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# Performance of gamma-irradiated $F_3$ lines of groundnut

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## ABSTRACT

When the seeds of $F_3$ lines from 3 genetically broad-based crosses 'Robut 33-1' × 'Chico', 'Chico' × 'Robut 33-1' and 'Robut 33-1' × 'MH 2' in groundnut (*Arachis hypogaea* Linn.) were irradiated with 30 kR, the performance of some $F_3$ lines for pod yield, shelling percentage and 100-kernel weight improved from medium to high in the $F_5$ generation showing the beneficial effects of irradiation which could have promoted desirable recombination. The levels of improvement obtained in the lines indicated the existence of reciprocal differences also.

Irradiation of groundnut with low doses of gamma-rays promoted pollen sterility leading to enhanced natural cross-pollination. The extent of cross-pollination varied from genotype to genotype and it was about 20% in some varieties. The results suggested that seed irradiation within families of segregating generations could enhance their productivity through successive cycles of desirable genetic recombination (Dutta, 1983). A study was conducted to test this hypothesis in groundnut (*Arachis hypogaea* Linn.).

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## MATERIALS AND METHODS

Three crosses—'Robut 33-1' × 'Chico', 'Chico' × 'Robut 33-1', and 'Robut 33-1' × 'MH 2'—in their $F_2$ generation were chosen for the study. 'Robut 33-1' is a high-yielding Virginia bunch cultivar released as 'Kadiri 3' in Andhra Pradesh.

'Chico' is an introduced Russian genotype with earliest maturity of 75 days from Spanish bunch group. 'MH 2' is a Valencia cultivar with a very compact plant frame. The parents of the crosses chosen were thus genetically broad-based. The $F_2$ plants from these crosses were forwarded to the $F_3$ generation on a plant-to-progeny family basis. In each $F_3$ family selections were made on the basis of pods/plant. Following 5 categories of selections were made :

| Selection category | Criterion |
|---|---|
| UB | Unselected bulk of plants with pod number less than or equal to X |
| A | Plants with pod number exceeding X but less than (X + 10) |
| B | Plants with pod number between (X + 11) and (X + 20) |
| C | Plants with pod number between (X + 21) and (X + 30) |
| D | Plants with pod number between (X + 31) and (X + 40) |
| E | Plants with pod number exceeding (X + 40). |

where X is the number of pods/plant of the better parent of the $F_1$ cross.

Three $F_3$ families from 'Robut 33-1' × 'Chico' giving 13, 1 from 'Chico' × 'Robut 33-1' giving 4 and 1 from 'Robut 33-1' × 'MH 2' giving 5 selections formed the experimental material. Seeds of 22 selections were irradiated with 30 kR gamma-rays from a $^{60}Co$ source at the Osmania University and were sown in 10-m-long ridges with plants spaced 10 cm and ridges 60 cm apart during the post-rainy season of 1981–82. Each row was surrounded by 'Robut 33-1' to aid cross-pollination with it, as it was a high-yielding variety with a good general combining ability (Arunachalam *et al.*, 1982). The material was advanced to the $F_4$ as families during the post-rainy season of 1982–83. The crops were grown under the normal agronomic practices with protective irrigation and plant protection. In each generation observations were recorded on pod yield, kernel yield, shelling percentage and 100-kernel weight on plot basis. In the $F_4$, the overall performance of each of the 22 selections over the 4 characters was assessed by a scoring process as follows :

1. The mean (m) and sd (s) of selections was calculated for each character.
2. A selection whose value was greater than or equal to (m+s) was designated as high and given a score, +1; one whose value was less than (m+s) and greater than or equal to (m—s) as medium and given a score, 0; all others as low and given a score —1 each.
3. The scores were totalled across characters to provide a final score for each selection. The mean and sd of these final scores were used in a similar manner to associate a final high-medium- or low-performance status with each selection.

Eight selections thus classified as low were eliminated and the remaining 14 forwarded to the $F_5$ during the rainy season of 1983. In each generation, the material was grown unreplicated. The total variation among the selections was partitioned into the variation due to various sources.

A ranking process was adopted to assess the relative amount of variation associated with each source over pod yield, shelling percentage and 100-kernel weight. For each character, mean squares highest in magnitude was given a rank value of 1, and those in descending order of magnitude subsequent rank values, 2, 3 etc. They were added across characters to obtain a final value for each source. The final values were ranked and a final rank was associated with each source of variation (Tables 1, 2).

