Proceedings of Biennial Conference Indian Society of Weed Science

(February 5-7, 2020)

Venue: ICAR-Central Coastal Agricultural Research Institute, Goa, India

Theme: *"Weed management for enhancing farmers' income and food security"*

Despite adoption of developed technologies, the weed problems are virtually increasing. This is due to negligence towards certain traditional practices like intercropping, mulching and crop rotations involving legumes and continuous adoption of a few cropping systems. Further, emerging concerns like herbicide resistance development in weeds, growing menace of weedy rice, *Parthenium, Orobanche* and other alien invasive weeds due to several factors including globalization and liberalization are also responsible for increasing weed infestations. It is estimated that loses of agricultural produce due to weeds is worth over $11 billion in India.

The Indian Society of Weed Science (ISWS), a non-profit professional society was established in 1968. It promotes research, education, and extension outreach activities related to weeds; provides science-based information to the public and policy makers; create awareness of weeds and their impacts on managed and natural ecosystems in the country besides organizing conferences and seminars. This conference has provided an excellent opportunity to all stakeholders dealing with different aspects of weeds, to share their ideas and learn from international experiences. The conference also gave an opportunity for reunion of members of ISWS from India and abroad as well.

More than 60% population of India is depending on agriculture sector; therefore, Indian agriculture plays a major role in the country's economy. India may require at least 20 million tons of additional food every year to meet the minimum food and nutritional demands of the growing population, which is expected to be 1.7 billion by 2050. The greatest challenge of the 21st century is to meet the rising food demand while maintaining the sustainability of the natural resources. Hon'ble Prime Minister of India, Shri Narendra Modi has repeatedly urged agricultural scientist for doubling the income of farmers by 2022. In order to address the emerging challenges and for doubling farmers' income over the next two years, Indian Society of Weed Science has organized ISWS Conference on the theme of '***Weed management for enhancing farmers' income and food security'*** during 5-7 February, 2020 at ICAR- ICAR-Central Coastal Agricultural Research Institute. Following sub-themes were focused during the event.

- Weed biology, ecology and climate change
- Weed management in rice-based cropping system
- Sustainable weed management in cereals, pulses, oil seed crops, commercial crops, fibre and fodder crops under irrigated and rain-fed agriculture
- Weed management in fruits, vegetable, medicinal, spices, floriculture horticulture
- Management of problematic weeds in cropped and non-cropped situations
- Non-chemical weed management including biological control
- Herbicide resistance in weeds and herbicide tolerant crops
- Herbicide residues, monitoring, mitigation and effect on non-target organisms
- New herbicides molecules/formulations including nanoherbicides, herbicide compatibility *etc*
- Weed education, extension, socio-economic implications, adoption, and impact assessment
- Weed utilization
- Weed threat to plant biodiversity in forest, wasteland and aquatic ecosystem

The major highlights of the conference included: (i) About 274 delegates from all over the India and overseas including members of the Society, scientists, students from agricultural research institutions and State Agricultural Universities (SAUs), representatives from concerned government departments and industries, (ii) There was General Body Meeting of ISWS on 5 February, 2020, (iii) Nine technical sessions were organized, (iv) One Keynote lecture, 3 Plenary presentations, 14 lead papers, 71 oral papers and 170 posters were presented,(v) Gala Dinner on 5Th February 2020 (viii) Field visit of the delegates to On-Station and On-Farm trials and aquatic weed problem in aquatic bodies on 7, February 2020.

Proceedings of technical sessions

February 5-7, 2020

Inaugural session

ISWS Biennial Conference under the theme '*Weed management for enhancing farmers' income and food security*' was organized at ICAR-Central Coastal Agricultural Research Institute (CCARI, Goa) w.e.f. February 5-7, 2020. Advocate Mr Narendra Sawaikar, Ex MP of Goa graced this conference as the chief guest. The other dignitaries on the dais were: Dr. Sushil Kumar President, ISWS; Dr. P.K. Singh, Director, DWR, Jabalpur; Dr M. Thangam, In-charge Director, ICAR-CCARI; Dr. Shobha Sondhia, Organizing Secretary of Conference and Secretary of ISWS and Dr V. Parmesha, Local Organizing Secretary, CCARI, Goa. Other dignitaries in the session were: Dr. N.T. Yaduraju, Ex-President, ISWS; Dr. L.S. Brar, Former Presidents, ISWS; Dr. G.S. Rao, Director, TFRI, Jabalpur; Dr M. Thangam, In-charge Director, ICAR-CCARI; General Manager, NABARD, Dr. V.P. Singh, Ex-President, ISWS, Dr Govindra Singh; Dr T.V.R. Shetty, Dr J.C. Majumdar, Dr P.C. Bhowmick, Dr Mayank Yadav from Corteva Agriscience™, and many other from India and abroad. Dr Stephane Cordeau of INRAE, Agroecology Lab, Dijon, France also participated.

