Guidelines for Selecting Herbicide Additives for Reed Canarygrass Control

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Herbicide performance depends on how an herbicide is used. Field conditions and selection of herbicide additives can affect the outcome of reed canarygrass (*Phalaris arundinacea* L.) control strategies. Grass-specific herbicides (e.g., Vantage®, Poast Plus®, Select 2EC®, Assure® and Fusilade DX®) require additives to work effectively. There are several types of additives, including crop oils, surfactants, acidifiers, and conditioning agents, to name a few. Although they are not phytotoxic themselves, herbicide additives enhance herbicide phytotoxicity by increasing solubility of the herbicide in water, promoting herbicide uptake and translocation, or altering tank mixture pH. When more herbicide is taken up and translocated, more control is achieved. Choosing an additive (or combination of additives) can be difficult. The adjuvant industry is not regulated and there are no set standards for composition, quality, or even terminology among additives. Furthermore, the availability, price, and active ingredients of additives can change year-to-year. The purpose of this article is to briefly define the conditions under which grass-specific herbicides should be applied, and which additives to use for optimum reed canarygrass control.

Crop oils and nonionic surfactants are additives that enhance uptake and translocation of herbicides. Crop oils are designed to dissolve the waxy cuticle that covers plant leaves. The cuticle acts as a barrier to the passage of substances into and out of the leaf, and removal of the cuticle enhances absorption of foliar-applied herbicides. As a result, more of the herbicide ends up in plant tissues where it can have phytotoxic effects. Crop oils may be petroleum or vegetable (e.g. soybean) based. Nalewaja and Skrzypczak (1986) tested the effects of crop oils on grass control with sethoxydim. In the absence of additives, treated leaves absorbed only 17% and translocated only 10% of the total applied herbicide. In contrast, total uptake and translocation of sethoxydim more than doubled when tank mixtures were supplemented with additives. Absorption increased to 42% and translocation to 26% when soybean-based crop oil was added to tank mixtures. Petroleum-based crop oils were somewhat more effective at enhancing herbicide uptake and movement than vegetable-based oils. Absorption increased to 48% and translocation to 34% when petroleum-based crop oil was added to tank mixtures.

Surfactants reduce surface tension of spray water, allowing spray mixtures to cover leaf surfaces evenly and be absorbed over a larger surface area. Surfactants will usually not dissolve cuticular cells, but some surfactant blends contain a chemical penetrant for this purpose. Surfactant-oil blends are also available. These mixtures take advantage of both the surface tension-reducing properties of a surfactant and the cuticular-penetrating properties of crop oils. Although research shows that crop oils are more effective at promoting herbicide uptake and translocation than nonionic surfactants (Beckett et al. 1992), a number of crop oil blends can cause “spotting” (localized areas of tissue chlorosis and/or necrosis) on non-target species. This is especially true for petroleum-based blends. The spotting is usually not serious and typically goes away within one month, but if you are applying selective herbicides near sensitive species, you may want to consider using a nonionic surfactant to avoid spotting.

Separate additives may be required for hard water tank mixtures. Hard water is alkaline (basic) and can affect the chemical properties of grass-specific herbicides. Hard water will do two things to sethoxydim: First, it will ionize the herbicide (creating a weak acid), decreasing the amount of herbicide absorbed (Beckett et al. 1992). (Sethoxydim uptake proceeds via passive diffusion of the non-dissociated weak acid through leaf tissues). Second, hard water cations (such as calcium and magnesium) accelerate physical and chemical decomposition of sethoxydim (Shoaf and Carlson 1992). If you cannot avoid using hard water in tank mixtures, you can add an acidifier to the mixture. As the name implies, an acidifier is an additive that lowers the pH of tank mixtures. How much you will need to add depends on the pH of your water source, the volume of herbicide you are mixing, and the concentration of acidifying agent in the additive. Acidifiers are sold individually, or as components or some surfactant blends. LI-700® is a familiar example of a surfactant blend available from most orchard suppliers. LI-700® contains a surfactant, an acidifying agent, and a penetrant designed to break down the cuticle and enhance passive diffusion into leaf tissues. Water conditioning agents are another option for hard water tank mixtures. In addition to stabilizing tank mixture pH, conditioning agents (such as ReQuest®) also inactivate and sequester hard water cations.

Field conditions at the time of application can also affect herbicide performance. Air temperature influences herbicide translocation rates and where herbicides are partitioned within the plant. Shoot translocation rates of grass-specific herbicides increase as air temperature increases while rhizome translocation rates remain constant (Harker and Dekker 1988). Applying grass-specific herbicides when air temps are greater than 70°F (20°C) can enhance topkill without diminishing rhizome control. In contrast, glyphosate (Roundup®) translocation patterns favor translocation to shoots at the expense of rhizomes at air temperatures greater than 70°F, resulting in greater topkill but less rhizome bud kill.

