OnLine Journal of Biological Sciences 1 (9): 805-808, 2001

Induced Mutation Studies in Some Mungbean *(Vigna radiata* L.)wilczek Cultivars

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Abstract: The induced mutation through different gamma irradiation frequencies viz. 100, 200, 300, 400 and 500 Gy in some agronomic traits of five mungbean cultivars was studied for consecutive three years. A wide range of variability exist in all the characters except plant height. The genotypic effect on days to flowering, days to maturity, plant height, number of branches, number of pods and number of clusters ranged from 43.82. to 44.96 days, 87.60 to 91.75 days, 42.16 to 51.61 cm, 1.83 to 2.07, 16.97 to 21.46 and 4.44 to 5.56 respectively. Similarly, mutagenic effects on days to 50% flowering, days for maturity, plant height, number of branches, number of pods and number of clusters ranged from 44.05 to 45.62 days, 88.62 to 91.83 days, 47.07 to 48.43 cm, 1.62 to 2.00, 17 to 22.30 and 4.53 to 5.50 respectively. The genotype X dose interaction were highly significant for days to 50% flowering, maturity, number of branches and clusters and non-significant for plant height and number of pods.

Key words: Induced mutation, mungbean, cultivars.

Introduction

Variability, the base of crop improvement, can be quickly brought about through induced mutagenesis. The possibility of using gamma rays as a physical agent for creating hereditary changes in desirable characters in crop plant has been reported by the earlier workers. Consequently, the high yielding varieties of gram (CM-72, NIFA-88), cotton (NIAB-78) and other crops have been developed through gamma rays which act as an effective alternate method to conventional breeding. Gamma irradiation as a mutagen can induce useful as well as harmful mutation in plants. It is therefore, necessary to predict the most beneficial dose of gamma rays for improvement of specific traits of crop plants. Several attempts in this regards have been made to evolve the desirable plants by using physical and chemical mutagen. Singh and Chaturvedy (1981) and Khalil *et al.* (1987) reported late flowering mutants in mungbean and soybean respectively. Wazir (1986) in wheat and Haq (1990) in chickpea reported early flowering and short statured mutants. Chaudhry (1988), Haq (1990) and Khan (1990) also reported delay in maturity in various pulse crops due to gamma rays. Kharkwal (1982); Hassan *et al.* (1986a), Chaudhry (1988) and Singh and Yadev (1991) have reported the improvement in number of branches and pods due to the effect of mutagen in various pulses. Similarly, Singh *et al.* (1981) and Chaudhry (1988) have shown the increase in number of clusters in different food legume mutants. Sharma and Sharma (1982); Dixit and Dubey (1986) and Khan (1990) found reduction in number of pods and short stature mutants in various pulse crops. Khan (1989) reported lowest number of clusters in some mutagenized plant of pulses. They attribute the desirable mutation in mungbean due to effect of various doses of gamma rays. The study was made to find out more about the effect of gamma rays on various plant characteristics to improve the quality of five currently available cultivars of mungbean.

Materials and Methods

Seeds of five different cultivars of mungbean (*Vigna radiata* L. wilczek) namely, NM-19-19, M-22-24, M-29-37, M-38-54 and M-133-100 were exposed to gamma irradiation with 100, 200, 300, 400 and 500 Gy. The Gamma irradiation was carried out at Nuclear Institute For Food and Agriculture (NIFA), Tarnab, Peshawar in a Cobalt^{60} gamma cell.
Moisture content of seed at the time of irradiation was 12%. The experiment was conducted in the Research Area of Department of Plant Breeding and Genetics, Faculty of Agriculture, Gomal University, D.IKhan. Treated and untreated seeds (control) were sown in field manually with a single row hand drill during second week of July, 1990. The experiment was laid out in Randomized Complete Block Design with a split plot arrangement. The cultivars were assigned the main plots while, the irradiation doses including checks were kept in sub-plots. Each sub-plot measured 4 X 1.80 m^2 comprising six rows spaced at the distance of 30 cm. The ultimate plant to plant distance was maintained at 10 cm apart. A basal dose of N : P fertilizer @ 20:50 kg ha^{-1} was applied before planting. Irrigation, hoeing and weeding was uniformly done in all the treatments.
The data were recorded on various plant parameters like, days to 50% flowering, days to maturity, plant height, number of branches, number of pods and number of clusters. The data were subjected to statistical analysis with the help of computer's package MSTAT-C.