The inaugural session of ISWS Biennial Conference was started with the opening remarks of Dr Shobha Sondhia, Secretary, Indian Society of Weed Science which was followed by welcome address given by Dr. Sushilkumar, President, ISWS. In the welcome address, Dr Sushilkumar welcomed all the stalwart and distinguished ISWS members, notable and eminent scientists from ICAR Institutes, Universities, Other government and non-government organizations and industries, students and participants. In his address Dr Sushilkumar highlighted the importance of Indian Society of Weed Science with special reference to doubling of farmers' income by 2022. He also mentioned the emerging weed problems like parasitic weeds, weeds in aquatic system, alien invasive weeds, development of climate smart weed management technology, risk associated with herbicide resistant weeds, weed dynamics and shift in weed flora under changing climatic condition. Dr Sushilkumar also mentioned recent development in weed science that include sensor-based weed management technology, herbicide application through drones, new molecules in weed management and environmental impact of herbicides, etc.



Dr P.K. Singh, Director, ICAR-Directorate of Weed Research, Jabalpur, welcomed all the participants for attending the conference and wished active deliberation and fruitful discussion on the presentations. Dr P.K. Singh mentioned huge yield losses caused by the weeds in various crops in the country. Mr Sawaikar, Chief Guest of the function, discussed various weed problems emerging in the Goa state and hoped that during the conference various ways will be discussed to manage these weeds especially through non-chemical approaches. He urged the weed scientists to develop eco-friendly low cost weed management technologies for the benefit of the farmers.

Distribution of Awards and Fellowships: Dr. Shobha Sondhia, Organizing Secretary, announced the names of awardees in various categories of awards. In glittering inaugural function, the following scientists were honoured for their outstanding contributions in weed science:

Awardees list

Life Time Achievement Award	1. Dr Govindra Singh, (2018-19) 2. Dr N.T. Yaduraju, (2018-19)
ISWS Recognition Award	1. Dr S.V.R. Shetty, (2018-19) 2. Dr C.M. Singh, (2018-19) 3. Dr JC. Majumdar, (2018-19)
ISWS Gold Medal	1. Dr C. Chinnusamy, (2018) 2. Dr Ratikanta Ghosh, (2019)
ISWS Fellow	1. Dr Makhan S. Bhullar, (2018) 2. Dr Parvender Sheoran, (2018) 3. Dr Basudev Behera, (2018) 4. Dr Manoj Kumar Singh, (2019) 5. Dr Malay K. Bhowmick, (2019)
ISWS Special Recognition Award	1. Dr Mayank Yadav, Hyderabad
ISWS Young Scientist Award	1. Dr Dibakar Ghosh, (2018) 2. Dr Chaitanya Prasad Nath (2019)
ISWS Best Ph.D. Thesis Award	1. Dr K. Brindha, (2018) 2. Dr Amandeep Kaur (2019)
ISWS Best Book Award	1. Dr V.S. Rao, USA for the book "Principles of Weed Science" (2018)
IJWS Best Paper Award	**1. Authors**: Veeresh Hatti, B.K. Ramachandrappa and Mudalagiriyappa "*Weed dynamics in conservation agricultural systems as influenced by conservation tillage and nutrient management practices under rainfed finger millet*" Volume: 50(4): 355-364 DOI: http://dx.doi.org/10.5958/0974-8164.2018.00076.X **2. Authors**: Neeraj Kumar Dubey, Pawan Yadav, Nisha Gupta, Kapil Gupta, Jogeswar Panigrahi, Aditya Kumar Gupta "*Suppression of seed setting and viability in phytoplasma-infected Parthenium weed in nature through differential gene expression*" Volume: 51(2): 188-197 DOI: http://dx.doi.org/10.5958/0974-8164.2019.00040.6

ISWS Student Travel Grant Award	1. Ms Stuti Debapriya Behera 2. Ms Y. Lavanya 3. Mr Bheru Lal Kumhar 4. Ms Sunita Meher 5. Mrs Pujari Shobha Rani 6. Mr Muni Pratap Sahu
Best poster awards	Six best poster awards were also distributed

Session ended with the presentation of vote of thanks by Dr. Shobha Sondhia, Organizing Secretary of Conference and Secretary of ISWS. After inaugural session, plenary session was conducted.

Key Note and Plenary Lecture Session
Chair: Dr S.V.R. Shetty
Rapporteur: Dr Malay K. Bhowmick

Keynote speaker: Dr P.C. Bhowmick

Dr Prasant C. Bhowmik of the University of Massachusetts presented key note address on "*Weed management in sustainable agriculture: Farm economy and food security*". His deliberation illuminated an overview on the focal theme of the conference. He prioritized sustainable agriculture as a common theme for global food production in the context of burgeoning population and changing climate. He elaborated different dimensions of weed management owing to the potential threats arising with the invasion of new weed species, evolution of herbicide resistant weeds, introduction of genetically modified crops *etc.* in current cropping systems. He emphasized on adopting smarter options for durable weed management toward ensuring food security and improving farm income. He also pointed to include economic assessment of any weed management strategies, which should be a standard procedure for sustainable practices.

