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EFFECTIVE NATURAL NODULATION OF PEANUTS IN QUEENSLAND

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SUMMARY

In field experiments, peanuts nodulated naturally in both a scrub and a forest soil at Kingaroy. Seed and soil inoculations were attempted, but it was difficult to superimpose the inoculum strain on the existing soil rhizobial population.

There was a yield response to some inoculation treatments on new land with lower rhizobial count but not on land cropped previously to peanuts. Glasshouse tests confirmed that the majority of field isolates of peanut rhizobia were effective in nitrogen fixation. Natural transfer of rhizobia on seed was recorded.

It was concluded that inoculation of peanuts was unlikely to be adopted in this peanut growing district.

I. INTRODUCTION

Peanuts (*Arachis hypogoea*) are grown in the Kingaroy district in a wide variety of soils without the extensive use of nitrogenous fertilizers (Saint-Smith, Rawson and McCarthy 1969). Copious nodulation occurs naturally without artificial inoculation of the seeds with rhizobia. This paper reports experiments conducted to gauge the effectiveness of this natural nodulation.

II. FIELD INOCULATION TRIALS

Materials and methods

Experiment 1 compared the performance of plants nodulated by indigenous rhizobia (figure 1) with those nodulated by the standard commercial inoculant strain, CB 756, at two selected sites at Kingaroy (lat. 26°S). Site 1, at Booie, was a fertile, red, clay loam scrub soil of pH 6·0 carrying native grass pastures. Site 2, at Taabinga, was a red-brown, clay loam forest soil of pH 5·5 with higher clay content (67% clay) and which had carried two previous crops of peanuts.

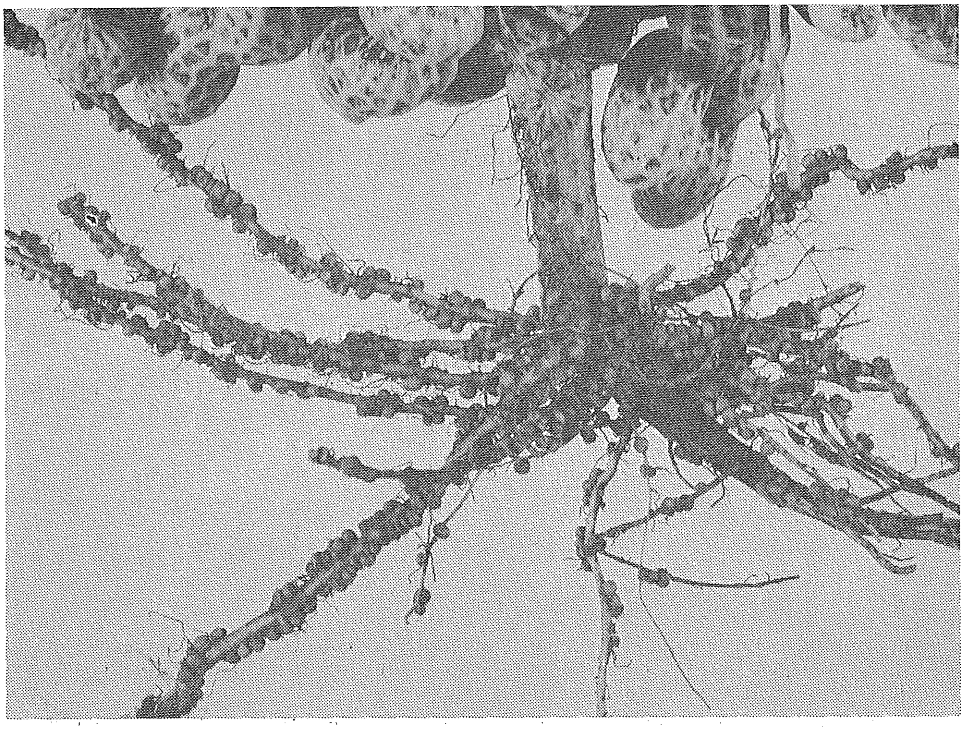

Fig. 1.—Natural nodulation of Virginia Bunch peanuts at Taabinga.

At planting, nitrogen levels at both sites were low although a slightly higher nitrate level (10 to 15 p.p.m. (NO_3) N) was recorded at Booie. The only nutritional supplement added was 500 kg ha^{-1} of superphosphate at Taabinga.

