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THE INDUCED MUTAGENIC EFFECT OF ETHYL METHANE SULPHONATE ON YIELD CONTRIBUTING CHARACTERS IN *PSOPHOCARPUS TETRAGONOLOBUS* (L.) DC.

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Abstract

Psophocarpus tetragonolobus (L.) DC., commonly known as winged bean has been described as a wonder legume in the sense that virtually every part of the plant is edible and comprises a rich source of good quality protein. The present investigation was carried out to find out the effect of chemical mutagen such as Ethyl Methane Sulphonate (EMS) in M_2 and M_3 generations on yield contributing traits of winged bean. The different characters studied related to yield includes; number of pods per plant, pod length, number of seeds per pod and hundred seed weight. The mutagen EMS have shown negative and positive shifts in mean values for yield contributing traits. The present investigation therefore, has provided significant base for selection and improvement of winged bean for yield contributing traits.

Key words: EMS, Wonder legume, Pod length, Contributing traits, M_2 and M_3 generation.

Introduction

Seed legumes, "The poor man's meat", are universally accepted as a key sources of proteins and comprise major parts of human diet in several developing countries. The well developed/wealthy nations have high levels of nutrition and face little problem in supplying all their citizens with quality food. However, it is now widely recognized that in developing/poor countries, the scenario is quite different. More than one billion people live in utter poverty and about half of that number suffers from severe protein deficiency and malnutrition. This problem is closely associated with the more general kind of malnutrition resulting from shortage of calories. To overcome this problem, the winged bean (*Psophocarpus tetragonolobus* (L.) DC.) offers exceptional promise as a high protein food source for developing world. Winged bean is also popularly known as God-sent vegetable, princess pea, choughula sem, Goa bean, chara konisem and four angled bean has assumed considerable importance at present as a protein rich multipurpose crop (Amoo *et al.,* 2006; Ray *et al.,* 2012). It may find wide application in the first place in human nutrition and animal feeding and serve as an important raw material for food products rich in protein and fat. The nutritional value of the winged bean is mainly due to its mature seeds. The seeds contain high amount of protein (29 % - 42 %) and are thus comparable to those of soybean (NAS, 1981). The amino acid profile in the winged is quite similar to that of soybean (Claydon, 1978, 1979; Haq, 1982). Besides the protein, the winged bean seeds contain about 20 % edible oil (Claydon,1978, 1979). The winged bean is a potentially important plant which has received considerable attention over recent years due to its extraordinary nature. It can be consumed as young pods, flowers, leaves, green seeds, dried seeds and also tuberous roots, are all edible and highly nutritious (Singh *et al.,* 2013; Prasanth *et al.,* 2015).

Winged bean is considered as a wonder legume which has recently received attention throughout the world and in future it will be used as a major source of protein and other physiologically active substances, joining the soybean, groundnuts etc. Winged bean is extensively cultivated especially in the tropical areas. The countries like Indonesia, Papua New Guinea, Myanmar and India are the probable centers of its origin. Except India, much

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of germplasm diversity and long history of cultivation of winged bean have been found in other countries (Pickersgill, 1980; Khan, 1982).

Winged bean is a self pollinating and possesses limited variability. Consequently the extent to which winged bean cultivars may be improved through conventional breeding method is limited. Despite possessing several good qualities and nutritional potential, so far the winged bean has neglected all over the world due to some undesirable features possessed by the plant. Some such features include – antinutritional factors in some plant organs, long duration, climbing nature of the plant with strong requirement for staking and absence of market demands. To overcome this problem, induced mutations are the best techniques to induce variability in yield contributing characters. The mutagenesis helps to enhance natural mutational rate and to enlarge the genetic variability thereby generating added scope for making further selections. The induction of micromutations in polygenic system controlling the quantitative characters is important for crop improvement. Mutagenic treatments increase the genetic variability regarding yield traits, which can be used for selection and improvement of plants. Several investigators have studied the various aspects of quantitative genetics. Some of the pioneers in this field are (Gaul, 1967) in barely, (Grifith and Johnston, 1962) in oats, (Sakai and Suzuki, 1964) in rice. Thus the present study was undertaken to investigate the mutagenic effect of Ethyl Methane Sulphonate (EMS) as a means of increasing the variability in yield contributing traits within the cultivars and hence improve its nutritional value and productivity through selection.

Materials and methods

The authentic seeds of two cultivars (varieties) such as II- EC- 178313 and 2I-EC- 38825 of winged bean (*Psophocarpus tetragonolobus* (L.) DC.) were obtained from the National Bureau of Plant Genetic Resources (NBPGR), Regional station, PKV, Akola (M.S.) India, for present research work.

Mutagen used

The chemical mutagen like Ethyl Methane Sulphonate ($CH_3SO_2OC_2H_5$) a monofunctional alkylating agent with molecular weight of 124 manufactured by Sigma Chemical Company Ltd., USA was used in the present investigation.

