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HYBRID VIGOUR IN *VIGNA MUNGO* L.

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Abstract

Heterosis over mid, better and top parent values for yield and yield components were conducted in complete diallel involving 5 parents of mash viz., S 58, S 60, S 222, S 535 and NARC 87, all belonging to local origin. Bi- directional (both for crosses and characters) heterotic effects were observed, maximum being for pods and grain yield in the hybrid S 222 X S 58. The same hybrid gave maximum heterotic effects for plant height, branches per plant, pods per plant and grain yield which were followed by S 60 X NARC 87 (for plant height), S 58 X S 60 (for branches per plant), S 535 X NARC 87 (for pods per plant) and NARC 87 X S 58 (for grain yield). Most of the hybrids involving S 222, S 60 and NARC 87 as one of the parent proved better in cross combinations. The hybrids S 222 X S 58 and NARC 87 X S 58 which produced high heterotic effects for grain yield are suggested to be utilized for developing high yielding mash cultivars.

Introduction

Heterosis is being considered important in breeding most of the field crops. Genetic information regarding heterosis provides a clue for selecting the most suitable parents for hybridization. Heterosis has been generally expressed in increase in vigour and productivity obtained by crossing inbred lines. The presence of heterosis in food legumes has been demonstrated by Solomon *et al.*, (1957), Bhatnagar & Singh (1964), Singh & Singh (1971), Singh *et al.*, (1973), Singh *et al.*, (1975), Sagar & Chandra (1977), Arora & Pandya (1987), Malik *et al.*, (1987) and Shinde & Deshmukh (1989). Selection of potential cross combinations should be exploited on the basis of manifestation of heterosis for varietal improvement (Joshi, 1979). Although, heterosis is exploited in most of the field crops, yet its usefulness remained unexplored in legumes mainly because of high degrees of self pollination (cleistogamous in nature) and lack of male sterile lines. Therefore, presence of heterosis can only be utilized in pulse crops for development of high yielding pure-line varieties (Singh, 1971). Little information about heterosis is available in mash. The present study was carried out to estimate the extent of heterosis in a 5 parent diallel for utilization of existing genetic variability to develop high yielding early cultivars of mash.

Materials and Methods

Five pure-lines of mash or urdbean (Vigna mungo) viz., S 58, S 60, S 222, S 535 and NARC 87 all belonging to local origin were crossed in a complete diallel under green house condition during spring seasons of 1988 and 1989. All possible measures were conducted to avoid un-desirable contamination of breeding material. The pollination was followed simultaneously after emasculation in the evening. The hybrid seeds of 20 crosses alongwith 5 parents (self) were collected and sown in a randomized complete block design with 3 replications in experimental fields of National Agricultural Research Centre, Islamabad during summer, 1989. One row of each hybrid/parent line accommodating 10 plants was dibbled by keeping 35 and 10 cm spacings between and within rows, respectively. At maturity, the data were recorded for the characters like, plant height (cm), branches per plant, pods per plant, pod length (cm), seeds per pod, 100-seed weight (g), biological yield per plant (g) and grain yield per plant (g) on all the plants. Harvest index expressed as ratio between economic and biological yield was also calculated. The averaged data were subjected to analysis of variance to establish the level of significance (Steel & Torrie, 1960). Heterosis and heterobeltiosis (word coined by Fonseca, 1965) were calculated as % increase or decrease over mid and better parent values, respectively. Further increase or decrease over top parent included in hybridization programme were also calculated.

Results and Discussion

All the genotypes exhibited highly significant differences for all the characters (Table 1). Moderate to high heritability estimates in broad sense were observed for all the characters. The results regarding heterosis are presented in the Table 2.

Table 1. Means and analysis of variance for 9 characters in 5 parent diallel of mash.

