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Effect of gamma rays, hydroxylamine and maleic hydrazide on germination, plant survival and pollen viability in sesame (*Sesamum indicum* L.)

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Abstract
An experiment was conducted at research farm, R.B.S College Bichpuri, Agra, to study the effect of mutagens on germination, plant survival, pollen viability in sesame under the laboratory condition. The result showed that the germination was reduced due to increase mutagenic dose in the treatments 20kR + o.2HA %, 20kR+ 0.2% MH, 0.2% HA, 0.2% MH and 0.2% HA + 0.2% MH except 0.1% MH. Under laboratory condition seedling vigor index was found highest in the treatment 15kR followed by 0.1% MH wet and dry control. Under field condition highest germination percentage was recorded under wet control followed by dry control and mutagenic treatments. The plant survival decreases with increase the dose of gamma rays, concentration of chemical mutagen and their combination. Highest pollen viability was observed in dry control followed by wet control and decrease with dose of gamma rays chemical mutagen and their combination treatment.

Keywords: Mutation, Sesame, Gamma rays, Hydroxylamine and Maleic hydrazide

Introduction
Among the oilseeds, sesame (*Sesamum indicum* L.) is an important and ancient oil yielding crop. It is also known as Til, Gingerly Benniseeds, Simsim, Tillinuvrulavellvor and Rasi. Africa is considered to be the primary centre of origin due to presence of diverse wild species. It belongs to the family pedaliacae, which comprises 16 genera and 60 species, distributed over tropical South Africa, South East Asia and tropical Australia. India and Japan are considered secondary centre of origin. Sesame has been cultivated from centuries in India, China, Pakistan, Japan and Africa. Recently it is introduced to Mexico, Central America, South America and United States. (Kar and Swain 2005) [1]

Sesame is rich source of edible oil containing about 46 to 52 percent and highest recorded as 60% in Russia. Fats are highly stable and do not develop rancidity in its oil as compared to other oils, leading to loss of flavor and vitamins. Besides, its oil contains two sulphur containing amino acids, cysteine and methionine, maximum is cysteine content and with appreciable quantity of methionine. An anti-oxidant "Sesamol" enhances its keeping quality for a long time. The chemical analysis of sesame seed reveals the composition of water 5.8 percent, crude fibre 3.2 percent and carbohydrate 18 percent. Sesame seed is a rich source of linoleic acid, vitamins E, A, B1, B2 and niacin and minerals including calcium (1.0%) and phosphorous (0.77%.) (Kar and Swain 2002) [2].

Sesame has remarkable antioxidant function due to the presence of lignin and tocopherol. The seed, highly rich in quality proteins and essential amino acids, especially methionine is considered rejuve native and anti-aging for human body. The seeds are used in the preparation of baby foods considered as the best substitute for mother's milk to compensate the breast-feeding. The oil with 85 percent unsaturated fatty acids, is highly stable and has reducing effect on cholesterol and prevents coronary heart diseases. Sesame is grown in all seasons of the year and being a short duration crop, fits well into various cropping systems (Mohsina and Datta, 2006) [3].

Material and Methods
The experiment was conducted in *kharif* Season at Agricultural Research farm, R.B.S. College, Bichpuri, Agra, U.P. situated 11 Km from Agra in West on Agra-Bharatpur Road, at

27.2º Nlatitude and 72.9º E longitude and 163.4 m above the mean sea level (MSL).

The experimental material consisted of Gujarat Til-1 variety of sesame, which was procured from National Seed Corporation, as a certified seed. The variety produces white seeds and much popular among the farmers of western Uttar Pradesh. The seeds of sesame were got treated with gamma rays doses of 15, 20, 25, 35, 45 and ^{60}CO kR at CIMAP Lucknow, U.P. The source of gamma rays was gamma chamber containing and for combinations treatments of radiation and chemical, the seeds treated with 15 & 20 kR gamma rays were soaked in 0.1 and 0.2 recent aqueous solutions each of hydroxylamine and maleic hydrazide and in combination of both for 6 hrs (Das and Haque, 1997) [5]. Volume of solutions was kept 10 times approximately to the seed volume. A detailed account of treatments is tabulated as under.

Single Treatment

1. Dry Control
2. 15 kR
3. 20 kR
4. 25 kR
5. 30 kR
6. 45 kR
7. 60 kR
8. Wet control

Combined treatments of radiation and chemical

9. 15 kR + 0.1% HA
10. 15 kR + 0.1% MH
11. 20 kR + 0.2% HA
12. 20 kR + 0.2% MH

Single & Combined Treatments of Chemicals

13. 0.1% HA
14. 0.1% MH
15. 0.2% HA
16. 0.2% MH
17. 0.1% HA + 0.1% MH
18. 0.2% HA + 0.2% MH

Raising the M_1 Generation:

50 seeds of each of the treatments were placed in Petri dishes lined with blotting paper and one forth filled with water, these were replicated 2 times. The Petri dishes were kept in growth chamber at 28±2 ºC temperature and 55±5 percent humidity (Mohsina and Datta, 2006) [3].

To raise the M_1 generation the above treated 200 seed of each of the treatment were sown at first shower of monsoon of July 2012 at Agricultural Research Farm of R.B.S. College, Bichpuri, Agra in Randomized Block Design with three replications, each accommodating 5 rows of 4 meter length and spacing of 45X10 cm. before sowing, seeds treated with chemicals and thoroughly washed in running water for 30 minutes. Untreated dry seeds were used as dry control and untreated seeds soaked in water for six hours as wet control (Boranayaka *et al*. 2010) [6].