After the keynote address, two plenary lectures were given as under:

Dr N. T. Yaduraju presented an interesting plenary lecture on "*Weed management in the digital era*". He advocated for the adoption of advanced ICT tools and technologies, artificial intelligence, machine learning, field-/crop-level sensors, robotics, unmanned aircraft vehicles (drones), image processing *etc.* to correctly identify the weeds and manage them in different farming systems. Progressive farmers are gradually being inclined toward accessing internet services, using smart phones, utilizing social media, sharing farming videos *etc.* for keeping themselves updated regarding supply chain, direct marketing, real time input use, precision agriculture and farm mechanization. Suitable mobile apps are needed to hire machinery and impose site-specific precision weed management. Although aerial spraying with drone in India is not yet advisable for averting the herbicide load into the environment, best management practices need to be formulated. For instance, he referred to the usage of *See and Spray* technology as a target-oriented herbicide application that can save chemical costs, reduce negative

environmental impact, manage the dreaded HR weeds and even bypass the need for genetic engineering of herbicide-tolerant plants.

Dr Stephan Cordeau from INRAE (Agroecology Lab, Dijon, France) gave a plenary lecture on *Weed diversity mitigates crop yield losses: a perspective from European grain-based systems and insights for biodiversity-based weed management.* Dr Stephane Cordeau highlighted the role of biodiversity and weed diversity in mitigating crop yield losses. He explained that higher diversity of traits (characteristics) within the weed community can induce complementarity in resource use (light, water, nitrogen) and alleviate crop-weed competition. Further, high weed community evenness leads to lower total weed biomass and reduced crop-weed competition. Since current weed control practices do not allow targeting a specific species in a complex community, future studies are needed to identify if weed diversity can rather be indirectly promoted by diversifying weed management tools as well as farming practices.

In the end of plenary session, Dr S. V. R. Shetty from the Chair concluded that the key note and plenary lectures have set the scene for the whole Conference and have provided basis for making an appropriate plan toward developing smart weed management options for enhancing crop productivity as well as improving farmers' profitability. The papers have provided directions for future weed research aiming at improving whole farm productivity and enhancing farmer's income. Dr Shetty pointed out that the Proceedings of ISWS Biennial Conference should consider how to contribute towards the Honorable Prime Minister's vision of "doubling farmer's income by 2022" and link the weed research activities with the NITI Aayog recommended strategy and action plan.

Technical Session 1: Weed Management in rice-based cropping system
Chair : Dr. L.S. Brar
Rapporteur : Dr. PijushKanti Mukherjee

The session was started with brief introduction about the importance of rice-wheat and rice-based cropping system by Chairman. In this session two invited and 11 oral presentations were made. Invited papers were presented by Dr. Virendra Pratap Singh and Dharmbir Yadav. Dr M. L. Jat and Dr K. Srinivasulu were absent during the session. The presentations of the speakers have been summarized as follows:

Dr V Pratap Singh, GBPUAT, Pantnagar (Uttarakhand), presented the experimental details encompassing five establishment methods in main plot [TPR (CT)-Wheat, TPR (CT)-Wheat (ZT)-*Sesbania* (ZT), DSR (CT)-Wheat (CT)-*Sesbania* (ZT), DSR (ZT)-Wheat (ZT)-*Sesbania* (ZT) and DSR (ZT)+residue-Wheat (ZT)+residue-*Sesbania* (ZT)] and three weed control methods. He highlighted several issues like ecological issues, agricultural issues, livelihood issues and climatic issues. Water productivity as influenced by sowing methods and it is higher under DSR over TPR. He reported that on an average of five years, the highest system yield of rice-wheat was recorded with TPR (CT)-wheat (ZT)-*Sesbania* (ZT).

Dr Dharam Bir Yadav, HAU, Hissar, explained significance, issues and, context and also long-term effect of green manuring on rice-wheat cropping system. Antagonism between cyhalofop and bispyribac was recorded in controlling *Echinochloa.* DSR (CT)-ZT Wheat resulted in more infestation of *Phalaris minor* in wheat. He concluded that long-term planning for management of resistant *P. minor* in terms of diversification in favor of sunflower, sugarcane or any other crop, zero tillage should be refocused and rotavator based wheat cultivation should be discouraged, selection of competitive varieties, herbicide and crop rotations and use of clean seed should be included as integral part of *Phalaris* management

Dr U. P. Singh, BHU, Varanasi highlighted the major challenges like weed management, weed shift, occurrence of herbicide resistance in rice-wheat cropping system. He reported that integrated crop and resource management practices along with use of herbicides like pendimethalin 1.0 kg/ha (direct-seeded rice), or pretilachlor 0.75 kg/ha (transplanted rice) as pre-emergence followed by bispyribac-sodium 25 g/ha+ metsulfuron 4 g/ha or pyrazosulfuron 20 g/ha for rice and sulfosulfuron 30 g/ha+metsulfuron 2 g/ha or clodinofop 60 g/ha + carfentrazone 20 g/ha /metsulfuron 4 g/ha as post-emergence in wheat are promising herbicides for broad-spectrum weed management.

