



Research Article

Induced variability in quantitative characters of groundnut (*Arachis hypogaea* L.)

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Abstract:

Groundnut genotype AK-280 was treated with EMS 40 mM, 60 mM, gamma rays 30 kR, 40 kR, 50 kR and combination treatment of EMS 20 mM + gamma rays 20 kR. The observations on various quantitative characters were recorded in M₂ generation. The flowering and maturity period was not much affected. For the character height of main axis genotype showed differential response to different treatments of mutagens. Significantly reduced height was observed in 40 kR gamma rays (7.57 cm) as compared to control. Lower doses of EMS (40 mM) and combined treatment of EMS 20 mM + gamma rays 20 kR proved effective in increasing the number of primary branches. Significant increase in number of secondary branches was observed in various treatments. Significant reduction in number of hanging pegs per plant was observed in 40 kR treatment. Number of matured pods per plant were found decreased in all the treatments except 40 mM EMS treatment. Pod yield per plant and kernel yield per plant were found increased in combined treatment of EMS 20 mM + gamma rays 20 kR. Hundred pod weight and hundred kernel weight was found increased in combined treatments and in lower dose of gamma rays (30 kR). Combined treatments and lower doses of mutagens were found effective in increasing sound mature kernel per cent. Shelling per cent and oil content were found increased in all the treatments. In the present investigation the combined treatment of EMS 20 mM + gamma rays 20 kR and gamma rays 40 kR alone were found more effective for inducing wide range of mutation in groundnut.

Key words :

Mutagenesis, EMS, gamma rays, groundnut, pod yield, kernel yield, shelling percentage, 100 seed weight

Introduction

Groundnut is a predominant oilseed crop in India ranking first among the edible oilseed groups. Groundnut kernels are the rich source of edible oil (40-55%) and proteins (22-28%). The breeding objective in groundnut is to develop varieties with high yield, early maturity, high protein and oil content, resistant to diseases and insect pests. To achieve these objectives and bring about desired improvement in crop, the most sophisticated technique of mutation breeding can be exploited by the plant breeders. Mutation breeding is an important method for inducing new variability, which is an essential requirement of any plant breeding programme in the changing agricultural pattern of the day. The present investigation was undertaken to study the variability for morphological and economical characters in groundnut occurring through mutagenesis by gamma rays and EMS alone as well as in combination in M₂ generation of groundnut.

Material and methods

The experimental material comprised of a promising groundnut genotype AK-280 obtained from Senior Research Scientist, Oilseeds Research Unit, Dr. PDKV, Akola. Matured and well filled 100 grams of seeds were used for each treatment. These seeds were irradiated with 20, 30, 40 and 50 kR doses of gamma rays at BARC, Trombay, Mumbai. For giving the ethylmethane sulphonate treatment, the seeds were presoaked in distilled water for 6 hours, immersed in freshly prepared 40 mM and 60 mM of EMS solutions for 12 hours with intermittent shaking. Combined treatment was given by first irradiating the seeds with 20 kR of gamma rays and then soaking in water for 6 hours and then giving the 20 mM EMS treatment for 12 hours. The seeds after chemical treatment were thoroughly washed under running tap water. These treated seeds along with one control were hand dibbled immediately after treatment during *Kharif* 2004 to raise M₁ generation at Oilseeds Research Unit, Dr. PDKV, Akola. All recommended package of practices were followed. The M₁ plants were harvested and bulked treatment wise to raise the M₂ generation. Sowing was done in non replicated

trial during late *Rabi* 2004 with protected irrigation facilities. The plot was sown on the basis of plant to row progenies with a spacing of 30x15 cm. The observations were recorded on 14 quantitative characters *viz.*, days to first flowering, days to maturity, height of main axis (cm), primary branches per plant, secondary branches per plant, hanging pegs per plant, number of immature pods per plant, number of mature pods per plant, pod yield per plant (g), kernel yield per plant (g), 100-pod weight (g), 100-kernel weight (g), sound mature kernel percentage and shelling per cent to study the nature and magnitude of induced polygenic variability in groundnut

Results and discussion

In mutation breeding programme the breeders are more interested in the extent of variability, which is more reflected by mean, range and standard deviation. The variation in mean of yield and its contributing characters of groundnut genotype AK-280 in M_1 generation is given in Table 1. During M_1 generation, most of the characters *viz.*, pod yield per plant, number of matured pods per plant, number of immature pods per plant, number of hanging pegs per plant, number of primary and secondary branches per plant, height of main axis and days to maturity showed increased variation in positive direction in most of the mutagenic treatments. Remaining characters such as shelling percentage, hundred pod weight, hundred kernel weight, sound matured kernel per cent and kernel yield were found to be decreased in most of the treatments. The results on mean, range and standard deviations in M_2 generation are given in Table 2.

