SOYBEAN HERBICIDE INJURY

Weed management is an important component of soybean production practices. Preemergence and postemergence herbicides, while valuable weed management tools, can also injure soybean plants. Typical soybean herbicide injury symptoms observed are stunting, drawstring (puckering), chlorosis (yellowing), and necrosis. Herbicides are sometimes blamed for crop injury caused by environmental conditions, nutrient deficiencies, or diseases that cause similar symptoms (Figure 1). When diagnosing injury, detailed information about conditions prior to injury symptom appearance as well as plant and soil sample results should be considered before making a diagnosis.

Repeated use of herbicides with the same site of action can result in the development of herbicide-resistant weed populations. The herbicide site of action refers to the site at which the herbicide inhibits or restricts a plant's normal physiological processes at the cellular level. This is sometimes referred to as mode of action, although there is a difference between the two, as mode of action refers to the biological process that is affected by the herbicide, e.g. photosynthesis, amino acid synthesis. The Weed Science Society of America (WSSA) herbicide classification groups help determine the site of action for the myriad of herbicides on the market. Each site of action has been assigned a number, and most herbicide labels prominently display this group number on the product label. If a product includes two different sites of action, the label will have two different group numbers listed. Keeping track of the herbicide group numbers is the simplest way to keep track of the different sites of action used in a herbicide program.

During or at Emergence		
Mimics of Herbicide Injury to Soybean		
GROUP #	HERBICIDE SITE OF ACTION	SYMPTOM
4 19	GROWTH REGULATORS	Crusted soil
5 6 7	PHOTOSYNTHESIS INHIBITORS	Frost
		Sunblasting
		Sun scald
		Disease- Phytopthora
		Disease- Rhizoctonia seedling rot
14	PPO INHIBITORS	Sandblasting
		Disease- Bacterial leaf blight
3	SEEDLINGS ROOT GROWTH INHIBITORS	Cold/Wet soil
		Compacted soil
		Swollen hypocotyls caused by crusted soil or deep planting
		Damage- Nematode

After Emergence		
Mimics of Herbicide Injury to Soybean		
GROUP #	HERBICIDE SITE OF ACTION	SYMPTOM
2	ALS INHIBITORS	Iron deficiency
		Potassium deficiency
9	EPSP SYNTHASE INHIBITOR (GLYPHOSATE)	Iron deficiency
		Potassium deficiency
10	GLUTAMINE SYNTHASE INHIBITOR (GLUFOSINATE)	Frost
		Iron deficiency
4 19	GROWTH REGULATORS	Disease- Virus
		Damage- Aphid feeding
5 6 7	PHOTOSYNTHESIS INHIBITORS	Frost
		Sandblasting
		Sun scald
		Iron deficiency
		Potassium deficiency
		Disease- foliar
		Disease- root
		Disease- seedling
22	PHOTOSYSTEM I ELECTRON DIVERTER	Frost
		Sun scald
		Disease- Septoria leaf spot
		Disease- Bacterial leaf blight
14	PPO INHIBITORS	Disease- Pythium
		Disease- Rhizoctonia
		Disease- Phytopthora
8 15 16	SEEDLING SHOOT GROWTH INHIBITORS	Deep planting
		Crusted soil
		Disease- Phytopthora
		Disease- Pythium
		Disease- Rhizoctonia

Figure 1. Mimics of herbicide injury to soybean during or after emergence.

Source: Bosak, L. 2015. Herbicide injury during and after emergence in soybean. Wisconsin Crop Manager Newsletter. Integrated Pest and Crop Management. University of Wisconsin-Madison. http://ipcm.wisc.edu.

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Factors for Herbicide Injury

The likelihood of crop injury from herbicides depends on several factors, including:

- Environmental conditions. All herbicides require optimum conditions for maximum efficacy. Temperature, relative humidity, soil texture, and soil moisture impact potential soybean injury.
- Directions for use. Herbicide labels provide information about herbicide rate, application methods, and adjuvants, along with the crop and weed growth stage to apply herbicide. Any violation to instructions may result in soybean injury.
- Herbicide active ingredients. Some herbicide active ingredients, such as PPO inhibitors, along with the additives, may cause some level of injury to soybean, but injury resulting from an application made according to the label instructions usually does not cause a reduction in yield.
- Off-target movement. Off-target movement of herbicides may cause injury, resulting from either physical spray drift or vapor drift. Physical drift occurs during herbicide application when small droplets move from the site of application to nearby fields. Vapor drift occurs when herbicides evaporate off the target site and are transported by the wind off-target. It is often intensified and can result in greater injury when a temperature inversion exists. Vapor drift is chemical-specific and occurs under high temperatures and low relative humidity.
- Tank mixtures. Herbicide pre-mixtures and/or tank mixtures may result in combined symptoms of injury in crops.

