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INDUCTION OF MORPHOLOGICAL MUTANTS IN MUNGBEAN (VIGNA RADIATA (L.) WILCZEK) THROUGH CHEMICAL MUTAGENS

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A wide range of morphological mutants were identified in two varieties of mungbean. These mutants involved traits effecting plant height, growth habit, seed and pod. The frequency of morphological mutants differed in different mutagenic treatments and also between the varieties. The highest mutation frequency was noticed in the EMS treated population whereas the lowest frequency was observed SA treatments, HZ treatments being the intermediate. Variety NM-1 gave the broader spectrum and frequency of morphological mutations than the var. PDM-11. Of all the mutant types, maximum occurrence of mutation was observed for plant height.

Keywords: Chemical mutagens, Morphological mutants, Mungbean

1. Introduction

India grows a variety of pulse crops, also called as grain legumes, under a wide range of agro-climatic conditions and has a pride of being the world’s largest producer of pulses. Unique characteristics like high protein content, nitrogen fixing ability, soil ameliorative properties and ability to thrive better under harsh environmental conditions make pulses an integral component of sustainable agriculture particularly in dry land areas [1]. Indian population relies on pulses for meeting its protein requirement mainly because of its vegetarian food habit and high cost of animal based protein. Mungbean, which ranks third to chickpea and pigeonpea, is an important pulse crop in Southeast Asia and the Indian sub-continent [2]. It is grown in almost all the states of India and is cultivated as a kharif (monsoon) crop in different agro-ecological regions.

Mutation breeding, a much heralded short cut breeding method, brings novel genotypes through heritable changes in genotype and phenotype of a particular trait. Often ever, desired variation is lacking in grain legumes especially in mungbean. The mutation breeding has become a proven way since the beginning of this century as one of the driving force for evolution [3], besides creating genetic variation within the crop variety. It offers the possibility of inducing desired attributes that either can not be found in nature or have been lost during evolution. Enhancement of the frequency and spectrum of mutations in a predictable manner and thereby achieving desired plant characteristics through mutagenesis is an important goal of mutation research. In the mutation induction programme, the choice of an effective and efficient mutagen will certainly increase the possibility of recovering desired mutations. In the present study, the effects of EMS, HZ and SA were studied on the frequency and spectrum of morphological mutations in M_2 generation of mungbean.

2. Materials and Methods

Uniform and healthy seeds of two varieties of mugbean, PDM-11 (selection from parent variety, LM 95) and NM-1 (selection from cross between G 65 and UPM 79-3-4), presoaked in distilled water for 9 hours, were treated with chemical mutagens at concentrations of 0.1, 0.2, 0.3 and 0.4% of EMS (ethylmethane sulphonate) and 0.01, 0.02, 0.03 and 0.04% of HZ (hydrazine hydrate) and SA (sodium azide) for 6 hours. The solutions of EMS and HZ were prepared in phosphate buffer of pH 7, whereas SA solution was prepared in phosphate buffer adjusted to pH 3. Following these

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treatments, the seeds were thoroughly washed in running tap water to reduce the residual effect of the mutagens sticking to the seed coat. The treated seeds were directly sown in the field at the Agriculture Farm, Aligarh Muslim University, Aligarh, India alongwith untreated controls. Three replications of 100 seeds per treatment were sown in a randomized complete block design to raise M_1 generation in 2007 kharif season. The seeds of M_1 plants were harvested separately and sown in plant progeny rows to raise M_2 in 2008 kharif season. The distance between the seeds in a row and between the rows was kept 30 x 60 cm in both generations, respectively. The control and the mutagenized population were screened for phenotypically detectable mutations at different stages of growth in the M_2 generations.

