



President's message

Dear Colleagues,



I hope you are all having a great and productive 2013 after our wonderful gathering at the IWSS Congress in Hangzhou, China, that was excellently hosted by Prof. Zhang from the Chinese Academy of Agricultural Sciences in Beijing and had a most relevant scientific program assembled by Dr. Per Kudsk and the team of Main Topic Organizers. Preparations are now underway for our next International Weed Science Congress in Prague in 2016. The local organization will be under the leadership of Prof. Dr. Josef Soukup of the Czech University of Life Sciences in Prague with the scientific support of the European Weed Research Society (EWRS). To that effect, the IWSS Executive Committee has recently appointed Dr. Bernal Valverde to Chair the Scientific Committee for IWSC 2016. We would also like to solicit your suggestions for:

1. Session Topics
2. Main Topic Organizers
3. Theme for the 2016 Congress

(Please send your suggestions to Dr. Samunder Singh, Secretary IWSS; secretary@iwss.info, sam4884@gmail.com).

Information about the Congress will be made available on our new webpage, which can be visited at <http://www.iwss.info/iwsc.php>. We request members to login at the Society's webpage (<http://www.iwss.info/index.php>) to access the most recent information, which is available to registered members only. Kindly register yourself on the webpage <http://www.iwss.info/member-login.php>. The registration procedure is available at <http://208.43.17.46/~iwssinf/downloads/files/n50d9dd3e1d809.pdf>

Consequent with our commitment to support Regional Weed Science Societies in workshops, short courses, or helping with training events and conferences involving participation of young Weed Scientists and students (see President's Message IWSS Newsletters Spring 2009 and September 2010), several IWSS members have contributed their time to such activities in the Americas, Asia, and Europe. Some of these activities will be highlighted in the Newsletter. Please contact us for more information regarding regional collaborations for organizing such workshops/trainings in your region/country.

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IWSS wants to show the young generation that our profession can make a unique and critical contribution to science and food security in a safe environment. In the 6th Congress, we were able to award travel grants to 25 students, thanks to the joint forces of the European Weed Research Society (EWRS), the Weed Science society of America (WSSA), and IWSS. In 2016, we hope to be able to award even more. Thus, I would also like to inform you that now is the time to start preparing your students for participation in the 7th IWSC in Prague. Our membership to the IWSS makes a significant contribution to this objective. Therefore, we encourage you to continue renewing your annual membership so that together we can enable the Society to accomplish this mission. You can renew your membership by visiting the corresponding section of our web page at <http://www.iwss.info/membership.php?AM3>. I would like to take this opportunity to thank you all for your participation in the 2012 IWSC and to all those whose collaborations made this memorable event possible. We look forward to working together again to make the 7th IWSC another successful reality.

Albert Fischer,
President

AUSTRALIA

PUTTING THE CRUNCH ON WEED SEED – Corrigendum

Material on Harrington Seed Destructor (HSD), supplied by Prof. Stephen Powles, Australian Herbicide Resistance Initiative (AHRI), University of Western Australia was published in the last issue of IWSS Newsletter (Sept. 2012). Unbeknownst to us at the time, the same article (minus photos) was also published in the June 2012 issue of IPMnet NEWS, vol. #195. IPMnet NEWS was edited and coordinated by Dr. Allan E. Deutsch, at the Integrated Plant Protection Center in Oregon State University, Corvallis, Oregon, USA. The Editor apologizes for not attributing the source for the news item as it was in continuity with other news items from Australia.

Global Herbicide Resistance Challenge Conference, Esplanade Hotel, Fremantle (Perth), Western Australia, Feb. 18-22, 2013



More than 400 delegates from 32 countries participated in the Global herbicide resistance challenge conference in Perth. In spite of high cost, more than 150 international delegates attended the meeting dealing solely with weeds and their resistance to herbicides of different modes of action (MOA). Herbicide

resistant weeds and their management were the topic of more than 100 speakers and 60 posters. Resistant weeds have become such a nuisance that all the top growers in Australia hire consultants. The cost of weeds was estimated at AS\$ 1.5 bn in Australia per annum. In the last two decades (1990-2012) glyphosate resistant weeds have spread in to 61.2 m ha of farmlands. Globally herbicide resistant weeds are spreading @25% with 400 unique cases from 217 weed species reported in 65 crops from 61 countries. Weed resistance has left 148 herbicides vulnerable for their effective use, covering 21 out of 25 known MOA. The situation is further aggravated as no new MOA herbicide has been introduced since 1982. The Perth meeting was the third such international conference dealing with herbicide resistant weeds and crops; earlier meetings were, Long Ashton International Symposium on Herbicide Resistance in Weeds and Crops, Long Ashton, UK, Sept. 1989 attended by over 220 researchers from 23 countries and the International Symposium on Weeds and Crop Resistance to Herbicides, Cordoba, Spain, 3-6 April 1995 and attended by 270 researchers from 37 countries.

Stephen Powles, Professor at the University of Western Australia and Director AHRI (Australian Herbicide Resistance Initiative) presided over the conference opening and John Harvey the Chief Executive Officer from the Grains Research and Development Corporation (GRDC), a major conference sponsor, talked about the role of the Australian Grains Industry and GRDC role in funding research programs for managing weeds efficiently and the programs to communicate information to farmers.



Prof. Stephen Powles at inaugural speech



Dr. Dale Shaner clarifying a point from the presentation of Dr. Ian Heap on herbicide resistant weeds

Several keynote speakers made relevant contributions to the event. **Jerry Green**, DuPont, USA discussed the scenario on herbicide resistance as of today. In the last century, weed management has evolved through cultural to mechanical and chemical methods, where weeds often had a role on the size of holding, a family can effectively manage! The genetic technology has evolved from open pollinated varieties to double and single cross hybrids with biotech traits with a new paradigm ahead in weed management. Glyphosate resistant crops had the most rapid adoption in the history of agriculture. Transgenic herbicide traits were inducted in canola, corn, soybean, cotton, rice, alfalfa and sugar beet in the last century to different selective and non-selective herbicides. Glyphosate was a great herbicide, but few weeds adapted and need new management approach by changing, diversifying, alternating and combining several tactics. Because of evolution of resistant weeds and shift in weed flora, multiple herbicide resistant crop varieties and functional genomics using RNAi gene silencing are on the way.

Ian Heap (USA) presented a review on herbicide resistant weeds worldwide, lessons learnt and how international survey of resistant weeds can form a skeleton for future research on weed management and its advisory use. **Rick Llewellyn**, Commonwealth Scientific and Industrial Research Organization (CSIRO), Australia, impressed upon considering the socio-economics of herbicide resistance management decisions. Farmer's perception about herbicide choice for resistance management does not always coincide with research scientists' recommendations which depend upon on-farm constraints, resistance risks and profitability. **Christopher Preston**, University of Adelaide, Australia, analyzed, 'what has herbicide resistance taught us'? Continued use of herbicide is sure shot for the evolution of resistant weeds; herbicide mixtures,

sequential use and increased efficacy using different strategies can best delay the evolution, but there are no examples on total avoidance of resistance evolution. Weeds having several mechanisms may evolve resistance with or without fitness penalty and the rate of evolution varies with weed species and herbicides. The latest technology on genome sequencing may throw more light on new targets/mechanisms.

Glyphosate was termed the 'miracle' herbicide in 1995, **Ford Baldwin** Consultant, Arkansas (USA), as it captured 100% soybean, corn and cotton area raising the bar to 100% weed control by killing diverse weed species, but this was only for a decade after which resistant weeds appeared. One more decade and there will be hardly any glyphosate resistant crop grown in the USA due to wide spread resistance to glyphosate in several weed species. The million dollar question is - will the same happen to other herbicides used frequently?

Douglas Sammons, Monsanto, USA presentation on 'just how many glyphosate resistance mechanisms are there, anyway' had the most rapt attention while reviewing current knowledge on the diversity of ways weeds have evolved resistance to this herbicide. Glyphosate resistance has been reported in several weed species due to variable uptake, reduced translocation, vacuole sequestration and multiple copies of the EPSPS gene. More EPSPS maintains enzyme activity and correlated with less shikimate. Resistance mechanisms may vary with weed species, but one species can have multiple resistance mechanisms as well. *Lolium rigidum* was found to have active target site mutation, gene duplication and also vacuole sequestration. Gene duplication in amaranths, ryegrass and kochia and active site mutation at P106X in ryegrass are documented due to target enzyme EPSPS, vacuole sequestration in *Conyza* and ryegrass. Reduced cell uptake (membrane transport) in amaranths and sorghum and chloroplast uptake in amaranths, mimicry behavior in giant ragweed have been documented as glyphosate resistance mechanisms. Amputation of sinks, avoidance of shikimate export and metabolism of any amount anywhere could also be a resistance mechanism associated with glyphosate.

Phil Westra, Colorado State University, USA talked about the whole plant and molecular response of *Kochia scoparia* to glyphosate. Glyphosate R-Kochia had no variations in EPSPS binding site sequence, but resistance was conferred due to over production of EPSPS. With abundant seed production and wide seed dispersal, kochia has become a serious weed that evolved eight fold resistance to glyphosate (**Phil Stahlman**, KSU, USA). Not only is it having a negative impact on conservation tillage, but the cost of management has increased due to increased tillage which eats away farm profitability.

Patrick Tranel, University of Illinois, USA updated the audience on herbicide resistance in *Amaranthus tuberculatus*. Due to staggered germination (April to July), prolific seed production and dioecious nature and forced out-crossing has resulted in resistance evolution to triazines (1990), ALS (1991), PPO (2000), glyphosate (2004) HPPD inhibitors and 2,4-D (2009). Many populations were found to possess multiple resistance mechanisms to herbicides of different MOA's even before the release of HRC this is a real cause for concern. **Pat Tranel**, also reviewed resistance to PSII and HPPD inhibitor herbicides and role of synergists on evolution of resistance. Substitution of Ser₂₆₄Gly in D1 protein and several other mutations (Ser₂₆₄Thr, Leu₂₁₈Val, Val₂₁₉Ile, Ala₂₅₁Val, Phe₂₅₅Ile and Asn₂₆₆Thr) have also been reported to confer resistance to several PSII inhibitors. Not only are there variations among herbicides of the same MOA, but also species with the same mutations as some herbicides also impose negative cross resistance; the level of resistance and fitness penalty as thought earlier to PSII resistance is also not true for all species. Other than target site mutation, enhanced metabolism by glutathion S-transferases (GST) in *Abutilon theophrasti* and *Amaranthus tuberculatus*, cytochrome P450 mono-oxygenases (P450s), in *Lolium* sp., *Alopecurus myosuroides* and *Phalaris minor* and Aryl acylamidase in *Echinochloa* sp. has been documented as mechanisms of resistance to this group of herbicides. Similarly HPPD inhibitors isoxaflutole (1999), mesotrione (2001) and pyrazone (1980) evolved resistance to *Amaranthus tuberculatus* and *A. palmeri* in 2009. A tenfold resistance to HPPD inhibitors in amaranthus was characterized by P450 mediated enhanced metabolism. In most of the cases HPPD inhibitors resistance is associated with triazine resistance; some synergy of both may be short lived and may complicate things in the long run.

John Soteres from USA discussed Monsanto's global strategy to manage herbicide resistant weeds. He emphasized early detection of resistance and following diversified best management practices (BMP), for effective weed management. **Mike Owen**, Iowa State University, USA presented results of benchmark studies and large scale demonstrations on the sustainability of glyphosate-based crop production. It is more important as 22% corn, 54% soybean and 23% cotton are still treated only with glyphosate in USA. BMP treatments had 21% lower weed populations. For long term effective weed management, we need to reduce the number of glyphosate applications by combining with other PRE/POE herbicides. Changes in weed communities are occurring in response to management tactics, but seed banks remain generally stable after five years. **David Shaw** from Mississippi State University, USA reported that no new herbicides with new MOA are in the advance development trials and for the foreseeable future, thus we have to manage weeds with currently available herbicides using best management practices.

Francois Tardif, studies from Canada revealed that resistance to glyphosate in giant ragweed (*Ambrosia trifida*) was due to reduced herbicide translocation mediated by light. A glufosinate resistant population of *Eleusine indica* was also found to be resistant to glyphosate due to double amino acid substitution in the ESPSP gene (**Adam Jalaludin**, UWA, Australia). Twelve applications per year of glufosinate (one per month) for five consecutive years in an oil Palm nursery in Malaysia resulted in the evolution of resistant populations of *E. indica* (**Bernd Laber**, Bayer, Germany). Glufosinate has been found to effectively control glyphosate resistant water hemp in Liberty Link® soybean in Iowa (USA), but an Italian ryegrass population resistant to glyphosate (due to reduced translocation) showed cross-resistance to glufosinate in Oregon with a resistance index of 2.8. A D171N amino acid substitution in the plastidic GS2 gene was identified in the R population.

