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Short communication

BINATIL-2: A GAMMA RAYS INDUCED MUTANT VARIETY OF SESAME

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Abstract

Seeds of local sesame variety T-6 were irradiated with gamma rays and grown as M_1 during Kharif-I 2002. The yield potential of two M_6 mutants, SM-5 and SM-12 was evaluated through different trials in some sesame growing areas of the country during 2007 to 2009. Results showed that mutant SM-12 produced the highest seed yield in all the locations and years. Mutant SM-12 also produced the highest number of capsules/plant. Average seed yield of SM-12 over the locations and years was 1531 kg/ha which was 6.2 and 11.2% higher than two popular check varieties, Binatil-1 and BARI Til-2, respectively. Binatil-1 and BARI Til-2 produced the seed yield of 1446 and 1377 kg/ha, respectively. Results of yield trials carried out across the country indicated SM-12 was found suitable and thus National Seed Board of Bangladesh registered SM-12 as Binatil-2 in 2011 for commercial cultivation in Bangladesh.

Bangladesh is deficient in edible oil production. The domestic production of edible oil including rice bran oil can hardly meet 20% demand of the country. Therefore, it is urgently needed to expedite efforts for increasing the local production of oilseeds. In Bangladesh, among the oilseed crops, sesame is cultivated on 35.65 thousand hectares of land with a production of 34.00 thousand tons with seed yield of 954 kg/ha (BBS 2017). There are many factors responsible for its low yield per unit area but the most important is the non-availability of high yielding varieties. It is therefore, imperative to develop high yielding varieties of sesame for higher production.

The main objective for plant breeding is to increase genetic diversity and induction of variability for the selection of high yielding varieties. Among the different breeding methods, induced mutation has been extensively and successfully used for genetic improvement of any yield attributes either qualitative or quantitative in nature for sesame and other crops (Das *et al.* 1999 & 2004; Ahloowalia *et al.*, 2004, Khatri *et al.* 2005, Sarwar *et al.*, 2008 & 2010, Uddin *et al.* 2007, Naeem *et al.*, 2009, Malek & Monshi 2010, Malek, *et al.*, 2012a & 2012b; Ghanei *et al.*, 2013; Ambavane *et al.*, 2015; Begum *et. al.*, 2015; Aristya *et al.*, 2018). It is notable that using this technique, a large number of mutant varieties of different crops with improved traits have been developed and released worldwide, many of which have substantial economic values (Maluszynski *et al.*, 2000). Over 3275 mutant varieties in more than 220 plant species have to-date been officially released worldwide (see http://mvd.iaea.org/). The commercial utilization of mutant-induced and mutant-derived varieties strongly shows

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that mutation breeding is a useful tool for generating new germplasm for crop improvement (Ishige, 2009). The present research was therefore, carried out to evolve sesame variety(s) having suitable plant type, heavy bearing and high seed yield potential through treating seeds of local sesame variety, T-6 with gamma rays.

