Research Article

Development of new vegetable soybean (*Glycine max* L. Merill) mutants with high protein and less fibre content

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Abstract

Soybean (*Glycine max* L. Merill) tops the world production of oil seeds. Mutation breeding is the most useful and vital technology for soybean. Selection of effective and efficient mutagens are very essential to recover high frequency of desirable mutants. The seed material of vegetable soybean cultivars viz., Himso 1563 and TS 82 were used for study. Gamma rays and EMS are the two mutagens selected for mutagenesis. Mutated population had manifested a reduced expression than the untreated population for all biometrical traits. Reduction in phenotypic expression is linear with the dose or concentration of the mutagens in the M_1 generation. Higher the dose or concentration more reduction in the expressivity of the traits. Viable mutants were observed in the M_2 generation. Induced mutations delivered fairly good amount of genotypic coefficient of variation, the heritability and GA as per cent of mean with respect to all the biometrical observations. High protein content (Himso 1563-37.73 and TS 82-39.49 percent) and low fibre content (Himso 1563 - 7.27 and TS 82-10.55 percent) mutants identified in M_2 generation.

Key words: Vegetable soybean, mutation breeding, gamma rays, EMS, protein and fibre content, mutants.

Introduction

Pulses constitute an important role in human dietary. Pulse protein provides good supplement to cereal diets and enhances the biological value of protein consumed. Pulses are often attributed as poor man's diet. Soybean is one of the most important pulse cum oil seed crop which contains 38 per cent protein and 19 – 20 per cent oil content. Soy proteins are rich source of essential amino acid lysine, which is limiting in cereal proteins. The productivity of soybean in India is much low in comparison with the world average. The attributes identified for such a low productivity are limited genetic diversity, narrow genetic base of Indian soybean varieties, short growing period available in Indian latitude, stagnant genetic potential for yield (Tiwari, 2003). The narrowing down of the genetic potential is due to the repeated use of the few parents for the breeding programmes. Vegetable soybean is a rich source of vitamin A, carbohydrates, protein and iron. Vegetable soybean is more nutritious than vegetable green peas (Gu *et al,* 2003). In soybean creation of variation through hybridization is a tedious process, due to small, fragile flowers which makes it difficult to carry out the process of emasculation injuring the parts of the flower and are prone to heavy flower shedding even under favourable conditions. These coupled with complete self fertility impose limitation on the success of hybridization programme. Hence the classical breeding methods have got limited application in soybean as such; mutation breeding appears to play an important role in the improvement of this important crop. Therefore mutation breeding is an important tool to create genetic variability in plant characters with both physical and chemical mutagens. In the present investigation mutations were induced in two soybean cultivars with two mutagens and the plants of the M_2 generations were screened for quantitative and qualitative mutants. The present report shows the mean, components of variance and qualitative characters of mutants isolated from the M_2 generation compared with control plants.

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Material and methods

The healthy seeds of two vegetable soybean varieties viz., Himso 1563 and TS 82 were used for mutagenesis study. The seeds were subjected to 10,20,30,40 and 50kR gamma rays and 5,10,15,20 and 25mM concentrations of EMS treatment. The dried seeds were packed into the butter paper cover and inserted into the gamma chamber for gamma rays exposure upto to a calculated time intervals. The seeds were sown into the field after irradiation treatments. For EMS treatment the seeds were pre-soaked upto six hours prior to the treatment and again seeds were dipped into EMS solution for another six hours in distilled water at different concentrations. Then the treated seeds were rinsed with running tap water for half an hour with gentle shaking. Untreated seeds of both varieties were soaked in distilled water for the same period to serve as control. After treatment seeds were immediately sown into the research field by following randomised block design to rise the M_1 generation. The seeds of the M_1 plants were collected plant wise and again sown in next season to rise the M_2 generation on plant to row basis. The M_2 population was screened for the presence of the qualitative mutants. All the data were statistically analysed and results were expressed in comparison with control.