I- Variety/ hybrid	X 1	X 2	X 3	X 4	X 5	X 6	X 7	X 8	X 9
1- S 58 X S 60	34.35	17.33	34.09	4.28	5.97	4.71	28.22	30.57	8.60
2- S 58 X S 222	31.73	13.77	43.87	4.33	6.13	4.21	27.57	30.99	8.54
3- S 58 X S 535	29.42	11.09	25.44	4.16	5.53	4.36	21.91	20.65	4.46
4- S 58 X NARC 87	31.66	13.13	29.47	4.39	5.76	4.76	25.75	24.44	6.29
5- S 60 X S 58	31.60	10.14	28.75	4.21	5.76	4.35	22.31	23.12	5.15
6- S 60 X S 222	34.81	12.43	32.74	4.41	5.95	4.35	25.18	24.54	6.16
7- S 60 X S 535	32.77	11.49	20.21	3.97	5.97	4.81	23.88	25.04	5.48
8- S 60 X NARC 87	36.34	17.16	49.21	4.41	6.13	4.18	29.93	34.44	10.07
9- S 222 X S 58	39.98	20.52	61.70	4.45	6.06	4.20	45.70	29.93	13.66
10- S 222 X S 60	33.83	11.72	40.55	4.42	6.00	4.54	35.24	21.58	7.60
11- S 222 X S 535	30.33	13.89	37.67	4.27	5.52	4.40	24.44	25.18	6.12
12- S 222 X NARC 87	29.58	8.58	39.42	4.27	5.90	4.28	30.45	25.07	7.61
13- S 535 X S 58	33.53	17.58	36.39	4.32	5.83	4.45	28.27	27.69	7.78
14- S 535 X S 60	33.37	15.32	38.61	4.46	6.25	4.73	36.22	25.13	8.28

(Table 1 Contd.)

15- S 535 X S 222	32.08	14.73	37.37	4.46	5.99	4.91	24.42	28.67	7.27
16- S 535 X NARC 87	32.33	11.88	49.25	4.41	5.83	4.38	31.34	28.30	8.81
17- NARC 87 X S 58	35.02	18.03	41.28	4.40	5.94	4.40	35.99	30.59	10.98
18- NARC 87 X S 60	29.93	16.24	44.68	4.31	5.83	4.27	34.84	24.74	8.62
19- NARC 87 XS 222	27.23	11.43	39.47	4.37	6.37	4.08	25.47	30.21	7.71
20- NARC 87 X S 535	32.89	15.24	32.64	4.38	5.82	4.91	31.09	25.93	8.01
21- S 58	30.11	11.63	27.70	4.25	5.83	4.66	17.75	29.96	5.33
22- S 60	30.28	10.81	31.06	4.26	5.98	3.98	22.85	26.03	5.94
23- S 222	33.50	13.25	38.26	4.14	5.39	4.62	38.71	17.27	6.67
24- S 535	29.98	13.10	26.34	4.23	5.46	4.00	18.92	30.88	5.83
25- NARC 87	31.19	16.17	43.22	4.10	5.57	3.99	31.39	25.38	7.87
Means	32.31	13.87	37.18	4.31	5.87	4.42	28.71	26.65	7.55
	**	**	**	**	**	**	**	**	**
MS (genotypes)	20.99	25.17	237.45	0.05	0.18	0.24	127.48	44.73	12.21
MS (replications	0.43	1.71	13.41	0.01	0.04	0.09	1.69	15.84	0.32
MS (error)	5.04	1.64	5.21	0.01	0.01	0.08	7.51	8.62	20.28
Standard error	1.30	0.74	1.32	0.04	0.07	0.16	1.58	1.70	0.31
Heritability (BS)	0.51	0.83	0.94	0.79	0.80	0.41	0.84	0.58	0.93

**- Highly significant

X 1- Plant height X 2- Branches per plant

X 3- Pods per plant X 4- Pod length

X 5- Seeds per pod X 6- 100-seed weight

X 7- Biological yield per plant X 8- Harvest index

X 9- Grain yield per plant

The results showed that 14 hybrids produced positive heterosis over mid parent, 13 over better parent and 8 over top parent (S 222) included in hybridization. The maximum average heterosis (21.46 %) was observed in the hybrid S 222 X S 58 which was top in all three cases and it was succeeded by the hybrid S 60 X NARC 87. The reciprocals of these crosses exhibited negative effect. Average heterosis for plant height was 5.33, 2.78 and -2.35 over mid, better and top parent, respectively which were quite low. Singh *et al.,* (1973) reported 11.7 and 5.9 % heterosis and heterobeltiosis, respectively in 8 crosses of chickpea. Shinde & Deshmukh (1989) also reported high heterosis for plant height in urdbean.