Preemergence Herbicides

Seedling root growth inhibitors (Group 3) (examples: pendimethalin, trifluralin): Injury from these herbicides can cause swelling of the hypocotyl, reduced root growth, and delayed emergence. Injury is most likely where cool, wet soils slow emergence, therefore increasing absorption of the herbicide into the emerging soybean. Occasionally, a preemergence application or shallow incorporation of dinitroaniline herbicides can cause callus tissue to form on the plant stem near the soil surface. This can result in a brittle stem and increased susceptibility to lodging.

Figure 2. Excessive rates of dinitroaniline herbicides may result in seedling soybean with pruned roots and swollen or cracked hypocotyls. Photo courtesy of Purdue University.

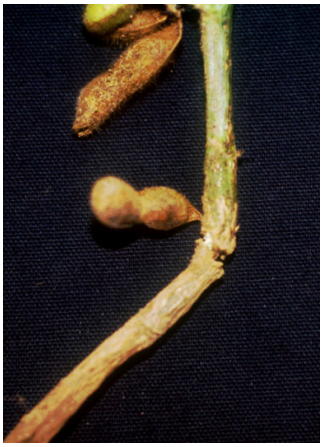

Figure 3. Sometimes a preemergence application of dinitroaniline herbicides can cause callus tissue to form on the plant stem near the soil surface. This can result in a brittle stem and plant lodging. Photo courtesy of Steven Gower.

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Photosystem II inhibitors (Group 5) (example: metribuzin): Injury symptoms include interveinal chlorosis and necrosis on emerged leaves. Symptoms typically appear on the unifoliate and first trifoliate leaves, later-emerging leaves are usually unaffected. In severe cases, two or three nodes may be killed. The risk increases in fields with high pH soils due to greater availability of the herbicide.

Figure 4. Interveinal chlorosis (yellowing) and necrosis (browning) of older soybean leaf tissue may result from the use of triazine herbicides such as metribuzin or the carryover of herbicide residues of atrazine or simazine. Photos courtesy of Purdue University.

PPO inhibitors (Group 14) (examples: sulfentrazone, flumioxazin): Injury is most likely when rain increases herbicide availability as the hypocotyl approaches or emerges through the soil surface. Symptoms include necrotic lesions on the cotyledons and hypocotyl, and often are more severe in poorly-drained areas of the field. With severe injury, the hypocotyl can be girdled, resulting in plant death. Herbicide contact with the apical bud results in malformed leaves and occasionally death of the primary stem. In most cases yield is not affected by damage, except in cases where the hypocotyl is girdled, or apical bud is damaged.

Figure 5. Heart-shaped leaflets on soybean from metolachlor injury. Photo courtesy of Steven Gower.

Seedling shoot growth inhibitors (Group 15) (examples: acetochlor, metolachlor): These herbicides (amide type) are less likely to cause soybean injury than Group 14 products. The most common symptom is development of heart-shaped leaflets. Soybean plants typically grow out of this very quickly. An interaction between Group 15 products and flumioxazin reduces soybean tolerance, therefore increasing the potential for damage. Fields treated with tank mixes of these products prior to heavy rains may exhibit symptoms.

Herbicide Carryover

The potential for carryover injury to rotational crops is influenced by the amount of herbicide present in the soil, the susceptibility of the rotational crop, and conditions that occur after application.

Soil residual herbicides are an important component of weed management, and carryover problems generally do not occur under normal conditions. Most soybean residual herbicides labeled for soybean must be applied before emergence. Residual herbicides can be utilized effectively with minimal concerns for the current or future crops. Keep

records of which fields received a residual herbicide and check these records prior to planting the following spring. Be careful during the residual herbicide application. Be sure the correct rate is used, and that the sprayer is properly calibrated. Avoid boom overlaps in the field and while spraying the ends of the rows. Consult the individual product labels for instructions and precautions for use.

Figure 6. HPPD (Group 27) corn herbicide carryover to soybean.

