Biology and Management of Nursery Weeds©

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INTRODUCTION

The cost of weed control in nurseries in the United States of America has been estimated to be between $2,389 and $5,506 (about $3700 and $8470 AU$) per ha per year (Gilliam et al., 1990; Darden and Neal, 1999) but may be as high as $96,000 per ha (about $148,000 AU$ per ha) when difficult to remove weeds such as bittercress (*Cardamine* sp.) and liverwort (*Marchantia polymorpha*) are present (Mathers, 1996). Research has shown that preemergence herbicides currently labeled for use in container nurseries are effective on the common nursery weeds (Judge and Neal 2001; Ruter and Glaze, 1992; Whitwell and Kalmowitz, 1989). Yet, despite frequent herbicide applications, weeds continue to emerge and must be removed by hand, a laborious and expensive process. To reduce weed control costs, nursery managers need to implement an integrated weed management program that includes an understanding of the target weeds and the available weed management options.

BIOLOGY OF NURSERY WEEDS

Most nursery weeds are annuals that would typically be categorized as either winter annuals or summer annuals. However, as a result of the unique microclimates in container nursery crops, the distinctions between winter annual and summer annual life cycles may be blurred. For example, spotted spurge (*Chamaesyce maculata*) is typically considered a summer annual but in warmer regions it can be present through late fall. Conversely, common chickweed (*Stellaria media*), a common winter annual, may be present year-round in shaded, moist areas. Consequently, I have found it to be more useful to categorize weeds by whether they are more prevalent in cool conditions or warm conditions. Table 1 lists some of the most common cool-season and warm-season weeds in container nurseries in the U.S.A., as well as species observed in recent tours of nurseries in Australia. Weed species adaptations to nursery crop production conditions have resulted in surprisingly similar species in U.S.A. and Australian container nurseries. Most of the common nursery weeds have several characteristics in common including multiple generations per year, a means of seed dispersal within the nursery, and shade-adapted germination and growth characteristics.

Most nursery crop producers would agree that it is not the first generation of weeds that is difficult to control it is subsequent generations. In order to have multiple generations per year, it is advantageous for a weed species to have limited or no seed dormancy or after-ripening, and to rapidly reach reproductive maturity. Little research has been conducted on the reproductive biology of nursery weeds. Recent studies with mulberry weed (*Fatoua villosa*), a weed of increasing importance in the southeastern U.S.A., have demonstrated that under optimum conditions seeds germinated in less than 5 d (Penny and Neal, 2003). Also, this species is capable of producing viable seeds within 12 d of reaching the two-leaf growth stage (Penny 2000). Bachman and Whitwell (1995) reported germination of hairy

Table 1. Common cool-season or warm-season weeds in U.S.A. nurseries, based on weed scouting reports from North Carolina and New York (U.S.A.) container nurseries; and Australian nurseries.

Cool season weeds	Warm season weeds
Reported from eastern U.S.A. nurseries (Neal et al., 1997; Neal and Williams, 1998)	
Cardamine sp.	*Cardamine* sp.
Conyza canadensis	*Cyperus esculentus*
Erechtites hieracifolia	*Digitaria ischaemum*
Marchantia polymorpha	*Eclipta prostrata*
Oxalis sp.	*Chamaesyce* sp.
Senecio vulgaris	*Gnaphalium*
Sonchus sp.	*Oxalis* sp.
Stellaria media	*Phyllanthus* sp.
Observed by the author in Australian nurseries during 2003	
Cardamine sp.	*Cardamine* sp.
Cerastium vulgatum	*Chamaesyce hirta*
Conyza canadensis	*Chamaesyce drummondii* (syn. *Euphorbia drummondii*)
Epilobium ciliatum	*Euphorbia peplus* (syn. *Chamaesyce peplus*)
Marchantia polymorpha	*Oxalis* sp.
Oxalis sp.	*Phyllanthus* sp.
Sagina procumbens	*Sonchus* sp.
Sonchus sp.	

bittercress (*Cardamine hirsuta*) seeds within 5 d and had reached 90% germination by 13 d. Furthermore, bittercress produced about 2000 seeds per plant by 7 weeks of age. Other weeds having a similar potential for multiple generations per season include: woodsorrel (*Oxalis* sp.), common groundsel (*Senecio vulgaris*), liverwort, and several species of spurge (*Chamaesyce* syn. *Euphorbia*).

