Symbiosis, 9 (1990) 315–320
Balaban Publishers, Philadelphia/Rehovot

Seasonal Patterns of Vesicular-Arbuscular Mycorrhizal Occurrence in Grasslands*

I.R. SANDERS

Department of Biology, University of York, Heslington, York Y01 5DD, UK.

Abstract

Temporal patterns of vesicular-arbuscular mycorrhizal occurrence in a semi-natural grassland were studied during a two year period. The results indicate that plant species can exhibit significantly different levels of mycorrhizal infection from one year to another. The ecological significance of these findings is discussed.

Introduction

Vesicular-arbuscular mycorrhizas (VAM) are abundant in grasslands. Investigating seasonal patterns of their occurrence is important in understanding VAM functioning and ecological significance. Recent investigations of the spatial and temporal patterns of mycorrhizas (McGonigle, 1987; Brundrett and Kendrick, 1988) have indicated that there may be marked seasonal patterns in overall colonisation levels though seasonal peaks in VAM infection can occur in the spring (Rabatin, 1979). Sparling and Tinker (1975) found no temporal patterns of infection in a Pennine grassland. However, these studies only monitored the levels of infection for a single year.

The aims of this investigation were to: (1) measure VAM infection over a period of two years in order to establish whether there are any differences between species in seasonal patterns that occur and (2) to identify any peaks or troughs in infection at the same time in a following year, i.e. a seasonal pattern of VAM infection.

Materials and Methods

On six occasions in each of two years (1988 and 1989) six plant species were

*Reviewed

removed from eight randomly selected points at Wheldrake Ings (a species rich, semi-natural, alluvial meadow). The roots were measured for VAM infection, and the above-ground biomass, phosphorus, copper, zinc and manganese contents of each plant were recorded. Harvests were taken every six weeks from February to March and every three weeks from April to June. Regular harvesting ceased at the end of June when the site was cut for hay.

The VAM infection data (measured as the percentage of root length infected) was arc sin square root transformed for analysis of variance. Oneway and twoway analysis of variance and covariance were used to establish whether significant seasonal patterns occurred in the data. In addition, the lowest degree orthogonal polynomials that adequately fit the data were calculated. The 95% confidence intervals in Figures 1 and 2 were calculated using the transformed data.

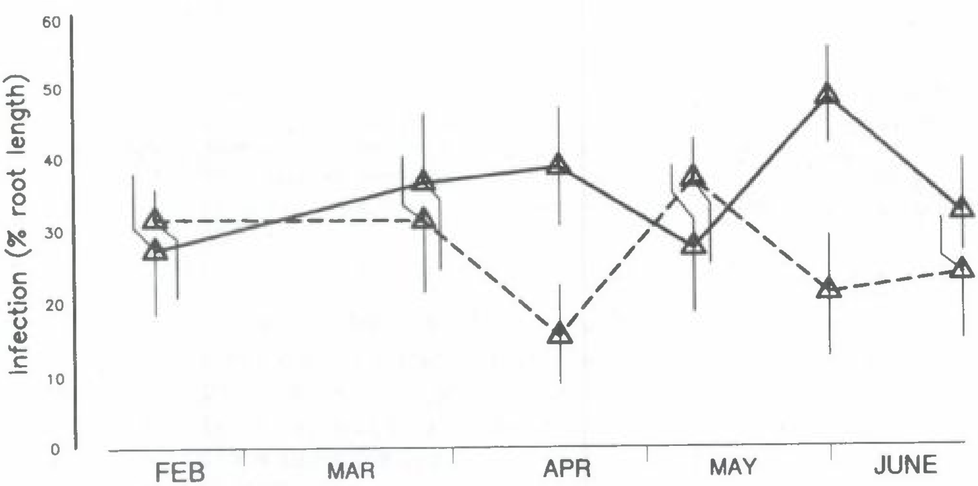

Figure 1.

Results

Total VAM infection for the six plant species (Fig. 1) indicates that for much of the period of study the mean levels of infection for all species are the same in the two years, except in April and June when infection was lower in 1989 and in 1988.

Infection levels in *Trifolium pratense*, *Holcus lanatus* and *Festuca rubra* show the same trend in 1988 and 1989 (Fig. 2), suggesting a consistent seasonal pattern, though *T. pratense* has a peak in March and April, whereas *H. lanatus* has minimal infection in April. Levels of infection in *F. rubra* are low and are more or less constant.

