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Studies on the Breeding Behaviour of Interspecific Hybrid Derivatives in the Genus *Arachis* L.

by

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Improvement of groundnut (*Arachis hypogaea*) has so far been confined to the exploitation of the natural genetic variability in the cultivated species. The existing variability being limited, the breeder has to resort to hybridization. The wild relatives of *A. hypogaea* possess desirable features such as resistance to drought, pests and diseases besides high pod to kernel ratio. The breeding behaviour of three populations of interspecific hybrids was studied and presented in this paper.

Materials and Methods: The following hybrid derivatives were utilised for the study. (1) F_3 population (77 plants) of the hybrid *A. hypogaea* × *A. glabrata* var. *hagenbeckii*. (2) BC_1F_3 population (146 plants) of *A. hypogaea* × (*A. hypogaea* × *A. Sp.* A 329) and (3) BC_1F_4 population (51 plants) of *A. hypogaea* × Allotriploid (*A. hypogaea* × *A. villosa*).

The seed material was sown in July, 1962 with a basal application of 2.5 tons of farm yard manure per acre. The habit of growth of plants were recorded when they were six to eight weeks old (Patel *et al* 1936). The morphological characters were described and measurements were recorded for quantitative characters. The genetic improvement in economic characters was assessed. Plants were grouped according to pod yield ranging from 10 to 40 gm. Oil and free fatty acids were estimated from representative samples of the above yield group by methods described by Patel and Seshadri (1934) and Woodman (1941).

Results and Discussion: The observations made are presented in the following three sections. 1. *F_3 population of A. hypogaea × A. glabrata* var. *hagenbeckii:*

Seeds gathered from eight F_2 plants were sown. The duration for germination and first flowering was 7 and 37 days respectively. Of the 77 plants studied, 64 were bunch and 13 semi-spreading in habit. The leaf colour varied from light green to green. Variation in stem colour from green to dark purple was observed. Stem hairiness ranged from slightly hairy to very hairy, the latter being predominant. The mean pollen sterility was 5.18 per cent. Plants varied in their degree of resistance to natural infection of 'Tikka' leaf spot from susceptible to tolerant. None of them are resistant.

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Five new recombinations were observed. One semi-spreading plant had green foliage with densely hairy stem and dark purple pigmentation. One bunch plant with green leaf and very hairy stem produced pegs in abundance. One of the bunch segregants exhibited forking of main stem with only one primary branch arising below the point of forking. Another plant produced two primary branches only. A bunch segregant had five primary branches arranged in alternate manner instead of the normal opposite and decussate arrangement of the branches. Eight economic characters of the F_3 population were compared with that of the F_2 and the data are presented in Table 1.

TABLE 1. *Economic characters of the hybrids of A. hypogaea×A. glabratta var hagenbeckii (Mean values of 35 F_2 Plants and 77 F_3 plants)*

Character	F_2	F_3
	Mean ± S.E.	Mean ± S.E.
Number of pods per plant	0.7 ± 1.3	12.8 ± 1.1
Weight of pods per plant (gm)	5.8 ± 0.7	8.8 ± 0.6
Weight of two-kernelled pod (mgm)	562 ± 42	784 ± 18
Shelling out-turn (percent)	65.1 ± 2.5	71.2 ± 0.8
100 pod weight (gm)	57.8 ± 5.8	73.3 ± 1.9
100 kernel weight (gm)	27.9 ± 1.7	29.0 ± 0.8
Oil content (percent)	....	51.9 ± 0.6
Free fatty acid (percent)		0.41 ± 0.1

Distinct improvement was observed in all the characters of F_3 population. An increase of 51.7% and 39.5% over the F_2 general mean in pod yield per plant and weight of two-kernelled pods in the F_3 was evident. The F_3 population showed an increase of 6.1% in the shelling out-turn. The pod size was bolder in F_3 than in F_2 as could be seen from the increased 100 pod weight by 41.5%. The 100-kernel weight of F_3 is 4.0% higher than that of F_2.