The days to first flowering were found increased in most of the treatments. Its range was less affected by various treatments of EMS and gamma rays. The standard deviation was found decreased in all the treatments as compared to control. The mean values for days to maturity were found shifted in both the direction in different treatments of EMS and gamma rays as compared to their control. The maximum mean value was observed in 40 kR gamma rays. The evidence for early maturing mutants was given by Mathur *et al.* (1997) with EMS and DES in groundnut, while delayed maturity period has been reported by Motagi *et al.* (2000). Singh *et al.* (1988) reported that bi-directional shift of days to maturity in groundnut mutants was due to gamma irradiation.

Height of main axis was reduced significantly in 40 kR gamma rays (7.57 cm) as compared to control (9.43 cm). It was increased in all treatments except in 60 mM EMS (9.27 cm) and 40 kR gamma rays (7.57

cm). The maximum height of main axis was observed in combined treatment of EMS 20 mM + gamma rays 20 kR (10.13 cm). In general, the mean values for height of main axis were lower in treated population as compared to controls. The combined treatments have affected the plant height more than gamma rays alone (Kumar *et al.* 1997). The results for reduced height of main axis obtained are in conformity with those of Mathur *et al.* (1999). Naik and Nadaf (1997b) reported increased mean plant height in EMS and DES treated populations of groundnut with increased variance as compared to control. The number of primary branches were found to be increased in most of the treatments of EMS and gamma rays. It ranged from 4.27 in 40 mM EMS to 3.93 in 30 kR gamma rays. The treatment with lower dose of EMS and combined treatment of EMS and gamma rays showed increasing effect on this character.

Secondary branches per plant were increased significantly in most of the treatments. The standard deviation for this character was highest in 60 mM EMS treatment. Increased number of secondary branches due to EMS treatments has been reported by Mathur and Manivel (2000). The mean values for number of hanging pegs per plant was found negatively shifted in most of the treatments. The number of hanging pegs per plant was found to be maximum due to combined treatment of EMS 20 mM + gamma rays 20 kR, EMS 40 mM and gamma rays 30 kR respectively. The significant shift in negative direction was observed in treatment of gamma rays 40 kR. Similar results were reported by Mathur and Manivel (2000) with EMS and DES chemicals in groundnut.

The mean values for number of immature pods were significantly shifted in positive direction in most of the treatments. The minimum immature pods were recorded in treatments 40 kR gamma rays (6.10) followed by 60 mM EMS (6.60). The standard deviation was also found to be increased about two folds in the treated population as compared to control. With the unit increase in dose of gamma rays, alone or in combination with EMS, the mean value of immature pods per plant correspondingly decreased (Singh, 1998). The mean values for number of matured pods were shifted significantly in negative direction in all treatments of gamma rays and higher dose of EMS (60 mM). Positive shift was observed only in one treatment of EMS 40 mM (12.77) as compared to its control (12.70). The standard deviation was found increased in combined treatment of EMS 20 mM + gamma rays 20 kR (4.88) and 30 kR gamma rays (4.50) and 40 mM EMS

(4.17) as compared to its control (3.68). The range for pod yield per plant was found to be more in 30 kR gamma rays. The mean pod yield per plant was found significantly shifted in negative direction in most of the treatments of EMS and gamma rays while it showed increased values in combination treatment of EMS 20 mM + gamma rays 20 kR. The most decreased pod yields were found in higher dose of 60 mM EMS (5.88g) and 40 kR gamma rays (2.98g). Amongst treatments, the combination of gamma rays with EMS was found to be more effective in creating higher variability in the character dry pod yield (Kumar *et al.*, 1997). Decrease in pod yield due to mutagenesis has been reported by Singh (1998) in groundnut. Increase in pod yield as a result of mutagenic treatments was reported in groundnut by Pathirana *et al.* (1988).

