JOINT INFLUENCE OF Pratylenchus penetrans (NEMATODA) AND Glomus fasciculatum (PHYCOMYCETA) ON THE ONTOGENY OF Phaseolus vulgaris

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ABSTRACT


The joint influence of Pratylenchus penetrans and Glomus fasciculatum on the ontogeny of Phaseolus vulgaris (navy beans) was examined under greenhouse conditions. Root colonization by G. fasciculatum was less in the presence of P. penetrans than in its absence. Population densities of P. penetrans were initially (prior to 600 cumulative degree days at a base of 10°C [DD10]) lower in plants exposed to only P. penetrans than in plants grown in the presence of both organisms. After 600 DD10, nematode population densities were greater in plants exposed to both P. penetrans and G. fasciculatum than in those grown only in the presence of the nematode. In addition, the reproductive rate of G. fasciculatum was reduced in the presence of P. penetrans. Plant growth and yield were reduced in the presence of P. penetrans, and increased in the presence of G. fasciculatum.

Additional key words: root-lesion nematode, dry beans, vesicular-arbuscular mycorrhizae.

RESUMEN


La influencia conjunta de Pratylenchus penetrans y Glomus fasciculatum en la ontogénica del Phaseolus vulgaris (frijol blanco) fue examinada bajo condiciones de invernadero. La colonización de las raíces del frijol por G. fasciculatum fue menor en presencia de P. penetrans que en su ausencia. La densidad de las poblaciones de P. penetrans fueron inicialmente [inferior a 600 grados días acumulativos a base de 10°C (DD10)] más bajas en plantas expuestas solamente a P. penetrans que en plantas creciendo en presencia de ambos organismos. Por encima de 600 DD10, las densidades fueron mayores en plantas expuestas a ambos P. penetrans y G. fasciculatum que aquellas creciendo sólo en presencia del nematodo. En adición la proporción de re-
INTRODUCTION

Vesicular-arbuscular (VA) mycorrhizal fungi (Phycomyceta) and the root-lesion nematode (Pratylenchus penetrans Filipjev & Schuurmans Stekhoven, 1941) are commonly found in soils associated with dry bean (Phaseolus vulgaris L.) production in Michigan (5). VA mycorrhizal-nematode interactions have been studied by a number of researchers (2.
7, 10, 16, 17, 19, 20). Although the results of these studies vary, there is increasing evidence that under a number of environmental conditions, the detrimental influence of plant-parasitic nematodes can be at least partially alleviated by the presence of an endomycorrhizal association (11, 21). The objective of this investigation was to evaluate the impact of *P. penetrans* on *P. vulgaris* cv 'Sanilac' in the presence and absence of the VA mycorrizal fungus *Glomus fasciculatum* sensu Gerdemann, 1974.

**MATERIALS AND METHODS**

A randomized-design greenhouse study consisting of 4 replicates of 4 treatments was used to evaluate the joint influence of *G. fasciculatum* and *P. penetrans* on the ontogeny of *P. vulgaris*. The 4 treatments included: (i) an initial nematode population density of 300 *P. penetrans*

![Graph](image)

**Fig. 2.** Influence of *Pratylenchus penetrans* on spore density of *Glomus fasciculatum*. 


per 100 cm³ soil, (ii) 1000 spores of *G. fasciculatum* per 100 cm³ soil, (iii) 300 *P. penetrans* plus 1000 spores of *G. fasciculatum* per 100 cm³ soil, and (iv) a control where the plants were grown in the absence of these two organisms. One hundred and twelve 23.7-cm-diameter clay pots were filled with 3000 cm³ of soil containing the desired densities of *P. penetrans* and *G. fasciculatum*, obtained by mixing steam-sterilized sandy clay loam soil with *P. penetrans*-infested soil and soil containing spores of *G. fasciculatum*. Three navy bean seeds were planted in the soil in each pot. The plants were thinned to one seedling per pot after germination, watered daily, and maintained at 30 ± 5.5 °C under greenhouse conditions for 98 days.

