 0030-0950/85/0004-0151 $2.00/0

THE EFFECT OF FIRE ON THE ROOT HAIRS AND MYCORRHIZAE OF *LIATRIS SPICATA* [1]

RICHARD J. MEDVE, Department of Biology, Slippery Rock University, Slippery Rock, PA 16057

ABSTRACT. *Liatris spicata* (L.) Willd. plants that had either been unburned, subjected to a one-yr spring burn, or spring burned for two successive years, showed no significant difference in percentage of mycorrhizae, vesicles or arbuscules, intensity of mycorrhizae, presence of root hairs, or intensity of root hairs. Plants from all three treatments had vesicular-arbuscular mycorrhizae (VAM). Vesicles were consistently abundant, but arbuscules were scarce. The percentage of roots with VAM was strongly correlated with VAM intensity, but no other significant correlations were detected for various root hair and mycorrhizal characteristics.

OHIO J. SCI. 85(4): 151-154, 1985

INTRODUCTION

Perturbations investigated for their effects on mycorrhizae include tillage (Kruckelmann 1975), mining (Schramm 1966), clearing of forests (Schenck and Kinloch 1980), soil removal (Medve 1984), pasturing (Crush 1978), roadbed abandonment (Reeves et al. 1979), and biocides (Persidsky and Wilde 1960). The importance of mycorrhizae to the survival of most plant species has been well docu-

[1]Manuscript received 10 May 1985 and in revised form 28 June 1985 (#85-16).

mented (Hacskaylo 1972) and any disturbance, such as fire, may jeopardize this relationship. Although fire is a common perturbation that is used as a resource management tool (Wright and Bailey 1982), relatively few studies have considered its effects on below ground plant structures (Kummerow and Lantz 1983), and specifically on mycorrhizae (Medve 1984). Some investigators have studied the response of fungi to fire (Wicklow 1973, Rice and Parenti 1978, Annala and Kapustka 1982), but did not include an analysis of mycorrhizae.

Fire has been used to manage and maintain the Lynx Prairie Preserve in Ohio (Annala and Kapustka 1982) and the Jennings Blazing Star Prairie in Pennsylvania (Rabatin 1978). Blazing star (*Liatris spicata*) is a perennial composite herb that is common to both relict prairies. Current management practices at Jennings are centered on preserving *L. spicata*.

The objective of this research was to investigate the effects of one- and two-yr burns on the mycorrhizae of *Liatris spicata*. Because of the functional similarity of mycorrhizae and root hairs, the effects of burning on the presence of root hairs was also considered and correlations were evaluated between the presence of root hairs and mycorrhizae.

METHODS AND MATERIALS

Thirty, 16-m^2 quadrats were established along three line transects in a dense stand of *L. spicata* located near West Sunbury, PA. Using a random number table, 10 quadrats were selected for two spring burns (22 April 1982 and 1983), 10 quadrats for a single spring burn (22 April 1983), and 10 quadrats to remain unburned. Plots were separated on all sides by a four-m buffer zone.

On 23 August 1983, all *L. spicata* plants were removed from 0.25 m^2 quadrats located at the center of each of the 30, 16-m^2 quadrats. Twenty-seven plants were obtained from the control quadrats, 26 from the one-yr burn, and 21 from the two-yr burn quadrats.

Roots from each specimen were returned to the laboratory where they were washed in distilled water and stored in formalin-acetic acid-ethanol. Microslides were prepared for each root system. Sections were stained with trypan blue in lactophenol (Phillips and Hayman 1970) and examined for mycorrhizae and root hairs at 100X and 400X. The gridline intersect method (Giovannetti and Mosse 1980) was used to evaluate the roots for percent mycorrhizae. Intensity of root hairs and mycorrhizae followed the scale described by Kormanik et al. (1980) for intensity of infection.

Analysis of variance (ANOVA) was used to test for differences in intensity of mycorrhizae, intensity of root hairs, and percent mycorrhizae between treatments. Correlation coefficients were calculated for pairs of selected root parameters. Using a 3×2 contingency table, a Chi-square test was used to test for a difference between the presence of root hairs and treatments.

