Ministry of Higher Education
Salahaddin University
College of Agricultural Engineering Sciencies
Plant Protection Department

Weeds and Weed Control
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Lecture 8

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Herbicides resistance

There are three main plant responses to herbicide application.

1. Susceptibility

Is demonstrated when the treated plant dies as a result of a herbicide used at a normal rate.

2. Tolerance

Is the inherent ability of a plant to survive and reproduce after herbicide treatment. This implies that there is no selection or genetic manipulation but that the plant is naturally tolerant- for example, grass tolerance to 2,4-D or carrot tolerance to trifluralin.

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3. Resistance

As defined by the Weed Science Society of America, is the inherited ability of a plant to survive and reproduce following exposure to a dose of herbicide normally lethal to the wild type. Resistance may occur naturally or be induced by selection pressure.

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Within resistance there are three subcategories used to describe particular types of resistance.

1. Cross-resistance occurs when a plant selected for resistance to a specific herbicide is also

resistant to other herbicides within a similar chemical group (such as resistant to atrazine and to other s-triazines as well).

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2. Multiple resistance occurs when a plant is resistant to herbicides that are chemically unrelated and that have different modes of action (such as a well resistant to both sulfonylurea and aryloxy phenoxy propanate herbicides).

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3. Negative cross resistance

Occurs when a biotype resistant to a particular herbicide is more susceptible to other classes of herbicides than the susceptible biotype- for instance, an atraxzine-resistant redroot pigweed (*Amaranthus retroflexus*) that is more susceptible to flometuron (cotoran/meturon) that the triazine-susceptible biotype.

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Herbicide resistance

Herbicide resistance is the ability of a weed biotype to survive and reproduce after treatment with herbicides that would typically have been lethal.

The development of herbicide resistance poses three serious problems:

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1. It is very expensive and time consuming to test for and to develop alternative management plans.

2. Develop management techniques to continue utilizing current herbicides and protect them against resistance development. Few new active ingredients are being discovered and developed into commercial products due to their high costs of development.

3. Development of herbicide resistance in a biotype limits weed management options and creates economic consequences.

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Factors that control development of resistant weeds

1. Selection Pressure.

If highly effective and applied often, has long soil residual activity, and is the only practice utilized to control a weed species, high selection pressure is placed for resistant biotypes of a weed.

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2. Weed biology

a. Genetic variability: Some plant species have high genetic variability meaning that many different varieties or biotypes exist under the one species. Cross pollinating species like kochia have greater genetic variability that self-pollinating species. Weeds with higher genetic variability generally develop resistance quicker, since chances are there are more resistant biotypes within a population prior to spraying.

b. Seed longevity: Plant species that produce long-lived seed tend to develop resistance more slowly. This is because susceptible seeds from the seedbank germinate over many years adding variation to the population.

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3. Genetics of resistance

This is regarding the site of action of the herbicide on the plant.

There are differences pertaining to the frequency mutations occur at different biological target sites within plants.

Sites that have high frequency of mutation, tend to develop quickly.

The target site of glyphosate do not mutate as often. Glyphosate resistance does not exist, but it took many years to develop.

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Herbicide Resistant Crops

The use of biotechnology to develop crop plants with new resistance to herbicides, notably broad-spectrum herbicides such as glyphosate, has had a significant impact on weed control practices.

This will continue as the ability to manipulate herbicide tolerance using these methods expands: More genes for herbicide resistance are being developed and the number of crops that can be genetically modified in this way is increasing.

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Indeed, it is possible that this approach will change the manner in which herbicides are developed. Rather than identifying a herbicide with selectivity, genes for resistance to specific herbicides (including new ones) may be incorporated into specific crops.

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Principal requirements for manipulating herbicide resistance in plants through biotechnology:

1. Identification of a gene that can provide resistance to a herbicide

2. Modification of this gene so that it can be expressed in the target crop plant.

3. Transfer of the modified gene into the crop plant.

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Each of these components has been developed over the last 15 years as our understanding of plant biochemistry, physiology, and molecular biology has increased.

The application of genetic engineering to herbicide resistance is the first major commercial success in agricultural biotechnology.

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Identification of Genes for Herbicide Resistance

Plants use a number of mechanisms to tolerate herbicides, including reduced uptake of the

herbicide, increased metabolism, and a target site that is not affected by the herbicide.

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Conceptually, genes could be identified that would alter any of these steps to provide resistance to a specific herbicide.

In practice, the two mechanisms that have been favored for genetic engineering are modification of the target site and metabolism of the herbicide.

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The revolutionary aspect of this new technology is that genes for such traits need not come from the traditional germ plasm resources used by plant breeders. Rather, genes for herbicide resistance may be found in any organism, including microbes. Once identified, these genes can be isolated, modified to function appropriately in a plant, and transferred to the crop.

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The strategy used to identify genes for herbicide resistance depends on the nature of the herbicide and its mode of action.

An approach that has proven effective in many cases is to identify microbes that either survive in the presence of the herbicide or use the herbicide as a food source.

There are a number of advantages to screening for herbicide resistance genes in bacteria:

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- Large numbers of bacteria can be tested through simple procedures, such as screening for bacteria that grow on agar medium supplemented with the herbicide.
- Large collections of bacteria can be obtained simply from soil samples or other sources.
- Genes that are responsible for herbicide resistance can be isolated rapidly because bacterial genomes are small and molecular genetic techniques facilitate this process.

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