three soil samples. Our findings indicated a mechanism of invasion by F. bidentis.

Keywords: Diversity, Flaveria bidentis, functional bacteria, rhizosphere soil

EFFECT OF Agasicles hygrophila RELEASE ON THE CONTROL OF Alternanthera philoxeroides

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Abstract

Alternanthera philoxeroides is a perennial invasive weed, which destroys the biodiversity of invasive areas and brings great losses to shipping and aguaculture. Biological control is an effective way to control the spread of A. philoxeroides, which has become one of the research hotspots. Agasicles hygrophila is a natural enemy insect introduced from the United States. It has good control effect on A. philoxeroides, and has the characteristics of good ecological environment protection, low investment and long control effect. The release technology of natural enemy insects has a significant impact on the control effect. In this study, control effect of different natural enemy release methods (0 pairs m⁻²-8 pairs m⁻²) on A. philoxeroides were analyzed. The population density, plant morphology, chlorophyll content, biomass, and other biological and biochemical indices were determined through an environmental control test in a breeding plant of A. hygrophila, and the population amount of A. hygrophila under different conditions was also tested. The results showed that, under the initial density of 40 stems m^{-2} of A. philoxeroides, the numbers of adults and emergence holes increased first and then decreased with the increase of the release, while the numbers of edgs, larvae, and pupae varied in different ways. Stem density and biomass (wet weight and dry weight) of A. philoxeroides decreased gradually with the increase of natural enemy release, while the morphological parameters such as internode length and stem diameter decreased first and then increased with the increase of natural enemy release. It indicated that the release of 4 pairs of A. hygrophila can achieve the best control effect in this controlled experiment. Under this condition, the highest numbers of emergence holes and the adults of A. hygrophila were achieved, while the population density of A. philoxeroides was the lowest, the internode length and stem diameter were the shortest, the chlorophyll content in leaves was low, and the biomass was few. Further analysis showed that this release amount could not only ensure the stable propagation and increase the population of A. hygrophila, but also obtain the best control effect on A. philoxeroides, which had the characteristics of low cost and high control efficiency. The results provide a theoretical basis for the further optimization of the propagation and release technology of A. hygrophila.

Keywords: *Alternanthera hygrophila*, *Alternanthera philoxeroides*, biocontrol, control effect, release

P17

GENETIC DIVERSITY ANALYSIS OF DIFFERENT POPULATIONS OF Cenchrus spinifex IN NORTHERN CHINA

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Abstract

Cenchrus spinifex is a perennial malignant weed that invades the farming and pastoral areas of northern China. It is resistant to drought, barren, cold and pest, which seriously affects the structure and function of the ecosystem in the invaded areas. It is of great significance to explore its taxonomic status and invasion pathway for revealing its invasion mechanism. The population differences of two phenotypes of Cenchrus weeds in northern China were studied by using ITS, rbcL and trnH-psbA conservative sequence alignment analysis, and the taxonomic status was determined by combining biological characteristics and variation characteristics. RAPD technique was then used to analyze the genetic diversity of C. spinifex from different geographical populations, revealing its diffusion path and main genetic diversity characteristics in northern China. The results showed that the two phenotypic plants were C. spinifex and C. echinatus, which were widely distributed in arid and semi-arid areas of the agro-pastoral ecotone in northern China. They were two highly related species of the same genus Cenchrus. There are two main transmission lines of C. spinifex invading the three northeastern provinces of China and Inner Mongolia. The results of this study provide a theoretical basis for revealing the invasion mechanism of C. spinifex, and lay a foundation for further research on comprehensive management methods of C. spinifex and ecological restoration of its invaded and destroyed environment.

Keywords: Cenchrus spinifex, classification and identification, DNA barcode, genetic diversity, transmission route

P18

EFFECT OF ENVIRONMENTAL FACTORS ON GERMINATION AND EMERGENCE OF Erodium cicutarium L.: AN EXOTIC WEED IN KOREA

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Abstract

Erodium cicutarium L. also known as redstem filaree, redstem stork's bill, common stork's-bill or pinweed, is a member of the Geraniaceae family. It is native to Macaronesia, temperate Eurasia and north and northeast Africa and was introduced to Korea as an exotic weed before 1993. The following trials were tested to determine the optimum conditions for breaking of seed dormancy, seeds respond with environmental factors, including variations temperature. salinity, CO₂ concentration and burial depth. In order to overcome dormancy, the seeds were treated with sulfuric acid (97%), gibberellin (100 ppm) and hot water (55°C) immersion. The seed treatment with H₂SO₄ substantially stimulated germination, disturbing the hard seed coat sufficiently to facilitate these processes. However, warm water and GA3 treatments did not affect the process of embryo enlargement and also did not improve the germination rate. To establish the optimum temperature for germination, the seeds were incubated under fluctuating temperatures of 15, 20, 25, 30 and 35°C. The germination rate of seeds was not significantly inhibited by various temperatures. The seeds germinated at near optimum rates strongly to very strongly (greater than 95%) in all temperature range of 15 to 35°C after one week but after the germination, the seedlings did not grow at all at the high temperature range. To assess the germination ability under salt stress, the seeds were germinated in sodium chloride solutions of varying concentrations from 10 to 320 mM that could be typical of saltaffected regions. Germination became slower with increasing saline concentration. Germination of *E. cicutarium* was approximately 10% at the 160 mM concentration of NaCl. Seed germination was not observed at the 320 mM concentration of NaCI. The effect of burial depth on seedling emergence was studied in a glasshouse experiment with buried in the soil at varying depths within the pot (0.5, 1.0, 2.0, 3.0, 4.0 and 5.0 cm). Seedling emergence of E. cicutarium decreased in proportion with sowing depth. The seeds placed at depth of 0.5 cm showed 97% germination. Emergence decreased progressively with increasing depth of burial and was completely inhibited at 4 cm. The early growth of *E. cicutarium* also depends on CO₂ concentration. The plant biomass gradually increased with the increase of the CO₂ concentration and reached to the maximum level at 1400 ppm, whereas it started gradually decreasing at 2800 ppm. Information gained in this study will be used in developing management strategies for this species.

Keywords: Exotic weed, Erodium cicutarium L, salt stress, burial depth, CO2

P19

BIOSECURITY AWARENESS ON POTENTIAL INVASIVE WEED SPECIES IN OIL PALM PLANTATION IN MALAYSIA

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Abstract

In every production system of crops, weed management is recognized as the vital component. This is because the presence of weeds affects the yield and growth of crops due to competition in term of basic growth requirement. Typically, weeds compete with crops for water, light and soil nutrients. Based on Global Plant database, a total of 99 weed species associated with oil palm plantations under tropical or sub-tropical climatic region, which are not present / recorded yet in Malaysia were analysed using the Weed Risk Assessment (WRA system) for their potential threat to oil palm plantation in Malavsia. The assessments were derived based on numerical score that consisted of several correlation such as the biogeography factors (the documented distribution, climate preferences and weediness in other parts of the world), undesirable attributes (noxious or invasive characters) and biology or ecology (capacity of the species to reproduce, spread and persist). The results from the WRA shows ninety five weed species such as Ageratina adenophora, Ranunculus sceleratus, Alternanthera philoxeroides, Anagallis arvensis. Solanum mauritianum and Convza canadensis were rejected for introduction (e.g. cultivation for ornamental / medicinal purpose / fruits), whilst five weed species were rejected for introduction as pending for further evaluation or when newer information becomes available. A. adenophora, commonly known as crofton weed or sticky snakeroot, is native to Mexico and Central America and was reported as invasive weed around the world. Moreover, A. adenophora is toxic to horses, who develop respiratory disease after eating it. Whilst, R. sceleratus generally grows in moist or muddy sites and can displace native species from such areas. A. philoxeroides is considered a major threat to ecosystems because of the adverse effects it poses on both aquatic and terrestrial environments, as well as negatively influence both the ecosystem and society particularly because it can disrupt the natural flow of water due to the dense mats created from its cluster of stems. Thus, it outcompetes the native vegetation for space and solar energy through these dense mats because they are large cluster and limit the amount of light that submerged vegetation receives. Furthermore, the situation directly and indirectly gives impact to native herbivore because their food source is declining. A. philoxeroides is listed as a serious weed in the Malaysian Plant Quarantine Regulations 1981. Nonetheless, one weed species namely Phaulopsis falcisepala was accepted for introduction (minor impact on agriculture, environment, and/or health).

Keywords: Biosecurity, invasive weeds, oil palm

P20

MANAGEMENT OF LORANTHUS (Dendrophthoe falcata) IN SAPOTA

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Abstract

The parasite, Dendrophthoe falcata was noticed on sapota trees (Manikara zapota) on farmer's fields in Karnataka, India and the management practices were imposed from 2013-2015. At present, farmers follow mechanical trimming the portion of branch infested by Dendrophthoe, it is tedious, labour consuming, costly affair and will not give full control of parasitic weed. Further, infestation continues and farmer has to incur lot of money for its control. A large scale research cum demonstration on the management of D. falcata in sapota was undertaken with the treatments viz., cotton padding of 4 g copper sulphate + 0.5 g, 2, 4- D sodium salt 80% WP. directed spray of paraguat 24 SL 5 ml per litre of water, directed spray of glyphosate 71% WP 1% solution and directed spray of glyphosate 41 SL - 1 ml in 5 ml of water. Percent of control was recorded at 30 and 60 days after treatment. The results indicated that, the infestation of parasite D. falcata was considerably reduced and about 55 and 90 per cent control was achieved after 30 and 60 days of imposing cotton padding of 4 g copper sulphate + 0.5 g 2,4-D sodium salt 80% WP followed by directed spray of glyphosate 71% WP 1% solution (35 and 55 per cent). Among the treatments, cotton padding of 4 g copper sulphate + 0.5 g 2, 4-D sodium salt 80% WP found safer to the sapota trees without any phytotoxicity symptoms and satisfactory control of the parasite.

Keywords: Cotton padding, herbicide, Loranthus, sapota.

P21

EVALUATION ON CONTROL EFFICACY OF *Parthenium hysterophorus* L. THROUGH CHEMICAL APPROACHES

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Abstract

Herbicides have been used by the Department of Agriculture Malaysia to stop the spread of Parthenium but current efficacy of Parthenium weed chemical control at the label rate is not satisfactory and not evaluated under different abiotic conditions. Thus, this study was conducted to evaluate the performance of several pre- and post-emergent herbicides for effective immediate control on Parthenium weed seeds and plants under different abiotic conditions. Efficacy of seven pre-emergent herbicides; diuron, imazathepyr, atrazine, pretilachlor, metsulfuron-methyl, salt water and indaziflam were applied at 0, RR (recommended rate), 1.5RR and 2RR to twenty seeds of Parthenium in petri dish placed in growth chamber for 14 days. Number of germination, lengths of coleoptile and radicle were recorded. The effective dose of each herbicide producing minimum germination then applied on twenty seeds to compare the best pre-emergent herbicide for Parthenium weed control, in a trav inside a guarantine glasshouse under 3 soil moisture conditions (field capacity. saturated and flooded). At 21 days after treatment (DAT), plants were analysed on percentage of weed control, plant height, number of leaves and aboveground dry weight. Efficacy of six post-emergent herbicides; glyphosate isopropylamine, glufosinate ammonium, 2, 4-D, bentazone sodium + MCPA, propanil, and metsulfuron-methyl were sprayed at 0, RR, 1.5RR and 2RR to ten plants of Parthenium in each polybag at 30 days old in a guarantine glasshouse. Evaluation was made at 7, 14, 21, and 28 days after treatment on plant height, number of leaves, and percentage of weed control at each time interval. At 28 DAT, plants were harvested, dried in an oven at 65°C for 72h, and then weighed. The discriminating dosage causing minimum of 85% control of each herbicide was then applied at Ladang Infoternak Jabatan Veterinar Sg. Siput, Perak and Kg. Tampin Linggi, Negeri Sembilan to determine the efficacy of various post-emergent herbicides for the control of Parthenium weeds under field condition. Atrazine, metsulfron-methyl, diuron, and indaziflam showed control efficacy of 100% under field capacity, saturated and flooded soil conditions at the selected discriminating dose while salt, imazathepyr and pretilachlor showed control efficacy of 100% in both field capacity and flooded but under saturated soil it showed the efficacy of >85% but lower than the other treatments. All the post-emergent herbicides were found highly effective to control Parthenium weed with the control efficacy higher than 90% observed in both fields (Ladang Infoternak and Kg. Tampin Linggi) at each discriminating dosage.

Keywords: Parthenium weed, herbicides, post-emergent, pre-emergent

P22

TARGET SITE-BASED PENOXSULAM RESISTANCE IN BARNYARDGRASS (Echinochloa crus-galli (L.) P. Beauv.) FROM CHINA

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Abstract

Barnyardgrass (Echinochloa crus-galli (L.) P. Beauv) is acknowledged to be the most troublesome weed in rice fields, and in some areas of China, it cannot be effectively controlled using certain acetolactate synthase (ALS) inhibitor herbicides, including penoxsulam. Barnyardgrass samples from populations with suspected resistance to penoxsulam were collected to identify the target-site based mechanism underlying this resistance, and to characterize the cross-resistance in order to provide information for improved weed management. Whole-plant dose response assays revealed that populations AXXZ-2 and JNRG-2 showed 33.33- and 7.31-fold resistance to penoxsulam, respectively, than the sensitive JLGY-3 population. At the same time, cross-resistance to ALS inhibitors was found in AXXZ-2, which was resistant to imidazolinone (IMI), pyrimidinyl-thiobenozoate (PTB), sulfonyla-mino-cabonyl-triazolinone (SCT), triazolopyrimidine (TP), and sulfonylurea (SU) herbicides, whereas JNRG-2 was sensitive to other ALS inhibitors, and sometimes even more sensitive than JLGY-3. In vitro ALS activity assays revealed that penoxsulam concentrations that required to inhibit 50% of ALS activity were 11.42 and 5.17 times higher in AXXZ-2 and JNRG-2, respectively, than in JLGY-3, DNA and predicted amino acid sequence analyses of ALS revealed Alanine-205-Valine and Alanine-122-Glycine substitutions in AXXZ-2 and JNRG-2, respectively. None of the other mutants known to confer resistance to ALS inhibitors in E. crus-galli or other Echinochloa species was detected in the present study. Our results indicate that these substitutions in ALS are at least partially responsible for resistance to penoxsulam. Overall, amino acid substitutions and the low sensitivity of ALS to penoxsulam might be the target-site bases for resistance to penoxsulam in E. crus-galli, as they are the typical target-site bases of resistance to ALS inhibitors in many Echinochloa species. The cross-resistance patterns in resistant populations harboring different mutations reported here highlight the need to apply herbicides based on research findings with the aim of managing herbicide-resistant E. crus-galli effectively in rice fields.

