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**Fruit Varieties Journal 49(2):90-93 1995**

# Effects of Simazine on the Mycorrhizal Population in Soil Beneath an Apple Tree Canopy[1]

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## Abstract

Simazine treatments were applied during four consecutive years to the soil beneath the trees of a young apple orchard in southern Quebec. Following a one-year interruption in treatments, the population of mycorrhizal propagules (spores and sporocarps) in the soil under the tree canopy was quantified. Simazine diminished the population of mycorrhizae. The effect of simazine was linear and only Glomus species were found in the soil.

Key Words: *Malus domestica* Borkh., VAM fungi, 'Spartan'/M.7 EMLA, *Glomus calospora, Glomus constrictum, Glomus aggregatum, Glomus rubiformis.*

## Introduction

Inoculation of apple tree roots with certain vesicular-arbuscular mycorrhizal (VAM) species has been shown to stimulate growth (Covey et al., 1981; Koch et al., 1982; Hoepfner et al., 1983). It could also promote phosphorus and zinc uptake in apple seedlings (Geddeda et al., 1984; Benson and Covey, 1976). The response to such a treatment was dependent on the rootstock or the species of mycorrhizal fungi used (Granger et al., 1983; Covey

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et al., 1981). It also has been observed that high levels of phosphorus or the application of certain herbicides could interfere with mycorrhization of apple or citrus trees (Hoepfner et al., 1983; Nemec and Tucker, 1983). Herbicides may be detrimental to the survival of ectomycorrhizal fungi (Chakravarty and Chatarpaul, 1990); however, in apple, the effect of such a widely used herbicide as simazine on the mycorrhizal population of the root system is not well documented.

The purpose of the present study was to assess the short-term residual effects of simazine on a mycorrhizal population in the rhizosphere of apple trees within the herbicide-treated strips.

## Materials and Methods

A group of eight-year old 'Spartan'/ M.7 EMLA trees was selected at the Agriculture Canada experimental substation in Frelighsburg, Quebec. They were not artificially inoculated with VAM fungi. Trees were spaced 3.5 x 5 m in a Blanford soil. They were grouped into 4 blocks with 3 replicates of three trees each. In the spring of 1979 and again in 1980, 1981, and 1982, simazine was applied at 0, 3, 6, and 12 $kg \cdot ha^{-1}$. Each of these dosages was applied as a spray to one block comprised of nine trees in a 2-m wide strip in the row beneath the canopy of these trees. The herbicide strip was one meter wide on each side of the tree row. There were two buffer trees between each of the four blocks. In the zero simazine treatment, the weeds were left to grow freely and mowed whenever the alleyway was mowed. In 1984, soil samples of 500 ml each were collected at a depth of 0-15 cm within the simazine treated strips and at the drip line of each tree. Composite samples of three trees (one replicate) were made in order to have three samples per treatment for a total of 12. The soil samples were mixed thoroughly, and a sub-sample of 200g was taken to quantify propagules of mycorrhizal fungi. The sub-samples were suspended in water, agitated vigorously, and passed through 1000, 500, 250, 125, and 53 l sieves under a gentle stream of water while shaking. Each soil fraction was recovered in a flask and mixed with water (about 10 times the soil volume). The soil solutions were decanted, and the supernatant was vacuum-filtered (Whatman #2 filter paper). Spores and sporocarps were removed manually with fine forceps from the filter papers and separated visually according to their appearance, size, and color using a stereomicroscope. Every spore category was mounted on microscopic slides for evaluation. The fungal species were identified, and their respective numbers were evaluated as described previously (Dalpé et al., 1986).

Growth and yield of apple trees was assessed in 1979 only. Two representative horizontal shoots at breast height which were perpendicular to the alleyway on each side of every tree were used to measure shoot for the season. Leaf and fruit samples were also collected, dried, weighed, ground in a Wiley Mill, and dry ashed at 550 C. K, Zn, Cu, Ca, and Mg were analyzed by atomic absorption spectrophotometry and P was quantified colormetrically by the phosphomolybdovanadate procedure. The soluble solids of the ten fruits were measured with a hand refractometer and firmness was measured with an Effigi penetrometer. The total crop of every tree was weighed and the apples were sorted into different sizes on a sorting table (Greefa Type A3, Normal, Holland). Fruit color was appraised visually using a scale ranging from 1 (low) to 5 (high).

The analysis of variance (ANOVA) was done using the General Linear Model (GLM) of SAS (SAS Institute, Cary, NC, USA) and orthogonal polynomial contrast was employed to study the effect of simazine concentration.

