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Heterosis in F_2 Population of Mung Bean Germplasm

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ABSTRACT

Pulses in India have long been considered as only source of poor man's protein. India is the largest importer, producer and consumer of pulses (Jitendra et al., 2011). India accounts for 33% of the world area and 22% of the world production of pulses (Amarender, 2009). Pulses production in India 18.34 million tonne (ICAR 2013-14). Heterosis in F_2 would provide information on residual heterosis with respect to yield, general vigour, quality etc., which may provide scope for selection of desirable hybrids for further progressive generation for selection of elite lines one needs to elucidate the nature of gene action controlling economic characters. Relative heterosis as well as heterobeltiosis in high magnitude was observed in F_2 population in cross PS-16 x TM-99-50 of for 50% maturity, days to 50% flowering and number of pods plant^{-1}. Among the F_2 population significant and maximum average heterosis and heterobeltiosis was observed in HUM-12 x Basanti for number of pods plant^{-1}. Relative heterosis as well as heterobeltiosis were observed in high magnitude for HUM-12 x Bireswar for protein content. Highest significant average heterosis and heterobeltiosis over mid parent was observed for pod length in HUM-12 x PS-16.

Key words: *Heterosis, Yield, Hybrid, Germplasm*

INTRODUCTION

The manifestation of increased size, greater vigour in development, higher productivity and similar intensifying effects has long been observed by biologists in many hybrids of plants and animals. Such a phenomenon was termed as heterosis and defined as the increased vigor of F_1 generation of a cross over the mean of parents[3]. Several genetic hypotheses have been advanced to account for heterosis. Theory of dominance[4], reciprocal effects of changed nucleus and relatives unaltered cytoplasm on each other[5], theory of linked favorable dominant genes[2,13], physiological hypotheses[7,8,9], theory of interallelic interaction, and rare occurrence of unfavorable recessive genes[6], have all been put forward. But according to the most accepted hypothesis, it is the combined effect of additive, dominance and epistatic type of gene action[3]. Hybrid vigour in artificial plant hybrids was first studied by Koleruter in 1866, Shull[10], proposed the term heterosis as the developmental stimulus resulting from the union of different gametes and hybrid vigour as the manifest effect of heterosis.

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However these two terms are now a days used as synonyms. The crop plant heterosis was defined by Stebbins[11], as greater adaptiveness to human needs which has been obtained in a particular environment through artificial selection followed by hybridization. Fonseca and Patterson described heterosis as improvement of heterozygote in relation to better parent and coined a new term "Heterobeltiosis". Mather and Jinks[12], defined heterosis as the amount by which the mean of an F_l family exceeds its better parent.

MATERIAL AND METHODS

For estimation of protein by Lowry's Method, 27 genotypes and 21 genotypes of mung bean from each genotype was pipette in different test tube separately. In this method, the blue colour developed by the reduction of the phosphomolybdic-phosphotungstin components in the Folin-Ciocalteu's reagent by the amino acids tyrosine and tryptophan present in the protein plus the colour developed by the biuret reaction of the protein with alkaline cupric tartrate are measured in the Lowry's Method at 660nm with the help of spectrophotometer.

Protein estimation by Lowry method

Reagents used in this method are phosphate buffer (pH 8.0) for extraction protein and bovine serum albumin (BSA) for working standard. Preparations of different buffer solutions with their composition are listed below:

Reagent A: 2% sodium carbonate in 0.1(N) sodium hydroxide.

0.4g sodium hydroxide pellet was dissolved in 100ml distilled water to prepare 0.1 (N) sodium hydroxide solutions. 2g sodium carbonate was added and dissolved in 0.1 (N) sodium hydroxide solutions.

Reagent B: 0.5% copper sulphate (CuSO4 5H20) in 1% potassium sodium tartrate.

0.5% copper sulphate was dissolved in 100ml distilled water. Then 1g potassium sodium tartrate was added and dissolved completely.

Reagent C: alkaline copper solution: Mixture of 50ml of reagent A and 1ml of Reagent B

Reagent D: Folin and Ciocalteu's Phenol Reagent 1(N).

