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Effect of Gamma Rays on some Yield Parameters and Protein Content of Soybean in M_2, M_3 and M_4 Generation

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ABSTRACT: The effectiveness and efficiency, yield parameters and statistical analysis for M_2, M_3 and M_4 generation of Soybean (*Glycine max* (L.) Merr.) using gamma rays treatment. Effectiveness and efficiency was recorded at increase for low concentration and decrease for high concentration level. The most of the treatment was positive shift was recorded. The statistical analysis such as variability, heritability and genetic advance as per cent of mean was recorded in high for treatment than the untreated plants for all the generation. 50KR of gamma rays treatment was effective than the other mutagenic treatments compared to control.

Key words: Soybean, Mutation, Effectiveness, Efficiency, Frequency

Introduction

Soybean (*Glycine max* (L.) Merr.) posses a very high nutritional value. It contains about 20 % oil and 40% protein. Soybean protein is rich in valuable amino acid lysine (5%), in which most of the cereals are deficient. In addition, it also contains a good amount of minerals, salts and vitamins such as thiamine and riboflavin.

It is self pollinated consequently the extent to which soybean cultivars may be improves conventional breeding method in plant breeding as a source of increasing variability and could confer specific improvement without significant phenotype (Ojomo *et al*., 1979).

Experimental mutagenesis is an important source produce mutation in higher frequencies in cultivated crops. Excellent source of valuable materials for breeding work can be provided by establishing extensive collection of mutations based on productive characters. The simultaneous realization on different breeding objective could be made possible through induced mutagenesis, especially in grain legumes like soybean. Mutation breeding may be an effective tool for generating variability in the existing varieties and selecting desirable early maturing lines which would be proved to be an ideal crop for summer seasons (Khan & Goyal, 2009). Mutation breeding has been employed successful for soybean (Balakrishnan, 1991; Maheshwari *et al*., 2003; Dhole *et al*., 2003; Karthika and Subba Lakshmi, 2006; Ganapathy *et al.,* 2008 and Pavadai *et al.,* 2009). Induced mutations delivered fairly good amount of genotypic coefficient of variation, the heritability, GA as percent of mean with respect to number of seeds per plant.

Several breeding workers used radiation very extensively for inducing mutations in crop plants sincerely for inducing mutation in crop plants since 1928. Radiation might be ionizing and non-ionizing. A gamma rays is a packed of electromagnetic energy photon. Gamma photons are the most energetic photons in the electromagnetic spectrum. Gamma rays are emitted from the nucleus of some unstable atoms. Gamma rays were used by Sharma, 1965; Geetha; 1994 and Pavadai, 2006.

It has been demonstrated by many workers that genetic variability for several desired characters can be induce success practical value in plant breeding programme has been established. The present programme was undertaken to investigate the mutagenic effects of gamma rays variability and genetic advance within the Soybean cultivars and hence improve its production.

Materials and Methods

The seeds of Soybean variety CO 1 were collected from Tamil Nadu Agricultural University, Coimbatore. Physical mutagens namely, gamma rays were used in the present study. 300 well filled healthy seeds packed in moist germination paper were selected for each treatment in the gamma chamber at 10, 20, 30, 40, 50 and 60 KR doses of gamma rays in ^{60}CO gamma source (irradiation source capacity to release 3000 Ci delivery 7200 r/min). The gamma irradiation was carried out at sugarcane breeding institute (ICAR), Coimbatore, India.

The seeds were subjected to treatment were sown in the field along with the control in a randomized black design with three replication. A total number of 100 seeds were sown in each treatment. All the treatments including the control were raised adopting a spacing of 30 cm in between rows and 20 cm in between plants.

Ten randomly selected plants in the M_1 generation were advanced to M_2 generation. They were sown in family rows in a randomized block design with three replications, followed by M_3 and M_4 generation.
All the generation were recorded in the some characters such as plant height, number of branches per plant, number of seeds per plant and yield per plant were observed in the mature time and protein content were also observed in seed materials.

All the parameters were recorded in mean value, phenotypic co-efficient and genotypic co-efficient of variation, heritability and genetic advance as per cent of mean were used for ANOVA for RBD method. The value was recorded in Table II and III.

Mutation frequency was estimated on M_2 plant basis. Mutagenic effectiveness is a measure of the frequency of mutation induced by unit of mutagen, whereas mutagenic efficiency gives an indication of the proportion of mutation in relation to undesirable change like lethality and injury.

Results and Discussion

Mutation frequency, effectiveness and efficiency

The effect of gamma rays was different doses on survival percentage, mutation frequency and mutagenic effectiveness. The survival percentage and mean value of M_1 generation were decreased with increase the dose of treatments. The present results confirm these earlier reports in soybean (Pepol and Pepo, 1989 and Pavadai *et al.,* 2009); mung bean (Khan and Wani 2005) and sesame (Prabhakar 1985).

The mutagenic frequency was recorded in the present investigation ranged from 2.18 – 3.09 and the frequency increase with increase the dose of gamma rays. The mutation effectiveness and efficiency was increase with increase doses of treatment than the decrease for higher doses of treatments (50KR and 60KR). The frequency and effectiveness and efficiency were high at 40KR of gamma rays treatment than the other mutagenic treatment (Table-1).

