Pak. J. Bot., 36(3): 589-594, 2004.

GENE ACTION FOR SYNCHRONY IN POD MATURITY AND INDETERMINATE GROWTH HABIT IN MUNGBEAN (*VIGNA RADIATA* (L.) WILCZEK)

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Abstract

The nature of gene action for days to flowering, plant height at different growth stages, synchrony in pod maturity and indeterminate plant growth habit were assessed in two sets of crosses involving four parents through generation mean analysis. The mean data of six populations (both parents, F_1, BC_1, BC_2 and F_2) were subjected to joint scaling test. In the presence of epistasis, six-parameter model was used to detect all types of gene effects. The analysis indicated that most of the traits appeared to be complex in the expression of gene effects in both the crosses. Both additive (d) and dominant (h) gene effects were important in both the crosses for all the traits examined except days to first flower and first pod maturity in ML-5 x NM 54, where dominant gene effects were non-significant. The days to 90% pods maturity and plant height at first flower in case of 6601 x NM 92, and days to first pod maturity and plant height at first flower in ML-5 x NM 54 cross had showed no digenic interactions. The digenic interactions i.e., additive x additive (i), additive x dominance (j), and dominance x dominance (l) played an important role in the expression of all those traits which showed complex gene effects for their inheritance. The biparental approach is suggested for the exploitation of the complex inherited traits particularly for improved synchrony in pod maturity and determinate growth habit in mungbean.

Introduction

Indeterminate growth habit in grain legumes has evolved more to natural than human selection (Tickoo *et al*., 1996). In mungbean, flowering comes in different flushes. In summer season (March –June) the newly short statured and early maturing varieties can be manipulated to a great extent to have improved synchronous flowering and maturity by controlled irrigation, provided there is no rainfall. But seed yield of these new varieties in summer is low compared to those of the kharif season (July-October), which is the main growing season for mungbean in Pakistan. In summer mungbean produces flowers in one flush. In the kharif season, due to high humidity, the flowering once started continues till harvesting. Developing mungbean genotypes having improved determinate growth habit (clear-cut demarcation between the vegetative and the reproductive phases) with synchronous maturity is not only essential for mungbean to survive as a kharif main pulse crop in Pakistan, but also would fill the gaps in high input farming systems in good lands with available irrigation without competing directly with major crops like wheat, rice and cotton (Khattak *et al*., 2001b, c, 2002a, b).

In view of little information available on the inheritance of the synchrony in pod maturity and determinate growth habit in mungbean, the present study was conducted to understand the nature and magnitude of genetic components in the divergent parents.

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Materials and Methods

Three local i.e., 6601, NM 92 and NM 54 and an exotic Indian i.e., ML-5 mungbean genotypes were hybridized in two sets of combinations according to the crossing technique of Khattak *et al*., (1998). The basic population of each cross viz., two parents, their F_1, F_2 and back crosses BC_1 (F_1 x male parent) and BC_2 (F_1 x female parent) were developed and planted in a completely randomized block design with three replications on the research farm of Nuclear Institute for Food and Agriculture, Peshawar, during kharif 2003. The parents, F_1 and back crosses were sown in two rows each, F_2 in 20 rows with the row length of 4 meter, and the spacing between rows and plants 30 and 10 cm, respectively. Data were recorded on 30 random plants in each parent and F_1, 50 plants in each back cross and 300 plants in each F_2 population. The parameters studied were as follows:

Days to first flower: Days from sowing to the first open flower on a plant.

Days to first pod maturity: Days from sowing to the first pod maturity on a plant.

Days to 90% pods maturity: Days from sowing to 90% pods maturity on a plant.

Plant height (cm) at first flower: Plant height from the base of the plant to the top peduncle on the main branch at the first open flower.

Plant height (cm) at first pod maturity: Plant height from the base of the plant to the top peduncle on the main branch at first pod maturity.

Plant height (cm) at 90% pods maturity: Plant height from the base of the plant to the top peduncle on the main branch at 90% pods maturity.

Degree of indetermination of pod maturity from first flower to 90% pods maturity: [(Days to 90% pods maturity - Days to first flower)/Days to 90% pods maturity] x 100.