Test of significance:

The standard error computed as the square root of the variance of the estimates was used in the test of significance, where degrees of freedom will be equal to that of error component

GCA effect t(g_i) $= \frac{g_i}{SE(g)_i}$ compare with t – value at (P-1) d.f

SCA effect t(s_{ij}) $= \frac{S_{ij}}{S(S)_{ij}}$ compare with t value at $\frac{P(P-1)}{2}$ d.f

Estimation of heterosis:

Heterosis (H), expressed as percentage of increase or decrease of F_1s over mid parent (MP) and better parent (BP) were calculated as suggested by Matzinger *et al.*, (l962).

Heterosis over mid parent (MP) = $\frac{F_1 - MP}{MP}$ x 100

Heterobeltiosis over better parent (BP) = $\frac{F_1 - BP}{BP}$x 100

Where, F_i = mean value of F_1,

MP = mean value of mid parent

BP = mean value of better parent (i.e. higher scoring parent of the hybrid). Test of significance was done following Bitzer *et al.*, (1967).

SE of H Over MP $= \sqrt{\frac{3}{2} M_e}$

SE of H over BP $= \sqrt{2M_e}$

(M'_e = EMS of combining ability analysis)

% tests of heterosis over mid parent and better parent were done with their respective standard errors, where degrees of freedom were same as that of error in ANOVA.

RESULT AND DISCUSSION:

F_2 population from fifteen F_1 hybrids were studied for heterosis over mid parent (relative heterosis), with better parent (heterobeltiosis) for eleven different characters. The results were represented in table 5.5 which revealed the heterotic effect for the eleven characters. The range for average heterosis was -2.31 to 16.75 and that for heterobeltiosis -2.58 to 13.43. Highest average heterosis and heterobeltiosis observed between Basanti x Bireswar. No significant positive average heterosis for plant height was observed. The range of average heterosis was between -1.15 to 13.95 and that for heterobeltiosis was between -3.34 to -9.45. Among crosses highest average heterosis was found WBM-314 x HUM-12 and significant for heterobeltiosis observed in PS-16 x TM-99-50. Barad *et al.*[14], Patel *et al.*[15] and Dhuppe *et al.* [16], also reported presence of relative heterosis and heterobeltiosis in some crosses for character. The estimates of relative heterosis ranged from -0.097 to 8.48 and that for heterobeltiosis from -13.21 to 7.38. Among F_2 plants significant average heterosis and heterobeltiosis over mid parent observed in PS-16 x TM-99-50. Zubair *et al.*[17], reported positive heterosis and heterobeltiosis for this character. The estimate of relative heterosis was between -1.99 to 1.12 and that for heterobeltiosis between -1.86 to -8.18. Among the F_2 plants highest significant for average heterosis found in HUM-12 x Basanti. And highest but non-significant heterobeltiosis was observed in WBM-314 x HUM-12. Khattak [13], also reported relative heterosis and heterobeltiosis for this trait. Range for average heterosis for number of pods plant-1 was between -0.48 to 18.78 and that for heterobeltiosis between -3.39 to 17.52. Highest significant average heterosis and heterobeltiosis observed in PS-16 x TM-99-50 followed by HUM-12 x Bireswar and Basanti x Bireswar. Dethe *et al.,* [18, 19], Kumar *et al.*[1], Sathya and Jayamani[20] also reported significant heterosis for this trait. The range of relative heterosis for number of seeds pod^{-1} was extended from -2.68 to 25.23 and that for heterobeltiosis between -2.78 to 24.62. Among the F_2 plants significant and maximum number of seeds pod^{-1} for average heterosis and heterobeltiosis observed in HUM-12 x Basanti. WBM-314 x Basanti was found to be superior with respect to both relative heterosis and heterobeltiosis. Dethe and Patil[18, 19], Sathya and Jayamani[20], also reported presence of significant relative heterosis and heterobeltiosis among some hybrids. Relative heterosis for pod length ranged -1.70 to -15.53 and that for heterobeltiosis between -1.64 to 11.58. Highest significant average heterosis and heterobeltiosis over mid parent was observed for pod length in HUM-12 x PS-16 and significant average heterosis observed in HUM-12 x TM-99-50, HUM-12 x Basanti and WBM-314 x PS-16. Like the present investigation Zubair *et al.* [17], also reported lower extent of heterosis for this trait. However Sathya and Jayamani[20] reported highly significant heterosis for this trait. Relative heterosis of pod width was extended from -2.88 to 13.68 and that for heterobeltiosis between -0.72 to 2.15. No significant heterosis observed for pod width. Highest pod width for average heterosis observed in Basanti x TM-99-50 and for heterobeltiosis was observed in HUM-12 x TM-99-50. Range of average heterosis for 100 seed weight plant^{-1} was between -0.75 to 18.720 and that for heterobeltiosis between -0.54 to 16.72. Highest significant average heterosis observed in HUM-12 x TM-99-50. Positive significant for heterobeltiosis was not found but it was maximum in WBM-314 x HUM-12. Zubair *et al.*[17], also reported a low to medium heterosis for this trait which imposed restriction on improving the trait with the material used in their study. However, Sathya and Jayamani[20], observed significant heterosis for the trait. Range of average heterosis was between -2.5 to 10.23 and that for heterobeltiosis between -2.5 to 5.32. Highest significant for average and heterobeltiosis observed in HUM-12 x Bireswar. In contrast Sawale *et al*.[21], failed to find positive heterosis in any of the hybrids. Range of average heterosis was between in -2.35 to 26.69 and that for heterobeltiosis between -2.87 to 14.5. Highest significant positive average heterosis was observed in Basanti x Bireswar followed by WBM-314 x TM-99-50 and WBM-314 x Bireswar. Highest significant heterobeltiosis was observed in Basanti x PS-16. Sawale *et al.*[21], Dethe *et al.* [18, 19], Kumar and Prakash[22], reported significant relative heterosis and heterobeltiosis for seed yield and yield components. WBM-314 x Bireswar had exhibited significant desirable relative heterosis and heterobeltiosis and sca effect accompanied by good per se performance for yield plant^{-1}. The cross also found to be superior with respect to per se performance for a number of characters like 100 seed weight, pod length, pod width, number of pods plant^{-1}. The parents involved in the cross were with high and average gca effect so following population breeding method the heterosis can be exploited in high yielding segregants in advanced generation which are mainly contributed by additive × additive gene action.

