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RESEARCH ARTICLE

Genetic Analysis of Certain Quantitative Traits like Weight of 1000 seeds and Yield per plant in *Trigonella foenum graecum* L. under the influence of Sulphonate Compounds

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ABSTRACT

The study was carried over for the variability in economic important characters under the influence of different doses of sulphonate compounds like EMS, MMS and MES on two varieties of Trigonella. A significant effect of these compounds was noticed in M_2 and M_3 generations.

The increase in genotypic variability in M_3 generation was noticed as increase in heritability and genetic advancement for seed weight and yield in treated population. The average seed yield per plant decreased in M_2 generation, but in M_3 seed yielding capacity increase because of random selection. The data on range, variance and phenotypicco-efficient of variation revealed that there was a net increase in variability in both M_2 and M_3 generations.

INTRODUCTION

The *Trigonella foenum-graecum* L. belongs to family Fabaceae, is an important crop of food, fodder and medicinal values in India. The crop is cultivated as a multipurpose annual autogamous crop of central India. Breeding programmes are the most commonly used approaches for the improvement of crop. Mutation breeding is a powerful and effective tool in the hands of plant breeders especially for autogamous crops having narrow genetic base. Mutagenic agents have been used to induce useful phenotypic variations in plants for more than seven decades ago. Among the various agents sulphonate compounds are important one. These sulphonate compounds have bifunctional alkyl reactive groups that react with DNA, causes extensive cross linkage of DNA, chromosome breakage, chromosome mutations and gene mutation. Among the chemical mutagens, EMS, MMS and MES reported to be the most effective and powerful mutagen. Khan [1] studied the effect of gamma rays and EMS in single and combination treatments on frequency and spectrum of chlorophyll mutations in M_2. Vasu and Hasan [2] were studied the effect of radiomimetic agents like MES, EMS and MMS in *Trigonella* to induce plant height and pod number. Also frequency of viable mutations and their spectrum in two varieties of *Trigonella* is done by Vasu and Hasan [3].

Therefore, the present investigation was undertaken to induce genetic analysis of certain mutants in quantitative traits like weight of 1000 seeds and yield per plant, which could be utilized directly or introduced into *Trigonella* improvement program.

MATERIAL AND METHODS

Material

Two varieties, seeds of *Trigonella foenum-graecum* L. *viz.* desi methi and kasuri methi were procured from Jawahar Lal Agriculture farm Eintkhedi, Berasia Road, Bhopal (M.P.). Three concentrations of each mutagen *i.e.,* 0.1%, 0.2% and 0.3% are selected on the basis of preliminary experiment, LD-50 dose.

$$\text{Arithmetic mean} = \frac{\text{Sum of number of observations}}{\text{Total number of observations}}$$

Phenotypic co-efficient of variation (PCV) $= \dfrac{\sqrt{VP}}{X} \times 100$

Genotypic co-efficient of variation (GCV) $= \dfrac{\sqrt{VG}}{X} \times 100$

Heritability (h^2) $h^2 = \dfrac{VG}{VP} \times 100$

Genetic Advancement (GA) $GA = \dfrac{\sqrt{VP} \times h^2 \times K}{\overline{X}}$

Genotypic Variance $(VG) = \dfrac{M_1 - M_2}{r}$

Phenotypic Variance (VP) = VG – M_2.

RESULT AND DISCUSSION

1. Weight of 1000 seeds

(a) Mean

The mean value of this particular character for both varieties desi methi and kasuri methi in M_2 generation and M_3 generation are summarized in (Table 1 and 2).

From tables we concludes that in both generations, varieties show the significant increase in mean under higher doses of sulphonate compounds than the control. The highest mean observed under 0.3% MMS of both varieties in M_2 and M_3 generation in comparison of control. The mean value of control was 4.32, 4.33 in desi methi in M_2 and M_3 generation respectively and 4.00, 4.01 in kasuri methi, in M_2 and M_3 generation respectively (Table 1 and 2).

(b) Variance

It was noticed that range of variance was highest in the both varieties in M_2 and M_3 generations with higher doses (Table 1 and 2). In desi methi it rangese 2.8 -6.5 under 0.3% MMS in M_2 generation and 2.8-5.7 under 0.3% EMS treatments in M_3 generations.