Keywords: Acetolactate synthase (ALS), cross-resistance, target-site mutant

P23

RESEARCHES ON THE RESISTANCE MECHANISM OF QUINCLORAC IN Echinochloa cruss-galli var. zelayensis

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Abstract

Echinochloa crus-galli var. zelayensis is one of the most wide-spread gramineous weeds in rice production in the middle and lower reaches of the Yangtze River in China that always causes severe yield loss of rice production. Quinclorac is a selective, auxin-like, and effective herbicide that has been used in China to control Echinochloa spp. for about 30 years. Auxinlike herbicides are generally considered to be similar to the plant endogenous auxin, IAA, which would bind with the auxin receptor TIR1/AFB and the co-receptor Aux/IAA, and then induce the accumulation of ethylene, cvanide and abscisic acid (ABA), which could cause abnormal growth of plants. The previous studies have shown that the E. crus-galli var. zelayensis biotypes, JCWJ-R1 and SSXB-R2 have evolved resistance to guinclorac. By determining the ethylene induced after quinclorac treatment, it has been found that quinclorac could not induce the releasing of ethylene in SSXB-R2, but causes a significant increase in JCWJ-R1 and JNNX-S, especially in JNNX-S. When JCWJ-R1 and SSXB-R2 were pretreated with ethylene inhibitor, no increased ethylene was detected after quinclorac treatment. However, a significant increase in ethylene could still be observed in JNNX-S pretreated with the ethylene inhibitor. Then the expression of genes involved in ethylene biosynthesis were evaluated by qRT-PCR. A positive correlation between the expression level and the ethylene amount were observed. Also, the activity of the β -cyanoalanine synthesis (β -CAS) which can degrade cyanide is significantly higher in JCWJ-R1 and SSXB-R2 than that in JNNX-S, which would be explained by an amino acid substitution in β -CAS of JCWJ-R1 and SSXB-R2, and a higher mRNA level of EcCAS in JCWJ-R1 and SSXB-R2 than that in JNNX-S. By the way, the mRNA level of ADP/ATP carrier protein (ANT) gene can be strongly induced by guinclorac in JNNX-S, while no significant changes in JCWJ-R1 and SSXB-R2 were detected. It was speculated that β -CAS may play a crucial role in the mechanism of quinclorac resistance in E. crus-galli var. Zelayensis. In general, the mechanism of guinclorac resistance in E. crus-galli var. Zelayensis were a combined and complicated mechanism, in which at least ethylene biosynthesis and detoxifying of cyanide were involved, and further explorations are needed to explain the mechanism.

Keywords: Auxin-like herbicide, *Echinochloa crus-galli* var. *zelayensis*, quinclorac resistance

P24

RINSKOR[™] ACTIVE CONTROLS ALS-RESISTANT *Echinochloa crus-galli* (L.) IN DIRECT SEEDED RICE IN THAILAND

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Abstract

Rinskor[™] active is a new arylpicolinate herbicide, a new structural class of synthetic auxin herbicide. It provides effective control of Echinochloa spp. and represents an alternative weed management tool in direct-seeded and transplanted rice. Field studies were established in representative rice growing areas in Thailand with the objective of determining the efficacy of Rinskor on ALS inhibitor-resistant E. crus-galli. Seeds from resistant weed populations were collected from 16 locations in Ayutthaya, Chainat and Suphanburi, the central region in Thailand during the summer seasons of 2016, 2017 and 2018. Rinskor, penoxsulam and bispyribac-sodium were used for greenhouse screening tests. Experimental treatments were arranged in Randomized Complete Block Design with four replications. The results of the screening test showed that the labelled dose of Rinskor at 25 g a.i. ha⁻¹ provided 97-100% efficacy on ALS-resistant E. crus-galli at 7 and 14 day after application (DAA). On the other hand, bispyribac at 25 g a.i. ha⁻¹ and penoxsulam at 15.6 g a.i./ha provided less than 30% efficacy at 7 and 14 day after application. Higher doses of bispyribac, i.e. 50 and 100 g a.i. ha ¹ provided less than 50% efficacy, whereas penoxsulam at 31.25 and 62.5 g a.i. ha⁻¹ provided less than 35% efficacy at 14 DAA. These results suggest that Rinskor at 25 g a.i. ha⁻¹ offers the best control of ALS-resistant E. crus-galli. The result is important for establishing further research with this new herbicide, Rinskor, against the troublesome weeds in rice fields in Thailand and to manage resistance including the control of ALS-resistant weed species.

Keywords: Acetolactate synthase (ALS), *Echinochloa cruss-galli* (L.), Florpyrauxifen-benzyl, Rinskor[™]

P25

DEVELOPMENT OF RESISTANCE TO NOVEL ALS INHIBITORS IN Schoenoplectiella juncoides IN THE PADDY FIELDS OF MIYAGI PREFECTURE IN JAPAN

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Abstract

Sulfonylurea (SU) herbicides were marketed in Japan in the 1990s, and the emergence of SUresistant weeds caused problems in rice in the 2000s. Therefore, SUs are being replaced in the 2010s by new ALS inhibitors. Meanwhile, biotypes resistant to these new ALS inhibitors have been found in Schoenoplectiella juncoides since the 2000s. In this study, we examined the risk of development of cross-resistance to the ALS inhibitors in S. juncoides in prevalence of the new ALS inhibitors in Miyagi prefecture. In 2012, when new ALS inhibitors began to prevail in this prefecture, we surveyed the survived weeds after herbicide application at about 100 paddy fields. When S. juncoides was found in the survived weeds, SU-resistance and cross-resistance to the new ALS inhibitors were diagnosed by the rooting method and target site gene sequencing. The survey was repeated in 2014 and 2018. ALS inhibitor crossresistance was confirmed in 2012 only at three of the 31 fields where SU-resistance was found. Two of the three fields were those using new ALS inhibitors, but one was conventional SU. Similarly, the cross-resistance was identified at 5 out of 31 fields in 2014, and 5 out of 18 fields in 2018, and 1 or 2 of them were with no history of using new ALS inhibitors. Thus, the results suggest that the risk of occurrence of the cross-resistance increased in the continuous use of new ALS inhibitors. However, it is also important to note that cross-resistance can occur even in the fields without a history of use of new ALS inhibitors. The new ALS inhibitors have high efficacy to the other noxious weeds such as Echinochloa spp. and perennial weeds, and continue to play a valuable role in the control of paddy weeds. For the sustainable use of the promising novel ALS inhibitors, it is essential to diagnose cross-resistance continually, to use anti-resistance ingredients mixed in one-shot herbicides, and/or to use effective pre-/posttreatment herbicides sequentially.

Keywords: ALS inhibitor, cross-resistance, Schoenoplectiella juncoides, sulfonylurea

P26

SUPPORTING FARMERS WITH THE <u>RESISTANCE IN-SEASON QUICK TEST FOR</u> Phalaris minor IN WHEAT FIELDS OF NORTHERN INDIA AND PAKISTAN

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Abstract

Wheat is the staple crop of India and Pakistan, with a total production area of nearly 38 million hectares. Littleseed canarygrass (Phalaris minor) is the most serious weed of wheat in the wheat-rice cropping area of Northern India and Pakistan, impacting an estimated 15 million hectares. High P. minor infestation levels cause yield losses of over 50%, and application of herbicides is the most effective and economical means of control. The sustained use of herbicides for more than 40 years, and the limited availability of alternative mode-of-action groups, has resulted in the evolution of resistant biotypes, now affecting more than five million hectares. Farmers urgently need guidance on how to improve their weed management programs. The Resistance In-Season Quick (RISQ) test has been successfully deployed in Northern India and Pakistan, to support farmers with control of P. minor. This innovative approach provides farmers with data on the *P. minor* biotypes infesting their farms, within a few weeks of sample collection. Farmers are therefore able to make an informed decision on the optimal herbicide program to maximize crop yield and profitability in their farms. Samples were processed from nearly 2000 farms in the 2018-2019 wheat season. Results indicated variable levels of resistance to ACCase (HRAC Group A) and ALS (Group B) herbicides, reflecting the high reliance on these herbicide groups over the last few decades. The success of this ambitious program is based on a well-established protocol, skilled laboratory scientists, and outstanding teamwork to ensure rapid and efficient processing of samples.

Keywords: Herbicide, Phalaris minor, resistance, wheat

P27

POTENTIAL WEEDINESS OF STACKED TRANSGENIC RICE LINE T2A-1 WITH CRY2A*/BAR GENE

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Abstract

The possession of modified genes with strong selective advantage traits may increase the plant fitness associated with competitiveness and invasiveness of transgenic rice. Therefore, it is imperative to clarify whether the transgenic crop potentially generates a weed problem compared to its non-transgenic counterpart. Stacked transgenic rice T2A-1 with Cry2A*/Bar genes, its receptor rice MH63 and a local indica rice 510 (CK) were compared for agronomic performance under pure or mixed planting without weed competition, and under four sowing stages and three sowing densities of pure planting with weed competition. Agronomic traits (plant height, effective tiller number, and aboveground dry biomass), reproductive ability (panicle length, and filled grain number of main panicles, 100-grain weight seed set, and yield per plant), and weedy characteristics (seed shattering, seed overwintering ability, and volunteer seedling recruitment) were used to assess the potential weediness. The results showed that in most cases, agronomic performance of T2A-1were similar to its receptor MH63 or CK. T2A-1 demonstrated greater agronomic performance than MH63 under higher and medium sowing densities in the second stage. Compared to CK, T2A-1 showed greater agronomic performance in mixed planting, and under medium sowing densities in second stage. Both T2A-1 and MH63 had lower seed shattering than CK. The three rice lines had no volunteer seedlings and similar seed viability over winter. From above results, T2A-1 did not demonstrate superiorly weedy characteristics; it had weak overwintering ability, low seed shattering and failed to establish volunteers. Exogenous insect and herbicide resistance genes did not confer competitive advantage to transgenic rice T2A-1 grown in the field without the relevant selection pressures.

Keywords: Agronomic traits, reproductive ability, stacked transgenic rice, T2A-1, weediness
P28

THE RESISTANCE OF Cyperus difformis TO ACETOHYDROXYACID SYNTHASE INHIBITORS IN CHINA PADDY FIELD

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Abstract

With successive and wide applications of chemical herbicides, weed resistance develops rapidly worldwide. Cyperus difformis is a common annual weed belonging to the Cyberaceae family, which infects rice in China. AHAS inhibitors are widely employed in agriculture in which pyrazosulfuron-ethyl and bensulfuron-methyl could control C. difformis effectively in paddy rice. However, some farmers complained that these AHAS inhibitors failed to control C. difformis under field recommended rate in partial paddy fields in China after they have been applied for over 20 years. The aims of this study were to detect for possible resistance of 38 C. difformis populations collected from the main occurrence areas in Hei longiang, Liaoning, Hubei, Hunan, Jiangsu, Anhui and Jiangxi paddy fields, viz. seven provinces of China in total, to AHAS inhibiting herbicides, and to confirm their resistance indexes (RI) and mechanisms. The results of single dose of pyrazosulfuron-ethyl to 38 Cyperus difformis populations showed that 16 resistant populations could survive at 30 g a.i. ha⁻¹ of pyrazosulfuron-ethyl, and other 22 populations were susceptible and were killed effectively. The mRNAs of resistant and susceptible populations were isolated and compared, and the Pro-197, Pasp-376, and Try-574 mutations were found in the AHAS gene of the 16 resistant populations. The R1 populations with 197 site mutation, R2 population with 574 site mutation and susceptible population S were chosen to detect the cross-resistance to pyrazosulfuron-ethyl (SUs). penoxsulam (TPs), imazapic (IMIs), and bispyribac-sodium (PTB) by whole-plant experiments. Compared with susceptible population, the resistant index (RI) values of the R1 to pyrazosulfuron-ethyl (SUs), penoxsulam (TPs), imazapic (IMIs), and bispyribac-sodium (PTB) were 829.63, 6.59, 1.03, and 1.04, respectively. The RI values of the R2 to pyrazosulfuronethyl (SUs), penoxsulam (TPs), imazapic (IMIs), and bispyribac-sodium (PTB) were 3331.01, 382.79, 1294.98, and 154.34, respectively. The sensitivity of the AHAS isolated from R1 and R2 to the above four herbicides also showed similar trend. These results demonstrated that the target-site mutations were confirmed as the resistant mechanism of the C. difformis to AHAS inhibitors, and R2 with Try-574 mutation showed higher resistant level to R1 with Pro-197 mutation.

Keywords: Acetohydroxyacid synthase inhibitors, target-site mutation

P29

THE STUDIES ON EXPRESSING BAR GENE USING ATTENUATED VIRUS-BASED VECTOR TO ENHANCE THE RESISTANCE OF TOBACCO PLANT TO GLUFOSINATE

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Abstract

It is difficult to control weed in farm field. The herbicides often have the crop to be injured. The transgenic plants with herbicide resistance genes can avoid herbicide injury and can control weed using target herbicides. However, there are some biological safety problems, such as the changing of plant genetic traits, the reducing of crop species diversity, and so on. There is a method to express exogenous gene using attenuated virus-based vector to enhance the plant resistance to the target herbicides. It is simpler than the genetic transformation method. It does not change the plant genetic traits and only moves in the living plants, and there is no biological safety problems. In this paper, the expressing Bar gene with attenuated virus (CMV- $\Delta 2b$) vector from cucumber mosaic virus (CMV) to enhance the resistance of tobacco plant to glufosinate is studied. Firstly, the recombined plasmid pCB-CMVF209-A2b-Bar of the attenuated virus was constructed by restriction enzyme digestion, ligation and transformation method. The recombined plasmid pCB-CMVF209-∆2b-Bar was confirmed by PCR identification, and sequencing analysis. Secondly, the experiment has been conducted to test the resistance of the tobacco plant to glufosinate. The plants from Nicotiana benthamiana have been inoculated with the mixture of the plasmids (pCB-CMVF209-A2b-Bar, pCB-CMVF109 and pCB-CMVF309) of the attenuated virus by agrobacterium infiltration. The control plants have been inoculated with the mixture of the plasmids (pCB-CMVF209- Δ 2b, pCB-CMVF109 and pCB-CMVF309) of the attenuated virus, and mock plant has not been inoculated. After the virus had been detected in the non-inoculated leaves of the plant inoculated with plasmid-agrobacterium, all plants of each treatment in the experiment were inoculated with sap of plant leaves containing the corresponding virus, except for mock plants. Ten days later, the tobacco plants were sprayed with 100 or 200 times dilution of 400 g L-1 glufosinate solution. The results showed that ten days later, the tobacco plants with the expressing Bar gene have been growing normally while all control and mock plants are dead. The results indicate that the expressing Bar gene using attenuated virus-based vector can enhance the resistance of the tobacco plants to glufosinate. This approach to express herbicide-resistant gene using attenuated virus-based vector is of great meaning for application of herbicide-resistant gene in crop production.