Degree of indetermination of plant height from first flower to 90% pods maturity: [(Plant height at 90% pods maturity – Plant height at first flower)/Plant height at 90% pods maturity] x 100.

The joint scaling test (Cavalli, 1952) was used to detect epistasis. In the presence of epistasis, the additive (d), dominance (h) effects and non-allelic interaction components (i, j and l) of generation means were estimated according to Hayman (1958).

Results and Discussion

The estimates of joint scaling test (Table 1) showed non-significant values of χ^2 for days to first pod maturity in the cross ML-5 x NM 54, for days to 90% pods maturity in the cross 6601 x NM 92 and for plant height at first flower in both the crosses, indicating adequacy of the additive-dominance model to explain inheritance of these traits. For the remaining traits examined in both the crosses χ^2 values were significant, indicating the presence of non-allelic gene interaction role in the inheritance of these traits.

Table 1. Estimates of gene effects for some quantitative traits in mungbean crosses.

Character	Cross	m	d	h	i	j	l	χ^2	Type of non-allelic interaction
Days to first flower	6601 x NM 92	41.13*	5.07*	4.56*	-5.84*	14.65*	18.21*	336.84*	Complementary
	ML-5 x NM 54	43.02*	5.37*	-0.73^{ns}	2.79*	8.18*	8.85*	196.25*	-
Days to first pod maturity	6601 x NM 92	66.46*	15.07*	36.66*	11.63*	21.73*	-13.70*	81.59*	Duplicate
	ML-5 x NM 54	54.32*	4.42*	1.05^{ns}	-	-	-	3.37	-
Days to 90% pods maturity	6601 x NM 92	90.55*	-7.21*	3.68*	-	-	-	3.76	-
	ML-5 x NM 54	75.13*	6.87*	-0.43	0.67	8.23*	12.07*	47.19*	-
Plant height at first flower	6601 x NM 92	75.17*	46.19*	-28.20*	-	-	-	3.37	-
	ML-5 x NM 54	60.56*	5.12*	2.53*	-	-	-	2.73	-
Plant height at first pod maturity	6601 x NM 92	70.83*	15.93*	-22.7*	-33.2*	36.17*	71.11*	79.34*	Duplicate
	ML-5 x NM 54	66.63*	1.87*	5.75*	6.99*	0.87*	-9.72*	127.95*	Duplicate
Plant height at 90 % pods maturity	6601 x NM 92	77.63*	6.93*	-22.2*	-22.9*	30.85*	24.83*	86.42*	Duplicate
	ML-5 x NM 54	79.61*	12.9*	19.82*	1.37*	-5.18*	-21.0*	15.05*	Duplicate
Degree of indetermination for pod maturity from first flower to 90% pods maturity	6601 x NM 92	46.02*	-3.14*	8.16*	5.30*	14.0*	13.9*	23.64*	Complementary
	ML-5 x NM 54	42.24*	-38.4*	27.08*	20.26*	5.12*	41.0*	28.67*	Complementary
Degree of indetermination for plant height from first flower to 90% pods maturity	6601 x NM 92	48.52*	19.36*	-27.10*	-38.1*	30.30*	-61.3*	66.60*	Complementary
	ML-5 x NM 54	51.31*	9.10*	-3.29*	-24.4*	-0.84*	-36.6*	61.94*	Complementary

The estimates of d, h, i, j and l in the cross 6601 x NM 92 for days to first flower were significant with a negative sign of i indicating that selection should be deferred to later generations when desirable segregates became available. The significant and same sign of h and l in a cross 6601 x NM 92 indicates the involvement of complementary types of non-allelic interactions in the inheritance of days to first flower. The non-significant value of h and significant value of l in a cross ML-5 x NM 54 indicated the dispersal of alleles in the parents for days to first flower. The additive, dominance and non-allelic gene interactions were important in the cross 6601 x NM 92, whereas only additive gene effect was significant in the cross ML-5 x NM 54 for days to first pod maturity. The significant but opposite sign values of the h and l in a cross 6601 x NM 92 indicated the involvement of duplicate type of non-allelic interaction in the inheritance of days to first pod maturity. For days to 90% pods maturity, the additive and dominant gene effects are important in a cross 6601 x NM 92 whereas d, j and l were significant in a cross ML-5 x NM 54 indicating the important role of additive gene effect, additive x dominance and dominance x dominance interactions in the inheritance of this trait in the cross. The additive, dominance and non-allelic gene interactions have been reported for days to flowering and maturity in mungbean by some earlier researchers (Malik & Singh, 1983; Khattak *et al*., 2002b).