Tim Hawkes, Syngenta UK, presented an excellent review on paraquat resistance mechanisms in weeds. Paraquat resistance has been recorded in 49 biotypes of 28 weed species in 14 countries and *Conyza* alone counts for >30% resistant weed species. Several possible resistance mechanisms were discussed along with the role of various abiotic stresses. Overall the major mechanism is *most likely* vacuolar sequestration which, despite segregating as if a single gene and occurring across diverse weeds is of rare occurrence (possibly requiring multiple mutations) and has not yet been found in model plant/mutation studies. **Terry Wright**, Dow AgroSciences, **Les Glasgow** and **Vinod Shivrain**, Syngenta, USA presented strategies on using alternative herbicides to enhance the shelf life of older herbicides and to increase weed control efficiency. **Craig White**, Bayer CropScience, Australia discussed the use of pyrasulfotole, an HPPD inhibitor herbicide in mixture with bromoxynil and MCPA using a safener for selective broad spectrum weed control.

Mithila Jugulam, Kansas State Univ. USA discussed, how knowledge on genetics and mechanisms of resistance are important to predict evolution and spread of herbicide resistance and **Mark Peterson** from Dow AgroSciences, USA explained their technology of stacking of glyphosate with 2,4-D choline which provides an additional MOA and reduce off-target herbicide movement. **Qin Yu**, UWA, Australia talked about current understanding of resistance to AHAS inhibitor herbicides. Both target site mutations at eight positions of AHAS gene and enhanced metabolism were discussed as mechanisms of resistance. The use of PCR based diagnostics for early detection of target site mutation was proposed. Non-target site resistance in weeds is example of crop mimicry (enhanced metabolism by P450's and GT's). High number of P450 genes (200-400) are reported which may involve in different weed species and herbicides. Rapid progress in P450/GT gene research is expected to help efforts to delay the onset of resistance.

Shiv Shankar Kaundun, Syngenta, UK visited the ACCase resistance in weeds. Plants possess two nuclear encoded ACCase isoforms, cytoplasmic and plastidic as target for ACCase inhibitor herbicides. Plastidic ACCase is homomeric in grasses and heteromeric in most other plants. Selectivity between grass and BLW is based on the difference of plastidic ACCase. Target site resistance due to mutation (amino acid change) and metabolic resistance are well documented in several weed species. Mutation at seven ACCase codon positions (I1781L/V, W1999C/L/S, W2027C, I12041N/V, D2078G, C2088R and G2096A/S) are identified. Non-Target site resistance (NTSR) via P450s, GST and glucosyl-transferases is polygenic and complex as P450 genes involved in metabolism are yet to be uncovered. Syngenta quick resistance

detection test has been found effective to detect both target and NTSR. Development of crops resistant to ACCase inhibitors are an attractive prospect as few herbicides are selective on monocot crops. Several lines resistant to ACCase inhibitors have been created for corn, sorghum, turfgrass, rice and wheat; however, resistance in weeds is an increasing problem and proactive measures are needed to delay the onset of resistance.

Roland Beffa, Bayer CropScience, Germany discussed *diagnostic technologies to detect herbicide resistance*. Timely and accurate diagnostics can help in increasing herbicide longevity; screen house tests though are reliable, but time consuming and can't always differentiate between TSR and NTSR. Pyrosequencing test for TSR and the analyses of NTSR by measuring the metabolism using radiolabelled compounds and the power of transcriptome analysis using next-generation sequencing assist to better understand the mechanisms involved. Novel molecular technologies could offer the tools to fill knowledge gaps and help guide the appropriate recommendation in Integrated Weed Management programs. **Harry J. Streck**, also with *Bayer CropScience, Germany* reported, *Status and development of ACCase and ALS inhibitor-resistant black-grass (Alopecurus myosuroides Huds.) in local landscapes in Germany*. ACCase resistance was both TSR and NTSR, but no particular relationship between fields of the same farmer was observed (independent evolution, with no major role of pollen flow or seed dispersal).

Lolium rigidum is another notorious weed which has evolved resistance to several herbicides in many countries. **Alberto Collavo** from Italy, and **Rupinder Kaur Saini** from the University of Adelaide discussed *L. rigidum* resistance to ACCase and ALS inhibitors. Pyrosequencing analysis revealed five different ACCase mutations, while none of the tested plants displayed amino acid substitutions at positions 197 or 574 of the ALS gene. Significantly higher level of mesosulfuron metabolites were recorded in plants that originated from seeds from ALS treated plants, though lower level of metabolites were found with ACCase inhibitors. Rotating ACCase with ALS inhibitors is a short-term tactic, but is not sustainable in the medium- to long-term without the additional use of other integrated weed management tools.

Hugh J Beckie, Agriculture and Agri-Food Canada, reviewed glyphosate-and ALS-resistant *Kochia scoparia* in western Canada. The resistance was conferred by Pro197, Asp376, or Trp574 amino acid substitutions. **Andreu Taberner** from University of Lleida, Spain highlighted the value of using nitriles and tank mixture with SU's and auxinic herbicides to deal with the problem in most cases.

Roberto Busi, Australian Herbicide Resistance Initiative, Australia discussed the management of resistance to mitosis disrupters (e.g. dinitroanilines) and very long chain fatty acid (VLCFA) synthesis inhibitors (e.g. chloroacetamides and thiocarbamates). Resistance evolution to the mitosis disrupters and VLCFA inhibitors is limited to grass weed species (21 resistant weed species), with a few rare exceptions and they have a potential for use against ALS, ACCase and glyphosate resistant weeds. Pyroxasulfone (a VLCFA inhibitor), under recurrent selection for three years against moderately resistant *L. rigidum* revealed risk of resistance even at 2.4X dose (30% survival). This population also exhibited XR to prosulfocarb and triallate.

Dr. Franck Dayan (Treasurer, International Weed Science Society), USDA, Oxford, USA made a presentation on resistance to inhibitors of protoporphyrinogen oxidase (PPO) and phytoene desaturase (PDS) inhibitors. *Amaranthus tuberculatus* resistance to PPO inhibitors was due to codon deletion on the mitochondrial gene (Gly210). There was no change on the chloroplastic isoform, the actual molecular target site of PPO inhibitors, nor affected the affinity for the substrate or the FAD content, but negatively affected the catalytic efficiency of the enzyme. There were three nucleotides encoding for glycine amino acid and deletion of Gly210 had a significant impact on the architecture of PPO that accounts for the biochemical changes. PDS inhibitor (fluridone) used against hydrilla resulted in the evolution of three resistant populations and all had single point mutation at Arg304 leading to amino acid substitution (Ser304, Cys304 or His 304) decreasing the sensitivity of PDS to fluridone. Thr304 (double point mutation) provided the highest level of resistance to fluridone. Interestingly, these mutations conferred XR to norflurazon (Pro and Trp deactivated PDS), but overall negative XR to beflubutamid, picolinafen and diflufenican was observed. Transgenic *Arabidopsis thaliana* plants harbouring the resistant forms of hydrilla PDS were also herbicide-

resistant, suggesting that these genes can be used as excellent markers for the selection of transgenic plants. The evolution of glyphosate-resistant weeds will force farmers to return to other classes of chemistry to combat their emerging weed problems. While resistance to PPO inhibitors has been scarce, it is inevitable that renewed interest in these compounds will restore the selection pressure that will select resistance if farmers do not modify their current agricultural practices.

Christophe Délye, INRA, France dealt non-target-site-based resistance (NTSR) which is most widespread in grassy weeds. NTSR genetics is poorly known as there are no quick molecular-based diagnostic tools. The role played by several families of enzymes (e.g. cytochromes P450, glutathione-S-transferases, esterases, glycosyl-transferases and transporters) in reducing herbicide efficacy is well known, but neither the vast majority of the corresponding genes are currently known nor the genes involved in the regulation of NTSR. The recent rise of 'next gen' sequencing and proteomics technologies allows us to identify sets of genes associated with a phenotype among the thousands expressed in one plant. Thus NTSR genes can be identified, provided an adequate procedure is subsequently implemented to unambiguously demonstrate their role in managing NTSR.

Paul Neve, School of Life Sciences, University of Warwick, UK debated the role of low or reduced herbicide rates exacerbating evolution of resistance? 'There is increasing field epidemiological evidence for the evolution of NTSR where the magnitude of resistance of most individuals in the population continues to creep up with each selection cycle, Gressel (1995) — a Catch22 situation where higher rates lead to monogenic resistance and lower rates to quantitative resistance. The low rate debate addresses fundamental questions in evolutionary genetics such as micro-mutationism (adaptation proceeds via the substitution of many genes of small effect); standing genetic variation versus new mutations, stress and mutations rates and epigenetics. Simulation studies indicate that application of high dose selects plants beyond range of genetic variation and resistance only evolves as a result of new mutations, whereas application of lower rates select resistant plants within range of genetic variations and resistance evolves as a result of recombination of standing genetic variations. An almost 50-fold increase in GR₅₀ values after three generations of recurrent selection on additive genetic variations (enhanced metabolism) in 39 plants of *Lolium rigidum* (VLR1) to diclofop-methyl was observed. Similarly, metabolic resistance was reported in a case of *Alopecurus myosuroides* from UK and *Phalaris minor* from India. Many of these populations had both TSR and NTSR mechanisms. However, in reality, there may be few universal truths in resistance management based on application rates. Low rates may have important implications in some circumstances and not in others. These important questions are worthy of further study and can throw a light on important issues and questions in herbicide resistance evolution and management.

Two concurrent sessions covered almost two dozen papers on different aspects of resistance management from different crops and geographic location (New Zealand, Germany, Australia, Indonesia, Malaysia, UK, USA, S. Africa, Italy, Brazil, Chile, China, Japan and France). The evolutionary ecology of resistance to herbicides: insights into the role of plant fitness was discussed by **Martin Vila-Aiub**, **Roberto Busi**, **Stephen Powles** and "Modelling as an integration tool for helping to understand, predict and manage herbicide resistance" by **David Thornby** and **Michael Renton** from Australia. *Ryegrass integrated management (RIM) a decision support system for evaluating the impact of weed control strategies and herbicide resistance on long-term cropping profitability* was launched by **Myrtille Lacoste** and **Stephen Powles** (Australia). **A relaxing River Cruise followed at the end to relax and rejuvenate the participants.**

Day four began with the presentation from **Jason Norsworthy**, *University of Arkansas, USA* on glyphosate-resistant *Amaranthus palmeri* in southern USA row-crop production followed by herbicide resistance management in cereal cropping systems by **Michael Walsh**, University of Western Australia, Resistance management – rice systems by **Chanya Maneechote**, *Department of Agriculture, Thailand*, and Weed control systems in HR canola – a resistance reprieve by **K Neil Harker**, *Agriculture and Agri-Food Canada*. **This was followed by the WeedSmart launch.**

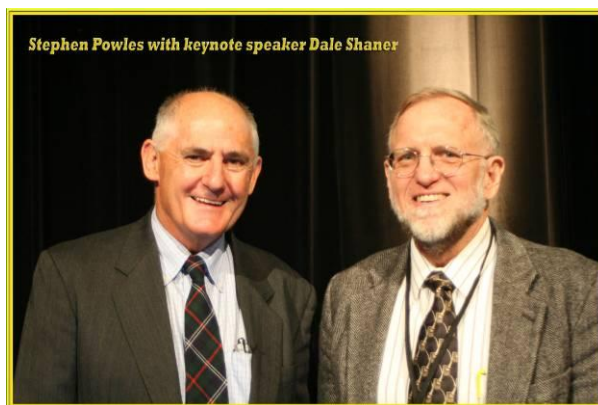
Two concurrent sessions were held for presentations on weed detection technology, surveying, and herbicide resistance management to commonly used herbicides in different parts of the world.

Samunder Singh, (Secretary, International Weed Science Society), *Department of Agronomy, CCS Haryana Agricultural University, Hisar, India* made a presentation on the detection of ACCase herbicide resistance in *Phalaris minor* and its management in India. With >28 m ha area under wheat, India is an important wheat producer. *P. minor* is the major weed affecting wheat productivity in the 'grain bowl' of this country due to multiple herbicide resistant (PSII, ACCase and ALS) populations, making it the most dreaded weed to control. Its emergence in several flushes during the winter season and regeneration following the application of most available herbicides, further aggravate its propensity to defy new herbicides. However, not all the populations are resistant to the existing herbicides in the same field, but sufficient information in this case is lacking. Early detection of resistant populations can lead to the adoption of a robust management strategy. Whole plant test, an agar based seed/seedling test and a hydroponic seedling test was evaluated for the seed collected from resistance-affected areas of northwest India. The agar method using seed in the Petri plates was most reliable to confirm resistance in *P. minor* within seven to 10 days. The seed/seedling method has great potential to predict resistance well in advance of wheat sowing/spraying, enabling adoption of suitable herbicides for efficient weed management.

The plenary session followed with presentations from **Todd Gaines**, **Hugh Beckie** and **Dale Shaner**. **Todd Gaines**, Bayer Crop Science, Germany summarized the presentations on the biochemical and molecular basis of resistance and reported that there are still many questions such as - how applicable are markers for particular mechanisms? There remain several unknown and new mechanisms for many herbicides. Rapid necrosis in *Ambrosia* (giant ragweed) and EPSPS protein of different sizes was observed as a new mechanism of glyphosate resistance.

