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VIABLE MUTATIONS INDUCTED BY GAMMA RAYS IN GROUNDNUT

K. Pushkaran and V. Gopinathan Nair
College of Agriculture, Trivandrum695 522, India

The lack of short duration varieties maturing in about 90 days is a limiting factor for large scale cultivation of groundnut in summer rice fallows during kharif as a rainfed crop. The groundnut crop has a delicately balanced system of genetic units capable of polydirectional changes and the embryo has many potential mutation sitas (Gregory, 1956a). Ashri and Goldin (1965) pointed out that the advantages and disadvantages associated with polyploids are felt in groundnut. Besides, the highly autogamus nature of the crop with delicate floral structure and the prevalence of genetic breakdown favours mutational approach against recombination breeding in the crop.

Materials and Methods

Ninety three groundnut varieties of diverse origin with wide variability were screened for the selection of high yielders under the upland conditions during kharif and rice fallows during summer. TG 14 and Spanish Improved were found to be superior with more or less stable yield and other desirable attributes in both the situations. But they are longer in duration by 15 days forthe summer rice fallows. Therefore, with the prime objective of evolving promising genotypas maturing in 90 days or less, to fit in the rice based cropping system during summer, a corrective breeding programme was attempted on the two promising varieties viz., Spanish Improved and TG 14 and the popular variety TMV 2 through induced mutagenesis. They are all 'bunch type' varieties, normally produce two seeded pods.

One hundred kernels each of the three varieties were irradiated with gamma rays at doses of 20, 30 and 40 krad at the Gamma Unit of the Tamil Nadu Agricultural University. The irradiated seeds were sown in two replications with 50 seeds each along with untreated control, adopting a randomised block design. Tha various M_1 effects were studied. The M_1 progeny rows were raised and M_2 effects observed. The progenies segregating for chlorophyll mutants were scored to calculate the mutation frequency per one hundred M_1 plants. The number of mutants and normal seedlings in all the progenies were counted to estimate the mutation frequency per one hundred M_2 plants. The different types of chlorophyll mutants were scored separately for calculating the spectrum. Mutagenic effectiveness and efficiency were estimated adopting the formulae proposed by Konzak *et al.* (1965). The progenies segregating for viable mutations were scored in M_2. Early mutants were spotted by rioting the days to first flowering and on the duration upto maturity.

Results and Discussion

Effects in the M_1 generation

Data relating to the effects of the three doses of gamma rays on the three genotypes in the M_1 generation are presented in Table 1. Germination of seeds was reduced by gamma rays and a progressive decline in germination with increasing dose was noticed in all the three genotypes. This is in consonance with the findings of Dorairaj (1979) and Sivasubramoniam (1979). The survival was reduced by gamma rays in all the genotypes and the relationship with doses of radiation was inverse. In tune with this, there were earlier reports by Gregory (1968) and Sivasubramoniam (1979). The frequency of survival could be an index of post germination mortality as a result of physiologic and toxic effects of radiation. Reduction in pfant height was observed in all the three genotypes on the 30th day and the effect was dose dependent as reported already by Sinha and Roy (1969). The height reduction noticed on the 45th day was negligible. The pollen fertility decreased with increasing doses of gamma rays, though the pattern of reduction was different in the three genotypes. Result of a similar trend was reported by Gregory (1968).

Table 1

Effects of gamma rays in the M_1 generation

Genotypes and gamma ray doses (krad)	Values as % of control				
	Germination	Survival on the 30th day	Plant height 30th day	Plant height 45th day	Pollen fertility
Spanish Improved					
20	93.0	87.2	90.2	99.7	95.9
30	89.5	80.2	82.4	96.9	87.3
40	81.4	69.8	69.4	95.8	82.2
TG 14					
20	96.7	93.2	87.0	100.0	90.9
30	90.0	78.4	85.0	97.8	82.2
40	90.0	76.6	71.1	97.0	68.8
TMV 2					
20	27.9	98.9	84.3	93.6	78.5
30	94.4	93.6	78.5	96.6	86.7
40	22.7	87.1	70.5	93.6	79.2

Plants "with chlorophyll deficient sectors were noticed in all the three varieties in low frequencies. Various sorts of morphological abnormalities were detected among the M_1 plants of all the varieties. Among them, stunted and dwarf types were important.