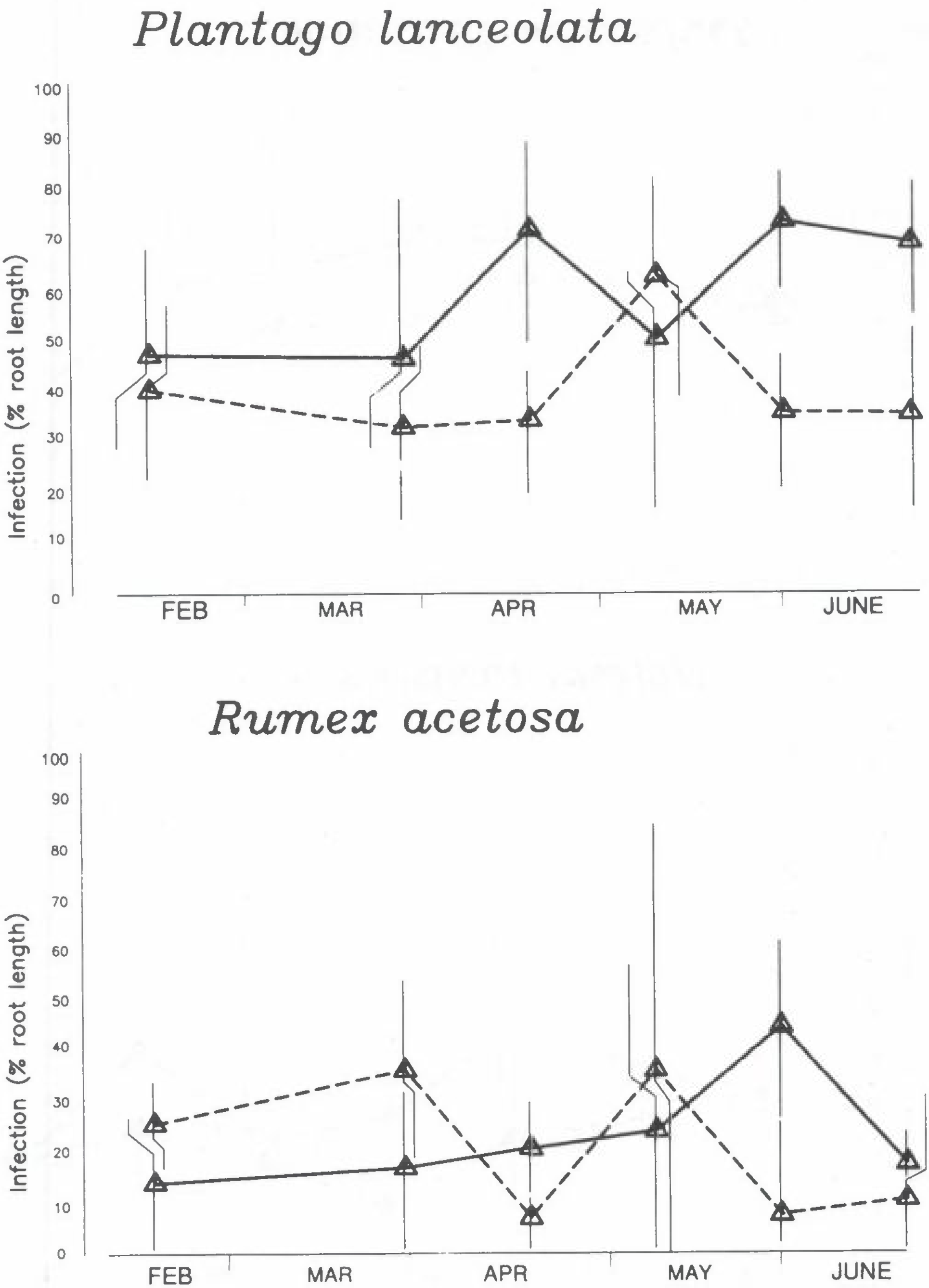
Plantago lanceolata
Infection (% root length)
100
90
80
70
60
50
40
30
20
10
0
FEB
MAR
APR
MAY
JUNE
Rumex acetosa
Infection (% root length)
100
90
80
70
60
50
40
30
20
10
0
FEB
MAR
APR
MAY
JUNE

Figure 2a.

