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VARIATION IN SOME QUANTITATIVE CHARACTERS OF *Pisum sativum* L. AFTER SEED IRRADIATION

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Pea seed soaked in distilled water for different intervals (0,12,24,36,48,60 and 72 hours) were irradiated with different doses of gamma irradiation (0, 5, 10 and 15 KR). Lesser period of seed soaking resulted in higher germination and early flowering than prolonged period of soaking and no soaking (0 hour). Seed soaking treatments for plant height, number of pods/plant, 100-seed weight and seed yield/plant were found to be non-significant. Gamma irradiation decreased germination percentage, number of pods/plant, number of seeds per pod and seed yield/plant while number of days taken for flowering, plant height and 100–seed weight were found to increase with the increasing dose of gamma irradiation. Interaction between seed soaking and gamma irradiation treatment was found to be significant for germination percentage and number of seeds/pod suggesting that different seed soaking treatments reacted differently to gamma irradiation.

INTRODUCTION

Improvement of any crop can be affected easily through the availability of variation in gene pool. Conventional plant breeding techniques undoubtedly have exerted lot of scope for improving the present pea varieties but narrow range of genetic variability is the main hurdle in this important vegetable. Mutation breeding offers an attractive alternative to conventional breeding for creating the genetic variability to evolve high yielding varieties having desired plant type. Akilov (1966) observed increase in plant height and reduction in number of pods in M1, when seeds of three soybean varieties were irradiated with gamma rays (Co^{60}) prior to sowing. Germination and seedling vigour was found to be reduced by gamma irradiation when seed of four pea cultivars were treated with ethyleneimine and gamma rays (Sidorova *et al.*, 1966). Response of 24 pea varieties was investigated by Monti and Donini (1968), subjecting them to 34 different exposure rates ranging 5–200 R/d. After two weeks, all lines clearly showed delay in flowering. Delay in flowering has also been observed by Bajaj *et al.* (1970) in *Phaseolus vulgaris* L. when seed was irradiated with 10–12 KR of gamma rays. Rubaihayo (1975) observed increased plant height and 100–seed weight but decreased yield in M1, after irradiation of *Phaseolus vulgaris* L. seed with 7–12 KR of gamma rays. Decrease in germination percentage and number of pods per plant has also been reported by El–Shhar *et al.* (1986) in pea cultivars 'Calland' and 'Hampton' when seed was exposed to 8 doses (2.5 – 40 Krad) of gamma rays or soaked in 8 doses (0.1 – 1.5 %) of EMS.

MATERIALS AND METHODS

Seed of pea variety, Green Feast were soaked for different intervals to represent different soaking conditions. Soaking treatments included 0(S0), 12(S1), 24(S2), 36(S3), 48(S4), 60(S5) and 72(S6) hours soaking in distilled water. Soaked seeds were then irradiated with gamma rays using Co^{60} as a radiation source at NIAB, Faisalabad, in various doses like 0(G0), 5(G1), 10(G2) and 15 KR (G3). Treated seed were then planted in germination trays. After 14 days when germination was almost completed, seedlings were transplanted in field in a randomized complete block design with factorial arrangement in three replications, keeping plant to plant and bed to bed distance of 10 and 105 cm, respectively. The net plot size measured 2.5 x 1.05 m^2. Data on different growth and yield characters were collected and analysed statistically (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Mean squares from the analysis of variance of seven traits of Green Feast Pea variety treated with different seed soaking and gamma rays treatments are given in Table 1. Significant results for control vs treatments (single degree contrast) were observed for all the traits indicated in Table 1 except plant height. Among seed soaking treatments, significant differences existed for germination percentage, days to flower, and number of seeds per pod. However, all the plant traits evaluated indicated significant differences among gamma rays treatments. The seed soaking x gamma rays interaction was significant for germination percentage and number of seeds per pod (Table 1). This indicated that seed soaking and gamma rays treatments are not independent of one another.