The pod yield per plant of the different progeny rows which constitute the F_3 population was analysed statistically and presented in Table 2.

The yield differences among the progeny rows are significant. The progeny rows V-3 and III-15 exhibited 344 and 53% increased pod yield over that of the F_2 family mean.

The weight of two-kernelled pods is more in F_3 than that of F_2. All the progeny rows showed increase in two-kernelled pod weight ranging from 7 to 101% over that of the F_2 family mean. Progeny rows II-4, III-8, III-12, III-15, and V-14 have surpassed and significantly superior over the respective F_2 family mean with 47, 42, 31, 34 and 67% increased pod weight. The frequency

TABLE 2. *Pod yield of F_3 population (gm).*

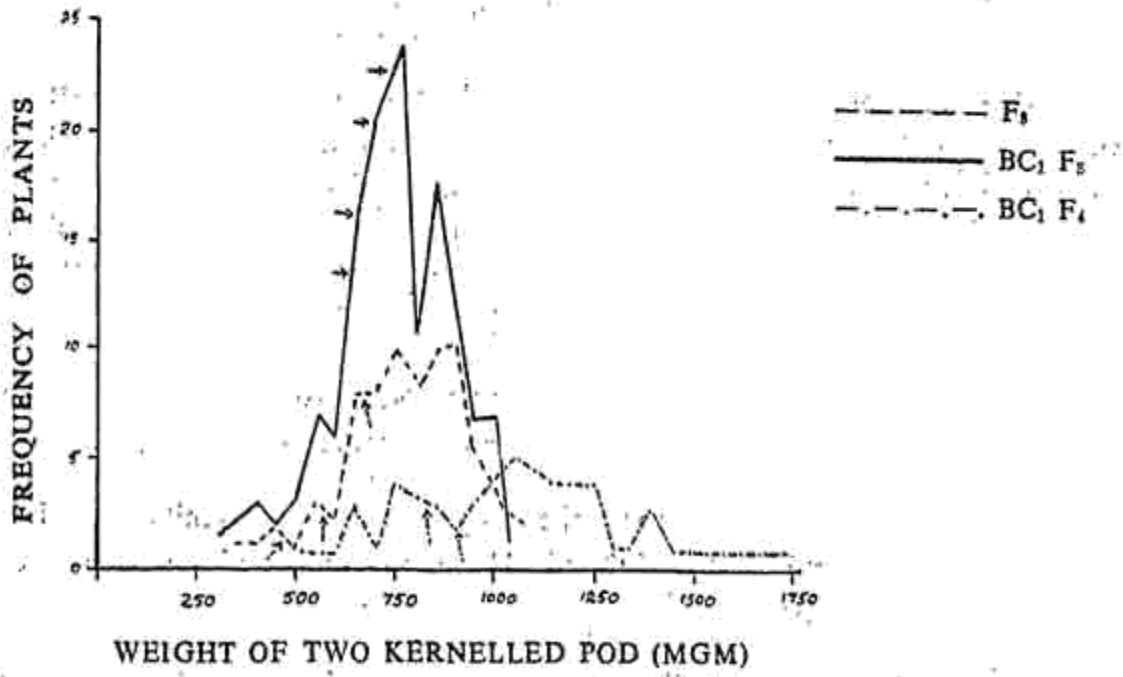
Progeny Row	F_2 Family mean	F_3 Progeny row mean	Percent over F_2 family mean	't' test
II-7	8.0 ± 5.8	9.1 ± 1.4	114	
III-4	7.7 ± 2.2	8.0 ± 1.5	104	
III-8	7.7 ± 2.2	4.6 ± 1.1	60	
III-12	7.7 ± 2.2	9.9 ± 1.9	129	
III-15	7.7 ± 2.2	11.8 ± 1.4	153	
V-3	3.6 ± 3.0	16.0 ± 1.0	444	
V-14	3.6 ± 3.0	6.0 ± 2.3	167	
V-15	3.6 ± 3.0	4.0 ± 0.7	111	
S.E.	....	0.64	....	
C.D. at 5%	....	1.92	....	