Dr Murali Arthanari Palanisamy, TNAU, Coimbatore, reported that pre-emergence application of bensulfuron-methyl + pretilachlor *fb* hand weeding during *Rabi* and pre-emergence application of pyrazosulfuron-ethyl *fb* hand weeding during *Kharif* recorded significantly higher grain yield and income in rice – rice cropping system of clay loam soil in Western agro-climatic zone of Tamil Nadu. **Dr Teekam Singh**, ICAR- IARI, New Delhi, presented yield losses in direct-seeded rice under weeding times. He reported the highest yield losses due to weeds were 20.4% in DSR and concluded that early weeding in DSR resulted in higher productivity of rice and minimum yield loss due to weeds. **Dr. K. Sreelakshmi**, AICRP on Weed Control, KAU, Thrissur presented biology of *Sacciolepis interrupta* (Wild) Stapf, locally known as 'Polla' a problem grassy weed in semi-dry rice ecosystem of Kerala leading to significant yield loss in farmers' field. She concluded that sequential application of pre-emergent herbicide (pretilachlor + bensulfuron-methyl) followed by application of post-emergence herbicide (cyhalofop-butyl + penoxsulam) and a hand weeding at 45 DAS was found to be effective and economical in controlling *Sacciolepis interrupta*. **Dr T. Girija**, KAU, Thrissur, mentioned that ALS and ACCase inhibitors do not show any visible phytotoxicity symptoms on rice but causes physiological stress to the plants which affects productivity. Combination of urea IAA and micronutrient spray can improve productivity. 2, 4-D causes phytotoxicity but yield reduction is not evident at recommended dosage. Development of herbicide resistance is also faster in ALS inhibitors as compared to 2, 4-D.

Dr Manoj Kumar Singh, BHU, Varanasi, recommended use of *Sesbania* as a cover crop and green surface mulch for weed management followed by application of Penoxsulam 30 g/ha 18 DAT recorded highest grain yield in unpuddled transplanted rice. **Dr Malay K. Bhowmick**, Kolkata mentioned that transplanting of rice seedling in unpuddled soil condition is a new emerging technique to reduce water requirement and excessive tillage prevalent in traditional transplanting. He concluded IWM involving post-emergence application of bispyribac-sodium (25 g/ha at 15 DAS/15 DAT) orazimsulfuron (35 g/ha at 15 DAS/15 DAT) or penoxsulam (25 g/ha at 10 DAS/DAT) supplemented with one Cono Weeding (25 DAS/DAT) proved to be cost-effective in minimising weed growth, exhibiting higher grain yield, and fetching more net return under all establishment methods. **Dr J.K. Singh**, BHU, Varanasi, reported that post-emergence application of bispyribac-sodium + penoxsulam w/v either at 23.75 g +19.5 g or 25.65 g +21.06 g /ha is effective for controlling weeds in transplanted rice and no phytotoxicity on transplanted paddy crop was observed. **Dr. Ratneswar Poddar**, BCKV, presented the effect of different herbicides on crop growth and yield of transplanted rice at BCKV. He reported that pre-emergence application of oxadiargyl at the rate of 100 g/ha followed by 2 hand weedingat 20 & 40 DAT or pretilachlor 500 g/ha followed by 2 hand weeding at 20 & 40 DAT can be recommended to farmers for weed control in transplanted rice for higher yield & best economic return. **Dr Pramod Kumar Gupta**, JNKVV, Jabalpur presented results of experiments that were conducted at farmer fields in Katni district of Madhya Pradesh to validate, refine and popularize the technology for managing *Commelina benghalensis* in transplanted rice. He reported bispyribac-sodium 20 g/ha at 20-21 DAT reduced the infestation of *Commelina benghalens* other weeds to a significant extent in transplanted rice

Technical Session 2: Sustainable weed management in cereals, Pulses, Oil seed crops, Commercial Crops, Fibre Crops under irrigated and rainfed Agriculture (Part 1)

Chair: Dr. C. Chinnusamy
Rapporteur: Dr. Dr. Parmeet Singh

In this session total twelve lectures were delivered including one from Dr. B.R Bajaya, SKUAST Jammu from other session. Dr V.P. Singh, IISR, Lucknow and Dr. Mukesh Kumar were absent.

Dr. S.S Punia, HAU, Haryana presented the lead lecture on 'Inheritance of resistance against alternate herbicides in various biotypes of *Phalaris minor* from different parts of Haryana'. Dr. Punia presented collection of herbicide resistant biotypes and their management with high dosage of herbicides under pot conditions along with GR_{50} and Resistant index. In the last it was discussed how higher dosage of herbicides is justified in managing herbicide resistance. Dr. Punia elaborated that it is working on field and farmers of Haryana are managing this menace accordingly. Some questions pertaining to herbicidal chemistry were discussed by participants from industry.