Although the cost of gene sequencing has gone down following Moore's law from \$100 m in 2001 to <\$10 m in 2012 for the genome size of human, but the genome of *Avena fatua* and *Alopecurus myosuroides* still are 4.6 and 1.4 times larger than the human genome (3 Gb), respectively. The major challenges remain, such as understanding and validating results and strengthening role of functional genomics in weeds. To overcome the problem in future, more emphasis is needed on NTSR mechanisms. Understanding the evolutionary process at an early stage, synergy using herbicides, surfactants and agronomic practices, selection of application rates based on weed intensity, faster NTSR diagnostics using DNA based technology and functional genomics of weeds will go a long way to avoid herbicide resistance.

Hugh Beckie (Canada) summarized the papers presented in different sessions on resistance characterization, rapid diagnosis, herbicide resistant weed surveys, resistance mechanisms, inheritance of resistance, fitness of resistant weeds, biology, ecology, evolution, herbicide resistant crops, gene flow and decision support systems. Since the weeds, herbicides, cropping systems and edaphic factors have large variations in different geographical locations; a single approach may not work for all situations. However, herbicide rotations, mixtures and sequential applications hold ground for most situations. This approach can delay the onset of resistance, but may not prevent resistance evolution altogether. A combination of different approaches by using herbicides, cultural, chemical, biological, mechanical and even manual weeding can be used to manage multiple herbicide resistant weeds. Stacked genes in herbicide resistant crops also need a combination of different approaches for long term sustainable weed management. Preventative approaches, clean seed, weed seed bank management, planting methods and weed biology knowledge need to be incorporated into BMP as herbicides alone will fail in the long run.



Dale Shaner (USDA-ARS, USA) reviewed the strategies adopted in the past (the mistakes made, lessons learnt) and how to successfully manage weeds for improving the economics of growers and lower the risk of crop failure due to weeds pressure and environmental dangers. Dale discussed IWM and new tools as well as the major obstacles to the management of resistant weeds.

Conference proceedings can be accessed at <http://www.herbicideresistanceconference.com.au/>



The last day of the meeting included an interesting field visit to the eastern parts of Western Australian cropping region and a demonstration of weed seed destroying mechanical devices during wheat harvesting. The day was complete with presentations from farmers who were part of the success story in developing these new tools to manage weed seeds at harvest thereby controlling weed numbers in subsequent cropping phases.





— Samunder Singh, Secretary, IWSS



Siam weed control continues on Cocos Islands



Government of Western Australia
Department of Agriculture and Food



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Department of Agriculture and Food staff has returned from the Cocos (Keeling) Islands where they continued highly successful work to control Siam weed. In addition to weed control, the team helped boost the Islands' biosecurity, encouraging the shire to recognise Siam weed (*Chromolaena odorata*) as a threat to newly-established agricultural enterprises on the island and the environment.

Department development officer David Atkins said the department had been involved in weed control on the Cocos Islands since 2010, conducting three to four visits each year. "Siam weed is recognized as one of the world's worst tropical weeds," Mr. Atkins said. The success of the department's Siam weed program on the Islands has been recognized with the Commonwealth and Western Australian Governments extending the program for a further 12 months. Senior technical officer Brad Rayner, biosecurity officer Terri Jasper and development officer Andrew Reeves recently returned from the Islands where they advised the shire to include weed control activities in future contract operations and ensure a Siam weed free area around site works and equipment storage areas. This arrangement is expected to significantly reduce the risk of Siam weed being transported back to mainland Western Australia on machinery after it is used on the Islands. Murdoch University legume trials to assess the Cocos Islands' potential for agriculture also benefited from weed control on the trial site, which was previously heavily infested with Siam weed. Mr. Atkins said

economic benefits of the department's weed control efforts included the promotion of local employment and training in weed control techniques. The removal of Siam weed also appears to have resulted in health benefits, with locals reporting a reduced incidence of asthma caused by Siam weed, he said.

The pollen load of Siam weed is considerable because the plant flowers several times during the year. A survey has been initiated to quantify health benefits resulting from Siam weed reduction and demonstrate a clear link between the weed control program and health improvements. Department staff also presented biosecurity information to Year 9 and 10 students as part of the school curriculum and helped raise the profile of the department within the Island community.

Funding for the department's Siam weed control on the Cocos Islands is provided under Service Delivery Arrangement by the Department of Regional Australia, Local Government, Arts and Sport.



Photo caption: *Department of Agriculture and Food staff Brad Rayner and Terri Jasper undertake weed control with Cocos Island locals Sauiffullah Zaitol, Zaikat Omal and Shafiee Zaitol.*

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CANADA

INTRODUCING IWSS MEMBERS TO THE INTERNATIONAL BIOHERBICIDE GROUP

The International Bioherbicide Group (IBG) is a freely organized group of researchers interested in the different aspects of "inundative" biological control of weeds, including bioherbicides. The researchers have diverse backgrounds, specializing in areas such as weed science, plant pathology, entomology, microbial fermentation and formulation, and agronomy. The group meets about every two years by organizing IBG Workshops, usually in conjunction with related International Congresses and other professional societies. The group also communicates via the IBG Newsletter which is published twice a year on the IBG website (<http://ibg.ba.cnr.it/>), thanks to volunteer contributions of people from the group. The Newsletter is emailed to all persons who subscribe to our website. The website also houses information about our meetings, abstracts and proceedings, pictures and other links. We are a volunteer organization and do not have any membership fees to join. If you would like to subscribe to our site or make a contribution to our December issue of the Newsletter, please email our Newsletter Editor, Maurizio Vurro, at maurizio.vurro@ispa.cnr.it.

The XIth IBG Workshop was held for two days in Nanjing, China on August 22-24, 2013, just prior to the International Congress of Plant Pathology in Beijing. Dr. Qiang Sheng from the Nanjing Agricultural University graciously hosted a total of 121 participants from the United States, Canada, Australia, New Zealand, Turkey,

Costa Rica and China. Under the background of global environmental change and the continued input of agrochemicals, the meeting explored the development of bioherbicides that will provide an alternative agro-product supporting sustainable agriculture. The specific topics included in this workshop were: 1) Progress and prospects of bioherbicides, 2) Screening and biological study of bioherbicides, and 3) Commercialization and registration of bioherbicides. More than 32 papers and abstracts, 17 oral presentations and eight posters were enthusiastically contributed. Papers from the talks will be collated in the proceedings and posted to the website this autumn. The participants also visited Weed Research Laboratory, Nanjing Agricultural University (NAU) and Bioherbicide Field Demonstration trials (Jiangpu Farm). This was our largest IBG meeting to date and it reflected our traditions of maintaining a high academic standard with a convivial scientific atmosphere.

Planning is underway for IBG to meet with IWSS in Prague 2016. We are excited about this opportunity to interact with IWSS members and invite you to join us at the XIIth IBG Workshop in 2016.

Karen Bailey, Chairperson of IBG
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The Korean Society of Weed Science held its spring meeting on 25-26 April 2013 in Boseong, a city located on the south of the country and world renowned for its superb green tea production. This is one of the two scientific meetings organized every year to update local weed scientists on research results.

At this meeting, some international guests lectured on specialized topics, including Prof. Dai Wei-min from Nanjing Agricultural University (China), Dr. Bernal E. Valverde (former President of IWSS) and Dr. Hüsrev Mennan from Ondokuz Mayıs University (Turkey). A proceedings book was prepared (mostly in Korean) as a special issue of the Korean Journal of Weed Science.



Venue of Boseong Meeting



Boseong meeting in progress, April 2013

Dr. Bernal E. Valverde, Costa Rica



EUROPE

16th European Weed Research Society Meeting

The 16th EWRS Symposium took place in Samsun, Turkey from 24—27th June 2013. The Symposium was held in the campus of the Ondokuz Mayıs University (OMU) with active support of the University and especially the group of Prof. Dr. Husrev Mennan who was the convenor of the Symposium. The central location of the symposium in Turkey is important since the region including neighbouring countries like Greece, Iran, Lebanon, Israel and Jordan have a very important role in the specific natural conditions, farming systems and crops where weeds and weed research has a vital role.

This Symposium was the biggest so far as we attracted 326 participants from 46 countries. Most participants (61) came from Turkey, bigger European countries had more than 20 attendees; an average number from smaller countries ranged between 2-10 participants. Very pleasing is the fact that we had 16 participants from Australia, 4 from Canada and also participants from many, (for us) exotic countries like Mauritius, Sri Lanka, Pakistan, Korea, Japan, Brazil, and Argentina, etc.

The Scientific program was divided into seven sessions with 37 oral presentations and 256 posters in total. Many of the invited and other oral speakers were from non-European countries which enabled participants to see problems from other perspectives. The Symposium contributions covered a wide range of research topics in weed biology, ecology and control; majority of them with excellent theoretical or applied approach. Weed management practices (both chemical and non-chemical) and their consequences (biodiversity, plant invasions, changes in weed communities, herbicide resistance) were of interest for the majority of scientists over a long period of time. It is clearly indicated that the emphasis of the EWRS is not only just theoretical science, but has an important practical use. All participants had the unique opportunity to take part in half a day excursion that demonstrated the local agricultural practices.



Members of EWRS Board- László Radics, Andrej Simončič, Josef Soukup, Ben J. Post and Editor-in-Chief of Weed Research Jon Marshall



Michaela Kolářová interacting with EWRS delegates

The participants attended the eight working group (WG) meetings organized during the symposium and learnt first-hand knowledge about the current work of the WGs, future plans and in case of interest to take part in ongoing activities. Positive tendency has been seen in the number of young scientists interested in weed research. EWRS supported the participation of 44 young scientists, MSc and PhD students, all being younger than 35 years. It makes 14% of all participants and many other young scientists that did not apply for subsidy. The special meeting of all subsidized young scientists with the EWRS SciCom members left a

good feeling and showed good scientific background of young researches, communication skills, enthusiasm and especially the endeavour for professional growth.



End of Symposium - thank you to local organizers



Field excursion

The Symposium was considered by all participants as very successful. Taking into account the number of participants, the quality of contributions, number of non-European guests and young scientists, the good health of the European weed research was clearly visible and we can believe in its good future.

Prof. Ing. Josef Soukup, CSc., EWRS Scientific Secretary

UK



Dr Ralph C Kirkwood: Botanist, Educator and International Enthusiast — Professor George Marshall, Assistant Principal, SRUC, Edinburgh, Scotland, UK

Ralph Kirkwood's career exemplifies a botanist of special merit. Plants, vegetation, their physiology and dynamics have always held a fascination for Ralph. In the formative years Ralph lectured at the West of Scotland Agricultural College, Auchincruive, Ayr, Scotland. Lecturing in botany but especially agricultural botany was combined with field experimentation on hill and upland vegetation. This was not esoteric research. In the 1960's there was still a very strong driver for improved agricultural production from poorer farmland. One plant in particular was to be associated with Ralph - the bracken (*Pteridium aquilinum*). He worked on its biology and control with a range of herbicides for many years long after moving to the University of Strathclyde in Glasgow. The work led to a publication on *Bracken and its Control* in 1981.

In the University Ralph thrived and swiftly became a popular lecturer and supervisor of post-graduate and under-graduate students. His practical nature ensured that he worked with many of the leading agrochemical companies and became ‘the’ expert in asulam, aminotriazole, glyphosate and a host of soil-applied residual compounds. The work spanned field and laboratory studies and this was an especially attractive platform for students and their future careers. The breadth of the topics that he pursued is encyclopedic – annual and perennial weeds, biochemical mode of action, herbicide tolerant crops, herbicide resistant weed, herbicide fate and metabolism. His extensive publications in books and papers are testimony to this summary. Ralph published over 140 refereed and conference proceedings papers, 12 book chapters and eight books. His book on *Herbicides & Plant Growth Regulators* (1982) with W. W. Fletcher was very popular among graduate students. Similarly, *Target Sites for Herbicide Action* (Edited 1991) and *The Mechanism of Action of Herbicides* (2000) with A. H. Cobb, were standard text books for students and researchers. Ralph not only had thorough understanding of weeds and herbicides, but also had a deep knowledge of environment and biodiversity and he published books on *Clean Technology and the Environment* (1994) and *Biodiversity and Conservation in Agriculture* (1997). His love for environment reflected from the fact that even after his retirement in 1996, he taught in Graduate School of Environmental Studies for 15 years.

Students and their supervision have always been a priority and love for Ralph. He has supervised more than three dozen students from many and varied backgrounds, truly International in his contribution across nations. Every year Ralph used to take his students on an excursion to different islands in Scotland for the first hand knowledge on local flora and fauna. His interest and knowledge in the local Flora and Fauna was amazing and he was approached by Royal Society of Edinburgh for a book on ‘*The Environment of the Estuary and Firth of Clyde*’ (1986) and Ayrshire Archaeological & Natural History Society for a book on ‘*Plant Life in Ayrshire*’ in 1992. For his significant work in the understanding of herbicides physiology and biochemistry leading to improved weed management and his excellent teaching skills, he was honoured by the Royal Society of Edinburgh by conferring upon him a fellowship of this prestigious Society. Ralph was also honoured with ‘Outstanding International Achievement Award’ by the International Weed Science Society in 1997.

