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IMPROVING YIELD AND SEEDS IN OKRA CROP THROUGH INDUCED USEFUL MUTATIONS

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ABSTRACT

Cultivation of okra in Egypt is challenged by low yield due to lack of improved cultivars. Gamma irradiated okra seeds can generate genetic variability to improve the crop. Field experiment was carried out in a private farm at Sidy salim distrect, Kafr El-Sheikh Governorate, Egypt during 2017, 2018 and 2019 seasons. Samples of dry seeds each of two okra cultivars Balady" and Sabahia were irradiated with different doses of gamma rays (0, 10, 20, 30 and 40 KR) and variability in growth characteristics, earliness and pod yield were investigated in M_1, M_2 and M_3 generations. Data were statistically analyzed for all the levels of significance. For significant F ratios New Duncan's Multiple Range (DMRT).

***The results of this investigation showed that** the M_1 plants exhibited different degrees of reduction in growth in comparison with those of the untreated control plants. In M_2-generation, 26 different mutant lines were selected. Analysis of variance in M_3 generation showed a highly significant difference among M_3 lines and control for vegetative and agronomical traits of two okra cultivars. Among 26 M_3 lines, one mutant line was produced higher pod yield (29.4 g/plant) compared with control plants (14.6 g/plant). This line will be being to evaluated for the desired traits and wide adaptability to biotic and abiotic stress to obtain new variety with high yield and good quality.*

***Conclusively**, Induced mutation is a valuable breeding tool for inducing new genetic recombination and selectsuseful lines with desired traits in okra. The present study made an extensive phenotypic evaluation from M_1 to M_3 generations which enabled us to select promising mutant lines with higher pods yield in M_3generation. These lines could be valuable genetic resources for genetic improvement and breeding of okra in Egypt. Further selection and improvement are needed for testing* *mutant lines for adaptability and stability under different environments under large-scale production for releasing new improved okra cultivars.*

Key words: Yield, Seeds, Mutations, Okra.

INTRODUCTION

Okra (*Abelmoschus esculentus* L., Moench) is very important vegetable crop in Egypt and throughout the world. In addition to the use of its immature pods as a vegetable and it used cooked. The potential of the seeds as a new protein source was emphasized by Karakoltsides and Constantinides (1975). Protein content of the seed is about 20 percent or more and oil content is about 14 percent. Thus, it would appear that okra seed can be used as a protein and oil crop (Martin, 1982). The genus *Abelmoschus* belongs to family *Malvaceae* is represented by 12 species (Bentham and Hooker, 1967) in which the most common vegetable crop.

Okra flowers are self-pollination, but usually up to 20% cross pollination occurs by insects a broad range of variation with levels varying from 0 to 60% (Gurbben, 1977). There is not much variability in okra in Egypt and most of the available varieties low yield. Mutation breeding is one of the conventional breeding methods in plant breeding. The radiations are the best tools to induce genetic variability within a very short span of time. Induced mutation is highly effective in enhancing natural genetic resources and has been used in developing improved cultivars of cereal, fruits and other crops. For example, Metwally *et al.*(1992 and 2004) on pea, Sarker *et al.* (1997) on mung bean and Lee *et al.*(2002) on potato showed that variability could be achieved using mutagens. In okra, mutation breeding has been done by Norfadzrin *et al.* (2007), Manju and Gopimony (2009), Phadvibulya *et al.* (2009), Hegazi and Hamideldin (2010) and Muralidharan and Rajendran (2013) by using different doses of gamma rays aiming to make large scale of genetic variability which can be used in increasing the effectiveness of selection. The effect of gamma irradiation on the various yield attributing characters were reported in this study.

Therefore, the aim of this study to improve yield and seeds in okra crop through induced useful mutations.

MATERIALS AND METHODS

Seeds of two okra (*Abelmoschus esculentus* (L.), Moench) cultivars were obtained from vegetable crop seed production and Technology Department, Horticulture Research institute, Agriculture Research center, Giza, Egypt. The first cultivar "Balady" has red pods, the other one is "Sabahia" with green pod. The dry seeds of the two cultivars were exposed to four doses of Gamma-rays, *i.e*., 10, 20, 30 and 40 KR bedsidethe control "0". The source of Gamma-rays was generated from cobalt 60 with a dose level of 7.69 rad/sec at Cyclotron Department, Nuclear Research center, Atomic Energy Authority, Egypt. Field experiment was carried out in a private farm at Sidy salim distrect, Kafr El-Sheikh Governorate, Egypt during 2017, 2018 and 2019 seasons.