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Table-1: Mutagenic effectiveness and efficiency for viable mutation in M_2 generation

Treatment (Dose)	Per cent of survival reduction lethality (L)	Per cent of height reduction injury (I)	Mutation for 100 M_2 plants	Effectiveness M×100/KR	Efficiency	
					M×100/L	M×100/I
10KR	43.98	26.58	2.42	5.15	4.72	7.35
20KR	48.17	31.60	2.18	5.45	4.52	6.89
30KR	55.33	36.55	2.88	5.76	5.20	9.11
40KR	65.33	41.99	3.09	10.08	5.50	9.10
50KR	71.25	49.31	2.27	6.30	3.18	4.60
60KR	77.18	54.71	2.29	5.45	2.96	4.18

M= Mutation frequency
L= Lethality
I = Injury

Mean performance in M2, M3 and M4 generation

The efficiency of plant breeding programme is determined by the amount of genetic variability available in the segregating generation. Improvements in the quantitative characters have been achieved through accumulation of genes affecting their expression in a positive and negative direction and thus increasing the variability. In the present investigation, the mean for different quantitative characters shifted both in positive negative direction due to mutagenic treatments. The most of the treatment were recorded in positive shift the maximum values were recorded in 50KR gamma rays treatment for M_2, M_3 and M_4 generation (Table-II). Such observations were reported by previous workers in soybean (Balakrishnan, 1991; Cheng and Chandlee, 1999; Dhole *et al.*, 2003; Geetha, 1994 and Pavadai, 2006). Similar observations were also made in other crops in Lentil (Dixit and Dubey, 1985) and sesame (Sengupta and Datta, 2004).

Table-2: Effectiveness of gamma rays on some yield parameters and protein content of soybean in M_2, M_3 and M_4 generation

Treatments (Dose)	Plant height (cm)			No. of branches per plant			No. of pods per plant			Yield per plant			Protein content (%)		
Generations	M_2	M_3	M_4	M_2	M_3	M_4	M_2	M_3	M_4	M_2	M_3	M_4	M_2	M_3	M_4
Control	73.50	70.75	80.66	4.27	4.25	4.30	50.39	54.08	61.74	9.72	10.28	10.39	37.56	39.01	38.56
10KR	73.01	76.43	81.44	4.30	4.28	4.72	51.37	55.42	62.75	10.11	12.05	9.27	38.75	37.35	36.27
20KR	75.08	78.43	81.99	4.32	4.31	4.39	52.27	52.19	64.37	9.36	9.63	10.56	37.61	38.64	38.76
30KR	75.66	80.71	82.65	4.41	4.35	4.43	53.97	57.33	59.27	11.07	10.37	11.04	39.04	37.41	39.43
40KR	77.94	81.02	83.40	4.62	4.32	5.27	51.60	58.19	65.61	10.41	11.46	11.28	39.27	38.54	40.17
50KR	82.91	83.94	83.62	4.87	5.40	5.65	54.27	58.64	69.02	11.54	12.55	11.58	39.32	39.91	41.05
60KR	75.94	82.68	80.37	4.75	4.19	5.11	50.62	51.25	65.41	10.39	9.42	11.06	38.72	37.63	39.41

Statistical analysis

In the present study shows moderate and high phenotypic co-efficient of variation (PCV) and genotypic co-efficient of variation (GCV), heritability (h^2) and genetic advance as per cent of mean (GA) in all the generation. The highest PCV, GCV, h^2 and GA as per cent of mean were recorded in 50KR gamma rays (Table-III). Similar results were made in soybean (Amarnath *et al.,* 1991; Mehetra *et al.,* 1998; Pavadai, 2006) and black gram (Arulbalachandran, 2006). Biradar (2007) was reported that the local germplasm collection had wide range of variability for different traits coupled with high heritability and high genetic advance for improvement yield traits; hence selection is effective for these traits. Early vigour may be used as one of the selection criterion in breeding programmes for yield improvements.

Table-3: Variability, heritability and genetic advance as per cent of mean for M_2, M_3 and M_4 generation using gamma rays treatment for soybean

Characters	Treatment	M_2 generation				M_3 generation				M_4 generation			
		PCV	GCV	h^2	GA as % of mean	PCV	GCV	h^2	GA as % of mean	PCV	GCV	h^2	GA as % of mean
Plant height	Control	8.72	6.70	59.09	10.62	9.40	5.04	28.34	5.50	10.29	5.62	30.18	6.39
	Treated	13.71	11.68	72.53	20.45	12.43	7.21	34.25	8.77	15.72	7.38	22.15	7.17
No. of branches per plant	Control	4.38	2.16	24.29	2.19	13.40	7.40	30.77	8.49	8.52	4.96	33.78	5.93
	Treated	9.24	5.19	31.54	6.00	15.16	9.10	35.66	11.14	9.80	7.22	55.62	11.20
No. of pods per plant	Control	6.20	4.29	45.09	6.12	8.94	6.97	53.95	0.97	11.68	3.73	10.21	2.45
	Treated	9.81	6.59	47.95	9.11	9.59	7.04	60.88	1.21	13.75	6.19	20.30	5.75
Yield per plant	Control	8.69	6.13	49.90	8.93	10.75	7.77	52.22	4.61	10.80	7.43	34.39	9.82
	Treated	20.33	17.85	77.14	32.16	12.02	8.28	47.52	4.89	13.87	8.13	47.51	10.55
Protein content	Control	10.55	3.86	25.65	5.04	9.29	6.33	46.48	8.90	11.28	7.71	37.21	9.69
	Treated	14.25	7.93	20.48	7.51	10.24	8.83	74.34	15.66	12.64	7.85	48.32	11.23

PCV= Phenotypic Co-Efficient of variation
GCV= Genotypic Co-Efficient of variation
H2 = Heritability
GA= Genetic advance as per cent of mean

In conclusion, high variance combined with moderate to high heritability for economic traits and protein contents. In general it was found that the treatment at 50KR gamma rays produced high mean and high variance in the mutagenic population. This enhanced variability in the genotype soybean variety CO 1 due to mutagenic treatments provide an opportunity to utilize the generate variability for selection and further improvement in these characters.

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