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RICK RAY: How do you put the toothpicks into the roots?

DAN STRUVE: It depends on if you have electricity or not. We have done such crass things as driving a nail into the root and pulling it out and then inserting the toothpick. Ideally you should have an electric drill.

RICK RAY: Could you use a system like they use in the army for injecting?

DAN STRUVE: It is possible.

CAMERON SMITH: Have you done any direct injection experiments?

DAN STRUVE: No.

CAMERON SMITH: With a little DMSO you might be able to mobilize the auxin.

HERBICIDES FOR CONIFER SEEDBEDS

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Weeds are the most costly pest to control during the production of conifer seedlings. Competition from weeds causes losses in density and quality. Hand-pulling weeds is expensive and also causes a decrease in density when conifer seedlings are pulled along with the weeds. For these reasons, a safe and effective form of chemical weed control is needed.

Weed Control Program. When planning production schedules, growers should include a weed control program. In the past, weed control was often treated like firefighting — the problem was attacked after it was started. But you can have much safer and effective weed control by developing a weed control program. A program incudes three basic steps:

Step 1. Eliminate all weeds prior to planting. It is especially important to kill all perennial weeds because they are not controlled by preemergence herbicides, which are generally the safest.

Step 2. Prevent weed growth. There are now several preemergence herbicides labelled for use in conifer seedbeds. Repeat applications may be necessary for season-long control.

Step 3. Eliminate weeds when they appear. There will always be some weeds that escape your preventive measures. Destroy them before they get too well established and difficult to control.

Eliminating Weeds Prior to Planting. Fumigation has been the standard practice used to eliminate weeds prior to planting. The disadvantages of fumigation are its high cost and its destruction of beneficial soil microorganisms, including mycorrhizae-forming fungi.

Nursery seedbeds do not have to be refumigated every time a new crop is sown. When the beds are not going to be fumigated, Roundup (glyphosate) can be applied before planting to eliminate weeds. For beds to be sown in the fall Roundup can be applied 7 to 10 days before bed preparation. For beds to be sown in the spring the Roundup should be applied in the preceding September. Spring applications are not recommended because many weeds are at too early a developmental stage to be adequately controlled by Roundup.

Roundup is a nonselective, systemic herbicide that is absorbed through the foliage and translocated to all palnt parts. Since it kills below-ground plant parts, it effectively controls perennial weeds. For best results, Roundup should be applied to actively growing well-developed weeds. Do not mow or cultivate before applying Roundup. Mowing reduces the leaf area capable of absorbing the chemical, and cultivation breaks up the weed roots and spreads the pieces deeper and over a wider area. Each piece is capable of forming a new plant. These pieces do not all start growing at the same time and it is very difficult to kill all of them.

Roundup should not be applied when rainfall is predicted within the next 24 hours. It is best to allow 24 hours for absorption by the plant, but some control can be obtained if there is 6 hours between application and rainfall. Roundup requires 3 to 10 days to move throughout a plant, depending on weed species and growing conditions. The better the growing conditions, the faster it will be absorbed and translocated. Though the weed is doomed as soon as a sufficient amount of Roundup has translocated to its roots, injury symptoms may

not appear for 2 weeks or more. You do not have to wait until the weeds are dead to work the soil. Generally, a 3 to 5 day waiting period after application is sufficient.

Roundup is inactivated rapidly in the soil so it can be safely used just prior to planting.

Preventing Weed Growth. There are 5 herbicides available that can be used to prevent weed growth in conifer seedbeds. Three of them are labelled for use at the time of planting.

Enide (diphenamid) has been labelled for use on conifer seedbeds for a number of years. It should be applied one day prior to seeding or within one month after seeding. It has not been widely used because of its limited spectrum of control and its short residual. It primarily controls grasses but for only 4 to 6 weeks. Reapplications can be made at 6 week intervals, but this practice gets expensive and is of limited value if broadleaved weeds are present.