Twelve hybrids produced positive heterosis over mid parent, 10 over better parent and only 6 over top parent (NARC 87) for branches per plant. S 222 X S 58 produced the highest average heterosis (48.91%) which was followed by the cross S 58 X S 60 with average value of 36.88. Singh *et al.,* (1973) reported similar results of chickpea whereas, Singh *et al.,* (1975) and Shinde & Deshmukh (1989) reported much higher heterotic effects in lentil and urdbean, respectively.

The results for pods per plant revealed that 13 hybrids produced positive heterosis over mid parent, 9 over better parent and only 5 over top parent (NARC 87). Eleven hybrids gave positive average heterosis for pods per plant. The hybrid S 222 X S 58 produced the highest average heterosis (63.70%) which was followed by S 535 X NARC 87 with average value of 23.17%. Singh *et al.*, (1973) reported similar results in chickpea whereas, Singh *et al.*, (1975), Malik *et al.*, (1987) and Shinde & Deshmukh (1989) reported much higher heterotic effects in lentil, chickpea and urdbean, respectively.

For pod length 17 hybrids produced positive heterosis over mid, better and top parent values. Maximum average heterotic effect (5.57%) was exhibited by the hybrid S 535 X S 222 which was followed by the hybrid S 222 X S 58 with an average value of 5.08%. The extent of heterosis for this character was very low.

Eighteen hybrids produced positive heterotic values over mid parent, 13 over better parent and 7 over top parent (S 60) for seeds per pod (Table 2). The extent of heterosis for this character was low and parental values were also not much diversified in this character. The cross NARC 87 X S 222 produced maximum heterotic effect in all 4 cases which was followed by S 535 X S 222. The heterotic effects in seeds per pod were also lower as compared to other characters which restricted further improvement in pod length in mash. Shinde & Deshmukh (1989) also reported low heterosis for seeds per pod in mash.

Table 2. Heterosis over mid, better and top parental values for yield and yield components in 5 parent diallel of mash

Hybrid	+/- over	Plant height (cm)	Branches per plant	Pods per plant	Pod length (cm)	Seeds per pod
S58	MP	13.76(4.65)	54.46(-9.63)	16.03(-2.14)	0.59(-1.06)	1.10(-2.46)
X	BP	13.44(4.37)	49.01(-12.81)	9.76(-7.44)	0.47(-1.17)	-0.17(-3.68)
S60	TP	2.54(-5.67)	7.17(-37.29)	-21.12(-33.48)	0.47(-1.17)	-0.17(-3.68)
	Av.	**9.91(1.12)**	**36.88(-19.91)**	**1.56(-14.35)**	**0.51(-1.13)**	**0.25(-3.27)**
S58	MP	-0.24(25.70)	10.69(64.95)	33.02(87.08)	3.22(6.08)	9.27(8.02)
X	BP	-5.28(19.34)	3.92(54.87)	14.66(61.27)	1.88(4.71)	5.15(3.95)
S222	TP	-5.28(19.34)	-16.84(26.90)	1.50(42.76)	1.64(4.46)	2.51(1.34)
	Av.	**-3.60(21.46)**	**-0.74(48.91)**	**16.39(63.70)**	**2.25(5.08)**	**5.64(4.44)**
S58	MP	-2.08(11.60)	-10.31(42.18)	-5.85(34.68)	-1.19(1.89)	-2.04(3.28)
X	BP	-2.29(11.36)	-15.34(34.20)	-8.16(31.37)	-2.12(1.65)	-5.15(0.00)
S535	TP	-12.18(0.09)	-31.42(8.72)	-41.14(-15.80)	-2.35(1.41)	-7.53(-2.51)
	Av.	**-5.52(7.68)**	**-19.02(28.37)**	**-18.38(16.75)**	**-1.89(1.65)**	**-4.91(0.26)**
S58	MP	3.30(14.26)	-5.54(29.71)	-16.89(16.41)	5.15(5.39)	1.05(4.21)
X	BP	1.51(12.28)	-18.80(11.50)	-31.81(-4.49)	3.29(3.53)	-1.20(1.87)
NARC 87	TP	-5.49(4.54)	-18.80(11.50)	-31.81(-4.49)	3.05(3.29)	-3.68(-0.67)

(Table 2 Contd.)

