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GENETIC VARIABILITY IN GUAR FOLLOWING HYBRIDIZATION AND IRRADIATION

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The present investigations were undertaken with a view to study the nature and magnitude of variability in an experiment comprising of unirradiated 15 F_1's and 15 F_2s and the irradiated 15 F_1 M_1's and 15 F_2 M_2's population of guar. It was observed that irradiation caused earliness in flowering and maturity and increase in 100-seed mass and reduction in the remaining characters. The phenotypic and genotypic coefficients of variation increased for pod length, seeds per pod, protein and gum content and reduced for days to flowering, maturity, plant height, clusters and seed yield per plant in both F_1M_1 and F_2M_2 i.e. the irradiated populations. High estimates of heritability and high genetic gains were observed for number of clusters and seed yield per plant in F_1 and F_2 populations. The mean value was reduced and coefficient of variation was increased in majority of the crosses in F_2M_2 or F_2 population for some of the characters. However, reverse was also observed for some characters.

Key words : Guar, *Cyamopsis tetragonloba*, variability, hybridization, irradiation

Owing to small sized, delicate flowers and low seed setting in outcrossed flower buds in guar, not much diverse breeding material could be generated through hybridization. Nevertheless, mutation breeding offers an alternative to hybridization since quantitative variation generated by the two methods is equally heritable (Gregory, 1956). Moreover, the reports are also not available on the effects of mutagens when super imposed on hybridization in guar. Accordingly, the present investigation was undertaken with a view to study and compare the variability generated through hybridization alone and by the combined effect of hybridization and irradiation.

MATERIALS AND METHODS

A six parent diallel excluding reciprocals was attempted to obtain 15 F_1 crosses. The half of the seed of each F_1 cross was irradiated with 40 KR gamma rays using a ^{60}Co source and the rest seeds were untreated and used as control. These two sets of material were grown in the field to advance them to F_2M_2 and F_2 seed generations. Fresh F_1 crosses in all possible combinations excluding reciprocals were again prepared among the same six parents. The half of the seed form each cross was again irradiated with the same source and the remaining half seed was kept as control. This set of material gave rise to F_1 and F_1M_1 generation.

The unexposed and gamma rays exposed progenies comprising of 15 F_1's, 15 F_2's, 15 F_1M_1's and 15 F_2M_2's were sown during kharif, 1990 in a randomised complete block design with three blocks. Each F_1 and F_1M_1 hybrid was sown in 2.8 m long rows was spaced 45 cm apart. Each F_2 and F_2M_2 progeny was represented by 6 rows each with the same inter and intra-row spacings as in F_1 and F_1M_1's. Five random and competitive plants from each F_1 and F_1M_1 and twenty plants in each F_2 and F_2M_2 were taken for recording data on 11 characters. Protein content was determined by the analytical method as proposed by Mckenzie and Wallace (1954) and gum content was estimated according to the method described by Das *et al.* (1977). Mean, coefficient of variation, heritability and genetic advance were calculated.

RESULTS AND DISCUSSION

A comparison of mean values of the eleven characteristics studied in F_1, F_1M_1, F_2 and F_2M_2 generations (Table 1) revealed that mean values for all the characters except 100-seeds mass were reduced in the treated populations. Thus the desirable variability was generated as early flowering and maturity and more seed mass are considered desirable traits in guar breeding.

Chowdhury *et al.* (1975) also observed a decrease in mean values for number of branches and seed yield per plant in M_2 than control but increase in peduncle length and plant height was observed in guar. The mean values for various traits in irradiated populations were also found low as compared to unirradiated populations by many other workers (Virupakshappa *et al.*, 1988 Krull and Frey, 1961; Kumar *et al.*, 1988), however, for some traits it remained either unaltered or higher in treated populations (Sharma *et al.*, 1982; Sinha and Joshi, 1986).