The mean values were significantly shifted in negative direction in higher doses of EMS (60 mM) and gamma rays (40 kR and 50 kR). But it was found positively significant in combined treatments of EMS 20 mM + gamma rays 20 kR. Decrease in kernel yield per plant with increased dose of gamma rays alone or in combination with EMS was reported by Singh (1998). Ramanathan (1984) reported increased kernel yield per plant due to gamma rays and EMS in groundnut.

Maximum increase in hundred pod weight was observed due to combined treatment of EMS 20 mM + gamma rays 20 kR. The standard deviation was also found increased about two folds in the treated population as compared to control. Shift in mean values for 100-pod weight in both positive and negative direction has been recorded by Singh *et al.* (1988). The mean values for hundred kernel weight were found to be significantly increased due to combined effect of EMS 20 mM + gamma rays 20 kR and gamma rays 30 kR dose, while it was found decreased in EMS 40 mM treatment. The standard deviation for hundred kernel weight was also found increased in all the treatments. Increased 100-kernel weight was also recorded by Naik and Nadaf (1997a) with EMS and gamma rays in groundnut. Decreased 100-kernel weight in mutants was recorded by Gowda *et al.* (2002) in groundnut. The increase or decrease in the proportion of genes with positive or negative effects would have caused the shift in the mean of the treated genotype (Brock, 1965). The range for sound mature kernel per cent was found decreased in combined treatments of EMS and gamma rays while increased in higher dose of gamma rays (50 kR). The combined treatment of EMS 20 mM + gamma rays 20 kR and treatments with lower dose of gamma rays (30 kR and 40 kR) showed

increased mean values for sound mature kernel per cent. The maximum SMK per cent (90.69%) was recorded in combination treatment of EMS 20 mM + gamma rays 20 kR, while minimum were recorded in higher doses of EMS and gamma rays alone. The range of shelling per cent was found decreased in all the treatments. The mean values for this character was found to be shifted in positive direction in all the treatments but significant shift was observed in combined treatments of EMS 20 mM + gamma rays 20 kR (69.44%) as compared to control (57.34%). The standard deviation for the shelling percentage was found decreased in all the treatments. Increased shelling per cent due to EMS and gamma rays have been reported by Ramanathan and Rathinam (1983).

In general the mutagenic treatments had an adverse effect on the means of various characters. The study showed that the combination of gamma rays 20 kR + EMS 20 mM and gamma rays 30 kR alone were found more effective for creating significant variability in desirable direction in various characters studied *viz.*, number of secondary branches per plant, kernel yield per plant, hundred pod weight, hundred kernel weight and shelling percentage. Similarly, it is also concluded that it would be more pertinent to use the combination of physical and chemical mutagens for groundnut crop.

References

- Brock, R.D. 1965. Induced mutations affecting quantitative characters. *The use of induced mutations in plant breeding*. Rep. FAO/IAEA. Tech. Meeting Room, Pergamon Press Oxford. 443-450.
- Gowda, M.V.C.; Motagi, B.N.; Sheshagiri, R.; Naidu, G.K. and Rajendraprasad, M.N. 2002. Mutant 28-2: a bold seeded disease and pest resistant groundnut genotype for Karnataka, India. *Intl. Arachis Newsl.*, **22**: 32-34.
- Kumar, S.; Singh, D.N. and Shrivastava, S. 1997. Combined mutagenesis in groundnut (*Arachis hypogaea* L.). *Gujrat Agric. Univ. Res. J.*, **22** (1): 19-22.
- Mathur, R.K. and Manivel, P. 2000. Prediction of performance of segregating mutation generation in groundnut (*Arachis hypogaea* L.). *Annals of Agril. Res.*, **21** (2): 298-300.
- Mathur, R.K.; Manivel P. and Samdur, M.Y. 1999. Girnar-1 nlm-A new narrow leaf mutant of groundnut. *Indian J. Genet.*, **59** (4): 527-530.
- Mathur, R.K.; Manivel, P.; Gor, H.K. and Chikani, B.M. 1997. Effect of DES and EMS on field germination and survival in groundnut. *J. Oilseed Res.*, **14** (1): 122-123.
- Motagi, B.N.; Gowda, M.V.C. and Nigam, S.N. 2000. Oil recovery and quality as influenced by foliar diseases in groundnut. *Intl. Arachis Newsl.*, **20**: 87-88.