Irradiated and non-irradiated seeds of the two okra cultivars were sown on the first week on May for three seasons separately in hills of 30cm apart and 70cm row width. All agricultural practices were done as commonly practiced in okra cultivation. At least 250 plants were chosen from each treatment and divided into 3 replicates/treatment and these plants have been named M_1-plants were selfed pollinated. The seeds of these plants were separately harvested and gave the M_2 seeds.

M_2- seeds from individual of M_1-plants from each treatment which results that self-pollination were sown on the first week of May 2018 given 250 families comparing with control. During the season, 26 mutant lines were selected which have pod concentration, early maturity and higher pods yield compared with original cultivars.

M_3- seeds from the 26 mutant lines which results self-pollination from M_2 plants and control were sown on the first week of May 2019 for evaluated and the following data were recorded, *i.e*.; plant height, number of branches/plant, number of leaves/plant, number of days from sowing to first flowering, then after six days from anthesis (as reported by Abdel-Fattah *et al.*, 1978) these pods were picked and the following data were recorded, *i.e.;* number of pods/plant, pods weight/plant, and pod characteristics, *i.e;* pod length, pod diameter and average pod weight.

Data were statistically analyzed (Steel and Torrie, 1980) for all the levels of significance. For significant F ratios, New Duncan's Multiple Range (Leclarg *et al.*, 1962).

RESULTS AND DISCUSSIONS

M_1- generation:

During this study the effects of gamma radiation on various characters of two cultivars in M_1-generation.The results presented in Table (1) showed that varied significantly in their response to irradiation treatments, as the doses 10, 20, 30 and 40 KR have a highly significant effect on plant height, total chlorophyll content and number of pods per

Table 1: Effect of different doses of gamma-rays on the morphological traits in M_1-generation of okra (2017).

Varieties	Dose	Plant height (cm)	Total chlorophyll content	Fresh weight /plant	Dry weight/ plant (g)	Leaf area/plant (cm^2)	No. of pods/plant	No. of seeds/ plant
Balady	Contro	119.7a	41.8b	363.7	56.2	583.4	3.7b	325.5
	10KR	118.2a	55.1a	344.2	48.1	663.4	5.5ab	443.0
	20KR	120.2a	44.3b	351.2	52.2	744.9	6.7a	447.0
	30KR	119.2a	43.4b	315.2	45.9	570.2	5.2ab	314.5
	40KR	99.5b	41.2b	330.7	47.6	703.7	4.5b	330.7
L.S.D		**10.5**	**7.4**	**NS**	**NS**	**NS**	**1.9**	**NS**
Sabahia	Contro	69.7	51.3	252.5	34.2	633.5	9.2	746.7
	10KR	59.7	44.5	208.2	29.9	568.5	7.2	516.2
	20KR	70.5	41.5	193.2	29.3	519.5	7.7	459.5
	30KR	72.7	47.2	251.2	38.1	558.6	7.5	487.5
	40KR	69.2	43.7	216.7	31.1	553.7	6.7	364.0
L.S.D		**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

plant in cultivar "Balady". On the other hand, two same irradiation doses showed no significant difference in this character in cultivar "Sabahia". In this generation found that the maximum reduction in plant height with dose 40 KR and showed that there was no significant difference between the two cultivars in fresh and dry weight, leaf area and number of seeds per plant.

As regard to different doses, it is clear that irradiation dose of 40KR gave the less results in two cultivars than the control. "Balady" cultivar gave high records for plant height, leaf area, fresh and dry weight per plant when compared to the other cultivar "Sabahia" which recorded the high values of number of pods and number of seeds/plant when both had the same irradiation doses. These results demonstrated by Norfadzrin *et al.* (2007) who noticed that higher gamma ray doses particularly 600 and 800 Gy had negative effect on the morphological characteristics of tomato and okra seeding derived from irradiated seeds Dubey *et al.* (2007) showed an increase in plant height, number of leaves and branches per plant when okra seeds were irradiated with different doses of gamma rays. These results were similar with earlier reports, Singh and Singh(1998) were indicated that low doses of mutagens (*i. e.* 15-30 KR gamma rays and 0.25 and 0.50 percent EMS) increased plant height and number of pods per plant of okra. Warghat *et al.* (2011) noticed that sodium azide and gamma rays mutagens caused to increase in plant height and number of pods in musk okra (*Abelmoschus esculentus*) as compared to control. Similar to our result, Pushparajan *et al.* (2014) reported that in the comparison with control, gamma rays produced increased plant height, pod number, pod length, number of seed, number of locules and 100 seed weight(seed index) in okra. These effects might be due to the structural rearrangements in DNA caused by different types of DNA structural changes (Breeks, transposition, deletion, *etc*.) (Danylchenko and sorochinsky, 2005).

