17B-Witcher-Anthony-2021

Weed Control in Propagation: Hand Weeding is NOT the Only Option

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Keywords: mulch, pre-emergent herbicide, seedlings, stem cuttings

Summary

Weed control in nursery crop propagation is difficult due to the limited methods that are safe and effective. Hand weeding is labor intensive and time consuming and the availability of agriculture labor has become limited in recent years. Adoption of sanitation practices helps minimize weed infestations, but utilization of pre-emergent herbicides and mulches may be a viable weed control method in propagation. Although certain pre-emergent herbicides may cause injury to seedlings and rooting cuttings, there are non-root-inhibiting herbicides that may be safe for use in propagation. Three studies were conducted evaluating pre-emergent herbicides and mulches in seedling and stem-cutting propagation in small diameter containers. For seedling propagation, we found that isoxaben (Gallery) was safe when applied to small seedlings of several tree species after transplant and several pre-emergent herbicides were safe when applied prior to germination of oak seeds. For stem cutting propagation, oxadiazon+oxyfluorfen (Regal O-O) provided broad spectrum weed control and was safe when applied 2 weeks after sticking cuttings of several crop species. Pine pellet mulch provided excellent weed control at 1-cm (0.5-in.) depth with no impact to cutting root development.

INTRODUCTION

Plant propagation is a key component of the nursery industry, with many nurseries specializing in propagating crops for sale to other nurseries for growing on to a finished size. In the United States, propagative material is produced on 9700-ha (24,192-ac) with annual sales of $753 million. The majority of nursery crops are propagated by seed or vegetative cuttings. Although many nursery crop species can be propagated in field beds, container-grown seedlings and rooted cuttings provide advantages such as an extended transplant season and increased transplant success (Fare, 2013). Weeds are a major issue in container-grown propagative material but limited weed control methods are available for use during propagation. Weeds can become established and produce seed within a few weeks, quickly infesting liners prior to finishing.

Although weeds can be removed prior to shipping, seeds have already infested the containers and will be a problem in crop production. Manual weed removal (hand weeding) is the most common method of weed control in propagation, but it is time consuming, costly, and requires a labor pool that has greatly diminished in recent years. As a result, growers must prioritize tasks which can result in less frequent hand weeding. Development of improved weed control methods is needed to reduce labor and cost inputs during propagation and improve crop quality.

SANITATION

Weeds can infest propagation from a number of sources including container substrate, containers, floors within the propagation area, surrounding areas, stock plants, and workers. Container substrates, especially pine bark in bulk piles, should be stored indoors or in a protected area to prevent weed seed infestation. Propagation containers that are re-used should be thoroughly cleaned with high pressure water sprays to remove weed seeds, especially seeds with

a sticky outer coating such as bittercress and woodsorrel (Neal, 2016). Surrounding areas, nearby container production blocks, floors of the propagation space, and stock plants used for cuttings should be maintained weed free to prevent infestation of the crops in propagation. Post-emergent herbicides can be used to control actively growing weeds, but care must be taken to avoid contact with foliage of desirable crops. Several post-emergent herbicides are labeled for use inside structures (such as greenhouses) and can be used to control weeds during propagation. These products include diquat (Reward), glufosinate (Finale), glyphosate (Round-Up), and pelargonic acid (Scythe). Pre-emergent herbicides can be used to prevent weed seed establishment in container-grown crops in production, on gravel production pads, and non-crop areas such as gravel drives and walkways. Pre-emergent herbicides such as flumioxazin (Sureguard) and indaziflam (Marengo) can also be used on greenhouse floors, but these products should be applied prior to moving in flats/containers.

HERBICIDE USE IN PROPAGATION

Currently, there are no pre-emergent herbicides labeled for use in propagation and many products restrict use in small diameter containers [less than 10 cm (4-in)] and on non-rooted cuttings. Additionally, no pre-emergent herbicides are labeled for use in enclosed structures. Seed and cutting propagation involve the initiation, growth, and development of new roots which are sensitive to chemical substances such as herbicides. As a result, pre-emergent herbicides have not been widely used during propagation. Pre-emergent herbicides function by inhibiting germination or root/shoot development and sensitivity can vary by chemical class and plant species.