	Av.	**-0.23(10.36)**	**-14.38(17.57)**	**-26.84(2.48)**	**3.83(4.07)**	**-1.28(1.80)**
S60	MP	9.16(6.08)	3.33(-2.58)	-5.54(16.99)	5.00(5.24)	4.66(5.54)
X	BP	3.91(0.99)	-6.19(-11.55)	-14.43(5.99)	3.52(3.76)	-0.50(0.33)
S222	TP	3.91(0.99)	-23.13(-27.52)	-24.25(-6.18)	3.52(3.76)	-0.50(0.33)
	Av.	**5.66(2.69)**	**-8.66(-13.88)**	**-14.74(5.60)**	**4.01(4.25)**	**1.22(2.07)**
S60	MP	8.76(10.57)	-3.89(28.15)	-29.58(34.53)	-6.48(5.06)	4.37(9.27)
X	BP	8.22(10.20)	-12.29(16.95)	-34.93(24.31)	-6.81(4.69)	-0.17(4.52)
S535	TP	2.18(-0.39)	-28.94(-5.26)	-53.24(-10.67)	-6.81(4.69)	-0.17(4.52)
	Av.	**6.39(6.85)**	**-15.04(13.28)**	**-39.25(16.06)**	**-6.70(4.81)**	**1.34(6.10)**
S60	MP	18.24(-2.62)	27.21(20.39)	32.50(20.30)	5.50(3.11)	6.15(0.95)
X	BP	16.51(-4.04)	6.12(0.43)	13.86(3.38)	3.52(1.17)	2.51(-2.51)
NARC 87	TP	8.48(-10.66)	6.12(0.43)	13.86(3.38)	3.52(1.17)	2.51(-2.51)
	Av.	**14.41(-5.77)**	**13.15(7.08)**	**20.07(9.02)**	**4.18(1.82)**	**3.72(-1.36)**
S222	MP	-4.44(1.07)	5.43(11.80)	16.63(15.70)	2.03(6.57)	1.75(10.41)
X	BP	-9.46(-4.24)	4.83(11.17)	-1.54(-2.33)	0.95(5.44)	1.10(9.71)
S535	TP	-9.46(-4.24)	-14.10(-8.91)	-12.84(-13.54)	0.23(4.69)	-7.69(0.17)
	Av.	**-7.79(-2.47)**	**-1.28(4.69)**	**0.75(-0.06)**	**1.07(5.57)**	**-1.61(6.76)**
S222	MP	-8.55(-15.81)	-41.67(-22.30)	-3.24(3.12)	3.64(6.07)	7.66(16.24)
X	-11.70(-18.72)		-46.94(-29.31)	-8.79(-8.68)	3.14(5.56)	5.92(14.36)
NARC 87	TP	-11.70(-18.72)	46.94(-29.31)	-8.79(-8.68)	0.23(2.58)	-1.34(6.52)
	Av.	**-10.65(-17.75)**	**-45.18(-26.97)**	**-6.94(-4.75)**	**2.34(4.74)**	**4.08(12.37)**
S535	MP	5.71(7.54)	-18.82(4.13)	41.60(-6.15)	5.88(5.16)	5.71(5.53)
X	BP	3.66(5.45)	-26.53(-5.75)	13.95(-24.48)	4.20(3.55)	4.67(4.49)
NARC 87	TP	-3.49(-1.82)	-26.53(-5.75)	13.95(-24.48)	3.52(2.82)	-2.51(-2.68)
	Av.	**1.96(3.37)**	**-23.96(-2.46)**	**23.17(-18.37)**	**4.55(3.84)**	**2.62(2.45)**
Av. +/-	MP	5.33	9.38	14.96	3.34	5.03
	BP	2.78	0.37	1.57	2.25	2.26
	TP	-2.35	-13.00	-11.75	1.74	-0.89

Hybrid	+/- over	100-seed weight (g)	Biological yield per plant (g)	Harvest index (percentage)	Grain yield per plant (g)
S58	MP	9.03(0.69)	39.01(9.90)	9.20(-17.41)	52.62(-8.61)
X	BP	1.07(-6.65)	23.50(-2.36)	2.04(-22.83)	44.78(-13.30)
S60	TP	1.07(-6.65)	-27.10(-42.37)	-1.00(-25.13)	9.28(-34.56)
	Av.	**3.72(-4.20)**	**11.80(-11.61)**	**3.41(-21.79)**	**35.56(-18.82)**
S58	MP	-9.27(-9.48)	-2.34(61.88)	31.23(26.74)	42.33(127.67)
X	BP	-9.66(-9.87)	-28.78(18.06)	3.44(-0.10)	28.04(104.80)

(Table 2 Contd.)