Results and Discussion

All the traits except number of branches were highly significant affected (P>0.01) due to genotypes. While, variation in number of branches was only significant (P>0.05). The gamma irradiation effects showed highly significant variability (P>0.01) in all the characters except plant height (P<0.05). Similarly, genotypic-cum-dose interaction indicated that days to 50% flowering, days to maturity, number of branches, and number of clusters were highly significant (P>0.01), while non-significant (P<0.05) effect was exhibited in plant height and number of pods (Appendix-I)

Days to 50% flowering: The means regarding the main varietal effects revealed that 50% flowering ranged from 43.82 to 44.96 days. The cultivar M-19-19 appeared one of the early flowering completing its 50% flowering within 43.82 days. While cultivar M-38-54 being the late one, completed 50% flowering in 44.96 days (Table 1).
The main effect of gamma rays irradiation revealed that the period of 50% flowering varied from 44.05 to 45.62 days. A thorough study of the means as effected by gamma rays irradiation revealed that flowering period in mungbean crop increased linearly with increasing irradiation frequencies.
The interaction between genotypes and doses indicated that response of various cultivars to gamma rays was differential in nature. The dose of 10 K-rad exerted stimulating effect on all the genotypes except NM-19-19 as far as days to 50%

Table 1: Genotype x Dose interaction for days to 50% Flowering in M_1 Generation of mungbean (irrigated)Gamma Rays (K-rad)

Genotypes	0	100	200	300	400	500	Means
M-29-37	44.42	44.17	45.67	44.83	43.17	45.92	44.69BC
M-19-19	43.25	44.08	43.56	43.33	43.83	44.92	43.82 C
M-22-24	42.90	44.83	45.58	45.92	45.08	45.00	44.56BC
M-133-100	44.25	43.58	44.42	44.58	46.42	45.83	44.85AB
M-38-54	46.17	45.58	45.17	46.25	46.17	46.42	44.96A
Means	44.20 C	44.05C	44.87B	44.98B	44.93B	45.62A	

Table 2: Genotype X Dose Interaction for Days Maturity in M_1 Generation of Mungbean (Irrigated) Gamma Rays (K-rad)

Genotypes	0	100	200	300	400	500	Means
M-29-37	92.25	90.58	92.33	90.00	87.17	89.75	90.35B
M-19-19	90.33	89.58	88.67	94.00	90.67	90.58	90.64AB
M-22-24	88.67	90.75	88.33	92.00	84.33	83.50	87.60C
M-133-100	85.25	89.08	91.92	92.25	92.17	89.00	89.84B
M-38-54	93.25	90.67	92.33	92.92	91.08	90.25	91.75A
Means	89.95BC	90.13BC	90.72AB	91.83A	89.08CD	88.62D	

The means sharing common letter(s) do not differ significantly at 5% level of probability.

Table 3: Genotype X Dose Interaction for Plant Height in M_1 Generation of Mungbean (Irrigated)gamma Rays (K-rad)

Genotypes	0	100	200	300	400	500	Means
M-29-37	49.57	53.43	52.19	49.26	48.16	46.57	49.93A
M-19-19	52.95	47.16	53.69	51.30	47.83	56.73	51.61A
M-22-24	39.92	41.24	42.67	40.79	43.90	44.43	42.16C
M-133-100	45.33	48.24	44.53	47.74	49.38	44.65	46.64B
M-38-54	50.22	49.55	51.56	48.50	49.12	48.00	49.49A
Means	47.07	47.92	48.43	47.52	47.67	48.07	