**Table 1. Effects of several concentrations of simazine on populations of mycorrhizal spores and sporocarps in the rhizosphere of 'Spartan' apple trees.**

| Simazine ($kg.ha^{-1}$) | Number of spores and sporocarps[z] | | | | |
|---|---|---|---|---|---|
| | *G. agg.* | *G. rub.* | *G. cal.* | *G. con.* | Total |
| 0 | 69.7 | 18.7 | 12.3 | 3.0 | 103.7 |
| 3 | 33.3 | 7.0 | 26.0 | 3.0 | 69.3 |
| 6 | 19.3 | 2.7 | 4.0 | 1.0 | 27.0 |
| 12 | 4.0 | 3.3 | 3.0 | 0.0 | 10.3 |
| Orthogonal polynomial contrast[y] | L | NS | L | L | L |

[z]*Glomus aggreatum, Glomus rubiformis, Glomus calospora* and *Glomus constrictum*, respectively.
[y]L = linear, NS = not significant at P = 0.05

## Results and Discussion

Examination of spores and sporocarps extracted from the soil samples revealed that the mycorrhizal fungi present in the plots all belonged to the genus Glomus (i.e *G. calospora, G. constrictum, G. aggregatum,* and G. rubiformis). The population of spores and sporocarps of the Glomus species were reduced by all concentrations of simazine (Table 1). Effects were linear and negative in nature for the individual species and total propagule count. For *G. calospora* there appeared to be an enlargement of propagule number with the application of simazine at 3kg $ha^{-1}$. This result may confirm those of Schwab et al. (1982), who found that sublethal doses of simazine increased exudation of sugars and amino acids from the roots of non-mycorrhizal plants such as that of Chenopodium quinona, rendering them attractive to VAM fungi.

The terminal growth/number of leaves ratio in 1979 was 2.0 cm/leaf for control trees and 1.6 cm/leaf for trees which received 12 $kg{\cdot}ha^{-1}$ of simazine. These findings are confirmed by work of Hogue and Neilsen (1988), who found that the same concentration had a deleterious effect on trunk radial growth of 'Delicious' apple trees grown in a coarse soil at Summerland, B.C. We found that simazine had no significant effect on the yield, size, or color of fruit, on fruit and leaf mineral content, or on fruit firmness. High application rates of simazine decreased fruit soluble solids content (Table 2). Since simazine treatments had no significant effect (p 0.05) on the growth, mineral content, or yield of the experimental trees, no results have been included herein.

Some VAM fungi are beneficial to apple tree growth (Benson and Covey, 1976; Granger et al., 1983; Mosse, 1957; Plenchette et al., 1981; Trappe et al., 1973). The results of this study clearly show that high levels of simazine adversely affected the population of mycorrhizae which in turn could reduce tree vigor. Since the mycorrhizal counts were carried out in 1984 and the simazine treatments were done in 1979, 1980, 1981 and 1982, it is not known what the yearly effects of simazine were on the population of mycorrhizae. It is clear however that simazine affected the soil mycorrhizal population for at least one year.

## Grower Benefits

Even one year after the cessation of the treatments, the residual effects of four consecutive years of simazine treatments on the survival of VAM

**Table 2. Effects of several concentrations of simazine on terminal growth/number of leaves, soluble solids content, and flesh firmness of fruit of 'Spartan' apple trees.**

| Simazine ($kg.ha^{-1}$) | SL ratio (cm shoot length/leaf)[z] | Soluble solids content (%) | Flesh firmness (N) |
|---|---|---|---|
| 0 | 2.0 | 11.2 | 85 |
| 3 | 1.8 | 11.2 | 80 |
| 6 | 1.7 | 11.4 | 85 |
| 12 | 1.6 | 10.5 | 82 |
| Orthogonal polynomial Contrast[y] | Q | Q | NS |

[z]SL (sh;oot leaf) = (Terminal growth/Number of leaves).
[y]L = linear, Q = quadratic, and NS = not significant at P = 0.05.

fungi in the orchard soil could be detected. In the four VAM species examined, we found that high dosages of simazine were associated with lower numbers of propagules.

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## Thinning Time on Firmness at Harvest

Hand thinning 'Cox' at various intervals indicated that 5 to 15 days after FB gave the greatest increase in harvest firmness with no increase when thinned at 25 d after FB. Further delay of thinning again led to some increase in firmness. Increased firmness was generally associated with the extent of the reduction in fruit number and yield and the commensurate increase in fruit dry matter concentration. Harvest firmness increases as a result of thinning were sustained during storage in 2% O but not in air or 1.25% O. From Johnson, 1994. J. Hort. Sci. 69:197-203.

## Shelterbelt Proximity and Flowering Kiwifruit

Kiwifruit vines growing near natural shelterbelts often crop poorly. The number of flowers per winter bud was significantly reduced on vines adjacent to shelterbelts. This was primarily because of reductions in the % of shoots which produced flowers on each shoot. Shading studies imply that the level of incident radiation is not the only factor affecting flowering. Authors suggest that reduction in flowering caused by reductions in both quantity and quality of light. From Manson et al. 1994. J. Hort. Sci. 69:205-212.