Nursery weeds have fascinating adaptations for seed dispersal including ballistic dehiscence, wind dispersal, and water dispersal. Well known to most nursery and greenhouse growers are the forceful seed dispersal mechanisms of woodsorrel and bittercress. Research has shown that hairy bittercress seeds are dispersed an average of 50 cm from the parent plant (Bachman and Whitwell, 1995); however, I have observed dispersal of over 2 m. Woodsorrel seeds have been documented to disperse seeds over 1.5 m (Williams and Sanders, 1984) but I have observed evidence of dispersal of up to 3 m. Seeds of many weeds in the Asteraceae (syn. Compositae) have a feathery papus that can facilitate dispersal in wind and water. Williams and

Sanders (1984) trapped goldenrod (*Solidago* sp.) seeds blown into a nursery. The majority of seeds were trapped within 3 m of the weedy border, yet over 10% of the seeds were trapped between 7.5 and 10 m from the border. Travel distance depend upon wind speed and direction, but it is clear that the majority of the wind-dispersed seeds will travel relatively short distances (less than 3 m). The papus may also facilitate water dispersal by allowing seeds to float. Open drainage ditches in nurseries would provide a mode of weed seed transport in nurseries, although the importance of this has not been studied. One might, therefore, assume that irrigation ponds would be a significant source of weed seed contamination. However, after sampling about 18,600 L of nursery irrigation water, Williams and Sanders (1984) reported finding only three weed seeds. This suggests that a typical 2.5-cm irrigation cycle would contribute only about 38 weed seeds per h, a negligible contribution to the weed seed bank. In that same trial, it was shown that several weed species could be splashed by rainwater up to 28 cm from soil into pots. Other weeds have special adaptations for dispersal by rain or irrigation water. Seeds of pearlwort and gemmae of liverwort are produced in cup-like structures that facilitate spread when water drops land in the structures (Uva, et al., 1997).

Copious seed production will also facilitate weed survival and spread. Bittercress has been reported to disperse over 2500 seeds per plant over a 3-week study period (Bachman and Whitwell, 1995). Mulberryweed may produce up to 6000 seeds per plant (Penny, 2000), and *Eclipta prostrate* has been reported to produce more than 17,000 seeds per plant in tropical environments (Holm et al., 1977).

Most common nursery weeds do not require light for germination (Penny and Neal, 2003; MacDonald et al., 1992; Krueger and Shaner, 1982). This adaptation allows weeds to germinate in the shade of crop canopies. Several nursery weed species have prostrate growth habits and can flourish in the low light conditions under crop canopies; whereas others have upright growth habits that allow plants to reach above the crop canopy.

WEED MANAGEMENT

Due to the potential for weed populations to increase within a cropping cycle and disperse from established crops to newly potted, it is essential that nursery weed management programs integrate sanitation practices with traditional herbicide programs. Inspect plant materials brought onto the nursery. If plants are weedy, remove and discard the top 2 cm of potting substrate before potting. Regularly monitor the newly potted plants for weeds. To prevent weeds from producing seeds hand weed pots on a regular and frequent schedule. The "cleanest" nurseries hand weed at least every 2 weeks. The role of sanitation in nursery weed management is more fully discussed in a previous report (Neal, 2000).

Preemergence herbicides are typically applied every 8 to 12 weeks. Despite these frequent applications, weeds continue to emerge. Little research has been conducted to address the dissipation and fate of herbicides applied to nursery crops and how this might relate to weed control. Our recent research has demonstrated that trifluralin (Treflan) residues dissipate much more rapidly in soilless nursery substrates than in field soils. The half-life of trifluralin was less than 5 days in the surface of a pine-bark-based substrate (Judge and Neal, 2002), compared to half-lives of 19 to 132 days in soils (Webber, 1990). In pine-bark substrate trifluralin dissipated to levels inadequate to control large crabgrass (a sensitive species) within 21 d (Judge and Neal, 2002). Although similar dissipation data are not available for other herbicides in nursery substrates, these data suggest that herbicides have dissipated to ineffective levels before reapplication would normally occur. It is therefore no surprise that weeds emerge. Further research needs to be conducted to clarify the dissipation of nursery herbicides in soilless substrates and to develop methods for extending their efficacy. It is also further evidence that greater emphasis must be placed on sanitation in nursery weed management programs.

