

Interaction of *Scutellonema cavenessi* and *Glomus mosseae* on growth and N₂ fixation of soybean

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SUMMARY

The influences of a parasitic nematode (*Scutellonema cavenessi*) and a vesicular arbuscular mycorrhiza (*Glomus mosseae*) alone or in combination on growth and N₂ fixation of one cultivar of soybean (44 A73) were studied in the greenhouse. In combined inoculations of soybean with *G. mosseae* and *S. cavenessi*, development of mycorrhizae nullified the stunting and the reduction of N₂ fixation caused by the nematode. Growth and N₂ fixation of mycorrhizal plants were greater than that of non mycorrhizal plants.

RÉSUMÉ

Interaction de Scutellonema cavenessi et Glomus mosseae sur la croissance et la fixation de N₂ du soja

Les auteurs exposent les résultats de l'inoculation simple et combinée du nématode *Scutellonema cavenessi* et de l'endomycorhize *Glomus mosseae* sur le cultivar de Soja 44 A73. Des mesures ont été effectuées au 46^e jour du cycle végétatif : elles portaient sur (1) le poids et la teneur en N et P de parties aériennes (2) le nombre et le poids des nodules bactériens (3) la fixation de N₂ (4) l'infection par les nématodes et par les endomycorhizes. Les valeurs des paramètres étudiées sont significativement diminuées par *S. cavenessi* et significativement augmentées par *G. mosseae*. Dans le cas d'une inoculation combinée des deux organismes, l'effet négatif des nématodes est inhibé par l'effet bénéfique des mycorhizes : les valeurs des paramètres considérées ne sont pas différentes de celles observées sur des plantes inoculées avec des mycorhizes seules.

Studies on plant parasitic nematode-endomycorrhiza interactions have been recently discussed in many reviews (Menge *et al.*, 1977; Schenck & Kellam, 1978; Schönbeck, 1979). O'Bannon *et al.* (1979) and O'Bannon and Nemecek (1979) have shown that stimulation of *Citrus* growth by *Glomus mosseae* or *Glomus etunicatus* was to some extent reduced in the presence of *Tylenchulus semipenetrans* or *Radopholus similis*. However, mycorrhizal plants parasitized by nematodes always grow better than plants infected with nematodes alone (Atilano *et al.*, 1976; Roncadori & Hussey, 1977; Hussey & Roncadori, 1978; O'Bannon *et al.*, 1979). Other papers (Schenck & Kellam, 1978) have also shown variation in host response to a nematode-mycorrhizal complex.

The effect of nematodes on the behaviour of vesicular-arbuscular mycorrhizal (VA) fungi is also variable. It may be detrimental (Schenck &

Kinloch, 1974; Schenck, Kinloch & Dickson, 1975) without effect (Atilano *et al.*, 1976; Hussey & Roncadori, 1978) or stimulative (Bagyaraj, Manjunath & Reddy, 1979).

Many papers have reported significantly reduced numbers of root-knot nematodes or reduced formation of root galls in different plants preinoculated with *Glomus mosseae*, *Glomus fasciculatus* or *Glomus macrocarpus* (Sikora & Schonbeck 1975; Sikora 1978; Sikora, 1979; Bagyaraj, Manjunath & Reddy, 1979; Kellam & Schenck, 1980). Inversely, other workers have reported greater populations of root knot larvae in mycorrhizal plants than in non mycorrhizal plants (Rich & Bird, 1974; Atilano *et al.*, 1976).

Preliminary works have shown that under controlled conditions in the laboratory, *Scutellonema cavenessi* Sher, 1963 may severely affect growth and N₂ fixation of soybean and peanut

(Germani, Diem & Dommergues, 1980; Germani, 1981). It has been recently shown that N₂ fixation of two cultivars of peanuts was reduced to different degrees by the presence of *S. cavenessi* in fields studies (Germani, 1981b).

The present study has been designed to determine the effect of the dual inoculation with *Glomus mosseae* and *Scutellonema cavenessi* on growth and nitrogen fixation of one cultivar of soybean.

Material and methods

Five-day-old seedlings of soybean cv. 44 A 73 germinated in sand were transplanted singly into 20 cm clay pot containing autoclaved soil. The soil was a sandy soil from the ORSTOM Center in Dakar (clay 3.3%; silt 4.4%, sand 92.1%; pH: 7.1; available P (Olsen): 104 ppm).

The *S. cavenessi* inoculum was prepared by extraction from naturally infested soil under field conditions. The nematodes were extracted by the Dalmasso's (1966) simplified technique and observations were made to ensure that the inoculum was free from other pathogens. The extracted nematodes were then washed several times in sterilized deionized water.

At the time of transplantation, 5 000 nematodes were added to the soil. Plants designated to become mycorrhizal were inoculated with a small pad of spores, hyphae and infected root segments obtained from a *Vigna unguiculata* infected with *Glomus mosseae*. Soybean plants of all treatments, including controls, were inoculated with a liquid culture of *Rhizobium*, strain USDA 138. Plants designated to become non mycorrhizal were similarly inoculated with mycorrhized inoculum washings passed through a 50 µm sieve and a Whatman N° 1 filter paper to standardize microflora.

Treatments consisted of inoculations with *Glomus mosseae* or *S. cavenessi* alone, inoculations with both, and controls inoculated with *Rhizobium* only.

Treatments were replicated seven times and arranged in a completely randomized design. Pots were watered daily and stored under greenhouse conditions. 46 days after inoculation plants were harvested. Roots were cleared and stained according to the method of Phillips and

Hayman (1970) the percentage of root segments infected was then determined on more than 100, 3.5 mm length root segments under a dissecting microscope (×65). Nematodes populations in the soil and in the root were estimated at the end of the experiment.

