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INHERITANCE OF LODGING COMPONENTS IN MUNGBEAN (*VIGNA RADIATA* (L.) WILCZEK)

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Abstract

Inheritance of lodging related traits in mungbean i.e., average inter-nodal length and average circumference of the main stem were studied using Triple Test Cross (TTC) technique. Both traits showed highly significant differences among treatments and between first (P_1) and second parent (P_2) of a cross ML-5 x Ramzan used as third tester in the TTC combination. The traits showed significant total epistasis. (i, and j + l types). Additive x additive (i type) interactions were non-significant whereas additive x dominance and dominance x dominance (j and l types) interactions were highly significant for both traits. This shows the complex nature of inheritance of lodging components in mungbean.

Diverse genetic background of lines is indicated by the significant epistatic effect contributed by individual lines for average inter-nodal length and average circumference of the main stem. In case of average inter-nodal length, the genotypes Var. 6601 and Chakwal 97 contributed major portion of negative and positive non-allelic interaction, respectively, to the total epistasis of average inter-nodal length. Genotypes NFM 13-1 and NM 92 imparted major portion of positive and negative non-allelic interaction, respectively to total epistasis of average circumference of the main stem. Improvement in mungbean lodging resistance through breeding for short inter-nodal length and thick/more circumference of the main stem, bi-parental hybridization between suitable recombinants in F_2 generation is suggested to produce better genetic combinations through which the accumulations of desired genes could be achieved for selection in advanced generation.

Introduction

In Pakistan, mungbean is grown both in summer (March-May) and kharif (July-October) but kharif is the main growing season of this crop in the country. Summer is normally dry while kharif is rainy season and more precipitation is received in this season due to moon soon rains. Lodging and short growth durations are important morphological traits which cause low seed yield in mungbean (Jahan & Hamid, 2006, Khattak *et al.,* 2002).

In mungbean, lodging is influenced by structural (morphological) plant trait i.e., plant height, inter-nodal length on main stem, thickness and stiffness of main stem, and conducive environmental conditions for lodging i.e., rains and winds. Mungbean crop at fruiting is more prone to lodging compared to vegetative stages. Information about the genetics of morphological components of lodging in mungbean e.g., plant height, and inter-nodal length and thickness of the main stem may help to breed genotypes tolerant to lodging. Plant height in mungbean has been extensively studied and evidence of additive and dominance components with predominant effect of additive effect has been reported (Malik and Singh, 1983, Patel *et al*., 1989, Khattak *et al*., 2004). Main stem's stiffness of a plant plays an important role in tolerance to lodging in mungbean but this trait can not be measured or recorded to estimate its inheritance. Stiffness in stem can only be reported as present or absent. Thus two traits i.e., average inter-nodal length and average main stem circumference can be recorded and used to estimate their inheritance. The genetic information of these traits may help to breed mungbean genotypes tolerant to lodging.

The current study was designed in Triple Test Cross (TTC) manner to estimate inheritance of average inter-nodal length and average main stem circumference in mungbean.

Materials and Methods

Two mungbean genotypes, viz., ML-5 and Ramzan were hybridized in a combination ML-5 x Ramzan during kharif (July-October) 2006. The resulted F_1 and their parents were used as testers. Triple test cross combination of these three testers was attempted by hybridizing it with ten true breeding genotypes viz., 6601, NM 20-21, Chakwal 97, Mung-88, NM 93, AEM 96, NFM 8-1, NM 13-1, NM 92 and NM 28 during summer (March-July) 2007. True breeding genotypes were used as male in hybridization. The developed experimental material i.e., F_1 (ML-5 x Ramzan), 12 inbred lines (2 testers and 10 inbred lines), 20 single crosses, and 10 three-way crosses were planted in a randomized complete block design with three replications at the research farm of Nuclear Institute for Food and Agriculture (NIFA), Peshawar, Pakistan, during kharif 2007. A plot size of 0.6 m^2 (single row plot of 2-meter length) was assigned to each entry in each replication. The plant-to-plant spacing between and within rows was kept 30cm and 10cm, respectively. The experimental material was bordered by standard mungbean variety NM 92 to avoid border effect. The experimental field soil was clay loam. Fertilizer was applied at the sowing at the rate of 20N:60P Kg/ha (one bag of DAP per acre). Weeds were removed manually. No irrigation was required by the experimental crop due to rainy season. The data were collected from 10 randomly selected plants per replication for the following traits:

i. Average inter-nodal length on main stem (each internodes length on main stem was measured at maturity from 10 randomly selected plants and averaged).
ii. Average circumference of the main stem (circumference at the middle of each internodes on main stem was measured by vernier caliper from 10 randomly selected plants and averaged).

TTC analyses were performed as suggested by Khattak *et al.,* (2002) in mungbean.

