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UTILIZATION OF NATURAL HYBRIDS IN THE IMPROVEMENT OF GROUNDNUTS (*ARACHIS HYPOGAEA*)†

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SUMMARY

Groundnuts (*Arachis hypogaea* L.) are generally considered to be self-pollinated, but natural hybrids due to outcrossing have been observed in cv. Robut 33-1. Selections in segregating generations of these natural hybrids identified stable lines with large yield potentials in more than one environment. The role of natural hybrids in generating useful additonal variability is discussed.

The cultivated groundnut is generally regarded to be self-pollinated (Smith, 1950). However, natural cross-pollination has been detected at levels ranging from 0 to 3.9% depending on season, genotype and location (Bolhuis, 1951; Hammons, 1964; Culp *et al.*, 1968; Gibbons and Tattersfield, 1969). Pollen is vectored by several bee species (Leuck and Hammons, 1969; Gibbons and Tattersfield, 1969). Indeed, the occurrence of natural hybrids in cultivated groundnuts was noted more than 60 years ago (van der Stok, 1923) and plants suspected of originating from natural outcrossing have been reported frequently in many breeding nurseries (Kushman and Beattie, 1946; Hammons, 1964).

Even at small frequencies, natural outcrossing makes it difficult to maintain uniformity of cultivars in a predominantly self-pollinated species such as groundnut. In Indonesia, for example, the maintenance of varietal purity in the breeding nurseries was considered impossible due to out-crossing (Bolhuis, 1951). Nevertheless, outcrossing provides a source of additional genetic variation that might be exploitable. Van der Stok (1923) reported the utilization of natural hybrids to develop new groundnut cultivars in Java. Hammons (1964) discussed the utilization of natural crossing as a new genetic technique which he called 'pedigreed natural crossing'. He indicated that large numbers of F1 hybrids could be produced in conjunction with conventional breeding procedures. There are a few reports of the exploitation of natural hybrids in groundnut breeding (Seshadri, 1962; Gibbons, 1971; Hildebrand and Smartt, 1980). In this paper we describe a role for the natural hybrids in improving the yield potential of groundnut based on our experience at ICRISAT, India.

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MATERIALS AND METHODS

Selection

The material consisted of natural hybrids derived from cv. Robut 33-1, a cultivar released in Andhra Pradesh, India. Seeds of this cultivar (also known as Robout 33-1) were obtained by ICRISAT in 1976 from the Regional Oilseeds Research Station, Kadiri, Andhra Pradesh, India. Cv. Robut 33-1 (probably a corruption of Rehovot 33) is an early-maturing Virginia type selected from a plot of an exotic bunch cultivar (Anon., 1978), introduced into India from Israel in 1964 as exotic collection (E.C.) 27988.

Seed of Robut 33-1 was multiplied at ICRISAT (17° 27′ N, 78° 28′ E; 545 m altitude; alfisols; annual rainfall 740 mm) during the 1976 post-rainy season. In the 1977 rainy season it was used as a repeated check in the germplasm evaluation block. Although the cultivar was generally uniform for growth habit and other morphological characters, several variants with flowers on the main axis were noticed. The Virginia type, *Arachis hypogaea* subsp. *hypogaea* var. *hypogaea* (to which group Robut 33-1 belongs) has alternate branching and does not bear flowers on the main axis. In contrast, the Spanish type, subsp. *fastigiata* var. *vulgaris*, has sequential branching and produces flowers on the main axis (Krapovickas, 1968). Seventy-eight such variants, probably natural hybrids, were grown in progeny rows during the 1977 post-rainy season. The population segregated for growth habit and other morphological characters such as branching pattern and seed size. Forty-one plants, each with more pods than the check cultivar Robut 33-1, were selected and grown as progenies in the 1978 rainy season. Plants with large numbers of pods were selected again and, finally, 15 bulks from individual plant progenies were made for yield evaluation during the 1978-79 post-rainy season. At this stage, segregation for branching pattern was still occurring. Thereafter, the material was advanced by bulking large-yielding and phenotypically-similar plants.

Yield testing

In the 1978-79 post-rainy season 15 bulks were evaluated in a randomized block design replicated twice. Each selection was grown in four rows of 9 m (75 cm apart) with 10 cm between plants. During subsequent seasons the 15 selections were tested in randomized block designs with four replicates of four-row plots on beds of 9 m x 1.5 m with a spacing of 30 cm x 10 cm. The trials at Patancheru (ICRISAT) were conducted under rainfed conditions in the rainy seasons 1979-81, with supplementary irrigation in the rainy seasons of 1980 and 1981, and under irrigated conditions in the post-rainy seasons 1979 and 1980. In irrigated trials in 1979 and 1980, 40-60 kg P ha^{-1} were applied and plants were protected against insect pest depradations. In the rainfed trials, 20 kg P ha^{-1} were given and plants were not protected. During the 1980 rainy season, the trial was conducted also at Dharwad (15° 27′ N, 75° 00′ E; 727 m altitude; vertisols; annual rainfall 620 mm) and during the 1981 rainy season at

Dharwad and Anantapur (14° 41′ N, 77° 37′ E; 350 m altitude; alfisols; annual rainfall 450 mm) as well as Patancheru.

Stability analysis

Yields of the 15 natural hybrid selections and two checks cultivars (J 11 and Robut 33-1) in the 10 environments were subjected to stability analysis following the method of Eberhart and Russell (1966).