Seeds of local sesame variety T-6 were exposed to gamma rays in 2002 to induce genetic variability for the selection of improved mutant genotypes. The treated seeds were sown to obtain M_1 generation along with mother check at the experimental field of BINA head quarters, Mymensingh. Seeds from five selected capsules from the lower part of the rachis of each M_1 plant were harvested. The M_2 seeds from each individual M_1 plants were grown along with mother check in plant-progeny-row in 2003. In M_2 population, all the plants were carefully observed and plants appearing different from mother variety for one or more morphological traits were harvested separately. From first segregation M_2 population, a total of 265 mutant variants appearing different form from the mother variety for one or more morphological traits were selected and M_3 seeds from 265 individual mutant variants were collected separately. Then M_3 seeds from 265 individual mutant variants were grown in plant-progenies row along with mother variety in 2004. A total of 47 mutant variants were selected from M_3 population. For the observation trial M_4 seeds of selected 47 mutant variants were grown following plant-progeny row along with mother variety. From the observation trial of M_4 generation a total of 25 individual mutant variants were selected. M_5 seeds of 25 individual plants were grown in 2006 following plant-progeny row along with mother variety and were found to breed true. Among the 25 true breeding mutants, two most promising M_6 mutants (SM-5 and SM-12) for having their desirable morphological traits and yield attributes compared to their mother variety T-6 were selected from 700Gy during observation trial (non-replicated) and were put into extensive trial in different sesame growing areas of the country during 2007 to 2009. Considering the better performance of SM-5 and SM-12, advanced yield trial (AYT) was conducted in the farms of BINA sub-stations at Magura, Satkhira and Ishurdi during Kharif-I 2007. In Kharif-I 2008, on-station and on-farm trials were carried out in the farms of BINA sub-stations at Magura and Ishurdi, and in the farmers' field at Nachole of Chapainawabganj and Tetulia of Panchagor districts. In Kharif-I 2009, again on-station and on-farm trials were carried out in the farms of BINA sub-stations at Magura and Ishurdi, and in the farmers' field at Atgharia of Pabna and Sadar of Jhenaidah, Jashore and Satkhira districts. AYT conducted in 2007 was laid out in a randomized complete block design with three replicates and, On-station and on-farm yield trials conducted during 2008 and 2009 were also laid out following the same design with three replicates. Unit plot size was maintained 15m^2 (5m × 3m) for AYT, 16m^2 (4m × 4m) for on-station and on-farm trial conducted in 2008 and 25m^2 (5m × 5m) for on-station and on-farm trial conducted in 2009. Recommended fertilizer doses were applied. Seeds were sown within the 2nd week of March of each year. Row to row distance was maintained 30cm. Different intercultural operations were followed as and when necessitated for proper growth and development of the plants of each plot. Two popular sesame varieties, Binatil-1 and BARI Til-2 were included in all trials as check for comparative assessment in respect of seed yield, maturity period, plant height, number of branches and capsules/plant, number of seeds/capsule etc. The data were analyzed statistically following Gomez and Gomez (1984) and the mean values were compared by DMRT at 5% level of significance.

Gamma rays irradiated seeds of T-6 were grown as M_1 during 2002. Selection of desirable individuals was made from M_2 during 2003 and true breeding nature was confirmed in M_5 generation in 2006. A total of 25 mutants having high seed yield and other yield attributes were selected from M_5 generation. Two promising M_6 mutants (SM-5 and SM-12) with desirable morphological characters and yield attributes compared to the mother variety (T-6) and check varieties were selected from 700Gy from observation trial (non-replicated) conducted in Kharif-I of 2006 (data not shown). The selected two mutants were evaluated though extensive trials in different sesame growing areas of the country during 2007 to 2009.

Combined means of quantitative characters of the mutants and check varieties for advanced yield trial conducted during 2007 are presented in Table 1 and, on-station and on-farm trials conducted during each of 2008 and 2009 are presented in Table 2 and Table 3, respectively. Results of advanced yield trial showed that on an average of three locations, mutant SM-12 produced the highest plant height of 104cm followed by BARI Til-2 (90cm) while SM-5 had the shortest height of 81cm. Binatil-1 produced the highest number of 75 seeds/capsule followed by SM-12 which produced 68 seeds/capsule. Mutant SM-12 produced the highest number of 52 capsules/plant and gave the highest seed yield of 1444 kg/ha and two checks, Binatil-1 and BARI Til-2 produced 1331 and 1317 kg/ha seed yield, respectively (Table 1). On-station trial of 2008 (Table 2) showed that SM-12 produced highest number of 3.3 branches/plant and highest seed yield of 1870 kg/ha. On-farm trial during 2008 (Table 2) showed that BARI Til-2 and SM-12 produced the significantly higher number of branches than Binatil-1 and SM-5. Binatil-1 produced the highest seed yield of 1345 kg/ha followed by SM-12 (1276 kg/ha). Mutant SM-5 and check variety BARI Til-2 produced statistically lower seed yield (1203 and 1154 kg/ha, respectively)

Table 1. Mean of two mutants and checks for different yield attributing characters in AYT during Kharif-I, 2007

Locations	Mutants/ check	Days to maturity	Plant height (cm)	Branches plant^{-1} (no.)	Capsules plant^{-1} (no.)	Seeds Capsule^{-1} (no.)	Seed yield (kgha^{-1})
Magura	SM-5	76d	93c	0.0c	42.3	68b	1293b
	SM-12	91a	110a	1.9b	44.3	66b	1570a
	Binatil-1	82c	104b	0.0c	42.0	83a	1383b
	BARI Til-2	85b	107ab	2.6a	43.0	64b	1430ab
Satkhira	SM-5	83d	75b	0.00b	47b	68b	1258c
	SM-12	100a	100a	3.2a	60a	73a	1445a
	Binatil-1	87c	80b	0.00b	51b	74a	1370ab
	BARI Til-2	96b	76b	3.2a	49b	68b	1295b