- Naik, S.I. and Nadaf, H.L.. 1997a. Differential response of groundnut genotype of chemical mutagenic treatment. *Crop Improv.*, **24** (2): 253-255.
- Naik, S.I. and Nadaf, H.L.. 1997b. Induced variability for quantitative characters in groundnut (*Arachis hypogaea* L.). *Crop Improv.*, **24** (2): 226-230.
- Pathirana, R.; Weersena, L.A. and Jayamanna, P.B. 1988. Induced mutations for improvement of groundnut and mungbean. *Improvement of Grain Legume Production Using Induced mutations: Proc. of Workshop, Pullman, Washington, USA.* 465-474.
- Ramanathan, T. 1984. Induced high yielding mutants in *Arachis hypogaea* (L.) *Madras Agric. J.*, **71** (2): 85-88.
- Ramanathan, T. and Rathinam, M. 1983. Induced qualitative mutations in groundnut. *Madras Agric. J.*, **70** (7): 427-432.
- Singh, A.B.; Singh, O.B. and Shrivastava A.N. 1988. Recurrent radiation in groundnut (*Arachis hypogaea* L.) *Farm Sci. J.*, **3** (1): 60-65.
- Singh, D.N. 1998. Variability and dose effect of gamma rays in combined mutagenesis of groundnut (*Arachis hypogaea* L.) *Annals of Agric. Res.*, **19** (1): 98-99.



Table 1. Variation in mean of polygenic characters in M₁ generation of groundnut genotype AK-280

Characters	Treatment Details						
	Control	EMS 40 mM	EMS 60 mM	20 kR γ rays + EMS 20 mM	30 kR γ rays	40 kR γ rays	50 kR γ rays
Days to first flowering	33.4	32.8	32.2	33.4	33.2	32.6	32.8
Days to maturity	117.2	115.8	117.0	118.2	118.2	117.8	118.4
Height of main axis (cm)	15.9	16.2	16.2	16.8	16.6	15.8	16.2
No. of primary branches per plant	5.0	5.8	6.0	4.8	5.0	5.0	5.4
No. of secondary branches per plant	0.0	0.0	1.2	0.2	0.0	0.0	0.0
Hanging pegs per plant	1.0	4.0	2.4	1.2	4.0	2.4	5.6
No. of immature pods per plant	2.6	2.8	1.6	3.2	3.4	2.4	5.6
No. of mature pods per plant	11.0	13.4	10.2	11.6	17.8	12.2	11.2
Pod yield per plant (g)	7.9	9.7	6.3	8.2	13.2	7.6	6.8
Kernel yield per plant (g)	5.1	5.9	3.2	4.7	7.6	4.3	3.4
Hundred pod weight (g)	95.5	91.1	78.0	87.9	85.5	84.0	76.5
Hundred kernel weight (g)	33.0	35.0	30.5	32.5	32.0	31.5	23.5
Sound mature kernels (%)	93.5	86.6	51.9	87.1	83.6	71.3	53.9
Shelling percentage	64.4	61.5	51.9	57.4	57.5	55.9	49.7



Table 2. Effect of mutagenic treatments on pod yield and its contributing characters in M₂ generations of groundnut genotype AK-280