Dr C.R. Chinnumuthu, TNAU delivered an invited lecture on 'Encapsulation of herbicides'. He sensitized about new field of weed science in which encapsulation of herbicides was elaborated. There were many questions on encapsulation, however due to limitation of time, few questions alone were allowed. **Dr Bikas Mandal** from BCKVV, WB presented 'Standardization of weed management practices in transplanted scented rice in lower gangetic alluvial zone of West Bengal'. **Dr B Behera** presented results of 'Assessment of performance of maize+ runner bean intercropping under planting pattern and weed management'. **Dr D.D. Chaudhari** presented salient findings of 'Enhancing productivity and profitability through herbicidal weed management in maize-wheat cropping system'. **Dr Dibakar Ghosh** presented 'Effect of nutrient and weed management practices on weed growth and crop productivity in sweet corn'. Dr A. Ramachandran presented salient finding on 'Influence of brown manuring on weeds and growth attributes of irrigated maize'. **Dr Rajeev Bharat** presented salient findings on 'Bio-efficacy of various herbicides on weeds and yield of Indian mustard under subtropical agro-ecosystems of Jammu region'. **Dr. S.K Jha** presented paper on weed management in jute, while **Dr. Sheela Barla** presented weed management in chickpea. **Dr R Thirumalaikumar** presented 'Influence of tillage, weed and nutrient management practices on crop-weed competition for nutrients in green manure – maize – pulse-based conservation agriculture system. **Dr. B.R. Bajaya**, whose presentation was listed in Technical Session 7 presented his paper in this session on 'Chemical weed management in vegetable pea'. Last presentation was from **Mr. Sagar Dhage** on weed management in aerobic rice. Dr. Chinnusamy, Chairman, pointed out that some presenters did not given the conclusion precisely, which should be done in future. Apart from that presenter were using notations of the treatment like T1, T2 in tables. This need to be taken care in future by elaborating at least best treatment at the footer of table. Further it was strongly advised by the chairman to avoid keeping trade name of herbicides in the presentations. It is established fact that critical period of crop-weed competition has already been quantified in almost all the major crops of India. There is advisory that we should avoid keeping weed free treatments like weed free up to 45 DAS, 60 DAS etc. in weed management trials.

Technical Session 3: Sustainable weed management in cereals, pulses, oil seed crops, commercial crops, fibre and fodder crops under irrigated and rainfed agriculture (Part 2)

Chair: Dr R.M. Kathiresan
Rapporteur: Dr Simerjeet Kaur

In this technical session, one lead, one invited and 14 oral lectures were scheduled. Twelve speakers presented their paper and two speakers- Dr R.K. Singh and Mr Kartik Sharma were absent. The lead lecture was delivered by **Dr Guriqbal Singh** on weed management in pulse crops. He discussed various cultural measures such as intercropping, spacing, mulching, planting methods along with mechanical and chemical weed control methods. He stressed on exploring genetic variability for herbicide tolerance in pulse crops. The paper insisted on expanding label claims for herbicides based on research results. The invited lecture was delivered by **Dr M.L. Kewat** in which he shared with the house that mesosulfuron methyl 12 g/ha resulted in effective weed control in wheat and its residues were found below detectable limits.

Dr A.S. Rao shared weed management options and varied weed species including *Vicia* and *Cuscuta* that are problematic in rice-pulse crop rotation in relay cropping of Andhra Pradesh. **Dr Ramesh K. Singh** elaborated that pre-mix of mesotrione + atrazine 56.25+112.5 g/ha was effective for weed control in winter maize. **Dr B.D. Patel** discussed use of new herbicides such as diclosulam, clomazone, propaquizafop+imazapyr, flauzifop+fomesafon in soybean crop. Application of post-emergence herbicides as follow-up after pre-emergence application resulted in better weed control. **Dr D. Subramanyam** shared that pendimethalin 1000 g/ha followed by florpyrauxifen-benzyl 25 g/ha or halosulfuron methyl 67.5 g/ha is effective for controlling grasses, broad-leaves and sedges in rainfed lowland rice. **Dr Tej Pratap** presented his paper on pre-emergence use of RIL-066/F1 (48% EC) 960-1200 g/ha for controlling complex weed flora in wheat. **Dr M.T. Sanjay** presented paper on post-emergence use of new herbicides such as halosulfuron 67.5 g/ha, tembotrion g/ha, topramezone and their tank-mix with atrazine in maize. **Dr Dhiman Mukherjee** presented his paper on weed control with metsulfuron methyl+carfentrazone in wheat. **Dr Vinod Singh Mehra** presented a paper on post-emergence application of new pre-mix herbicide- Paradigm (halauxifen methyl+florasulam) 750 ml/ha at 2-4 weed leaf stage for control of broad leaf weeds in wheat. **Dr T Kiran Kumar** presented his work on control of Orobanche in tobacco through plastic mulching. Dr M Raju presented his paper on weed control options in Mesta crop. **Er. C.R Chethan** presented results of herbicide application with flat fan and flood jet nozzle using 250 and 500 litre of spray volume. **Ms Bishnupriya Patra** presented that metribuzin+hand weeding in potato resulted in better weed control.

The session ended with the concluding remarks by Chairman Dr. Kathiresan. Chairman with suggestion that before presenting research findings, coded product such as RIL-066/F1 must get decoded from Pesticide Company. Herbicide application technology should be refined to have desired results from a herbicide. Integrated weed management techniques should be developed for sustainable weed management in field crops.