Table 4: Genotype X Dose Interaction for Number of Branches in M_1 Generation of Mungbean (Irrigated)gamma Rays (K-rad)

Genotypes	0	100	200	300	400	500	Means
M-29-37	1.58	1.78	1.80	2.24	1.93	1.77	1.85BC
M-19-19	1.49	1.80	1.82	1.93	2.25	2.38	1.94AB
M-22-24	1.62	1.72	2.01	2.18	1.62	1.59	1.88BC
M-133-100	1.44	1.76	1.94	2.05	1.78	2.02	1.83C
M-38-54	1.95	1.83	2.06	2.25	2.14	2.19	2.07A
Means.	1.62BC	1.78BC	1.92AB	2.13A	1.94AB	2.00A	

The means sharing common letter(s) do not differ significantly at 5% level of probability.

Table 5: Genotype X Dose Interaction for Number of Pods in M_1 Generation of Mungbean (Irrigated)gamma Rays (K-rad)

Genotypes	0	100	200	300	400	500	Means
M-29-37	17.7	20.9	19.8	23.3	24.6	22.5	21.46A
M-19-19	18.0	18.1	19.6	20.6	20.8	23.1	20.03A
M-22-24	16.0	14.8	19.5	18.2	19.1	14.2	16.97B
M-133-100	16.3	16.9	19.5	20.5	26.1	23.9	20.54A
M-38-54	16.8	18.3	21.1	21.3	21.0	21.9	20.07A
Means	17.0D	17.8D	20.0BC	20.8AB	22.3A	21.1AB	

Table 6: Genotype X Dose Interaction for Number of Clusters in M_1 Generation of Mungbean (Irrigated) Gamma Rays (K-rad)

Genotypes	0	100	200	300	400	500	Means
M-29-37	5.29	5.60	5.05	5.35	6.28	5.78	5.56A
M-19-19	4.68	5.36	4.90	4.60	5.58	5.98	5.18AB
M-22-24	5.81	4.08	4.33	4.74	4.87	3.78	4.44C
M-133-100	3.43	4.23	4.21	5.04	4.85	6.74	4.75BC
M-38-54	4.41	5.27	5.80	5.40	3.98	5.20	5.02AB
Means	4.53C	4.91BC	4.86BC	5.03B	5.11B	5.50A	

The means sharing common letter(s) do not differ significantly at 5% level of probability.

flowering is concerned. While 50 K-rad dose had shown inhibitory effect on flowering in M-29-37, NM-19-19 and M-38-54. In these cultivars the flowering was completed in 45.92, 44.92 and 46.42 days respectively. Similarly, in case of M-22-24 and M-133-100 the inhibition was observed at 300 and 400Gy doses. All the doses of gamma rays inhibited the flowering in M-22-24. A linear increase in days to flowering have been reported by Singh and Chatervedi (1981) in mungbean and Khalil *et al.* (1987) in soybean. However, the exception from the above rule have been reported by Haq (1990) in chickpea who observed early flowering mutants in his studies.

Appendix I: Analysis of Variance in Mungbean as Affected by Genotypes and Gamma Rays

S. O. V.	D. F.	DFE 50% flowering	Days to Maturity	Plant Height	No. of Branches	No. of Pods	No. of clusters
Replications	3	3.57	42.73	151.47	0.206	27.776	0.678
Years	2	22.03^{NS}	47.803^{NS}	211.17^{NS}	3.754^{**}	312.65^{*}	15.856^{*}
Error (a)	6	6.63	28.714	80.014	0.27	39.507	2.274
Genotypes	4	42.72^{**}	168.34^{**}	988.89^{**}	0.917^{*}	206.51^{**}	13.019^{**}
Year X Genotypes	8	7.92^{NS}	47.074^{*}	41.863^{NS}	0.654^{*}	180.78^{*}	6.552^{*}
Error (b)	36	7.10	17.07	67.402	0.290	46.20	2.839
Doses	5	19.69^{**}	79.56^{**}	15.686^{NS}	1.906^{**}	253.15^{**}	6.055^{**}
Year x Doses	10	5.617^{*}	27.56^{*}	96.613^{NS}	0.466^{*}	100.24^{**}	1.584^{NS}
Genotypes x Doses	20	8.825^{**}	55.16^{**}	82.817^{NS}	0.398^{**}	38.98^{NS}	5.693^{**}
Year x Gen X Doses	40	7.89^{**}	17.569^{*}	58.01^{NS}	0.245^{NS}	71.06^{**}	3.943^{*}
Error ©	225	2.620	11.604	60.578	0.163	37.04	1.141
Total	359	---	---	---	---	---	
CV %		3.61	3.78	16.32	21.27	30.72	21.42

