WSWS Officer and Committee Report
2017 Anaheim, CA

Office or Committee Name: HERBICIDE RESISTANT PLANTS
Officer or Chairperson Name: JOAN CAMPBELL
Date of Preparation (include year): JULY 28, 2017

Committee Activities during the Year:
1. A summary of the PNW region of the WSSA resistance listening sessions was provided at the 2017 annual meeting.
2. Members of this committee attended the Global Herbicide Resistance Challenge and Harvest Weed Seed Control Symposium held in May 2017 at Denver, CO. The following summary was prepared for WSWS member who were unable to attend.

Opening Session

The massive increase in global human population requires massive increases in food production. However, over-reliance of herbicide on weeds control in crop system results in the evolution of herbicide-resistant weeds and threats the crop production worldwide (Powles, 2017).

The goal of GHRC 2017 is to explore how to change Herbicide Only Syndrome (HOS) to Herbicides and Diversity (HAD) such as Harvest Weed Seed Control and RNAi to keep herbicides the sustainable and effective tool of weed control (Gaines, 2017).

In South America, glyphosate without implementation of resistance management programs has led to the evolution of glyphosate-resistant weed populations across the main cultivated row crops regions. Growers are facing increased management complexity due to the presence of weed populations with multiple resistance to herbicides (Ovejero et al., 2017).

In Europe, future herbicide-resistance problems could be affected by the absence of proactive measures, lack of integrated weed-management strategies, occurrence of volunteer crops, trend of warmer climate, increasing adoption of minimum tillage (Collavo, 2017).

In Asia, grass weeds with multiple resistance to ALS and ACCase-inhibiting herbicides are severe problem in rice and wheat. *Eleusine indica* has developed multiple resistance to ACCase, PSI, EPSPS, and glutamine synthase inhibitors (Shivrain et al., 2017).

In Australia, despite high frequencies of multi-resistant populations, annual ryegrass densities remain low and may even be declining due to the use of new and existing alternate weed control technologies (Walsh, 2017).

Besides supporting the International Survey of Herbicide Resistant Weeds, Global Herbicide Resistance Action Committee (GHRAC) has recently launched a new website containing information on site of action classification, guidelines for resistance testing, and perspectives on monitoring to help combat herbicide resistance worldwide (Peterson, 2017).

Auxin Resistance Symposium

There are 5 grasses and 27 broadleaves weeds resistant to auxin herbicide worldwide. In the US, *Kochia scoparia* with resistance to dicamba and fluroxypyr in cereal crops is a major problem. Additionally, 2,4-D resistant *Amaranthus tuberculatus* might become the worst synthetic auxin-resistant weed in the US as the recent release of synthetic auxin-resistant crops (Heap, 2017).

The frequency and level of resistance to auxinic herbicides are generally low compared to other herbicide families. The low resistance frequency is attributed to the complex mechanism of action of these herbicides (Jugulam, 2017).

A new chemical family of auxin herbicides, the 6-aryl-picolinates from Dow AgroSciences will be used in cereal and rice crops (Satchivi et al., 2017).

New 3-dimensional pharmacophoric maps of auxin model bring new insights into auxin action in plant. The diverse receptors and specificities for auxin herbicides could influence the development of resistance (Napier et al., 2017).

Dicamba-resistant *Kochia scoparia* from Colorado, US showed reduced translocation compared to susceptible accessions, which might be due to the upregulated auxin-transport genes (Westra et al., 2017).

Raphanus raphanistrum from Australia is resistant to 2,4-D due to reduced 2,4-D translocation, which is conferred by the loss of function of an auxin efflux transporter. This resistance mechanism is governed by a nuclear inherent, monogenic and highly dominant gene (Busi et al., 2017).

Reduced 2,4-D translocation and less ethylene production are involved in synthetic auxins resistance in *Papaver rhoeas* L. populations from Spain. 2,4-D metabolism study in resistant and sensitive populations were under way to investigate if rapid metabolism contributes to the 2,4-D resistance in resistant *Papaver rhoeas* L. populations (Torra et al., 2017).

Reduced translocation is involved in 2,4-D resistance in resistant *Lactuca serriola* L. biotype and this mechanism is governed by a single co-dominant gene (Riar et al., 2017).

Genomics Session

A target-site resistance mutation that confers a significant level of resistance in a diploid species may not necessarily endow resistance in a polyploid species. This might explain why herbicide resistance evolution occurs much more rapidly in a diploid species than a polyploid species (Yu et al., 2017).

The high-quality draft genome of a glyphosate sensitive *Amaranthus palmeri* biotype will serve as a solid genomic foundation for discovery and comparative genomics in weedy species (Saski et al., 2017).

A new point mutation at amino acid position 102 resulting in Thr-102-Ser substitution is very likely responsible for the low-level glyphosate resistance in *Tridax procumbens* from Australia (Li et al., 2017).

The transcriptomics study of glyphosate-resistant and sensitive *Conyza bonariensis* populations revealed a gene involved in cell transport, which is likely the candidate for non-target-site resistance in the resistant *Conyza bonariensis* population (Hereward et al., 2017).