Seed soaking treatments mean (Table 2) revealed that less intensity of soaking (12, 24, and 36 hours) provided higher germination percentage than high intensity of seed soaking (48, 60 and 72 hours). Dried seed or no soaking (control) resulted in poorest germination of 63.1 percent and differed significantly from all other soaking treatments. Moisture is needed as a stimulant for seed germination. Prolonged seed soaking (60 and 72 hours) might have diluted the cotyledon solution and joined hands with no soaking. Higher doses of gamma rays irradiation adversely affected the seed germination percentage (Table 3). Germination percentage was found to be decreased as dose of gamma irradiation increased. Among gamma rays doses, control (0 KR) presented the maximum seed germination of 95.3 percent. These results are in agreement with the findings of Sidorova *et al.* (1966) and El-Sahhar *et al.* (1986). Decrease in seed germination percentage may be attributed to the assumption that higher doses of gamma irradiation may inhibit mitotic cell division which leads to reduced germination.

Data on mean number of days taken to flower (Table 2) indicated that lesser period of seed soaking (12,24,36 and 48 hours) resulted in early flowering. Whereas prolonged soaking (60 and 72 hours) and no soaking (control) took greater number of days for flowering. These soaking treatments appear to have imparted initial advantage of plant development, so that plants were in a position to complete growth factors earlier than other treatments. Gamma rays of 15 KR took significantly greater number of days to flower (76.6 days), followed by 10 KR (72.9 days) as evident in Table 3. No significant difference was observed between control (0 KR) and 5 KR. However, both resulted in early flowering of 69.7 and 70.1 days, respectively. In general, the flowering was delayed as the gamma rays irradiation increased. These results are in accordance with the findings of Monti and Donini (1968) and Bajaj *et al.* (1970). The plant hormone 'florigin' is supposed to be responsible for flowering. The present study revealed that the production of this hormone is likely to be influenced with higher doses of gamma irradiation resulting in delayed flowering.

Higher doses of gamma rays (10 and 15 KR) presented significantly greater plant height than the lower doses. 10 and 15 KR doses of gamma rays stood at par with one another but ousted the control (0 KR) and 5 KR which in turn exhibited statistical similarity (Table 3). Plant height increased with the increase in gamma rays dose. Similar results have been reported by Akilov (1966)

Table 1. Mean squares from the analysis of variance of seven traits of Green Feast Variety of pea treated with different seed soaking and gamma rays treatments.

S.O.V.	D.F.	Germination percentage	Days to flower	Plant height (cm)	Number of pods per plant	Number of seeds per pod	100–grain weight (g)	Seed yield per plant (g)
Replication	2	4.131	2.182	24.853	326.896**	1.561**	17.472**	146.543**
Control vs Treatment	1	807.310**	35.870*	3.560	112.750*	2.760**	19.450**	76.620*
Soaking	6	117.092*	43.349**	22.368	16.086	0.587*	1.176	17.261
Gamma rays	2	3315.933**	224.873**	168.821**	208.966**	6.973**	11.324**	309.499**
S X G	12	225.406**	13.040	24.036	16.821	0.464*	1.899	18.916
Error	42	44.693	7.102	14.893	17.155	0.229	1.334	14.717

*,** Significant at the 0.05 and 0.01 probability levels, repectively.

Table 2. Means for seven traits of Green Feast variety of pea averaged across three doses of gamma rays.