Conclusion: 6, 5, 4, 1, 2, 7, 3, 8

* Significantly superior over F_2 at 5% level
** Significantly superior over F_2 at 1% level

distribution with regard to weight of two-kernelled pod of the hybrid populations is presented in Figure 1.

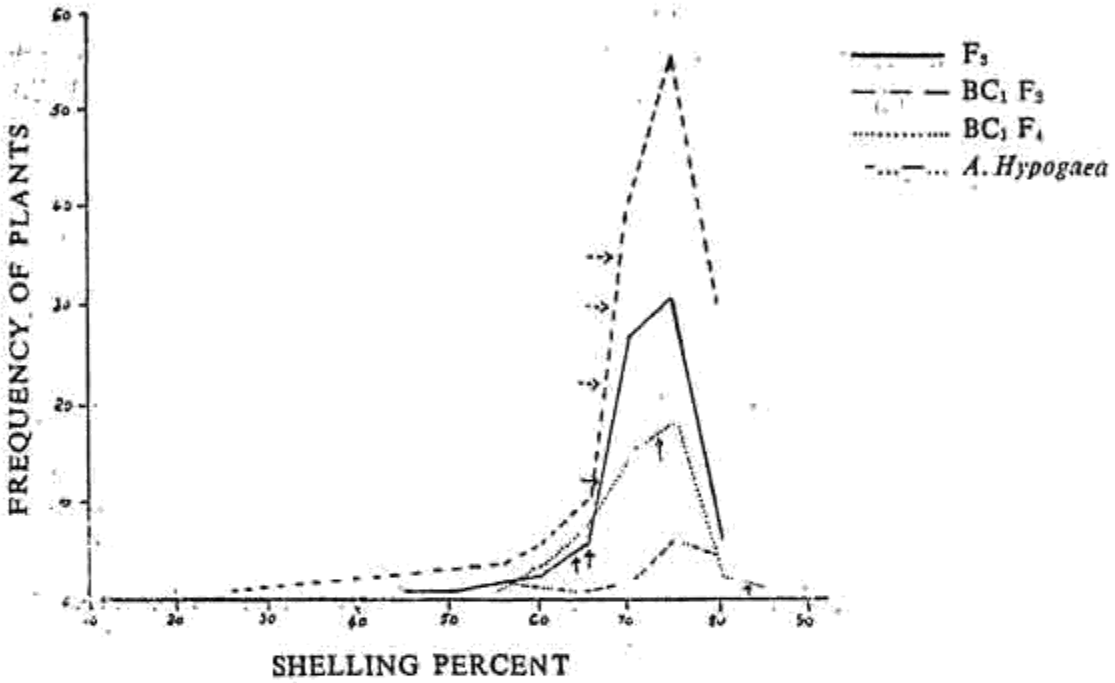
FIG. 1. Graph showing the frequency distribution of two-kernelled pod-weight in straight cross F_2, backcross F_3, and backcross F_4, populations. (Arrows indicate the family mean values of the preceding generation)



2. *Back-cross F_3 population of A. hypogaea × A. hypogaea × A. sp.* (A. 329): A total of 146 plants was studied in the F_3 population, of which 140 were bunch and six semi-spreading in habit. The pre-germination and pre-flowering period were 7.0 and 35.7 days respectively. The pollen sterility

ranged from 0.29 to 19.5%, the mean being 3.32%. The leaf colour was green in one plant and light green in the rest. Stem pigmentation varied from green to purple. Variation in hairines ranged from slightly hairy to very hairy; hairy being most frequent. The plants differed in their reaction to natural infection of 'Tikka' leaf spot disease ranging from very susceptible to tolerant; susceptible being most frequent.

FIG. 2. Graph showing the frequency distribution of shelling % in the hybrid derivatives and *A. Hypogaea*. (Arrows indicate family mean values of the preceding generation)



Eight economic characters of back-cross F_3 population were compared with that of the back-cross F_2 to evaluate the genetic improvement and presented in Table 3.