Pre-emergent herbicides in the dinitroaniline family act as root inhibitors and numerous research reports noted reduced rooting percentage and root development when used in cutting propagation. Root inhibiting herbicides such as oryzalin (Surflan), pendimethalin (Pendulum), prodiamine (Barricade), and trifluralin (Treflan) should not be used in propagation.

Nevertheless, other studies have shown that certain non-root-inhibiting pre-emergent herbicides could be safely applied during propagation. In seedling propagation, Willoughby et al. (2003) reported that isoxaben and pendimethalin could be applied prior to seed germination of several woody species. South and Carey (2005) found that oxyfluorfen (Goal) was safe to apply to several large-seeded tree species (*Carya* spp, *Juglans* spp., and *Quercus* spp.) prior to germination. Halcomb and Fare (1997) demonstrated that isoxaben did not damage small field-grown tree seedlings when applied over the top of actively growing plants. In cutting propagation, oxadiazon (Ronstar) has been found safe to apply prior to sticking cuttings of several crop species (Johnson and Meade, 1986; Langmaid, 1987; Thetford et al., 1988; Thetford and Gilliam, 1991). Isoxaben was also safe to apply to *Loropetalum chinense* at various stages of propagation (Cochran et al., 2008).

RESEARCH AT TENNESSEE STATE UNIVERSITY

Most of the previous work evaluating pre-emergent herbicides in propagation was completed over twenty years ago and there are newer products that may be viable for weed control in propagation. Pre-emergent herbicides such as flumioxazin and indaziflam may have potential for use during propagation, while other types of products such as mulches may be viable alternatives for weed control in sensitive crops and inside greenhouses. In recent years, several studies have been completed at the Tennessee State University Otis L. Floyd Nursery Research Center in

McMinnville, TN evaluating pre-emergent herbicides and mulches in seedling and cutting propagation.

In the first study, container-grown tree seedlings were treated with various pre-emergent herbicides and mulches (Table 1). Containers [9 cm (3.5-in) diameter filled with pine bark substrate] planted with seeds of two oak species [sawtooth oak (*Quercus acutissima*) and willow oak (*Q. phellos*)] were treated prior to seed germination, while seedlings (128 cell trays) of four other tree species [kousa dogwood (*Cornus kousa*), sweet gum (*Liquidambar styraciflua*), sweetbay magnolia (*Magnolia virginiana*), and yellow poplar (*Liriodendron tulipifera*)] were transplanted to containers and treated after 3 days. Compared to the non-treated control, reduced root dry weight was only observed for kousa dogwood (dimethenamid-P+pendimethalin, pendimethalin, pine pellets, prodiamine, and trifluralin) and yellow poplar (trifluralin) (Fig. 1). Weed control efficacy varied by product and weed species but pine pellets provided excellent control of bittercress and large crabgrass. Overall, several pre-emergent herbicides were safe and effective for use in seedling propagation of several tree species.

In the second study, stem cuttings, stuck in 6 cm (2.5-in) diameter containers filled with pine bark substrate of three crop species [butterfly bush (*Buddleja davidii* ‘Nanho Blue’, holly (*Ilex cornuta* ‘Dwarf Burford’), and viburnum (*Viburnum plicatum f. tomentosum* 'Mariesii')] were treated with various mulches (prior to sticking) and pre-emergent herbicides (2 weeks after sticking) (Table 2).

