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EVALUATION OF EFFECT OF GAMMA RAYS ON SESAME GENOTYPE TTVS 51 AND TTVS 19 IN M_1 GENERATION

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ABSTRACT

Sesame (*Sesamum indicum* L. syn. *S. orientale* Linn.) genotypes TTVS 51 and TTVS 19 was exposed to variable doses of gamma rays to study their consequence on several characters like plant height, number of branches, days to 50% flowering, Number of capsule per plant, thousand seed weight and single plant yield. In M_1 generation the results disclosed that there was more reduction at higher doses compared to lower doses for all the characters. The findings were obtained in this study evidently indicate the difference doses of gamma rays can be successfully utilized to create variability for various quantitative traits of this crop.

INTRODUCTION

Sesame (*Sesamum indicum* L. syn. *S. orientale* Linn.) (2n = 26), is a well-known oil seed crop that belongs Pedaliaceae family. The genus *Sesamum* contains over 30 species of which *S. indicum* is the most commonly cultivated (Kobayashi *et al*., 1990). It was cultivated and domesticated in the Indian subcontinent during Harappan and Anatolian eras (Bedigian, 2003). Modern genetic studies revealed that mutation occurs in DNA sequence and result in changes which occur within the limits of a single gene. The most of the gene mutations show recessive inheritance. On the other hand a dominant mutation occurs at a very low level. The mean seed yields of sesame are very low, although potentially they could considerably be higher. Low yields are due to lack of improved cultivars, low harvest index, susceptibility to diseases, seed shattering, indeterminate growth habit, asynchronous capsule ripening and abiotic stresses. Improvement in sesame has been low due to limited exchange of knowhow materials. Research in main areas of adaptation is limited and in developed countries, it is a minor crop with little or no attention. Moreover, sesame is not dealt with by any of the international agricultural research centres. Therefore, it is necessary to evolve new strategies in crop improvement programme to increase the productivity of the crop particularly for poor/marginal soil under Indian conditions. Sesame has a wide range of genetic variability in its extensive germplasm collection. However, certain highly desirable traits have not been found so far, including good seed retention, resistance to certain diseases, modified plant architecture, lustrous white seed, etc., (Ashri 1988). Therefore, induced mutation can be used to enhance the genetic variability of sesame so that desirable characters can be easily identified in large segregating populations. Sesame improvement is still in its infancy and yield improvement achieved through conventional breeding procedures has been only marginal. Most of the crop improvement for yield in sesame is being attempted through conventional breeding methods by exploiting the natural variability available in the germplasm. However, to isolate the most attractive useful genotypes, adequate variability is not available in the existing germplasm. Under such circumstances, induced mutagenesis can be efficiently employed as an alternative or supplement

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source (Brock, 1971) to increase the variability in quantitative characters. Creation of variation is the core for any successful crop improvement programme. Among various breeding methodologies, mutation breeding is known to achieve rapid genetic changes in the targeted material for crop improvement. The mutation breeding has been found to be a potent and handy tool to induce new and additional variability in both the quantitative and qualitative characters. In this context this study was undertaken to study the effect of gamma rays on quantitative traits to induce the variation in two genotypes, namely TTVS 51 and TTVS 19.

MATERIALS AND METHODS

Two promising genetically pure sesame genotypes namely, TTVS 51 and TTVS 19 obtained from Oilseed Research Station, Tindivanam were chosen to study the effect of the gamma radiation on quantitative traits. Well filled seeds having a moisture content of 9 per cent were used as seed sample for irradiation. One gram of seeds per treatment was packed in butter bags and Gamma irradiation (250Gy, 350Gy, 450Gy, 550Gy and 650Gy) was done through the gamma chamber (GC 1200) installed by the Board of Radiation and Isotope Technology (BRIT), Govt. of India, Mumbai at the CPBG, TNAU, Coimbatore where cobalt-60 was loaded as the source of gamma irradiator. This chamber could operate in both automatic and manual modes. The specific time period for different doses depended upon the dose rate and the capacity of Co-60 source available in the chamber at the time of treatment. Five doses of gamma irradiated seeds in each of the two genotypes (TTVS 51 and TTVS 19) were sown immediately in the field along with control in a Randomized Block Design with three replications by adopting a spacing of 30 cm between rows and 30 cm between plants. The experimental plots were boarded with untreated sesame plants. All the recommended agronomic practices and plant protection measures were followed uniformly for all the treatments. This study aims to study the effects of gamma rays on seed germination, seedling survival, plant height on 30th day, days to 50% flowering, plant height at maturity, number of branches per plant, number of capsule per plant, 1000 seed weight and single plant yield were recorded based on mean performance.

