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COMMUNICATION II

The Effect of Different Soil Types on Growth and Nodulation of *Vigna radiata* (L) Wilczek Inoculated with Vesicular-arbuscular Mycorrhiza (VAM)

RINGKASAN

Kajian awal ini ialah untuk menguji potensi satu sampel tanah yang mengandungi spora mikoriza yang tinggi bilangannya sebagai satu unsur inokulum di dalam 4 jenis tanah : Serdang, Munchong, Malacca dan Bungor. Keputusan berat kering dan kandungan P dalam tisu daun tidak memberi perbezaan yang bermakna di antara rawatan, tetapi memberi perbezaan yang bermakna di antara jenis-jenis tanah yang digunakan. Ini mungkin disebabkan oleh jangka masa kajian ini dijalankan, terlalu singkat untuk memboleh-kan spesies-spesies kulat ini membiak dan menghasilkan pertumbuhan yang bermakna.

SUMMARY

The potential of using a 'natural' soil with high mycorrhizal spore count as a source of inoculum was evaluated in this preliminary experiment using 4 soil types : Serdang, Munchong, Malacca and Bungor. Results obtained on the dry weight and P content of plant tops was not significant between treatments but was significant between the soil types used. This could be due to the duration of the experiment being too short to enable these endogonaceous species to establish well in these soils and bring about significant growth response of the mungbean plants.

INTRODUCTION

Legumes need adequate phosphorus supply for satisfactory nodule production and nitrogen fixation (van Schreven, 1958, cited from Mosse, 1979). Since the root systems of legumes are relatively restricted, it has been established that these legumes respond favourably to mycorrhizal infections (Mosse, 1979). Several experiments carried out in P-deficient soils have shown improved nodulation and nitrogen-fixation on inoculation of the plants with mycorrhiza (Abbott and Robson, 1977; Crush, 1974; Mosse *et al.*, 1976). Mosse (1979) has also shown that in *Centrosema,* only mycorrhizal or P treated seedlings produce nodules. Without any of these, no nodules were produced in spite of a reasonably well-developed root system.

It has been demonstrated by Harley (1969) and Gerdemann (1975) that inoculation of forest trees and agricultural plants with mycorrhizal fungi can stimulate their growth in nutritionally poor soils. Such soils occur in very large areas of the tropics. The possible impact of mycorrhizas seems obvious from the observation that almost all plant species of economic importance in the tropics are infected with VA endophytes (Crush, 1974; Mosse *et al.*, 1976; Ross and Harper, 1970). In the light of the present knowledge, this preliminary investigation has been initiated to determine the growth response and hence nodule production of mungbean plants inoculated with *Rhizobium* and mycorrhizal spores (from the sandy beach soils) in four different unsterilized inland soils.

MATERIALS AND METHODS

This pot experiment was conducted in four unsterilized soils namely : the Serdang and Bungor series (Typic Paleudult) and the Munchong and Malacca series (Tropeptic Haplorthox). Table 1 gives the physicochemical properties of the four soil types used. Three of the soils have pH 4.7 except Munchong with pH 5.2. Twenty-two cm diameter pots were used for the experiment, each pot containing 5 kg soil. Urea, triple-syperphosphate and muriate of potash were applied to each pot (top-dressing) at the equivalent rate of 50 kg N, 100 kg P and 120 kg K per ha respectively. There were four treatments per soil type : (1) uninoculated control, (2) inoculated with VA mycorrhizal fungus (comprising mixed species from sandy beach soil), (3) inoculated with *Rhizobium* compost of variety CV 5000 (obtained from RRIM) and (4) inoculated with (2) and (3).

The soaked mungbean seeds (of uniform size 4mm x 5 mm ± 2mm) were mixed with the

TABLE 1
Physicochemical properties of the four soil types used

	Serdang	Manchong	Malacca	Bungor
Horizon	Ap	Ap	Ap	Ap
+Depth (cm)	0–15	0–10	0–10	0–15
+Coarse sand (%)	35.1	7.7	16.7	16.8
+Fine sand (%)	31.9	27.8	5.5	53.1
+Silt (%)	7.4	13.3	17.6	11.4
+Clay (%)	25.6	51.2	60.2	18.7
Organic carbon (%)	1.30	2.35	1.44	2.46
Total N (%)	0.10	0.23	0.18	0.11
Extractable P (ppm)	36.6	21.1	15.3	12.70
pH (O.1N $CaCl_2$)	4.7	5.2	4.7	4.7

+S. Paramananthan (1978)

Rhizobium compost before sowing. At the time of planting, 50g sandy beach soil (containing about 100-200 viable VAM spores) were placed at about 5 cm below the top-soil in each pot. The seeds were then planted 2 cm above the inoculum soil at an average of 4 seeds per pot. The uninoculated plants were similarly treated using 50g autoclaved sandy beach soil. The plants were thinned to two per pot 2 weeks after sowing. Five replicates were used for each treatment.