Effects in the M_2 generation

The data relating to mutagenic effects in the M_2 generation are presented in Table 2 and 3. The frequency of chlorophyll mutations increased with increasing doses of gamma rays in the three genotypes which is in conformity with the report of Sivasubramoniam (1979). Albina, xantha, chlorina and viridis were the chlorophyll mutants found and the relative percentage of these mutants varied in the different treatments, the most frequent being viridis and the least albina. A wide spectrum of chlorophyll mutants has been reported by Sivasubramoniam (1979).

No defenite relationship was seen in any of the genotypes between doses of radiations and mutagenic effectiveness. In TMV 2 and Spanish Improved, effectiveness was the highest at the highest dose of radiation tried (40 krad). Mutagenic efficiency based on the biological parameters such as lethality, injury and sterility too

Table 2

Frequency and spectrum of chlorophyll mutants in the M_2 generation

Genotypes and gamma raydoses (krad)	Mutation frequency		Spectrum (Relative percentage)			
	Per 100 M_1 plants	Per 100 M_2 plants	Albina	Xantha	Chlorina	Viridis
Spanish Improved						
20	2.94	1.12	...	...	...	100.0
30	3.57	2.08	...	...	33.3	67.7
40	11,43	3.20	...	25.0	25.0	53.0
TG 14						
20	4.76	1.15	...	...	33.3	67.7
30	12.50	4.42	...	20.0	40.0	40.0
40	15.09	5.06	12.5	12.5	25.0	50.0
TMV 2						
20	3.77	0.96	...	...	...	100.0
30	4.35	0.94	...	...	...	100.0
40	9.43	2.14	20.0	20.0	20.0	40.0
Total			5.7	11.4	22.9	60.0

did not show any specific relationship with doses of gamma rays in the genotypes. Differential responses among genotypes to varying doses of mutagens were reported by Dorairaj (1979) while Sivasubramoniam (1979) concluded that 30 krad is the most efficient dose.

Viable mutations

In all the three genotypes, a wide spectrum of both academically and economically significant viable mutants has been isolated. The details of these mutants are furnished in Table 4.

Early flowering mutants, in general, were found to be early maturing as well. Six mutants in TMV 2 and three each in TG 14 and Spanish Improved, maturing in as early as 85 days were recovered whereas Spanish Improved took 104 days and TMV 2 and TG 14 took 106 days for maturity. Twenty two mutants maturing in 90 days and 10 mutants maturing in 95 days were also isolated. Thus the exigent varietal requirements of short duration genotypes for summer rice fallows were achieved. The suggestion of Misra (1980) that induced mutagenesis is a tool for breeding for earliness in groundnut has proved to be fruitful. Early mutants were reported earlier by Patil and Thakara (1969) and Dorairaj (1979). As reported by Gregory (1968) late flowering and late maturing mutants were also detected.

Summary

The effects of gamma radiation at three doses (20, 30 and 40 krad) were studied in three selected genotypes of groundnut viz., Spanish Improved, TG 14 and TMV 2 with the prime objective of evolving early mutants. Observations on seed germination, seedling survival, plant height, pollen fertility and other effects were made. Chlorophyll mutation frequency, mutant spectrum, mutagenic effectiveness and efficiency were worked out.

Germination of seeds was reduced by gamma rays and a progressive decline in germination with increasing doses was noticed. The survival was also reduced in all the genotypes and the relationship between the percentage of survival and doses of radiations was inverse. A reduction in plant height was noticed in tha three genotypes on the 30th day. Pollen fertility deceased with increasing doses.

