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UTILIZATION OF GAMMA IRRADIATION FOR THE GENETIC IMPROVEMENT OF ORIENTAL MUSTARD (*BRASSICA JUNCEA* COSS.)

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Abstract

Homogeneous seeds of Oriental mustard cv. Agati Sarhein (*Brassica juncea* Coss.) were treated with different doses of gamma rays (750 to 1250 Gy) to induced genetic variability for the selection of genotypes with improved agronomic traits. Seventy-five useful mutants selected from M_2 generation were tested in progeny rows to confirm the stability of genetically altered economic traits in M_3 generation. Thirteen mutants with promising performance for yield and yield components were evaluated in preliminary yield trial. Five mutants produced significantly ($P \leq 0.05$) higher yield than parent.

Introduction

Rapeseed and mustard is an important oilseed crop of Pakistan. It is grown over an area of 339.5 thousand hectares with 291.5 thousand tonnes of production having an average yield of 85.9 kg per hectare (Anon., 1998). The yield is very low as compared with other oilseed producing countries in the world mainly due to non-availability of high yielding varieties of rapeseed and mustard.

Induction of genetic variability is pre-requisite for the evolution of high yielding varieties. Induced mutation has been extensively used for creating new genetic variation in crop plants. A large number of mutant varieties of different crops with improved agronomic traits have been released to the farmers for general cultivation in the world (Micke *et al.*, 1993). Mutagenesis has also been very successfully employed in rapeseed and mustard by the plant breeders to alter the genetic architecture of plants and isolate the mutants with desired economic characters such as plant height, number of pods per plant, number of grains per pod, 1000-grain weight, grain yield, oil content and disease resistance (Anon., 1997; Mahla *et al.*, 1990, 1991; Rahman *et al.*, 1987; Rahman, 1996; Shah *et al.*, 1990, 1998, 1999). Studies wre carried out to develop the high yielding mutants of oriental mustard cv. Agati Sarhein (*Brassica juncea* Coss.) through mutagenesis.

Material and Methods

Homogeneous seeds of oriental mustard cv. Agati Sarhein (*Brassica juncea* Coss.) were irradiated with gamma rays 750, 1000 and 1250 Gy from Cesium-137 (Cs^{137}) at the dose rate of 30.80 Gy per minute. The irradiated seeds along with non-irradiated (control) were sown in the field to raise M_1 generation. All normal cultural practices were carried out throughout the growth of the crop. At maturity, 5 pods from each terminal and primary racemes of each plant were harvested and seed was bulked dose-wise to raise M_2 generation. Based on visual observations for important agronomic characters such as stature, maturity and yield components, 75 mutants were selected. Progeny rows of the selected mutants were raised in M_3 generation to confirm the stability of genetically altered traits. True breeding mutants were selected for further evaluation in the subsequent generations.

Thirteen mutants along with the parent variety were evaluated in preliminary yield trial in RCB design with 3 replicates. Each plot consisted of 4 meter long, 3 rows 45 cm apart. Five plants were selected from each plot to record the data on yield and yield components while three rows were harvested to estimate the yield per unit area. Six promising mutants alongwith parent variety were advanced in yield trial in RCB design with 3 replicates. Each plot consisted of 4 meter long 5 rows 45 cm apart. The data were recorded as described in preliminary yield trial. The data were analysed statistically and the mean values were compared by using DMR Test at 5% level of significance.

Results

Significant difference were observed amongst all the entries in preliminary yield trial for the traits under evaluation (Table 1). All the mutants were significantly ($P \leq 0.05$) shorter in stature than the parent variety, Agati Sarhein. The plant with minimum height was observed in AS95-1003 (148.00) followed by AS95-755 (163.00) and AS95-1257 (165.80) which respectively showed 29, 21 and 20% reduction in plant height over the parent. The maximum primary branches were produced by the mutant AS95-7527 (8.33) followed by AS95-7530 (8.07) and AS95-7517 (7.93) which respectively showed 10.62, 7.17 and 5.3% increase over Agati Sarhein. The highest pods per plant were recorded in mutants AS95-7527 (856.60) followed by AS95-1003 (835.53) and AS95-7517 (779.33) with respectively 15, 12 and 5% increase in pods per plants over the parent. The mutant AS95-7520 (4.88) had the maximum pod length followed by AS95-7530 (4.67) and AS95-758 (4.55). The highest number of grains per pod were recorded in AS95-7533 (13.57).