## RESULTS AND DISCUSSION

The variation in the $F_4$ was higher than in the $F_3$ for all characters for the selections from 'Chico' × 'Robut 33-1' (Table 1). The variation in the $F_4$ for pod yield within selections of the lines, 354 and 1423-4 of 'Robut 33-1' × 'Chico' was much lower than the corresponding variation in the $F_3$. On an overall basis (inferred by the ranks), however, variation in the F in selections of 'Robut 33-1' × 'Chico', 'Chico' × 'Robut 33-1' and

Table 1. Analysis of variation for 3 characters in the $F_3$ and $F_4$ generations of irradiated groundnut

| Source | df | Mean squares | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Pod yield | | Shelling percentage | | 100-kernel weight | | Rank | |
| | | $F_3$ | $F_4$ | $F_3$ | $F_4$ | $F_3$ | $F_4$ | $F_3$ | $F_4$ |
| 'Robut 33-1' × 'Chico' selections | 12 | 1072.0 | 632.7 | 330.1 | 578.6 | 53.3 | 1526.4 | 3 | 4 |
| Between lines of 'Robut 33-1' × 'Chico' | 2 | 994.3 | 1038.2 | 265.8 | 1764.4 | 29.8 | 2146.5 | 2 | 1 |
| Within Line 354 | 3 | 1418.9 | 481.6 | 120.0 | 548.3 | 66.1 | 193.8 | 1 | 3 |
| Within Line 1358 | 3 | 401.4 | 742.2 | 378.1 | 402.0 | 121.1 | 2259.9 | 1 | 2 |
| Within Line 1423-4 | 4 | 1353.7 | 461.2 | 484.0 | 140.9 | 4.7 | 1665.6 | 1 | 4 |
| 'Chico' × 'Robut 33-1' selections | 3 | 1943.4 | 2742.6 | 113.6 | 2616.3 | 273.5 | 281.1 | 3 | 2 |
| 'Robut 33-1' × 'MH 2' selections | 4 | 841.3 | 464.2 | 389.7 | 10045.9 | 146.8 | 1014.1 | 3 | 3 |
| 'Robut 33-1' × 'Chico' vs 'Chico' × 'Robut 33-1' selections | 1 | 18.7 | 38240.0 | 797.6 | 2122.4 | 10580.7 | 239618.5 | 2 | 1 |
| 'Robut 33-1' × 'MH 2' vs ('Robut' 33-1' × 'Chico' + 'Chico' × 'Robut 33-1' ) selections | 1 | 295.3 | 1240.4 | 1025.7 | 20791.9 | 836.7 | 6956.0 | 1 | 1 |

Table 2. Analysis of variation for 3 characters in the $F_5$ of high and medium selections made in the $F_4$ of irradiated groundnut

| Source | df | Mean squares | | | |
|---|---|---|---|---|---|
| | | Pod yield | Shelling ercen tage | 100-kernel weight | Rank |
| High selections | 2 | 163.9 | 198.8 | 3718.0 | 3 |
| 'Robut 33-1' × 'Chico' | 1 | 35.4 | 380.2 | 6.4 | 6 |
| 'Robut 33-1' × 'Chico' vs 'Chico' × 'Robut 33-1' | 1 | 292.3 | 17.3 | 7429.5 | 5 |
| Medium selections | 10 | 1570.0 | 4850.5 | 6842.4 | 1 |
| 'Robut 33-1' × 'Chico' | 5 | 229.5 | 5741.4 | 4776.1 | 4 |
| 'Chico' × 'Robut 33-1' | 2 | 2936.6 | 1344.8 | 691.5 | 3 |
| 'Robut 33-1' × 'MH 2' | 1 | 605.1 | 15322.1 | 14105.9 | 1 |
| 'Robut 33-1' × 'Chico' vs 'Chico' × 'Robut 33-1' | 1 | 1723.8 | 49.1 | 17148.7 | 2 |
| 'Robut 33-1' × 'MH 2' vs (Robut 30-1' × 'Chico' + 'Chico' × 'Robut 33-1') | 1 | 6349.8 | 1737.1 | 11905.5 | 1 |
| High vs medium | 1 | 1221.4 | 422.0 | 4264.2 | 2 |

'Robut 33-1' × 'MH 2' was lower than the means squares due to 'Robut 33-1' × 'Chico' versus 'Chico' × 'Robut 33-1' or 'Robut 33-1' × 'MH 2' versus ('Robut 33-1' × 'Chico' + 'Chico' × 'Robut 33-1'). The lowest variation in the $F_4$ was found in selections of 'Robut 33-1' × 'Chico', followed by selections of 'Robut 33-1' × 'MH 2' and of 'Chico' × 'Robut 33-1' (Table 1), indicating that the amounts of segregation and recombination realised in the $F_4$ varied in the 3 crosses, particularly in the direct and reciprocal crosses between the parents, 'Robut 33-1' and 'Chico'. It is possible that seed irradiation in the $F_3$ produced differing magnitudes of variation, but it must also be admitted that they would depend on their