Results

Average inter-nodal length and average circumference of the main stem showed highly significant differences among treatments and between first (P_1) and second parent (P_2) of a cross ML-5 x Ramzan used as third tester in the current TTC combination (Table 1). Mean square values for the test of epistasis are presented in Table 2. Both average inter-nodal length and average circumference of the main stem exhibited highly significant variation for total epistasis. (i, and j + l types). Additive x additive (i type) interactions were non-significant whereas additive x dominance and dominance x dominance (j and l types) interactions were highly significant for both traits.

An individual contribution of lines to the total epistatic effect for average inter-nodal length and average circumference of the main stem is presented in Table 3. In case of average inter-nodal length, the genotypes var. 6001 and Chakwal 97 contributed major portion of negative and positive non-allelic interaction, respectively to the total epistasis of average inter-nodal length. Genotypes NFM 13-1 and NM 92 imparted major portion of positive and negative non-allelic interaction, respectively to total epistasis of average circumference of the main stem.

Table 1. Analysis of variance (mean squares values) of average inter-nodal length and average circumference of main stem in mungbean during Kharif 2007.

Source of variation	df	Mean squares	
		Average inter-nodal length	Average circumference of main stem
Replications	2	0.12	0.24
Treatments	42	4.13**	2.47**
Hybrids	29	3.39*	1.67**
Parents	12	6.22**	4.41**
Lines	9	1.28*	5.63**
Testers	2	24.78**	1.12**
$P_1 + P_2$ vs. F_1	1	19.64**	0.85**
P_1 vs. P_2	1	29.93**	1.40**
Lines vs. Tester	1	13.61**	0.02
Hybrids vs. parents	1	0.49*	2.43**
Error	84	0.20	0.05

*, ** = Significant at 0.05 and 0.01 levels, respectively

Table 2. Analysis of variance (mean squares values) for the test of epistasis for average inter-nodal length and average circumference of main stem in mungbean during Kharif 2007

Source of variation	df	Mean squares	
		Average inter-nodal length	Average circumference of main stem
Total epistasis	10	10.84**	4.99**
Epistasis (i type)	1	0.16	2.58
Epistasis (j and l type)	9	12.02**	5.26**
Epistasis (i type) x Blocks	2	0.81	0.04
Epistasis (j and l type) x Blocks	18	0.85	0.26
Total epistasis x Blocks	20	0.85	0.23

*, ** = Significant at 0.05 and 0.01 levels, respectively

Table 3. Epistatic deviations of individual mungbean genotypes for average inter-nodal length and average circumference of main stem exhibiting significant differences among genotypes tested in Kharif 2007.

Genotypes	Average inter-nodal length	Average circumference of main stem
Var. 6601	-3.73**	0.10
NM 20-21	-2.13**	0.43
Chakwal 97	2.53**	1.70**
Mung 88	0.30	0.77*
NM 93	0.90	0.01
AEM 96	0.10	-1.30**
NFM 8-1	-1.70**	1.43**
NFM 13-1	1.43*	2.20**
NM 92	2.13**	-2.07**
NM 28	0.90	-0.33
SE	0.53	0.28

*, ** = Significant at 0.05 and 0.01 levels, respectively

Discussion

Existence of considerable variation is indicated by the significant variation among treatments i.e., parents, testers and hybrids evaluated in the present study for average inter-nodal length and average circumference of the main stem. Diverse genetic background of lines is also indicated by the significant epistatic effect contributed by individual lines for average inter-nodal length and average circumference of the main stem (Pooni *et al.*, 1980; Khattak & Iqbal, 2010).

Significant differences between first and second parents for both the studied traits revealed that they were extremely high vs low selections from the population and they would provide an estimate of additive and dominance variation with equal precision as suggested by Kearsey & Jinks (1968) and also reported by Saleem *et al.*, (2009) in rice and Khattak & Iqbal (2010) in mungbean.

The significant effect of j + l types interactions for average inter-nodal length and average circumference of the main stem show complex inheritance. Both additive and dominance inheritance was reported for average inter-nodal length in mungbean by Khattak *et al*., (2002). The absence of epistasis in earlier report for average inter-nodal length could be due the difference in environments as genetic components of variance change to different extent over environments (Khattak *et al*., 2002a). No reports have been found about the inheritance of circumference of the main stem in mungbean, thus the current is the first report regarding the inheritance of this trait.

Lodging in mungbean can be minimized through breeding genotypes with close inter-nodal length and thick/more circumference of the main stem (Khattak *et al*., 2002). The j + l types interactions of average inter-nodal length and average circumference of the main stem indicated that these traits are non-directional and unfixable by selection under self – fertilization, and thus would not be favorable/easy to breed mungbean pure lines having close inter-nodal length and more circumference of the main stem. The bi-parental hybridization between suitable recombinants in F_2 generation would produce better genetic combinations through which the accumulations of desired genes could be achieved for close inter-nodal length and more circumference of the main stem. Breeding mungbean for mentioned desired characters of the studied traits will require delay in selection to latter/advanced generation of segregating populations and bulk method of selection after attaining homozygosity for maximum heterozygous loci.

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