Details of Mutagenic Treatments

Healthy, dry, mature and uniform seeds of two winged bean cultivars (varieties) such as II- EC- 178313 and 2I-EC- 38825, were surface sterilized with 0.1 % mercuric chloride solution for about one minute and washed thoroughly with distilled water. These selected seeds were presoaked in distilled water for 6 hours. Such presoaked seeds were treated with different concentrations of freshly prepared EMS solution (such as 0.05 %, 0.10 % 0.15 %) for 6 hours. Seeds soaked in distilled water for 12 hours served as control (untreated seeds). The seeds treated with various concentrations of EMS were washed thoroughly under running tap water. Later on they were kept for post soaking in distilled water for 2 hours.

300 seeds of each treatment were sown in the field following randomized block design (RBD) with three replications along with control for raising the M_1 generation. Various morphological parameters were studied from M_1 generation. After maturity, M_1 plants (seeds) were harvested separately on the plant basis. The separately collected seeds were sown as to raise M_2 generation. The seeds of M_2 were collected and sown to raise M_3 generation. The M_2 and M_3 populations were screened for quantitative traits to study the induced variability. From each treatment 25 plants were randomly selected for recording data on different quantitative characters in both the M_2 and M_3 generations. Similarly 25 plants were picked up from the control for comparative assessment. Data on the following four important quantitative characters were recorded.

Number of pods per plant

Total number of pods on each selected plant was counted separately and the average was noted.

Pod length

The length of 20 pods per plant was measured in centimeters (cm) and average was recorded.

Number of seeds per pod

Ten pods per plant were opened and the number of healthy seeds was counted. The mean was calculated for each plant and then for each treatment.

Hundred seed weight

A composite sample was drawn from the seed yield of plants and hundred seeds were counted, weighed and the weight was recorded on electronics balance in grams.

Statistical analysis

A through statistical analysis was carried out by using standard formulae. The shifts of mean was also studied to assess the amount of induced variability due to mutagenic treatment. The data pertaining to M_2 and M_3 generation recorded for the different polygenic traits in both the cultivars of winged bean are presented in tables 1 and 2.

Results and Discussion

In the present studies an attempt was made to estimate the induced variability with reference to quantitative parameters in M_2 and M_3 generations. Induced variability was thoroughly studied in winged bean cultivars II-EC-178313 and 2I-EC-38825 for both the M_2 and M_3 generations in regard to number of pods per plant, pod length, number of seeds per plant and hundred seed weight.

Number pods per plant (Table 1 and 2)

It is found from present study, that at all the concentrations of EMS a significant negative shift in mean values pertaining to pods per plant was noted in M_2 and M_3 generations of cultivars II-EC-178313 and 2I-EC-38825. The parameter like number of pods per plant is important in deciding the yielding ability of plants. This was supported by (Sagade, 2008) in urdbean and (Patil, 2009) in cowpea. However, (Shakoor *et al.*, 1978) and (Tickoo and Jain, 1979) in green gram reported negative shift in mean in M_2 generation. It has been indicated that a number of factors like pollen sterility, genetic and physiological imbalances along with environmental variations either singly or in combination could be the decisive factors in shifting the mean values of yield parameters in the negative direction.

Pod length (Table 1 and 2)

In the pertinent studies, it is found that the mean values in regard to pod length indicated a shift towards positive and negative directions in M_2 and M_3 generations of both the cultivars of winged bean. The significant positive shift in mean values was observed except at 0.05 % and 0.15 % of EMS in cultivar II-EC-178313, in M_2 and M_3 generations of both the cultivars. The maximum pod length 21.15 cm was observed at 0.10 % of EMS in M_3 of 2I-EC-38825. Increase in pod length can contribute to higher seed yield by increasing number of seeds per pod. Similar results were obtained by (Singh *et al.*, 2000) in urdbean and (Sheeba *et al.*, 2003) in sesame.

Number of seeds per pod (Table 1 and 2)

In the present investigation, it is found that the data pertaining to number of seeds per pod revealed shift in mean in both positive and negative directions in M_2 and M_3 generations of both the cultivars of winged bean. In M_2 generation, the cultivar II-EC-178313 showed a significant positive shift in mean value at 0.15 % concentrations of EMS, while the cultivar 2I-EC-38825 revealed that feature at 0.10 % concentration of EMS. In M_3 generation the cultivar. II-EC-178313 demonstrated a significant negative shift in mean values except at 0.15 % of EMS, while in cultivar 2I-EC-38825 this trend was observable at different concentrations except 0.10 % of EMS. Number of seeds per pod is a main character which affects the yield of plant. Plants containing pods with increased number of seeds may contribute to better yield. Similar results were recorded by (Singh and Chaturvedi,

Table 1: Effect of Ethyl Methane Sulphonate on some yield parameters of winged bean in M_2 generation.