The frequency of chlorophyll mutations increased with increasing doses of gamma rays in all the genotypes; the maximum being for TG 14. Albina; xantha, chlorina and viridis were the chlorophyll mutants observed, of which viridis was seen the most frequent. No definite relationship was seen in any of the genotypes between doses of radiation and mutagenic effectiveness. In TMV 2 and Spanish Improved, effectiveness was the maximum at the highest dose of radiation tried (40 krad) while in TG 14, it was at the intermediate dose (30 krad). Mutagenic efficiency, too, did

Table 3

Mutagenic effectiveness and efficiency (chlorophyll mutations)

Genotypes and gamma ray doses (krad)	M_1 damage			Mutation frequency	Mutagenic effectiveness	Mutagenic efficiency		
	Lethality (L)	Injury (I)	Sterility (S)	(M)	M x 100 / dose	Mx 100 / L	Mx100 / I	Mx100 / S
Spanish Improved								
20	12.79	9.78	4.14	2.94	14.70	22.99	30.37	71.74
30	19.77	17.63	12.66	3.57	11.90	18.05	20.25	28.20
40	30.33	30.61	17.81	11.43	28.58	37.62	64.18	64.18
TG 14								
20	6.82	13.05	2.11	4.76	23.80	69.79	36.48	51.81
30	21.59	14.97	17.76	12.50	41.67	57.90	83.50	70.38
40	23.86	28.92	21.23	15.09	37.73	63.24	52.18	48.32
TMV 2								
20	1.08	15.72	7.71	3.77	18.85	349.07	23.28	48.90
30	6.45	21.50	13.35	4.35	14.50	67.44	20.23	32.58
40	12.91	29.55	20.82	9.43	23.58	73.04	31.21	45.29

Table 4

Important viable mutants isolated in the M, generation

Sl. No.	Mutants isolated	Specific characteristics	Parent variety
1	Early flowering	Flowered four days earlier	Spanish Improved TG 14, TMV 2
2	Early maturing	Early in maturity by 20 days	"
		" " 15 days	"
		" " 10 days	"
3	Late flowering	Late in flowering by 14 days	TG 14
		" " 12 days	Spanish Improved
4	Late maturing	Late in maturity by 28 days	Spanish Improved
		" " 26 days	TG 14
5	Dwarf	Plants with more than 50% reduction in plant height	Spanish Improved TG 14, TMV 2
6	Tall	Plants with more than 50% increase in height	Spanish Improved TG 14
7	Stunted	Very stunted in appearance	Spanish Improved TG 14, TMV 2
8	Compact	Very compact with dark green leaves; set pods	TG 14
9	Non-branching	No branches produced; set pods	Spanish Improved TMV 2
10	Semi-spreading	Semi-spreading in habit	TG 14
11	Little leaf	Leave very small	TG 14
12	Curly leaf	Leaves curled	TG 14
13	Narrow leaf	Leaves very narrow	Spanish Improved TG 14
14	Dark green	Leaves dark green	TMV 2
15	Multiple leaflet	Six leaflets against the normal four	TMV 2
16	Sterile	No pod set	TG 14, TMV 2
17	Small poded	Pods smaller in size	Spanish Improved TMV 2
18	Bold poded	Pods bolder in size	Spanish Improved TMV 2
19	Deeply pod constricted	Pods very deeply constricted	TMV 2
20	Single kernel	All pods set with single kernel	Spanish Improved

not show ony specific relationship with the radiation doses in the genotypes. TMV 2 and TG 14 at 20 krad and Spanish Improved at 40 krad recorded the maximum mutagenic efficiency based on lethality. Based on injury and sterility, the highest efficiency was noted at 40 krad and 20 krad in TMV 2 and Spanish Improved respectively and both at 30 krad in TG 14.

A wide range of viable mutants was isolated in the M_2 generation affecting almost all the characters including early mutants of great practical utility. Macromutants with simultaneous change in a constellation of characters were also isolated

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