RESULTS AND DISCUSSION

Evaluation of the effects of mutagen in M_1 generation is a common procedure in any mutation breeding experiments. Physical mutagens induce physiological damages (injury), gene mutations (point mutations) and chromosomal mutations (Chromosomal aberrations) in the biological material in M_1 generation (Gaul, 1970). The biological damages caused by the mutagens in M_1 generation could be measured based on seed germination, survival reduction (lethality), plant growth reduction (injury) and fertility reduction (sterility). Gaul (1970) reported that the damage to the biological material as reflected in the above parameters might be considered as an indication of the mutagenic effects. As similar to aforesaid findings, the following different M_1 damages (effects) have been studied in the present investigation with sesame. The mutagenic effects for the dose ranging from 250 Gy to 650 Gy were presented in Table 1. The effect of gamma rays on quantitative traits were studied in all the doses (250, 350, 450, 550 and 650Gy) like seed germination, seed germination, seedling survival, plant height on 30th day, days to 50% flowering, plant height at maturity, number of branches per plant, number of capsule per plant, 1000 seed weight and single plant yield. Effects of gamma rays on these traits are furnished in Table.1 and 2. All the mutagenic treatments showed a gradual reduction of mean performance over control with increasing doses/concentrations.

Germination

The germination percentage recorded on 7th DAS. The percentage of seed germination progressively decline with increasing dose of the mutagen in both the varieties and its showed highest reduction at 650Gy. The decrease in germination due to mutagenic treatment observed in the present study was also in conformity with the earlier reports of Prabhakaran (1992), Anitha Vasline (1998), Radhakrishnan *et al.* (2001), Shivaji gohini *et al.* (2001), Sheebha *et al.*(2003) and Mensah *et al.* (2007) in sesame, Jegadeeswaran (1989) in groundnut, Shamsi (1981) in sunflower, Ahmed John (1991) and Deepalakshmi (2000) in blackgram, Gunasekaran (1992), Thimmaiah *et al.* (1998) and Rizwana Banu (2000) in cowpea, Yashin Jashima (2000) in soybean. The gradual reduction in seed germination percentage was noticed corresponding to an increase in the dosage of treatments for both the varieties TTVS 51 and TTVS 19. The survival percentage of germinated seedlings was also found to be decreasing progressively with the increase in dosage of gamma rays. The LD_{50} for germination and survival was around 350 – 450 Gy for both the genotypes studied. This finding was in agreement with the report of Ganesh kumar *et al.* (2001) in sesame. The high proportion of seedling lethality observed. Mutagenic treatment may be associated with weakening of intra – chromosomal linkage or to accumulation of deleterious mutations at genomic level. The reduction in germination was due to the alkylation of sulphahydral (-SH) group of important proteins causing death of the seeds (Ehrenberg *et al.,* 1966).

In accordance with the above findings, in the present investigation, at higher dosage of mutagens, the seed germination got delayed and the seedlings were shorter which subsequently died in a short period. This might be due to the effect of mutagens by which, affected seedlings after the cotyledonary emergence remained alive only for a particular period of time. The mutagenic sensitivity of a biological material can be attributed to the level of differentiation and development of embryo at the time of treatment and also to the extent of damage to the growth processes like rate of cell division, cell elongation, various stages of hormone and biosynthetic pathways observed by Scholz and Lehman (1962). The reduction in germination per cent due to treatment may be attributed to a drop in the auxin level or chromosomal aberrations as reported by Reed (1959) and Sparrow (1961). In the present study, the characteristic feature of effect of irradiation in dicots seems to be that, the affected seedlings, after the emergence of cotyledonary leaves, remain alive in the critical stage for a considerably long time (Dubinin, 1964). During this phase there is some type of repair or unaffected cells after the primary shoot dies or the so called irtrasomatic or diplontic selection (Gaul, 1958) takes place and unwanted cells and other disturbances detrimental to the plant are eliminated, alternatively, the seedlings are not able to overcome the radiation damage and hence they die without putting forth any

Table. 1. Effect of gamma rays on germination, survival on 15th and 30th day, plant height on 30th day, days to 50% flowering and Plant height at maturity in M_1 generation

Treatment	Germination (%)		Survival on 15th day		Survival on 30th day		Plant height on 30th day		Days to 50% flowering		Plant height at maturity	
	TTVS 51	TTVS 19	TTVS 51	TTVS 19	TTVS 51	TTVS 19	TTVS 51	TTVS 19	TTVS 51	TTVS 19	TTVS 51	TTVS 19
0 Gy	87.00	88.17	87.00	88.17	86.17	87.83	19.55	12.95	45.00	43.33	122.25	110.69
250 Gy	60.00	66.00	68.32	73.33	68.66	63.33	12.33	12.31	45.00	44.33	109.67	103.72
350 Gy	55.33	54.33	57.66	54.00	53.33	52.66	12.24	11.29	49.67	43.67	102.67	96.04
450 Gy	48.00	43.67	44.66	47.33	45.33	40.33	10.86	11.39	45.67	46.33	101.97	95.71
550 Gy	41.67	34.67	36.33	40.66	36.64	31.00	9.81	11.05	47.67	48.00	100.16	89.43
650 Gy	30.33	30.33	29.00	35.00	32.00	24.97	9.19	8.17	50.67	49.00	92.72	82.20

Table. 2. Effect of gamma rays on No. of Primary and secondary branches/plant, number of capsule/plant, 1000 seed weight, number of seeds per capsule and single plant yield in M_1 generation