Keywords: Bar gene, glufosinate, pCB-CMVF209-△2b-Bar, plant resistance, virus vector

P30

PRELIMINARY SURVEY ON HERBICIDE-RESISTANT WEEDS AT RUBBER CULTIVATION AREAS IN THE SOUTHERN REGION OF PENINSULAR MALAYSIA

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Abstract

With persistent and continuous extensive use of herbicides, weed populations have evolved resistance to herbicides worldwide. Surveying and monitoring levels of weed infestation and herbicide resistance in rubber regions could provide data to create guidelines and awareness for sustainable herbicide use. There is limited information on the extent and frequency of herbicide-resistant weeds in rubber plantations and systematic herbicide-resistant weed survey is still scarce in Malaysia. Therefore, the study aimed to examine the distribution and frequency of the herbicide-resistant weeds found in the respective rubber area. A total of 413 ha of rubber cultivation area have been surveyed at the Malaysian Rubber Board (MRB) Experimental Station of Kota Tinggi, Permatang Division, Johore in Southern Region of Peninsular Malaysia. Weed collection (either seeds or young shoot) was conducted in a 1 x 1 m² guadrat at each random sampling point (i.e. 223 sampling points) which was tracked using the Global Positioning System. Young shoots of weeds were planted in polybags or pots immediately after sampling in a glasshouse for seed production. Subsequently, seeds or stem cuttings were used to propagate seedlings for herbicide treatments. Seedlings of each weed sample at the 3-4-leaf stage were treated with glyphosate (1,080 g ai ha⁻¹) and paraquat (600 g ai ha⁻¹) at their respective recommended doses. A total of 96 out of 467 weed individuals were screened for herbicide resistance using both herbicides. Plant survival was recorded 28 days after herbicide treatment. *Eleusine indica* seedlings showed 80% plant survival when exposed to paraguat treatment whereas 60% of Asystasia gangetica seedlings survived both glyphosate and paraguat treatments. These findings indicate that *E. indica* population has evolved resistance to paraguat whilst A. gangetica has evolved multiple resistance to both glyphosate and paraguat. Other weed species such as Hedyotis verticillata, Phyllanthus niruri, Centotheca lappaceae and Kyllinga brevifolia were found to be susceptible to both glyphosate and paraguat. Dose-response studies will be conducted to guantify the resistance index of these herbicide-resistant weeds. These findings are useful to decision making in managing herbicide-resistant weeds that could potentially save wasteful use of ineffective herbicides and enables other approaches to be chosen for effective weed control.

Keywords: Asystasia gangetica, Eleusine indica, glyphosate, herbicide-resistant weed, paraquat

P31

STUDY ON BIODEGRADATION OF BUTACHLOR BY ANAEROBIC MICROBIAL COMMUNITY

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Abstract

This study investigated the microbial degradation of butachlor, a herbicide widely used in rice fields in Taiwan, under anaerobic conditions. Sediments were collected from the Er-Jen River in southern Taiwan, and sampling was conducted separately at the South Coast, river course, and North Coast. Butachlor was then applied to the sediment sample at concentrations range from 0.5 to 100 µg mL⁻¹, and microbial degradation (natural attenuation) was then monitored at 30°C. Butachlor residues were analyzed by gas chromatography-electron capture detector (GC-ECD). Denaturing gradient gel electrophoresis (DGGE) was used for analyzing the bacterial community structures during pesticides degradation periods. The affinity graph was drawn by cluster analysis software. The results showed that the dissipation rate of butachlor is higher in the original sediment compared to sterilized sediment, which suggests that the microbial action is the main degradation pathway of butachlor under anaerobic conditions. Furthermore, the degradation rates of the anaerobic bacteria in the sediment at different collection sites were different for each concentration of butachlor. When the anaerobic bacteria were treated at the concentrations of 0.5-5 µg mL⁻¹ of butachlor, the residual amount was lower than the detection limit after 30 days of incubation. Treatment at 100 µg mL⁻¹ of butachlor, the degradation rate could reach 80% or more. In terms of t_{1/2}, the highest degradation activity was observed in the sediment from the South Coast of the river with 2 µg mL-1 butachlor as compared from North Coast with 0.5 µg mL-1 butachlor. DGGE analysis revealed that the application of butachlor changes the original microbial community structure and induced the growth of some flora during the incubation periods. When a higher initial concentration of butachlor was added, the growth of some bacteria would be inhibited due to the toxicity of butachlor. This study evaluated the degradation potential of native anaerobic bacteria on herbicide butachlor, and investigated the change of the bacterial phase during the degradation process of butachlor by DGGE molecular technique. Therefore, this research shows the relationship between butachlor and the microbial community in the environment. In addition, it can be used as a reference for remediation with microorganisms in anaerobic environment.

Keywords: Anaerobic degradation, butachlor, denaturing gradient gel electrophoresis (DGGE)

P32

RESIDUES OF BROMACIL AND DIURON FOR WEED CONTROL IN PINEAPPLE FIELDS

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Abstract

The widespread use of bromacil and diuron in pineapple fields raises the possibility of residue accumulation following repeating applications. This can impact health, food and environmental safety. Therefore, the objectives of this study were to evaluate the effect of herbicide following repeated applications on pineapple fields and determine the herbicide residues in soil by UPLC-MS/MS. Field experiments were conducted from November 2015 to August 2016 in Chon Buri, Thailand. The experiment was a RCBD with four replications. Herbicide applied at 0, 90 and 180 DAP. Application of bromacil 2,000 + diuron 2,000 g a.i./ha was sufficient to provide satisfactory full-season control of several weed species, caused no visible crop injury and had no effect on plant growth. Bromacil 5,000 + diuron 2,500 g a.i./ha caused visible crop injury after herbicide applications. The visual injury seen in pineapple after herbicide application was chlorosis and transient and had no effect on the plant. Furthermore, determination of herbicide residues showed low levels of bromacil and diuron in the soil at 90 DAA. The application of bromacil 5,000 + diuron 2,500 g a.i./ha caused the highest herbicide residues in soil. Bromacil residues were higher than of diuron residues in soil. During the dry season, herbicide residues were showed accumulation in soil. In the rainy season, herbicide residues were not accumulation in soil. The results indicated that bromacil 2,000 + diuron 2.000 g a.i./ha was the optimal dosage for weed control. Herbicide residues were present in soil, which are not above the maximum permissible concentration as restricted by the Pollution Control Department.

Keywords: Bromacil, diuron, herbicide residues, pineapple

P33

EFFECT OF TEMPERATURE ON SOIL ADSORPTION AND DURATION OF ACTIVITY OF THREE AMIDE HERBICIDES UNDER SUBMERGED CONDITION

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Abstract

Duration of activity is the key performance of pre-emergence herbicide. However, there is limited information on the effect of temperature on duration of activity in relation to herbicide behavior and weed susceptibility to them. The previous study showed that the soil adsorption (Kd) of three amide herbicides for paddy rice, i.e. mefenacet, pretilachlor and thenylchlor were not affected by temperature at 15, 20, 25 and 30°C by means of OECD Test guideline 106. And the pretilachlor dissipation was faster with temperature increase under soil culture condition, although it was not affected under water culture condition. In this study, these three herbicides were applied into water at three given dosages under submerged soil culture conditions in growth chamber. The duration of activity of these herbicides to Echinochloa oryzicola (early watergrass) at 30°C were clearly shorter than at 20°C, in simulated and observed value, although the slight differences were shown among the herbicides and the dosages. And the dissipation of these herbicides in surface water at 30°C was clearly faster than at 20°C, in view points of half-life (DT50) and the concentration. However, the median inhibition concentration (IC50) of these herbicides against E. orvzicola were not affected by temperature under water culture condition, and the IC50 of pretilachlor was also not affected by temperature under soil culture condition. It was suggested that decisive factors in duration of activity of amide herbicides under submerged condition were their persistence in surface water, but not the soil adsorption and weed sensitivity to the herbicides, which were almost unchanged in different temperature.

Keywords: Amide herbicides, duration of activity, soil adsorption, temperature

P34

MICROBIAL DEGRADATION OF HERBICIDES AMETRYN AND DIURON BY DISSIMILATORY METAL REDUCING BACTERIA Shewanella spp. KR12

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Abstract

In the past few decades, pollution and environmental issues have been taken seriously within well-developed countries with rapid population growth. Several sources such as excessive pesticide application and industrial wastewater discharge inevitably lead to pollutants entering the water system, thereby deteriorating environmental conditions. These warrants immediate action to protect our environment and maintain overall guality of life. To combat the pollution issue, bioremediation has received considerable attention, especially microbial degradation, which is often used in contaminated sites containing heavy metals or organic pollutants. According to previous studies, the bacterial genus Shewanella is noted for its outstanding ability to utilize metal ions as electron acceptors in anaerobic respiration. During this process, the metal ions may be transformed into immobilized forms or lower-mobility species through reduction. Furthermore, certain studies indicate that Shewanella bacteria are capable of precipitating zinc sulfide nanoparticles on the cell surface by reductive transformation. Due to the high reactivity characteristic of nanoparticles, the biosynthetic zinc sulfide nanoparticles could potentially be used as a photocatalyst to degrade organic pollutants. In this research, the herbicides ametryn and diuron are chosen as target compounds that are frequently detected in certain rivers in Taiwan to determine the capability of pollutant degradation of the zinc nanoparticles produced by Shewanella sp. KR12, a strain of bacteria isolated from river sediment. Results suggest the nanoparticles could effectively decrease the concentration of the herbicides in water through a series of photo-treatment. Under aerobic conditions, our findings revealed that the Shewanella sp. KR12 can synthesize zinc sulfide nanoparticles with a diameter of 10-20 nm sphere structure on the cell surface. When photo treatment is applied, the zinc sulfide nanoparticles perform as an oxidative photocatalyst and degrade ametryn and diuron in water. This approach of coupling biosynthesis with heavy metal removal may offer a potential material for photocatalytic water treatment.

Keywords: Bioremediation, dissimilatory metal reducing bacteria, Shewanella.

P35

DAYS TO GERMINATION AND FLOWERING OF DIFFERENT WEED SPECIES IN SRI LANKA RICE CULTIVATION

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Abstract

Weed of rice cultivation has been categorized based on their life span as annuals, biennials and perennials. No literature found on days to germinate and days to flowering of different weed species in Sri Lanka. Knowledge of days to germination and days to flowering of weed species are very much important in the management of those weed using herbicides. In order to fill the aforesaid knowledge gap, a pot experiment was carried out during January to June 2018 at Rice Research and Development Institute, Batalagoda, Sri Lanka, 33 plastic pots with a height of 19.5 cm and width of 24.5 cm were taken and filled with sterilized soil up to a height of 17 cm. A few amount of viable dry weed seeds were sown belonging to 11 selected weed species such as Echinochloa crus-galli, Ischaemum rugosum, Leptochloa chinensis, Isachne globosa, Cyperus pulcherimus, Fimbristylis miliacea, Fimbristylis dichotoma, Cyperus iria, Ludwigia octovalvis, Eclipta alba and Aeschynomene indica were sown in pots separately. Each species was grown in 3 pots, watered and kept in a protected house under the ambient temperature. Average maximum temperature was 31.4°C whereas average minimum temperature was 22.16 °C during the study period. The results show that number of days for germination and flowering varied between species to species. I. rugosum, E. alba and A. indica germinated within 7 days, L. chinensis, I. globosa and C. iria germinated within 10 days, F. miliacea and L. octovalvis germinated within 12 days, crus-galli, C. pulcherimus and F. dichotoma germinated within 5, 16, 12 and 11 days, respectively. E. crus-galli and L. chinensis flowered within 60 days, C. pulcherimus and F. dichotoma flowered within 46 days, I. rugosum, I. globosa, , F. miliacea, , C. iria, L. octovalvis, E. alba and A. indica flowered within 55, 72, 43, 49, 45, 52 and 68 days, respectively.

Keywords: Germination, flowering, weed species, maximum temperature, minimum temperature

P36

ANATOMICAL CHARACTERISTIC COMPARISON BETWEEN MALAYSIAN WEEDY RICE VARIANTS AND CULTIVATED RICE

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Abstract

A study was conducted to compare the anatomical characteristic of nine Malaysian dominant weedy rice variants and two cultivated rice (MR220CL2 and MR219) plants. Nine weedy rice seeds were randomly collected based on different morphological characteristics selectively were same height with cultivated rice MR220CL2 (SH), taller than cultivated rice MR220CL2 (TH), open panicle (OP), compact panicle (CP), awnless (AL) or awned (AD) from Malaysia's main rice granary area MADA (Muda Agricultural Development Authority): MADA District I (Mi), MADA District II (Mii), MADA District III (Miii) and MADA District IV (Miv). Morphological characteristics of the nine weedy rice variant were: 1. Mi-SH-OP-AL, 2. Mi-TH-CP-AL, 3. Mii-TH-OP-AL, 4. Mii-TH-CP-AL, 5. Mii-TH-CP-AD, 6. Miii-TH-CP-AL, 7. Miv-SH-CP-AL, 8. Miv-TH-OP-AL and 9. Miv-TH-CP-AL, MR220CL2 and MR219 seeds were obtained from MARDI Gene Bank, Seberang Perai, Penang. The weedy rice and cultivated rice seeds (MR220CL2 and MR219) were planted in plant house at MARDI Seberang Perai, Leaf blade and stem of weedy rice and cultivated rice at flowering stage were sampled for preparing cross-section specimens using a sliding microtome and examined using microscope. Epidermis thickness of stem's outer layer, midrib, vein and lamina parts, number of bulliform cell group, vascular bundles and aerenchyma cell of weedy rice and cultivated rice were recorded. The findings found that only some weedy rice variants demonstrated significant differences between epidermis thickness of stem's outer layer, midrib, vein and lamina of weedy rice and cultivated rice. However, the difference anatomical characteristics were not consistent. The study also revealed that there was no obvious difference between the number of bulliform cell group, vascular bundle and aerenchyma cell in leaf blade or stem of weedy rice and cultivated rice. Anatomical knowledge of Malaysian weedy rice variants can be used as a guideline to develop effective techniques for controlling weedy rice.