LITERATURE CITED

Bachman, G. and **T. Whitwell.** 1995. Hairy bittercress seed production, dispersal and control. Southern Nursery Assoc. Res. Conf. 40:288-290.

Darden, J. and **J.C. Neal**. 1999. Granular herbicide application uniformity and efficacy in container nurseries. Proc. Southern Nursery Assoc. Res. Conf. 44:427-430.

Gilliam, C.H., W.J. Foster, J.L. Adrain, and **R.L. Shumack**. 1990. A survey of weed control costs and strategies in container production nurseries. J. Environ. Hort. 8: 133-135.

Holm, L.G., D.L. Plucknett, J.V. Pancho, and **J.P. Herberger**. 1977. The world's worst weeds, distribution and biology. Univ. Press of Hawaii, Honolulu, Hawaii.

Judge, C.A. and **J.C. Neal.** 2000. The susceptibility of common nursery weeds to preemergence herbicides. Proc. Southern Nursery Assoc. Res. Conf. 45:370-374.

Judge, C.A. and **J.C. Neal**. 2002. Trifluralin dissipation in a soilless substrate. Proc. Weed Sci. Soc. Amer. 42:80.

Krueger, R.R. and **D.L Shanner.** 1982 Germination and establishment of prostrate spruge (*Euphorbia supina*). Weed Sci. 30:286-290.

MacDonald, G.E., B.J. Brecke, and **D.G. Shilling**. 1992. Factors affecting germination of dogfennel (*Eupatorium capillifolium*) and yankeeweed (*Eupatorium compsitifolium*). Weed Sci. 40:424-428.

Mathers, H.M. Ed. 1996. Cost benefits of an integrated approach. British Columbia Ministry of Agriculture Fisheries and Food Nursery Industry News. March, 1996.

Neal, J.C. 2000. Weed control in woody liner production. Comb. Proc. Intl. Plant Prop. Soc. 50:528-531.

Neal, J.C., C.A. Casey, and **K.E. Dean.** 1997. Western New York nursery IPM program: 1995-1996 weed scouting results. Proc. Northeastern Weed Sci. Soc. 51:104.

Neal, J.C. and **A. Williams**. 1998. Eastern North Carolina nursery weed scouting program - 1997. Proc. Northeastern Weed Sci. Soc. 52:134.

Penny, G.M. 2000. Biology and management of mulberry weed, *Fatoua villosa* (Thunb.) Nakai. M.S. thesis. North Carolina State University, Raleigh, North Carolina.

Penny, G.M. and **J.C. Neal.** 2003. Light, temperature, seed burial, and mulch effects on mulberry weed (*Fatoua villosa*) seed germination. Weed Technol. 17:213-218.

Ruter, J.M. and **N.C. Glaze.** 1992. Herbicide combinations for control of prostrate spurge in container-grown landscape plants. J. Environ. Hort. 10:19-22.

Weber, J.B. 1990. Behavior of dinitroaniline herbicides in soils. Weed Technol. 4:394-406.

Whitwell, T. and **K. Kalmowitz**. 1989. Control of prostrate spurge (*Euphorbia humistrata*) and large crabgrass (*Digitaria sanguinalis*) in container grown *Ilex crenata* 'Compacta') with herbicide combinations. J. Environ. Hort. 7:35-37

Williams, D.B. and **J. Sanders.** 1984. The origin and dissemination of weed seed in container-grown nursery stock. Southern Nursery Assoc. Res. Conf. 29:244-251.

Uva, R.H., J.C. Neal, and **J.M. DiTomaso**. 1997. Weeds of the Northeast. Cornell University Press, Ithaca, New York.