Table 3. Mean and variation in yield components of 14 lines in $F_3$, $F_4$ and $F_5$ generations of irradiated groundnut

| Character | Generation | Mean | Range | cv | sd |
|---|---|---|---|---|---|
| Pod yield | $F_3$ | 37.4 | 5.8—80.0 | 53.6 | 20.03 |
| | $F_4$ | 25.3 | 14.7—43.1 | 43.4 | 10.97 |
| | $F_5$ | 8.1 | 3.4—14.6 | 36.0 | 2.90 |
| Shelling percentage | $F_3$ | 56.2 | 42.8—72.6 | 16.3 | 9.17 |
| | $F_4$ | 51.3 | 27.0—62.3 | 18.8 | 9.65 |
| | $F_5$ | 58.4 | 52.6—67.4 | 7.8 | 4.58 |
| 100-kernel weight | $F_3$ | 32.0 | 18.9—50.0 | 27.1 | 8.67 |
| | $F_4$ | 40.6 | 31.3—55.0 | 20.1 | 8.17 |
| | $F_5$ | 30.4 | 21.0—37.5 | 17.9 | 5.45 |

Table 4. Performance status of lines in $F_3$, $F_4$ and $F_5$ generations in irradiated groundnut

| Line identity | Performance status | | |
|---|---|---|---|
| | $F_3$ | $F_4$ | $F_5$ |
| 'Robut 33-1' × 'Chico' | | | |
| 354 A | High | High | Medium |
| 354 D | High | Medium | Medium |
| 1358 B | Medium | High | Medium |
| 1358 E | Medium | Medium | Medium |
| 1358 UB | Low | Medium | Medium |
| 1423-4 A | High | Medium | Medium |
| 1423-4 B | Medium | Medium | Medium |
| 1423-4 C | Medium | Medium | Medium |
| 'Chico' × 'Robut 33-1' | | | |
| 393-1 A | Medium | Medium | High |
| 393-1 B | Medium | Medium | High |
| 393-1 C | Medium | High | High |
| 393-1 UB | Medium | Medium | Medium |
| 'Robut 33-1' × 'MH 2' | | | |
| 834 A | Medium | Medium | Low |
| 834 D | Medium | Medium | Medium |

$F_1$ parental genotypes too.

The variation in the $F_5$ was higher among the families descending from medium families of the $F_4$ than among those descending from high families of the $F_4$ (Table 2). While the $F_4$ medium selections from 'Robut 33-1' × 'MH 2' produced high variation in the $F_5$, those from 'Chico' × 'Robut 33-1' and 'Robut 33-1' × 'MH 2' produced less variation. The variation in the $F_5$ from the $F_4$ high selections of 'Robut 33-1' × 'Chico' was the lowest. The results suggest that genetic variation among high selections of the $F_4$ was lower than that in medium selections.

Pod yield in the $F_3$ was high and decreased progressively in the $F_4$ and $F_5$ (Table 3). The low yields in the $F_5$ were due to the high incidence of bud-necrosis, rust and leaf-spots in the rainy season in which it was grown, as compared with $F_3$ and $F_4$ that were raised in the post-rainy seasons with less incidence of diseases. Such sharp variations were not observed for shelling percentage and 100-kernel weight. Further genetic uniformity increased with advancing generations as seen from the decreasing values of coefficients of variation (Table 3).

The various lines showed variable performance which depended also on the parental genotypes of their respective $F_1$ crosses (Table 4). For instance, 13 selections from 'Robut 33-1' × 'Chico' were evaluated in the $F_4$ of which 5 were poor in performace (= 38%) and hence eliminated. Such elimination was of the order of 3/5 (= 60%) in 'Robut 33-1' × 'MH 2' and there was no elimination in 'Chico' × 'Robut 33-1'. The results also provided evidence for reciprocal differences in 'Robut 33-1' × Chico'.

In some lines like 1358-UB of 'Robut 33-1' × 'Chico', the low performance in the $F_3$ improved to medium in the $F_4$ and remained so in the $F_5$. In some others like 834-A of 'Robut 33-1' × 'MH 2', the medium performance in the $F_3$ and $F_4$ was not maintained, but dwindled to low in the $F_5$. Such an analysis showed that the performance of all the 4 lines in 393-1 of 'Chico' × 'Robut 33-1' either improved from medium in the $F_3$ to high in the $F_5$ or remained stable (as in 393-1-UB). The performance of line 1358-UB of 'Robut 33-1' × 'Chico' was found to be fluctuating, that of 354-A showed degradation from high to medium in the $F_5$. Thus the results indicated the would-be beneficial effects of seed irradiation in the $F_3$ by a possible promotion of a certain degree of inter-mating, as reported by Dutta (1983), and hence improved yield in higher generations. At the same time, the results also indicated varying levels of those beneficial effects in various lines. There is thus a need to identify the crosses and $F_3$ lines that would respond to seed irradiation and improve in yield performance later. Nevertheless the use of seed irradiation, in promoting inter-mating and enhancing yield was in evidence, though more intensive studies would be needed to derive higher dividends using this tool.

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