Keywords: Malaysian weedy rice, cross-section anatomy, epidermis thickness,

P37

ADAPTABILITY OF Aegilops tauschii, Alpecurus myosuroides AND Lolium multiflorum IN DIFFERENT TYPES OF SOIL

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Abstract

Aegilops tauschii, Alopecurus myosuroides and Lolium multiflorum are the three most important wheat fields in the Huang-Huai-Hai region of China. The effects of soil types on the emergence and growth of these 3 important gramineous weeds in wheat fields, a pot experiment was conducted to study their adaptability in 24 different types of soil. The results showed that *A. tauschii* has the best adaptability to all of the 24 different types of soil with 64.2%-80.8% seedling emergence, and *L. multiflorum* has best adaptability to 24 types of soil with above 90.0% seedling emergence, but 2 types of soil affected its growth in plant height and fresh weight. A low adaptability of *A. mysuroides* on 4 types of soil obviously affected its emergence with 32.5%-50.8% (other 20 soils was about 70.0%), and 11 types of soil influenced either its height, fresh weight, spike number or its seed yield. The results showed that the growth of grass weeds was affected by unsuitable soil pH (strong acid less than 6.0 or strong alkali greater than 8.0), sticky soil texture and high salinity soil, but other five soil parameters included nitrogen content, phosphorus content, potassium content, organic matter content and soil types show no effects. This study will provide a theoretical basis for controlling the spread mechanism of gramineous weeds in wheat fields.

Keywords: Adaptability, *Aegilops tauschii, Alopecurus myosuroides, Lolium multiflorum,* soil types

P38

COMPOSITION AND DISTRIBUTION OF WEED SEED BANK IN SOILS OF FOUR SUGARCANE (Saccharum officinarum L.) FARMS, SUDAN

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Abstract

Weeds are considered as the main problem to sugarcane production in the Sudan. Understanding the weed seed bank is important for increasing efficiency of management programs. This research was conducted to determine the composition and distribution of weed seed bank in four commercial sugarcane farms which belong to the Sudanese Sugar Company including Guneid, New halfa, Sennar and Assalaya farms. Soil samples were collected from 0-10 cm, 11-20 cm and 21-30 cm depths of the soil profile in May, 2013. Two kilograms of the sieved soil samples were used to fill aluminum trays and were arranged in a randomized complete block design with five replicates in a green house at Sugarcane Research Center, Guneid. The trays were watered on alternate days. Emerging weed seedlings were counted, identified, and then removed for six months. 29 weed species belonging to 16 families were identified. The recorded species included 77 % grasses and 23 % broadleaved weeds. The weed species with high number of emergence were Brachiaria eruciformis, Echinochloa colonum, Panicum hygrocharis, and Dichanthium annulatum, Euphorbia hirta, Corchorus olitorius, E. aegyptiaca, and Portulaca oleracea. B. eruciformis recorded the highest emerged grass weed (383), while E. hirta recorded the highest emerged broadleaved weed (36), and they were both reported in all farms. Farms showed significant differences in number of weed seedlings that emerged. The farm of Assalava recorded the highest number of emerged weeds per kg of soil (86), followed by New halfa (67), Sennar (50), and Guneid (23). Within farms, soil depth also showed significant difference in number of emerged weeds per kg of soil. The soil depth 0-10 cm gave the highest number of emerged weed seedlings (67), followed by 11-20 cm (57), and 21-30 cm (46). These results could be used to predict the subsequent weed problem in sugarcane farms of Sudanese Sugar Company and that would assist in planning effective future management programs.

Keywords: Seed bank, sugarcane, weeds

P39

NA+/K+ BALANCE AND TRANSPORT REGULATORY MECHANISMS IN WEEDY AND CULTIVATED RICE (*Oryza sativa* L.) UNDER SALT STRESS

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Abstract

Salinization is a primary abiotic stress constraining global plant growth and production. Weedy rice, though highly homologous to cultivated rice, is more salt tolerant during seed germination and seedling growth; it is hypothesized that this is owing to ionic homeostasis and changes in the expression of genes encoding ion transport regulators. It was found that the four different genotypes of weedy (JYGY-1 and JYFN-4) and cultivated (Nipponbare and 9311) rice have different salt-tolerance during seed germination and seedling vegetative growth under salt stress. In this study, Na⁺ and Ca²⁺content increased in weedy and cultivated rice genotypes under salt stress while K⁺ and Mg²⁺decreased; however, JYGY-1 had the lowest Na⁺/K⁺ ratio of assessed genotypes. Genes in the high-affinity K⁺ transporter (HKT) and tonoplast sodiumhydrogen exchanger (NHX) families, and salt overly sensitive 1 (OsSOS1) have more than 98% homology in amino acid sequences between weedy and cultivated rice genotypes. Under salt stress, the HKT family members were differentially expressed in the roots and shoots of four different genotypes. However, the NHX family transcripts were markedly up-regulated in all genotypes, but there are significant differences between different genotypes. OsSOS1 was significantly up-regulated in roots, especially in JYGY-1genotype. The results showed that different genotypes had different germination and nutrient survival under salt stress, which was related to the difference of ion content and the difference of a series of ion transport gene expression. At the same time this study will provide new insight into the similarities, differences in ion homeostasis and gene regulatory mechanisms between weedy and cultivated rice under salt stress, which can aid in novel rice breeding and growth strategies.

Keywords: NaCl stress, weedy rice, Na⁺/K⁺ homeostasis, *HKT* family, *NHX* family, vacuolar SOS1

P40

STUDY ON SEED GERMINATION AND GROWTH OF QUINCLORAC-RESISTANT Echinochloa crusgalli UNDER SALINITY STRESS

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Abstract

The heavy use of quinclorac in paddy for a year in the middle and lower Yangtze River of China caused the quinclorac-resistant of *Echinochloa crusgalli* arose. This study has been conducted to determine the effects of salinity stress (NaCI) on the germination and seedling growth of *E. crusgalli* in the growth chamber experiment. All the selected seven biotypes of *E. crusgalli* were collected from Hunan province and designed as quinclorac-susceptible (QS), Dingcheng (DC), Hekou (HK), Shimen (SM), Hanshou (SH), quinclorac-resistant (QR) and Chunhua (CH) based on the their resistance. The results showed that a significant decrease of the germination rate and fresh weight of the plants, as well as the length of the roots and young shoots appeared, along with the increase resistant. However, without the treatment of NaCI, no significant differences shown between quinclorac-resistant and -susceptible *E. crusgalli* biotypes. A further study with spectrophotometer showed that the salinity treatment resulted in the increase of the GST activity in all *E. crusgalli* biotypes, which are more obvious in those resistant biotypes. This study demonstrated that how quinclorac-resistance affected the biological characters of *E. crusgalli*, and the increased quinclorac-resistance is possibly associated with the increased metabolic activity of GST in *E. crusgalli*.

Keywords: GST activity, quinclorac-resistant *E. crusgalli*, seed germination, seedling growth, salinity stress.

P41

SEEDLING EMERGENCE OF THREE GRASS IN WHEAT FIELD AT DIFFERENT SOIL DEPTHS

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Abstract

The effects of less tillage and no tillage on the occurrence of weeds, seedling emergence of several species of wheat weed at different soil depths were studied in greenhouse. Weed species were Avena fatua. Aegilops squarrosa. Alopecurus myosuroides, Lolium multiflorum. Bromus japonicas, Descurainia sophia, Capsella bursa-pastoris, Silene conoidea, Lithospermum arvense, Galium aparine. 18 different soil depth treatments range from 0 to 20cm has been chosen. The results showed that the seedling emergence were related to the soil depth and seeds sizes. Most of the weeds had good seedling emergence in the shallow soil layer. The smaller the seed is, the shallower the suitable emergence soil layer is, the bigger the seed is, the wider the suitable emergence soil layer is, and the deeper the emergence seedling can be. The suitable seedling emergence depth of D. Sophia and C. bursa-pastoris, which have small seed size, is 0~1.0cm. The seedling could not emerge when the soil depth was more than 2.0cm. The suitable seedling emergence depth of most weed species, with median seed size, such as S. conoidea, L. arvense, G. aparine, A. myosuroides. L. multiflorum, B. japonicas, were 0.5~3.5cm. For the soil layer of 5.0-8.0 cm, the seedling emergence rate decreased significantly with the increase of depth. However, no seedlings emerged from the soil layer of 10-20 cm. The suitable emergence depth and seedling emergence rate of A. tauschii were between 0.5~8.0 cm and 66.7%~79.3%, respectively. There was low seedling emergence at 8.0~14.0 cm. No emergence was observed in the soil depth of 16.0~20.0 cm. A. fatua being the biggest seed size could emerge within a wide range of soil depth from 0.5~18.0 cm, with the emergence rate from 84.2%~94.4%. The emergence rate was still more than 75% at 0 cm and 20.0 cm depth. The results indicated that less tillage and no tillage can increase the occurrence of weeds, because those measures could cause most of the weed seeds concentrated in the shallow soil layer, thus leading weed emergence in the field. Deep tillage could control A. tauschii, B. japonica populations in some degree, but nearly have no effect on A. fatua.

Keywords: Soil depth, emergence, wheat weeds

P42

GROWTH AND SEED PRODUCTION OF CAROLINA DAYFLOWER (*Commelina caroliniana* Walter) AND THE EMERGENCE CHARACTERISTICS IN FOLLOWING YEAR

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Abstract

Carolina dayflower (Commelina caroliniana Walter), a native plant to India and Bangladesh, has invaded in the soybean cultivated fields on northern Kyushu Island, located on the western side of Japan and seems to be developing into a troublesome weed species. Therefore, we investigated to determine the growth, seed production and the seedling emergence of Carolina dayflower. One plant was grown in non-woven root wrap of 1m² (1*1*0.5m height) filled with commercial organic culture soil and andosol in Jul, 2017. The plant height, numbers of primary branches and spathes were recorded every week. The shoot weight and total branch number of the plants sampled at 155 days after transplanting were also measured. Although some of root wraps were left until the next year (in 2018), we divided them into two plots; 1) disturbed plots where take the seedlings away at the time of the survey, and 2) naturally leaved plots where the emerged and grown plants were remained. The number of emerged or remained plants in each plot were counted every week. The experiments were conducted with 4 replications. The height of a plant was 42.4 cm and the number of primary branches was 29 in the maximum. The spathes began to form in Sep., and their number was 3,696 in the maximum. The total number of spathes produced was 6,532 to 14,306, and the total number of seeds were ranged in 5,279 to 15,731. On the disturbed plot, the peaks of development in spathes were observed in late May and early Aug. The total number of seedlings emerged until Oct. was about 2,100. On the naturally leaved plots, it began to emerge one week earlier than the disturbed plot. The number of surviving plants in late May was 325, and they increased to 679 in early August. The plants emerged in July began to develop from the mid Sep. and its size reached the peak from late Sep. to early Oct. In addition, about 10,000 seeds on average were produced per a plant. It was thought that the number of emerged plants in the following year might have attributed to about 20% of the total number of seeds produced in previous year.

Keywords: Carolina dayflower, *Commelina caroliniana*, emergence behavior, growth, seed production

P43

WEED DIVERSITY AND CHARACTERISTICS OF WEED COMMUNITIES IN PEANUT FIELDS OF MAIN GROWING REGIONS IN HUBEI PROVINCE, CHINA

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Abstract

The field weed survey was conducted to clarify weed diversity and characteristics of weed communities in peanut fields of main growing regions in Hubei province, China, by using an inverted W-pattern with 9 sampling points. A total of 76 weed species belonging to 24 families were found. Among these, the family of an Asteraceae (16) ranked the first, representing 21.1% of the total while Poaceae (14) and Cyperaceae (6) families ranked the second and third, respectively. There were 4 dominant species, 6 regional dominant species, 10 minor species, and 56 sporadic species in peanut fields. The relative abundance (RA) of Digitaria sanguinalis, Eclipta prostrate, Commelina bengalensis and Acalypha australis were above 45, higher than other weed species and indicated as a dominant weed species. The regional dominant species (15≤RA<45) were Bulbostylis barbata, Celosia argentea, Eleusine indica. Echinochloa hispidula. Ageratum convzoides and Cyperus rotundus. The minor species (5≤RA<15) were Cyperus iria, Portulaca oleracea, Panicum bisulcatum, Lindernia crustacean, Alternanthera philoxeroides, Mollugo stricta, Leptochloa chinensis, Conyza Canadensis, Chenopodium album and Fimbristylis miliacea has been recorded. The most common weed communities were Eclipta prostrate, Digitaria sanguinalis, Commelina bengalensis in peanut fields in northeastern while Digitaria sanguinalis. Acalypha australis. Eclipta prostrata were found in northern Hubei province. The Commelina bengalensis. diversity of weeds in peanut fields in northeastern Hubei were greater than those in northern Hubei, however the Simpson index was relatively low.

Keywords: Characteristics of weed, Hubei province, relative abundance, weed diversity, weed species.

P44

EXPLORE RICE WEEDY TRAIT GENETICS USING RICE 3K DATABASE

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Abstract

Weedy rice belongs to the same biological species as cultivated rice (*Oryza sativa* L.). Weedy rice usually shows high degree of shattering and low grain quality while its good vigour to competes the field resources with cultivated rice. One hypothesis on the occurrence of weedy rice is the de-domestication of cultivated rice. In order to explore the genetics of weedy traits in rice, we explore the phenotypic and genotypic data of more than three thousand rice accessions from the publicly available rice 3K database and cross-checked the results using other publicly available weedy rice datasets. We have explored the genetic architecture of weedy, or domestication-related, traits within sub-populations using genome-wide association study. Our results showed that loci controlling weedy traits differed among sub-populations and the underlying genetic mechanisms vary between cultivated rice and weedy rice populations.

