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Effects of Triclopyr Amine on Purple Loosestrife and Non-target Wetland Plants in South-eastern Ontario, Canada

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ABSTRACT

We studied the effects of triclopyr amine, the triethylamine salt formulation of triclopyr [[(3,4,6-trichloro-2-pyridinyl)oxy] acetic acid] on purple loosestrife (*Lythrum salicaria* L.) and non-target vegetation in a southern Ontario wetland during 1991 and 1992. Triclopyr was applied during bud to early bloom stage at rates of 4.0, 8.0 and 12.0 kg/ha. During 1991, all treatment levels effectively controlled the aboveground portion of purple loosestrife. Grasses (family Gramineae) were unaffected during 1991, however, sedge species (*Carex* spp.) declined in numbers at higher treatment levels. At 1 year post-treatment, adult purple loosestrife were not present in the 12.0 kg/ha treatment indicating that triclopyr effectively killed the root system. Seedlings dominated the total number of loosestrife plants in the 8.0 and 12.0 kg/ha treatment plots 1 year post-treatment. Sedges recovered in 1992 and grasses increased above 1991 levels. Removal of adult purple loosestrife allowed more light to reach the substrate surface and created favourable conditions for seed germination and plant growth. Triclopyr amine can effectively reduce adult loosestrife stem densities, however, additional herbicide applications may be required to prevent re-establishment through regeneration from the seed bank.

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INTRODUCTION

Purple loosestrife, hereafter called loosestrife, is an invasive emergent perennial plant species native to Eurasia (Thompson et al. 1987). It forms dense monotypic stands displacing native food and cover plants important to wildlife. Some assessments of the loosestrife problem suggest that it is responsible for the degradation of more wetland habitat than current human development pressure (Mal et al. 1992). Presently there are few management options available to control this problem species. Herbicide evaluations have been conducted to determine the effectiveness of a variety of chemicals and formulations for controlling loosestrife (McKeon 1959, Smith 1964, Rawinski 1982, Balogh 1986, Reinartz et al. 1986, Skinner and Hollenhorst 1989). Unfortunately results have varied and little effort has been made to address the effects of herbicides on non-target native plants.

Triclopyr amine is a systemic herbicide selective for broad-leaved weeds. It has a number of other characteristics that make it a potential tool for loosestrife control. It is easily absorbed and translocated to the root system (Dow Chemical 1988) and breaks down quickly in soil and water. Research indicates that triclopyr has minimal effects on fish (Mayes et al. 1984, Barron et al. 1991, Janz et al. 1991) and other aquatic organisms (Gersich et al. 1984). Triclopyr amine has been identified as a potential herbicide for loosestrife control (Skinner and Hollenhorst 1989) and is registered for loosestrife control in the United States. However, little quantitative information is available on its effects on loosestrife in northern latitudes and on non-target wetland vegetation in general.

Our objective was to monitor density changes of loosestrife and non-target plants following application of varying dosages of triclopyr amine herbicide in a shallow wetland in south-eastern Ontario, Canada.

MATERIALS AND METHODS

The study was conducted during 1991 and 1992 at Green Gables Marsh near Smith Falls, Ontario (44° 46' N, 76° 01' W). The wetland is 87 ha in size with a relatively uniform water depth of 50-60 cm. Much of the vegetation occurs on floating mats of litter, roots and associated soil. Loosestrife was first observed in the wetland in the early 1980's and is now well established (approx. 100 stems/M^2, 1 to 1.5 M in height). These densities are similar to other infestations observed in southern Ontario.

On 16 July 1991, 4 treatments of triclopyr amine were applied in a randomized complete block design at rates of 4.0, 8.0, and 12.0 kg/ha and control (no herbicide application). Treatments were replicated 3 times. Each plot was 3 by 10 M with 3 M buffer zones between plots to avoid problems due to herbicide drift. The herbicide was applied to all plants in the treatment plots during bud to early bloom stage of loosestrife. A battery powered, hand held spray apparatus (Great Northern Sprayer) was used to apply the herbicide. Each treatment was applied from a standing position on a platform attached to a canoe to ensure an even application of the herbicide over the entire plot. A total of 6.7 litres of solution were applied to each treatment plot (2,233 l/ha). The canoe was repositioned 3 times during the spraying of each plot.