* = Significant, ** = Highly significant, NS = Non-significant

Days to maturity: Maturity period ranged from 87.60 to 91.75 days depending upon the genetic architecture of varieties. The cultivar M-22-24 took significantly short period from rest of the cultivars and matured in 87.60 days. While cultivar M-38-54 appeared late maturing and required 91.75 days for its maturity (Table 2).

The effect of different gamma ray frequencies on the days to maturity revealed that maturity period ranged from 88.62 to 91.83 days. It is evident that higher frequencies of gamma rays produced early maturing plants and conversely the lower doses induced late maturity in mungbean genotypes (Table 2).

In case of interaction between genotypes and doses, as compared to control, the cultivar M-29-37 (except with 200 Gy) and M-38-54 with all the irradiation doses showed stimulating effect on the crop maturity. Maximum stimulation of 5.83% and 5.51% occurred in M-22-24 and M-29-37 with 500 and 400 Gy doses respectively (Table 2). Similarly 500 Gy dose also stimulated the maturity in M-29-37 (2.71%) and M-38-54 (3.22%).The inhibitory effect on crop maturity with 300 Gy was noted in cultivar M-133-100 (8.2%) and NM-19-19 (4.1%) and the same with 100 Gy was noted in cultivar M-22-24 (Table 2). These findings contradicted with Chaudhry (1988), Haq (1990) and Khan (1990) who observed linearly delay in maturity of various legume crop when treated with gamma rays. The differences in the results could be attributed to different genetic materials used and grown in different set of environmental conditions.

Plant height: Plant height varied from cultivar to cultivar and it ranged from 42.16 to 51.61 cm (Table 3). NM-19-19 was appeared as tallest variety showing a height of 51.61 cm followed by the cultivars M-29-37 and M-38-54 with the heights of 49.93 and 49.49 cm respectively.

With regard to irradiation effect on the plant height, the differences in mean values were not enough to reach the level of significance (Appendix-I). However, plant height ranged from 47.52 with 300 Gy to 48.93 with 200 Gy dose. Similarly the interaction effect on the height of plant in M_1 generation of mungbean was also insignificant. The significant reduction in plant height has been previously reported in lentil (Sharma and Sharma, 1982 and Dixit and Dubey, 1986), wheat and triticale (Wazir, 1986), mungbean (Chaudhry, 1988) and chickpea (Haq, 1990). The deviation in the results could be attributed to different genetic materials used which were grown under different environmental conditions.

Number of branches: The number of branches ranged from 1.83 to 2.07 in the under study cultivars. Highest number of branches (2.07) were produced by cultivar M-38-54 which were statistically significant from all the other cultivars (Table 4).

The means concerning the main irradiation effect showed a linear increase with increase in number of branches by gamma rays frequencies (Table 4). The maximum stimulating effect on number of branches was observed with 300 and 500 Gy doses showing 23.94% and 19.00% respectively increase as compared to control. The effect of both the treatments was however, statistically insignificant to the effect of 200 and 400 Gy doses respectively showing 15.62% and 16.49% increase over control (Table 4).