RESULTS AND DISCUSSION

All *L. spicata* plants sampled in the burned and unburned plots had vesicular-arbuscular mycorrhizae (VAM). Vesicles were found in all root sections, but arbuscules were scarce (table 1). These results are consistent with Rabatin (1978) who reported levels of vesicles to increase in the late fall and winter and numbers of arbuscules to be higher in the spring and early summer.

Wicklow (1973) and Rice and Parenti (1978) found an increase in the number of fungi after a fire. Major increases in fungal densities that occurred in recently burned grasslands resulted in a post-fire "fungal-bloom" (Wicklow 1973). If this type of fungal response occurred in the *L. spicata* stands, it did not manifest itself as an increase in mycorrhizal colonization. Differences in the percentages of roots with VAM for *L. spicata* from the three treatments (table 1) were insignificant at the 0.05 level (ANOVA). The 65.3% VAM for the two-yr burn plants compares favorably with the 60.1% reported for *L. spicata* when burned in alternate years (Rabatin 1978).

The intensity of mycorrhizae in the three treatments was not significantly different (ANOVA $p < 0.05$). The percentage of roots with VAM, however, was positively correlated with VAM intensity (table 2). This shows that most non-woody roots are mycorrhizal with large infection sites that are rather uniformly distributed throughout the infected root, but with rare coalescence (Kormanik et al. 1980).

TABLE 1
The effect of fire on root hairs and mycorrhizae of Liatris spicata.

Characteristic	Unburned	Burned 1 yr	Burned 2 yr
Mycorrhizae			
Percent of plants with vesicular-arbuscular mycorrhizae	100	100	100
Percent with vesicles	100	100	100
Percent with arbuscules	4	4	5
Intensity	1.8(0.7)*	1.9(0.7)	2.1(0.8)
Percent mycorrhizae	70.2(20.5)	69.9(19.8)	65.3(28.1)
Root hairs			
Percent of plants with root hairs	44	42	29
Intensity	1.6(0.9)	1.5(0.7)	1.3(0.8)

*Figures in parentheses are standard deviations

Fire did not significantly affect the percentage of *L. spicata* plants with root hairs (Chi square, $p < 0.05$) or the intensity of root hairs (ANOVA, $p < 0.05$). Fire was similarly found to have a negligible effect on the fine root system close to the soil surface of *Adenostoma sparsifolium* (Kummerow and Lantz 1983). Correlation coefficients for mycorrhizal and root hair characteristics showed no significant correlations ($p < 0.05$) for plants from the unburned and burned quadrats (table 2).

The response of mycorrhizae to various perturbations shows a great deal of variation, but generally there is a decrease in percent mycorrhizae. Recent investigations showed monoculture (Schenck and Kinloch 1980), biocides (Persidsky and Wilde 1960), road abandonment (Reeves et al. 1979), mining (Allen and Allen 1980), and the addition of nutrients (Mosse and Phillips 1971) resulted in a decrease in mycorrhizae. Removal of topsoil and topsoil-subsoil, however, showed an initial community response of increased VAM, but a decrease in percent mycorrhizae after three years (Medve 1984). These perturbations can be considered as stress factors that result in a negative impact on mycorrhizae. Fire, however, did

TABLE 2
Correlation coefficients (r) for selected comparisons of vesicular-arbuscular mycorrhizal (VAM) and root hair parameters of Liatris spicata *plants that have been subjected to burning.*

Correlations	r values: Control	Burned 1 yr	Burned 2 yr
% VAM vs. intensity VAM	.5989*	.6881*	.8348*
%VAM vs. intensity root hairs	−.1984	−.3294	.2901
Intensity VAM vs. intensity root hairs	−.1542	−.1421	.2379

*Significant at 0.05 level

not stress the growth of either mycorrhizae or root hairs of *L. spicata*.

Liatris spicata is a grassland species that is subjected to natural and man-made fires. An obvious explanation for the neutral responses of root hairs and mycorrhizae to fire is that they illustrate this species' adaptations to fire. This explanation, however, may not be acceptable for a similar neutral response of mycorrhizae to fire was also observed in a *Solidago-Aster* community in western Pennsylvania (Medve 1984). To ascertain the extensiveness of fire as a nonstress perturbation in regards to the formation of root hairs and mycorrhizae will require further studies on plant species from a variety of habitats and stages of succession.