TABLE 3. *Economic Characters of the Hybrids of (A. hypogaea × A. hypogaea × A. sp. A. 329) : (Mean values of 188 BC_1F_2 and 146 BC_1F_3 plants).*

Character	BC_1F_2	BC_1F_3	Percentage of increase over BC_1F_2 general mean
	Mean ± S.E.	Mean ± S.E.	
Number of pods per plant	12.6 ± 0.5	14.6 ± 0.7	15.9
Weight of pods per plant	8.1 ± 0.4	9.9 ± 0.5	22.2
Weight of two-kernelled pod (mgm)	674 ± 16	741 ± 13	9.9
Shelling out-turn (%)	67.6 ± 0.9	2.6 ± 0.6	7.4
100 pod weight (gm)	60.6 ± 1.5	6.9 ± 1.3	10.4
100 kernel-weight (gm)	29.8 ± 0.8	8.7 ± 0.5	—
Oil content (%)	—	4.1 ± 1.0	—
Free fatty acid (%)	—	.29 ± 0.01	—

The back-cross F_3 population exhibited genetic improvement over the preceding generation in respect of number of pods per plant, weight of pods per plant, average weight of two-kenelled pods, shelling out-turn and 100 pod weight to the extent of 15.9, 22.2, 9.9, 7.4 and 10.4% respectively. The oil content was high (54.1%) in the back-cross F_3 population.

The frequency distribution with regard to shelling out-turn of the hybrid populations studied is illustrated in Figure 2. Variation among the progeny rows of the back-cross F_3 population with regard to eight characters, *viz.*, number of branches (total number of primaries and secondaries), average length of primary branches, number of pods per plant, weight of pods per plant, weight of two-kernelled pods, shelling out-turn, 100 pod weight and 100 kernel weight was statistically analysed and found to be significant. While