The means regarding varietal-cum-dose interaction revealed that varietal response to different gamma rays was identical. All the cultivars except M-38-54 (with 100Gy) showed stimulating effect on number of branches per plant. The enhancement ranged from 5.81% with 100 Gy in cultivar M-22-24 to 37.39% with 500 Gy in cultivar NM-19-19. The doses of 30 K-rad showed maximum stimulating effect on cultivars M-29-37, M-22-24, M-133-100 and M-38-54 showing an increase of 29.92%, 25.69%, 29.76 and 13.33% as compared to their respective controls respectively. Negative effect of gamma rays was observed only in cultivar M-22-24 and M-38-54 with 500 and 100 Gy showing 1.89% and 6.56% reduction in number of branches as compared to their respective control (Table 4). These results are in agreement with the findings of Kharkwal (1982) in gram, Singh and Yadav (1991), Hassan (1986a) and Chaudhry (1988) all in mungbean.

Number of pods: The means concerning the main genotypic effect revealed that number of pods ranged from 16.97 to 21.46 per plant. Numerically the highest number of pods (21.46) were observed in cultivar M-29-37. It however remained statistically insignificant to the cultivars M-133-100, M-38-54 and NM-19-19 showing 20.54, 20.07 and 20.03 pods per plant respectively (Table 5). The number of pods linearly increased with increase in dose of gamma rays (Table 5). The maximum stimulating effect of pod development was observed with 400 Gy where 31.17% increase was observed. It was followed by 300 and 500 Gy doses showing respectively 22.35% and 24.11% more pods than control. The number of pods were stimulated at all dose levels of doses even the lower dose of 100 Gy showed 4.7% increase over control.

The interaction effect revealed that in all the cultivars pod number increased with all the dose of gamma radiation. However, the differences were not significant statistically. The cultivars M-29-37 and M-33-100 produced as high as 24.60 and 26.10 pods per plant with 400 Gy dose as compared to 17.70 and 16.30 pods in control respectively (Table 5).These results well coincide with Hassan (1986b) and Chaudhry (1988), Singh and Yadava (1991) in mungbean, Kharkwal (1982) in gram. They have reported that number of pods increased in various pulse crops with 40 K-rad dose. However, the findings of Sharma and Sharma (1982) and Dixit and Dubey (1986) and Khan *et al.* (1990) in lentil contradict the findings of the present study. According to them the number of pods decrease at higher doses of gamma rays. The differences could be due to various environmental conditions and divergent genotypes included in these studies.

Number of clusters per plant: The main varietal effect showed that number of clusters ranged from 4.44 to 5.56 per plant. The cultivar M-29-37 produced maximum clusters (5.56) and surpassed all the cultivars under study. It was however, statistically insignificant when compared to NM-19-19 and M-38-54 producing 5.18 and 5.02 clusters per plant respectively (Table 6).

The individual comparison between the means of gamma rays effects reveal that clusters ranged from 4.53 to 5.50 per plant. A linear stimulation in number of clusters in mungbean was observed with increase in dose of gamma rays. Maximum stimulation (22.35%) was observed with 500 Gy which was significantly highest. It was followed by 400, 300, and 100 Gy doses respectively showing 12.80%, 11.04% and 8.39% increase as against check (Table 6).

In case of genotype-cum-dose interaction, a differential response of different mungbean varieties to gamma irradiation was noted. The cultivar NM-19-19 and M-133-100 exhibited maximum stimulation of 27.78% and 96.50% respectively with 500 Gy dose. While maximum stimulation was observed in cultivar M-29-37 (18.71%) and M-38-54 (30.04%) with 400 and 200 Gy dose respectively. The cultivar M-22-24 showed interesting response to gamma rays. Unlike other cultivars, the number of clusters per plant were reduced at all the frequencies of gamma rays. The irradiation adversely affected the number of clusters in M-22-24 with no stimulatory effect. Maximum reduction of 34.93% was observed with 50 Gy dose. Singh *et al.* (1980); Chaudhry (1988) and Malik *et al.* (1988) found same results in mungbean.

In foregoing discussion it has been observed that desirable mutation/variability in mungbean crop can be possibly created through the gamma rays. Effect of gamma rays was genotype specific for various plant parameters. It is, therefore, suggested that various traits can be improved in various genotypes through variable gamma rays doses.

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