Weed control efficacy was also evaluated for four weed species [bittercress (*Cardamine hirsuta*), crabgrass (*Digitaria sanguinalis*), creeping woodsorrel (*Oxalis corniculata*), and mulberryweed (*Fatoua villosa*)]. Compared to the non-treated control, rooting percentage was only reduced for butterfly bush with isoxaben, while rooting percentage was not affected for

holly or viburnum (data not shown). Similarly, butterfly bush root and shoot dry weight was only reduced by isoxaben, while no differences were observed for the other crop species (data not shown). Oxadiazon+oxyfluorfen provided excellent control of all tested weed species and has potential for propagation of a number of crops. Mulches did not provide adequate weed control of all weed species, but increased application depth may enhance efficacy.

In the third study, mulch type and depth were evaluated for rooting cuttings of three crop species [butterfly bush (*Buddleja davidii* 'Nanho Blue'), crape myrtle (*Lagerstroemia indica* 'Catawba'), and hydrangea (*Hydrangea paniculata* 'Phantom')]. Mulches included coarse vermiculite, paper pellets, pine pellets, and rice hulls applied at 1-2.5 cm (0.5 or 1-in) depth prior to sticking cuttings (Fig. 2). Weed control efficacy was also evaluated for creeping woodsorrel, bittercress, crabgrass, and mulberry weed. No differences in rooting percentage were observed for any treatments. Crape myrtle root dry weight was lower for paper pellets (both depths), but no differences were observed for butterfly bush or hydrangea. Pine pellets and paper pellets (both depths) reduced growth of all four weed species. Pine pellets and paper pellets at 1 cm (0.5-in) depth can be effective in suppressing the weed population with minimal effects on rooting.

CONCLUSION

We demonstrated that several pre-emergent herbicides and mulches have potential for use in seedling and cutting propagation. Several pre-emergent herbicides may be applied prior to germination of large-seeded tree species, while small seedlings of certain tree species can be safely treated with isoxaben after transplant. For cutting propagation, oxadiazon+ oxyfluorfen was safe when applied 2 weeks after sticking cuttings of several crop species, and provided broad spectrum weed control under intermittent mist. Paper and pine pellet mulches

may be alternatives to pre-emergent herbicides for use on sensitive crop species and in enclosed structures and provided excellent weed control at 1 cm (0.5-in) depth. Growers should conduct small trials with individual products and crop species prior to large scale adoption.

Literature Cited

Cochran, D.R., Gilliam, C.H., Eakes, D.J., Wehtje, G.R., and Knight, P.R. (2008). Herbicide use in propagation of *Loropetalum chinense* 'Ruby'. J. Environ. Hortic. *26*:139-143.

Fare, D.C. (2013). Propagation container and timing of propagation affects growth of oak seedlings. J. Environ. Hort. *31*:43-48.

Halcomb, M.A., and Fare, D.C. (1997). Tolerance of seedlings to preemergence herbicides. Proc. South. Nurs. Res. Conf. *42*:315-318.

Johnson, J. R., and Meade, J.A. (1986). Pre-emergent herbicide effect on the rooting of cuttings. Proc. Intl. Plant Prop. Soc. *36*:567-570.

Langmaid, M. (1987). Herbicides used in propagation at Wight Nurseries. Proc. Intl. Plant Prop. Soc. *37*:539-540.

Neal, J. (2016). Weed control in woody plant propagation and containerized liner production. N. Carolina St. Univ. Coop. Ext. Bul. AG-287.

South, D.B., and Carey, W.A. (2005). Weed control in bareroot hardwood nurseries. USDA Forest Serv. Proc. *35*:34-38.

Thetford, M., and Gilliam, C.H. (1991). Herbicide use in propagation: Effects on rooting and root growth of stem cuttings. J. Environ. Hort. *9*:21-23.

Thetford, M., Gilliam, C.H., and Foster, W.J. (1988). Herbicide use in propagation. Proc. Intl. Plant Prop. Soc. *38*:479-481.

Willoughby, I., Clay, D., and Dixon, F. (2003). The effect of pre-emergent herbicides on germination and early growth of broadleaved species used for direct seeding. Forestry *76*:83-94.

Table 1. Mulches and pre-emergent herbicides evaluated in a seedling propagation trial.