It is important to note that corn injury from fomesafen carryover has become an increasing problem. Fomesafen herbicide products are used in soybean crops to help manage tough-to-control weeds like waterhemp and Palmer amaranth and can result in multiple and late-season applications. Fomesafen is relatively persistent, and when less than average late-season rainfall occurs, the product can carryover into corn as a rotational crop. Dry and cold weather during the fall and winter can reduce herbicide dissipation and contribute to a carryover problem. The primary symptom of fomesafen injury is striped leaves due to chlorotic or necrotic veins on the leaves. Other factors can cause striping on leaves, but fomesafen is unique in that the veins are affected rather than interveinal tissue.

Fall-planted crops and cover crops may also have limited tolerance to some herbicide residues. Cropping plans may need to be changed in fields where carryover could occur. Good weed management planning and recordkeeping is necessary to help minimize potential carryover to rotational crops.

Figure 7. Corn injury from carryover of fomesafen. The primary symptom is striped leaves due to chlorotic or necrotic veins on the leaves.

Postemergence Herbicides

ALS inhibitors (Group 2) (examples: chlorimuron, imazethapyr, thifensulfuron, imazamox): The leaves of soybean plants with ALS inhibitor injury show stunting, leaf chlorosis and distinctive reddish leaf veins. Postemergence application injury with these herbicides increases on days with high temperatures and humidity. Young leaves are the first to be affected after herbicide application due to systemic activity throughout the plant. Soybean plants can typically overcome injury symptoms within several weeks due to their rapid growth.

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Plant growth regulators (Group 4): (examples: 2,4-D, dicamba). Soybean plants are sensitive to plant growth regulator herbicides if they do not contain herbicide tolerance traits for the specific herbicide being considered. Several herbicides from this site of action group are volatile, and the misapplication or drift of these herbicides may cause injury to soybean plants or other sensitive plants. As these herbicides are systemic in nature, soybean injury can be observed on newly developed tissues or leaves. Injury symptoms include epinastic (downward) bending or twisting of the stems and petioles, along with leaf cupping and curling. Leaf shape and venation are often abnormal after exposure to plant growth regulator herbicides, followed by chlorosis of young leaves, and wilting. It may take two to four weeks to kill soybean plants after an application of a plant growth regulator herbicide.

Figure 8. ALS injury to soybean. Photo courtesy of Steven Gower.

Figure 9. 2,4-D Injury to soybean (left) and dicamba injury (right). Photos courtesy of Steven Gower.

Photosystem-II inhibitors (Group 6) (example: bentazon): Few herbicides from this site-of-action group are registered for postemergence use in soybean. Bentazon is believed to be safe on soybean foliage, but under certain conditions may cause bronzing or necrotic spots starting from the leaf margin, or chlorosis of the leaves.

Glutamine synthetase inhibitors (Group 10) (example: glufosinate): Glufosinate can be applied postemergence in glufosinate-resistant soybean, though misapplication of glufosinate on glyphosate-resistant soybean will cause significant injury. Chlorosis and wilting of the soybean plants can be observed within three to five days after application, followed by necrosis in one to two weeks. These symptoms can mostly be observed on older leaf tissues. Bright sunlight, high humidity, and moist soil can increase the intensity of glufosinate injury on soybean plants that are not tolerant to glufosinate.

Figure 10. Injury from glufosinate to soybean. Photo courtesy of Steven Gower.

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Long-chain fatty acid inhibitors (Group 15) (examples: dimethenamide, acetochlor, pyroxasulfone): Herbicides from this site of action group are registered for residual control of grass and small-seeded broadleaf weeds. A few herbicides from this group are also labeled for postemergence application in soybean. Cold and wet weather during herbicide application increases the possibility of injury to soybean leaves, with symptoms including shortening of the mid-vein with crinkled and heart-shaped leaves.

Figure 11. Acetochlor injury to soybean. Photo courtesy of Steven Gower.

PPO inhibitors (Group 14) (examples: lactofen, fomesafen, acifluorfen): Postemergence herbicide applications with PPO-inhibiting herbicides may result in soybean injury, specifically during hot and humid weather. Tank contamination and drift can sometimes result in PPO inhibitor herbicide injuries to soybean. Injury symptoms range from bronzing and speckling of the leaves to necrosis of the leaf tissue. PPO inhibitors are contact herbicides, and symptoms can be observed on the fully opened leaves at the time of herbicide application. Lactofen injury to soybean can appear 7 to 14 days after herbicide application, but soybean plants can usually overcome injury symptoms 21 to 30 days after herbicide application without yield loss.

Figure 12. Leaf speckling caused by lactofen injury to soybean. Photo courtesy of Steven Gower.

Sources

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Legal Statements