Modown (bifenox) is labelled for use on conifer seedbeds only in the southern and western United States. It should be applied to seedbeds within 48 hr of sowing the seed. It controls broadleaved weeds for about 8 weeks at recommended rates, but is weak on grasses. The label warns that it may reduce the survival of Douglas fir, though I have not seen this problem in studies I have conducted.

Goal (oxyfluorfen) should be applied after seeding and mulching, but prior to conifer seed germination. It provides excellent control of broadleaved weeds and very good control of grasses. The recommended rate of application extends from 0.25 to 1 lb active ingredient per acre (AIA). Colorado spruce has limited tolerance to Goal, so you should not apply more than 0.5 lb AIA on seedbeds of Colorado blue spruce. Depending on the rate of application, Goal will control weeds for 8 to 16 weeks.

Ronstar and Scott's Pro-Gro Ornamental Herbicide I (Scotts OH-I) are different formulations of the same chemical — oxadiazon. Ronstar contains 2% active ingredient and Scott's OH-I, 4%. Ronstar, or OH-I, should not be applied until 5 weeks after emergence of the conifer seedlings. Both provide excllent control of broadleaved weeds and very good control of grasses for 8 to 12 weeks.

Modown, Goal, and Ronstar/Scott's OH-I are all in the same class of herbicides — they kill weeds on contact. Their preemergence activity is based on the fact that they have a low solubility in water and they form a chemical barrier on the soil surface. Weed seedlings are burned off at the soil line as they emerge through the barrier.

Devrinol (napropamide) is the last of the preemergence herbicides that is labelled for use in conifer seedbeds. It is an inhibitor of root growth and may cause injury to the conifers if applied during the first growing season. Because it can be lost to photodecomposition and volatilization in warm weather, it should be applied in cool weather (less than 45°F). It can be applied in warm weather if application is immediately followed by 0.5 to 1 in. of irrigation water. Devrinol can be applied in the fall following the first growing season. It has a low solubility in water so it will be active the following spring and summer. Devrinol provides long-term control of grasses, but is weak on broadleaved weeds.

Eliminating Weeds in Plantings. There are also 5 herbicides available that can be used to eliminate weeds that escape the preventive measures. Goal and Modown, in addition to their preemergence activity, provide limited postemergence control of weeds. They will kill broadleaved weeds less than 4 in in height or diameter, and most grasses less than 3 in tall. Larger weeds will be burned, but their growing points will not be killed. Ronstar/Scott's OH-I is in the same herbicide class as Goal and Modown, but it does not have postemergence activity because it is only available in the granular formulation.

Goal provides better postemergence control of weeds than Modown, but it is also more likely to injure the conifers if improperly applied. Neither should be applied less than 5 weeks after emergence of the conifer seedlings because of the probability of injury to the primary needles and growing point. During this time weeds can grow past the stage at which they can be controlled, so the value of a preemergence application is evident.

Though the primary needles and growing point are sensitive to postemergence applications of Modown and Goal, secondary growth apparently is not. A number of studies, including a range of application rates, have shown that these herbicides can be safely used 5 or more weeks after conifer seedling emergence.

If the weeds are at least 4 in. taller than the conifer seedlings, a wick applicator can be used to apply Roundup. Depending on the weed species present, use either a 10 or 20% solution of Roundup. Carefully control the flow rate to the wick to avoid dripping herbicide solution on the conifers.

Two new herbicides that have just been cleared for use on ornamentals this year are Fusilade (fluazifop-butyl) and Poast (sethoxydim). Both provide postemergence control of almost all

annual and perennial grasses. They do not provide any broad-leaved weed control or any preemergence control of grasses.

Fusilade and Poast are both rapidly absorbed by the foliage of the plant. Within an hour of application, the majority of the chemicals have been absorbed. This reduces the chance that rainfall will decrease the effectiveness of a treatment.