Keywords: Oryza sativa L.; weedy rice, rice 3K database

P45

PLASTICITY OF LOWLAND ECOTYPE Cyperus rotundus L. IN RESPONSE TO FLOODING, BURYINGAND CLIPPING INTERVENTIONS

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Abstract

Water management by flooding is one of the most recommended management strategies against weeds of rice. The effectiveness of the technique, however, has limited information against Philippine lowland ecotype Cyperus rotundus that had been reported having physiological adaptations under flooded conditions. Two separate experiments were conducted to determine the a) responses of pre-sprouted and non-sprouted tubers of C. rotundus to flooding x burying depth, and b) responses of growing seedlings to flooding x clipping intervention. For Experiment I, pre-sprouted and non-sprouted tubers in plastic pot with sterilized soil were subjected to flooding depth (0, 3 and 5cm) and burial depth (0, 5 and 10cm) combinations. The experiment was conducted in two trials in a two-way factorial design in randomized complete block design (RCBD) with 5 replications. Plant height, number of shoots, shoot and root weights, and number of tubers were recorded and analyzed through ANOVA. Treatment means were compared using FLSD at 5% level of significance. For Experiment II, growing seedlings in clay pots were subjected to different conditions (saturated. early flooding, and late flooding) at different clipping periods (0, 10, 20, 30 and 40 days after planting (DAP)). Early flooding was applied at 7 to 60 DAP while late flooding was applied simultaneously with clippings at 10, 20 and 30 and maintained until 60 DAP. The experiment was arranged in completely randomized design (CRD) with 5 replications. Data were gathered and analysis same as on Experiment I. Results of first experiment showed that all tubers of lowland ecotype C. rotundus developed into new plants at 0cm flooding regardless of burial depths. On the other hand, 20 to 50% of the tubers on soil surface at 3 and 5cm flooding depths developed into new plants. No growth was observed on tubers buried in 5 and 10cm depths and flooded with 3 and 5cm water depths. Despite the inhibition, tubers germinated and developed into new plants after 100 days of burying and flooding. Results of Experiment Il showed no significant differences on growth and development of the weed under unclipped and clipped treatments when grown at saturated condition. However, height, number of shoots, weights of shoots and roots, and number of tubers of the weed were significantly inhibited/reduced when treated with early flooding at 7 DAP and clipping at 10, 20 and 30 DAP. Late flooding x clipping was only effective at 20 and 30 DAP.

Keywords: Burying depth, clipping, flooding, lowland ecotype Cyperus rotundus, plasticity

P46

EVALUATION OF WEED CONTROL EFFICACY AND CROP SAFETY OF THE NEW HPPD-INHIBITING HERBICIDE-QYR301

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Abstract

QYR301, 1,3-Dimethyl-1H-pyrazole-4-carboxylic acid 4- [2-chloro-3- (3,5 -dimethyl-pyrazol-1ylmethyl)-4-methanesulfonyl-benzoyl]-2,5-dimethyl-2H-pyrazol-3-yl ester, is a novel HPPDinhibiting herbicide. Here, QYR301 was evaluated to provide a reference for post-emergence (POST) application under greenhouse and field conditions. The crop safety (180 and 360 g active ingredient (a.i.) ha⁻¹ treatments) experiment revealed that wheat, paddy, garlic and corn were the only four crops without injury at both examined herbicide rates. The weed control efficacy (60 and 120 g a.i. ha⁻¹) experiment showed that QYR301 exhibited high efficacy against many weeds, especially weeds infesting paddy fields including Cyperus iria, Echinochloa crus-galli, Eclipta prostrata, Monochoria vaginalis, Eleusine indica, Leptochloa chinensis and Echinochloa phyllopogon. Furthermore, it is interesting that both susceptible and mult-herbicide resistant E. crus-galli and E. phyllopogon, two notorious weed species in paddy field, remained susceptible to QYR301. Further crop tolerance results indicated that 20 tested paddy hybrids displayed different levels of tolerance to QYR301, with the japonica paddy hybrids having more tolerance than indica paddy hybrids under greenhouse conditions. Results obtained from field experiments at two locations in 2017 showed that QYR301 POST at 135 to 180 g a.i. ha⁻¹ was recommended to provide satisfactory full-season control of E. crus-galli and L. chinensis and to maximize rice yields. These findings indicate that QYR301 possesses great potential for the management of weeds in paddy fields.

Keywords: Paddy hybrids, post emergence herbicide, *Echinochloa crus-galli, Leptochloa chinensis*

P47

EVALUATING THE EFFECTS OF CHEMICAL RIPENING ON ITS COMPONENTS AND QUALITY TRAITS OF SUGARCANE USING YAMAHA UNMANNED HELICOPTER

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Abstract

Ripening in sugarcane refers to an increase in sugar content on a fresh weight basis prior to commercial harvest. Recently, there is interested in the Thailand sugar industry in the potential sugarcane ripeners to increase its productivity. However, this lack of information in terms of ripening efficacy that can be used as a ripener in sugarcane and there was no effective spraying application for grown tall sugarcane in Thailand. Therefore, the aim of this work was to evaluate the efficiency of the various chemical ripener treatments as a chemical ripening agent in the cultivation of the sugarcane variety Khon Kaen 3 using Yamaha Unmanned Helicopter. Treatments were arranged in a RCBD with four replications per ripener treatment. At stage the ration crop of 9 months old, spraying was done on October 2017, at the field in Wang Dong Sub-district, Mueang District, Kanchanaburi, Thailand. The growth response and phytotoxic effects of bispyribac-sodium 18.75 and 31.25 g a.i./ha, and glyphosate 120 g a.i./ha were very responsive to sugarcane, suppression of phytotoxic effects up to approximately 15-60 DAA, but not in the case of trinexapac-ethyl 187.50 and 262.50 g a.i./ha, and potassium chloride 1.312.50 g a.i./ha. Effect of chemical ripener treatments on cane guality showed that the Commercial Cane Sugar (CCS) of sugarcane, percentage soluble solids by weight (% Brix), percentage apparent sucrose by weight or sucrose content (Pol % cane), and percentage purity in cane stalks of sugarcane following bispyribac-sodium, trinexapac-ethly, potassium chloride, and glyphosate treatment has increased which ranged between 1.8-3.5 units of CCS compared to the control, indicating a positive significant correlation between these parameters. However, the fiber cane did not show any significant difference with the various chemical ripener treatments. Based on these results, bispyribac-sodium was a highly effective ripener of sugarcane to increase its productivity. Better sucrose responses were more effective at 30-60 DAA.

Keywords: Bispyribac-sodium, chemical ripening, commercial cane sugar, sugarcane

P48

GENETIC EVALUATION OF NEW WEED COMPETITIVE AND DROUGHT TOLERANCE RICE LINES

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Abstract

Marker-assisted backcross breeding is a popular method to enhance desired plant's performance. One of the most studied traits is the ability of rice plant to adapt with drought. A number of traits are responsible to control plant responses to drought; however, deeper root development is more auspicious than other traits. Root trait evaluation through phenotypic selection in conventional breeding is unfeasible without markers manipulation to support the findings. In previous research, 59 SSR markers comprised of two foregrounds (RM242 and RM263) and 57 background markers were found polymorphic and useful to be used in this study. This study was focusing on incorporating root length genes from aerobic rice variety, AERON1 (donor parent) by using SSR markers to a local rice variety, MRQ74 (recurrent parent), through marker-assisted backcross breeding technique. MRQ74 is an aromatic variety and was identified earlier as a weed competitive rice variety. Therefore, this study was conducted to evaluate the improved rice lines in BC_2F_2 population by their genetics properties. A pot experiment was conducted in a net house at Ladang 10, Faculty of Agriculture, UPM, Selangor, Malaysia in 2016. The BC₂F₂ progenies were planted along with MRQ74 as check variety. For molecular analysis, procedures of DNA extraction, PCR amplification and gel electrophoresis were done according to previously published studies. Foreground markers segregation in BC₂F₂ population were analyzed using Chi-square (χ^2) analysis, to calculate the goodness of fit to 1:2:1 ratio. Background markers were used to evaluate recurrent parent genome in selected rice lines. GGT2.0 software was used to evaluate and represent molecular marker data by simple chromosomes drawing. This study revealed 12 potential rice lines that possessed homozygous band appearance similar to AERON1 alleles in the target regions and homozygous band appearance similar to MRQ74 alleles in non-target regions of each chromosome. The Chi-square (χ^2) values for RM242 and RM263 were χ^2 =2.81 and χ^2 =2.97, respectively. In addition, all selected rice lines showed longer root length than their parental plant, MRQ74. To conclude, this study was successful to enhance the ability of local rice variety to withstand water and weed stresses. These improved rice lines could be further study in multiple locations to evaluate their yield stability.

Keywords: Chi-square, drought, homozygous, markers, rice

P49

HERBICIDE APPLICATION AT REDUCED DOSE USING INTELLIGENT PLANT PROTECTION MACHINE IN WINTER WHEAT FIELD IN NORTH CHINA PLAIN

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Abstract

Under the circumstance of reducing pesticide input in agriculture in China, putting the intelligent machines in use, especially the plant protection machines on herbicide application at reduced dose in cereal crops field is meaningful and helpful on enhancing the herbicide use efficiency and environmental safety. This is also favorable on implementing the precision weed control practice in intensive cereal crops production. A two-year field experiment was conducted to detect the efficacy on Descurainia sophia (L.) and safety on winter wheat of tribenuron-methyl applied at reduced dose using the intelligent machine and the traditional machine in 2017 in North China Plain (NCP). The results indicated that the application of tribenuron-methyl at 20% reduced dose by intelligent machine could achieve a similar weed control efficacy and significant higher crop yield compared with the application by the traditional machine. A 3-factor field experiment, two carry water volume (180 L/hm² and 150 L/hm²), two nozzle types (TTI110-04 and TTI110-03), and two herbicide doses (the recommended dose and the 20% reduced dose) was further conducted to detect these 3 factors on the weed control efficacy and the safety on wheat in 2018. Results indicated that carry water and nozzle types had no effect on the efficacy of weed control, while the factor of herbicide dose influenced the wheat safety significantly. Compared with the weed free treatment, the yield loss of the treatment at recommended dose was 9.13%, while the one of 20% reduced dose with intelligent machine was 6.77%. The yield loss after herbicide application reduced by 20% was decreased by 2.36%. We can conclude that the intelligent machine which can apply the herbicide in a much more precise way could take the place of traditional machine on herbicide application in the winter wheat field where Descurainia sophia (L.) is the dominant weed in NCP. When the carry water was $150-180 \text{ L/hm}^2$ and the nozzle type was TTI110-04 or TTI110-03, efficacy of 20% herbicide reduction treatment would not be decreased significantly, but the damage on the crop would be decreased and the yield would be increased well.

Keywords: Crop safety, herbicide reduction, intelligent plant protection machine, winter wheat

P50

INFLUENCE OF HERBICIDES APPLICATION ON THE INCIDENCE OF BASAL STEM ROT DISEASE CAUSED BY Ganoderma boninense IN OIL PALM

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Abstract

Malaysia is the second world's largest producer and exporter of palm oil that covers over 5.8 million hectares of land. Weed management is a major challenge in the oil palm plantation during the immature phase to avoid inhibition of growth and late yield of the oil palm, so the herbicides are frequently applied to manage weeds. Most commonly used herbicides are paraguat dichloride, glufosinate-ammonium, glyphosate, metsulfuron-methyl, trichopyrbutoxy, fluoxypyr, sodium chlorate, 2-4-D dimethylamine, diuron and monosodium methylarsenate. Besides, basal stem rot (BSR) disease caused by Ganoderma boninense is the major problem to oil palm growing countries. As part of the Integrated Ganoderma Management (IGM), the impact of ground application of herbicides to control the BSR disease in oil palm were studied in nursery (seedlings) and field (mature oil palms). In total six treatments (five herbicides and one untreated plot with herbicide, as control (H6) were involved in nursery and field studies, and the herbicides used were paraguat dichloride (H1), glufosinate-ammonium (H2), glyphosate isopropylammonium (H3), metsulfuron-methyl (H4), and trichopyrbutoxy (H5). In nursery, seedlings were applied with these treatments and artificial inoculated with G. boninense using root inoculation technique. Disease assessments were recorded at 3-month interval for external BSR symptoms and destructive sampling was carried out after 12 months of inoculation. In field study, these six treatments were applied on mature oil palms planted in coastal soil and the progress of BSR disease incidence were recorded at 6-month interval. It is shown that metsulfuron-methyl (H4) and paraguat dichloride (H1) have potential to reduce BSR disease incidence in oil palm in comparison with glufosinate-ammonium (H2), glyphosate isopropylammonium (H3), and trichopyrbutoxy (H5). It is suggested that herbicides used to control weeds can influence the incidence and outbreak of BSR disease in oil palm.

Keywords: Oil palm, basal stem rot, Ganoderma, herbicide

P51

THE COMBINED TOXICITY OF BISPYRIBAC-SODIUM AND CYHALOFOP-BUTYL TO BARNYARD GRASS

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Abstract

Hunan Province is one of the biggest rice planting states in China. Currently, there are 3 kinds of technology for planting rice, namely "Transplanting Rice", which has derived from the traditional transplanting seedling to Machine-transplanting Seedling; "Direct-seedling Rice" and "Throwing Rice". The area apply Direct-seedling Rice technology increased year by year. Consequently, the weed taking place in the rice field become more serious. There are 29-38 kinds of germanous weeds and latifoliate weeds appear in rice field in Hunan Province, such as barnyard grass, chinese sprangletop, Monochoria vaginalis (Burm.f.) and so on. Therefor the weed control become difficult. In order to guide the field application of the herbicide precisely, reduce the pesticide use and provide the scientific and effective theory basis for dispelling direct-seedling rice field weeds, the combined toxicity of bispyribac-sodium and cyhalofop-butyl to barnyard grass at 2-3 leaf stage was assayed. The virulence of these two agents and the mixture agents with 1:1 were compared by the whole bioassay at 37.5 g/hm²-150 g/hm². The results showed that the regression equation of the virulence after 10 d treatment of bispyribac-sodium and cyhalofop-butyl was Y=1.2811X+2.904 (R=0.977) (ED₅₀ was 43.26 g/hm²) and Y=1.4774X+2.6339 (R=0.9497) (ED₅₀ was 39.95 g/hm²) respectively; The regression equation of the virulence of the mixture was Y=2.3576X+1.6031 (R=0.8684). and ED₅₀ was 27.59 g/hm². The co-toxicity coefficient of the mixture agent was 150.96, which showed the synergistic effect. The mixture of bispyribac-sodium and cyhalofop-butyl can be applied to control barnyard grass.