FIG. 3. Variation in the progeny rows of the backcross F3 population

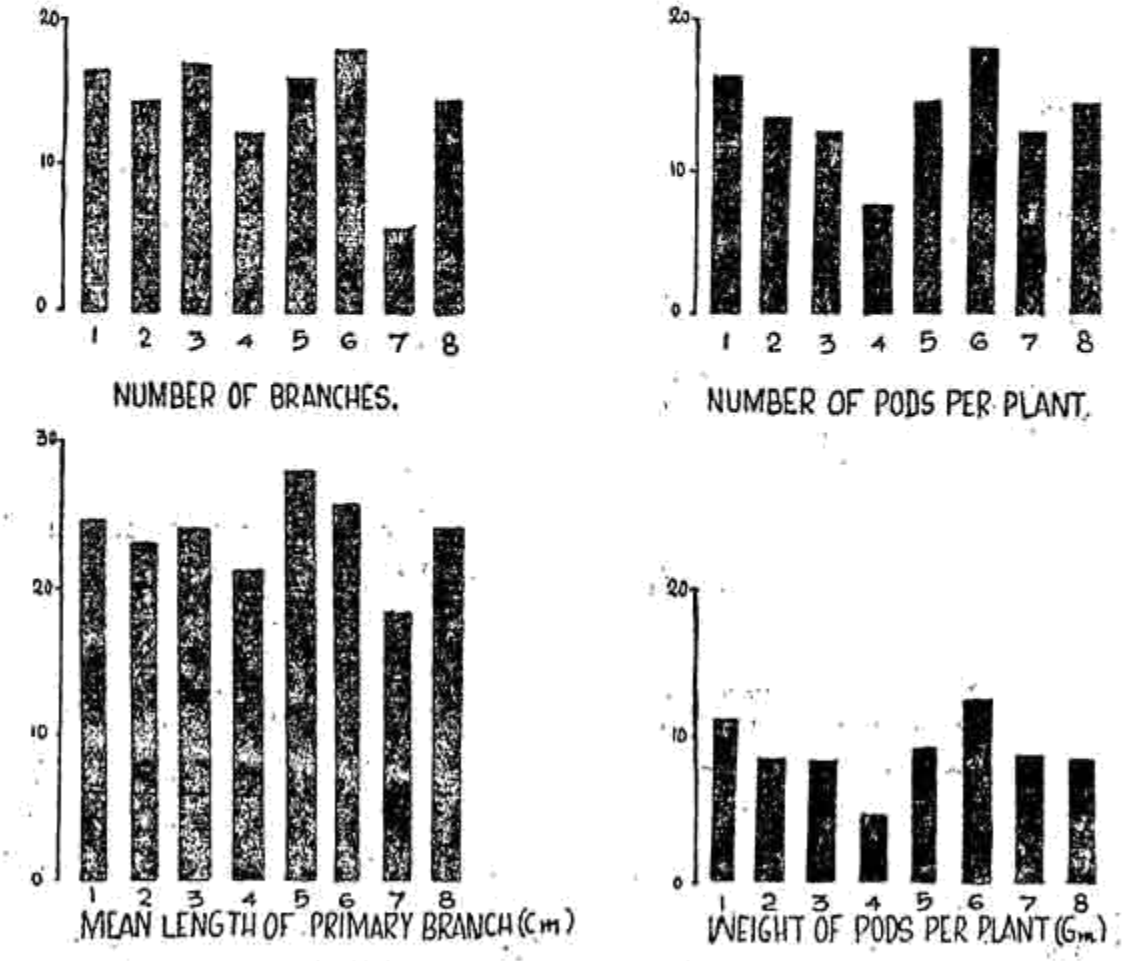


Figure 3 shows the variation with regard to the first four characters mentioned above that of the economic characters is presented in Table 4.

TABLE 4. *Variation in economic characters of back cross F_2 population*

Progeny row	Number of plants	Weight of two-kernelled pod (mgm)	Shelling out-turn (%)	100 pod weight (gm)	100 Kernel weight (gm)
E 41	34	701 ± 21	72.7 ± 0 9	63.5 ± 2.2	27.6 ± 0.9
F 5	11	709 ± 47	69.5 ± 2.2	64.4 ± 5.3	26.5 ± 2.5
F 34	15	705 ± 28	73 2 ± 0.9	67.0 ± 2.4	29.3 ± 0.8
F 71	13	792 ± 42	74.3 ± 1.2	71 7 ± 4.9	29.8 ± 1.6
L 32	25	800 ± 27	74.0 ± 1.1	70.8 ± 3.4	30.4 ± 1.1
L 60	28	718 ± 27	70.6 ± 1.2	65.0 ± 2.4	27.5 ± 1.1
P 31	20	783 ± 47	73.8 ± 2.7	68.8 ± 3.9	30.4 ± 1.7
General mean	146	741 ± 13	72.6 ± 0.6	66.9 ± 1.3	28.7 ± 0.5