Table 1: Percent heterosis over mid parent (relative heterosis and better parent (heterobeltiosis) for different characters

F_2	Plant Height cm		Days to 50% Flowering		Days to Maturity		Primary Branches Plant^{-1}		No. of Seeds	
	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP
Basanti X Bireswar	16.75	13.43	9.35**	9.45**	3.19	2.75	6.26	4.09	-9.58	-16.68*
Basanti X PS-16	-33.1*	-38.5**	-4.35	-9.12**	-0.97	-3.78	1.38	-10.92**	4.42	-3.62
Basanti X TM-99-50	-12.31	-13.20	1.15	0.00	0.34	0.00	0.00	-6.36	7.38	6.28
HUM-12 X Basanti	-2.31	-4.75	7.28**	6.68*	1.35	0.68	16.12**	3.18	25.23**	24.62*
HUM-12 X Bireswar	-5.51	-14.43	-1.61	-3.09	-1.63	-3.79	10.63**	-12.14**	8.92	0.00
HUM-12 X PS-16	-13.95	-16.92	2.84	1.15	1.01	0.00	-3.88	-9.12	19.62*	17.81
HUM-12 X TM-99-50	5.58	-2.58	2.29	-4.48	-3.75	-5.94*	-4.12	-4.12	12.48	4.72
PS-16X BIRESWAR	-7.49	-16.38	4.25	3.54	2.14	0.68	7.28*	-10.91**	2.95	-2.78
PS-16 X TM-99-50	-2.52	-15.82*	-2.71	-9.12**	-9.52**	-13.23**	7.72*	-13.35**	5.92	-3.65
TM-99-50 X BIRESWAR	-25.95**	-30.75**	12.95**	6.19*	5.29*	1.92	10.64**	-12.08**	-5.32	-11.74
WBM-314X BASANTI	3.75	-6.49	4.25	2.35	-1.12	-2.69	1.78	-9.58*	14.92	7.42
WBM-314 X BIRESWAR	-27.25**	-38.43**	13.63**	6.16*	7.92**	3.18	-1.91	-728	-14.26*	-15.36
WBM-314 X HUM-12	-16.19	-20.47*	-1.15	-3.34	0.00	-1.88	10.43*	8.18	3.28	2.18
WBM-314X PS-16	11.49	3.26	4.06	2.28	-6.12*	-7.35*	-3.68	-15.88**	13.52	11.74
WBM-314 XTM-99-50	3.28	-5.28	2.89	2.35	8.48**	7.39*	5.81	-1.86	-2.68	-5.23
SE	3.408	3.423	1.047	1.198	1.948	2.123	0.126	0.132	0.719	0.823