Based in Scotland, the teams that he built in weed biology and control touched EU countries, Canada, the USA, India, Australia and New Zealand. Ralph has explored an appreciation and intellect that supports our understanding of how herbicides and weeds interact. He has published extensively and contributed to his peer community over almost half a century. The impact of this work and endeavor may seem understated in an era of environmental prudence, anti-chemical sentiments and risk assessments. None-the-less, in the 21st century we can learn much from his logical, systematic and thorough approach to research as we need greater agricultural production with minimum environmental impact. Sustainable intensification will not be achieved without an understanding of weed control and vegetation management. Weed scientists have become an endangered species in the UK. We should be inspired and appreciate the contribution that Ralph Kirkwood has made to botany and agriculture in a national and international context.

Ralph is also an avid sailor and keeps himself busy in the summer organizing sailing competitions in the Irish sea — a picturesque sight of several Scottish Islands.

IWSS wishes Dr. Kirkwood a very happy retired life and a call to young weed scientists to emulate his feat for both professional achievements and personal hobbies- **Secretary IWSS**





Role of Biotechnology in Indian Agriculture

As per the statistics of ISAAA (International Service for the Acquisition of Agri-Biotech Applications) more and more developing countries are embracing biotechnology to meet the challenges of producing high quality foods under limiting resource conditions. Adverse climatic conditions as a result of erratic rainfall, soil degradations, losses caused by major pests (weeds/insects), reduced land holding and poor economic health of small and marginal farmers in India is worrying for sustainable food production. Biotechnology holds promise for the future, but many farmers' and lobbyists are having doubts in their mind or feel that it will have negative effect on local flora and fauna and may also impact human health in the long run. The weedy issues are more serious because they are the silent robbers and no enough tools are available to the Indian farmers for their management in different cropping systems. Herbicide resistant weeds (*Phalaris minor*), parasitic weeds (*Orobancha* and *Striga*) and several alien invasive weeds are major threat to sustainable crop production. Government of India is taking one step forward and two backwards; presently the case is with the Supreme Court of India. To discuss these issues a series of meetings/workshops were held in the first half of 2013 with emphasis on weeds. The salient points emerged out of these debates/discussions are summarized in the following pages:

— Samunder Singh, Secretary IWSS.

Scientific Conclave, Hyderabad, March 1-2, 2013

A group of scientists represented by Vice Chancellors, Directors of Research, Deans, Professors working directly in the area of plant biotechnology or those involved in making decisions on research and development in the area of plant biotechnology were invited by Monsanto India Limited for a conclave to discuss the role of Agricultural Biotechnology. **Dr. D. R. Arya**, Technology Development Lead, Monsanto designed this conclave as a platform for scientists to discuss technology potential as well as the associated challenges to identify the path forward to address them. A major highlight of the conclave was the visit to the *seed processing unit* and *quality control lab* of Monsanto at Shamirpet during the post-lunch session on March 1st. The visit to the world class seed processing plant for corn and vegetables and fully equipped seed physiology lab was very impressive, informative and interactive for the participants. The presentation of Dr. Ravi Reddy at the processing plant highlighted the role of seed as a vital factor in increased production and success story of Monsanto.

Dr. Dev Raj Arya welcomed all the participants and **Dr. Gyanendra Shukla**, CEO Monsanto India made a presentation about Monsanto's vision, progress, products and the purpose of this conclave and desired collaborative work with SAU's (State Agricultural Universities). The conclave was attended by more than 50 persons. The participants raised lots of questions during this session. The questions and summary of discussion from this session as well as other sessions of this conclave is presented at the end in the "Discussion Highlights".

The inaugural session was chaired by **Dr. H. S. Nainawatee**, Ex-Asstt. Director General Education, ICAR and he talked about the success story of Bt cotton, safety protocols adopted and exploring technologies to generate marker free plants to alleviate the concerns around antibiotic resistant marker as well as emerging technologies such as Cisgenesis and Intragenesis. This was followed by a presentation on new biotechnology advances by **Dr. Mohammed Oufattole**, Director, Monsanto Research Center, Bangalore. Innovation in transformation technologies; automated phenotyping; protein engineering, RNA Interference (RNAi), investment and expertise in MAB, seed chipping technology and improved and stable IT Systems were discussed.



Dr. Shukla and Arya at the inaugural session



Delegates in the seed physiology lab of Monsanto

The plenary session on regulatory framework for **Biotech Crops in India** was chaired by **Dr. R. B. Deshmukh**, Advisor to Government of Maharashtra on Dry Land Agriculture Mission and Ex-Vice Chancellor, MPKV, Rahuri. He emphasized on the role of biotechnology to harness its benefits in rainfed areas to increase water (WUE) and nitrogen use efficiency (NUE) for Indian agriculture. **Dhiraj Pant**, Regulatory Affairs, Monsanto made an elaborate presentation on ‘Regulatory Framework for Biotech Crops in India’ followed by **Dr P. J. Suresh’s**, Stewardship & Seed regulatory Lead and **Mr. Sharad Kumar**, Director Legal Affairs Monsanto.

The second session on **Safety of Bio-tech Crops** was chaired by **Dr C. R. Kole**, Vice Chancellor, BCKV, Nadia, West Bengal. In his presentation entitled “**Biotech Plants: Pandora’s Box or The Holy Grail**”, he discussed the studies so far conducted by different global agencies demonstrating that biotech crops are safe. The regulatory agencies in India must ensure the safety of Biotech crops on three counts- safety to humans as food; safety to animals as feed and safety to environment by adopting standards defined by the international agencies such as CODEX and OECD. General conclusions from National and International Scientific Organizations (FAO/WHO/OECD/ILSI) were as follows:

- ❖ Food from GM crops is not inherently less safe than those developed by conventional breeding.
- ❖ Types of risks for food from GM crops are of the same nature as those from conventional breeding.
- ❖ Same food safety assessment principles and standards apply (“reasonable certainty of no harm”).
- ❖ Extensive safety assessments conducted with plant biotechnology products provide equal or greater assurance of safety of food products

Biotech crops are being evaluated for their bio-safety aspects more than any other products and clear guidelines for evaluating the safety norms are established in India.

Dr B. Dinesh Kumar, Dy. Director, National Institute of Nutrition, Hyderabad discussed the importance of safety studies, and important stakeholders involved in this crucial aspect. He cited several examples to highlight the complexities of food safety studies, and the importance of making right decision using the right rationale. The regulators take decisions based on scientific data and not on beliefs and perceptions. **Dr. S. L. Goswami**, Director, National Academy of Agriculture Research Management, Hyderabad presented data on animal feeding studies using Biotech crops in NDRI to illustrate the fact that Biotech crops have been proven safe for both human and animal consumptions. Further he also pointed out at some of the socio-economic studies in which NAARM is involved to emphasize the utility of Biotech crops from Socio-Economic point. **Dhiraj Pant**, Dir., Regulatory Affairs, Monsanto highlighted “**Monsanto’s approach to safety assessment**”. This presentation covered the concept of “**Substantial Equivalence**” which is the basis for most safety assessment of Biotech crops.

The third session, **Role of Scientific Community for Biotech Awareness** was chaired by **Dr. B. V. Patil**, Vice Chancellor, University of Agricultural Sciences, Raichur and clearly articulated the need for scientific outreach, and also emphasized on the role of scientists in responding to the allegations made by the activists. He stressed that development of biotech crops is a very time drawn, investment resource intensive process that undergoes significantly higher levels of regulatory scrutiny on various scientific parameters before being approved. However, there are vested interests that thrive on overall lack of scientific awareness on the subject and take advantage of the situation to drive personal ideologies and motives. We have all seen sustained efforts on the part of anti-biotech activists to misrepresent scientific facts, create fear psychosis amongst masses by making false and unfounded claims completely disregarding facts about benefits of such scientific inventions that have been adopted in our country and elsewhere in the world. On top of this, the anti-biotech activists have disregard for robust regulatory process that is in place in India. It is often said that scientists' prime job is to do what they are best at i.e. innovate and excel in developing something new and superior- and not necessarily to be high decibel slanging match for activists. But the recent challenges that have led to a situation of possible moratorium or ban on agriculture biotech research has clearly highlighted the need for scientific community to be able to effectively and forcefully articulate and defend the science in public forums lest we want to put future of our agriculture in jeopardy. Therefore, the scientific community involved in the field of Agriculture, have immense role to play as they form a very credible face to condemn the false propaganda against science. These thoughts were echoed by **Dr. K. S. Varaprasad**, Director, Oil seeds Research, Rajendranagar, Hyderabad; **Dr Sain Dass**, Advisor, Government of India for Hybrid Crops, New Delhi and **Dr. I. S. Dua**, Professor Emeritus, Panjab University, Chandigarh.

The fourth session on **Ag Biotechnology: Way forward for sustainable Agriculture** was chaired by **Dr K. N. Gowda**, Vice Chancellor, GKVK, Bangalore, Karnataka. He shared his thoughts on how technology adoption is a complex process, and the adoption rate of Bt Cotton itself is the testimony for the benefits of technology. Dr Gowda also emphasized the importance of extension and farmer advocacy, and shared his model of "Organized movements to popularize the new technologies and how it brings greater rates of adoption". **Dr. Gyanendra Shukla**, CEO Monsanto thanked the participants.



Dr. Deshmukh raising a question on the use of GM Crops for dry land areas on **Dr. Shukla's** presentation, Novotel hotel Hyderabad, India



Drs. Jayana, Singh, Gowda, Dass, Kole, Arya, Singh, Bhatnagar, Kumar and Babu at BioTech Colclave, Hyderabad

Discussion Highlights

- So far 100% seed production program of Monsanto is not under single cross hybrids (SCH). Fully knowing that SCH have high yield production potential, responsive to inputs, acceptable to farmers and economical. Monsanto should make efforts to convert their program to 100% SCH. Even today, more than 50% of double cross seeds are marketed by Monsanto.

- Monsanto being such a big organization – it should award at least 200 fellowships instead of 20 to Indian Agri University Students.
- Monsanto should start PPP model for Drought tolerance, particularly pulse crops like chickpea & pigeonpea; nutraceutical enhancements through horticultural crops to address the nutrition security of society; herbicidal tolerance in maize, onion, soybean; virus resistance in tomato and okra; increased shelf life- as part of post harvest management.
- SAUs should facilitate a common platform; vociferous approach will not solve the problem. Debate on scientific grounds and list of the pros/cons of the technology to adopt an approach acceptable to both pro and against technology groups.
- Yes, Bt Cotton is a success story, but has not worked consistently in all the geographies, for example, dry lands of Maharashtra which forms significant acreage of cotton belt. The need of the hour is to develop technologies which provide WUE and NUE, and more essentially the technologies should be available in local popular varieties.
- Focus on crops of regional importance and impact like pigeonpea, chickpea, etc.
- Current status of BGIIRRF (HTC), and impact of “intercropping” in cotton and other crops?
- Why Monsanto is sourcing the gene/relying on only Bt? Sourcing genes from other crop plants may provide beneficial traits.
- Specifically many participants stressed on the value of hybrids/varieties developed by SAU’s, and models to bring Bollgard trait to these varieties/hybrids- again stressing on the need of “collaboration”.
- Many SAUs have varieties with tolerance to diseases, salinity and drought, and there is opportunity to have the Bollgard traits in these varieties.
- Bollgard technology is working well in many parts of the county, and there is no need for Bollgard II in these areas. Why are you insisting this as the farmers have to pay more for this technology?
- Role of SAU in scientific advocacy, especially to facilitate policy decisions. SAUs should make efforts to get the proponents and opponents of the technology to have a dialogue in a forum and that is the only way forward.
- In Punjab the varietal cotton used to yield more in pre-Bt cotton era and then it went down. Bt cotton is adopted and the farmer’s are getting better yields, but the yields of these hybrids are not comparable to those from the earlier varieties?

Dr. D. R. Arya (Monsanto) and Dr. Samunder Singh (IWSS)



Workshop on “Taking Forward Herbicide Tolerant GM Crops: Opportunities and Challenges”

Biotech Consortium India Limited (BCIL), New Delhi in association with Indian Society of Weed Science (ISWS) organized a one day workshop at National Academy of Agricultural Sciences (NAAS) Complex, New Delhi on 02.05.2013 to discuss the current situation on herbicide tolerant crops (HTC) adoption in India.

Herbicide tolerance is one of the most important traits being targeted worldwide for the development of transgenic crops. Since their first commercial use, HT crops area worldwide has increased to > 100 m ha in 2012. In India, initiatives are underway in both public and private sectors to reap benefits of this technology. Field trials of HT cotton and corn have already been conducted to assess the performance of these crops. Approximately 80 participants including scientists from agriculture research institutions, concerned Ministries and Government Departments discussed the key issues regarding the use of HTC in India. In the opening session, **Dr. Vibha Ahuja**, General Manager, BCIL welcomed all the participants and appraised the participants about current position with respect to field trials, Supreme Court

directives and constitution of Technical Executive Committee to submit the report to the Supreme Court on the pros and cons of GM crops. A negative publicity is in the press thanks to some NGO's and some conflicting publications on the web are enough to create a doubt in the minds of common man about the harmful effects of GM crops.

Dr. A. R. Sharma, Director of Weed Science Research, Jabalpur (India) and Secretary of ISWS discussed the weed management practices and challenges in mitigating the losses caused by weeds (37%) and increased food grain production to meet the demand of ever increasing population. Weed management problem is likely to worsen in the near future with changing climate, shift in rice cultivation from flooded to direct seeding, parasitic (*Orobancha*, *Striga* and *Cuscuta*), aquatic (water hyacinth) and non-cropped weed *Parthenium*. Adoption of conservation agriculture (CA) and HTC are the key technological tools to increase production and productivity.

