Influence of Environmental Factors on the Efficacy of Postemergence Herbicides. Anil Shrestha, California State University, Fresno, CA

The Weed Science Society of America has classified herbicides into 29 groups based on their mode of action. Most of these herbicides fall under one of the following eight major physiological modes of action: cell membrane disrupters, growth regulators, amino acid synthesis inhibitors, lipid synthesis inhibitors, glutamine synthesis inhibitors, photosynthesis inhibitors, pigment inhibitors, and seedling growth inhibitors. Among these, the first five modes of action listed are mostly found in post-emergence herbicides, whereas the last three are mostly found in pre-emergence herbicides.

Factors that strongly influence post-emergence herbicide efficacy include characteristics of the plant (leaf orientation, leaf area, pubescence, cuticular wax, growth stage etc.), characteristics of the spray (surface tension, droplet size, spray volume etc.), and environmental conditions during spray application (temperature, moisture, relative humidity, light etc.). Of the post-emergence herbicides, some are contact type while others are systemic. Contact herbicides only directly kill plant parts on which the chemical is deposited, and thus are most effective against small weed seedlings and annual weeds. Therefore, plant and spray solution characteristics may affect efficacy of contact herbicides more strongly than environmental factors. Systemic herbicides are absorbed either by roots or foliar parts of a plant and are then translocated to other parts of the plant system. This suggests that characteristics of the plant, spray solution, and environmental factors may have equally important influence on the efficacy of systemic herbicides. Environmental factors (both physical and chemical) influence the amount of herbicidal penetration and translocation, and ultimate toxicity. Thus, not only short-term but long-term effects induced by environmental factors are important for herbicide efficacy.

Photosynthesis and respiration are temperature dependent and higher temperatures generally enhance herbicide penetration and translocation within plants. However, certain herbicides are less effective at high temperatures and some herbicides (e.g. dicamba) can volatilize at temperatures >77°F. Generally, under warmer temperatures the waxy cuticle is more permeable which allows herbicides to penetrate through this layer more easily and enter plant cells. Lower temperatures can reduce cuticle permeability and also reduce herbicide translocation. For herbicides to translocate more rapidly, the plants must be actively growing for the herbicide to inhibit the targeted process. However, very high temperatures can result in reduction in herbicide activity due to lack of metabolic activity in the plants. Generally, contact herbicides are less influenced by cool air temperatures than systemic ones because they do not need to be translocated. In the case of glyphosate efficacy on hairy fleabane (*Conyza bonariensis*), it was reported that the herbicide provided better control of the plants when it was applied on plants that were grown in 60/50 and 78/68°F day/night temperature than plants that were grown in 95/85°F. Under the low temperatures some of the glyphosate- and paraquat-resistant hairy fleabane plants were also controlled (Dennis et al. 2016).

Similarly, relative humidity can also influence the efficacy of post-emergence herbicides. Plants growing under low relative humidity tend to have thicker cuticles and thus herbicide penetration would be reduced under such conditions. Low relative humidity combined with high air temperatures can make the cuticle thicker and less penetrable.

Light (both quantity and quality) is another important environmental factor that influences the effectiveness of post-emergence herbicides. Plant response to foliar applied herbicides is usually more rapid on sunny days. Light intensity will directly and indirectly effect herbicide performance through many processes. For example, high light intensity directly improves herbicide penetration into leaves and promote systemic movement of herbicide in the phloem. Furthermore, light influences leaf shape and plant architecture. For example, under high light intensity plants tend to have short internodes, smaller, and thicker leaves with a waxier cuticle than plants growing under low light intensity which have larger, thinner leaves with thinner cuticles and less wax. These factors will influence the amount of herbicide that penetrates and thus their efficacy. Light is an essential factor for the activity of some herbicides such as paraquat and PPO inhibitors. A study by Dennis et al. (2016) reported that glyphosate provided better control of hairy fleabane plants when applied in fall than in spring indicating the role of light intensity even for glyphosate. Similarly, a study by Cox et al. (2016) reported that junglerice (*Echinochloa colona*) control by sethoxydim was reduced under shade compared to full sun conditions.

Along with the environmental factors discussed above, soil moisture is another factor influencing weed control with postemergence herbicides. Dry conditions can cause the plants to develop thicker cuticles, reduce absorption, retention, and translocation of the herbicides, and alter plant metabolisms, ultimately influencing the efficacy of postemergence herbicides. Recommendations from Purdue University (Legleiter and Johnson, 2012) for weed control under drought conditions suggest using maximum label rates, making herbicide applications in the morning when weeds are most active and before leaves begin to curl and roll, applying contact herbicides at higher carrier volumes and in the morning when leaf surface exposure is most favorable for contact, and maximizing adjuvant rates. Cox et al. (2016) reported that the efficacy of glyphosate on junglerice was affected by soil moisture levels. The efficacy was generally greater under shade than under full sun conditions and mortality was greater at 100% and 75% Field Capacity (FC) than at 50% FC. However, control of junglerice with sethoxydim was lower under shaded and low moisture conditions. Therefore, this study suggested that both shade and soil moisture conditions should be taken into consideration when selecting postemergence herbicides for control of junglerice.

In summary, environmental conditions along with the type of weed species present have to be taken into consideration while selecting postemergence herbicides. Although it is difficult to make specific recommendations, as a general rule for best weed control with postemergence herbicides, they have to be applied under ideal temperatures (65 to 85°F), when the weeds are actively growing, and the relative humidity is higher. The soil moisture needs to be adequate for active growth of the weed for successful translocation of systemic herbicides.

References:

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