In kasuri methi it ranges 2.8-6.5 0.3% MMS in M_2 generation. Over all variance in both varieties in M_2 and M_3 generation was higher in both varieties in comparison of control. It clearly shows that in both varieties under all the treatments of radiomimetic agent variability of this character increased both upward and downward directions, in both M_2 and M_3 generations.

In both varieties significantly higher phenotypic variability was observed as compared to their control in M_2 and M_3 generations. Similarly higher GCV was observed in both varieties comparatively higher GCV was observed in variety desi methi (Table 1 and 2).

(c) Heritability and genetic advancement

Significantly higher heritability was observed in both varieties in both M_2 and M_3 generation as compared to their respective controls. Genetic advancement was also found to be significantly higher in both varieties in M_2 and M_3 generations of all the three radiomimetic agents (Table 1 and 2).

2. Yield per plant

(a) Mean

Mean values regarding yield for both varieties treated with three sulphonate compounds, in M_2 and M_3 generations are summarized in (Table 3 and 4). In both the varieties there were no significant differences as compared to their controls in both generations. In variety desi methi highest mean 4.99 in 0.3% MMS in M_2 generation and 4.90 in 0.3 % MMS in M_3 generation, while in kasuri methi 4.99 in 0.2% MMS in M_2 generation and 4.30 in 0.3% MMS in M_3 generation against their controls 4.00 and 4.01, respectively.

(b) Variance

In variety desi methi highest range of variance was 2.9-5.5 is under 0.3% MES treatment in M_2 generation and 2.8-6.0 under 0.2% MMS in M_3 generation against 2.9-4.9 and 2.9-5.4 of respective controls. In variety kasuri methi highest range 2.5-5.6 with 0.2% MMS treatment in M_2 generation and 2.7-5.9 with 0.3% MMS treatment in M_3 generation against their controls *i.e.* 2.6-5.4 and 2.6-5.5, respectively.

In variety desi methi highest overall variance was recorded under 0.3%, MMS *i.e.* 3.98 in M_2 generation and under 0.3% MMS *i.e.* 3.99 in M_3 generation against their control 2.92 and 2.89, respectively.

All the treatment in both the varieties in both M_2 and M_3 generation showed a significantly higher overall variance as compared to their respective controls. In both the varieties negative as well as positive variability was induced.

In both varieties significantly higher phenotypic variability was observed under all the treatments of sulphonate compounds, in both generations. The higher PCV in variety desi methi was 11.31% obtain with 0.3% MMS treatment in M_2 generation and 10.98% was obtained with 0.3% MMS in M_3 generation. In variety kasuri methi highest PCV was 7.32% under 0.3% MMS in M_2 generation and 8.32% under 0.3% MMS in M_3 generation. Similarly in both varieties with all the treatments of three sulphonate compounds, in both generations significantly higher genotypic variability was observed as compared to their respective control (Table 3 and 4).

(c) Heritability and genetic advancement

All the treatments of three radiomimetic agents in both M_2 and M_3 generation in both varieties desi methi and kasuri methi induced significantly higher heritability as compared to their respective controls. Genetic advancement was also found to be significantly higher in two varieties in all the three sulphonate compounds, in both M_2 and M_3 generations against their respective controls.

Micromutations in M_2 and M_3 Generations

In most of the genetic analysis on artificial induction of variability of crop plants, usually greater stress has been laid on induction of drastic changes of the phenotype brought about in changes in variability of the major genes. On the other hand genetic control of quantitative traits is exerted through large number of genes understood to be as minor genes, where each single gene contributes a little bit to the total variability. Although the importance of minor mutations in evolution was stressed by Stubbe and Von-Wettestein as early as 1941, only in the last few years, the effects of mutagenic agents have been evaluated in relation to minor genes which control the quantitative characters in *Cicer arietinum* L. (Scossiroli, 1965; Kharkwal, 2001).

In both the varieties of *Trigonella faenum-graecum* L. average weight of seeds altered. The increased variability is evidenced in both the generations from the increase in range, variance and phenotypic co-efficient of variation as well as from the phenotypic frequency distribution.

Many workers have earlier reported induced variability for the seed characters in crop plants [4] in mungbean; Rao and Josi [5] in *Triticales*; Gupta and Gupta [6] in Sesame; Mishra [7] in Chick pea (*Cicer arietinum* L.); Verma *et al*. [8] in *Coriandrum sativum* L.; Singh *et al.* [9] in Lineseed; Berwal *et al.* [10] in fenugreek; Mahey *et al.* [9] in fenugreek; Datta and Chatterjee [11] in fenugreek; Kumar and Gupta [12] in black cumin (*Nigella sativa* L.).