Diagnostic Session

Molecular markers for analyzing target-site mutations or non-target-site based resistance mechanisms might offer novel tools to develop quick field tests. These early, fast and reliable diagnostics can offer the opportunity to recommend the best integrated weed management strategy and mitigate the evolution of herbicide resistance in weeds (Beffa, 2017).

Derived Polymorphic Amplified Cleaved Sequence (dPACS) involves in PCR, restriction digestion and horizontal gel electrophoresis for genotyping individual samples. It has been used to detect target mutation for EPSPs, ACCase, and PSII inhibiting herbicides. dPACS will benefit resistance mechanism and monitoring of herbicide resistance studies (Kaundun et al., 2017).

Syngenta Resistance In-Season Quick (RISQ) test uses transplanting suspected, resistant, and sensitive *Amaranthus spp.* populations to agar plates containing informative rates of herbicide to monitor herbicide resistance. RISQ has been fast and reliable for the detection of resistant *Amaranthus spp.* to a wide range of herbicides (Jackson et al., 2017).

Lessons from Other Disciplines Session

Mechanisms of insecticide resistance generally involve in reduced penetration, enhanced metabolic detoxification, and changes in target site sensitivity. Like weeds, resistance evolution in insects involves a response to a selective pressure and that the stronger the selective pressure, the greater the risk of resistance (Siegfried, 2017).

Lack of effective integrated management practice and fungicides diversity has hindered effective management of fungicide-resistant pathogen. Some pathogen strains have evolved resistance to pesticides involving multiple modes of action (McGrath, 2017).

Modeling & Population Genetics Session

Nonlinear differential equations were used to represent enzyme kinetic reactions of P450, GST, glycosyltransferase and ABC transporter. This model indicated rotation of crop and herbicide with different modes of action can delay or prevent the evolution of resistant weeds (Riechter et al., 2017).

To analyze what factors affecting the success and long-term cost of an herbicide resistance eradication program, a new model involving spatial and genetic landscape was developed representing herbicide-resistance evolution and spread (Renton, 2017).

Transcriptomics / Genomics Session

Epigenetic changes regulate expression of genes involving herbicide detoxification and cause altered herbicide sensitivity in transgenic *Arabidopsis thaliana* that might be related to evolution of herbicide resistance (Merotto et al., 2017).

Genome sequencing and assembly of *Kochia scoparia* suggests that *Kochia scoparia* undergoes substantial gene duplication and increased genetic diversity at key loci involved in abiotic stress response (Patterson et al., 2017).
References: Global Herbicide Resistance Challenge, 2017
http://nebula.wsimg.com/872f402d7e359e9a5f7fd48cc701a11b?AccessKeyId=794987A26A776E19CC4A&disposition=0&alloworigin=1

The Harvest Weed Seed Control (HWSC) symposium was held at the completion of the Global Herbicide Resistance Challenge
. This symposium provided an opportunity to develop coordinated approaches to the introduction and adoption of HWSC systems in global cropping systems.

There were approximately 100 delegates and presenters representing many of the world's cropping regions at the symposium. Seed retention data were used to highlight HWSC opportunities on major weeds of these regions. Weed seed retention at crop maturity indicates the proportion of weed seed production that can be collected during crop harvest. The initial session of the symposium focused on presentation of currently available seed retention data for the dominant weeds of global cropping systems.

The second session of the symposium focused on the opportunities for HWSC in global cropping systems. Presentations in this session covered any available information on the evaluation of HWSC systems as well as speculation on opportunities or barriers to the use of these systems in global cropping systems. At the completion of this session, Peter Newman facilitated a discussion on the HWSC potential on many of the "driver" weeds of cropping systems. The issues/topics identified for future research are:

- Influence of "harvest aids" (crop desiccants) on weed seed retention
- Crop competition (row spacing) effects of seed retention
- Impact of crop swathing on early shedding
- Need for seed retention studies in south America and Europe
- Financial assessment of HWSC systems
- Opportunities for HWSC in fallow situations
- Potential for weed species shifts

The symposium concluded with industry perspective presentations. These included the development and use of the integrated Harrington Seed Destructor, adoption of HWSC in Australia and the impact of HWSC on cropping. The concluding discussion highlighted the need for further research and development of HWSC for production systems facing severe herbicide resistance threats in major weeds. Specifically, weeds of South American soybean production systems and blackgrass in the UK and Europe were identified as priority areas for further work.

Recommendations for Board Action: This committee should work collaboratively with other committees involved in herbicide resistance.

Budget Needs: None at this time

Suggestions for the Future:

1. The committee is considering providing a list of herbicide resistance websites and educational materials placed on the WSWS website for member's ease of access. This would include summaries of meetings and symposia such as the Global Herbicide Resistance Challenge provided in this report and a summary of the WSSA resistance listening sessions.
2. The committee is encouraged to use social media for disseminating information.
3. A symposium was considered, but another committee has already submitted.

Current Committee Members: Joan Campbell, Rong (Rachel) Ma, Drew Lyon

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