Seed soaking Treatments	Germination percentage	Days to flower	Plant height (cm)	Number of pods per plant	Number of seeds per pod	100–seed weight (g)	Seed yield per plant (g)
0 hours (control)	63.1 b*	76.8 a	55.1	20.1	4.45 b	16.54	15.1
12 hours (S1)	80.4 a	72.3 cd	54.7	22.1	5.11 a	17.16	19.1
24 hours (S2)	79.6 a	70.2 d	53.2	20.0	4.86 ab	17.31	16.9
36 hours (S3)	77.6 a	72.2 cd	50.6	18.7	5.00 a	16.52	15.5
48 hours (S4)	74.0 a	72.2 cd	52.6	18.0	5.16 a	16.72	15.4
60 hours (S5)	70.4 ab	73.3 bc	54.7	20.2	4.74 ab	16.72	16.3
72 hours (S6)	73.6 ab	75.3 ab	53.1	18.9	4.66 ab	17.37	15.6

* Means within a column followed by the same letter are not significantly different at $P = 0.05$ according to Duncan's MRT.

Table 3. Means for seven traits of Green Feast variety of pea averaged across seed soaking treatments.

Treatments	Germination Percentage	Days to flower	Plant height (cm)	Number of pods per plant	Number of seeds per pod	100-seed weight (g)	Seed yield per plant (g)
0 KR (control)	95.3 a*	69.7 c	52.3 bc	26.0 a	5.83 a	14.30 c	21.5 a
5 KR (G1)	89.5 b	70.1 c	50.2 c	22.2 b	5.42 b	16.06 b	19.3 ab
10 KR (G2)	78.4 c	72.9 b	54.4 ab	20.9 b	4.86 c	17.39 a	17.6 b
15 KR (G3)	54.4 d	76.6 a	55.6 a	16.2 c	4.27 d	17.26 a	11.9 c

* Means within a column followed by the same letter are not significantly different at $P = 0.05$ according to Duncan' s MRT.

in soybean and Rubaihayo (1975) in beans. This increase in plant height may be due to residual effect of gamma rays which cause destruction of an inhibitor or release of an activator which may increase the rate of cell division or cell elongation.

The control treatment (0 KR) of gamma rays was found to be superior for number of pods per plant (Table 3). This treatment proved statistically better than all other treatments. However, 5 KR and 10 KR doses were non–significant from each other. Minimum number of pods per plant (16.2) were recorded from the plants treated with 15 KR gamma irradiation. In general, pea seeds treated with lower doses of gamma irradiation proved better than treated with higher doses. Akilov (1966) and El–Sahhar *et al.* (1986) observed decrease in pod number in M_1. One logical reason for decreased pod number could be an increased flower abscission due to physiological or hormonal imbalance created by irradiation which resulted reduced pod number per plant.

The data on mean number of seeds per pod (Table 2) revealed significant superiority of soaking treatments over non–soaking (control). However, control treatment of gamma radiation expressed pre–dominance over the G_1 which, in turn, was superior to G_2 (Table 3). The lowest number of seeds per pod were obtained from pea plants treated with 15 KR gamma irradiation. Mean number of seeds per pod decreased with the increase in dosage of gamma rays. Thus confirming the findings of Akilov (1966), Balint *et al.* (1970) and El–Sahhar *et al.* (1986) who observed reduction in number of seeds after irradiating the seed with ionizing radiations.

Seed weight and seed size depends on the number of seeds per pod and their subsequent development. The pods that contained lesser number of seeds are likely develop more properly barring of the deleterious effect of any treatment. Present studies revealed that increased doses of gamma rays (10 and 15 KR) did not influence the 100–seed weight. These two doses were statistically significant from control and 5 KR (Table 3). Control treatment (0 KR) of gamma radiation had the lighter 100–seed weight of 14.30 grams. These studies corroborate with the findings of Akilov (1966) and Muresan *et al.* (1984).

Yield is the result of number of components of growth factors and it cannot be pinned out to the action of any single specfic growth factor. It was observed that lower doses of gamma irradiation (0 and 5 KR) presented better results for seed yield per plant (Table 3). Likewise, no significant difference could be located between 10 and 15 KR. A general trend observed was that the increased dose of gamma irradiation reduced the seed yield per plant. Decrease in yield has also been reported in field bean (Rubaihayo, 1975) as a result of gamma irradiation. This decrease in yield may be attributed to decrease in pod number per plant.

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