Commercial seed of the Virginia Bunch variety was used and this was routinely treated with a quintozene-captan mixture at 1:320 w/w. For seed inoculation, *Rhizobium* strain CB 756 was applied by the peat inoculum slurry method using a 40% gum arabic solution. The inoculum was separated from the fungicide dust in one treatment by a polyvinyl acetate seal (Diatloff 1970). Three coats of diluted P.V.A. resin were applied by spraying with intermittent drying of 10 minutes. Application of peat inoculum ($2 \cdot 5 \times 10^7$ rhizobia g^{-1} peat) to the furrow was done mechanically at the rate of $83 \cdot 3$ g m^{-1} or row following 1:1 dilution with sterile sand. Liquid inoculum (10^7 rhizobia ml^{-1}) was diluted 1:4 with water and trickled into the planting furrow at $83 \cdot 3$ ml^{-1} of row. The seeds were sown mechanically in January 1971 at 5 cm depth in a randomized block design of two replications. Each plot carried two rows, 12 m long and 1 m apart.

The number of 'cowpea type' rhizobia in the soil and inoculant was determined by the plant dilution technique (Date and Vincent 1962) using *Macroptilium atropurpureum* as the indicator plant.

Emergence counts were made 2 weeks after planting and nodulation was examined after 7 weeks. The identity of the nodule bacteria was determined in nodules from two randomly selected plants from each row. Isolations were made at 7 weeks from the top six nodules on the tap root. Following isolation, it was clear that the simpler criterion of colony morphology would suffice to identify the isolates. However, some colonies were checked in gel-diffusion tests against anti-CB 756 serum. The final harvest was made at 16 weeks.

Results

Yield and nodulation data are shown in table 1.

TABLE 1

EFFECT OF INOCULATION OF FUNGICIDE-TREATED SEED ON THE NODULATION AND YIELDS OF PEANUTS

Inoculum Treatment	Booie			Taabinga		
	Nodules of Recognized CB756 Type %	Dry Wt Whole Pods g	No. of Pods	Nodules of Recognized CB756 Type %	Dry Wt Whole Pods g	No. of Pods
Uninoculated control ..	0	874·6 ± 109·3	176	8	194·1 ± 24·6	226
Peat inoculum in furrow ..	16	1 024·9 ± 114·8	175	0	169·3 ± 15·3	199
Peat seed slurry	66	902·1 ± 75·5	178	41	149·5 ± 10·8	176
P.V.A. seal + peat seed slurry	66	973·9 ± 104·3	189	24	120·8 ± 5·4	149
Liquid inoculum in furrow	—*	1 109·8 ± 118·4	181	16	151·2 ± 23·1	184

* Missing isolation plates.

Prompt germination occurred at both sites and the emergence counts showed that the P.V.A. seal did not interfere with germination or emergence of seedlings. Under the prevailing high rainfall, growth was better on the sloping Booie site which was reflected in yield data (table 1).

Nodulation, however, was more prolific at Taabinga with a mean number of 83·6 nodules per plant at 7 weeks, compared with 22·3 at Booie. Likewise, the number of rhizobia detected initially in the soil was higher at Taabinga (5 900 rhizobia g^{-1} of soil) compared with 170 at Booie.

Isolates made from nodules showed two distinct bacterial colonies. The inoculum strain CB 756 formed small, white, glistening colonies while indigenous rhizobia from both sites formed larger, translucent, fluidal colonies on yeast-mannitol agar with congo-red additive. Twenty smaller colonies were checked serologically in gel-diffusion tests against the anti-CB 756 serum and proved identical to CB 756. Twenty larger fluidal colonies failed to produce bands in the agar. Seed inoculation with or without the P.V.A. seal resulted in a higher recovery of the inoculum strain particularly from the site with the lower rhizobial count.

Furrow application whether in liquid or dry form was comparatively unsuccessful on both sites leading to a poor recovery of the inoculum strain particularly from the site with the lower rhizobial count (table 1).

Yield differences occurred between treatments both in dry weight of pods and in number of pods but appear to be unrelated to the inoculum treatments.

III. GLASSHOUSE TESTS OF NATURALLY OCCURRING RHIZOBIA

Isolates made from uninoculated plots in experiment 1 were further tested for nitrogen fixation under controlled glasshouse conditions in bottle-jar units (Norris 1964). Sixty-six fluidal colonies were tested against the standard strain, CB 756.

