# HERBICIDE SITE-OF-ACTION AND MODE-OF-ACTION

One of the subjects that is prevalent in the discourse surrounding HR weeds is how the various herbicides work to control weeds. This leads to use of the terms "site-of-action (SOA)" and "mode-of-action (MOA)". These two terms are often used interchangeably, but they in fact refer to two different interactions/processes. The following narrative attempts to differentiate between the two terms.

In an article entitled "What's the difference between herbicide mode of action and site of action" authored by Dr. Gared Shaffer of South Dakota State University, the following is proffered.

- "All herbicide interactions with the plant, from application to final effect, are considered the **mode of action**. The MOA involves absorption into the plant, translocation or movement in the plant, metabolism of the herbicide, and the physiological plant response." In other words, the mechanism by which a herbicide kills a plant is known as its **mode of action**.

- "Herbicide **site of action** is the specific process in plants that the herbicide disrupts to interfere with plant growth and development. The SOA is the most important aspect of herbicides when dealing with prevention and control of herbicide-resistant weeds."

According to the content of an article entitled Herbicide Site of Action, Mode of Action Differences" that appeared in Ag Professional magazine, "The site of action is the location within the plant where the herbicide impacts the development process. The mode of action is the name for the process the herbicide uses to control the weed. So site of action is 'where' and mode of action is 'how'". According to Dr. Bryan Young in the same article, "Typically the target is an enzyme used in carrying out a process like amino acid production or photosynthesis. The herbicide targets the enzyme and stops the process".

Dr. Joe Armstrong of Oklahoma State University authored an article entitled Understanding Herbicide Mode of Action", where he states "The mode of action is the way in which the herbicide controls susceptible plants. It usually describes the biological process or enzyme in the plant that the herbicide interrupts, affecting normal plant growth and development. In other cases, the mode of action may be a general description of the injury symptoms seen on susceptible plants. Some herbicide modes of action comprise several chemical families that vary slightly in their chemical composition, but control susceptible plants in the same way and cause similar injury symptoms." He further states that "herbicides can also be classified by their 'site of action', or the specific biochemical site that is affected by the herbicide. The site of action is a more precise description of the herbicide's activity."

In an article entitled "Herbicide Sites of Action", Dr. Bob Hartzler of Iowa State University presents the following.

- "Herbicides kill plants by binding to a specific protein and inhibiting that protein's function. The protein is referred to as the herbicide's **site of action**."

An example of how site of action and mode of action differ in their meaning is provided in "Herbicide Site of Action and Injury Symptoms".

- "A triazine herbicide (e.g. atrazine, metribuzin) interferes with photosynthesis by binding to the D1 protein involved in photosynthetic electron transfer. Thus, the site of action for triazines is the D1 protein, whereas the mode of action is disruption of photosynthesis."

The Weed Science Society of America (WSSA) has devised a number system that can be used to classify individual herbicides according to their MOA and SOA. Examples from Dr. Shaffer's article are shown in the following table.

| **Herbicide MOA** | **Herbicide SOA–WSSA number** | **Herbicide Examples** |
|---|---|---|
| Lipid synthesis inhibitors | ACC-ase inhibitors–1 | Poast, Select, Fusilade DX |
| Amino acid synthesis inhibitors | ALS inhibitors–2 | Classic, FirstRate, Pursuit |
| | EPSP synthase inhibitor–9 | Roundup |
| Nitrogen metabolism inhibitors | Glutamine synthetase inhibitor–10 | Liberty, Cheetah |
| Pigment inhibitors | HPPD inhibitors–27 | Callisto |
| Cell membrane disruptors | PPO inhibitors–14 | Valor, Sharpen, Blazer |
| | Photosystem I inhibition–22 | Gramoxone |

The WSSA numbering system in the above table allows users to evaluate a herbicide program based on this SOA, with SOA diversity being an important component of a weed control program designed to prevent or delay herbicide resistance. This numbering system can be used to blend the "site of action" and "mode of action" information into one piece of knowledge that can be used to select a weed management program that includes diverse herbicides.

Click here for a detailed presentation on how to use MOA to select herbicides.

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