The values for variance in different generations revealed that both g.c.v. and p.c.v. were reduced in F_1M_1 and F_2M_2 populations. Chowdhury *et al.* (1975) also reported increase in variation for six quantitative characters in irradiated populations in guar. Gregory (1956) was one of the first to use irradiation and hybridization conjuctively in peanut breeding programme and showed increase in variation in both irradiated parents and hybrids than in unirradiated hybrids. Gregory's findings were further supported by the other investigators who also worked on irradiated hybrid populations (Krull and Frey, 1961; Emery and Wynne, 1976; Sharma *et al.*, 1982, Sinha and Joshi; 1986; Kumar and Yadava, 1988). However, the variance induced by radiation

Table 1. Comparison of genetic parameters in various generations

Parameter	Generation	1	2	3	4	5	6	7	8	9	10	11
Mean	F_1	44.18	115.78	105.12	22.0	94.55	5.48	7.91	2.33	13.04	29.03	30.34
	F_1M_1	39.22	109.93	90.76	16.78	82.38	4.22	5.43	2.55	9.22	25.98	27.28
	F_2	39.53	116.02	98.71	21.21	77.50	5.45	7.88	2.31	12.01	27.55	32.31
	F_2M_2	35.94	110.38	88.04	16.42	68.05	4.94	6.95	2.44	10.78	25.04	29.53
Genotypic coefficient of variation (GCV)	F_1	7.10	4.35	22.12	46.77	26.15	3.20	4.24	12.04	35.74	6.05	8.09
	F_1M_1	4.40	3.72	12.41	44.75	29.35	8.55	16.09	10.16	30.94	7.94	13.80
	F_2	9.95	5.68	16.12	42.87	16.84	3.73	3.11	8.68	27.14	7.18	6.40
	F_2M_2	8.09	3.38	14.00	19.29	12.77	4.57	5.45	8.80	11.14	7.39	8.98
Phenotypic coefficient of variation (PCV)	F_1	7.18	4.38	22.15	47.03	26.33	3.59	4.53	12.25	36.16	6.25	8.52
	F_1M_1	4.50	3.82	12.56	44.91	29.49	8.83	16.35	10.69	31.36	8.14	14.10
	F_2	9.98	5.74	16.18	42.91	16.92	4.00	3.57	8.93	27.42	7.34	6.79
	F_2M_2	8.15	3.41	14.01	19.43	12.80	4.94	5.76	9.13	12.10	7.70	9.15
Heritability (Broad sense)	F_1	97.82	98.34	99.73	98.92	98.62	79.16	87/60	96.59	97.68	93.70	09.08
	F_1M_1	95.53	94.92	97.69	99.28	99.01	93.95	96.85	90.37	97.30	95.16	95.84
	F_2	99.25	98.01	99.19	99.81	98.97	87.30	75.55	94.56	97.98	95.68	88.64
	F_2M_2	98.40	98.29	99.83	98.55	99.54	85.82	89.49	93.02	84.72	92.21	96.71
Genetic advance (% of mean)	F_1	14.46	8.88	45.51	95.83	53.30	5.86	8.17	24.38	72.77	12.06	15.82
	F_1M_1	8.85	7.47	25.27	91.86	60.15	17.08	32.62	19.91	62.87	15.95	27.83
	F_2	20.41	11.50	33.07	88.23	24.50	7.19	5.56	17.39	54.34	14.47	12.41
	F_2M_2	16.52	6.91	28.81	39.45	26.27	8.73	10.61	17.49	21.12	14.63	18.17

1 = Days to first flowering, 2 = Days to maturity, 3 = Plant height, 4 = Number of clusters per plant, 5 = Number of pods per plant, 6= Pod length, 7 = Number of seeds per pod, 8 = 100-seeds mass, 9 = seed yield per plant, 10 = Protein content, 11 = Cum content.

Table 2. Coefficient of variation (c.v.) and mean values for various characters within each cross of F_2 and F_2M_2 generations