Technical Session 4: Herbicide use in India: Safety regulations and policies

Chair: Dr. N.T. Yaduraju
Rapporteur: Dr. M.K. Singh

All together three paper was presented in that session. Dr. Ajit Kumar could not attend the conference. In this session lead paper was presented by **Dr C.T. Abraham** on the topic 'Environmental impact of glyphosate'. Glyphosate belongs to slightly toxic group and safer herbicide, however, after the report of international Agency for Research on cancer in 2015 and due to illegal trade of herbicide tolerant cotton; it was banned in Andhra Pradesh, Kerala and Punjab. It is being recommended for non-cropped areas in Punjab. In Kerala high court has lifted the ban on glyphosate use. Under the regulation of Insecticide Act, 1968 state government can ban for three months which may be further extended for one month. Further Dr Abraham reported in his research studies that glyphosate is toxic to fishes and causes

liver and lungs malformation, however it is not recommended for aquatic application. In case of earthworm it changes the site of application and therefore escapes the application. As per the review globally, glyphosate is not toxic to animals.

Dr P. J. Suresh gave detailed information about the various reviews regarding glyphosate toxicity till date and he concluded that it is not still concluded that the glyphosate is toxic for human health. **Dr Arun Dhuri** in his presentation explained about Insecticide Act 1968 which was adopted in 1971, which paved the way for establishment of Central Insecticide Board (CIB) and Insecticide Registration committee (RC). Registration of herbicide is being looked after by registration committee and the regulatory requirements are very exhaustive. He suggested that data requirement should be of practical utility and less cumbersome.

In the end, **Dr. N.T. Yaduraju**, Chairman said that all technologies will have merits and demerits and it is for the scientific community to take a stand after weighing them scientifically. He suggested that the ISWS in association with the ICAR-DWR should organize a brain storming session involving all stakeholders on the use and safety of glyphosate in the country. The recommendation coming out of the meeting could be communicated to Ministry of Agriculture and Farmer's Welfare for their suitable action.

Technical session 5: Weed education, extension, socio economic implications, adoption and impact assessment

Chair: Dr. G.R. Rao

Rapporteur: Dr. P. Murali Arthanari

In this session six papers were presented. Out of which two papers were lead papers and four were oral presentations.

Dr Virender Kumar from IRRI, Philippines presented lead paper on 'ICT – based decision tool for weed management'. He presented decision tool system for rice – wheat cropping system especially for weed management and importance of weed App and steps involved for development of weed map by using beta version images. He said there is need for Android based weed App for accurate weed control recommendations. **Dr Srikanth Rupavatharam** from ICRISAT, Hyderabad presented lead talk on 'How should students remain involved in weed research? He narrated 7 important steps to engage students. He said that reporting data and writing technical reports in scientific manner is important. He also said that data should be interpreted with proper statistical analysis. He informed about Plantix App and their usage in India and the world.

Dr G.S. Buttar presented paper on 'Phalaris minor infestation in wheat crop sown after different paddy straw management technologies at farmers' field'. He narrated different method of paddy straw management in rice-wheat cropping system. Paddy straw management through happy seeder has incurred low cost and reduced the *Phalaris minor* incidence in wheat crop when compared to mould board ploughing, incorporation and collection methods **Dr Parmeet Singh** presented paper on 'Building collaborative community actions to manage established weeds and prevent the introduction of new weeds'. He explained studies conducted through KVK with three case studies. Case study 1: Problem of saffron crop mimic weed *Iris reticulata* and their management options. Case Study 2: *Bitumusumbeletum* is the major problematic weed in rice crop. Case Study 3: Incidence of parasitic weed *Phoradentron serotinum* and control measures. **Dr Yogita Gharde** presented assessment of functional form of yield loss models for pulse crops. **Ms Banashri Lodh** presented quantification of yield losses due to dominant weed species in direct seeded rice in Chatisgarh plains. She has presented her paper on how different weed species

*Echinochloa colona, Cypers iria, Cynotis axillaris, Alternanthra triandra e*tc., influence the yield of direct seeded rice crop.

Chairman, **Dr. G.S. Rao** remarked that gaps exist with farmers on current weed management practices can be bridged with ICT – based decision tools (Android based weed management App) for accurate field-specific integrated weed management practices. It is important for discovery of new herbicides and biopesticides to create novel approaches for future weed management strategies in line with climate change. This can be achieved by involving more students' community in the weed management research. To reduce *Phalaris minor* incidence in wheat crop, wheat crop shall be sown with happy seeder in the spread of Paddy straw in the field.