Dr. NT Yaduraju, President ISWS delivering special address informed the house that due to Mahatma Gandhi **National Rural Employment Guarantee Act (MNREGA)** scheme of Indian Government, labour is not available for mechanical/manual weeding and it needs nine billion man days to manage weeds which is an uphill task. There are also gender issues as weeding is largely performed by women or children. In states like Kerala, not only the cost of labour for manual weeding has increased many folds, but they are not available. Similarly in some parts of Andhra Pradesh, farmers have to go for crop holidays due to non-availability of labour for agricultural operations. Herbicide use has increased in the country, but no single herbicide is effective against all the infesting weed species in a crop. A selective/non-selective herbicide with HTC can provide clean fields and reduce the drudgery of manual weeding. He called upon the policy planners for course correction, going by the sound understanding of science behind HTC and their wide adoption in several countries.

Dr. S. R. Rao, Advisor, Department of Biotechnology, Government of India discussed the ground reality of HTC and regulatory issues. The scientists or promoters of HTC lacked strategy to refute the bad publicity. There has been abysmally low investment in weed science compared to other plant protection sciences. A third of the positions of weed scientists are vacant at National Research Centre. Strangely enough even the Director of Weed Science Directorate is not a man of weed science. Also there is not enough strength of hard core weed scientists in the State Agricultural Universities (SAU). Moreover, the activist's takes cue from dissenting voice from some scientists and make a lot of sound, not only in the public but also publishing books and other material. Since the technology belongs to private sector, there has been less involvement of public sector due to the issues of IPR and profit which the activist's encased generating negative publicity in the masses about harmful effect of HTC. There has to be a better networking of public and private agencies in generating data on regulatory affairs particularly socio-economic data. Review Committee on Generic Manipulation (RCGM) in association with Department of Biotechnology (DBT) and Indian Council of Agricultural Research (ICAR) can provide some funding for capacity enhancement of HTC in generating regulatory data. Dr. Rao also mentioned that there is little work on HTC in SAU's and private sector should come forward to share some of their technology or work in collaboration with SAU scientists as Bt promoters were more active and enthusiastic than HTC promoters?

Dr. Swapan Datta, Deputy Director General (Crop Science), ICAR told that farmers have three options; higher yields, better plant protection and sound economics. So long HTCs are not in the field, we should guide them about conservation agriculture and sustainability through quality seeds, good moisture retention through reduced or zero tillage where weed management is essential to reduce losses in crop yields, weeds harbouring pests and usurping essential nutrients. As of today, the major players in HTC in India are Monsanto and Bayer Crop Science through glyphosate and glufosinate, respectively with the sole motto of racking profit. Indian R & D is simply following foreign companies; to change the public perception about these seed companies, joint R&D project should be initiated to win over public perception. HTC should be relevant to India and for Indian crops. Soil conservation and HTC together will make the best strategy for the long term benefit of industry and farmers.

In the first Technical Session: **HTC as part of IWM**, Chaired by **Dr. P. K. Gupta**, Emeritus Professor, CCS University Meerut, Uttar Pradesh and **Dr. C. Chinnusamy**, Prof. Deptt. of Agronomy, TNAU, Coimbatore delivered a talk on '**Agronomic Advantages and Management of HTC in Indian Agriculture**'. Dr. Chinnusamy told that the country will have to increase productivity from 1.6 to 2.7 t/ha to produce 350 m t by 2030. This is really challenging with fragmented land holding (0.28 ha/head) which is less profitable due to minimum use of machinery and technology. Sustainable crop production on the face of changing climate warrants IWM to thwart the onslaught of alien weed species. Experiments conducted on HTC (cotton and corn) revealed 93-98% weed control efficiency (WCE), using repeat application of glyphosate. Higher dose of glyphosate (5.4 kg ae/ha) caused some crop injury, but treated plants recovered in a week with no yield penalty. No residual effect of glyphosate was observed on soybean or other sensitive crops planted after cotton or corn. Agronomic practices of GM and non-GM crops have no different inputs requirements and HTC provided higher yields. However, over reliance on single method may not be helpful.

Dr. Samunder Singh, Prof. Weed Science at CCS HAU, Hisar and Secretary, International Weed Science Society delivered a talk on '**Herbicide Resistant Weeds and need of HTC**'. *Phalaris minor* resistance in wheat is getting serious in Haryana and Punjab states of north India. Resistance was first observed to isoproturon in 1992 followed by XR to clodinafop (1994) and multiple resistance to fenoxaprop (2002), clodinafop (2007), sulfosulfuron (2008), pre-mix of mesosulfuron+iodosulfuron (2010) and pinoxaden (2011). Both metabolic and target site resistance were confirmed which makes it challenging to effectively manage this dreaded weed. Weed biology study revealed its longevity in soil of no more than two years, but abundant seed production and seed movement through crop produce, wind, water, machinery, farm yard manure and other agents have made it very difficult to control. Sequential application of PRE and POE herbicides were suggested for its effective control. A seed germination test in the off season could be helpful to select the effective herbicide. Since no new herbicides are in the pipeline for effective control of *P. minor*, a herbicide resistant wheat can help in effectively managing resistant weeds. Dr. Singh completely overruled the possibility of developing super weeds as this is misnomer and not applicable even to multiple herbicide resistant weeds.



The losses caused by weeds are enormous in cotton due to its wider row spacing (0.45 to 1.2 m) and slow initial growth. No effective POE herbicides are available in India to take care of sedges, grassy and broadleaf weeds. Though, protective application of glyphosate in non-HT cotton and over the top application of glyphosate in RR flax cotton were effective; their repeat applications were needed to control several flushes of weeds emerging during the crop growth. As glyphosate has become vulnerable to several weeds due to its repeat applications in US and other countries, an IWM approach is needed using intercultural operation and tank mix of glyphosate with residual herbicides for long term weed management. Even if RR flax is launched, a combination of different herbicides (with glyphosate) will be needed to avoid weed flora shift and evolution of resistant weeds.

Prof. R. K. Malik, Ex-Director, Education, CCS HAU Hisar and Ex-President ISWS talked about **constraints including labour in weed management**. Not only the cost of farm labour in Bihar and eastern UP has gone from \$0.4 to \$3.0/day, but they are not available for weeding operations. Due to small land holding and poor employment, there has been a heavy shift from on farm to off farm. The ratio of rural and urban population has changed from 3:1 to 3:2 in 2000 and is expected to be 3:4 by 2030. Family labour is not engaged in weeding/agriculture any more in Punjab and Haryana and hired labour is hard to find thanks to MNREGA. This has resulted in >90% herbicide use in major crops (rice and wheat) in these states, but effective herbicides are not available for other minor crops. Almost 40% of food grains are produced from rainfed areas, where herbicide use is very little, but losses caused by weeds are enormous. Even in irrigated conditions, second generation problems (weed flora shift, resistance, moisture stress, etc.) need HTC. Glyphosate and ZT are complimentary and a reliable technology in Resource Conservation.

Dr. Sitaramana from ABLE-AG discussed **technological options available for weed management**. India needs a long term policy to address the issues whether we need GM or non-GM food crops. As there is little culture of advance research in agriculture in India, though SAU's are willing to work together with Industry, they lack the basic knowhow and resources. Stacking and stacking is the future; herbicide resistance is not linked to HTC. It may happen to any herbicide, but HTC is a solution for labour shortage. For greater acceptance of HTC by farmers, we need to tackle the bottlenecks. Instead of talking to the 'converts', we need to convince 'others' about the benefits of HTC. We should also concentrate on non-conventional crops for HTC. Public awareness is the key to success to counteract the misinformation spread by NGO and anti HTC lobby. The Chairman supported that we should work in a cohesive manner to break the non-tariff barriers.

The second session on **Safety Assessment of HTCs and the Herbicides to be used** was chaired by **Prof. Deepak Pental**, Director, Center for Genetic Manipulation of Crop Plants, University of Delhi. **Dr. K. V. Prabhu**, Head, Division of Genetics at IARI New Delhi, discussed about '**Gene Flow, Biodiversity and Super Weeds**'. Dr. Prabhu informed that center of origin and biodiversity is vital to study the effect of gene flow by pollens or other traits in the wild relatives of the transgenes before the same is released in the environment. GM brinjal was struck because the center of origin being India, proper study is needed before its release. Though transfer of gene occurs in the nature, many crops like soybean, barley, millets, beans and potato are of low risk. Gene flow index of wheat, maize or barley is low (8) compared to rapeseed (19). Moreover gene flow in self pollinating crops occurs infrequently. Throughout the world 50,000 tests on gene flow have already been conducted, but no dangers or consequences have been predicted. Though there are no super weeds, but resistant weeds and volunteers of HTC offers challenge to control them using a suitable herbicide.

Dr. Vibha Ahuja (BCIL) discussed '**food, feed and environmental safety of HTCs**'. HTC are grown in many countries and no adverse report has since emanated about the ill effects of food and feed of these crops on humans or animals. Sufficient data is available with regulatory authorities and no safety concerns have been detected. **Dr. Pental** raised the issue that when all the reports are in favour of HTC, why they are not released in India? The regulatory bodies should be blamed and not the NGOs, when they are not releasing the transgenes with sufficient data in their possession. He mentioned that Australia has the best risk assessment system where public comments with answers are included in the documents and when all the questions of NGO's are answered the resistance reduces largely from the detractors of the technology.

In the panel discussion, it was concluded that we should concentrate on the release of RR flax cotton, though there could be priority to have HTC for rice, wheat, corn and soybean in that sequence. It was agreed to have information in the public domain to remove the doubts of NGO's and others. Data need compilation on regulatory issues and timely submission as and when needed by the regulatory authority. The meeting ended with the note that the relevant information will help quell any doubts in the mind of regulatory authority in granting permission to launch HTC in India.

-: Dr. Samunder Singh, Secretary, IWSS

Workshop on Crop Weed Management in the Current Scenario through the Introduction of Newer Technologies, 29th May 2013, Chandigarh, India

“Ban Hunger and Not GM Crops” and “Guilty unless proven innocent rather than innocent unless proven guilty”, were echoed during the Workshop on **Crop Weed Management in the Current Scenario Through the Introduction of Newer Technologies**, held on May 29th, 2013 at Center for Research in Rural and Industrial Development (CRRID), Sector 19A, Madhya Marg, Chandigarh, India. The Workshop was organized by **Dr. I. S. Dua**, Prof. Emeritus and sponsored by Society for Promotion of Science and Technology in India (SPSTI), Punjab State Council for Science and Technology, CRRID and P. N. Mehra Botanical Society, Department of Botany, Panjab University Chandigarh, India and was attended by University Scientists, Government Officials, farmers and representatives of pesticide industry.

Sh. Dharam Vir ^{IAS}, ex-Chief Secretary, Haryana Government and President, SPSTI welcomed the delegates to discuss an important issue of crop weed management. Increased cost of production with higher cost of labour and their unavailability, dwindling water resources due to development coupled with erratic weather and onslaught of ‘silent robbers’ (weeds) is taking a heavy toll on agriculture and there is a need to look for newer technologies to meet the challenges of the day. The biotechnology is knocking at our doors since the introduction of ‘Genetically Modified/Engineered (GM/GE)’ crops in 1996 and non-popularization of Technology has been the weakest link.

Prof. R. B. Singh, President National Academy of Agricultural Sciences (NAAS) and Vice-Chancellor of Central University, delivered inaugural talk on **‘Transforming Indian Agriculture by Improved Crop Weed Management**. Prof. Singh highlighted that 42% of Indian populace is surviving on less than \$1.25 per day and majority of them are small and marginal farmers who can ill afford the technological innovations for efficient weed management. Scientists are in favour of GM crops, but there is an ‘Indian Enigma’ of poor communication to policy makers hence less adoption of GM crops. Weeds and incipient hunger (both soil & human) with 40% malnutrition in children are the two important silent killers. To meet the demand of population in 2051 we need 2, 3, 4 & 6 times energy use efficiency, water productivity, land productivity and labour productivity, respectively and low carbon emission. For food security, environmental sustainability and economic growth, we need to adopt agro-ecosystem approach where GM crops plays vital role. We need to ban hunger and not GM crops. He cited the paper of Dr. Jerry Green (USA) that GM crops are the most rapidly adopted technology in human history. The regulatory decisions on the adoption of GM crops should be based on the scientific rigours and not hearsay, because the hungry child and reprieved farmer cannot wait. He summarized that there is a crisis of scientific communication with regard to adoption of GE crops. GE technology is for greening economy and beneficial to the environment with less emission of CO₂. However, there is fear of unknown with the regulatory system in India and adoption of integrated weed management (IWM) is the key to manage weeds for sustainable agriculture. In the end he quoted Mr. Ban Ki Moon, Secy. Gen. UN that hunger can be eliminated in our life if we liberate science to serve the humanity and educate people scientifically.