Crosses	Days to flowering				Days to maturity				Plant height			
	CV		Mean		CV		Mean		CV		Mean	
	F_2	F_2M_2	F_2M_2	F_2M_2	F_2	F_2M_2	F_2	F_2M_2	F_2	F_2M_2	F2	F_2M_2
HG 75 × CP 68	12.06	16.49	41.22	38.57	6.03	6.78	115.03	112.42	21.27	26.71	97.11	92.24
HG 75 × PLG 85	9.87	14.59	40.62	38.45	7.96	5.66	116.47	111.74	23.53	28.62	100.41	90.44
HG 75 × FS 277	9.20	10.95	46.10	39.91	6.09	4.11	127.78	114.89	21.03	26.10	119.72	103.39
HG 75 × HG 314	10.75	12.53	46.51	41.10	5.28	5.5	126.20	114.39	21.59	35.32	109.80	103.84
HG 75 × HG 79-1-5	13.80	14.08	38.88	36.79	5.59	4.08	114.21	116.04	23.43	19.31	93.56	78.75
CP 68 × PLG 85	14.34	17.29	34.87	33.54	5.85	7.52	108.51	107.33	28.42	32.52	86.21	78.93
CP 68 × FS 277	17.28	22.37	36.32	31.96	8.73	6.87	114.62	111.42	20.44	30.44	90.23	95.59
CP 68 × HG 314	16.86	17.22	36.71	33.44	6.46	8.24	115.61	106.50	27.60	32.98	89.33	80.60
CP 68 × HG 79-1-5	17.68	16.93	35.64	30.42	8.63	11.04	108.12	103.20	27.22	19.77	69.33	59.03
PLG 85 × FS 277	12.77	12.40	39.43	36.46	8.27	6.35	115.79	109.36	29.07	28.47	117.66	80.99
PLG 85 × HG 314	10.17	9.20	39.39	35.31	6.84	7.40	114.61	109.55	22.84	28.36	109.76	98.16
PLG 85 × HG 79-1-5	10.37	10.76	35.98	34.48	8.25	13.43	107.17	104.44	28.58	35.47	85.59	83.17
FS 277 × HG 314	11.96	9.62	46.21	36.68	4.89	4.67	128.10	113.19	23.10	27.43	129.15	104.16
FS 227 × HG 79-1-5	11.51	9.67	37.08	35.86	6.54	6.58	111.71	110.94	31.83	24.88	98.10	90.59
HG 314 × HG 79-1-5	12.31	10.14	38.02	36.69	5.95	6.69	116.44	110.28	35.88	28.40	84.64	80.73
HG 75 × CP 68	41.99	39.34	32.35	19.37	52.60	47.43	86.33	73.48	8.38	10.37	5.25	4.81

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Crosses	Days to flowering				Days to maturity				Plant height			
	CV		Mean		CV		Mean		CV		Mean	
	F_2	F_2M_2	F_2M_2	F_2M_2	F_2	F_2M_2	F_2	F_2M_2	F_2	F_2M_2	F2	F_2M_2
HG 75 x PLG 85	54.05	52.18	17.41	14.62	48.59	60.44	69.97	62.28	6.98	9.24	5.44	4.30
HG 75 x FS 277	48.56	53.33	14.27	15.47	49.12	53.30	92.10	55.38	8.53	10.77	5.51	5.07
HG 75 x HG 314	49.14	63.46	16.24	14.04	50.82	65.55	68.97	58.70	11.55	9.84	5.85	5.13
HG 75 x HG 79-1-5	51.02	54.56	35.60	19.17	61.37	66.19	94.24	66.69	7.88	9.70	5.33	4.86
CP 68 x PLG 85	53.77	67.14	17.39	13.97	57.65	59.19	73.3	68.53	11.30	14.20	5.31	4.93
CP 68 x FS 277	38.94	83.77	29.79	13.93	50.77	74.82	95.58	61.64	7.34	12.71	5.77	5.03
CP 68 x HG 314	65.44	49.88	19.88	16.86	68.31	53.47	77.69	66.43	8.60	8.51	5.23	4.79
CP 68 x HG 79-1-5	44.92	49.08	40.31	19.64	53.70	73.21	84.26	68.34	8.98	13.17	5.12	5.01
PLG 85 x FS 277	43.08	42.76	12.51	14.50	47.07	61.46	54.41	63.91	8.92	7.62	5.49	5.25
PLG 85 x HF 314	36.76	30.79	14.99	17.57	41.98	36.08	65.81	85.86	8.13	11.41	5.41	5.06
PLG 85 x HG 79-1-5	27.97	46.73	20.84	19.73	42.73	51.66	85.87	81.32	7.82	10.37	5.50	5.00
FS 277 x HG 314	46.00	57.97	9.00	10.04	58.29	60.46	54.19	64.16	9.14	17.66	5.68	4.71
FS 277 x HG 314	46.00	57.97	9.00	10.04	58.29	60.46	54.19	64.16	9.14	17.66	5.68	4.71
FS 277 x HG 79-1-5	56.44	60.74	16.58	15.8	52.82	48.80	78.97	63.46	8.76	10.63	5.60	5.17
HG 314 x HG 79-1-5	64.65	49.93	21.02	22.27	56.71	53.98	81.11	80.53	9.66	10.12	5.28	5.04
HG 75 x CP 68	8.63	11.27	7.99	6.81	13.08	15.04	2.37	2.46	46.29	59.32	10.78	11.21
HG 75 x PLG 85	10.74	11.32	8.01	5.78	12.14	14.22	2.06	2.32	40.14	66.23	9.64	9.86