Within each plot, three permanent 1 M^2 quadrats were randomly selected and the numbers of stems of each plant species were recorded at 5 sampling periods; pretreatment, 2, 4 and 8 weeks following application and July 1992, 12 months post-treatment. Stems were considered dead when green portions were no longer detected. Loosestrife seedlings were distinguished by size and morphological characteristics. Most loosestrife seedlings had a single main shoot (Shamsi and Whitehead 1974a). Any stems arising from the base of an established plant were recorded as an adult stem.

Analyses of variance were conducted using the GLM procedure (SAS Institute, Inc., 1989). Contrasts were used to test for differences in treatment effects on response variables within each sampling period and over time. Tests were considered significant at $\alpha = 0.05$. Four plant taxa occurred frequently enough to conduct statistical analyses; loosestrife (adults and seedlings), combined grass species and combined sedge species. To reduce the heterogeneity of treatment variances, data were transformed using log(X+1) (Zar 1974).

RESULTS AND DISCUSSION

By the end of 1991, adult loosestrife stem densities in all treatment plots (Figure 1) were significantly lower ($P<0.05$) than densities in the control plots indicating that all treatments were similar in their effectiveness for controlling the aboveground portion of adult loosestrife plants. Adult stem densities in the control plots did not differ ($P>0.05$) over the course of the experiment. In 1992, no adult loosestrife were observed in the 12.0 kg/ha treatment plots whereas densities in the 4.0 and 8.0 kg/ha plots were significantly higher ($P<0.05$) than those observed during the last sampling period in 1991. Adult loosestrife has a large tap root that is the main organ of vegetative reproduction (Shamsi and Whitehead 1974a) and must be destroyed to control adult plants. The presence of adult plants in the 4.0 and 8.0 kg/ha treatment plots indicates that all root systems were not eliminated and a single application at these two rates was not effective for long-term control. Only the 12.0 kg/ha treatment plots had no adult plants in 1992. This suggests that a sufficient amount of herbicide had translocated to the root system to achieve effective root kill at this application rate.

Loosestrife seedling densities (Figure 2) were significantly lower ($P<0.05$) in all treatment plots than in the control plots 2 weeks post-treatment indicating that effective control was achieved at all treatment levels. Generally, seed germination occurs in late spring or early summer when temperatures are high (Shamsi and Whitehead 1974a) and therefore most seeds probably germinated prior to our herbicide appli-

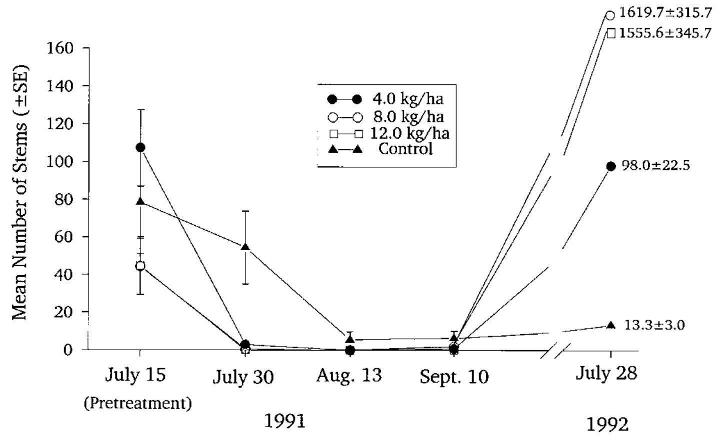

Figure 2. Mean number of loosestrife seedlings per M^2 (± standard error) in experimental plots treated with triclopyr amine on 16 July 1991 in eastern Ontario.