Dr. A. K. Singh ^{IAS}, Director General Agriculture, Haryana stressed that IWM technology is must to lower the losses caused by weeds. Not only weeds reduce crops yield by 15-50%, but they also usurp considerable amount of essential nutrients. Herbicide resistant crops (HRC) also need IWM to increase the shelf life of herbicide with lower cost to the farmers in the long run. Haryana was the first state in India to follow IWM technology (30% area under zero till in wheat, early sowing, herbicide rotation, timely and proper spray etc.) to fight isoproturon resistance in *Phalaris minor* in wheat in the nineteen nineties. The resistance to other herbicides was also delayed by adopting IWM technology and in the last two years Haryana achieved a rare feat of >5 t/ha wheat productivity in India. Dr. A. K. Singh cited the example of Haryana which has only 1.4% land area and 2% irrigated area, but contributes 10% of food grains production of the country. Again Haryana is the first State in India with 98% adoption of Bt cotton and 99% wheat is of high yielding varieties. He also stressed on zero tolerance of waste of agriculture produce (food grains, vegetables and fruits) as there is poor post-harvest management. Grain saved is grain produced, need to be

followed meticulously. In developed Society there is waste of well-offs in parties (birthday, marriage etc.), which are more frequent and sumptuous these days in India and again there should be zero wastage of food on these occasions.



Prof. R. B. Singh, Dr. A. K. Singh, Dharam Vir, I.S. Dua and P. K. Gupta at CRID, Chandigarh, India



Dr. A. K. Singh, Director General Agriculture Haryana, addressing workshop delegates

Dr. S. S. Gill, Director CRRID remarked that seed is most important input and spurious seed of GM crops can break the poor farmer. Public sector must provide good quality seed to the farmers and seed should be freed from the clutches of profit-mongering private companies. Critics are needed for the robustness of science and science is must for the service of farmers. He informed that there are some apprehensions as cotton seed cake is used for animal feed and cotton seed oil for human consumption; long term feeding should be conducted on their possible effect on humans and environment. **Dr. M. S. Bhullar**, Weed Scientist from Punjab Agricultural University (PAU), Ludhiana discussed **current methods of weed management and constraints** in the session chaired by **Dr. S. S. Ghosal**, Director of Research, PAU Ludhiana. Dr. Bhullar emphasized in breaking the cycle of seed replenishment to exhaust soil seed bank of major weeds for their effective management. Weeds like *Brachriaria*, *Acrachne* and *Commelina* are not effectively controlled by atrazine in sugarcane; *Phalaris minor* in wheat and *Orobanche* in mustard are the most troublesome weeds. In case of direct seeded scented rice, green manuring of *Sesbania* was found effective to suppress weeds and many farmers are even not using herbicides; however, effective herbicides are needed for other situations.

Dr. J. S. Sandhu, Biotechnologist from School of Biotechnology, PAU Ludhiana discussed **HTC safety assessment and risk management**. In a simple way he delivered the message of safety and rigours of regulators at different stages from discovery to commercialization of GE crops. For the first time, in the history of agriculture, the regulatory authorities in USA, India and other countries are using the stringent tests in releasing GM crops. **Prof. P. K. Gupta** from CCS Meerut University, Uttar Pradesh delivered a talk on **safety evaluation of herbicide tolerant crops**. Dr. Gupta informed that 59% of all GE crops are HTC and the new ones are coming with stack genes for several herbicides to lower the risk of quick evolution of resistant weeds. All the fears of more herbicides use, resistant weeds evolution, labour displacement, effect on non-target species, gene spread and residues in food, feed, water and environment have been set aside by the evaluatory studies published so far. These studies have shown that GE food has no more risk than conventional bread food and the media should not behave like GE crops or their promoters 'guilty unless proven innocent rather than innocent unless proven guilty' which undermines lack of trust in science.

Dr. M. S. Gill, Dir. Extension Education, PAU Ludhiana chaired the session on Socio Economic Aspects of HTC and Panel discussion. Dr. Gill was of the view that weeds are easily controlled in cotton and there is not enough pressure from Punjab farmers for the release of HT cotton (RR flax from Monsanto) compared to Bt cotton, a decade back. However, **Dr. Kamal Vatta**, PAU Ludhiana conducted a survey that clearly vindicate farmer's desire to have lower risk and greater profitability and with increased labour cost farmers are willing to use HT cotton, though the pace may not be the same as observed with Bt cotton. The use of insecticides has reduced and seed cost is increased, but labour alone accounts for 30-50% of production cost which makes the situation ideal for the adoption of HT cotton.

In the Panel discussion, two farmers shared their experience of pre- and post Bt cotton adoption and both were of the view that it is high time for the release of HT cotton for the benefit of farmers. The Chairman was of the view that attack of boll worms has reduced these days and white fly has become more of a nuisance and 50 to 300% higher cost of Bt and HT cotton seed over hybrid cotton seed could be a deterrent to farmers, but both farmers contradicted his views. To allay the fear of Bt cotton on animal health, **Mr. Balwinder Singh Tang**, a progressive farmer from Hanumangarh (Rajasthan) who has only 8-10 ha of family land, but raise cotton on >100 ha on rented land, is feeding left over of crop residues (open/unopened bolls) to his herd of goats and sheep and there had been no adverse effect on these animals for the last 10 years. He was the first to use Bt cotton and feel happy for this technology.

Dr. Kuldeep Singh, Prof. Biotechnology, PAU Ludhiana was of the view that launch of any new GM crop should be released after a thorough evaluation of various risk factors associated with the crop. **Dr. G. Ram Mohan** from Monsanto India and **Pankaj Kumar** from Syngenta India were desirous of working together with university scientists and regulatory authorities for the success of HTC.

To emphasize the importance of weeds, **Dr. Samunder Singh**, Secretary, IWSS made a presentation in the Panel discussion regarding losses caused by weeds. These losses in India exceed \$ 12 bn per year compared to \$7 bn in USA. The losses caused by *P. minor* alone in Haryana and Punjab were estimated at \$ 0.7 bn/yr from 4 m ha area. *Parthenium* a non-cropped weed spreading in 8 m ha from north to south of India cost \$0.3 bn/yr. Weeds in cotton and wheat result in 220 and 53% lower uptake of NPK by crop with 83 & 42% lower yield, respectively over herbicide treated plots. This does not include an average of 82, 70, 68, 111 and 160 kg/ha of nutrients (NPK) removal by weeds in wheat, rice, sorghum, maize and cotton, respectively. This signifies an urgent need of a new and effective herbicide in these crops or HTC. *Orobanche aegyptiaca* has become a major weed of mustard in sandy soils; glyphosate though provide some relief, but can cause crop injury and control is not always satisfactory. A glyphosate tolerant mustard crop can help in lowering the losses caused by *Orobanche* and other weeds. In wheat, *P. minor* has become resistant to all recommended wheat herbicides and need a modified strategy for its management. HT wheat is still a very sensitive issue in India as well as in many other countries and may take time for its adoption. HTC will serve just as another tool of weed management. HTC have greater chances of success where there is no effective herbicide to control weeds.

Dr. I. S. Dua, summed up the debate and emphasized on the role of greater scientific communication to convince the benefits of biotechnology to the policy planners and remove any fear of GE from the mind of producers and consumers.

-: Dr. Samunder Singh, Secretary, IWSS



THAILAND

The 4th Tropical Weed Science Conference (TWSC 2013) “Utilization and Management in the Tropics” Chiang Mai, Thailand, 23-25 January 2013



Keynote Speech by Dr. Steve Powles, Australia



Delegates of 4th TWSC meeting, 2013

The Weed Science Society of Thailand and the Department of Agriculture, Thailand hosted the 4th Tropical Weed Science Conference on January 23-25, 2013 in Chiang Mai. The conference was honorably opened by Mr. Yuttapong Jarassathien, the Deputy Minister of Agriculture and Co-operatives. The 3-day conference was packed with activities, topped by two keynote addresses: ‘Herbicide Sustainability vs. Herbicide Resistance: Diversity is the key to saving herbicide for future harvests’ by Prof. Stephen B. Powles (Australia), “GM Herbicide-Resistant Crops: Opportunities and Risks” by Prof. Carol Mallory-Smith (USA), and “Parasitic Weeds: An Overview” by Prof. K. Yoneyama (Japan). Other invited speakers included: Prof. Steve Adkins (Australia), Dr. Michael Braverman (USA), Prof. Nilda Roma-Burgos (USA), Assoc. Prof. Sansanee Jamjod (Thailand), and Prof. Hisashi Kato-Noguchi (Japan). The Scientific Program was comprised of eight sessions: 1) Allelopathy, Chair: Prof. Do Soon Kim, Korea; 2) Herbicide Resistance in Weeds and Crops, Chair: Prof. Nilda Roma-Burgos, USA; 3) Herbicide Application and Formulation; 4) Biopesticides, Chair: Dr. Michael Braverman, USA; 5) Invasive Weeds, Chair: Prof. Steve Adkins, Australia; 6) Weedy Rice Management, Chair: Dr. Chanya Maneechote, Thailand; 7) Utilization and Integrated Management of Weeds, Chair: Dr. Rungsit Suwanmakka, Thailand; and 8) Environmental Aspects of Weed Management, Chair: Prof. Nilda Roma-Burgos, USA. The third day of the conference was allocated to different field trip destinations, which included Weed Management in Direct-seeded Rice at Sunpatong Rice Research Station in Chiang Mai, Management of Aquatic weeds in Mae Kuang Dam and the Royal Project at Nong Hoi. A featured activity at the Rice Research Station was a demonstration of rice transplanter and interrow cultivator, and manual transplanting by throwing plugs of rice seedlings across the paddy, also known as ‘parachute’ transplanting (see photos). A presentation about the International Weed Science Society and the next International Congress in 2016 was made by Prof. Nilda Burgos at the opening and closing ceremonies. The conference concluded with a lavish and fun farewell reception that one could only experience in Chiang Mai, Thailand. The 5th Tropical Weed Science Conference will be held in 2017. It will certainly be an event worth the wait. We hope to see you there.



TWSC2013 Keynote & Invited Speakers



Parachute transplanting demo with Carol



Chanya Maneechote (3rd from left) with TWSC delegates



Rice seedling plugs for manual transplanting by 'parachute' method

By: Nilda Roma-Burgos, University of Arkansas, IWSS Vice-President and
Chanya Maneechote, President Weed Science Society of Thailand



Uruguay: International Seminar on the Viability of Glyphosate Use

During March 20 and 21, 2013, INIA (National Institute for Agricultural Research of Uruguay) at the experiment station "La Estanzuela", organized an International Seminar on 'Glyphosate Sustainability in Agricultural Systems' in the city of Colonia del Sacramento, Uruguay. The occasion gathered relevant researchers in the field and representatives from the agro-chemical companies. World known scientists from Argentina, Brazil, Chile, Ecuador, Paraguay, Peru, Spain, United States, and Uruguay exchanged their research outcomes and experiences about the current situation, glyphosate use and glyphosate-resistant weed species in their respective countries and worldwide. The discussions focused extensively on the evolution of glyphosate resistant weed biotypes in no-till and conventional systems.

Also, representatives of the agrichemical industry in the region presented their vision on future perspectives, and discussed research and management strategies to face this rising resistance problem as to ensure the long-term effectiveness and sustainability of this herbicide. Diversification of the current options and new

management practices together with a responsible and informed usage of herbicides were some of the key concepts highlighted among the talks of 25 speakers to a ca. 230 agricultural-related audience. The event was closed by the President of INIA, Dr. Alvaro Roel, and the Vice-Secretary of Agriculture and Fisheries of Uruguay Ing. Enzo Benech



From left to right, Dr. Amalia Ríos (INIA Uruguay), Dr. Albert Fischer (IWSS and UC Davis, EEUU) Dr. Juan C. Papa (INTA Argentina) and Dr. Dionisio Gazziero (Embrapa Brasil) at the closing discussion



From left to right: Dr. Rafael De Prado (Univ. De Córdoba, Spain), Dr. Fischer (IWSS-Univ. of California-Davis USA), Dr. Robinson Pitelli

— Note contributed by weed scientist Dr. Amalia Belgeri, based on a report by communications specialist Ing. Agr. Ernesto Restaino, with photos by Amado Vergara from INIA La Estanzuela; full details available at: <http://www.inia.org.uy/online/site/112439411.php>



Uruguay: Short Course on Herbicides and Herbicide-Resistance

As a follow-up to the Seminar on Glyphosate (above) and as part of the on-going professional training and extension efforts of INIA La Estanzuela, Uruguay, on the topic of herbicide-resistant weeds, Dr. Albert Fischer (University of California-Davis) was invited to give a two-day short course on herbicides and their resistance mechanisms in weeds. Dr. Fischer's participation was part of IWSS efforts to contribute to regional training events in weed science. On June 13 and 14, 2013, Dr. Albert Fischer explained the mechanisms through which plants evolve resistance to herbicides, prioritizing

some of the most currently used herbicides among Uruguayan farmers, such as glyphosate, ACCase and ALS inhibitors and photodynamic herbicides.



Dr. Albert Fischer (IWSS and UC-Davis) at INIA La Estanzuela, Colonia, Uruguay during a discussion on the evolution of resistance to herbicides.