Product Type	Product	Active ingredient
NA	Control	NA
Mulch 1 cm (0.3-in.) depth	Perlite	NA
	Pine Pellets	NA
	Cedar Shavings	NA
	Charcoal	NA
Herbicide (High Label Rate)	Treflan F	trifluralin
	Treflan 5G	trifluralin
	Pendulum AC	pendimethalin
	Pendulum 2G	pendimethalin
	Gallery SC	isoxaben
	Snapshot 2.5TG	trifluralin + isoxaben
	Barricade 4FL	prodiamine
	Freehand G	dimethenamid-P + pendimethalin

Table 2. Mulches and pre-emergent herbicides evaluated in a stem cutting propagation trial.

Product Type	**Product**	**Active Ingredient(s)**
Non-treated control	NA	NA
Herbicide (High Label Rate)	Gallery SC	isoxaben
	BroadStar	flumioxazin
	Marengo G	indaziflam
	Regal O-O	oxadiazon+oxyfluorfen
	Ronstar G	oxadiazon
Mulch 1 cm (0.3-in.) depth	Rice Hulls	NA
	Vermiculite	NA
	Pine Pellets	NA
	Paper Pellets	NA

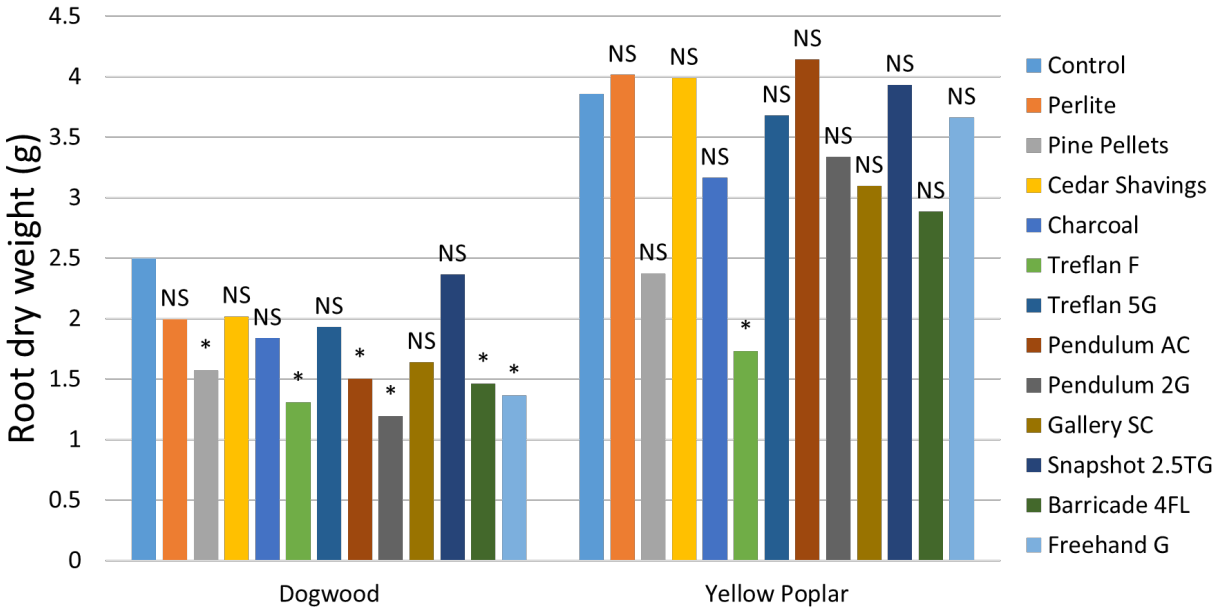

Figure 1. Root dry weight of kousa dogwood and yellow poplar seedlings treated with mulches and pre-emergent herbicides. Compared to the non-treated control, NS = not significant and * = significantly different at $p < 0.05$.

Figure 2. Paper pellet, pine pellet, and rice hull mulches (left to right) when applied dry (top) then saturated with irrigation (bottom).