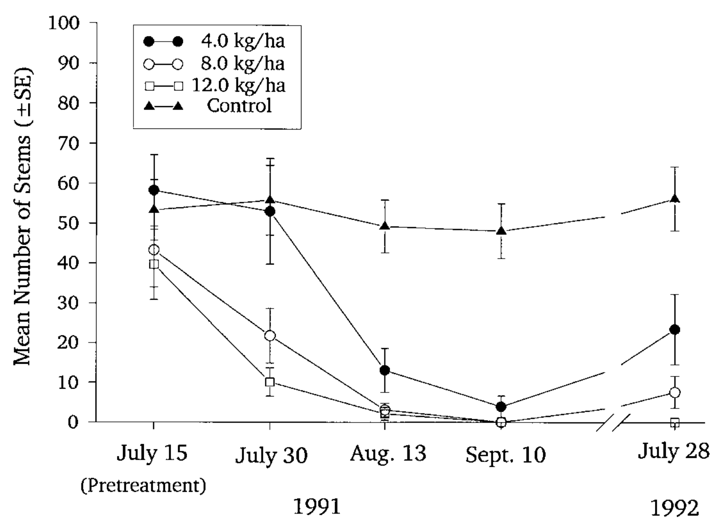

Figure 1. Mean number of adult loosestrife stems per M^2 (± standard error) in experimental plots treated with triclopyr amine on 16 July 1991 in eastern Ontario.

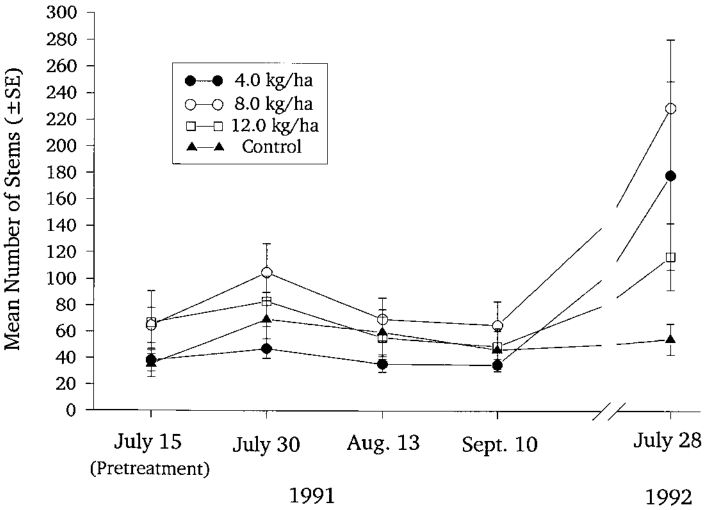

Figure 3. Mean number of grass stems per M^2 (± standard error) in experimental plots treated with triclopyr amine on 16 July 1991 in eastern Ontario.

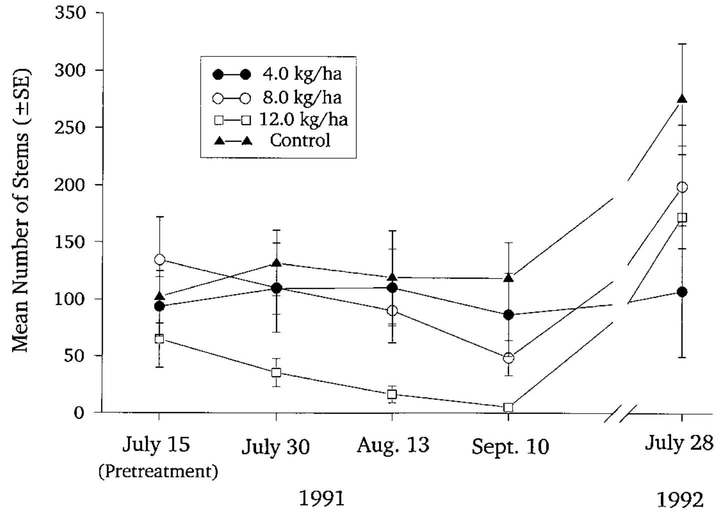

Figure 4. Mean number of sedge stems per M^2 (± standard error) in experimental plots treated with triclopyr amine on 16 July 1991 in eastern Ontario.