Most of the mutants had higher 1000-grain weight than other entries but two of them viz., AS95-754 (3.39) and AS95-1003 (3.39) were significantly ($P \leq 0.05$) superior to the parent variety. The mutants showed 7-44% increase over the parent in 1000 grain weight. The highest grain yield per plant was recorded in mutants AS95-7517 (22.40), AS95-7530 (21.80) and AS95- 7527 (21.53). The former two mutants were significantly superior to the parent Agati Sarhein which may be attributed to an increase in yield contributing parameters i.e., primary branches, pods per plant and 1000 grain weight. Seven mutants gave significantly higher yield with 49-60% increase over the parent. The maximum grain yield per hectare was recorded in AS95-1006 (3.37) followed by AS95-7527 (3.18) and AS95-755 (3.11).

The entries varied significantly ($P \leq 0.05$) from each other in yield trial for all the characters under study (Table 2). All the mutants were shorter in stature than parent where mutant AS95-1003 showed minimum height (148.47) followed by AS95-755

Table 1. Performance of mutants of Agati Sarhein for yield and yield components in preliminary yield trial

Sr.No.	Mutants	Plant height (cm)	Primary branches/ plant (No.)	Pods/plant (No.)	Pod length (cm)	Grains/pod (No.)	1000-grain weight (g) (g)	Grain yield/plant (g)	Grain yield/ha (M.T.)
1	AS95-754	167.33 fg	7.20 bc	466.73 e	4.16 cde	12.57 abcd	3.39 a	16.77 c	2.00 e
2	AS95-755	163.00 g	7.86 ab	634.80 cd	4.39 abcd	13.50 a	3.15 abc	19.53 abc	3.11 a
3	AS95-758	170.00 ef	7.73 ab	657.73 bcd	4.55 abc	12.48 abc	3.31 ab	18.92 abc	2.89 abc
4	AS95-7511	166.80 fg	7.33 abc	635.13 cd	3.87 e	12.26 bcd	3.23 abc	19.35 abc	2.56 ab
5	AS95-7517	166.93 fg	7.93 ab	779.33 ab	4.08 cde	13.29 ab	2.80 abc	22.40 a	3.04 ab
6	AS95-7520	188.53 b	7.40 abc	654.60 de	4.88 a	13.29 ab	2.80 abc	19.22 abc	2.40 cde
7	AS95-7527	177.67 cd	8.33 a	856.60 a	4.12 cde	12.31 bcd	2.27 c	21.53 a	3.18 a
8	AS95-7529	181.07 c	7.67 ab	633.27 cd	4.37 abcd	11.73 cd	2.99 abc	20.70 ab	2.29 de
9	AS95-7530	175.13 de	8.07 ab	770.33 ab	4.67 ab	11.53 d	2.27 c	21.80 a	2.44 cde
10	AS95-7533	193.50 b	7.06 bc	669.60 bcd	4.39 abcd	13.57 a	2.53 abc	16.87 c	3.04 ab
11	AS95-1003	148.00 h	7.33 abc	835.53 a	4.39 abcd	12.57 abcd	3.39 a	20.75 ab	2.89 abc
12	AS95-1006	170.80 ef	7.53 abc	639.93 cd	4.23 bcde	13.02 ab	2.67 abc	20.47 ab	3.27 a
13	AS95-1257	165.80 fg	6.67 c	479.47 de	4.01 de	12.18 bcd	2.27 c	16.63 c	2.18 de
14	Agati Sarhein(P)	208.87 a	7.53 abc	741.67 abc	4.53 abc	13.53 a	2.35 bc	17.61bc	2.04 de

DMR test (P(0.05): Means followed by the same letters are not significantly different from each other.

Table 2. Performance of mutants of Agati Sarhein for yield and yield components in preliminary yield trial.

Sr.No.	Mutants	Plant height (cm)	Primary branches/ plant (No.)	Pods/plant (No.)	Pod length (cm)	Grains/pod (No.)	1000-grain weight (g) (g)	Grain yield/plant (g)	Grain yield/ha (M.T.)
1	AS95-755	150.43 bc	6.63 c	478.40 cd	4.33 b	12.02 b	2.46 cd	15.96 d	1037.92 d
2	AS95-758	155.20 b	7.27 ab	491.77 bc	4.85 a	14.55 a	2.73 bcd	17.32 cd	1231.96 bc
3	AS95-7517	155.73 b	6.73 bc	453.13 cd	4.52 b	14.30 a	2.47 cd	16.82 cd	1142.96 cd
4	AS95-7527	152.10 bc	7.10 abc	548.63 a	4.82 a	14.82 a	3.27 a	23.26 a	1502.82 a
5	AS95-1003	148.47 c	7.20 ab	525.60 b	4.50 b	14.88 a	2.83 abc	19.61 b	1332.37 b
6	AS95-1006	153.33 bc	7.47 a	441.80 de	4.52 b	14.16 a	3.00 ab	18.46 bc	1332.52 b
7	Agati Sarhein (P)	190.83 a	7.00 abc	409.17 e	4.38 b	13.01 b	2.23 d	17.14 cd	1142.51 cd

DMR test (P(0.05): Means followed by the same letters are not significantly different from each other.