ACKNOWLEDGMENTS. Gratitude is extended to the Western Pennsylvania Conservancy for financial assistance and to Mr. and Mrs. Homer Thompson for providing the study site.

LITERATURE CITED

Allen, E. B. and M. F. Allen 1980 Natural reestablishment of vesicular-arbuscular mycorrhizae following stripmine reclamation in Wyoming. J. Appl. Ecol. 17: 139-147.

Annala, A. E. and L. A. Kapustka 1982 The microbial response to fire in the Lynx Prairie Preserve, Adams County, Ohio. Prairie Nat., 14(4): 101-112.

Crush, J. R. 1978 Changes in effectiveness of soil endomycorrhizal fungal populations during pasture development. N.Z.J. Agric. Res. 21: 683-685.

Giovannetti, M. and B. Mosse 1980 An evaluation of techniques for measuring vesicular-arbuscular mycorrhizal infection in roots. New Phytol. 84: 489-500.

Hacskaylo, E. 1972 Mycorrhiza: The ultimate in reciprocal parasitism? BioScience 22(10): 577-583.

Kormanik, P. P., W. C. Bryan and R. C. Schultz 1980 Procedures and equipment for staining large numbers of plant root samples for endomycorrhizal assay. Can. J. Microbiol. 26: 536-538.

Kruckelmann, H. W. 1975 Effects of fertilizers, soils, soil tillage, and plant species on the frequency of *Endogone* chlamydospores and mycorrhizal infection in arable soils. p. 511-525. *In*: F. E. Saunders, B. Mosse, and P. B. Tinker (eds.), Endomycorrhizas, Academic Press, New York.

Kummerow, J. and R. K. Lantz 1983 Effect of fire on fine root density in red shank (*Adenostoma sparsifolium* Torr.) chaparral. Pl. Soil. 70: 347-352.

Medve, R. J. 1984 The mycorrhizae of pioneer species in disturbed ecosystems in western Pennsylvania. Amer. J. Bot. 71(6): 787-794.

Mosse, B. and J. M. Phillips 1971 The influence of phosphate and other nutrients on the development of vesicular-arbuscular mycorrhiza in culture. J. Gen. Micro. 69: 157-166.

Persidsky, D. J. and S. A. Wilde 1960 The effect of biocides on the survival of mycorrhizal fungi. J. For. 58(7): 522-524.

Phillips, J. M. and D. S. Hayman 1970 Improved procedures for clearing roots and staining parasitic and vesicular-arbuscular mycorrhizal fungi for rapid assessment of infection. Trans. Br. Mycol. Soc. 55: 158-161.

Rabatin, S. C. 1978 An investigation of ecological factors influencing the dynamics and distribution of endogonaceous vesicular-arbuscular mycorrhizal fungi (A report to the Western Pennsylvania Conservancy). Univ. Pittsburgh, Pittsburgh, PA. (mimeo).

Reeves, F. B., D. Wagner, T. Moorman and J. Kiel 1979 The role of endomycorrhizae in revegetation practices in the semi-arid west. I. A comparison of incidence of mycorrhizae in severely disturbed vs. natural environments. Amer. J. Bot. 66(1): 6-13.

Rice, E. L. and R. L. Parenti 1978 Causes of decreases in productivity in undisturbed tallgrass prairie. Amer. J. Bot. 65: 1091-1097.

Schenck, N. C. and R. A. Kinloch 1980 Incidence of mycorrhizal fungi on six field crops in monoculture on a newly cleared woodland site. Mycologia 72: 445-456.

Schramm, J. R. 1966 Plant colonization studies on black wastes from anthracite mining in Pennsylvania. Trans. Amer. Phil. Soc., 56(1): 1-189.

Wicklow, D. T. 1973 Microfungal populations in surface soils of manipulated prairie stands. Ecology 54: 1302-1310.

Wright, H. A. and A. W. Bailey 1982 Fire Ecology. John Wiley and Sons, New York. 501 p.