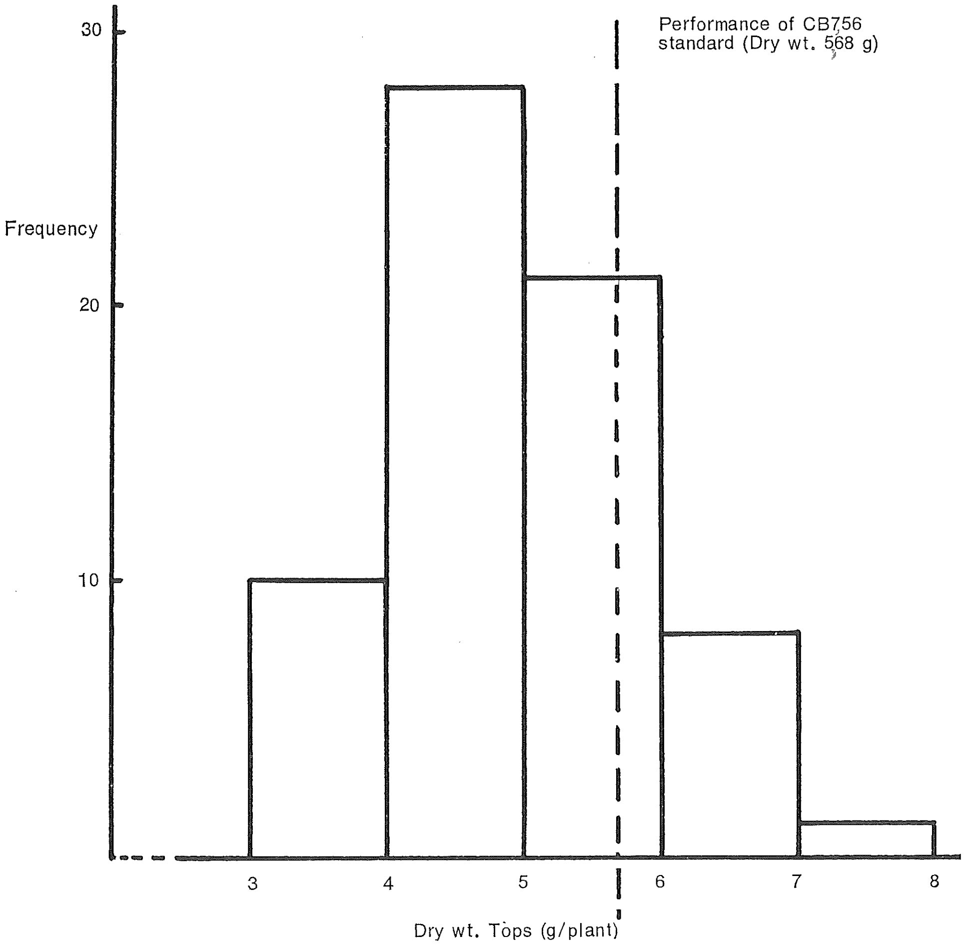

Fig. 2.—The effectiveness of naturally-occurring peanut rhizobia isolated from two sites at Kingaroy.

The dry weights of tops harvested at 8 weeks are shown in figure 2 in histogram form. The uninoculated controls averaged 1·74 g per plant. If the limits of effectiveness are set at 80% of CB 756, then 43 cultures fall into the effective category.

IV. SEED-BORNE RHIZOBIA

Two fungicide treated samples of commercial seed were checked in bottle-jar units for presence of rhizobia. A bulked sample of 80 seeds was planted individually without inoculation in sterile jars and assessed for nodulation after 6 weeks. Effectiveness in nodulated plants was compared with that in plants inoculated with the standard strain CB 756.

Thirty-two seedlings nodulated of which 20 had effective associations. The remainder failed to nodulate.

V. DISCUSSION

It was generally difficult to superimpose the inoculum strain over the existing rhizobial soil population in these trials even at the site of lowest rhizobial numbers. The success achieved depended not only on the site, but also on the method of application. The seed-slurry method proved more successful than soil application. The techniques used for avoiding seed-zone fungicide toxicity such as soil application or a plastic separating seal were ineffectual, suggesting that the fungicide dust routinely applied to seeds was less noxious than was previously believed. Competition from naturalized rhizobia probably was a greater influence than the fungicide in determining whether bacteria from the soil or the inoculum produced the nodules.

Glasshouse tests provide evidence that field isolates of nodule bacteria from the two sites are potentially effective nitrogen fixers. The majority of isolates were within the 80% efficiency limit of the standard inoculant strain, CB 756. The field inoculation and yield data are not as clear-cut and indicate the possibility that newly cultivated land could respond to rhizobial inoculation while replanted peanut soils carrying higher rhizobial numbers are less likely to respond. The yield differences in new land did not correlate with the recovery of the inoculant strain from the root system. This discrepancy could well be due to the method of nodule sampling used in the test since it favoured recovery from seed inoculation treatments. On the other hand, Langford (unpublished data) found that nitrogen fertilizer responses in a nodulated crop were not common and inconsistent depending on site, time and rate of application. Over four seasons, the maximum recorded yield increase was 15% with Virginia Bunch peanuts.

Inoculation of peanuts is unlikely to be adopted in this area for several reasons. First, the indigenous rhizobia suited to peanuts appear to be already effective. Second, there is a natural transfer of seed-born rhizobia which is unaffected by seed fungicide treatment. Third, the chances of success with seed or soil inoculation are minimal except on new ground. Fourth, any wetting of the seed such as slurry inoculation, unless carefully done, removes the testa which carries the fungicide. Finally, soil application requires special machinery and cultures which at present are not available.

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