Table 1. Continued

Locations	Mutants/ check	Days to maturity	Plant height (cm)	Branches plant^{-1} (no.)	Capsules plant^{-1} (no.)	Seeds Capsule^{-1} (no.)	Seed yield (kgha^{-1})
Ishurdi	SM-5	84d	75c	0.0b	42b	63c	1085b
	SM-12	99a	101a	3.8a	51a	66b	1313a
	Binatil-1	91c	83b	0.0b	44b	69a	1238a
	BARI Til-2	94b	86b	3.5a	49a	61c	1225a
Combined means over three locations	SM-5	81d	81c	0.0b	44c	66c	1212c
	SM-12	97a	104a	2.9a	52a	68b	1444a
	Binatil-1	86c	89b	0.0b	46bc	75a	1330b
	BARI Til-2	91b	90b	3.1a	47b	65c	1317b

In a column, values with same letter(s) for individual location/combined means do not differ significantly at p#0.05 by DMRT.

than Binatil-1 and SM-12. In Table 3, on-station trial conducted during 2009 showed that mutant SM-12 produced the highest seed yield of 1623 kg/ha while two checks Binatil-1 and BARI Til-2 produced the seed yield of 1498 and 1458 kg/ha, respectively. On-farm trial conducted during 2009 showed that mutant SM-12 also produced the highest seed yield of 1440 kg/ha and two checks Binatil-1 and BARI Til-2 produced the seed yield of 1272 and 1281 kg/ha, respectively (Table 3).

Table 2: Mean of two mutants and checks for different yield attributing characters in on-station and on-farm trials during Kharif-I, 2008

Locations	Mutants/ Checks	Days to maturity	Plant height (cm)	Branches plant^{-1} (no.)	Capsules plant^{-1} (no.)	Seeds Capsule^{-1} (no.)	Seed yield (kgha^{-1})
On-station trial							
Magura	SM-5	71c	100c	0.0b	49b	80ab	1761c
	SM-12	76b	122a	2.9a	52b	73bc	2047a
	Binatil-1	77b	126a	0.0b	63a	86a	2004ab
	BARI Til-2	79a	113b	3.1a	44b	70c	1913b
Ishurdi	SM-5	91c	96c	2.5b	58	62b	1116c
	SM-12	96a	105b	3.2a	65	61b	1692a
	Binatil-1	93b	113a	0.0c	60	75a	1563ab
	BARI Til-2	95a	105b	3.1a	64	61b	1438b
Combined means over two locations	SM-5	81d	98d	1.2b	54	71b	1439c
	SM-12	86b	114b	3.1a	58	67bc	1870a
	Binatil-1	85c	120a	0.0c	62	80a	1783a
	BARI Til-2	87a	109c	3.1a	54	65c	1675b
On-farm trial							
Nachole, Chapainawabgonj	SM-5	87c	83c	0.6b	46	79b	1136c
	SM-12	97a	97b	3.3a	50	71c	1240b
	Binatil-1	91b	108a	0.0b	54	85a	1302a
	BARI Til-2	97a	97b	3.5a	53	70c	1115c

Table 2. Continued

Locations	Mutants/ Checks	Days to maturity	Plant height (cm)	Branches $plant^{-1}$ (no.)	Capsules $plant^{-1}$ (no.)	Seeds $Capsule^{-1}$ (no.)	Seed yield ($kgha^{-1}$)
Tetulia, Pachagar	SM-5	86c	85b	0.5b	48ab	63b	1271bc
	SM-12	96a	85b	3.3a	52a	61bc	1313b
	Binatil-1	91b	97a	0.0b	49a	75a	1388a
	BARI Til-2	96a	88b	2.9a	44b	57c	1194c
Combined means over two locations	SM-5	86c	84c	0.5b	47	71b	1203c
	SM-12	96a	91b	3.3a	51	66c	1276b
	Binatil-1	91b	102a	0.0c	52	80a	1345a
	BARI Til-2	96a	92b	3.2a	48	64d	1154c

In a column, values with same letter(s) for individual location/combined means do not differ significantly at p#0.05 by DMRT.

Average of all the quantitative characters of mutant SM-12 along with two checks over three years trials are presented in Table 4. Results revealed that mutant SM-12 produced the seed yield of 1531 kg/ha followed by two checks Binatil-1 and BARI Til-2 with seed yield of 1446 and 1377 kg/ha, respectively. It was also estimated that promising mutant SM-12 produced 6.2 and 11.2% higher seed yield than the two checks Binatil-1 and BARITil-2, respectively.

