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Agriculture Intensive dans les Iles de la Caraibe : enjeux, contraintes et perspectives

Intensive Agriculture in the Caribbean Islands : stakes, constraints and prospects

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ASSESSING THE N_2 FIXING CAPABILITIES OF *RHIZOBIUM* STRAINS ISOLATED FROM ANTIGUAN SOILS.

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SUMMARY

Extensive efforts have been made to capitalize on the symbiotic relationship of legumes and *Rhizobium* bacteria by farmers worldwide. These benefits are even more important to farmers in tropical areas where nitrogen fertilizer is expensive. Our objective was to evaluate the effectiveness of the symbiotic relationship of the legumes, pigeonpea, (Cajanus cajan) and kidney bean,(Phaseolus vulgaris) inoculated with *Rhizobium* selected from Antiguan soils. Undisturbed soil cores measuring 25 cm in length by 10 cm in diameter were used for initial *Rhizobium* isolation. Surface sterilized seeds of the pigeonpea cultivar, Chaguaramas Pearl were inoculated with the *Rhizobium* isolated from the soil cores and grown in growth pouches in a growth chamber. Greenhouse and growth chamber studies were arranged as a completely randomized design. Plants grown in undisturbed cores had dry matter yield ranging from 1.4 to 0.7 gm per plant and showed significant nodulation. Nodule number from plants grown in pouches ranged from 35 - 120 per plant. A *Rhizobium* strain isolated from undisturbed core samples was identified as specific to *Phaseolus vulgaris.*

INTRODUCTION

Several legumes such as kidney bean and pigeonpea are widely grown and utilized in Antigua and other islands in the Caribbean

(Badillo-Felicano, J. et al, 1977). The production of these and other pulse crops is often limited by high diseases pressure and low nutrient availability. The most expensive chemical fertilizer in most of the developing countries is nitrogen. Legumes are capable of forming a symbiotic relationship with the *Rhizobium* bacteria which renders fixed nitrogen to the crop. This symbiosis should provide adequate nitrogen for the growth and development of the crop. However, reduced nitrogen fixation is also experienced under these growing conditions. This reduction is believed to be the result of ineffective indigenous *Rhizobium* stains (Quilt and Dalal, 1979). The abundance of the native strains sometimes overwhelms the nodule site and prevents nodulation by effective introduced strains.

To solve the problem of low productivity researchers have initiated breeding program to enhance the N_2 fixation capabilities of several legumes (Attewel and Bliss, 1985). The screening for efficient nitrogen fixing, bacteria strains introduced into foreign soils has been researched. This research project seeks to isolate *Rhizobium* strains indigenous to Antiguan soils and to test the effectiveness of these isolated strains on several legumes species.

MATERIALS AND METHODS

Ten undisturbed soil cores were collected from each of three sites in Antigua (CARDI Field Station, Jolly Hill and Shepherd's Farm) by inserting polyvinyl chloride tubing (10 cm diameter, 25 cm long and sharpened at the lower end) into the soil to within 1 cm of the upper end according to the method of Slyvester-Bradley, R. et al, 1983 (Table 1). Cores were removed with a spade and prepared for shipping to Lincoln University. For the greenhouse study the cores were arranged in a completely randomized design in grids. Pigeonpea cultivar, Chaguaramas Pearl and kidney bean cultivar, Portland Red, were planted into five cores of each site respectively. Soil cores were irrigated with sterile water. Plants were allowed to grow for 45 days after germination and plant height, shoot dry weight, and nodule number determined.

Soil removed to the depth of 15.5 cm at the same three sites were also transported to Lincoln University for use in *Rhizobium* isolation. Surface sterilized seeds of pigeonpea and kidney bean were planted in separate 20 cm pots containing soils from the research sites. Plants were irrigated with sterile water and general care and maintenance to prevent crop contamination of seeds was practiced. Plants were severed at the soil level at first bloom. Root samples were removed from pots and washed and nodules from each treatment removed and stored in the freezer until isolation. *Rhizobium* strains were isolated from both pigeonpea and kidney bean by the method of Vincent (1970). These strains were then typed and allowed to grow on yeast mannitol agar slants. Strains isolated from both crops were used to inoculate germinated seeds growing in growth pouches in a growth chamber set at 14/10 hr day/night. These plants were then harvested at 35 days after planting and measurements on plant height, shoot dry weight, nodule number and nodule dry weight determined.