RESULTS AND DISCUSSION

Natural hybrids were observed in cv. Robut 33-1 and selection was effected in later generations. The pollen donor was unknown but might have been a Spanish cultivar (var. *vulgaris*) since the natural hybrids were identified on the basis of the presence of flowers on the main stem and, later, sequential Spanish forms were observed in segregating material. The stable selections in later generations were tested in three locations, Patancheru, Dharwad and Anantapur. The dry pod yields of the lines (Table 1) were almost always larger (2215–2635 kg ha^{-1}) than those of the checks (2090–2230 kg ha^{-1}). Ten selections, each significantly superior to both checks, were named ICGS (ICRISAT Groundnut Selection) -1, -4, -11, -12, -33, -34, -35, -36, -37 and -44 and advanced for further testing. Of these, ICGS-1 (Robut 33-1-7-4-B1) and ICGS-4 (Robut 33-1-7-6-B1) were entered in the Indian National Testing Scheme in the Initial Yield Evaluation Trial (IET) through the All India Coordinated Research Project on Oilseeds (AICORPO) during the rainy season 1981 (AICORPO, 1981–82). ICGS-1,

Table 1. *Initial and final branching pattern, yield (kg ha^{-1}) and stability parameters of the natural hybrid selections*

Identity/pedigree	Branching pattern† Initial	Final	Mean yield (kg ha^{-1})	Variance	b	± SE	S^2	R^2
ICGS-1 (R33-1-7-4-B1)	AB, SB, IB	SB	2450	2020895	0.90	± 0.14	3.72*	95
ICGS-4 (R33-1-7-6-B1)	AB, IB	AB	2470	2235793	0.96	± 0.12	2.80	96
ICGS-11 (R33-1-18-8-B1)	AB, SB	SB	2525	2992266	1.12	± 0.08	1.08	99
ICGS-12 (R33-1-10-3-B1)	AB, SB	SB	2375	2427388	1.01	± 0.06	0.24	99
ICGS-33 (R33-1-21-11-B1)	AB, SB	SB	2545	2859930	1.09	± 0.08	0.80	99
ICGS-34 (R33-1-50-1-B1)	AB	AB	2390	2683001	1.01	± 0.10	1.70	98
ICGS-35 (R33-1-24-16-B1)	AB, SB	SB	2635	3628419	1.23	± 0.13	2.98	97
ICGS-36 (R33-1-18-17-B1)	SB, AB	SB	2360	2499320	1.03	± 0.14	3.55*	96
ICGS-37 (R33-1-1-1-B1)	SB	SB	2340	2319236	0.98	± 0.10	1.32	98
ICGS-44 (R33-1-1-5-B1)	SB	SB	2515	2947728	1.11	± 0.93	1.41	98
R33-1-11-7-B1	IB, SB	AB	2215	2016363	0.91	± 0.10	1.79	97
R33-1-11-15-B1	SB, AB	SB	2250	2278421	0.97	± 0.10	1.68	97
R33-1-12-10-B1	AB, SB	SB	2270	2530043	1.02	± 0.10	1.77	98
R33-1-13-6-B1	SB, AB	SB	2265	1463081	0.75	± 0.17	5.49**	90
R33-1-27-2-B1	SB	SB	2320	2416855	0.99	± 0.11	2.00	97
J11 (check)	SB	SB	2090	1990201	0.92	± 0.18	6.47**	92
Robut 33-1 (check)	AB	AB	2230	2119659	0.95	± 0.11	1.48	98

† SB, AB and IB indicate sequential, alternate and irregular branching, respectively.
* and ** denote significantly different from zero at P = 0.05 and 0.01, respectively.

a Spanish selection tested at 16 locations in India, with a mean pod yield of 2003 kg ha^{-1}, gave superior yields at four locations (2120–2240 kg ha^{-1}). ICGS-4, a Virginia bunch type, tested at 16 locations, gave large yields (3420–4020 kg ha^{-1}) in five locations with a mean yield of 1780 kg ha^{-1}. It was also the earliest to mature (after 115 days) in this group, though not earlier than the parental cultivar (109 days). Similarly, three other Spanish selections, ICGS-11 (Robut 33-1-18-8-B1), ICGS-35 (Robut 33-1-24-16-B1) and ICGS-44 (Robut 33-1-1-5-B1), were entered in Indian National Trials.

Stability analysis

Strongly significant differences between selection (cultivar) means and their regressions on the environmental index were observed (Table 1). The range of responsiveness of the 17 entries was great, with regression coefficients ranging from 0.75 to 1.23. Most entries had a good fit to a linear model, with small deviation mean squares from regression and large R^2 values (e.g. ICGS-33, -34, -12, -44 and -11). One check (J 11) and entries Robut 33-1-13-6-B1, ICGS -36 and ICGS-1 had mean square deviations from regression significantly different from zero and smaller R^2 values, illustrating their more erratic behaviour. However, ICGS-1 did well at four out of 16 locations in the AICORPO trials.

Three selections, ICGS-44, -11 and -35, had 'b' values greater than unity indicating that they were more responsive to favourable conditions. These are also promising because of their large mean yields and they have been entered in the National Testing System. Selections ICGS-12, -34 and -33 were more stable as they had near unity regressions and small mean square deviations from regression. Selections ICGS-4 and -37 had regression values less than unity and so they may perform better under less-favourable conditions. Selection ICGS-4 yielded well in five out of 16 AICORPO locations and in the remainder it was either equal or only slightly inferior to the national checks.

CONCLUSIONS

Natural outcrossing, which often presents problems for maintaining genetic purity of cultivars, can sometimes help to generate additional variability. In locations where facilities to carry out large-scale groundnut hybridization do not exist, such crosses provide an additional method for the breeder. Our experience has indicated that a systematic evaluation of natural hybrids that occasionally arise in groundnut plots can be rewarding.

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