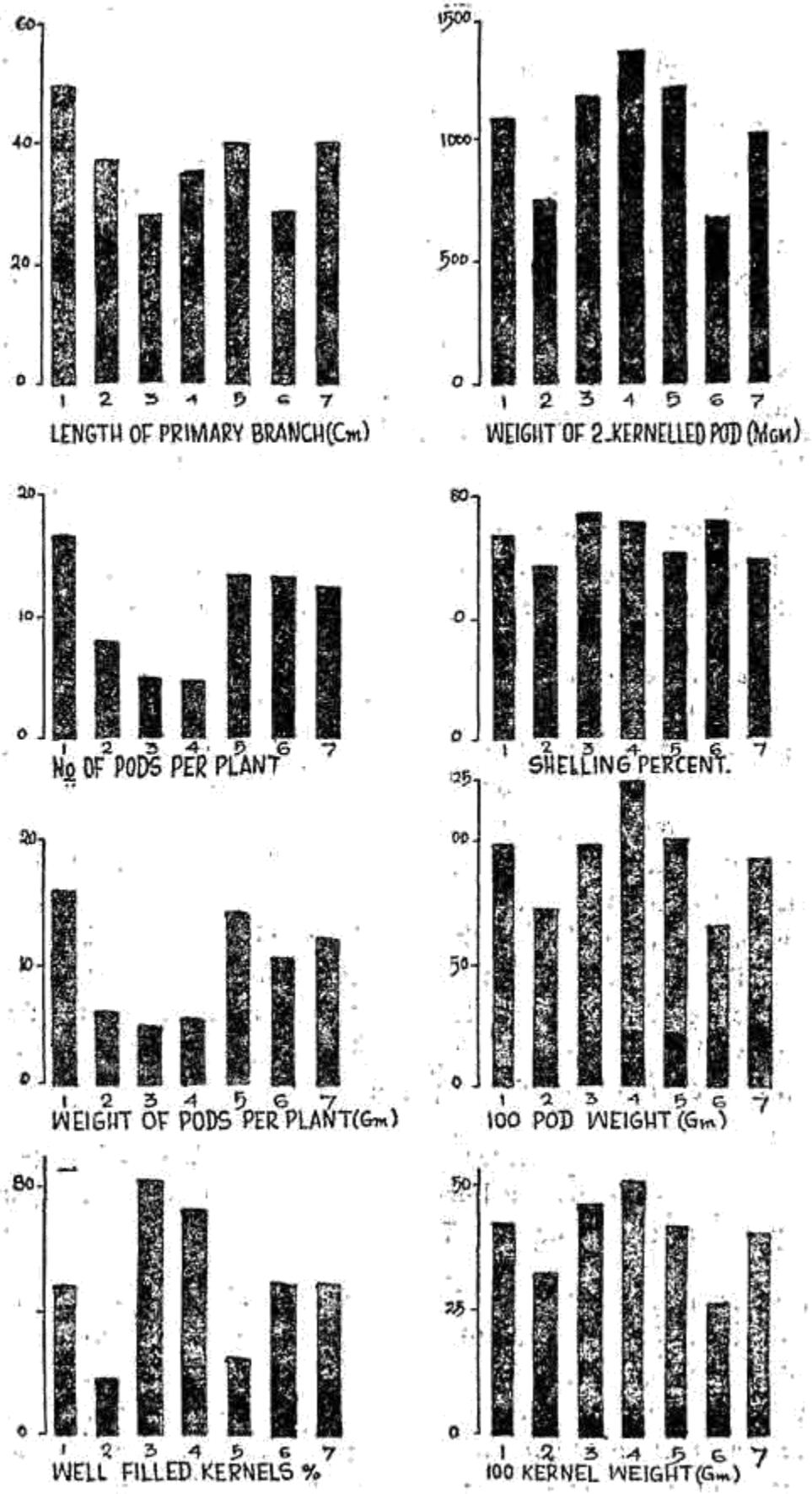
Progeny row L-60 was significantly superior to others in respect of number of branches, number of pods per plant and weight of pods per plant. L-32 showed high values for weight of two-kernelled pod and weight of 100 kernels. F-71 was superior in shelling out-turn and 100 pod weight.

3. *Back-cross F_4 population of A. hypogaea × (A. hypogaea × A. villosa):* Sixty seeds collected from six plants of the BC_1F_3 were sown, of which 55 germinated. Fifty one plants have established in the BC_1F_4 population. The pre-germination and pre-flowering period were 6.9 and 40.1 days respectively. In the population studied the following rare recombinations were observed. (i) Bunch, profuse branching with thin, glabrous stem devoid of anthocyanin pigmentation, tolerant to 'Tikka' leaf spot disease. (ii) Semi-spreading, profuse branching, thick stem, fairly tolerant to 'Tikka' leaf spot disease. (iii) Spreading, good branching, dark purple, very hairy stem with dark green foliage, fairly resistant to 'Tikka' leaf spot disease. (iv) Trailing, profuse branching, very hairy, purple, thick stem, long primaries and leaf green, fairly tolerant to 'Tikka' leaf spot disease.

The improvement with regard to two characters, *viz.*, weight of pods per plant and weight of two-kernelled pods in the BC_1F_4 population is significant over the preceding generation (vide Table 5).