Technical session 6: Weed biology, ecology and climate change

Chair: Dr. A. Ramesh
Rapporteur: Dr. Bikas Mandal

Out of six speakers as per schedule, five participated including one lead speaker and presented their research findings nicely in an attractive manner. **Dr C. Chinnusamy** presenetd on' Invasive Weeds: An eco-biological challenge for weed management under changing climate. **Dr I.C. Barua** presented on paper on 'Threshhold density of certain weeds in transplanted rice. He suggested that as the critical period of crop with competition of transplanted rice of Assam is 30-60 days after transplanting, the careful management of *Ludwigia decurrens, L. Hyssopifolia, Cyperus iria* and *Echichloa crusgalli* should be done at the early part of crop growth to keep population below the threshold level. **Dr Pijush Kanti Mukherjee** assessed the dissemination potential of the weeds associated with different fodder crops and reported that *Rumex dentatus* has the potential to disseminate through endozoochory mechanism and use of cattle shed water for irrigation may not be recommended if the berseem fodder is infested with seeds of *Rumex dentatus*. **Dr Subhash Chander** presented on 'Effect of elevated CO_2 and temperature on soybean and associated weed species'. He reported that elevated CO_2 and temperature has positive effect on the growth of soybean and two *Echinochloa colona* and *Ischaemum rugosum* species. **Dr M.S. Raghuvanshi** reported that *Phragnmites australis* would intensify the utilizable lands in Ladakh villages. It was noted that *Phragmites australis* is an alarming issue in the upper Himalayan Ladakh region and needs to be addressed immediately at national level in managing the weeds with minimal usage of herbicides and following alternative methods of control. The invasive weed namely *Cirsium arvense*, which is also taking toll on the minimal agricultural land in partial available in the Himalayan region needs immediate attention. Control of invasive weeds to increase the potential crop production through strict monitoring mechanism deserves prime importance. **Dr. A. Ramesh**, Chairman of the session remarked the need of development of technology keeping in view of climate change. He showed his concern to manage the weed *Phragmites australis* and *Cirsium arvense* in Ladakh region by integrated way using minimum herbicides.

Technical session 7: Weed Management in fruits, vegetable, medicinal, spices, floriculture, horticultural crops and problematic soils

Chair: Dr. Govindra Singh
Rapporteur: Dr. Avanish Prakash Singh

In this session, total twelve papers were enlisted, however two lead and six oral papers were presented by different speakers. **Dr. Neelam Choudhary** presented the lead paper on "Quarantined weeds and their management in India on behalf of Dr. N. Satyanarayana. **Dr. R.M. Kathiresan** presented the lead

paper on 'Aquatic weed problems and their sustainable management' . Based on residues of 60 rice cultivars for their allelopathic inhibition on water hyacinth in laboratory bio-assays as well as in micropond tests, cultivar 'BPT' was highly allelopathic on water hyacinth and imparted a weed biomass reduction of 47.68% in the laboratory screening and 45.62% in the micropond confirmative study. **Dr Simerjeet Kaur** presenetd on 'Integrated weed management in autumn potato' and reported that integrated weed control treatment of paddy straw mulch 6 t/ha with clodinafop plus metribuzin 195 g/ha resulted in the maximum tuber yield and the highest benefit: cost ratio with weed control efficiency of >90% at harvest. **Mr K.S. Rathod** presented 'Aquatic weed control for water resources project management in Maharashtra'. **Dr. K.N. Geetha** presented paper on weed management in ginger'. **Ms Puspa** presented paper on ' Application of sensor technology for precision weed management; while **Ms Stanzin Yangsdon** presented on ' Major weeds and pesticides use in vegetable crops in Jammu'. **Miss Stuti Debapriya Behera** presneeted 'Weed dynamics and productivity of rainfed organic maize + vegetables intercropping and impact on soil quality'. All organic nutrient management practices recorded higher soil pH and organic carbon than initial value and application of FYM 10 t/ha + vermicompost 2 t/ha as basal + pot manure proved to be the best with the maximum values. Chairman, **Dr. Govindra Singh** emphasised the need of irradiation of weeds from the area to check its further spread.

Technical Session 8: Non-chemical weed management including biological control and weed utilization

Chair: Dr. R.K. Singh
Rapporteur: Dr. M.T. Sanjay

In this session, out of total 12 listed papers, 7 papers were presented. Dr. Mahesh K. Upadhyay lecture was given by **Prof. K. R. Aneja**, University of Kurukshetra on the topic "non-chemical management of weeds through bioherbicides – current status, market constraints and future prospects". At present 24 bioherbicides have been developed to commercial products and author traced the history. He highlighted Progress on Gibbatrianth 2014 – *Gibbego trianthema* to manage horse purslane *Trianthema portulaca***.** Exploitation of biodiversity and understanding of genetic diversity of weed species to overcome its narrow herbicidal spectrum are important strategies for future success.

Dr. Ratikanth Ghosh presented lead paper on 'Expediency of botanical herbicides in organic green farming for sustainable productivity of agricultural crops in alluvial soils of India'**. Dr. R R Upasani**, presented on 'Utilization aspect of weeds in Jharkhand by tribal and rural people'. He concluded that in turmeric and ginger use of weed as mulch conserves soil erosion. **Dr. S.P. Singh**, presented on "Non-chemical weed management in rice-wheat cropping system'. He reported that rice (TPR) – soil solarisation + one hand weeding (40 DAT), wheat (ZT) with rice straw + one hand weeding (20 DAS) has given good weed management and yield. **Dr. P.S. Kumar**, presented on "Parthenium weed bio-control in India using Australian weevil'. Use of *Smicronyx lutulentus* to complement *Zygogramma bicolorata*. He stated the classic example of 11 biocontrol agents working to manage Parthenium in Australia. **Dr. A.K. Singh** presented status of invasive weed management by mycoherbicide in Indian prospective. Three mycoherbicides, their mode of action has been described and the technology has been patented. 24 patents out of which 21 are international and 3 are Indian. GLP toxicology data has been generated. **Mr. Sourabh Munnoli,** presented on "Non-chemical weed management in aerobic rice'. He recommended use of *Sesbania* in intercropping for weed management and better yield.