Keywords: Barnyard grass, bispyribac-sodium, co-toxicity coefficient, cyhalofop-butyl

P52

DISTRIBUTION AND CONTROL OF Lactuca scariola IN KOREA

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Abstract

Prickly lettuce (Lactuca scariola L.) is one of the Invasive Alien Species (IAS) in Korea. We investigated the distribution of L. scariola in Republic of Korea focusing on the invasion issue of this weed into arable lands and screening of herbicides for the development of L. scariola control in those lands. Distribution survey results showed that they have been found nationwide but have generally established at roadside. Lactuca scariola was also found in orchards such as grape and apple as well as on uplands (i.e. sweet potato and corn fields) but their populations were less than 10% of the total areas. Although this weed was not enough to cause critical damage to crop production at this point, we should always be prepared to manage the weed as it has the tendency to become a problematic weed in arable lands. Two pre-emergent and nine non-selective herbicides have provided good control on L. scariola. Oxyfluorfen perfectly controlled L. scariola and no L. scariola was survived. The efficacy of pendimethalin on germinated seeds of L. scariola was as good as the control treatment without any herbicide treatment but the seeds remain unchanged at the cotyledon stage for 42 days after herbicide treatment and no further growth was observed. Glufosinate-ammonium showed better herbicidal performance than glyphosate-isopropylamine in glasshouse conditions, but all non-selective herbicides perfectly controlled L. scariola at 20 days after herbicide treatment in field conditions. Systemic herbicide application with pre-emergent and non-selective herbicides could be an effective method for the management of L. scariola in arable lands and this could lead to the prevention of proliferation. Other methods such as biological and cultural weed management measures could also be an option for managing the weed when systemic herbicides are used.

Keywords: Invasive alien species, oxyfluorfen, pendimethalin, prickly lettuce

P53 SEQUENTIAL EVALUATION OF SPREAD OF KUDZU COMMUNITY BY AERIAL IMAGE PROCESSING

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Abstract

Remote sensing by unmanned aerial vehicles (UAV) is useful to acquire spatial data of plant community sequentially, but it has not been utilized so much to monitor growth of weed community. The objective of this study was to detect kudzu, Pueraria lobata (Willd.) Ohwi, by machine learning and to evaluate community expansion rates in each period in a season by colonization kernel. High spatial resolution RGB images of the riverbank (40 m x 30 m) were obtained from 50 m altitude from June to October, 2018. Orthomosaic images were generated and the whole images were devided into the grids (50 cm x 50 cm). These grids were classified into two classes (presence/absence) by support vector machine (SVM). Even though there was still some room to improve distinguishment of vegetation into kudzu and the other plants. the classifiers trained by the brightness values of the 5% of the all grids in each observation achieved an accuracy of over 0.9 and an F-measure (an index introduced to avoid overestimation and underestimation of the area of the community) of over 0.9. This result shows the possibility to detect community of target weed from aerial image by small training data. In order to approximate community expansion rates, we applied a logistic model representing the relationship between the colonization probability and the distance from the nearest grid occupied by kudzu at the previous observation. An indicator of the community expansion rate was calculated from the regression coefficients. The community expansion rate in July was higher than that in September and the area of the community recovered guickly after mowing in August. Grid-based image processing does not require high spatial resolution, but evaluation of community expansion needs sequential observation at a few weeks interval. This analysis is suitable for quantifying spatial spread, in addition to appropriately representing presence/absence of target weed. This study shows the usefulness of UAV for modeling community behavior in a season. Since the expansion of kudzu community is not uniform, it is necessary to consider factors such as the influence of other species, topography, disturbance and environmental conditions.

Keywords: Aerial image, kudzu, logistic regression, support vector machine, weed community

P54

NOVEL PRECISION RICE WEED MANAGEMENT SYSTEM IN TOHOKU AREA BY A NEW WAY OF WATER INLET APPLICATION OF 3-WAY 1KG GRANULE HERBICIDE, "PYRIFTALID, MESOTRIONE AND METAZOSULFURON" AFTER MIDSEASON DRAINAGE IN JAPAN

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Abstract

Large-size paddy fields (ca. 1 ha or more), which need to allow for efficient cultivation management are increasing in Tohoku area, northeast region in Japan. Full-scale mechanized faming has already been introduced in paddy cultivation. However, herbicide applications are still done manually in many occasions. Labor saving technologies, such as direct applicable formulation, have developed though, they sometimes do not work effectively in large-size paddy field. On the other hand, the use of boom sprayer for herbicide application in paddy field has problems due to manipulate sprayer in muddy and heavy clay soil. In order to solve these problems, we focused on; 1) 3-way 1kg granule herbicide, "pyriftalid, mesotrione and metazosulfuron" (PyMXal) which controls of advanced leaf stage weeds, 2) a way of water inlet application of PyMXal by reintroduced irrigation water after midseason water drainage period. This application method was tested for 3 years since 2016 in a 1 ha (200m x 50m) transplanted paddy field. After midseason water drainage period, firstly the species, number of weeds and their growth stages were checked in the field, and PyMXal was applied on the water inlets of the short side aiming the irrigation water stream to bring the formulation across the field. The reintroduced irrigation was managed until water depth became 6 cm from 3 cm, which took 6 hours. The herbicidal efficacy and crop injury on rice were evaluated at 23 days after the application, we also confirmed PyMXal spreading across the field by chemical analysis on concentration of pyriftalid, which has the lowest water solubility among 3 ingredients, in paddy water collected in the field after application. The results indicated that; 1) herbicidal efficacy was observed on *Echinochloa* spp., which was suppressed or killed up to 5th leaf stages grown at the application, and on Scirpus juncoides var. Ohwianus extract no spikelet up to 40 cm plant height and died up to 4th leaf stages grown at the application, 2) no crop injury was observed, 3) pyriftalid diffused uniformly after the application. In conclusion, PyMXal would be applicable in large size paddy field by direct application at water inlets after midseason drainage period. This new way of water inlet application of the 1kg granule could provide the novel precision rice weed management system in Tohoku area.

Keywords: 1kg granule herbicide, labor-saving paddy rice, water inlet application

P55

EVALUATING HERBICIDES FOR GLYPHOSATE-RESISTANT GOOSEGRASS (*Eleusine indica*) CONTROL IN OIL PALM

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Abstract

Glyphosate-resistant goosegrass (Eleusine indica) is becoming common problems in oil palm fields in Indonesia. Planters are solely dependent on post herbicides, mainly glyphosate to control weeds in oil palm areas. In an immature oil palm field in North Sumatra goosegrass became the predominant weed growing in the palm circles. The field had been sprayed repeatedly with glyphosate from three to seven rounds per year since years ago. Since 2017, on the field of immature palm field, glyphosate had been spraved almost once per month due to goosegrass problem. In a pot experiment, the population from the field was compared to a wild goosegrass population, it had been confirmed that goosegrass population in the oil palm field had developed resistance to glyphosate. This study evaluated the efficacy of alternative herbicides, Monex HC (premix of 39.5% MSMA+7.8% diuron), MSMA+diuron (tank mix of MSMA720 + Diuron 80SC), ammonium glufosinate, and glyphosate for a comparison with untreated plot. The herbicides were applied at the rates of 2945g MSMA + 600g diuron. 2880 g MSMA + 600g diuron, 450 g ammonium glufosinate, and 1080 g a.i glyphosate per ha respectively. Percentage of goosegrass mortality was assessed at 1, 2, 3, and 4 weeks after spraying (WAS). Results showed that Monex HC and ammonium glufosinate caused high goosegrass mortality (89.4 and 93.9% respectively) one week after spraying followed by MSMA+diuron (63.7%) and glyphosate (36.5%). However, the percentage of goosegrass mortality due to ammonium glufosinate application from one to four weeks after spraying continually decreased down to 67.8% whereas the other three herbicides did not decrease significantly. Goosegrass mortality due to the application of Monex HC (premix of 39.5% MSMA+7.8% diuron), tank mix of MSMA+diuron, ammonium glufosinate, and glyphosate assessed 4 WAS were 92.1, 61.5, 67.8, and 28.5% respectively. It is clearly that Monex HC (premix of MSMA + diuron) can effectively control the glyphosate-resistant goosegrass population where glyphosate not able to control in the immature palm oil field.

Keywords: Goosegrass; Monex HC; oil palm; resistance management.

P56

DEVELOPING AND ADAPTING BEST WEED MANAGEMENT PRACTICES FOR HIGHER PRODUCTIVITY IN DIRECT SEEDED RICE IN RAINFED LOWLAND AREAS IN CENTRAL PHILIPPINES

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Abstract

Weeds are among the major problems of farmers in the rainfed lowlands in Central Philippines. We conducted participatory adaptive trials with farmers to develop and adapt best management practices to manage weeds in direct seeded rice. In 2017 wet season, we worked with five farmers to determine yield losses using two weed management practices; T1- Farmer Practice (FP) and T2 – FP + hand weeding at 25-30 and at 40-45 days after seeding (DAS). In 2018 wet season, we tested five herbicide treatments (subplot) combined with farmer land leveling and laser leveling (main plot) in three farmers' fields at the lower, middle and upper toposequence in the village. The five herbicides tested were: 1) byspiribac sodium @ 10 g ai/ha. 10-15 DAS: 2) fenoxaprop ethyl + ethoxysulfuron @ 80 g ai/ha. 15-18 DAS; 3) pretilachlor @ 0.6 kg ai/ha, 2-3 DAS + byspiribac sodium@0.10 g ai/ha, 10-15 DAS; 4) pretilachlor @0.6 kg ai/ha, 2-3 DAS; and 5) pretilachlor @ 0.6 kg ai/ha, 2-3 DAS + fenoxaprop ethyl + ethoxysulfuron @ 80 g ai/ha, 18-15 DAS, and compared with farmers' practices. Major weeds include Echinochloa crusgalli L. P. Beauv. Leptochloa chinensis L., Cyperus sp., Echinochloa colona L. and Ischaemum rogusum Salisb. Yield loss due to weeds varied from 2 to 53%. Significantly higher rice yield was observed with laser leveling compared to farmer land leveling at the upper toposequence field. Pretilachlor @ 0.6 kg ai/ha, 2-3 DAS + byspiribac sodium @0.10 g ai/ha, 10-15 DAS had significantly higher yield than pretilachlor@0.6 kg ai/ha, 2-3 DAS in the lower toposequence field. In this treatment, income increased by 6% to 28% with farmer land leveling and 7% to 21% with laser leveling. The highest benefit of land leveling combined with the best herbicide treatment was seen in the upper toposequence field.

Keywords: Direct seeded rice, herbicides, land leveling, rainfed lowlands, rice productivity

P57

HERBICIDE SEQUENCES WITH AGIXA[™] HERBICIDE GIVE BEST WEED CONTROL IN AUSTRALIAN DRILL SOWN RICE, GROWN WITH DELAYED PERMANENT WATER

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Abstract

The rice industry in Australia has a clear goal to improve productivity to 1.5 T rice ML⁻¹ water used. Presently production efficiency is about 1 T rice ML⁻¹. To enable this significant improvement in production efficiency by 2023, better weed control options will be needed. In practice the industry is moving to drill sown rice (DSR) using delayed permanent water (DPW), where water is strategically applied and then removed in the establishment of rice. Aerobic conditions under DPW encourage early weed competition. This paper outlines research during the last three years, to demonstrate the value of herbicide sequences at planting followed by early post-emergence treatment to maximise weed control and yield potential. Agixa[™] herbicide with Rinskor[™] active (Rinskor 12 g ai L⁻¹ plus cyhalofop 160 g ai L⁻¹) at 2 L ha⁻¹ has been demonstrated to be selective to rice, whilst providing strong post-emergent control of key weeds (barnyard grass - bayer code ECHCG, silvertop grass - LEFFA and coolah grass - PANCO) in DSR when used in sequence with industry standard foundation treatment. The results clearly showed foundation treatments at planting not followed by postemergence Agixa gave poor weed control. Similarly, post-emergence Agixa without the preceding foundation treatment also gave variable results. These results clearly show the importance of use of herbicide sequences to maximise weed control and yield potential, whilst minimizing risk of onset of weed resistance. New work will be presented to illustrate the importance of sequences for best weed control, use of mixtures to reduce application time and cost and rice safety. The Australian rice industry has started to grow rice using less water and best growers are producing yields of more than 15 T Ha⁻¹.

Keywords: Australia, delayed permanent water, drill sown rice, Rinskor active, sequences

P58

PERFORMANCE OF TOLPYRALETE IN THAI, INDONESIAN, AND VIETNAMESE CORN FIELDS

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Abstract

Tolpyralate is a new, corn-selective, POST emergence herbicide that was originally discovered by Ishihara Sangyo Kaisha, Ltd. The mechanism of action of Tolpyralate is inhibition of HPPD (4-hydroxyphenylpyruvate dioxygenase), which causes chlorophyll destruction followed by death in susceptible weeds. Corn is tolerant to Tolpyralate, as it can rapidly detoxify the herbicide. Tolpyralate has been commercialized in Japan, USA, Mexico, and Argentina, among other countries. However, its biological performance under tropical conditions is unknown. The objective of this research was to evaluate its performance in South East Asian countries. Fourteen field trials were conducted in Thailand, Indonesia, and Vietnam in 2017 and 2018. In most of the trials, no phytotoxic symptoms were observed in corn. Slight chlorosis was observed in a very limited number of trials, but the symptom was transient and the corn recovered rapidly. Tolpyralate at 50 g ai/ha provided excellent control of most of the evaluated broadleaf weeds and some grasses, and the efficacy was similar to that of other HPPDI herbicides. There were some dose responses observed between 50 g ai/ha and lower dose rates (30 and 40 g ai/ha). Tolpyralate in combination with Atrazine even at 30 g ai/ha + 1000 g ai/ha provided excellent control of all the weeds tested, and the efficacy was comparable with, or superior to, those of the standard herbicide programs in these countries. In conclusion, Tolpyralate is a promising herbicide that will provide farmers with an excellent weed control method or option for corn farmers in South East Asian countries.