Progeny row A-3 showed 125% increased pod yield per plant besides 35% enhanced weight of two-kernelled pod over the parental generation. A-9 exhibited the maximum increase of 72% in the weight of two-kernelled pod over the parental mean. Progeny rows A-7, A-8 and A-9 were inferior to their parental generation with regard to pod yield per plant. Significant variation was observed among the progeny rows of the BC_1F_4 population with regard to eight characters and presented in Figure 4.

FIG. 4. VARIATION IN THE BACKCROSS F4 POPULATION



1. A.3 2. A.7 3. A.8 4. A.9 5. A.10 6. B.6 7. General mean

TABLE 5. *Genetic Improvement in BC_1F_4 population*

Progeny row	BC_1F_3 family mean	BC_1F_4 progeny row mean	Percent over BC_1F_3 family mean	't' test
Weight of pods per plant (gm):				
A-3	7.6 ± 2.8	17.1 ± 1.8	225	*
A-7	7.6 ± 2.8	6.0 ± 1.1	79	
A-8	7.6 ± 2.8	4.9 ± 1.5	64	
A-9	7.6 ± 2.8	5.3 ± 1.7	70	
A-10	7.6 ± 2.8	14.6 ± 3.5	192	
B-6	5.0 ± 1.6	10.9 ± 1.8	218	
Weight of two-kernelled pod (Mgm):				
A-3	824 ± 200	1114 ± 34	135	*
A-7	824 ± 200	790 ± 86	96	
A-8	824 ± 200	1237 ± 63	150	
A-9	824 ± 200	1415 ± 111	172	*
A-10	824 ± 200	1260 ± 130	153	
B-6	900 ± 150	712 ± 30	79	

* Significant at 5% level

It was noticed that progeny row A-3 was significantly superior to the rest with regard to length of primary branch, number of pods per plant and weight of pods per plant. A-9 was out-standingly superior in weight of two-kernelled pods, 100 pod weight and 100 kernel weight. With regard to shelling out-turn and percentage of well-filled kernels progeny row A-8 was significantly superior to others, closely followed by A-9.

One of the main philosophies of breeding has been termed "transgressive" breeding by Akerman and Mackey (1948). Frankel's (1950) terminology for this general scheme is "assembling of productivity genes". The genetic improvement observed in the present study in the hybrid populations over their parental generations with regard to certain economic characters could be attributed to the assembling of productivity genes.

Summary: Three populations of the interspecific hybrid derivatives (F3) *A. hypogaea* × *A. glabrata* var. *hagenbeckii*, (BC_1F_3) *A. hypogaea* × Allotriploid (*A. hypogaea* × *A. sp.* A. 329) and (BC_1F_4) *A. hypogaea* × Allotriploid (*A. hypogaea* × *A. villosa*) were studied for their breeding behaviour. Number of pods per plant, weight of two-kernelled pods, shelling out-turn, 100-pod weight and 100 kernel weight were the chief characters taken into consideration.

The analysis of different progeny rows with reference to different characteristics revealed significant differences between lines with regard to two characters, *viz.*, yield of pods per plant and weight of two-kernelled pods in F_3, four characters *viz.*, number of branches, length of primary branch, number of

pods per plant and weight of pods per plant in BC_1F_3, and eight characters, *viz.*, length of primary branch, number of pods per plant, weight of pods per plant, shelling out-turn, weight of two-kernelled pod, 100 pod weight, 100 kernel weight and percentage of well filled kernels in the BC_1F_4 population.

The genetic improvement in characters of the hybrid derivatives over that of the respective parental generations was evident. One progeny row in the back-cross F_3 showed significant increase in shelling out-turn. High pod yield was obtained in one of the progeny rows of back-cross F_4. Five lines in F_3, one in back-cross F_3 and two lines in BC_1F_4 exhibited phenominal increase in the weight of two-kernelled pod over the respective family means of their parental generations. The transgressive variations were attributed to the assembling of productivity genes. Six new recombinations were recorded. High oil-content of 54.1 was obtained in the back-cross F_3 population.

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