3. Results and Discussion

Data on the frequency and spectrum of morphological mutants are presented in Table 1; Figure 1. The highest frequency was noted in the EMS treated populations (4.21%) and the lowest with SA (2.21%), while HZ treatments (3.86%) were intermediate. The mutation frequency in the two varieties was also different. NM-1 was proved to be the most mutable variety, while PDM-11 showed the least mutability. Although most of the morphological mutants were uneconomical, nevertheless, some of the mutants may be used as a source of beneficial gene pool for cross breeding programmes or for the improvement of some quantitative traits. Such mutants might be either a result of pleiotropic effects of mutated genes or chromosomal aberrations or gene mutations. The morphological mutants differed not only in the two varieties of mungbean but also within the variety in different mutagenic treatments, suggesting that the varieties responded differently to the dose and type of mutagens employed. Tyagi and Gupta [4] reported that each gene which is of agronomic interest can mutate, hence a wide spectrum of viable mutants can be expected in mutation experiments. The progenies of tall, dwarf, semi-dwarf, bushy, prostate and bold seeded mutants bred true for the altered traits in M_3 generation. Such mutant types might be attributable under the influence of polygenes [5]. High frequency and broad spectrum of morphological mutants induced by physical and chemical mutagens have been reported in *Vigna mungo* [6, 7], *Lens culinaris* [8], *Cicer arietinum* [9] and *Glycine max* [10]. In both the varieties, EMS produced maximum mutation frequency followed by HZ and SA. A high frequency and broad spectrum of morphological mutants induced by HZ in comparison to EMS has been reported in *Hordeum vulgare* [11]. Relative differences in the mutability of genes for different traits have been observed, as some of the mutant types appeared with higher frequencies in some mutagens. For instance, dwarf mutants appeared more frequently with SA and HZ treatments, whereas EMS induced comparatively more mutations affecting growth habit (bushy and prostrate) than HZ and SA. The more frequent induction of certain mutation types by a particular mutagen may be attributed to the fact that the genes for these traits are probably more responsive to different mutagens with different modes of action. Nilan [12] reported that different mutagens and treatment procedures might also change the relative proportion of different mutation types. Dwarfness may be due to reduced internode length or internode number or both [13]. In the present study, reduction in internode length was mainly responsible factor for dwarfness. Semi-dwarf mutants accompanied with increased pod number may be utilized for producing high yielding lines. Long pod and bold seeded mutant is a useful variation and may be exploited to increase the number of seeds per pod and seed size leading to increased potential yield. Cytology of long pod and bold seeded mutants revealed normal meiotic divisions and 11 bivalents at metaphase-I. These long pod and bold seeded mutants may be the result of gene mutations. Bushy mutants showed reduction in yield and yield components. Though these mutants may not be useful for their use because of reduced yield, however, may be used in hybridization programmes to transfer useful traits for the development of high yielding varieties of mungbean. Though, it is not easy to eliminate the negative effects of the pleiotropy, the pleiotropic pattern of mutant genes can be altered to some extent by transferring it into a specific genotypic background [14]. Pod shattering mutants were noticed in the var. NM-1. Verma [15] reported a number of pod shattering mutants in *Phaseolus aureus* and found shattering of pod was monogenically dominant over non-shattering.

Table 1. Mutation frequency and spectrum of morphological mutants induced by various chemical mutagens in M_2 generation of mungbean in 2008 kharif season

Mutant Type	Characteristics	Variety	EMS*		HZ**		SA***		Total Frequency (%)	
			Conc.≠ (%)	Freq. # (%)	Conc. (%)	Freq. (%)	Conc. (%)	Freq. (%)		
Tall	Long internodes, taller growth (53 to 57 cm as compared to average 43 cm in control), low pod and seed setting, delayed flowering, smaller seed size.	PDM-11	0.1, 0.2	0.83	0.02	0.72	0.02	0.14	1.69	3.63
		NM-1	0.1,0.2	0.93	0.02	0.76	0.01	0.25	1.94	
Dwarf	Short internodes, reduced height (10 to 12 cm in comparison to 43 cm in control), poor seed yield.	PDM-11	-	-	0.03	0.32	0.04	0.44	0.76	1.82
		NM-1	0.4	0.10	0.03, 0.04	0.41	0.04	0.55	1.06	
Semi-dwarf	Reduced height (half the height of the control), slow growth, reduced number of internodes, increased number of pods and seed yield.	PDM-11	-	-	0.03	0.21	-	-	0.21	0.76
		NM-1	-	-	0.03	0.30	0.04	0.25	0.55	
Bushy	Dense growth, compactly arranged leaves and branches, early flowering and maturity, reduced yield components, lower seed yield.	PDM-11	0.1, 0.3	0.33	0.02	0.30	-	-	0.63	1.46
		NM-1	0.2	0.42	0.03, 0.04	0.41	-		0.83	
Prostrate	Creeping on ground, spreaded foliage, weak and longer internodes, delayed flowering, normal seed yield.	PDM-11	0.1	0.38	-	-	0.02	0.19	0.57	1.38
		NM-1	0.2,0.3	0.40	0.01,0.02	0.16	0.02, 0.03	0.25	0.81	
Non-flowering/ Vegetative	No flowers produced, erect stem, branches and leaves normal.	PDM-11	0.3	0.08	-	-	-	-	0.08	0.22
		NM-1	0.3, 0.4	0.10	0.04	0.04	-	-	0.14	
Bold seed and pod	Vigorous growth, increased pod length and girth, bigger seed size, increased 100 seed weight (5.25 to 6.50 g as against 3.30 to 3.57 g of control).	PDM-11	0.2, 0.3	0.18	0.02	0.11	-	-	0.29	0.66
		NM-1	0.2, 0.3	0.21	0.03	0.12	0.02	0.04	0.37	
Shattering pod	Pods shattered as soon as they matured.	PDM-11	-	-	-	-	-	-	-	0.35
		NM-1	0.3, 0.4	0.25	-	-	0.03	0.10	0.35	
Total				4.21			3.86	2.21		10.28