M_2-genertation

The other observations were recorded on single plant basis for the characters Viz, fruit length, and number of fruits per plant and fruit yield characters. In M_2generation, the limits of the range as well as the values of mean and mode showed a decrease. Also, variance increased at high dose. In M_2-generation, the mean values for pod yield and pod yield attributing traits in selected mutant showed positive shift as compared to their respective control.

M_3-generation for 26 mutant lines:

Data presented in Table (2) reveal that there is highly significant difference between the two cultivars for plant characters (plant height, Table (2): Some vegetative traits, pod yield and its component traits of 26 mutant lines in M_2 and their original parent grown in 2019 season.

Varieties	Mutant No.	Plant height (cm)	No. of branches/ plant	No. of leaves/plant	Pod weight (g)	Pod length (cm)	Pod diameter (cm)	No. of days from sowing to first flowering	No. of pods/Plant	Weight of pods /Plant(g)
Balady	Control	93.6a	0.0d	22.0de	2.7cd	4.0c	1.3	55.3ab	4.6de	16.6e
	1	45.3b	0.0d	16.0f	4.6ab	5.6ab	1.3	51.3bc	14.3a	41.8c
	2	87.3a	2.0bc	38.6c	5.1a	6.3a	1.3	48.3c	10.4c	42.1c
	3	97.0a	3.3b	45.3b	2.4cd	3.7c	1.9	39.6d	12.4b	35.2d
	4	93.3a	0.0d	20.6ef	2.8cd	4.0c	1.2	57.0ab	4.2e	17.1e
	5	93.0a	1.0cd	26.3d	2.5cd	4.2c	1.2	55.6ab	5.6d	48.3a
	6	95.0a	6.6a	64.3a	3.5bc	4.6bc	1.3	59.0a	13.4ab	44.2b
L.S.D		10.6	1.4	5.0	1.4	1.2	NS	5.90	1.1	2.0
Sabahia	Control	59.6af	1.0abc	29.0c-h	5.3bc	7.1abc	1.3b-e	45.1fg	14.6ef	46.1g
	1	67.0cde	0.0c	28.3d-h	3.1de	5.2gh	1.3de	45.6f	21.4b	44.6g
	2	62.3de	1.6abc	32.0b-f	4.2cde	5.5d-h	1.3b-e	50.7b	18.3c	61.6d
	3	72.0c	1.0abc	30.0c-g	5.5bc	6.5a-g	1.3b-e	49.2cde	18.4c	71.2b
	4	69.3cd	2.0abc	32.0b-f	5.1cd	5.9c-g	1.3cde	48.2e	15.3e	61.5d
	5	72.6c	2.6ab	38.0abc	7.7a	6.8a-d	1.7a	42.1h	29.4a	65.9c
	6	105.0a	2.6ab	31.0c-f	8.0a	6.4a-g	1.8a	42.0h	7.3l	26.8i
	7	61.3def	1.0abc	39.3c-g	5.4bc	6.7a-e	1.4bcd	50.5b	13.5fg	50.1f
	8	60.0def	0.0c	20.6ghi	2.8e	3.8i	1.3b-e	54.1a	8.6k	36.4h
	9	60.3def	0.0c	19.6hi	5.1cd	6.3b-g	1.4bcd	48.9de	11.5i	44.7g
	10	64.6cde	0.6bc	26.6d-i	5.0cd	6.0b-g	1.3b-e	44.2g	12.7ghi	50.5f
	11	71.6c	2.0abc	38.3abc	5.4bc	6.6a-f	1.4bcd	49.7bcd	16.5d	58.0e
	12	61.6def	0.0c	23.0fi	4.8cd	5.2gh	1.5b	50.6b	13.3gh	67.7c
	13	81.0b	2.0abc	40.3ab	7.2ab	7.7a	1.5bc	49.9bcd	11.6i	45.6g
	14	68.0cde	0.0c	23.0fi	4.1cde	5.9c-h	1.3cde	45.3f	15.0e	49.4f
	15	72.6c	3.0a	41.6a	4.1cde	6.0b-g	1.2de	50.1bc	7.3l	27.0i
	16	87.6b	1.3abc	32.6a-e	5.3bc	5.3fgh	1.7a	42.3h	10.1j	24.0j
	17	69.0cde	0.6bc	34.3a-d	9.0a	7.3ab	1.7a	49.9bcd	21.6b	99.3a
	18	38.6g	0.0c	18.6i	4.3cde	5.4c-h	1.5b	42.0h	13.6fg	48.7f
	19	39.3g	0.6bc	23.3e-i	5.4bc	5.4c-h	1.5b	50.3bc	12.5ghi	49.1f
	20	52.6f	1.6abc	28.0d-h	3.1de	4.6hi	1.2e	50.7b	12.2h	37.1h
L.S.D		8.1	1.8	8.0	1.7	1.1	0.1	0.9	1.1	2.5