Treatment	No. of primary branches/plant		No. of secondary branches/plant		Number of capsule/plant		1000 Seed weight		Number of seeds per capsule		Single plant yield	
	TTVS 51	TTVS 19	TTVS 51	TTVS 19	TTVS 51	TTVS 19	TTVS 51	TTVS 19	TTVS 51	TTVS 19	TTVS 51	TTVS 19
0 Gy	4.54	4.05	2.27	2.40	195.42	163.04	3.79	3.64	59.36	59.91	43.96	35.44
250 Gy	2.24	3.34	1.27	2.33	157.06	103.69	3.43	3.08	63.64	60.18	34.16	19.20
350 Gy	2.30	2.58	1.47	2.00	98.30	111.74	3.39	3.33	59.85	52.51	19.96	19.47
450 Gy	3.10	2.69	2.00	1.53	141.80	169.79	3.76	3.67	67.54	63.81	36.07	39.80
550 Gy	2.06	2.19	1.83	1.60	112.88	87.98	3.84	4.08	61.97	62.29	27.28	22.29
650 Gy	3.94	5.22	2.20	2.20	154.05	287.60	3.59	3.35	58.74	62.55	32.51	60.13

side shoots. The seedling mortality was reported to be due to the assimilation mechanism (Quastler and Baer, 1950), inhibition of auxin synthesis (Skoog, 1935), chromosomal damage and inhibition of mitosis (Gunkel and Sparrow, 1961).

Survival on 15th and 30th day

In the present study, the survival of the seedling was reduced with increase in dosage of gamma rays. The maximum percentage of reduction was noticed in 650 Gy in both the cases. Also, the increase in survival had an inverse relationship with in dose of mutagens. Similar trend of relationship was formed in sesame by Pugalendi (1992), Cagirgan (1996), Govindarasu *et al.* (1997), Anitha Vasline (1998), Sasikala and Kamala (1988), Khin Mar Mar New (2001) and Mensah *et al.,* (2007). Survival rate was less in TTVS 51 when compared to TTVS 19 on 15th day and vice versa in 30th day. The differential sensitivity of genotypes may be attributed to their metabolic processes affected in differential manner, either by mutagen uptake or degradation and sites of action in the embryo (Ahmed John, 1996).

Plant height on 30th day

The highest and lowest seedling heights were observed in 250 Gy and 650 Gy respectively in TTVS 51. The 350 Gy and 450 Gy had similar effect on reduction in plant height. And the reduction was dose dependent. The highest and lowest seedling heights were observed in 250 Gy and 650 Gy respectively. Similar results were observed in soyabean (pepol and pepo, 1989).

Days to 50 per cent flowering

The mutagenic treatment resulted in delayed flowering in both the genotypes. Related results have been recorded in soyabean by Raut et al. (1982); patil et al. (1985); Pavadai and Dhanavel (2004 and 2005); mungbean by Khan and Wani (2005).

Quantitative traits

The mutagenic effects on quantitative traits were studied in field grown plants and the observations are presented in Table. 2. Plant height at maturity, number of primary and secondary branches, number of capsule per plant, 1000 seed weight and single plant showed a decreasing trend with few exceptions for the mean values with increasing dosage of treatment. Number of seeds per capsule shows increasing trend for the mean values with increasing dosage. A delayed flowering for the treatments compared to the control was noticed in both the genotypes. These findings were in agreement with the previous reports of Rangaswamy (1980), Prabhakar (1985) and Rahman and Das (1989) and Govindarasu (1995). In contrary, Kamala and Sasikala (1983) reported that the mutagenic treatments increased the mean values of plant height in the M_1 generation. Negative shift in the mean value following mutagenic treatment have been reported as a gradual phenomenon attributed to the occurrence of deleterious or harmful mutations whose frequency was more than the mutations of desirable nature (Virupakshappa *et al.,* 1980). Reduction in capsule number due to mutagenic treatment observed in the study may be due to a probable inhibitory action of enzymes, changes in the enzyme activity and the toxicity of the mutagen on these attributes.

The marked reduction caused by mutagens in seed yield per plant can be attributed to high seed sterility as caused by physiological and biochemical disturbances in the development of seeds (Rangaswamy, 1973 and Prabakaran, 1992). The decline in yield could also be probably due to indirect influence of altered yield contributing components. All the treatments of gamma rays showed positive shift for number of secondary branches per plant in both genotypes. Some of the treatments shows increased mean values for number of branches per plant observed in the present investigation were in agreement with the report of Kamala and Sasikala (1983). Increase in number of branches per plant might be due to stimulation or activation of auxiliary buds in M_1 plants as a result of mutagenic treatments.

Conclusions

Quantitative traits were proportionately decreased with increased in dose of gamma rays in both the genotypes of sesame. This is due to physiological disturbance or chromosomal damage caused to the cells of plants. Based on the breeding objective we can select the plant especially improved yield by selecting correlated quantitative traits to achieve higher yield. On the other hand, we can select for pest/diseases resistance, improved oil content and seed coat colour.

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