cation. In 1992, seedling densities were significantly higher ($P<0.05$) in the 8.0 and 12.0 kg/ha treatment plots than in the 4.0 kg/ha plots and significantly higher ($P<0.05$) than pretreatment densities. This indicates that seedling densities were highest in the treatment plots with the lowest number of adult loosestrife plants. As well, densities in all treatment plots were higher ($P<0.05$) than control plot densities suggesting that the removal of most adult plants created favourable conditions for seed germination and growth. Adult loosestrife plants can produce an estimated 2.7 million seeds per year (Thompson et al. 1987) and therefore large seed banks exist in areas where loosestrife is well established (Welling and Becker 1990). As well, adult loosestrife plants can produce a significant amount of shade that probably inhibits loosestrife seedling establishment and growth. Shamsi and Whitehead (1974b) indicate that loosestrife growth can be affected by a reduction in light intensity.

During our experiment, the total number loosestrife stems in the 8.0 and 12.0 kg/ha treatment plots increased substantially the year following application, however, almost all loosestrife plants at this time were seedlings. Our results suggest that triclopyr amine can be effective for reducing adult loosestrife stem density, however, additional applications may be required to prevent re-establishment through regeneration from the seed bank. It is important to note that where loosestrife is well established and a large seed bank is present, totally exhausting the seed bank through seedling removal is unlikely (Welling and Becker 1990).

Stem densities of total grass species combined did not differ ($P>0.05$) between the treatment and control plots during 1991 (Figure 3) indicating that no herbicide effect was observed on grass species. For individual treatments over time, stem densities in all treatment plots were significantly higher ($P<0.05$) in 1992 than pretreatment densities. Control plot densities did not differ ($P>0.05$) between pretreatment and 1992. This suggests that adult loosestrife was suppressing the grass species and that a reduction in adult loosestrife plants created more favourable growing conditions. Skinner and Hollenhorst (1989) found that test plots treated with triclopyr had large increases in grass species 1 year post-treatment. Research by Gaudet and Keddy (1988) indicates that the growth of 44 native wetland species, including rice cut grass, declined following the establishment of loosestrife. Our study suggests that removing adult loosestrife may allow some of these species to reestablish in treated areas.

For sedge species, densities were significantly lower in the 12.0 kg/ha treatment plots than in the control from mid-August to the end of 1991 (Figure 4). As well, stem densities in the 12.0 kg/ha treatment were significantly lower ($P<0.05$) at sample periods 3 and 4 than pretreatment densities. This suggests that the herbicide was having an adverse impact on these species. From the end of 1991 to 1992, stem densities increased in all experimental plots except the 4.0 kg/ha treatment. Although within sample variation was high during 1992, the increases in the 12.0 kg/ha treatment plots suggest that the sedges were able to recover and that there was no long-term effect of the herbicide on these species.

In summary, triclopyr amine significantly reduced adult loosestrife plants, however, the number of seedlings increased substantially in the treated plots. Removal of adult loosestrife plants creates favourable conditions for loosestrife germination from the existing seed bank. No long-term effects of the herbicide were observed on monocot species. Our study suggests that reducing the number of adult loosestrife plants with triclopyr amine herbicide can be beneficial in wetlands where native plant communities have not been displaced by loosestrife. Further research is necessary to determine the long-term response of native plant communities to loosestrife removal and loosestrife seedling response to competing native plant species. As well, information on the effectiveness of additional low application rates of triclopyr for reducing loosestrife seedling densities would be beneficial.

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