The increase in the genotypic variability in M_3 generation was reflected in the form of increased heritability and genetic advance with all the treatments. Such an increase in the genotypic variability, heritability and genetic advancement for seed weight in the treated population has also been observed by Ibrahim and Shareen [13] in wheat. Thus, it is possible to select plants with higher seed weight in M_3 generation.

The average seed yield per plant decreased in M_2 generations of both varieties with all the treatments given. However the average seed yield per plant improved with all the treatments. The decreased in average seed yield capacity in M_2 generation was due to decrease in pollen fertility which directly effect on pod frequency and seed yielding. The improvement in the seed yielding capacity in M_3 generation is due to random selection as the generation was raised from the seeds of only highest

Table 1. Range, Mean, Overall Variance, Components of variable and genetic parameters for Weight of 1000 seeds in M_2 and M_3 generation of *Trigonella foenum-graecum* L. (desi methi).

S. No.	Sulphonate compounds	Doses (%)	Range	Mean	Overall variance	PCV %	GCV %	Heritability	Genetic advancement as % of mean
M_2 generation									
1.	—	Control	2.9-4.9	4.32	1.13	1.41	1.31	9.79	0.92
2.		0.1	2.9-4.8	4.32	1.48	3.12	2.56	25.82	9.93
3.	EMS	0.2	2.8-5.7	4.36	1.72	3.89	2.92	28.34	10.12
4.		0.3	1.8-5.8	5.17	1.93	5.01	4.12	31.71	12.24
5.		0.1	2.9-5.9	4.36	1.71	3.97	2.96	21.04	8.39
6.	MMS	0.2	2.8-5.7	4.19	1.93	4.78	3.89	30.90	9.01
7.		0.3	2.8-6.5	5.26	1.84	6.82	5.01	44.04	12.68
8.		0.1	2.7-6.4	4.30	1.50	3.23	2.67	24.05	8.93
9.	MES	0.2	2.8-5.2	4.21	1.78	4.01	3.78	27.34	9.56
10.		0.3	2.8-6.2	5.24	1.91	5.10	4.42	29.98	10.24
M_3 generation									
1.	—	Control	2.8-5.7	4.33	1.12	1.39	0.29	9.11	0.89
2.		0.1	2.7-5.8	4.83	1.42	3.10	1.26	23.17	8.71
3.	EMS	0.2	2.8-4.9	4.91	1.67	4.79	1.67	24.97	9.93
4.		0.3	2.8-5.7	5.28	2.89	5.89	2.93	30.11	11.21
5.		0.1	2.8-5.7	4.31	01.67	3.92	1.82	19.97	7.78
6.	MMS	0.2	2.8-5.3	4.59	2.82	4.12	2.78	29.89	8.92
7.		0.3	2.8-5.4	5.67	3.02	6.78	4.00	40.21	13.01
8.		0.1	2.8-5.4	4.32	1.56	3.21	1.65	21.05	6.82
9.	MES	0.2	2.8-5.9	4.31	2.76	3.97	2.63	24.76	9.72
10.		0.3	2.9-5.6	5.27	2.93	5.96	3.41	28.17	10.01

Table 2. Range, Mean, Overall Variance, Components of variability and genetic parameter for Weight of 1000 seeds in M_2 and M_3 generations of *Trigonella foenum-graecum* L. (kasuri methi).