The plants were harvested 35 days after sowing (when 80% of them had produced flowers). The number and size of nodules per treatment were measured and recorded. The plant tops were oven-dried at 60°C for 72 hours and their dry weights determined. Subsamples of the ground tissue were digested with concentrated sulphuric acid and 50% hydrogen peroxide (Thomas *et al.*, 1972) and analysed for N, P and K on a Technicon (R) Autoanalyser.

RESULTS AND DISCUSSION

Growth Response

Inoculation of plants with both *Rhizobium* and mixed mycorrhizal species did not seem to enhance plant growth when compared to plants receiving either one or no inoculation at all (Table 2). This could perhaps be due to the introduced endogonaceous species not being able to establish well in the four soils tested or that the level of inoculum added was insufficient to bring about significant plant response within the short period the experiment was conducted (35 days).

The best overall growth response was by plants growing in the Malacca series and the poorest was shown by plants grown in the Munchong series. The difference in top dry weights of plants between treatments were not significant (Table 2). Only the difference between soil types was significant.

Nodule Distribution

In general, the size and distribution of nodules within the root-zone of the test crop was influenced more by the physical properties of the different soil types used rather than by the treatments given.

Plants grown on the Serdang soil gave bigger (2–3 mm diameter) but fewer nodules (42–70 nodules/plant) compared to smaller and more numerous nodules (68–152 nodules of 1–1.5 mm diameter) produced in the Malacca soil. Most of the nodules in the Serdang soil were produced on the upper part of the lateral roots (about 40 cm from the crown) while in the Malacca series, pin-sized nodules were produced as deep as 10 cm from the crown along the length of the lateral roots. There was very poor nodulation in plants grown in either Bungor or

TABLE 2
Effect of inoculation with VA endophytes and *Rhizobium* on the dry weight (g) of tops of mungbean 35 days after sowing. The differences due to soil series are significant ($P<0.05$ and $P<0.01$) (Symbol : NS : Not significant)

Treatment	Shoot dry weight per plant (g) (NS)			
	Serdang	Munchong	Malacca	Bungor
Control	6.74	3.81	7.59	6.04
VAM	6.57	2.60	7.39	6.17
Rhizobium	6.22	3.70	6.82	5.56
VAM + *Rhizobium*	6.44	4.25	7.22	5.78
($LSD_{0.05}$(Soil) = 1.027)				
($LSD_{0.01}$(Soil) = 1.374)				

TABLE 3
Effect of inoculation with VA endophytes and *Rhizobium* on the phosphorus content (%) of tops of mungbean 35 days after sowing. (Symbol : NS : Not significant).

Treatment	Phosphorus content of tops (%) (NS)			
	Serdang	Munchong	Malacca	Bungor
Control	0.46	0.31	0.42	0.34
VAM	0.47	0.36	0.41	0.35
Rhizobium	0.47	0.35	0.42	0.33
VAM + *Rhizobium*	0.48	0.39	0.42	0.38
($LSD_{0.05}$(Soil) - 0.0818)				
($LSD_{0.01}$(Soil) = 0.1095)				

Munchong soil for all treatments (plants in both soils produced 0–20 nodules per plant with diameters 1–1.5 mm and 1–2.0 mm, respectively).

P Content of Tops

The highest P content of 0.48% was obtained from plants growing in the Serdang soil followed by plants grown in the Malacca series (0.42%, Table 3). However, the P contents of plant tops was also insignificant between all treatments but was significant between the soil types used. No significant increases in nitrogen and potassium concentrations of the tops was observed for all treatments in both soils.

Iruthayathas *et al.*, (1983) stated that the response of leguminous plants to the combined inoculation of *Rhizobium* and mycorrhizal spores was found to be dependent on three factors :

a) the successful establishment of the newly introduced rhizobia into the soil which is in turn influenced by the native microbial population.

b) establishment of the introduced mycorrhizal species in the soil.

c) the synergistic effect of both *Rhizobium* and mycorrhiza in enhancing plant growth.

The failure of the present experiment to demonstrate the beneficial effect of *Rhizobium* and mycorrhiza on the growth and nodulation of mungbean plants could be due to the absence of one or perhaps all the factors listed above.

The importance of factor number (b) ie, the establishment of introduced mycorrhizal species in the soil has been demonstrated by Bagayaraj *et al.* (1979) with his work on soyabean. It was found that the effect of *Rhizobium* and mycorrhiza was not significant at 45 days, but was significant at 60 days when the inoculated species had more time to establish itself.

From this preliminary experiment it is concluded that more studies are required to find the optimum conditions for VAM to produce its beneficial effect of enhancing plant growth.

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