Keywords: Corn herbicide, foliar application, HPPDI, tolpyralate

P59

PURPLE NUTSEDGE (Cyperus rotundus) CONTROL WITH FLAZASULFURON

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Abstract

Purple nutsedge (Cyperus rotundus) is a well-known problematic weed in sugarcane production and has been called the world's worst weed because of its wider distribution than any other weed in the world and high capacity to survive under various environmental conditions such as soil type, soil moisture, pH, and elevation. Flazasulfuron is an Acetolactate synthase-inhibiting (ALSi) herbicide. Flazasulfuron controls a wide range of annual and perennial weeds and has been used for weed management mainly in tree crops and turf. Greenhouse and field studies were conducted to evaluate the efficacy of Flazasulfuron on purple nutsedge. PRE and POST emergence application of Flazasulfuron at a dose of 50 g ai ha⁻¹ provided 85% control of purple nutsedge at 42 days after application (DAA) and 100% control at 35 DAA in pot-scale trials using purple nutsedge tubers. In field trials in Brazil, POST emergence application of Flazasulfuron at 50 and 75 g ai ha⁻¹ both provided 91% control of purple nutsedge at 77–97 DAA. POST emergence application of Flazasulfuron at dose rates of 37.5 and 50 g ai ha⁻¹ provided 80% and 90% control of purple nutsedge at 30 DAA, respectively, and 70% and 80% control at 60 DAA, respectively; however, PRE emergence application of Flazasulfuron at the aforementioned rates was less efficacious than POST emergence application in a field trial in Thailand. These results indicate that POST emergence application of Flazasulfuron at 50 g ai ha⁻¹ is the optimum dose and application strategy that provides long-term efficacy (two to three months) in controlling purple nutsedge in sugarcane.

Keywords: Cyperus rotundus, herbicide, purple nutsedge, weed control

P60

HERBICIDAL ACTIVITY OF POST-EMERGENCE NEW HERBICIDE, FLORPYRAUXIFEN-BENZYL EC (LOYANT EC), AGAINST ANNUAL WEEDS IN PADDY FIELD

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Abstract

Rinskor[™] Active, Florpyrauxifen-benyl is a new arylpicolinate herbicide from Corteva agriscience, which was is classified as a new structural class of synthetic auxin (HRAC group O/WSSA Class 4). Rinskor™ Active has broad spectrum activity on grasses, broadleaf weed, and sedge weed with excellent crop tolerance on rice. In Korea, Florpyrauxifen-benyl 3.75% (w/w) emulsifiable concentrate (Loyant[™] EC) was developed for foliar application product by Kyung Nong Corporation and the recommended agricultural dosage to control main weed at 5 leaf stage of *Echinochloa* (about 30 days after transplanting) is 35g ai ha⁻¹. Therefore, the single (35g ai ha⁻¹) and double dosage (70g ai ha⁻¹) was tested in field to confirm the efficacy against annual weed and phototoxicity on rice. In 2-year field study, Rinskor showed more than 95% of weed control including Echinochloa oryzicola, Monochoria vaginalis, Bidens tripartita. Persicaria hydropiper, and Aeschynomeme indica and no crop response even at double dosage. In addition to field study, laboratory bioassay at 35g ai ha⁻¹ of Loyant[™] EC was conducted against 4.5 leaf stage of E. oryzicola and 2 heart-shaped leaf stage of M. vaginalis to check a span of efficacy and a symptomology. The symptom of leaf's bending and lying within 7~10 days and stem's twisting within 1 to 2 days was observed on E. orizicola and *M. vaginalis*, respectively. Based on above study, the Loyant[™] 3.75% EC represent a new tool for rice weed management. And it has been manufactured and sold since 2018 in Korean paddy rice market.

Keywords: Rinskor, florpyrauxifen-benzyl, Loyant, annual weeds, synthetic auxin

P61

INTERFERENCE OF WEEDY RICE ON YIELD AND YIELD COMPONENTS OF CULTIVATED RICE IN THE PHILIPPINES

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Abstract

Weedy rice is becoming a major threat to rice production in the Philippines. Reports had shown that it affected the quality and quantity of cultivated rice. Because weedy rice germinates and emerges at the same time as cultivated rice and because it is taller, weedy rice competes more efficiently than cultivated rice for sunlight. Its similarity with cultivated rice in terms of morphology makes it a strong competitor for other basic growth resources such as water and nutrients. However, information about its negative effect on yield of rice under Philippine condition is very limited and the competitive abilities of weedy rice have yet to be studied which will address the knowledge gap on its effects on rice yield under Philippine condition. For this reason, this study had been undertaken and an experiment was conducted from August-November 2018 at PhilRice Central Experiment Station in Nueva Ecija, Philippines to determine the effect of weedy rice on vield and vield components of cultivated rice and to determine competitive abilities of weedy rice using replacement series method. The treatments involved were 100:0, 75:25, 50:50, 25:75 and 0:100 % rice: weedy rice ratio. Results showed that plant height of cultivated rice NSIC Rc 222 was not affected by the presence of weedy rice. Competition between rice and weedy rice were greatly shown in terms of tiller production. Tillers and panicle number of weedy rice were highest at 75:25 rice to weedy rice ratio. When the population of weedy rice was lower, the number of its tillers increased. Yield components of rice at 25:75 rice to weedy rice ratio were significantly reduced. Production of lower number of tillers, leaves, panicle length and total number of grains of cultivated rice resulted in significant reduction in biomass at 50:50 and 25:75 rice to weedy rice ratio. Findings of the study corroborate reports from other countries on weedy rice affecting negatively rice yield and its components.

Keywords: Weedy rice, replacement series, yield components

P62

TANK MIXTURE OF POST AND PRE-EMERGENCE HERBICIDES FOR BROAD SPECTRUM WEED CONTROL IN DIRECT-SEEDED RICE

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Abstract

Weed infestation is one of important problems causing yield losses in direct-seeded rice. The application of post-emergence with pre-emergence herbicides should be one of effective methods that eliminates weeds and their seeds. Aim of this study was to investigate the efficacy of tank mixing pre and post-emergence herbicides for weed control in direct-seeded rice. The study was conducted in May to September 2014 at Sam Chuk District, Suphan Buri Province. The observed values among the treatments were compared by using the Randomized Complete Block Design (RCB) with 3 replications in 18 treatments. The comparison of conventional treatment and application of herbicides at 8 days after sowing were observed. The result showed that oxadiazon 25% EC was slightly toxic for rice on day 7 after application but no significantly effect on rice growth and development. Interestingly, the action of herbicide mixtures, including pyribenzoxim 5% EC + pretilachlor 30% EC, pyribenzoxim 5% EC + thiobencarb 80% EC, penoxsulam 2.5% OD + pretilachlor 30% EC, penoxsulam 2.5% OD + thiobencarb 80% EC and propanil + butachlor 35+35% EC at 25 + 562.5, 25 + 2000, 10.9 + 562.5, 10.9 + 2000 and 1500 g (ai)/ha, respectively, were effectively control Echinochloa crus-galli (L.) Beauv., Leptochloa chinensis (L.) Nees, Sphenoclea zeylanica Gaertn., Fimbristylis miliacea (L.) Vahl. and Cyperus difformis L. for 60 days after treatment and their fresh and dry weight were decreased. Furthermore, productivity of rice was significantly higher in herbicide mixtures treatment (4,998.1-5,354.4 kg/ha) than control (2,031.25 kg/ha). This study suggested that the high actions of herbicide mixtures, including high productivity, low weeds, and low cost, were pyribenzoxim 5% EC + pretilachlor 30% EC, penoxsulam 2.5% OD + pretilachlor 30% EC, and propanil + butachlor 35+35% EC.

Keywords: Direct-seeded rice, tank mixing, post-emergence, pre-emergence

P63

FIELD EFFICACY AND CROP TOLERANCE OF LOYANT (Florpyrauxifen-benzyl) FOR CONTROL OF SELECTED WEEDS SPECIES IN MALAYSIAN RICE FIELD

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Abstract

A series of trials was conducted to evaluate the field efficacy and crop tolerance of Loyant (Florpyrauxifen-benzyl 25 g/L) against a current farmers' practice for control of selected weeds species in rice growing region of Selangor between March-July (off season) and August- Feb (main season) in 2018. Trials were conducted using the randomized complete block design (RCBD) with 4 replications per trials and plot size of approximately 1200m² (large scale) and sprayer used was mist blower, while 25 m² for small scale, where treatments were applied using motorized knapsack. Four major rice, Oryza sativa (Indica) varieties in Malaysia were tested for the crop tolerance; MR 220, 219, 297, and 269 cultivated by direct-seeding (DSR). Herbicides treatment consisted of Loyant (800ml/ha), Loyant (1200 ml/ha) and Nominee 100SC+ Basagran (100 ml/ha + 2 l/ha). Control efficacy against targeted weeds (LEPCH: Leptochloa chinensis, ECHCG: Echinochloa crus-galli, CYPDI: Cyperus difformis, CYPIR: Cyperus FIMMI: *Fimbristylis* iria. miliacea. LUDOC: Ludwigia octovanvis MOOVA: Monochoria vaginalis, BAORO: Bacopa rotundifolia) of different herbicides and growth responses of four rice varieties were observed at 7, 14, 28, 42 and 56 days after application (DAA) as compared to the untreated plot. At 56 DAA, Loyant applied at 10 days after sowing (DAS) in large scale field at both tested rates (800ml/ha and 1200ml/ha) showed effective control efficacy (80 - 100%) for e.g. ECHCG, CYPDI, CYPIR, LUDOC, MOOVA, BAORO and with acceptable suppression control (60 – 80%) for LEPCH and FIMMI. Nominee 100SC + Basagran showed an effective control, where has similarly to Loyant and significantly different as compared to untreated plot. The crop responses observed at all treated plots starting from 7 DAA and recovered after 28 DAA with variety MR 220 being slightly more sensitive to Loyant as compared to the other varieties. After 28 DAA, the crop responses to all herbicide's treatments shown there were no significant effect towards all varieties as compared to untreated plot.

Keywords: Herbicides, rice field, weeds
P64

GROWTH AND SEED PRODUCTION OF CAROLINA DAYFLOWER (*Commelina caroliniana* Walter) AND THE EMERGENCE CHARACTERISTICS IN FOLLOWING YEAR

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Abstract

Carolina dayflower (Commelina caroliniana Walter), a native plant to India and Bangladesh, has invaded in the soybean cultivated fields on northern Kyushu Island, located on the western side of Japan and seems to be developing into a troublesome weed species. Therefore, we investigated to determine the growth, seed production and the seedling emergence of Carolina dayflower. One plant was grown in non-woven root wrap of 1m² (1*1*0.5m height) filled with commercial organic culture soil and andosol in Jul, 2017. The plant height, numbers of primary branches and spathes were recorded every week. The shoot weight and total branch number of the plants sampled at 155 days after transplanting were also measured. Although some of root wraps were left until the next year (in 2018), we divided them into two plots; 1) disturbed plots where take the seedlings away at the time of the survey, and 2) naturally leaved plots where the emerged and grown plants were remained. The number of emerged or remained plants in each plot were counted every week. The experiments were conducted with 4 replications. The height of a plant was 42.4 cm and the number of primary branches was 29 in the maximum. The spathes began to form in Sep., and their number was 3,696 in the maximum. The total number of spathes produced was 6,532 to 14,306, and the total number of seeds were ranged in 5,279 to 15,731. On the disturbed plot, the peaks of development in spathes were observed in late May and early Aug. The total number of seedlings emerged until Oct. was about 2,100. On the naturally leaved plots, it began to emerge one week earlier than the disturbed plot. The number of surviving plants in late May was 325, and they increased to 679 in early August. The plants emerged in July began to develop from the mid Sep. and its size reached the peak from late Sep. to early Oct. In addition, about 10,000 seeds on average were produced per a plant. It was thought that the number of emerged plants in the following year might have attributed to about 20% of the total number of seeds produced in previous year.

Keywords: Carolina dayflower, *Commelina caroliniana*, emergence behavior, growth, seed production

P65

NOXIOUS WEEDS IN THE MALAYSIAN OIL PALM PLANTATIONS

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Abstract

A study has been conducted to evaluate the manifestation of noxious weeds in oil palm plantation. Seventeen species of weed reported to be associated with oil palm cultivation were assessed; 4 grasses (Eleusine indica (rumput sambau/goosegrass), Imperata cylindrica (lalang/satin tail), Ischaemum muticum (rumput kemarau/seashore centipede) and Pennisetum polystachion (rumput ekor kucing/mission grass), 10 broadleaves (Clidemia hirta (senduduk bulu/soapbush), Melastoma malabathricum (senduduk), Lantana camara (bunga tahi ayam), Chromolaena odorata (pokok kapal terbang/siam weed), Mikania micrantha (selaput tunggul/ceroma/mile-a-minute). Asystasia intrusa (akar ruas-ruas/ coromandel). Hedyotis verticillata (lidah tiong), Mimosa sp. (semalu), Ageratum conyzoides and Borreria latifolia, 2 sedges (Cyperus sp. and Fimbristylis miliacea), volunteer oil palm seedlings and various ferns species. The survey was conducted based on questionnaire disseminated to the oil palm plantations in Malaysia including Sabah and Sarawak. The survey involved 910 oil palm estates with total area covered of approximately 173, 6112.876 hectare. In immature oil palm area. E. indica (82%) was reported in the highest number of estates followed by I. cylindrical (81%) and *M. micrantha* (77%). However, 30% of the immature estates have more than 25% of ground cover coverage (medium to high density) of E. indica, 19% of I. cylindrical and 28% of *M. micrantha*. Asystasia intrusa has been reported as medium to high density weed in 30% of the immature estates. Meanwhile in mature area, ferns was reported in 88% of the estates followed by C. hirta (86%) and VOPs (85%). Medium to high density for ferns was reported by 43% followed by C. hirta (41%), A. intrusa (34%) and VOPs (29%). Better understanding of the composition of weeds in the oil palm plantation will help to formulate better weed management strategies.