S. No.	Sulphonate compounds	Doses (%)	Range	Mean	Overall variance	PCV %	GCV %	Heritability	Genetic advancement as % of mean
M_2 generation									
1.	—	Control	2.6-4.3	4.00	1.13	1.30	1.12	6.92	0.96
2.		0.1	2.7-5.3	4.12	1.48	2.98	2.24	18.10	7.24
3.	EMS	0.2	2.6-5.4	4.99	1.92	3.14	2.72	21.30	8.73
4.		0.3	2.7-6.4	5.01	2.23	4.24	3.91	29.01	11.12
5.		0.1	2.6-5.4	4.20	1.79	3.01	2.61	19.24	8.12
6.	MMS	0.2	2.6-5.3	5.02	1.98	3.97	2.92	22.67	10.10
7.		0.3	2.6-6.8	6.16	2.82	4.64	3.72	29.82	12.01
8.		0.1	2.7-4.4	4.00	1.49	2.12	1.11	18.13	7.21
9.	MES	0.2	2.6-5.3	4.13	1.96	3.01	2.14	20.31	7.92
10.		0.3	2.6-6.2	5.19	2.35	5.12	3.78	28.12	10.76
M_3 generation									
1.	—	Control	2.7-4.7	4.01	1.14	1.27	1.11	7.46	0.82
2.		0.1	2.7-4.6	4.00	1.51	3.01	2.21	22.16	7.01
3.	EMS	0.2	2.6-5.7	4.03	1.97	3.78	2.68	24.32	8.12
4.		0.3	2.6-6.6	5.04	2.29	4.26	3.78	30.04	10.76
5.		0.1	2.5-5.4	4.03	1.72	3.21	2.56	20.32	8.42
6.	MMS	0.2	2.6-6.5	5.01	1.99	4.12	3.01	23.04	10.01
7.		0.3	2.7-7.7	5.06	2.94	4.94	3.68	32.04	12.04
8.		0.1	2.7-4.6	4.01	1.48	2.61	2.10	19.14	7.01
9	MES	0.2	2.6-5.4	4.03	1.92	3.32	2.03	21.64	7.12
10.		0.3	2.6-6.5	5.05	2.34	5.17	3.48	29.36	10.14

Table 3. Range, Mean, Overall variance, Components of variability and genetic parameters for Yield in M_3 and M_3 generations of *Trigonella foenum-graecum* L. (desi methi).

S. No.	Radiomimetic agents	Doses (%)	Range	Mean	Overall variance	PCV %	GCV %	Heritability	Genetic advancement as % of mean
				M_2 generation					
1.	—	Control	2.9-4.9	4.32	2.92	6.23	1.92	4.23	1.92
2.		0.1	2.9-5.0	4.78	3.76	8.01	2.34	5.78	2.13
3.	EMS	0.2	2.9-5.1	4.82	3.12	9.21	2.64	6.24	2.54
4.		0.3	2.9-5.4	4.90	3.92	10.61	2.97	9.21	2.92
5.		0.1	2.8-5.0	4.82	3.12	8.01	2.62	5.91	2.51
6.	MMS	0.2	2.9-5.3	4.91	3.12	9.12	2.86	6.89	2.67
7.		0.3	2.8-5.4	4.99	3.98	11.31	3.91	10.32	3.00
8.		0.1	2.8-5.0	4.30	3.12	7.92	2.32	4.98	2.13
9.	MES	0.2	2.9-5.4	4.82	3.12	8.97	2.46	5.01	2.60
10.		0.3	2.9-5.5	4.90	3.78	10.76	3.01	10.02	2.98
				M_3 generation					
1.	—	Control	2.9-5.4	4.30	2.89	5.78	1.97	3.96	1.90
2.		0.1	2.8-5.8	4.60	2.12	8.13	2.30	5.70	2.10
3.	EMS	0.2	2.9-5.9	4.67	2.91	8.99	2.59	6.10	2.34
4.		0.3	2.8-5.0	4.82	3.76	10.26	2.92	9.00	2.80
5.		0.1	2.9-5.9	4.68	2.10	7.98	2.51	5.92	2.49
6.	MMS	0.2	2.8-6.0	4.78	3.19	8.92	2.80	6.16	2.56
7.		0.3	2.8-5.4	4.90	3.99	10.98	3.34	10.12	3.01
8.		0.1	2.9-5.9	4.52	2.30	7.67	2.28	4.91	2.10
9.	MES	0.2	2.8-5.8	4.60	3.00	9.01	2.51	5.00	2.46
10.		0.3	2.8-5.0	4.91	3.67	10.12	3.03	9.89	2.89

Table 4. Range, Mean, Overall Variance, Components of variability and genetic parameters for Yield in M_2 and M_3 generation of *Trigonella foenum-graecum* L. (kasuri methi).