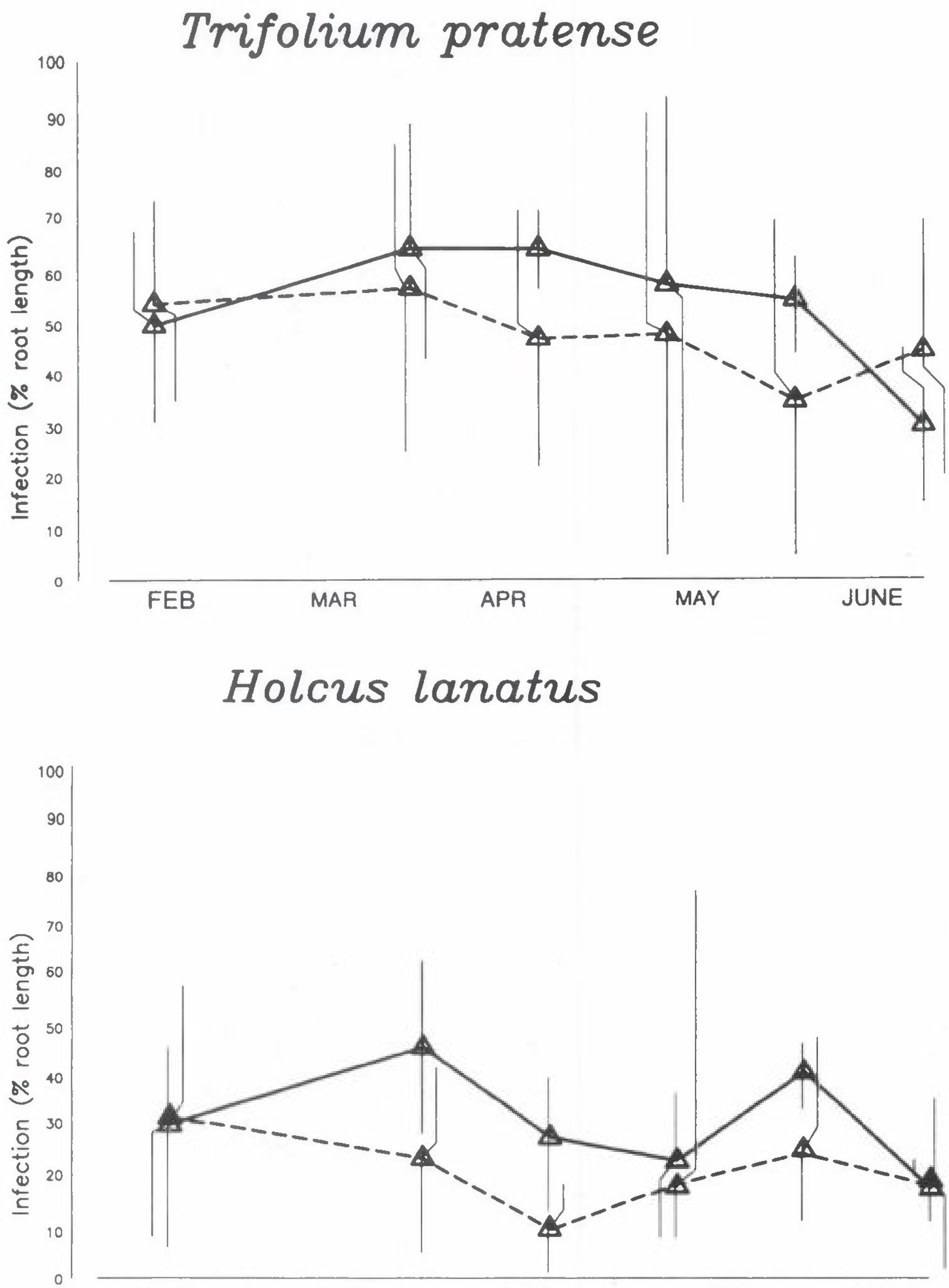
Trifolium pratense
Infection (% root length)
0
10
20
30
40
50
60
70
80
90
100
FEB
MAR
APR
MAY
JUNE
Holcus lanatus
Infection (% root length)
0
10
20
30
40
50
60
70
80
90
100
FEB
MAR
APR
MAY
JUNE

Figure 2b.