Result and discussion

In this study, the mean values for both the characters namely protein content and fibre content were found to be shifted in both positive and negative directions from the control due to mutagenic treatments. Aestveit (1968) suggested that an estimation of the extent of induced genetic variability in quantitative traits in M_2 itself would provide valuable information for designing selection programme. It was therefore, considered worthwhile to study the shift of mean values and gather information on induced genetic variance, heritability and GA as percentage of mean for different quantitative traits in the M_2 families of different mutagenic treatments. For protein content PV, GV, PCV, GCV and GA as per cent of mean was shown in table 1. Protein content varied to different treatments for in the varieties. In Himso 1563 the highest level of protein content (37.73) was observed at 30kR gamma rays treated population. In case of TS 82, the highest level of protein content (39.49) percent was observed in 5mM EMS treated population. Protein content ranged from 34.50 to 37.73 per cent in gamma treated Himso 1563, where as it was from 34.80 to 38.69 per cent in TS 82.In Himso 1563 fibre content increased in all the treatments except in 25mM EMS treated population (7.27 percent) where as the fibre content was 11.50 per cent in control. For TS 82 in both the treatments fibre content has decreased (10.55) with increased concentrations whereas in control 13.22 per cent was noticed. The value of PV, GV, PCV, GCV and GA as per cent of mean was highest at 30kR gamma rays in Himso 1563, and 10kR gamma rays in TS 82 (Table 2). Knowledge on genetic variability of the available population is very essential for any crop improvement programme, as it will positively enhance the efficiency of selection. Genetic variability, which is partitioned from environmental effects, is appreciated. The coefficient of variation helps to measure the range of diversity available in the character with reference to its mean and provides a means to compare the variability present in the quantitative characters (Sonali Sengupta and Animesh K. Datta, 2004). Most of the treatments expressed high level of heritability (more than 60 per cent) for gamma rays and low (below 30 percent) medium (30-60 percent) and high heritability was observed in EMS treatments. The genetic variability in terms of GCV alone is not sufficient for determination of amount of heritable variability. In addition estimation of heritability and genetic advance as per cent of mean is also needed to assess the heritable portion of total variation and extent of genetic gain expected for effective selection (Vanniarajan and Vijendra Das, 1996 and Alt *et al.*, 2002). As heritability in broad sense includes both additive and epistatic gene effects, it will be reliable only if accompanied by high genetic advance (Burton, 1952). This indicated that these characters are governed largely by additive gene effect, which may favourably be exploited in the M_2 generation through selection. The selected mutants with control were compared for some of the biometrical observations have shown in the Table 3. Plant height, number of pods per plant, number of nodes per plant, pod length, number of seeds per plant, seed yield per plant and hundred seed weight recorded a low level in the selected mutants in comparison with the control plants. Whereas increased level of protein content was noticed in the mutants over the untreated plants. The decreased quantity of fibre content was observed in the mutants. Negative association between the quantitative (yield parameters) and qualitative (protein and fibre content) characters have been observed by Hajduch, *et al.* (2000). In the vegetable soybean along with the protein content, less fibre content is also one of the desirable criterions for selection. Hence the above identified qualitative mutants are very much useful for further crop improvement programmes.

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Table 1. Mean and components of variance for Protein content (%) in Gamma and EMS treated M_2 population

Varieties and Mutagens	Mean	Range	PV	GV	PCV	GCV	Heritability (%)	GA as % of mean
Himso 1563- Gamma rays (kR)								
0	36.55	36.12-36.98	-	-	-	-	-	-
10	35.32	34.22-35.96	0.24	0.16	1.38	1.13	66.56	1.89
20	35.31	35.00-35.98	0.11	0.03	0.95	0.51	28.91	0.56
30	37.73	36.99-38.23	0.12	0.04	0.91	0.51	31.82	0.59
40	35.52	35.26-36.21	0.13	0.05	1.01	0.62	37.78	0.78
50	34.50	34.15-35.21	0.13	0.05	1.04	0.64	38.03	0.81
TS 82- Gamma rays (kR)								
0	36.55	36.25-36.89	-	-	-	-	-	-
10	37.85	37.45-38.56	0.08	0.05	0.77	0.59	59.66	0.94
20	38.69	38.35-39.12	0.07	0.03	0.68	0.48	50.50	0.70
30	37.77	36.22-37.99	0.30	0.26	1.45	1.36	88.67	2.64
40	35.55	34.96-35.98	0.10	0.07	0.91	0.75	67.63	1.27
50	34.80	34.25-35.26	0.07	0.04	0.76	0.55	51.99	0.82
Himso 1563- EMS (mM)								
0	36.62	36.12-36.98	-	-	-	-	-	-
5	34.57	33.99-34.96	0.13	0.03	1.03	0.50	23.80	0.51
10	35.50	35.00-35.98	0.11	0.01	0.94	0.34	13.30	0.26
15	35.78	34.96-36.00	0.11	0.01	0.92	0.28	9.09	0.17
20	35.12	34.25-35.35	0.12	0.02	0.97	0.38	15.65	0.31
25	37.38	37.00-38.12	0.12	0.02	0.92	0.39	18.14	0.34
TS 82- EMS (mM)								
0	36.55	36.25-36.89	-	-	-	-	-	-
5	39.49	38.65-39.95	0.18	0.14	1.06	0.96	80.80	1.77
10	38.11	37.52-38.30	0.07	0.04	0.71	0.52	53.23	0.77
15	38.31	37.85-38.75	0.12	0.08	0.89	0.75	70.97	1.30
20	36.55	35.48-38.59	1.86	1.83	3.73	3.70	98.18	7.55
25	37.28	36.86-37.85	0.08	0.05	0.78	0.61	60.08	0.97

