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GENETICS OF NONNODULATION IN GROUNDNUT (*ARACHIS HYPOGAEA* L.). STUDIES WITH SINGLE AND MIXED *RHIZOBIUM* STRAINS[1]

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SUMMARY

Genetic studies of nonnodulation in groundnut were carried out in a cross, NC 17 × PI 259747, with a single *Rhizobium* strain, NC 92, and a native *Rhizobium* population.

The normal nodulation of the parents, F_1 generations and backcross progenies, and the F_2 segregation for nodulation and nonnodulation confirmed that nonnodulation in groundnut is controlled by two duplicate recessive genes.

INTRODUCTION

GORBET & BURTON (1979), while reporting the occurrence of nonnodulating groundnut plants in F_3 progenies of the cross 487A-4-1-2 × PI 262090 (both parents belonging to the sub species *hypogaea* variety *hypogaea*) in 1975, indicated that the nonnodulating trait was probably not inherited as a simple recessive character.

NIGAM et al. (1980) observed nonnodulating groundnut plants in an F_2 rust screening nursery of the crosses NC 17 × PI 259747, and NC 2731 × PI 259747 in 1978. Based on segregation in the F_2 and F_3 progeny rows, they suggested that nonnodulation in groundnut is governed by two duplicate recessive genes.

In both studies the parental lines were nodulating, and no information was available on the nodulation behaviour of the F_1 generation. This paper reports the results obtained from F_1, F_2 and backcross generations of the cross NC 17 × PI 259747, with single and mixed *Rhizobium* strains.

MATERIAL AND METHODS

The experiment consisted of parents and F_1, F_2, BC_1 and BC_2 generations of straight and reciprocal crosses between NC 17 × PI 259747.

The plants were raised in 12.5 cm diameter plastic pots containing a mixture of sterilized sand and vermiculite (2:1) in December, 1980, in a Cambridge type glasshouse, with day and night temperatures of 30 ± 2 °C and 25 ± 2 °C, respectively. The seeds were treated with thiram (3 g/kg of seeds) before sowing. The F_2 and backcross

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generations were sown as individual plant progenies. The pots were inoculated with *Rhizobium* strain NC 92 at 10^8 cells per seed, before planting. The pots were watered regularly with sterile water. Sterilized nutrient solution containing $CaCl_2$ (1 mmole), KH_2PO_4 (0.5 mmole), $C_6H_5O_7$ $Fe.2H_2O$ (10 μmole), $MgSO4.7H_2O$ (0.25 mmole), K_2SO_4 (0.25 mmole), $MnSO_4.4H_2O$ (1 μmole), H_3BO_3 (2 μmole), $ZnSO_4.7H_2O$ (0.5 μmole), $CuSO_4.5H_2O$ (0.2 μmole), $CoSO_4.7H_2O$ (0.1 μmole) and $Na_2MoO_4.2H_2O$ (0.1 μmole), was applied to the plants every two days to ensure normal growth.

The plants were uprooted to record nodulation with strain NC 92 50 to 60 days after sowing. The plants were then transplanted to 20 cm diameter pots containing an unsterilized mixture of sand, soil, farm yard manure and vermiculite (4:2:1:1). The pots were inoculated with a mixture of native *Rhizobium* strains, including strain NC 92, and moved to a shade house which allowed 40–50% sunlight penetration. Final observations on nodulation with native *Rhizobium* strains were taken when the plants were harvested, at 125–130 days after sowing.

The plants were classified as nodulating or nonnodulating based on the presence or absence of nodules on roots. Plants with even a single nodule were classified as nodulating. The data was subjected to chi-square analysis, for testing the genetic hypothesis, after making Yates' correction for continuity (YATES, 1934).

RESULTS AND DISCUSSION

Both parents and the reciprocal F_1 generations were found to nodulate normally with the single strain, NC 92, and the native *Rhizobium* population including strain NC 92.

Table 1. Chi-square tests for the 15:1 F_2 ratio of plants segregating for nodulation vs. nonnodulation with single strain NC 92.

Cross	Number of plants		χ^2 value	P value
	nodulating	nonnodulating		
NC 17 × PI 259747	257	27	4.600	.05– .02
PI 259747 × NC 17	315	29	2.430	.20– .10
Pooled	572	56	7.175	0.01–0.001
Heterogeneity	–	–	0.145	0.8 –0.70

Table 2. Chi-square tests for the 15:1 F_2 ratio of plants segregating for nodulation vs. nonnodulation with native *Rhizobium* population including strain NC 92.

Cross	Number of plants		χ^2 value	P value
	nodulating	nonnodulating		
NC 17 × PI 259747	260	24	1.986	.20– .10
PI 259747 × NC 17	321	23	0.049	.90– .80
Pooled	581	47	1.428	0.30–0.20
Heterogeneity	–	–	0.607	0.5–0.3

Chi-square tests for a 15:1 F_2 ratio of plants segregating for nodulation and nonnodulation are presented in Tables 1 and 2.

With the single strain, NC 92 (Table 1), the chi-square fit for a 15:1 F_2 ratio was not good in the case of NC 17 × PI 259747. In the reciprocal cross, PI 259747 × NC 17, the fit for 15:1 F_2 ratio was good. Since there were no reciprocal differences in nodulation at the F_1 level, the straight and reciprocal progenies were combined and a pooled chi-square analysis was carried out. The pooled chi-square value was very high, thus rejecting the hypothesis. There was an excess of nonnodulating plants in the F_2 in both cases. However, the excess was more in the case of cross NC 17 × PI 259747.

With the native *Rhizobium* population (Table 2), the chi-square fits were good in both NC 17 × PI 259747 and PI 259747 × NC 17 crosses and for the pooled data.

Nine plants, which lacked nodules with the single *Rhizobium* strain (3 plants in NC 17 × PI 259747 and 6 plants in PI 259747 × NC 17) nodulated with the mixed *Rhizobium* population.

All the backcross progenies (61 in (NC 17 × PI 259747) × NC 17, 70 in (NC 17 × PI 259747) × PI 259747, 52 in (PI 259747 × NC 17) × NC 17 and 98 in (PI 259747 × NC 17) × PI 259747) nodulated normally with the single as well as the mixed *Rhizobium* strains population.

The normal nodulation behaviour of the parents, F_1's, and backcross generations with both the single strain and the mixed *Rhizobium* population and the segregation for nodulation vs. nonnodulation in the F_2's with the mixed *Rhizobium* population support the hypothesis of two duplicate recessive genes controlling the expression of nonnodulation in groundnut.

With the single strain the chi-square fit for F_2 data was not good due to an excess of nonnodulating plants.

The nine nonnodulating F_2 plants inoculated with the single strain, which became nodulating with mixed *Rhizobium* population, are considered escapes. Considering these plants as being mis-classified a good fit is observed for a 15:1 F_2 ratio. This confirms the earlier observation of NIGAM et al. (1980), who reported the two duplicate recessive gene control of nonnodulation based on segregation in the F_2 and F_3 progenies under field conditions.

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