Variety	EMS Conc.%	No. of pods per plant		Pod length		No.of seeds per pod		Hundred seed wt.	
		Mean	Shift in mean	Mean	Shift in mean	Mean	Shift in mean	Mean	Shift in mean
II-EC-178313	Control	22.00		16.20		12.40		33.05	
	0.05	19.66	-2.34	15.33	-0.87	11.66	-0.74	32.89	-0.16
	0.10	17.66	-4.34	18.00	2.00	10.92	-1.48	40.22	7.17
	0.15	15.66	-6.34	14.33	-1.87	13.07	0.67	32.31	-0.74
	S.E (Mean)	0.47		0.37		0.19		0.11	
	F(Replication)	0.60		3.46		4.38		3.21	
	F(Treatment)	2.04		5.28		8.25		20.80	
	C.D. at 1 %	2.16		1.71		0.87		0.51	
	C.D. at 5%	1.36		1.03		0.53		0.30	
2I-EC-38825	Control	24.40		17.20		13.10		35.08	
	0.05	23.33	-1.07	19.00	1.80	12.00	-1.10	31.42	-3.66
	0.10	21.33	-3.07	17.33	0.13	13.74	0.64	35.57	0.49
	0.15	19.00	-5.40	19.00	1.80	11.55	-1.55	41.83	6.75
	S.E (Mean)	0.34		0.22		0.44		0.51	
	F(Replication)	2.85		3.10		0.06		7.29	
	F(Treatment)	5.40		3.10		0.89		13.73	
	C.D. at 1 %	1.56		1.02		2.05		2.37	
	C.D. at 5%	0.94		0.61		1.24		1.43	

Table 2: Effect of Ethyl Methane Sulphonate on some yield parameters of winged bean in M_3 generation.

Variety	EMS Conc.%	No. of pods per plant		Pod length		No.of seeds per pod		Hundred seed wt.	
		Mean	Shift in mean	Mean	Shift in mean	Mean	Shift in mean	Mean	Shift in mean
II-EC-178313	Control	23.00		16.80		12.60		33.12	
	0.05	20.66	-2.34	19.33	2.53	11.66	-0.94	33.30	0.18
	0.10	19.48	-3.52	18.66	1.86	12.36	-0.24	31.60	-1.52
	0.15	17.33	-5.67	19.00	2.20	13.80	1.20	32.16	-0.96
	S.E (Mean)	0.36		0.48		0.24		0.18	
	F(Replication)	2.88		0.06		2.72		3.06	
	F(Treatment)	4.37		3.56		5.25		36.54	
	C.D. at 1 %	1.67		2.23		1.10		0.83	
	C.D. at 5%	1.00		1.35		0.68		0.50	
2I-EC-38825	Control	23.70		17.80		13.40		35.11	
	0.05	20.00	-3.70	19.78	1.98	11.25	-2.15	33.13	-1.98
	0.10	22.66	-1.04	21.15	3.35	15.48	2.08	35.40	0.29
	0.15	19.66	-4.04	18.29	0.49	10.52	-2.88	41.33	6.22
	S.E (Mean)	0.45		0.28		0.32		0.73	
	F(Replication)	0.31		3.31		5.44		0.83	
	F(Treatment)	1.75		13.70		9.00		4.47	
	C.D. at 1 %	2.08		1.31		1.50		3.36	
	C.D. at 5%	1.25		0.79		0.90		2.03	

1982) in mungbean, (Vandana and Dubey, 1990) in lentil, (Waghmare and Mehra, 2000) in grass pea.

Hundred seed weight (Table 1 and 2)

The treatments of EMS succeeded in inducing variability regarding hundred seed weight. The data revealed shift in mean values in negative and positive directions. The hundred seed weight in control of II-EC-178313 was in the range of 33.05 to 35.12 gm. While in 2I-EC-38825 it could be noted as ranging from 35.08 to 35.11 gm. In M_2 generation the maximum mean value for hundred seed weight namely 40.22 and 41.83 gm have been recorded at 0.10 % and 0.15 % concentrations of EMS, in cultivars II-EC-178313 and 2I-EC-38825 of the winged bean respectively. In M_3 generation the cultivar II-EC-178313 demonstrated a significantly negative shift in mean values except at 0.05 % of EMS, while the cultivar 2I-EC-38825 showed a significantly positive shift in mean values except for the 0.05 % of EMS as regards the hundred seed weight. Similar observations were also made by (Apparao *et al.*, 2005) in chickpea, (Singh *et al.*, 2000) in urdbean.

The mutagen EMS used in the present study, has definitely proved successful in broadening the genetic base to an appreciable extent. The results regarding yield contributing traits shows that the improvement in yield characters of winged bean is possible through induced mutation breeding programme.

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