number of branches, days to flowering and number of leaves), number of pods/ plant, pod weight/plant and pod characteristics such as length, diameter, weight. The differences between values were highly significant in all lines and both original cultivars, *i.e.* Balady and Sabiahia. In this concern, the only mutant line number 5 from cultivar Sabaiaha that green pod had high pod yield because of high number of pods. These results were similar with earlier reports, Malani *et al.* (1993) reported effectively of gamma rays induced mutation in okra cv. selection 2-2 with gamma irradiation (10 to 60 KR). The more altered range of characters arising from occurrence of polygenic mutation with equal frequencies towards positive and negative directions as reported by Singh and Singh (1998). It seems that mutagenic treatments were very effective in inducing macro mutations for desirable traits which corresponded well with previous studies in okra by Sharma and Arora (1991), Kulkarni and Nerkar (1992) and Jadhav *et al.* (2013). The dose of gamma rays radiation is important for inducing genetic variation that can lead to quantitative and qualitative changes (Kiong *et al.*, 2008). These desirable mutants may be useful and valuable in okra improvement program. Of course, it must be noticed that the useful mutant isolated through the present study need to be tested further on a wider scale to establish any changes in chromosome or allele frequency also to assess its performance in later generation. Generally, it can be concluded that mutant line 5 from cultivar "Sabahia" with green pod was the best in pod yield and pod characters comparing with the commercial cultivars.

CONCLUSION

Induced mutation is a valuable breeding tool for inducing new genetic recombination and selectsuseful lines with desired traits in okra. The present study made an extensive phenotypic evaluation from M_1 to M_3 generations which enabled us to select promising mutant lines with higher pods yield in M_3generation. These lines could be valuable genetic resources for genetic improvement and breeding of okra in Egypt. Further selection and improvement are needed for testing mutant lines for adaptability and stability under different environments under large-scale production for releasing new improved okra cultivars.

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التحسين الثمري والبذري لمحصول الباميا عن طريق إستحداث الطفرات

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تواجه زراعة الباميا في مصر صعوبات بسبب انخفاض المحصول ويرجع ذلك الى نقص في الأصناف المحسنة لذلك أجريت الدراسة خلال ثلاثة مواسم متتالية إبتداء من 2017 حتى 2019 على نباتات الباميا صنفي بلدي وصبحيه المنزرعة بمزرعة خاصة بمحافظة كفر الشيخ - مصر. وذلك بهدف استحداث اختلافات وراثية يمكن استخدامها في تحسين محصول الباميا حيت تم استخدام جرعات مختلفة من اشعة جاما (صفرو 10 و 20 و 30 و 40 كيلو راد) وتم دراسة تأثير الجرعات على خصائص النمو المختلفة والتبكير والمحصول ومكوناته بالإضافة الى الاختلافات الوراثية على الجيل الأول والثاني والثالث (M_1, M_2, M_3).

أظهرت النتائج وجود فروق معنوية بين نباتات الجيل الأول من الناحية المورفولوجية بالإضافة الى وجود اختلافات وراثية بين نباتات الجيل الثاني والثالث. كما أوضحت النتائج وجود زيادة معنوية في سلالات الجيل الثالث المنتخبة وخاصة السلالة رقم 5 الناتجة من الصنف صبحيه ذات القرون الخضراء في خصائص المحصول مثل (عدد القرون/نبات).

التوصية: توصي الدراسة الى ان استخدام اشعة جاما (من أفضل وأقصر الطرق الفعالة) في تحسين الباميا مع عمل تقييم لتلك السلالة تحت ظروف إجهاد مختلفة وذلك للحصول على صنف جديد ذو إنتاجية وجودة عالية.

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