Generation of new plant type with improvement in yield attributes leading to produce high yield is the main plant breeding objective. Gamma-rays induced mutations have been instrumental in creating useful genetic variability in characters of economic importance in sesame cultivars, which led to the development of improved mutant varieties. SM-12 showed superiority to control varieties in seed yield in all the trials. Important factors responsible for an increase in the productivity in sesame are the number of branches and capsules/plant, seeds/capsule and an increase in seed weight. SM-12 produced not only the higher number of primary branches, but also produced the higher number of capsules/plant though it had lower number of seeds/capsule. Number of seeds/capsule was lower in SM-12. Mutant genotypes with higher number of branches, capsules/plant and finally in seed yield have also been reported in sesame (Das *et al.*, 1999; Malek & Monshi, 2010; Sarwar *et al.*, 2010; Begum *et al.*, 2015; Aristya *et al.*, 2018) as a consequence of mutagenesis.

It was concluded that the performance of mutant SM-12 for seed yield and yield components was superior to the two check varieties, Binatil-1 and BARITil-2. Mutant SM-12, because of its high yield potential, held promise for selection and National Seed Board of Bangladesh (NSB) registered the mutant SM-12 as Binatil-2 in 2011 for commercial cultivation in the farmers' field of Bangladesh.

Table 3: Means of one mutant and two check varieties for different yield attributing characters in on- station and on-farm trials during Kharif-I, 2009

Locations	Mutants/ Checks	Days to maturity	Plant height (cm)	Branches plant^{-1} (no.)	Capsules plant^{-1} (no.)	Seeds Capsule^{-1} (no.)	Seed yield (kgha^{-1})
On-station trial							
Magura	SM-12	92b	115	2.5a	42a	64b	1620a
	Binatil-1	88c	113	0.0b	37ab	76a	1488b
	BARItil-2	94a	116	2.3a	33b	66b	1470b
Ishurdi	SM-12	96b	92	3.4a	65a	68b	1625a
	Binatil-1	91c	91	0.0b	41b	76a	1508b
	BARItil-2	100a	89	3.3a	59a	67b	1445c
Combined	SM-12	94b	104	2.9a	54a	66b	1623a
means over two	Binatil-1	89c	102	0.0b	39c	76a	1498b
locations	BARItil-2	97a	103	2.8a	46b	66b	1458b
On-farm trial							
Atgharia, Pabna	SM-12	93a	103	3.4a	62a	64b	1383a
	Binatil-1	90b	107	0.0b	56b	75a	1265b
	BARItil-2	94a	108	3.5a	61a	64b	1250b
Jhenaidah Sadar	SM-12	95a	112a	2.7a	46a	68b	1440a
	Binatil-1	89b	106b	0.0b	37b	78a	1241b
	BARItil-2	95a	113a	2.4a	42a	66b	1280b
Satkhira Sadar	SM-12	92b	121	2.7a	63a	65b	1431a
	Binatil-1	85c	116	0.0b	46c	80a	1258b
	BARItil-2	95a	121	2.4a	57b	65b	1250b
Jashore Sadar	SM-12	95a	90b	3.4a	51a	67b	1508a
	Binatil-1	89b	88b	0.0b	42b	78a	1325b
	BARItil-2	95a	95a	3.4a	45b	65b	1343b
Combined	SM-12	94a	106ab	3.1a	55a	66b	1440a
means over four	Binatil-1	88b	104b	0.0b	45c	77a	1272b
locations	BARItil-2	95a	109a	2.9a	51b	65b	1281b

In a column, values with same letter(s) for individual location/combined means do not differ significantly at p#0.05 by DMRT.

Table 4. Means (average of three years trial) of mutant SM-12 and two check varieties Binatil-1 and BARI

Mutant/check varieties	Days to maturity	Plant height (cm)	Branches plant^{-1} (no.)	Capsules plant^{-1} (no.)	Seeds Capsule^{-1} (no.)	Seed yield (kgha^{-1})	Seed yield increased over check varieties
SM-12	93	104	3.1	54	67	1531	6.2% over Binatil-1
Binatil-1	88	103	0.0	49	78	1446	11.2% over BARI Til-2
BARI Til-2	93	101	3.0	49	65	1377	

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