Four replicates of each of the treatments were analyzed every 14 days. Plant growth measurements, including leaf area, shoot fresh weight, and root area, were recorded throughout this experimental period. Relative

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**Fig. 3.** Influence of *Glomus fasciculatum* on population dynamics of *Pratylenchus penetrans.*
estimates of leaf and root areas were estimated by optical scanning. Individual leaves and root segments were passed through a Lambda leaf area meter, Model LI3000®. Shoot systems were oven-dried at 30 ± 5 °C, and leaf area ratios (6) were calculated (leaf area ratio = leaf area/plant dry weight). Soil and root samples were taken for nematode analysis, and *P. penetrans* densities estimated microscopically from 100 cm³ of soil and 1.0 g of root tissue (3, 9). VA mycorrhizal root colonization was determined using root staining (acid fuchsin) and microscopic observation procedures. Estimates were made from 1.0-g root tissue samples. Soil samples were analyzed for spores of *G. fasciculatum* using a modified centrifugation-flotation technique (9).

**RESULTS**

VA mycorrhizal root colonization by *G. fasciculatum* increased

![Graph showing influence of *Pratylenchus penetrans* and *Glomus fasciculatum* on root area of *Phaseolus vulgaris*.](image-url)

*Fig. 4. Influence of *Pratylenchus penetrans* and *Glomus fasciculatum* on root area of *Phaseolus vulgaris*.***
throughout the first 900 accumulative degree days at a base of 10 °C (DD\textsubscript{10} = 900) of the experimental period. The relationship between VA mycorrhizal root colonization and cumulative degree days was expressed as a second degree polynomial (Fig. 1). VA mycorrhizal root colonization was less in plants infected with *P. penetrans*, compared to mycorrhizal plants grown in the absence of this nematode. *G. fasciculatum* spore density declined, remained at a low density until 900 DD\textsubscript{10}, and then increased (Fig. 2). The presence of *P. penetrans* had no detectable impact on the spore density of *G. fasciculatum*.

During the first 600 DD\textsubscript{10}, population densities of *P. penetrans* were higher in plants infected with only *P. penetrans* compared to nematode population densities associated with plants grown in the presence of both organisms (Fig. 3), although differences were not statistically significant (P = 0.05). After 600 DD\textsubscript{10}, population densities of *P. penetrans* were higher in plants infected with both *P. penetrans* and *G. fasciculatum*. Maxima in nematode population densities were observed at 343 and 715 DD\textsubscript{10}, and remained relatively constant until 900 DD\textsubscript{10}. This was followed by a slight decline in population densities of *P. penetrans*.

The root area of *P. vulgaris* was lowest in plants infected with *P. penetrans*, and highest in those colonized with *G. fasciculatum* (Fig. 4). Root area increased through 715 DD\textsubscript{10}, and then decreased for the remainder of the experiment. Plant leaf area ratios fluctuated throughout the growth period. These were generally greatest in plants infected with *P. penetrans* and lowest in plants colonized with *G. fasciculatum*. Dry bean yield was significantly (P = 0.05) increased in plants colonized with *G. fasciculatum* and decreased in plants infected with *P. penetrans* (Fig. 5). There was no significant (P = 0.05) difference between dry bean yield of control plants and plants colonized with both *G. fasciculatum* and *P. penetrans*.

**DISCUSSION**

Colonization of *P. vulgaris* by *G. fasciculatum* resulted in increased plant growth and bean yield. The adverse effects of *P. penetrans* on growth and yield of dry beans was reduced in the presence of VA mycorrhizal colonization of *P. vulgaris* by *G. fasciculatum*. The mode of action and the function of the fungus in interactions with *P. penetrans* and navy beans is not known. Population densities of *P. penetrans* were not significantly different in plants infected with both *P. penetrans* and *G. fasciculatum*. The increased plant tolerance to *P. penetrans*, therefore, did not appear to be directly related to nematode population densities. Although a significant amount of additional research is needed, the presence of certain species of VA mycorrhizal fungi in navy bean produc-
tion systems can be considered as beneficial. Maintenance of optimum densities of selected VA mycorrhizal fungi may be desirable in future nematode management strategies in navy bean production. The influence of agricultural chemicals on mycorrhizal associations should be considered in development of nematode control strategies (1, 4, 14, 15). The value of VA mycorrhizal fungi as a future component of an integrated nematode management strategy for navy bean production systems will most likely vary with different nematode and VA mycorrhizal fungi species. The nature of the indigenous species must be determined and the impact of introducing other species evaluated. Relationships between mycorrhizae and nematodes may not always result in beneficial effects on plants. Where the beneficial mycorrhizal species are not in-

Fig. 5. Influence of Pratylenchus penetrans (PP) and Glomus fasciculatum (GL) on yield of Phaseolus vulgaris (C = control).
digogenous, it may be possible to introduce them, and increase population densities by effective crop rotation (12, 13).

LITERATURE CITED


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