Approximately 30 researches from INIA, Uruguay, and *ca.* 50 agronomists from the industry sector (both from Uruguay and Argentina) attended the workshop to understand the physiological and biochemical basis of target-site and non-target site resistance. Alejandro García, a PhD student from Albert's lab and a weed researcher at INIA-La Estanzuela, had the opportunity to show some interesting results of his doctorate thesis research on the mechanisms of *Echinochloa colona* L. resistance to glyphosate in California. Overall, awareness on the complexity of the problem was raised showing evidences on how, both multiple and cross-resistance have narrowed down chemical options for the control of some weed species around the world. Thus, the need to rotate among herbicides with different modes of action, mixtures and sequential applications, avoiding the usage of persistent herbicides, and diversification through integration of other cultural weed management strategies became clear. Rational herbicide use and weed management strategies to preserve these essential chemical tools and avoid the spread of herbicide-resistance were discussed. The discussions engaged the audience and gave the opportunity to both researchers in the field and from the agrichemical industry to share the most recent problems they have experienced in commercial fields and to elaborate on future research priorities.

— Note contributed by Dr. Amalia Belgeri, weed scientist at INIA La Estanzuela, Uruguay.

A Team of Weed Researchers in Uruguay

The team of weed researchers in Uruguay has expanded significantly in recent years. Two public institutions are engaged in weed research and extension: The National Agricultural Research Institute (INIA) and the University of the Republic through the Faculty of Agronomy (FAGRO). Senior weed scientist at the “La Estanzuela” Experiment Station of INIA, Dr. Amalia Ríos, has recently retired after many years of outstanding and internationally recognized service. In anticipation of Amalia's departure, INIA had reinforced training and recruitment efforts to build the current team of five weed scientists. FAGRO has three weed scientists under the leadership of Dr. Grisel Fernández at the “Mario Cassinoni” Experiment Station in Paysandú.



USA

Dr. Franck Dayan has been elected president elect of the Phytochemical Society of North America. He will assume the presidency next summer (2014) and will be responsible for organizing the next Phytochemical Society meeting in 2015. Many congrats Franck and IWSS wish you all the very best.

Franck was awarded the USDA-ARS Senior Research Scientist of the Year for the Mid-South Area in 2012. He is always in demand to speak on different topics including King George, Vampires and Herbicides. In Jan. 2013 he was invited to give a couple of keynote lectures at the California Weed Science Meeting and a plenary lecture at the 2013 Global Herbicide Resistance Challenge Conference in Perth, Australia in February.



Dr. Dale Shaner was awarded the WSSA OUTSTANDING RESEARCH AWARD and recognized at the 2013 WSSA meeting in Baltimore. Dale was a key note speaker at the Global Herbicide Resistance Challenge Conference in Perth, Australia in February 2013 and is also editing Herbicide Handbook which will be available in Feb. 2014. Keep it up Dale and all the very best from IWSS.



Donations of Weed Science Journals

International Weed Science Society (IWSS) and Principal, College of Agriculture, Kaul of Chaudhary Charan Singh Haryana Agricultural University, Hisar, India are thankful to Dr. Clyde L. Elmore, Weed Science Program, University of California, Davis (USA) for free of cost shipping the past issues of Weed Science, Weed Technology and Invasive Plant Science and Management

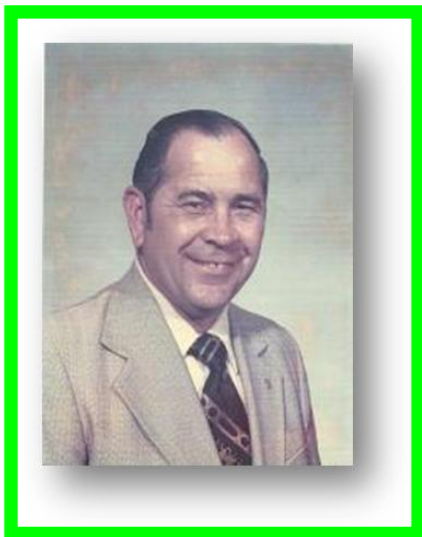


Dr. D. P. Nandal, Principal, College of Agriculture Kaul, District, Kaithal, Haryana (India) with Weed Science journals donated by Dr. Clyde Elmore (USA)

journals to the agriculture college library in Haryana. Dr. D. P. Nandal, Principal of the college expressed his gratitude to Dr. Elmore for this excellent gift to the college library. This will greatly benefit students of this college as these journals were not available in the college library and students had to go the main campus library (150 Km away) to access them. The old and new issues of journals in the college library will be an excellent repository for consultation not only for students but also for the teaching and research faculty of Agronomy and allied subjects in the college. Once again, many thanks to Dr. Elmore for donating weed science journals to college library; Dr. Albert Fischer, President IWSS and Dr. Samunder Singh, Secretary, IWSS for facilitating the valued gift to the college library.



OBITUARIES



Dr. Robert Eugene Eplee, Sr.

Life and Career Highlights – 1933-2013

Randy G. Westbrooks, Ph.D., IVS Prevention Specialist
Invasive Plant Control, Inc., Whiteville, North Carolina.

A. Douglas Worsham, Ph.D., Professor, Emeritus, Weed Science,
North Carolina State University, Raleigh, North Carolina

Lytton Musselman, Ph.D., Mary Payne Hogan Professor Botany,
Department of Biological Sciences, Old Dominion Univ., Norfolk, VA

WHITEVILLE, NORTH CAROLINA, USA -- Dr. Robert (Bob)
Eugene Eplee Sr., 79, passed away on Wednesday, Jan. 30, 2013,
at the New Hanover Regional Medical Center in Wilmington,

North Carolina. Dr. Eplee, born on November 15, 1933, was the son of the late Kelly Eplee and Madeline Price Eplee of Marion, North Carolina. He was preceded in death by one son, David F. Eplee. He is survived by his wife, Mary Mullins Eplee of Whiteville; and one son, Dr. Robert Eugene Eplee Jr. of Laurel, Maryland.

Dr. Eplee received his B.S degree in Agronomy from Berea College, Kentucky (1955), M.S. Degree in Agronomy from the University of Kentucky (1963) and Ph.D. in Crop Science (Weed Science) from North Carolina State University in December, 1965.

After serving in the U.S. Army in France from 1955-1957, Bob served as an Extension Agent with the Kentucky Cooperative Extension Service in Morehead County, Kentucky from 1957-1961. Upon completing his graduate studies at NCSU in December, 1965, he accepted the position as Director of the Witchweed Laboratory in the Crop Pest Division of the USDA ARS in Whiteville, North Carolina till 1995. From 1995 until his retirement in 2000, he served as the Director of the APHIS Oxford Plant Methods Center (Oxford, North Carolina), and the APHIS Center for Plant Health Science and Technology in Raleigh, North Carolina. Bob is best known and remembered for his research on the biology and control of Witchweed [*Striga asiatica* (L.) Kuntze], a parasitic weed that is native to Africa and Asia, that was first discovered in southeastern N. Carolina in July, 1956. Thanks to his 30 year research program to develop methods and equipment for the USDA-Carolinas Witchweed Eradication Program, *the infestation has been reduced from 432,000 acres in the North and South Carolina Coastal Plain (1970) to 1,542 acres (end of 2012).*

From a personal standpoint, Bob Eplee will always be remembered for his devotion to the local community through his work in the Boy Scouts of America and the Whiteville Lions Club. As a professional, he will be remembered for his contributions to the United States as a federal weed scientist. According to longtime friend and colleague Dr. Doug Worsham (one of his professors and graduate advisors at NCSU), Bob was a hands-on scientist who could take a complex problem and break it down to find simple solutions that could be applied in the real world. His work in USDA APHIS made Witchweed Eradication in the Carolinas not only possible, but practical, and economically feasible. On a broader scale, his influence on parasitic plant research was immense.

Although his emphasis was always the applied aspect, he garnered so much information on witchweed that has been used worldwide by other researchers. Perhaps as important is how Bob and his work heightened awareness of these pathogens on a worldwide basis. One way he so effectively did this was by mentoring a number of American and foreign graduate students who spent time working in the Whiteville lab. There they learned how lab science translates into effective field programs, and experienced firsthand the warm hospitality of the Eplees—and such local cuisine as chicken bog and barbecue.

The future savings to American Agriculture because of the success of the Witchweed Eradication Program are enormous. Based on plant growth chamber research by USDA ARS, without this program and the equipment that Bob Eplee designed and built, Witchweed could have spread throughout the corn growing regions of the US and resulted in losses up to 10% annually. In Nebraska alone, a 10% loss of the state corn crop due to Witchweed could have resulted in annual losses of \$915 million/year at current prices. *This is almost 4X the total public funding that was spent on the USDA-Carolinas Witchweed Eradication Program over the past 55 years from 1957-2012.* Dr. Eplee's legacy will live on in the volunteer work he did at the local level, in his achievements as an internationally recognized weed scientist, and through the work of young professionals he mentored in the field of invasion biology – particularly as it relates to *invasive species prevention, early detection, and rapid response*. People who worked with Bob Eplee will remember that he had a number of sayings that reflected his wit and wisdom, and joy for life. Some of them were simply 'cute', but some of them represent cold hard facts that people don't want to face at times. In every case – they are TRUE "Eplee-isms". Here are a few of them for your reading pleasure

- ✚ “Everything that’s said to be so, by those who think it to be so, ain’t necessarily so.....”
- ✚ “Boy – don’t you know what ASSUME means”????
- ✚ “How do you eat a watermelon? One bite at a time”!
- ✚ “Smart people solve problems..... Wise people prevent them”.
- ✚ “Nobody has no right to move a pest (or a plant/critter that might become a pest) from where it is to where might become a problem”.
- ✚ “The seven steps of project development and management include conceptualization, discussion, planning, research, implementation, evaluation, and modification”.

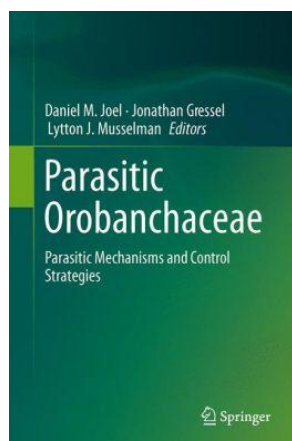
Dr. Jeff Mullahey, current Head of the Crop Science Department at NCSU, worked with Dr. Eplee on Tropical soda apple in Florida in the early 1990s. On one occasion when they were discussing how new weeds like Tropical soda apple never seemed to receive the government resources and focus that they should, Bob said, “*That’s simple.... these agencies don’t look at weeds because they don’t creep, crawl or fly*”..... another classic Eplee-ism. There is no doubt – Bob Eplee lived a happy and productive life. In those short 79 years, he achieved just about everything that he set out to do as a farm boy in the rolling foothills of Marion, North Carolina. He had a loving wife and two very successful sons, he contributed to the community, and he had a very productive career – *he was a respected scientist around the world*. There is one thing for certain - if there is an equipment shop in Heaven, Bob Eplee is already there, designing, building, and testing a new piece of equipment with a big smile on his face. Just imagine that

In any case, this world is definitely a better place because of the life and work of Dr. Robert Eugene Eplee, Sr. – 1933-2013.

— Randy G. Westbrook

NEW BOOKS

PARASITIC OROBANCHACEAE: PARASITIC MECHANISMS AND CONTROL STRATEGIES



DANIEL M. JOE, JONATHAN GRESSEL & LYTTON J. MUSSELMAN (ED).
ISBN-13: 9783642381454, US\$ 169

SPRINGER BERLIN HEIDELBERG, 2013, 400 PAGES

This book was written in response to significant recent advances in understanding the mechanisms of parasitism in the Orobanchaceae, and breakthroughs in the control of the parasitic weeds *Striga* and *Orobanche*. It consists of 26 contributions by internationally recognized leading scientists. The main book chapters are grouped into two parts:

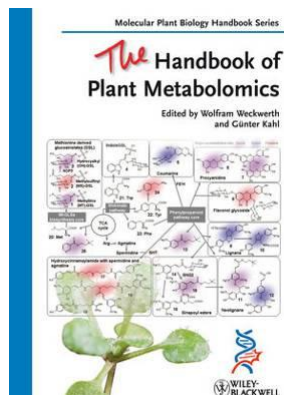
- Part I – The Orobanchaceae and Their Parasitic Mechanisms
- Part II – The Weedy Orobanchaceae and Their Control

The first part provides cutting-edge information on all key aspects of plant parasitism, such as the structure, development and function of the haustorium; nutrient transfer and the physiology of the parasite-host association; host reaction to parasitic plants; seed production and germination; the strigolactones and host-parasite signaling mechanisms; the parasite genome, phylogenetics, evolution and epigenetics; and ecology. Topics of the second part include: the problem posed by the weedy parasites; population diversity and dynamics; molecular diagnosis of seed banks; and detailed discussion of the various management

strategies, including agronomic, chemical and biotechnological approaches, as well as host breeding for resistance, allelopathy and biological control.

This book is intended for plant scientists, university lecturers and students, agronomists and weed specialists, breeders and farmers, extension personnel and experts in tropical and subtropical agriculture.