After absorption, the chemicals are rapidly translocated to both the above- and below-ground growing points, where they cause all growth to stop. The first symptoms of injury are termination of growth and death and decay of the inner whorl of the grass plant. At this time the outer leaves may appear green and healthy, but it is only a matter of time before they die. The application rate, plant species and size, and environmental conditions determine whether or not the underground parts of perennial grasses will be completely killed.

Under good growing conditions (good soil moisture, high temperature, and high humidity), the initial symptoms will appear in 5 to 7 days. It may take 2 to 3 weeks for the grass to wilt and die, so be patient.

The growth stage of the grass at the time of application is not critical. It is important that it be actively growing. Annual grasses 2 to 6 in tall are easily controlled with one application at 0.1 lb AIA. Grasses up to 18 in can be controlled, but the application techniques must be adjusted to assure complete coverage of the weeds. Raise the nozzles and increase the rate of application, spray pressure, and volume applied per acre. To obtain optimum control use a non-ionic surfactant at the rate of one quart per acre of 1% v/v.

The cost per gallon of Fusilade and Poast is high, but because low rates of application (0.1 to 0.5 lb AIA) provide excellent grass control, their cost per treated acre is reasonable.

RECOMMENDATIONS

All weeds should be eliminated prior to planting by fumigating the soil or by applying Roundup at 2 to 3 lbs AIA.

Goal is the best preemergence herbicide to use at the time of planting because it provides safe, broad spectrum, long lasting control. Use 0.5 lb AIA on spruces and 0.75 lb AIA on all other labelled species. For continued preemergence control follow these guidelines:

1. *Summer* — If needed, apply Goal at 0.25 to 0.5 lb AIA or Ronstar/Scott's OH-I at 2 lb AIA no sooner than five weeks after conifer emergence.

2. *Fall* — Apply Devrinol at 2 to 3 lb AIA in late fall, but before the ground freezes. This will provide preemergence grass control into the following summer.

3. *Following spring* — Apply Goal at 0.75 lb AIA in the spring prior to budbreak, or Ronstar/Scott's OH-I at 2 lb AIA anytime in the spring before weed emergence.

To eliminate grasses that escape the preventive measures apply Fusilade or Poast at 0.25 lb AIA plus a non-ionic surfactant. If perennial grasses regrow, reapply at the same rate. Small broadleaved weeds and some grasses can be controlled with an application of Goal at 0.25 to 0.5 lb AIA. Do not apply sooner than 5 weeks after conifer emergence. Goal can be reapplied in 6 weeks if needed. A 10 to 20% solution of Roundup can be wick-applied to control large or especially troublesome weeds.

Table 1. Conifers listed on herbicide labels.

Trade Name	Common chemical name	Formulation	Conifers listed on the label
Devrinol	napropamide	2G,5G,50WP	Douglas fir, fir, hemlock, Japanese larch, juniper, pine, spruce, *Taxus*
Enide	diphenamid	50WP,90WP	fir, hemlock, larch, pine, at the time seeding; spruce after seedlings are one month old
Fusilade	fluazifop-butyl	4EC	arborvitae, Douglas fir, fir, hemlock, pine, spruce, *Taxus* (delay applications until after initial hardening)
Goal	oxyfluorfen	1.6EC	Colorado blue spruce, Douglas fir, pine (loblolly, slash, longleaf, shortleaf, eastern white, Virginia, ponderosa, lodgepole)
Modown	bifenox	4F	southern United States — pine (loblolly, longleaf, shortleaf, slash, eastern white) western United States — Colorado spruce, Douglas fir, redwood, western hemlock, fir (California red, grand, noble, white), pine (Monterey, ponderosa, sugar)
Poast	sethoxydim	1.5EC	Fraser fir, pine (eastern white, loblolly, mugho, Virginia), spruce (Norway, white)
Ronstar/ Scott's OH-I	oxadiazon	2G 4G	pine (loblolly, slash, eastern white)