Characters		Treatment Details						
		Control	EMS 40 mM	EMS 60 mM	20 kR y rays + EMS 20 mM	30 kR y rays	40 kR y rays	50 kR y rays
Days to first flowering	Mean	33.13	33.13	33.03	33.27	33.57	33.30	33.13
	Range	31-35	32-35	32-34	32-35	32-35	32-35	32-35
	SD	(1.01)	(0.97)	(0.81)	(0.87)	(0.97)	(0.95)	(0.90)
Days to maturity	Mean	117.63	117.56	117.87	117.53	117.57	118.13	117.70
	Range	115-120	115-120	116-120	115-119	115-119	116-120	115-120
	SD	(1.47)	(1.38)	(1.20)	(1.20)	(1.22)	(1.17)	(1.34)
Height of main axis (cm)	Mean	9.43	9.97	9.27	10.13	9.87	7.57**	9.80
	Range	7-13	6-14	4-16	6-19	6-17	5-13	5-15
	SD	(1.43)	(1.71)	(2.82)	(2.71)	(2.89)	(1.85)	(2.12)
No. of primary branches per plant	Mean	4.03	4.27	4.13	4.20	3.93	4.00	4.10
	Range	3-5	3-7	3-6	3-6	3-5	3-5	3-5
	SD	(0.41)	(0.78)	(0.63)	(0.55)	(0.64)	(0.59)	(0.48)
No. of secondary branches per plant	Mean	1.43	2.10	3.20*	3.07*	2.70*	1.87	2.70**
	Range	0-6	0-6	0-14	0-11	0-9	0-5	0-6
	SD	(1.74)	(1.86)	(3.99)	(3.13)	(2.38)	(1.48)	(1.70)
Hanging pegs per plant	Mean	7.73	9.83	7.23	8.03	9.10	3.30**	5.93
	Range	1-19	0-33	2-17	0-34	2-75	0-11	0-17
	SD	(4.98)	(7.24)	(3.48)	(7.38)	(13.10)	(2.34)	(4.96)
No. of immature pods per plant	Mean	6.90	8.50	6.60	8.07	8.20	6.10	7.40
	Range	2-12	3-22	1-13	3-17	4-16	1-16	2-20
	SD	(2.63)	(4.73)	(3.14)	(3.61)	(3.36)	(3.21)	(3.85)
No. of mature pods per plant	Mean	12.70	12.77	7.70**	11.03	10.10*	5.33**	3.70**
	Range	6-24	4-20	3-14	4-20	6-24	1-13	2-11
	SD	(3.68)	(4.17)	(2.84)	(4.88)	(4.50)	(3.14)	(1.93)
Pod yield per plant (g)	Mean	9.83	8.50	5.88**	10.44	10.22	4.43**	2.98**
	Range	3.7-14.6	2.0-18.5	1.0-12.2	3.2-21.0	4.2-21.0	0.8-14.5	0.5-8.4
	SD	(2.65)	(3.60)	(2.46)	(4.72)	(4.56)	(3.24)	(1.72)
Kernel yield per plant (g)	Mean	5.74	5.12	3.78**	7.18*	6.00	2.74**	1.94**
	Range	0.8-10.5	1.4-12.5	0.3-8.7	1.9-13.7	2.0-13.5	0.3-10.0	0.3-6.2
	SD	(2.43)	(2.78)	(1.90)	(3.23)	(2.51)	(2.25)	(1.30)
Hundred pod weight (g)	Mean	78.26	66.68*	76.93	91.16*	103.48**	76.90	80.89
	Range	47.77-142.00	41.54-109.23	45.55-124.20	46.25-198.75	53.00-181.67	16.00-153.33	25.00-165.00
	SD	(20.31)	(18.15)	(22.80)	(29.15)	(32.05)	(28.73)	(33.04)
Hundred kernel weight (g)	Mean	33.02	28.98	34.82	45.12**	41.70**	34.87	36.65
	Range	15.00-48.00	12.00-18.57	10.00-57.50	30.00-74.00	22.86-62.00	15.00-56.36	15.00-55.00
	SD	(8.62)	(9.61)	(11.05)	(9.90)	(8.98)	(10.24)	(11.02)
Sound mature kernels (%)	Mean	87.18	77.43*	85.01	90.69	90.89	91.11	83.87
	Range	51.85-100	37.50-100	50.00-100	63.64-100	50.00-100	59.26-100	30.0-100
	SD	(11.29)	(17.76)	(12.76)	(11.59)	(10.95)	(13.30)	(17.59)
Shelling percentage	Mean	57.34	58.79	62.88	69.44**	60.38	58.99	63.70
	Range	21.62-79.45	27.63-73.33	26.09-78.38	32.35-77.97	37.93-77.14	27.27-76.92	36.36-79.41
	SD	(16.85)	(12.82)	(14.61)	(9.06)	(11.94)	(11.22)	(11.96)

*Significant at t(tab) 5% (∞) = 1.960

**Significant at t(tab) 1% (∞) = 2.576