Another field condition to consider when applying grass-specific herbicides of the cyclohexane-1,3-dione chemical family (Vantage®, Poast Plus®, Select 2EC®) is ultraviolet radiation. Ultraviolet light decomposes this class of herbicides. Ten-minute exposure to ultraviolet light has been found to degrade more than 50% of sethoxydim applied to leaf surfaces (Shoaf and Carlson 1992). Consider this: The uptake period for sethoxydim is about one hour. If you apply sethoxydim on a bright, sunny day during the early afternoon (when ultraviolet levels are high), you may be loosing most of the active ingredient to decomposition *before it even enters the plant*. To minimize degradation by ultraviolet light, apply grass-specific herbicides on cloudy days, or apply them in either mid-morning (after dew has evaporated from leaves) or late afternoon, when ultraviolet levels are lower. Ultraviolet light will also reduce the effectiveness of vegetable-based crop oils. Methylated vegetable oils are slightly more resistant to ultraviolet degradation (Matysiak and Nalewaja 1999) and can be used in place of ordinary crop oils if ultraviolet light levels are a concern. Grass-specific herbicides belonging to the aryloxyphenoxypropionic acid (APP) chemical family (Fusilade DX®, Assure®) are not decomposed by ultraviolet light (at least not at levels we are likely to encounter in the field) because of their chemical structure.

Perhaps the most important field condition to consider with respect to herbicide application is *active growth of the target species*. Active growth is a requirement for effective uptake and transport of herbicides. Actively growing shoots and leaves of herbaceous species will take up and translocate more herbicide than inactive shoots and leaves. Active growth and productivity of reed canarygrass is bimodal, peaking in early to mid-June, with a smaller peak in late July to mid-August. In general, I have observed that applications of sethoxydim during the first peak are more effective than applications during the second peak. This is probably because leaf growth predominates during the first peak while stem growth predominates during the second peak. Sethoxydim is a foliar-applied herbicide, and will be more effective if applied when leaf growth is active. (Applications of glyphosate appear to be effective during either peak). Nitrogen or orthophosphate fertilizers can enhance uptake and control when added to tank mixtures at low concentrations (no more than 1 pound per acre, or about 2 – 3 grams per gallon; higher concentrations can promote recovery from symptoms of herbicide phytotoxicity). Foliar-applied fertilizers encourage active growth and greening of leaves, enhancing their ability to absorb herbicide applied to leaf surfaces. In addition to genetically determined seasonal growth peaks, environmental factors can affect active plant growth. For example, drought stress can induce temporary growth stasis (quasi-dormancy) in many plant species, and herbicide applications made during precipitation deficits tend to be less effective.

In qualitative screenings, I have observed that combinations of surfactant-oil blends and water conditioning agents are the most effective additive options for reed canarygrass control. For instance, in June 2005, I applied sethoxydim to mixed stands of reed canarygrass and wet prairie in hard water at air temperatures of 95˚ F on clear, sunny days–conditions that should have considerably degraded sethoxydim and reduced its performance. I added water conditioner (ReQuest®) at a rate of 0.25% by volume (equal to 10 mL per mixed gallon) and a nonionic surfactant-methylated soybean oil blend (Destiny® or Dyne-Amic®) at a rate of 0.375% by volume (15 mL per mixed gallon) to tank mixtures, then applied the herbicide. This mixture resulted in quicker brown-up (within one to two weeks) and longer suppression (three or more months) of reed canarygrass than when a nonionic surfactant-penetrant blend was used (three weeks for brown-up and ten weeks of suppression).

Additives and additive blends are generally inexpensive (typically $10 – $25 per undiluted gallon, or about 10 cents per mixed gallon), but selection varies among agricultural and orchard supply centers. Remember to check the herbicide label for proper mixing order of additives and herbicides, as chemical or physical incompatibilities might occur if these substances are mixed in the improper order. Successful reed canarygrass suppression requires an adaptable management strategy that considers field conditions and herbicide additives.

Grass-Specific Herbicide Application Checklist:

1. Check herbicide label for proper mixing order of adjuvants and herbicide.
2. When applying herbicides in hard water, add an acidifier *or* a conditioning agent to the tank (in the order specified on the label). Generally, these additives are added to tank mixtures BEFORE herbicides, unless the herbicide label states otherwise.
3. Depending on the presence and composition of non-target species, add crop oil *or* surfactant-oil blend *or* surfactant-penetrant blend to tank mixture for optimum uptake and translocation (again, check the label for mixing order).
4. Agitation may be required to thoroughly mix the herbicide with its additives.
5. Apply grass-specific herbicides when UV light levels are low.
6. Apply grass-specific herbicides when air temperatures are greater than 70°F.
7. Apply grass-specific herbicides only to actively growing reed canarygrass that is not under drought stress.

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