Observation in M_1 generation in the field

1. **Germination percentage:** Germination counts were taken from the material sown in the field as control and treated population after five days of sowing.
2. **Plant Survival:** Plant survival in the field was counted after 4 weeks of germination. The morality percentage in each of the treatments was also calculated.
3. **Pollen Viability:** Pollen viability was determined in ten randomly selected plants in each treatment (in each plant five flowers were randomly selected by straining the pollen with two percent acetocarmine solution. Pollen grains stained fully were regarded as viable (fertile) while empty, partially stained and shriveled ones as sterile. The count were converted to percentage and averaged out.

Result and Discussion

Germination percentage

A perusal of the table under reference reveals that under laboratory conditions the germination was reduced due to mutagenic treatment and of became zero in some of the treatments. Single treatment (0.2% HA, 0.2% MH), combination of radiation and chemicals (20 kR + 0.2% HA, 20 kR +0.2% MH) and combination of chemical 0.2% HA + 0.2% MH were observed as lethal dose. While, the radiation treatments of 15 kR, 20 kR and chemical treatments of 0.1% MH did not show a considerable reduction in germination percentage.

Root length

A perusal of table 4.1 reveals that under laboratory conditions the maximum root length (28 mm) was observed in 15 kR as compared to dry (22 mm) and wet control (24 mm), with minimum (15 mm) being recorded in 60 Kr. A high reduction in root length was recorded in combination treatments of 15 kR + 0.1% HA, 15 kR + 0.1% MH and a low reduction in sole chemical treatments 0.1% HA, 0.1% MH and 0.1% HA + 0.1% MH was observed. Except 60 kR in treatments of radiations, the root length was increased in all the treatments over the dry control.

Shoot length

Table 1 reveals that under laboratory conditions, the maximum shoot length (75 mm) was in 0.1% MH being followed by in 15 kR and 25 kR and these estimates were higher than in controls. The minimum (56 mm) shoot length was observed in 60 kR and remaining other treatments also showed reduction in shoot length.

Seedling vigor index

Table 1 shows highest seedling vigor index (6528) in 5kR being followed by (6450) in 0.1% MH, (5336) wet control and (5060) dry control. The lowest (1980) was recorded in 60 kR. Other treatments have estimates between highest and lowest index. There is a reduction in seedling vigor index with increasing radiation doses. Combination treatments also decreased the index.

A. Field Observations

Estimates of mean germination, plant survival and pollen viability percentage

Table 2 presents the estimates of mean, germination percentage, plant survival percentage up to 4th week of germination and pollen viability percentage under field conditions. Their detail is as under –

Germination percentage

The highest (63 per cent) germination was recorded in wet control followed by (62%) in dry control 25 kR (52%), 30 kR (51%), 20 kR (48%), 45 kR (38%), 60 kR (32%) with the minimum (17%) being under 20 kR + 0.2% HA treatment. Higher doses of gamma rays and combination treatment

(gamma rays + HA and MH) reduce the germination percent up to 50% as compared to dry control indicating their drastic effect on the same.

Plant survival percentage

The attribute, plant survival percentage in the field condition exhibited a wide range of variation from 96% in 20 kR treatment (100% as compared to control) to 62% in 20 kR + 0.2% MH (64.5% as compared to 95% in dry) and 96% in wet control. Table 2 also reveals that highest dose of gamma rays, highest concentration of chemical mutagen and combination treatments show high decrease in plant survival thus have hazardous effect. The similar observation has been also recorded by the researchers (Diouf *et al.* 2010, Ghulam *et al*. 2008 and Yingzhong, 2003) [7, 8, 9].

Pollen viability percentage:

The attribute pollen viability percentage showed a range of variation from 38% in (20kR + 0.2%HA combination treatment) to 82% in control population. From the table 2 it can be clearly seen that the pollen viability percent was decreased with the increasing dose of gamma rays signally and in combination treatments.

Table 1: Estimates of mean germination percentage, root length, shoot length and seedling vigor index in M_1 generation (in laboratory)

S. No.	Treatments	Characters			
		Germination (%)	Root length (mm)	Shoot Length (mm)	Seedling vigour index
1	Dry control	70	22	55	5060
2	15 kR	65	28	68	6528
3	20kR	68	23	50	4550
4	25kR	60	24	60	5040
5	30 kR	60	23	55	5565
6	45kR	61	22	54	4482
7	60 kR	40	15	36	1980
8	Wet control	68	24	58	5336
9	15kR+ 0.1% HA	50	20	38	2660
10	15kR + 0.1% MH	55	17	52	3744
11	20 kR + 0.2 % HA	0	0	0	0
12	20 kR + 0.2 % MH	0	0	0	0
13	0.1% HA	45	20	38	2470
14	0.1% MH	67	19	75	6450
15	0.2% HA	0	0	0	0
16	0.2% MH	0	0	0	0
17	0.1% HA + 0.1%MH	44	20	50	3200
18	0.2% HA + 0.2% MH	0	0	0	0

Table 2: Estimates of Germination Percentage, Plant Survival and Pollen Viability in Field Condition in M_1 Generation

S. No.	Treatments	Characters		
		Germination (%)	Plant survival (30 Days)	Pollen viability (%)
1	Dry control	62	96	82
2	15 kR	50	95	76
3	20kR	48	96	76
4	25kR	52	90	74
5	30 kR	51	92	66
6	45kR	38	85	62
7	60 kR	32	74	50
8	Wet control	63	95	81
9	15kR+ 0.1% HA	20	73	52
10	15kR + 0.1% MH	21	70	56
11	20 kR + 0.2 % HA	17	68	38
12	20 kR + 0.2 % MH	18	62	42
13	0.1% HA	35	80	57
14	0.1% MH	33	85	61
15	0.2% HA	22	63	48
16	0.2% MH	24	64	45
17	0.1% HA + 0.1%MH	25	58	36
18	0.2% HA + 0.2% MH	23	64	40

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