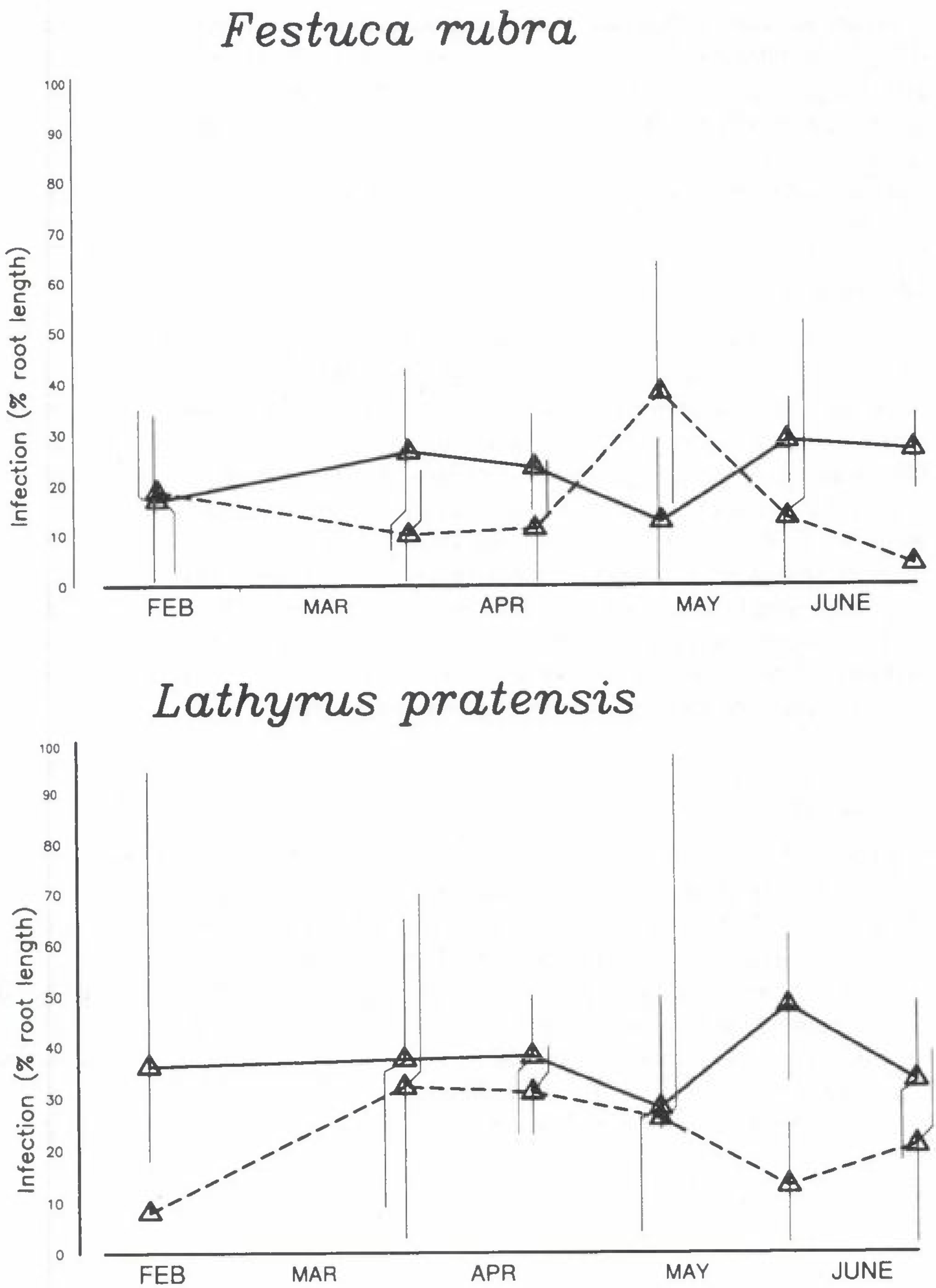
Festuca rubra
Infection (% root length)
0
10
20
30
40
50
60
70
80
90
100
FEB
MAR
APR
MAY
JUNE
Lathyrus pratensis
Infection (% root length)
0
10
20
30
40
50
60
70
80
90
100
FEB
MAR
APR
MAY
JUNE

Figure 2c.

In contrast, *Plantago lanceolata, Rumex acetosa* and *Lathyrus pratensis* are significantly different in infection between the two years (Fig. 2). These species exhibit lower infection in late May in 1989 as opposed to 1988 and *P. lanceolata* and *R. acetosa* show the same effect in April. There is no consistent seasonal pattern for these three species.

At no time were changes in plant biomass or nutrient content related to mycorrhizal infection.

Discussion

Peaks and troughs in mycorrhizal infection do occur. However, these trends are difficult to interpret since they do not always recur the following year. It is impossible to say from the data presented here why the patterns of VAM infection differ from one year to the next. However, studies of temporal patterns of VAM infection outline how little is known of the ecology and functioning of VAM. Differing patterns of infection may be due to either a plant or a fungus response to environmental conditions; 1989 was a much warmer and drier year than 1988. It is possible that some mycorrhizal types or species infect particular plant species more readily than others and that different seasonal patterns between plant species are changes in the relative abundance of these different fungal types. Thus, variation could be caused by selective infection of different fungal types. In contrast, uniform levels of infection could mask temporally separated peaks of infection by more than one fungal type.

REFERENCES

Brundrett, M.C. and Kendrick, B. 1988. The mycorrhizal status, root anatomy, and phenology of plants in a sugar maple forest. *Can. J. Bot.* **66:** 1153–1173.

McGonigle, T.P. 1987. Vesicular-arbuscular mycorrhizas and plant performance in a semi-natural grassland. DPhil Thesis, University of York.

Rabatin, S.C. 1979. Seasonal and edaphic variations in vesicular-arbuscular mycorrhizal infection of grasses by *Glomus tenuis*. *New Phytol.* **83:** 95–102.

Sparling, G.P. and Tinker, P.B. 1975. Mycorrhizas in Pennine grassland. In: Endomycorrhizas. (Ed. by F.E.T. Sanders, B. Mosse and P.B.H. Tinker), pp. 545–560. Academic Press, London.