THE HANDBOOK OF PLANT METABOLOMICS

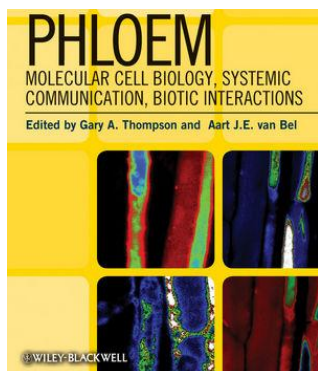


Wolfram Weckwerth (Editor), Guenter Kahl (Editor) US \$169.95

ISBN: 978-3-527-32777-5. Hardcover, 448 pages; April 2013, Wiley-Blackwell

This is the newest title in the successful Molecular Plant Biology Handbook Series. Just like the other titles in the series this new book presents an excellent overview of different approaches and techniques in Metabolomics. Contributors are either from ivy-league research institutions or from companies developing new technologies in this dynamic and fast-growing field. With its approach to introduce current techniques in plant metabolomics to a wider audience and with many labs and companies considering introducing metabolomics for their research, the title meets a growing market.

PHLOEM: MOLECULAR CELL BIOLOGY, SYSTEMIC COMMUNICATION, BIOTIC INTERACTIONS



Gary A. Thompson, Aart J.E. van Bel

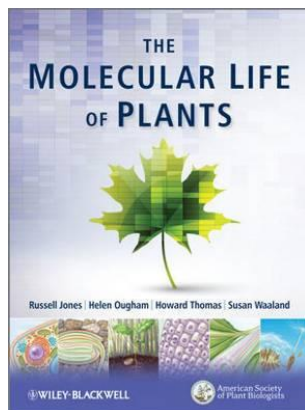
ISBN: 978-0-470-95860-5, US \$199.95

Hardcover, 368 pages, October 2012, Wiley-Blackwell

Phloem: Molecular Cell Biology, Systemic Communication, Biotic Interactions is a timely collection of research on the cellular and molecular biology of this plant vascular tissue. Recent advances in phloem research have revealed the centrality of this plant tissue to whole plant development and physiology. Building on advances made through developments of new analytical technologies, this book will provide readers with a current and comprehensive reference on the role of phloem in plant growth and development. Collecting the work of a global team of leading researchers, *Phloem* will provide the reader

with a valuable synthesis of the latest research in a single volume.

THE MOLECULAR LIFE OF PLANTS



Russell Jones, Helen Ougham, Howard Thomas, Susan Waaland
 October 2012, ©2012, Wiley-Blackwell
 A stunning landmark co-publication between the **American Society of Plant Biologists** and Wiley-Blackwell. US\$80.44

The Molecular Life of Plants presents students with an innovative, integrated approach to plant science. It looks at the processes and mechanisms that underlie each stage of plant life and describes the intricate network of cellular, molecular, biochemical and physiological events through which plants make life on land possible. Richly illustrated, this book follows the life of the plant, starting with the seed, progressing through germination to the seedling and mature plant, and ending with reproduction and senescence. This "seed-to-seed" approach will provide students with a logical framework for acquiring the knowledge needed to fully understand plant growth and development.

Written by a highly respected and experienced author team *The Molecular Life of Plants* will prove invaluable to students needing a comprehensive, integrated introduction to the subject across a variety of disciplines including plant science, biological science, horticulture and agriculture.

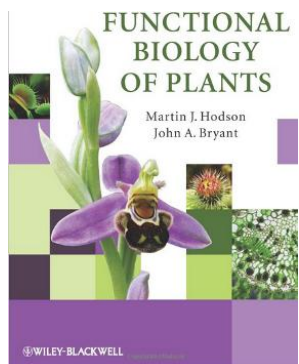
BIOLOGICAL CONTROL OF WEEDS IN AUSTRALIA



Jim Cullen; Mic Julien & Rachel McFadyen (ed.) US\$ 200
 CSIRO Publication; March 2012. 648 pages; ISBN 9780643104211

Biological control of weeds has been practised for over 100 years and Australia has been a leader in this weed management technique. The classical example of prickly pears in Australia by the cactus moth *Cactoblastis cactorum*, which was imported from the Americas, helped to set the future for biocontrol of weeds in many countries. Since then there have been many projects using Classical Biological Control to manage numerous weed species, many of which have been successful. Importantly, there have been no serious negative non-target impacts – the technique, when practised as it is in Australia, is safe and environmentally friendly. Economic assessments have shown that biocontrol of weeds in Australia has provided exceedingly high benefit-to-cost ratios. This book reviews

biological control of weeds in Australia to 2011, covering over 90 weed species and a multitude of biological control agents and potential agents. *Biological Control of Weeds in Australia* will provide invaluable information for biological control researchers in Australia and elsewhere. Agents used in Australia could be of immense value to other countries that suffer from the same weeds as Australia. The studies reported here provide direction to future research and provide examples and knowledge for researchers and students.



FUNCTIONAL BIOLOGY OF PLANTS

MARTIN J. HODSON (AUTHOR), JOHN A. BRYANT (AUTHOR) [PAPERBACK] US \$65.75
 Publ. April 30, 2012, ISBN-10: 0470699396, ISBN-13: 978-0470699393

Functional Biology of Plants provides students and researchers with a clearly written, well structured whole plant physiology text. Early in the text, it provides essential information on molecular and cellular processes so that the reader can understand how they are integrated into the development and function of the plant at whole-plant level. Thus, this beautifully illustrated book, presents a modern, applied integration of whole plant and molecular approaches to the study of plants. It is divided into four parts: Part 1: Genes and Cells, looks at the origins of plants, cell structure, biochemical processes and genes and

development. Part 2: The Functioning Plant, describes the structure and function of roots, stems, leaves, flowers and seed and fruit development. Part 3: Interactions and Adaptations, examines environmental and biotic stresses and how plants adapt and acclimatize to these conditions. Part 4: Future Directions, illustrates the great importance of plant research by looking at some well chosen, topical examples such as GM crops, biomass and bio-fuels, loss of plant biodiversity and the question of how to feed the planet.

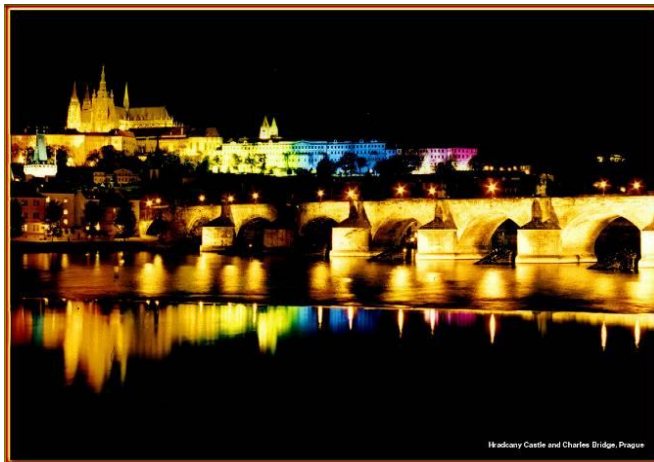
Welcome to Prague, Czech Republic for 7th IWSC, 19-25 June 2016



Charles Bridge, Prague



**Prague Castle seen from across
The River Vltava**



Prague Castle at Night



Prague-Prazsk-Hrad



**The National Museum with the
Statue of King Wenceslas**



Prague Theological Library

OTHER MAJOR UPCOMING EVENTS

2013

- Sept. 29-3rd Oct. Joint Meeting of the EWRS Weed Management in Arid and Semi-Arid Climate Working Group and of the Weed Mapping Working Group, Chania, Crete, Greece, Contact: Dr. Hanan Eizenberg, eizenber@volcani.agri.gov.il
- Oct. 22-25 AAB Conferences, Advances in Biological Control/ Biopesticides, Olde Barn Hotel, Marston, Lincs, UK
<http://www.aab.org.uk/contentok.php?id=184&basket=wwsshowconflist>
- Oct. 22-25 Asian Pacific Weed Science Society Conference "The Role of Weed Science in Supporting Food Security by 2020" Bandung, Indonesia. Denny Kurniadie Organizing Committee Chair, kurniadie@hotmail.com, <http://apwss2013.com/index.php/conference/invitation/>
- Nov. 5-7 XIV Congress of Spanish Weed Sci. Soc. Confr., XIV Congreso De La Sociedad Española De Malherbología (SEMH), Valencia, Spain Contact: Coordinator: Dr. José M^a Osca (josca@prv.upv.es) Technical Secretariat of the XIV Congress of the SEMh, Dr. Diego Gómez de Barreda, Dr. Nuria Pascual Technical University of Valencia, amino de Vera s / n 46022-Valencia, Email: 14congresosemh@upv.es, <http://14congresosemh.webs.upv.es/> Phones: 963877334/963877330
- Nov. 11-14 International Conference on Green Agro-Industry."Green Agro-Industry: Investment for Our Future", Agriculture Universitas Pembangunan Nasional "Veteran" Yogyakarta 55283, Indonesia on November 11-14, 2013. Contact: Dr. Mofit Eko Poerwanto, Tel.:+62 274 6669638 (office hour: 02:00 – 10.00 GMT), Fax: +62 274 486693, E-mail: icgai@upnyk.ac.id, web: <http://icgai.upnyk.ac.id>
- Nov. 11-15 WEED XXI Latin American Congress /XXXIV The Mexican Congress Weed Science. International Symposium on Resistance and Tolerance to Herbicide / IX International Symposium on Aquatic Weeds and Update Course and Weeds 2013, Cancun, Quintana Roo, Mexico, in the Headquarters Hotel Iberostar Paraiso Beach. <http://www.asomecima.org/> or contact: M. en Fit. Artemio Balbuena Melgarejo, Presidente de la ASOMECEIMA, Email: asomecima@yahoo.com.mx, Tel.: (044 or 045) 72 22 44 01 65/72 23 50 97 29, Teléfono de oficina: (01 722) 2 96 55 31 o terminación 29 y 18, extensión 101. or Dr. Germán A. Bojórquez Bojórquez, Presidente de la ALAM, E mail: germanbojorquez@yahoo.com
- Dec. 9–12 North Central Weed Science Society Annual Meeting, Columbus, Ohio, USA, www.ncwss.org
- Dec. 10-12 22nd COLUMA Conference, International Meeting on Weed Control, Dijon, France, 10-12 Dec. 2013. E-mail: afpp@afpp.net, Tel 33(0) 1 41 79 19 90, www.afpp.net,

2014

- Jan. 6–9 68th Annual Meeting of Northeastern Weed Science Society, Sheraton Society Hill Philadelphia, Pennsylvania, USA, www.newss.org
- Jan. 27-29 Southern Weed Science Society, Annual Meeting, Birmingham, Alabama, USA. www.swss.ws
- Feb. 3-6 54th Annual Meeting of the Weed Science Society of America, Hyatt Regency, Vancouver, British Columbia, Canada. Contact: Jim Kells, WSSA President, Tel. (517) 355-0271, ext. 1103 e-mail: kells@msu.edu, <http://wssa.net>
- March 10–13 Western Society of Weed Science Annual Meeting, Colorado Springs, Colorado, USA, www.wsweedscience.org
- March 11-14 26th German Weed Science Conference, Braunschweig, Germany, Contact: Dr. Henning Nordmeyer/Dr. Lena Ulber, Julius Kühn Institut (JKI), Messeweg 11 12, 38104 Braunschweig, Germany, E-Mail: unkrauttagung@jki.bund.de, Internet: www.unkrauttagung.de
- May 18-23 4th International Symposium on Weeds and Invasive Plants, Montpellier, France. Contact: Guillaume Fried, Plant Health Laboratory (Anses), Campus International de Baillarguet, CS 30016 FR - 34988 Montferrier-sur-Lez cedex, France, guillaume.fried@anses.fr, Phone: + 33 (0)4 67 02 25 53
- June 24-28 The 2nd International Workshop on Weeds and Invasive Plants, Pyrenees, Spain. Contact: Dr. Roger David Cousens, 61 (0) 3 8344 9749, Mobile +61 (0) 407 338 097, Email: rcousens@unimelb.edu.au; <http://andinallanos.weebly.com>

2015

- Feb 2015 Annual Meeting of Weed Science Society of America, Lexington, Kentucky, USA. www.wssa.net
- Aug. 24-27 XVIII. International Plant Protection Congress. Mission possible: food for all Through Appropriate Plant Protection. Free University Berlin, Garystraße 35, 14195, Berlin-Dahlem/Germany, Contact. Dr. Bernd Holtschulte, Vice President German Phytomedical Society, www.fu-berlin.de/hfb

2016

- Feb. 2016 Weed Science Society of America Annual Meeting, San Juan, Puerto Rico, www.wssa.net
- June 19-25 7th International Weed Science Congress, Clarion Congress Hotel Prague, Prague, Czech Republic, Contact: Dr. Josef Soukup, Tel. +420 22438 2780, E-mail: soukup@af.czu.cz, iwsc2016@guarant.cz, <http://www.iwss.info/iwsc.php>

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The IWSS Newsletter is available on the Internet at:
<http://www.iwss.info/newsletters>

The Newsletter is published twice a year to foster communication among and give information to our members and others around the globe interested in Weed Science.

Thanks to the contributors who helped with the present issue. We would love to hear activities in your areas; please contribute and share with all weed science fraternity.

**Deadline for items for the next Newsletter is
15 April 2014**

Editor: **Dr. Samunder Singh**

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Annual membership is from January to December.
Checks, bank drafts or money orders in US\$ should be made
payable to: International Weed Science Society
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