(150.43) and AS95-7527 (152.11). Maximum primary branches were produced by AS95-1006 (7.47) followed by AS95-758 (7.27) and AS95-1003 (7.20). Five mutants had significantly higher pods than the parent variety with maximum pods recorded on AS95-7527 (548.63) followed by AS95-1003 (525.60) and AS95-758 (491.77). The mutants AS95-758 and AS95-7527 were significantly superior in pod length. All the mutants produced significantly higher grains per pod than parent Agati Sarhein. Although all the mutants had higher 1000 grain weight than parent yet 3 of them viz., AS95-7527, AS95-1006 and AS95-1003 were significantly superior. The same three mutants maintained their superiority by yielding higher grains per plant as well as per unit area. This may be due to an improvement in yield components as a consequence of alteration in genetic architecture by irradiation.

Discussion

Breeding for high yield is based on the generation of new genotypes with improved yield components or such characters which are responsible for yield and increase in yield has to come as a consequence of increase in any of its components. Plant height is an important yield contributing character in oriental mustard. The reduction in plant height causes an increase in grain yield because of good response to higher doses of fertilizer and tolerance to lodging under unfavorable weather conditions. Moreover, the dwarfness in plant height is associated with earliness in maturity (Olejniczak & Adamska, 1999) which is a highly desirable character in crop plants. The mutants of Agati Sarhein viz., AS95-755, AS95-7517, AS95-7527, AS95-1003 and AS95-1006 were not only dwarf in stature but also had high yield as compared with their parent variety (Tables 1 & 2). Chauhan & Kumar (1986), Das & Rahman, (1988) and Shah *et al.*, (1990) have also isolated short statured mutants with high yield potential from mutagen treated populations of rapeseed and mustard. This confirmed that induced mutation through gamma rays have played a significant role in the alteration of plant architecture and selection of mutants with enhanced yield potential in rapeseed and mustard (Rahman, 1996; Shah *et al.*, 1999).

The most important factors responsible for an increase in the productivity in oilseed Brassica are the number of primary branches, pods per plant, number of grains per pod and an increase in seed index (weight/grain). Pods on the main stem is the most productive factor and this could be increased by decreasing the number of branches (Beg, 1984). The mutants AS95-7527, AS95-7533, AS95-7517 and AS95-1003 in preliminary yield trial (Table 1) and mutants AS95-758, AS95-1003 and AS95-1006 in yield trial (Table 2) had not only the higher number of primary branches but also higher pods per plant. Genotypes with more branches and pods per plant have also been reported in oilseed brassica (Chauhan & Kumar, 1986; Naz & Islam, 1979; Shah *et al.*, 1990) as a consequence of mutagenesis. Yadava *et al.*, (1973) demonstrated that seed per pod and 1000-seed weight directly influence the seed yield in mustard. About 10 mutants in preliminary yield trial and all the mutants in yield trial exhibited higher 1000-grain weight than the parent which indicated an increase in size of the grain as a result of induced mutation in oriental mustard. This is in conformity with the findings of Chauhan & Kumar (1986) and Shah *et al.*, (1990) who have also reported the bold-seeded mutants in oilseed brassica.

All the mutants except AS95-754 and AS95-1257 produced higher grain yield per plant but three of them viz., AS95-7517, AS95-7527 and AS95-7530 were significantly ($P \leq 0.05$) superior to the parent variety in preliminary yield trial. The 3 mutants AS95-7527, AS95-1003 and AS95-1006 had higher yield than other entries in yield trial. Six mutants AS95-1006, AS95-7527, AS95-755, AS95-7517, AS95-6533 and AS95-1003 showed better performance in preliminary yield trial while 3 mutants viz., AS95-7527, AS95-1003 and AS95-1006 were significantly superior in grain yield per hectare in yield trial. This may be due to an increase in any of the yield contributing factors such as plant height (short statured), primary branches, pod per plant, 1000-grain weight etc. The consistent superior performance of the later three mutants in both the trials indicated an improvement in the genetic constitution of the Agati Sarhein through gamma rays irradiation. These results are similar to the reports of Das & Rahman (1988), Kamla and Rao (1984), Mahla *et al.*, (1990, 1991), Qixin *et al.*, (1990) and Rahman *et al.*, (1997) who also developed mutants of rapeseed and mustard with high yield potential and other improved agronomic traits. Our studies provided a clue that gamma rays could be successfully employed for the induction of variation to select the new genotypes with improved agronomic characters in oriental mustard.

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