Nematodes were extracted from fresh soil samples by elutriation (Seinhorst, 1962) and from roots by mist chambers (Seinhorst, 1950). Nematodes were expressed as numbers per pot. The effect of nematode-mycorrhiza on plant growth was expressed by the dry weight of shoots measured at harvest after 48 h at 80°. P contents and N contents of dried material of shoots were measured respectively by the vanadate-molybdate method (Jackson, 1964) and the Kjeldhal method. N₂ fixation was estimated by the dry weight of nodules measured after 48 h at 80° and by the acetylene reduction method (ARA) on nodulated roots held in hermetically closed serum bottles. All results were analyzed statistically using the Mann-Whitney test (Snedecor & Cochran, 1967).

Results and discussion

Data in Table 1 show that *S. cavenessi* significantly affected growth and nitrogen fixation of the host plant as compared to uninoculated plants. As expected, mycorrhizae plants grew better (Fig. 1) and fixed more N₂ than non mycorrhizal plant (Tab. 1).

In the dual inoculation treatment (nematode infected mycorrhizal plants), shoot and nodules dry weight, N and P content and ARA per plant were statistically similar to that found in plants inoculated with *G. mosseae* alone. Atilano *et al.* (1976), O'Bannon and Nemeč (1979), Kellam and Schenck (1980) have already indicated that the presence of VA mycorrhizal fungi reduce the deleterious activity of nematodes, however, in their experiment the beneficial effect of VA mycorrhiza did not completely compensate for the damage caused by nematodes.

This experiment suggests that growth of nematode infected mycorrhizal plants is governed by a balance between inhibitory factors (nematode) and stimulatory factors (VA mycorrhizae). The state of the balance depends on the host plant, the nematodes and VA mycorrhizae fungus involved, and soil environment.

Table 1
Effect of single and combined inoculations with *Scutellonema cavenessi* and *Glomus mosseae* on growth and N₂ fixation of soybean cv. 44 A73

| | Shoots | | Nodules | | ARA | Mycorrhizal infection | Nematodes | |
|--|-------------|--------------|--------------|--------|--------------|-----------------------|----------------------------|------------------|
| | dry wt. (g) | N (mg/plant) | P (mg/plant) | number | dry wt. (mg) | nmoles/plant | root segments infested (%) | number per plant |
| None | 2.7 a | 57 a | 2.0 a | 84.5 a | 109 a | 3.9 a | | |
| <i>S. cavenessi</i> | 1 b | 17 b | 0.8 b | 35.3 b | 29.3 b | 0.6 b | | 8 700 a |
| <i>G. mosseae</i> | 4.3 c | 125 c | 5.8 c | 98.0 a | 320 c | 6 a | 49.6 a | |
| <i>S. cavenessi</i> + <i>G. mosseae</i> | 3.6 c | 100 c | 5.1 c | 70.5 a | 313 c | 7.4 a | 33.6 b | 15 900 a |

Values followed by the same letters are not significantly different (P : .05).

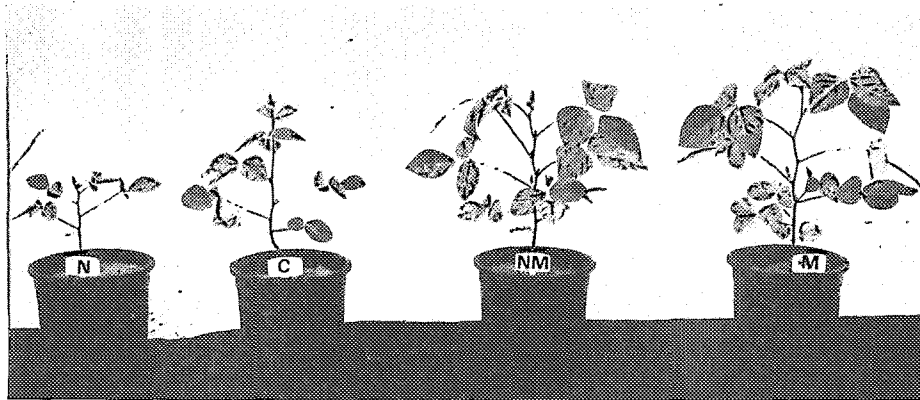


Fig. 1. Effect of single or double inoculation with *S. cavenessi* and *G. mosseae* on growth of soybean : *S. cavenessi* (N) ; control non inoculated (C) ; *S. cavenessi* and *G. mosseae* (NM) ; *G. mosseae* (M).

The present work shows that the harmful effect of plant parasitic nematode may be suppressed by the presence of VA mycorrhizae as suggested by statistical analysis (Tab. 1) : nematode infected mycorrhizal plants grow as well as plant infected with *G. mosseae* alone. The improved growth of plants inoculated with both *S. cavenessi* and *G. mosseae* was probably due to the well-known beneficial effect of mycorrhizae alone without any apparent interaction with nematodes. Similar observations have been made by Roncadori and Hussey (1977), Hussey and Roncadori (1978) and O'Bannon *et al.* (1979). There is no effect of VA mycorrhiza on the population of *S. cavenessi* but lower mycorrhizal infection was observed

in mycorrhizal plant inoculated with nematodes as compared to healthy mycorrhizal plants.

Conclusion

In the experiment carried out inoculation with nematodes alone exerted a negative effect on growth and N₂ fixation of soybean; this effect was inhibited by mycorrhizal infection to such an extent that there was no significant difference between plants jointly inoculated with nematodes and *G. mosseae* and plants inoculated with *G. mosseae* alone. This work in addition to that of many others on the effect of nematode-VA mycorrhiza interactions on

plant growth clearly indicate that these interactions appear complex and seem to vary with each plant species-nematode-mycorrhizal fungus species combination as discussed by Schenck and Kellam (1978).

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