The additive and dominant gene effects were mainly involved in the inheritance of plant height at first flower in both the crosses. The estimates of d, h, i, j and l were significant for plant height at first pod maturity and plant height at 90% pods maturity. The negative sign of i in the cross 6601 x NM 92 for both the traits made it obvious that negative additive genes are present in parents, which need to be eliminated in the early segregating generation. Thus it is important that selection for these traits should be deferred to later generation so that the desirable segregates are available. The significant values of h and l with opposite signs for plant height at first flower and 90% pod maturity indicated the duplicate type of non-allelic gene interaction in both the crosses. The involvement of non-allelic interaction along with additive and dominance gene effects in the inheritance of plant height in mungbean have also been reported earlier by some workers (Singh & Singh, 1996; Ram, 1997; Khattak *et al*., 2001a, 2002a).

The estimates of d, h, i, j and l were significant for degree of indetermination of pod maturity from first flower to 90% pods maturity in both the crosses indicated that additive, dominance and all types of digenic non-allelic interactions played an important role in the inheritance of this trait. The negative value of d and positive value of h indicated that dominant gene action is predominant in the inheritance of this trait. The significant but negative value of d and positive value of i in both the crosses indicated that alleles with positive effects were more often dominant. Similarly, the estimates of all the genetic components (d, h, i, j and l) were significant for degree of indetermination of plant height from first flower to 90% pods maturity in both the crosses. The positive and significant value of d and negative and significant value of i in both the cross-indicated that negative alleles were also dispersed in the parents involved in the crosses. Thus, selection for determinate growth habit in plant height should be delayed to later generation when desirable segregates become available. The negative and significant values of h and l in both the crosses indicated that dominant gene effects had a negative effect on the trait. The significant values of h and l with same sign in both the crosses for degree of indetermination for pods maturity from first flower to 90% pods maturity and degree of indetermination for plant height from first flower to 90% pods maturity indicated the involvement of complementary type of non-allelic gene interactions in the inheritance of these traits. The genetic architecture and inheritance pattern of synchrony in pod maturity and plant height at various growth stages differed in the crosses according to the involvement of genes present in the parents (Khattak *et al*., 2001d, 2002b).

Additive, dominant and digenic non-allelic interactions were found significant for the degree of indetermination of pod maturity (synchrony in pod maturity) and degree of indetermination of plant height (determinate growth habit), and for most of their components in both the crosses. The magnitude of the significant genetic components varied depending on the trait(s)/parent(s) chosen. In chickpea and mungbean, varying magnitudes of additive and non-additive gene effects have been reported earlier for different traits (Singh *et al*. 1993; Ram 1997; Khattak *et al*. 2001c, 2002b). Epistasis was observed more frequently in both the crosses, which indicated the greater diversity in the parents. The simultaneous occurrence of significant estimates of additive and i type interaction, and dominant and other type of epistasis (j and l) in most of the traits revealed the action of same genes contributing towards each genetic component. The characters, for which additive and additive x additive type gene effects are more important, the pedigree method of breeding involving multiple crosses would be more effective. It would also have an advantage to exploit the additive genetic components for complex characters like synchrony in pod maturity and improved growth habit. For exploitation of all types of gene effects the biparental approach of hybridizing recombinants among themselves and/or reciprocal recurrent selection may be practiced for developing elite population for selection of lines in advanced generations for improved synchrony in pod maturity and determinate plant growth habit in mungbean.

Acknowledgement

The Nuclear Institute for Food and Agriculture and Pakistan Science Foundation supported this research which is gratefully acknowledged.

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(Received for publication 19 June 2004)