Keywords: Immature oil palm, noxious weeds, questionnaire

P66

INHIBITORY EFFECT OF ALLELOPATHIC PLANTS' WATER EXTRACTS FOR WEED MANAGEMENT IN MAIZE

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Abstract

Current study was designed under pot trials in laboratory conditions. The specific objectives of this study were to evaluate the most effective, eco-friendly and economical treatment for weed management in maize using various allelopathic plant aqueous extracts. Selected allelopathic plant species were collected from farmers' fields. All the plants were cleaned, dried in oven and grinded. The grinded powders were soaked in distilled water according to treatments in the ratio of 1:10 (w/v) or 100 g/L and kept at room temperature. Atrazine 38 SC (atrazine) @ 100 g/L was used as recommended herbicide. Distilled water treatment was also included for comparison. All the treatments were applied on maize, T. (write in full first time) portulicastrum and Lolium regidum seeds. Data on Germination (%), Shoot Length (cm) and Dry Biomass (g) was recorded. Results showed that Sorghum bicolor, H. (write in full first time) annuus and P. hysterophorus (WE) (Weed Extracts) @ at a respective dose of 33.33% (g/L) reduced dry biomass of *T. portulacastrum* and *L. regidum* by 35-41 %, whereas the parallel values for commercial herbicide ranged from 45% to 47 %. Maize seeds were found more tolerant as compared with weed species. Furthermore, allelopathic plant water extracts applied in combinations had more inhibitory effect on dry biomass of treated plants than when applied alone. However, the efficacy of commercial herbicide was more pronounced in suppressing the germination and seedling growth of the test species. Hence, it is concluded from the current study that allelopathy could be a potential source for designing an alternative control tool to synthetic herbicides.

Keywords: Allelopathy, maize, weeds,

P67

SURVEY OF WILD PLANTS AND CHEMICAL CONTROL IN CAMELLIA OLEIFER ABEL FOREST IN HUNAN PROVINCE

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Abstract

Camellia oleifera Abel is a major kind of woody oil plant in the southern part of China. At present, single herbicide formulation is usually applied for wild plants control in C. oleifera forest, which push resistance of wild plants to such herbicide. And wild plants pulling or soil digging are also commonly used especially in the young stage of the forest, which is time-consuming and uneconomic. In this paper, the wild plants species and occurring regularities of six C. oleifera forests in Hunan province were surveyed, and ten tests of herbicides mixed in barrels by using glyphosate, glufosinate ammonium, fomesafen, or quizalofop-p-ethyl were carried out in C. oleifera forest with an area of 100 m² each, and pesticide residue and control effect were analyzed. The results indicated that there were 83 wild plants species belonging to 31 families in C. oleifera forests. And the main wild plants communities in C. oleifera forests belonged to the Gramineae family. The optimal herbicide formulation mixed in barrels for controlling the dominant gramineae species such as Imperata cylindrica was the mixture of glyphosate and guizalofop-p-ethyl. And the optimal herbicide formulation mixed in barrels for controlling the broadleaf wild plants species was the mixture of glyphosate and fomesafen. The above metioned formulations mixed in barrels with glyphosate had better herbicidal effect and could extend the grass control cycle. The herbicide formulations mixed in barrels with glufosinate had guickly weeds control effect, and it could be the better replacement for paraguat. The herbicides experimented in the optimal herbicide formulation were safety for application with little residue in leaves and soil. And it was no significant impact for surrounding crops, soil and water flow after spraying the herbicides. It had provided an theoretical reference for the application of chemical control in the C. oleifera forest.

Keywords: Wild Plants, Camellia oleifera Abel Forest, Chemical Control

APWSS YOUNG SCIENTIST FORUM

METABOLISM PROFILING OF CYTOCHROME P450 CYP81A SUBFAMILY TO DISCLOSE THE PATTERN OF HERBICIDE CROSS-RESISTANCE IN *Echinochloa phyllopogon* (Stapf) Koss.

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Abstract

Metabolic cross-resistance is a huge threat to the sustainability of herbicide use, as it is unpredictable and could extend resistance to existing, novel and to-be-discovered herbicides. A strategy to scrutinize the metabolism functions of key enzymes which are involved in herbicide metabolism will help predict cross-resistance in weeds. Members of CYP81A subfamily in multiple herbicide-resistant (MHR) Echinochloa phyllopogon (syn. E. oryzicola) were previously reported for conferring cross-resistance to six unrelated herbicide classes. We investigated the metabolism functions of all nine putative functional CYP81A genes of MHR E. phyllopogon to 33 herbicides from 24 distinct chemical groups via ectopic expression in Arabidopsis thaliana and Escherichia coli. CYP81A12, CYP81A15, CYP81A18, CYP81A21 and CYP81A24 exhibited wide substrate and distinct specificity when expressed in A. thaliana; and produced either hydroxylated, N-/O-demethylated or both metabolites when expressed in E. coli. The pattern of resistance conferred by these CYP81As is geared towards all chemical groups of acetolactate synthase inhibitors and is expanded to benzothiadiazinone (photosystem II inhibitor), pyridazinone (carotenoid biosynthesis at the phytoene desaturase pyrazole (protoporphyrinogen oxidase inhibitor), step inhibitor), triketone (4hydroxyphenylpyruvate dioxygenase inhibitor), and clomazone (1-deoxy-D-xylulose 5phosphate synthase inhibitor). Based on the metabolism profile, we predicted and confirmed cross-resistance in MHR E. phyllopogon to two novel acetolactate synthase inhibitors, pyrimisulfan and propyrisulfuron. Our results emphasize the risk of cross-resistance conferred by upregulated genes with wide substrate specificity, underpin the perilous role of CYP81As in the evolution of cross-resistance, and help identify appropriate chemical options to manage the existing and unexpected cross-resistances in *E. phyllopogon*.

Keywords: Cross-resistance, cytochrome P450, *Echinochloa phyllopogon*, herbicide detoxification, metabolism-based resistance

INCIDENCE OF MULTIPLE HERBICIDE RESISTANCE IN WINTER GRASS (Poa annua) ACROSS SOUTH-EASTERN AUSTRALIA

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Abstract

Poa annua is a problematic annual weed in established turfgrass where the intensive use of herbicides has resulted in the evolution of herbicide resistance. In 2017, thirty five populations of P. annua suspected to be resistant were collected from golf courses in across south-eastern Australia. The populations were tested for resistance to herbicides commonly used to control this weed in turf. Among them thirty four populations were resistant to multiple herbicides. Dose-response experiments on 4 populations confirmed resistance to propyzamide, simazine, rimsulfuron, foramsulfuron, endothal and pinoxaden. Levels of resistance to rimsulfuron. foramsulfuron, endothal and pinoxaden were high, but levels of resistance to propyzamide and simazine were much lower. For endothal and pinoxadin there was considerable variation in the level of resistance among the populations. Target site mutations in ALS and ACCase contributed to resistance, but were absent for PSII and microtubule assembly inhibitors. The resistance mechanism for PSII inhibitors, inhibitors of microtubule assembly and endothal remains unknown and needs to be explored. In this study, three populations had multiple resistance to all herbicides tested across the five modes of action. Since P. annua is primarily a self-pollinated species, it is likely that these multiple resistant populations have arisen due to sequential selection with multiple herbicides over a long period of time. A combination of target site and non-target site resistance is likely contributing to multiple resistance in this weed species. Such resistance to up to 5 modes of action herbicides, with both target-site and nontarget site mechanisms will make the management of *P. annua* very difficult.

Keywords: Multiple resistance, Poa annua, propyzamide

ECOLOGY AND PHENOLOGY OF Achillea millefolium– A FAST EMERGING INVASIVE WEED IN THE HIGHER HIMALAYAN RANGES

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Abstract

Achillea millefolium (family Asteraceae) - an herbaceous annual plant, is a native of Europe that has acquired invasive character in different parts of the world. The weed has also become invasive in the higher ranges of the Himalayas occupying sunny as well as moist habitats. The rapid spread of the weed may pose a threat to the local flora which includes the medicinally important plants. Therefore, there is a need to assess the spread of this weed before it becomes wide-spread. The weed mainly spreads through achenes which are produced in large numbers. The objective of the present study was to investigate the extent of spread and phenological phases of flowering of this weed across an altitudinal gradient. For this, we established four 20 × 20 m permanent plot which were further divided into 5 × 5 m and 1 × 1 m sub plots. The extent of weed spread and documentation of flowering phenology were done on the basis of abundance in each quadrat. The results revealed that the spread of weed ranged between 2500 to 4000m. Further, significant differences in the flowering phenological phases were observed across an altitudinal gradient. The flowering duration was more at higher altitudes in comparison to the lower altitudes. The variability in the phenophases across an altitude carries immense importance in providing reproductive fitness and better fertilization opportunities to the weed. During the deliberations of this conference, it is proposed to discuss various aspects such as ecology and flowering phenology of A. millefolium.

Keywords: Altitude, flowering phenology, invasiveness, reproductive fitness

EVALUATION OF THE LEVEL OF SEED DORMANCY IN WEEDY RICE SEEDS IN MALAYSIA

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Abstract

Seed dormancy is a key trait that promotes the survival of weedy rice (Oryza sativa L.) in the rice seed bank. This study was aimed to investigate the level of seed dormancy of various weedy rice (WR) biotypes in Malaysia. Seeds from a total of 66 WR biotypes determined based on their morphological characteristics, including the presence of awn, panicle type, degree of shattering, and the color of the hull and pericarp, were collected from a single plant at IADA Barat Laut Selangor rice granaries. The level of seed dormancy was determined by standard germination test at 7, 14, 21, 42, 49, 56, 84 and 280 days after imbibitions. All WR biotypes showed strong primary dormancy with an average germination rate 15.63% (±17.52), at 21d after imbibition. The germination rate increased by 25.3%, 73.5% and 90.18% at 56d, 84d and 280d respectively. Another separate standard germination test using heat (7d-2) and after-ripening time (7d-3) shows that dormancy breaking was influenced by after-ripening time and heat does not release dormancy completely. Correlation analysis (r = 0.60 to 0.88) between interval periods indicates significant dormancy loss over the time. Biotypes SD-02 and SD-14 displayed the strongest dormancy where the seeds germination rate <50% until 280d while 5 biotypes (SD-11, SD-12, SD-15, SD-20 and SD-33) recorded >50% germination rate at 21d indicating poor germination. This work demonstrated that weedy rice in Malaysia displayed a variation in germinability after imbibition as an adaptation to survive. More analysis needs to be answered to further interpret the ecological behaviour of seed dormancy in weedy rice in nature.

Keywords: Seed dormancy, weedy rice, germination test

RESPONSE OF WEED SPECIES UNDER DIFFERENT ATMOSPHERIC [CO₂]: IMPACT ON BIOLOGY AND GLYPHOSATE EFFICACY

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Abstract

Changes in the atmospheric carbon dioxide [CO₂] concentration may influence the growth and management of weed species in the future. The aim of this study was to evaluate the effect of ambient (400 ppm) and elevated [CO₂] (700 ppm) on the early growth and to evaluate glyphosate efficacy in controlling Chloris truncata R. Br., Sonchus oleraceus L., and Conyza bonariensis Crong. Glyphosate applied in this experiment was 0, 62.5, 125, 250, 375, 500, and 750 g a.i. ha-1. Results from the experiment showed improved biomass and growth of S. oleraceus and C. bonariensis under elevated [CO₂], whereas the growth of C. truncata seems to be negatively affected. Despite changes in weed growth, glyphosate activity seems to be more rapid in ambient [CO₂] as readings of SPAD meter (chlorophyll content) varied before herbicide application to 6 DAT as compared to elevated [CO₂]. Changes in the leaf chlorophyll content were visible on the plant injury (%) during the first assessment period. However, glyphosate was equally effective in controlling weeds under ambient and elevated [CO₂] in the second and third assessment period. Based on the experiment, it is assumed that the weed population experiencing changes in [CO₂] might develop increase tolerance in their future progenies. It requires further studies on the absorption and translocation of glyphosate under varying climatic conditions. Furthermore, possibilities still exist that these weed species might respond differently when high [CO₂] associate with high temperature or soil moisture stress.

Keywords: Australia, climate change, efficacy, glyphosate, weed Management

SCREENING AND EVALUATION OF FUNGAL PATHOGENS ASSOCIATED WITH Parthenium hysterophorus L. IN PENINSULAR MALAYSIA

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Abstract

Parthenium weed (Parthenium hysterophorus L.) (Asteraceae) is one of the most aggressive weeds originated from the tropical Americas. Due to major threats it poses to humans, animals and ecosystem, it has been dubbed the 'worst weed of the century'. In Peninsular Malaysia, parthenium-covered areas have been increasing at an alarmingly immense rate, urging the need for its management. The high dependence on effective, but detrimental chemical herbicides has led to the call for more study and development of environmentally-safe weed management programs. A series of extensive field surveys were conducted between September 2018 to December 2018 at three different locations (Rantau, Negeri Sembilan; Raub, Pahang; Sungai Siput (U), Perak) of which high infestations of parthenium were reported. Screening of fungal pathogens were done by collecting diseased parthenium leaves in order to identify prospective leaf-infecting fungi which can be used to further assess their potential as biological control agents of parthenium. Infected portions of the leaf were surfacesterilized and transferred onto potato dextrose agar (PDA) plates to cultivate the fungal isolates. These isolates were assessed molecularly using polymerase chain reaction (PCR) to amplify the internal transcribed spacer (ITS) region to reveal six different fungal pathogens such as, Curvularia geniculata, Daldinia eschscholtzii, Lasiodiplodia theobromae, Macrophomina phaseolina, Nigrospora oryzae and Nigrospora sphaerica. The detached leaf assay was incorporated to assess the in vitro fungal pathogenicity in order to obtain the disease severity indices of all six species, indicating its pathogenicity towards parthenium leaves. The most pathogenic was found to be *M. phaseolina*, while the least pathogenic is *D*. eschscholtzii.

Keywords: Biological control, detached leaf assay, invasive weed management, *Parthenium hysterophorus*, pathogenic fungi isolation

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