Preemergent Herbicides: How to Make Them Work

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To get the most efficacy out of the herbicide that you apply, there are several factors that need to be considered. Each factor can be the difference between partial control or full control of the weed spectrum in the field. What are these factors and how do they work?

There are several factors to take into consideration:

1) Weed spectrum
2) Properties of the herbicide
3) Timing of Application
4) Placement in the soil
5) Soil Moisture

Weed species react differently to different herbicides (selectivity). Grass seedlings respond differently than broadleaf seedlings. Most grass seeds germinate the first season, whereas broadleaves often have some dormancy factor involved, thus most of the seeds may live over into succeeding years. Weed seed size can also make a difference. The larger seeds because they have more energy, can germinate at deeper depths than small seeds. Also often weed species can have a long germination period, since their germination is not synchronized. Also, the placement of the seed in the seed-bank can affect control. Seeds are often distributed throughout the upper soil layer due to cultivation (shallow tillage or deep plowing) compared to shallow distribution in no-till culture.

Herbicide performance is dependent upon the herbicide properties. These include: chemical properties, water solubility, soil adsorption capability, volatility and degradation characteristics on the soil surface or in the soil.

Timing of application is critical. In general, the herbicide needs to be in place, either on or in the soil, when the seed is germinated. This is especially true when the mode of action is root stunting such as the dinitroanilines. It is also necessary to have a product like oxyfluorfen on the soil as the seedling germinates and starts though the herbicide in a shallow layer at the soil surface.

Soil moisture is critical for the optimum performance of any given herbicide. First there needs to be soil moisture for the seeds to imbibe water to germinate. Secondly, a herbicide can not move into the germinating seed if there is not free water for the herbicide to travel with into cells. Also, there needs to be moisture that distributes the herbicide on the soil surface, or move the herbicide into the upper soil surface where the seeds are germinating. The characteristics of some herbicides also affect the amount of time they can stay on the soil surface before rainfall or irrigation is required to get the herbicide into the germinating zone. The first water event is the most important in

moving the herbicide to the proper location in soil. Once the herbicide is adsorbed to the soil particles they are much less prone to move deeper into the soil with the next irrigation. If too much water is applied after application on a light, coarse soil, the water may move the herbicide too far into the soil, and seedlings may survive above the herbicide.

Table 1. Comparisons of common herbicides from different families as to the time before water and the amount of water needed to move the herbicide to the appropriate soil zone.

Herbicide	Surface stability	Moisture regime	Half-life (days)	Concerns
Solicam DF	Stable 4 wks	0.5 in water	45-180	Coarse soil, low areas
Goal 2XL	3-4 wks	> 0.25 in.	35	No soil disturbance
Simazine	2-4 wks	0.5 in	60	Movement in course soils with long use.
Barricade	w/in 14 d	0.5 in. or shallow incorporation	70-120	Slight disturbance OK

Temperature can have an affect on the action of preemergent herbicides, primarily because germination and growth responds to temperature. Each species has their own requirements for germination. Once germination has occurred, maximum growth will occur with the optimum temperature for the species. Relate uptake and growth, if moisture is present, the more growth, the more uptake.

Chemical characteristics of the herbicide will determine activity such as movement in the soil, uptake into the seedling and movement in the plant. Water solubility, volatility, lipophilicity (lipid affinity), resistance to degradation, chemical characteristics, and adsorption characteristics of the herbicide, all affect how the herbicide works. Even though many preemergent herbicides have low solubility (2.6 ppm in water for Surflan, or 0.013 ppm for prodiamine), only a small amount is needed to get to the growing point since they are so efficient in stopping cell division.

Volatility:
When the herbicide is volatile, it can be detrimental since it may be lost to the environment without benefiting herbicide activity (trifluralin or EPTC). Another herbicide that can benefit from its volatility to get a more uniform response is oxyfluorfen. If a herbicide is moved into the soil with water or shallow incorporation it can be beneficial, since it can be taken into the seedling through the vapor phase (trifluralin). This is very apparent when trifluralin is placed in a concentrated band in the soil, where it not only stunts roots but even causes shoot suppression of an established plant like field bindweed.

The primary method of uptake of the herbicide is with water into the root. The greatest absorption area is in the root tip and differentiation zone through the root hairs. These roots have very little obstruction to uptake since they are not like a leaf that has waxes on the leaf surface or a cuticle to pass through to get to a cell that will transport the

herbicide. Soil applied herbicides can pass through the cell walls and cell membrane of the root cell into living tissue on the way to the dead cells (xylem) and follows the water. Examples of these herbicides include the triazines, ureas, uracils or norfluorazon. Herbicides may also go through the living part of a cell on the way to the living cells (phloem) as part of the vascular tissue. An example of these herbicides include rimsulfuron. Some herbicides can move into cells at a location on the emerging stem. These herbicides can act as contact herbicides such as the diphenylether, oxyfluorfen or flumioxazin. Others act as shoot and root inhibitors from shoot uptake such as EPTC or metolachlor.

Shoot activity can be a second method of uptake for preemergent herbicides.
Shoot uptake takes place in the coleoptile, lower stem tissues and some root uptake exp. EPTC, Dual, and dimethenamid. These products inhibit leaf growth by the primary leaf failing to grow through the coleoptile sheath, thus the seedlings are stunted and are not competitive.

Thus to summarize one could say something similar to a real estate agent; it is location, location, location. A preemergent herbicide needs to be in moist soil, at the right place, at the right concentration, for the correct length of time, to be effective for control.
Additional reading:

Principles of Weed Science. 3rd Edition. 2002. Thompson Publications, Fresno, Ca 93791.
Monaco, T.J., S.T Weller and F.M. Ashton. 2002. Weed Science; Principles and Practices, 4th Edition. John Wiley and Sons, Inc. New York.
Herbicide Handbook, Weed Science Society of America, 8th Edition, 2002. W. K. Vencill, Ed. Weed Science Society of America, Lawrence, KS, 66044-8897
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Shaner, D. L., and S. L. O'Conner. The Imidazolinone Herbicides, 1991. CRC Press, Inc., Boca Raton, FL. 33431.