RESULTS AND DISCUSSION

Undisturbed soil cores produced significant nodulation in both pigeonpea and kidney bean grown on soils from all three sites (Table 2). Plant dry matter accumulation for kidney bean was highest when grown in cores removed from Shepherd's Farm. A similar trend was observed for plant height and nodule number. These results indicate that *Rhizobium* strains capable of nodulating both crops are present at all three sites (Table 2). Indications are that the most effective strain for nodulating kidney bean and pigeonpea are found at the Shepherd's Farm and CARDI Research Station respectively. Nodulation of pigeonpea grown in cores from Jolly Hill was comparable to those separated from the Shepherd's Farm soil core.

Response of the test crop, kidney bean to *Rhizobium* strains isolated from the three sites were comparable to that of plants from the undisturbed core samples (Table 4). Pigeonpea however, did not nodulate when inoculated with *Rhizobium* isolated from Shepherd's Farm (Table 3). This indicates that there is some amount of crop specificity for strains isolated. This also implies that there is significant difference between at least two of the strains isolated. Further serological work needs to be done to determine the differences between the strains isolated. Generally, nodulation had a more pronounced effect on dry matter accumulation of kidney bean than that of pigeonpea (Table 3.)

LITERATURE CITED

ATTEWEL, J. and R.A. BLISS. 1985. Host plant characteristics of common bean lines selected using indirect measures of nitrogen fixation. pp 3-9 *In*. H.J. Evans, P.J. Buttemley and W.E. Newton (Eds). Nitrogen Fixation Research Progress. Martinus Nijhoff.

BADILLO-FELICIANO, J., R. ABRAMS and R. PIETRI. 1977. Effect of foliar-applied fertilizer on pigeon pea (*Cajanus cajan*). J. Agric. Univ. P.R. G1. 217-220.

QUILT, P. and R.C. DALAL. 1979. Effect of SOil Mineral N levels and Inoculation on Nodulation, Nitrogenase Activity and Grain Yield of Pigeon Pea. Agron. J. 71:450-452.

SYLVESTER-BRADLEY, R., M.A. AYARZA, J.E. MENDEZ and R. MORIONES. 1983. Use of undistrurbed soil cores for evaluation of *Rhizobium* strains and methods for inoculation of tropical forage legumes in a Columbian oxisol. Plant and Soil 74:237-247.

VINCENT, J.M. 1970. A manual for the practical study of root-nodule bacteria. 1BP Handb. No. 15. Blackwell Scientific Pub. Oxford.

Table 1.Soil Core Sampling Sites and Types

Experimental Sites	Soil Type
CARDI	Fitches Clay
Jolly Hill	Blubber Valley Clay
Shepherd's Farm	Gunthorpes Clay

Table 2.Plant Growth and Development of Kidney Bean and Pigeonpea Grown in Undisturbed Soil Cores

	Kidney Bean			Pigeonpea		
Soil Core	Plant Ht. (cm)	Shoot Dry Wt. (g)	Nod #	Plant Ht.(cm)	Shoot Wt.(g)	Nod #
CARDI	27.2[b z]	1.04[b]	68[b]	32.6[b]	1.24[a]	32.5[a]
Jolly Hill	22.7[c]	0.77[c]	54[c]	24.5[c]	0.79[b]	28.6[b]
Shepherd's Farm	29.0[a]	1.46[a]	72[a]	35.4[b]	0.64[b]	20.0[c]

[z]Numbers within the same column followed by the same letters are not significantly different at 5% level as determined by LSD.

Table 3.Effect of Isolated *Rhizobium* Inoculum on *Pigeonpea* Growth and Development at 35 days after planting.

Rhizobium Treatment[y]	Plant Height (cm)	Shoot Dry Weight	Nodule #	Nodule Dry Weight (mg)
1	21.5[b z]	0.92[b]	58.1[b]	71.4[b]
2	19.1[b]	0.67[b]	35.1[b]	65.3[b]
3	15.1[c]	0.58[b]	--	—

[z]Numbers within the same column followed by the same letters are not significantly different at 5% level as determined by LSD.

[y]Treatments 1, 2, and 3 were isolated from soils from sites CARDI, Jolly Hill and Shepherds Farm, respectively.

Table 4. Effect of Isolated *Rhizobium* Inoculum on *Kidney bean* Growth and Development at 35 days after planting.

Rhizobium Treatment[y]	Plant Height (cm)	Shoot Dry Weight	Nodule #	Nodule Dry Weight (mg)
1	19.2[b] [z]	0.64[b]	68[b]	118.4[b]
2	18.1[b]	0.59[b]	44[c]	101.5[b]
3	25.4[a]	1.21[a]	120[a]	215.1[a]

[z]Numbers within the same column followed by the same letters are not significantly different at 5% level as determined by LSD.

[y]Treatments 1, 2, and 3 were isolated from soil from sites CARDI, Jolly Hill and Shepherds Farm, respectively.