Table – 2. Mean and components of variance for Fibre content (%) in Gamma and EMS treated M_2 population

Varieties and Mutagens	Mean	Range	PV	GV	PCV	GCV	Heritability (%)	GA as % of mean
Himso 1563- Gamma rays (kR)								
0	11.48	11.23-11.96	-	-	-	-	-	-
10	11.75	11.23-12.36	0.14	0.07	3.20	2.22	48.28	6.15
20	13.45	13.00-14.25	0.20	0.13	3.31	2.63	63.16	11.71
30	12.60	12.00-13.69	0.25	0.18	3.96	3.33	70.60	19.58
40	12.31	11.50-12.80	0.18	0.11	3.43	2.64	59.06	10.21
50	12.12	11.50-12.60	0.13	0.06	2.96	1.94	43.01	4.60
TS 82- Gamma rays (kR)								
0	13.11	13.00-13.50	-	-	-	-	-	-
10	13.10	12.10-13.50	0.16	0.13	3.03	2.77	83.88	5.23
20	13.05	12.90-13.90	0.09	0.06	2.16	1.82	70.49	3.14
30	12.51	11.90-12.90	0.08	0.06	2.28	1.88	68.59	3.21
40	12.15	11.90-12.50	0.05	0.02	1.75	1.15	43.46	1.56
50	11.67	11.30-12.10	0.06	0.04	2.18	1.69	60.59	2.72
Himso 1563- EMS (mM)								
0	11.56	11.23-11.98	-	-	-	-	-	-
5	11.35	10.90-12.30	0.21	0.12	3.99	3.02	57.18	4.70
10	12.21	11.50-12.80	0.14	0.05	3.08	1.89	37.75	2.39
15	11.60	11.10-12.30	0.15	0.06	3.33	2.13	41.05	2.81
20	14.40	13.65-14.90	0.20	0.11	3.12	2.34	56.48	3.63
25	7.27	7.00-8.10	0.24	0.15	6.68	5.29	62.76	8.63
TS 82- EMS (mM)								
0	13.22	13.00-13.60	-	-	-	-	-	-
5	12.13	12.00-13.10	0.12	0.07	2.89	2.19	57.54	3.42
10	12.39	11.80-12.95	0.12	0.06	1.96	1.45	54.45	2.20
15	13.10	12.50-13.10	0.14	0.09	2.61	2.06	62.54	3.36
20	10.55	10.00-11.20	0.18	0.13	4.05	3.42	71.06	5.93
25	12.36	12.00-12.90	0.10	0.05	2.59	1.81	48.48	2.59

Table 3. Variations for different traits of normal and mutants in vegetable soybean (*Glycine max* (L.) Merill)

Traits	Himso 1563			TS 82		
	Normal	Protein rich mutant	Less fibre mutant	Normal	Protein rich mutant	Less fibre mutant
Plant height (cm)	29.62	29.09	24.61	34.20	31.52	26.81
50% flowering (days)	33.99	38.01	39.97	28.17	31.10	35.16
Number of nodes per plant	12.63	12.03	10.89	12.87	11.01	10.36
Number of pods per plant	60.18	57.49	46.65	95.58	87.12	78.98
Pod length (cm)	3.04	2.97	2.62	4.46	4.44	4.10
Days of maturity	93.77	98.42	105.18	86.91	88.01	95.24
Number of seeds per plant	83.40	75.78	55.40	103.76	98.93	80.95
Seed yield (g) per plant	19.97	19.78	15.80	24.72	22.61	20.89
Hundred seed weight (g)	20.71	20.48	19.44	24.42	21.94	19.94
Protein content (%)	36.62	37.73	37.38	36.55	39.49	36.55
Fibre content (%)	11.56	12.00	7.27	13.22	12.13	10.55