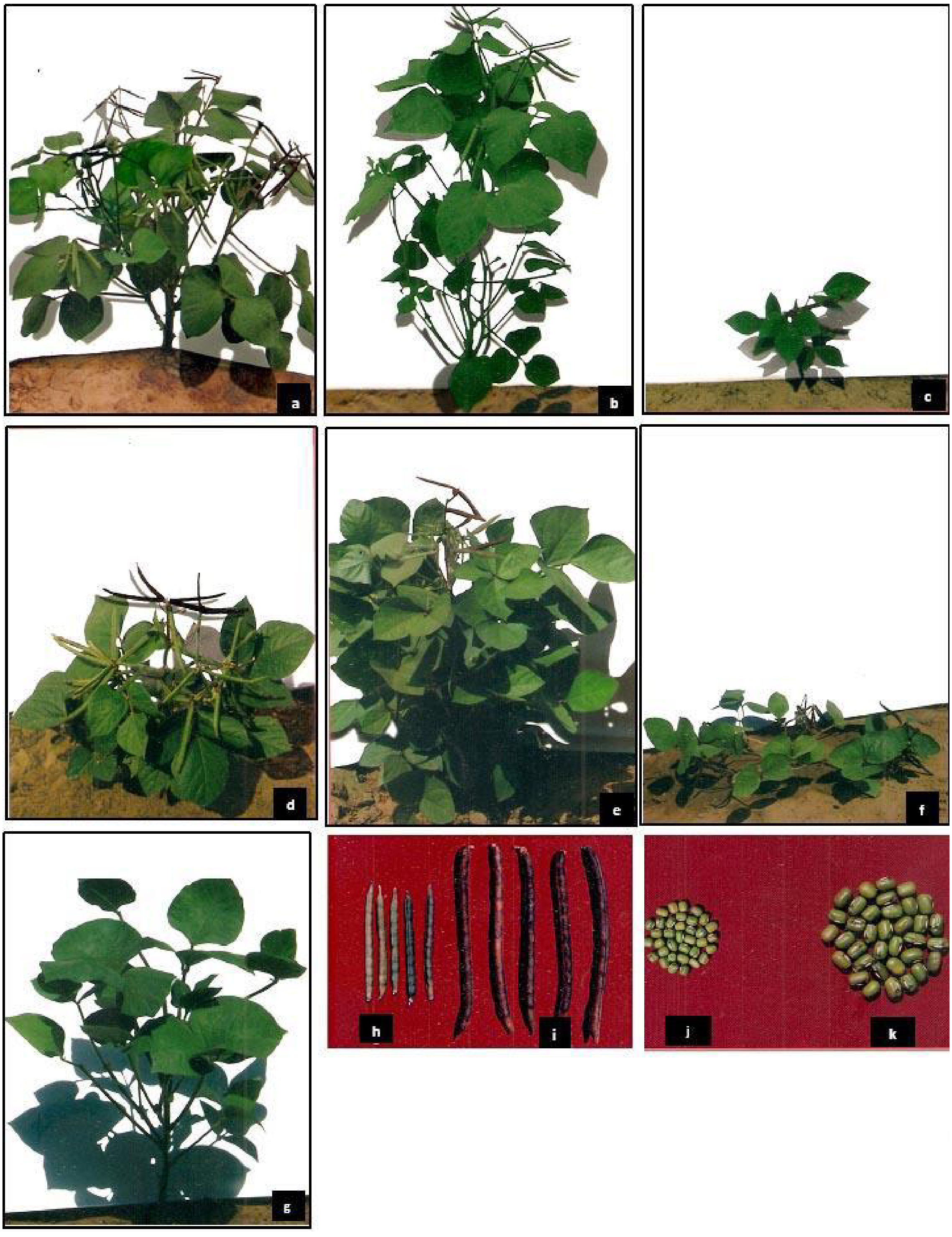

Figure 1. Morphological mutants in mungbean ; (a) Control plant, (b) Tall mutant, (c) Dwarf mutant, (d) Semi-dwarf mutant, (e) Bushy mutant, (f) Prostrate mutant, (g) Non flowering / vegetative mutant, (h) Pods of the control plant, (i) Mutant pods showing increase in length and girth, (j) Seeds of the control plant and (k) Bold seeds of the mutants.

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