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Crosses	Days to flowering				Days to maturity				Plant height			
	CV		Mean		CV		Mean		CV		Mean	
	F_2	F_2M_2	F_2M_2	F_2M_2	F_2	F_2M_2	F_2	F_2M_2	F_2	F_2M_2	F2	F_2M_2
HG 75 × Fs 277	9.21	13.61	7.82	6.84	16.37	10.39	2.26	2.31	53.75	44.85	13.88	9.61
HG 75 × HG 314	13.02	12.21	7.37	6.87	12.07	13.48	2.32	2.30	59.44	55.69	9.37	9.84
HG 75 × HG 79-1-5	9.26	11.24	7.99	6.83	14.41	15.58	2.29	2.31	69.15	57.78	14.62	10.28
CP 68 × PLG 85	11.56	17.27	7.35	7.00	12.99	15.87	2.54	2.52	54.07	60.64	10.08	9.30
CP 68 × FS 277	9.38	13.87	7.89	7.16	14.24	20.15	2.63	2.88	42.52	62.08	17.12	11.63
CP 68 × HG 314	12.69	9.74	7.72	6.80	9.79	16.47	2.45	2.61	62.41	60.50	12.13	13.90
CP 68 × HG 79-1-5	11.14	14.25	7.90	7.14	11.07	15.32	2.35	2.48	53.60	66.29	20.37	9.82
PLG 85 × FS 277	9.73	11.19	8.32	7.36	23.45	22.37	2.09	2.28	40.19	44.18	8.21	10.39
PLG 85 × HG 314	8.84	15.20	8.03	7.13	16.75	17.80	2.03	2.19	42.39	41.71	9.20	11.89
PLG 85 × HG 79-1-5	8.60	9.16	8.14	7.50	15.71	13.55	2.10	2.14	42.55	54.12	10.73	11.64
FS 277 × HG 314	12.11	23.66	8.01	6.93	16.20	21.20	2.53	2.83	63.10	47.57	10.92	10.72
FS 277 × HG 79-1-5	11.08	15.36	7.94	7.15	12.74	17.05	2.59	2.58	57.55	40.80	11.54	9.73
HG 314 × HG 79-1-5	10.30	15.85	7.77	6.88	17.45	13.62	2.12	2.35	56.98	46.49	11.53	11.83

and by hybridization were not always cummulative as has been reported by Gupta and Virk (1977), Virk *et al.* (1978) and Virupakshappa *et al.* (1980).

The heritability estimates in broad sense coupled with genetic advance were found to be higher for number of clusters and seed yield per plant in F_1, F_1M_1 and F_2 generations, for number of pods per plant in F_1 and F_1M_1 generations while for remaining characters the vlaues for genetic advance were less. Krull and Frey (1961) also reported that variability caused by irradiation in oats was equally heritable as that arising through hybridization.

A comparison of coefficient of variability (c.v.) within F_2 and F_2M_2 generations for each cross (Table 2) denoted that majority of the crosses had an increase in c.v. ov F_2M_2 generation. This increase was of considerable magnitude in some crosses whereas in other crosses a decrease in c.v. was observed, hence the changes observed were genotypes and character specific. This could be attributed to the differential radio-sensitivity of the genotypes (Crosses) and the trait under study which influences not only the total rate but also the spectrum of recoverable mutations. The influence of a particular genotypes on the mutation spectrum is rather unpredictable (Borojeciv *et al.*, 1977).

The increase in variability (cv.) in F_2M_2 over its control counterpart could be due to micromutations, enhanced recombination resulting from increased crossing-over among linked loci or an increase in somatic crossingover and breakage of tightly linked regions and permitting higher crossing over within those regions which as a whole results in the release of additional genetic variability. In some crosses, the decrease in coefficient of variation could be attributed to either experimentation techniques such as sample size and sampling error or biological reasons suh as antagonism of variability released by recombination in otherwise unirradiated set.

There were a few crosses for each character which exhibited an increase in both mean performance and coefficient of variation in F_2M_2 over F_2. For seed yield HG 75 × CP 68 and PLG 85 × HG 79-1-5 and for 100-seed mass HG 75 x *cp* 68, HG 75 × PLG 85 and CP 68 × FS 277 were included in this category. These crosses can be exploited for harnessing of their desired variability in future guar breeding programmes including intermating and selection in succeeding generation.

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