S. No.	Sulphonate compounds	Doses (%)	Range	Mean	Overall variance	PCV %	GCV %	Heritability	Genetic advancement as % of mean
				M_2-generation					
1.	—	Control	2.6-5.4	4.00	1.96	5.99	1.92	3.20	0.98
2.	EMS	0.1	2.6-5.7	4.13	1.97	6.01	2.00	4.90	1.34
3.	EMS	0.2	2.5-5.7	4.16	1.87	6.72	2.14	5.11	1.54
4.	EMS	0.3	2.5-5.9	4.28	2.11	7.12	3.31	6.36	2.72
5.	MMS	0.1	2.6-5.8	4.20	1.92	6.62	2.14	5.10	1.64
6.	MMS	0.2	2.5-5.6	4.29	1.99	6.92	2.64	5.58	2.01
7.	MMS	0.3	2.6-5.9	4.30	2.30	7.32	3.92	6.98	2.97
8.	MES	0.1	2.5-5.6	4.10	1.87	5.32	2.12	4.98	1.56
9.	MES	0.2	2.6-5.7	4.19	1.81	5.72	2.39	5.41	2.01
10.	MES	0.3	2.5-5.8	4.27	2.10	6.92	3.67	6.16	2.02
				M_3 generation					
1.	—	Control	2.6-5.5	4.01	1.84	5.60	1.89	3.01	0.90
2.	EMS	0.1	2.7-5.6	4.12	1.86	6.01	2.01	4.98	1.42
3.	EMS	0.2	2.6-5.7	4.19	1.87	7.60	2.32	5.12	1.72
4.	EMS	0.3	2.5-5.8	4.25	1.97	8.12	3.12	6.20	2.90
5.	MMS	0.1	2.6-5.7	4.20	1.62	6.92	2.89	5.21	1.80
6.	MMS	0.2	2.6-5.8	4.26	1.88	7.70	3.01	5.70	2.01
7.	MMS	0.3	2.7-5.9	2.30	2.52	8.32	3.76	6.24	3.18
8.	MES	0.1	2.7-5.6	4.14	1.52	6.00	2.10	4.89	1.63
9.	MES	0.2	2.6-5.9	4.18	1.67	7.01	2.40	5.23	2.13
10.	MES	0.3	2.5-5.8	4.24	1.98	7.89	3.10	6.00	2.99

yielding plants of each M_2 family. Scossiroli [14] also observed a decreased of seed yield per plant in *Triticum durum* in M_2 population which increased in M_3 generation. They considered this change as recovery effect and attributed to the elimination of bad genes after selfing. Similar results were obtained by Gaul and Aestveit [15] in hexaploid wheat. The data on range, variance and phenotypic co-efficient of variation revealed that there was a net increase in variability in both M_2 and M_3 generations.

The comparison of frequency distribution in M_2 and M_3 indicate more variability in M_3 over M_2 generation. The curve shifted more towards higher seed yield per plant in both M_2 and M_3 generations. The increased variability for seed yield per plant has been reported by several workers in different crops like, Ahloowalia [16] in ryegrass; Bansal [17] in barley; Verma [18] in *Brassica*; Rao and Joshi [5] in *Triticales*; Kwon and Oh [19] in mungbean; Verma *et al.* [20] in *Coriandrum sativum* L. and Castro *et al.* [21] in ryegrass (*Lolium perenne* L.) and Mensah *et al.*,[22] in *Vigna unguiculata* L. (walp) and Suneetha *et al.* [23] in brinjal.

Although the seed yield per plant with most of the treatments given was less than the control in M_2 generations yet the genotypic variability increased with all the treatments due to an increase in overall variance. The increase in the genetic component of variation further enhanced the heritability and the genetic advance. In M_3 generation there was a further increase in the genotypic variability as the estimates of genotypic co-efficient of variation heritability and genetic advanced expressed as percentage of mean were of higher magnitude as compared to their corresponding estimates in M_2 generations. Therefore the selection will be more effective for higher seed yield per plant in M_3 as compared to M_2 generation. Several workers have reported an increased in genotypic variability and other genetic parameters in the treated population. William and Narway [24] in Soybean; Gill *et al.* [25] in barley; Jain and Agarwal [26] in *Trigonella foenum-graecum* L Singh *et al.* [8] in Lineseed; Berwal *et al.* [9] in fenugreek; Mohanty and Prusti [27] in brinjal; Dash and Kole [28]) in fenugreek; Datta and Chatterjee [11] in fenugreek; Menash *et al.* [29] in Cowpea and Menash *et al.* [29] in Sesame.

It may be suggested that chemicals which are radiomimetic and alkylating agents are more effective for such crop and are therefore important tools for inducing beneficial mutations in *Trigonella* (methi).

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