In the end, Chairperson **Dr. R.K. Singh** explained the importance of non-chemical methods of weed management in present day agriculture and congratulated seven authors for nice and useful results which can be put for practical utility in near future. The session ended with vote of Thanks.

Technical session 9: Herbicide residues and herbicide resistance in weeds and herbicide tolerant crops

Chair: Dr. R.P. Singh
Rapporteur: Er. C.R. Chethan

The technical session had total of 11 presentations out of which one was lead presentation, three were invited papers and 7 were Oral papers. One presenter did not appear to present his paper.

Lead paper was presented by **Dr. A. Ramesh** on 'Challenges in herbicide detection at trace levels – Applications of isotopic internal standards in enhancing the accuracy of determination of residues by LC-MS-MS analysis'. He informed that stable isotope internal standards used in the quantification of herbicide residue are a valuable resource for minimizing measurement uncertainty with LC-MS-MS. He also explained about the pros and cons of the LC-MS-MS analysis system. **Dr Makhan Singh Bhullar** presented 'Emergence of resistance in *Phalaris minor* to the prevalent wheat herbicides in India: Challenges and interventions. He said that burning of rice residues reduces the 60 % of *P. minor* problem. However, it has been banned in India, hence alternate solutions need to be finding out. **Dr Ashok Yadav** presented findings on 'Dry-direct seeded rice and zero-tillage wheat–two most potential resource conservation technologies in rice-wheat cropping system for crop residue management, mitigating global warming and enabling sustainable intensification in India'. He reported that rice, wheat and sugar cane contribute more residue problem in India and managing these crop residues will solve the problem. Increase in every 1^0 centigrade of temperature reduces the wheat yield by 4-5 m tonnes. **Dr Neelam Sharma** presented 'Recent advances in mitigation methods for herbicide residues in the soil'. She reported that residue in soil can be mitigated by the addition of organic matter, increasing the microbial population, by phyto remediation, by soil solarisation, by bio-augmentation, bio-stimulation, by soil amendments etc. **Dr Jitendra Patidar** presented "Residue concentration, persistence and dissipation of fomesafen in soybean crop and soil'. He reported higher dose of fomesafen at 220 g/ha had some residue in soil with 4.44% of persistence level. **Dr Tirthankar Banerjee** presented method optimization for trace-level analysis of 147 crop protectants in black pepper by LC-MS/MS. The modified QuEchERS method using 25 mg PSA along with 25 mg C-18 was not suitable for clean-up and extraction of 147 pesticides from the black pepper. **Dr Neeraj Patanjali** presented 'Bioassay guided extraction of potential bioactive compounds from *Rhynchosia minima* and utilization in plant disease management'. **Dr RR Hasure** presented 'Effect of diuron 80 WP upon bio-efficacy against weeds and phytotoxicity on maize-wheat crops in crop sequence'. He said that the use of diuron 0.8 or 1.0 kg a.i. formulation per hectare is safe to use in *Kharif* maize and it is also for next succeeding wheat crop. **Mr Paras Kamboj** presented 'Inheritance of resistance against alternate herbicides in various biotypes of *Phalaris minor* from different parts of Haryana. He said most of the biotypes in North-Western Haryana **Dr. R.P. Singh**, Chairman concluded that judicious use of herbicides is to be followed to avoid herbicide resistance problems. Introduction of any molecules to the market should have all the safety precautions. The spraying and herbicide application techniques needs to be optimized based on the scientific knowledge and experience.

Major Recommendations of the conference

1. To orient weed research and development activities in accordance with the NITI Aayog's strategic themes on doubling farmer's income by improvement in productivity of crops, and resource use efficiency for saving in cost of production,
2. To devise a holistic approach of integrated weed management involving smart weed management strategies for enhancing farm economy
3. To acquaint and adopt advanced ICT tools and technologies such as artificial intelligence, machine learning, robotics, drones for weed management in cropped and non-cropped areas.
4. Development of mobile app through documentation of weed species and their seeds by digital photography for proper weed identification and deliver weed management options to users.
5. Development of molecular sensor-based machines for precision uprooting of weeds such as weedy rice and *Phalaris minor*.
6. Integrated approach of weed management avoids appearance of herbicide resistance and weed shift problems. Mono application of herbicides needs to be avoided.
7. It is important for discovery of new herbicides and biopesticides to create novel approaches for future weed management strategies in line with climate change.
8. To develop suitable weed management approaches for organic farming
9. To import of more host specific bioagents for biological control of problematic weeds like, Parthenium, water hyaienth. Alligator weed, Pistia, etc.
10. To give emphasis for complete eradication of quarantine weeds *Ambrosia psilostachya* from Turuvekere taluk, Tumkur district, Karnataka and *Ethulia gracilis* from Nippani–Chikkodi road, Belgavi district.
11. To study biocontrol efficiency of herbicides under climate changing scenario.

Date: 16 March 2020

Shobha Sondhia
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