	Pod Length cm		Pod width cm		No of Pods Plant^{-1}		100 Seed Weight		Protein Content		Seed Yield Plant^{-1}	
CROSS	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP
Basanti X Bireswar	-10.82*	-10.82*	1.65	-8.23	13.98**	13.12*	12.92	-6.48	5.0.5**	2.72	28.72**	-5.42
Basanti X PS-16	2.05	2.06	4.58	-7.26	-3.12	-4.28	4.76	4.75	-4.51**	-9.12**	7.25	14.15*
Basanti X TM-99-50	0.08	0.08	13.68	-0.72	6.38	1.41	14.38	7.92	-11.15**	-13.42**	8.35	-4.17
HUM-12 X Basanti	10.81*	7.12	10.52	-3.64	12.14**	11.48*	6.23	0.71	-1.88	-2.25	-3.74	-5.78
HUM-12 X Bireswar	2.36	1.56	-2.89	-4.79	18.25**	17.45**	-4.95	-9.85	10.23**	5.32**	7.58	-2.87
HUM-12 X PS-16	15.53**	11.58*	7.95	-7.65	-14.25**	-17.78**	15.86	15.28	-0.25	-2.41	10.16	0.63
HUM-12 X TM-99-50	15.94**	6.67	0.24	2.15	-11.23*	-12.25*	18.72*	-0.54	1.78	0.55	4.07	4.82
PS-16X BIRESWAR	-12.68*	-12.65*	2.52	-4.42	-7.96	-12.78**	-4.28	-19.35**	-6.48**	-9.58**	11.28	7.21
PS-16 X TM-99-50	1.63	-1.64	-4.58	-6.28	18.78**	17.52**	-0.75	-4.58	-1.19	-4.78**	0.28	-6.12
TM-99-50 X BIRESWAR	-1.76	-1.78	-2.87	-4.63	-0.48	-3.99	-10.65	-15.68	2.35	-0.25	-8.71	-15.58*
WBM-314X BASANTI	-16.96**	-16.98**	2.82	-15.41	2.79	2.12	-33.38**	-45.52**	0.39	-0.52	-2.35	-9.47
WBM-314 X BIRESWAR	-22.75**	-22.78**	-12.93	-19.98*	13.12*	10.98*	-40.92**	-52.52**	2.65	-3.28*	14.51*	-25.32**
WBM-314X PS-16	11.65*	10.98	13.26	2.08	6.72	6.92	-4.75	-8.47	-6.38**	-7.62**	3.48	-14.79
WBM-314 X HUM-12	1.39	-2.56	-3.85	-7.42	-2.95	-3.39	18.35*	16.72	-3.94**	-4.91**	3.75	-5.42
WBM-314 XTM-99-50	3.88	3.39	-11.95	-14.98	12.03**	6.95	2.82	0.89	-16.54**	-17.45**	28.69**	7.79
SE	0.329	0.378	0.0041	0.0044	1.2 18	1.323	0.278	0.309	0.288	0.342	0.568	0.654

SUMMAR AND CONCLUSION

Relative heterosis as well as heterobeltiosis in high magnitude was observed in F_2 population in cross PS-16 x TM-99-50 of for 50% maturity, days to 50% flowering and number of pods plant^{-1}. High relative as well as heterobeltiosis for earliness were also noted in WBM-314 x HUM-12. PS-16 x TM-99-50 also showed high heterotic effect for number of pods plant^{-1}. These heterotic values were found to be superior in WBM-314 x TM-99-50 for seed yield plant^{-1}, Among the F_2 population significant and maximum average heterosis and heterobeltiosis was observed in HUM-12 x Basanti for number of pods plant^{-1}. Relative heterosis as well as heterobeltiosis were observed in high magnitude for HUM-12 x Bireswar for protein content. Highest significant average heterosis and heterobeltiosis over mid parent was observed for pod length in HUM-12 x PS-16.

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