S222	TP	-9.66(-9.87)	-28.78(18.06)	0.36(-3.08)	8.51(73.57)
	Av.	**-9.53(-9.74)**	**-19.97(32.67)**	**11.68(7.85)**	**26.29(102.01)**
S58	MP	0.69(2.77)	19.50(54.19)	-32.12(-8.97)	-20.07(39.43)
X	BP	-6.44(-4.51)	15.80(49.42)	-33.13(-10.33)	-23.50(33.45)
S535	TP	-6.44(-4.51)	-43.40(-26.97)	-33.13(-10.33)	-43.33(-1.14)
	Av.	**-4.06(-2.08)**	**-2.70(25.35)**	**-32.79(-9.88)**	**-28.97(23.91)**
S58	MP	10.06(1.73)	4.80(46.48)	-11.67(10.55)	-4.70(66.36)
X	BP	2.15(-5.58)	-17.97(14.65)	-18.42(2.10)	-20.08(39.52)
NARC 87	TP	2.15(-5.58)	-33.48(-7.03)	-20.85(-0.94)	-20.08(39.52)
	Av.	**4.79(-3.14)**	**-15.55(18.03)**	**-16.98(3.9[illegible])**	**-14.95(48.47)**
S60	MP	1.62(5.58)	-18.19(14.49)	13.35(-0.32)	-2.30(20.54)
X	BP	-5.84(-1.73)	-34.95(-8.96)	-5.72(-17.10)	-7.65(13.94)
S222	TP	-6.65(-2.58)	-34.95(-8.96)	-20.53(-30.12)	-21.73(-3.43)
	Av.	**-3.62(0.42)**	**-29.36(-1.14)**	**-4.30(-15.85)**	**-10.56(10.35)**
S60	MP	20.55(18.55)	14.34(73.43)	-12.00(-11.69)	-1.79(48.39)
X	BP	20.25(18.25)	4.51(58.51)	-18.91(-18.91)	-7.65(39.40)
S535	TP	3.22(1.50)	-38.31(-6.43)	-18.91(-18.91)	-21.73(5.21)
	∴	**14.62(12.77)**	**-6.49(41.94)**	**-16.61(-16.50)**	**-13.30(31.00)**
S60	MP	4.89(7.15)	10.36(28.47)	33.98(-3.75)	45.84(24.84)
X	BP	4.76(7.02)	-4.65(10.99)	32.31(-4.96)	27.95(9.53)
NARC 87	TP	-10.30(-8.37)	-22.68(-10.00)	11.53(-19.88)	27.95(9.53)
	Av.	**-0.22(1.93)**	**-5.66(9.82)**	**25.94(-9.53)**	**33.91(14.63)**
S222	MP	2.09(13.92)	-15.18(-15.25)	4.59(19.09)	-2.08(16.32)
X	BP	-4.76(6.28)	-36.86(-36.92)	-18.46(-7.16)	-8.25(9.00)
S535	TP	-5.58(5.36)	-36.86(-36.92)	-18.46(-7.16)	-22.24(-7.62)
	Av.	**-2.75(8.52)**	**-29.63(-29.70)**	**-10.78(1.59)**	**-10.86(5.90)**
S222	MP	-0.58(-5.23)	-13.12(-27.33)	17.56(41.66)	4.68(6.05)
X	BP	-7.36(-11.69)	-21.34(-34.20)	-1.22(19.03)	-3.30(-2.03)
NARC 87	TP	-7.62(-12.45)	-21.34(-34.20)	-18.81(-2.17)	-3.30(-2.03)
	Av.	**-5.19(-9.79)**	**-18.60(-31.91)**	**-0.82(19.51)**	**-0.64(0.66)**
S535	MP	9.64(22.90)	24.59(23.59)	0.60(7.82)	28.61(16.93)
X	BP	9.50(22.75)	-0.16(-0.96)	-8.35(-16.03)	11.94(1.78)
NARC 87	TP	-6.01(5.36)	-19.04(-19.68)	-8.35(-16.03)	11.94(1.78)
	Av.	**4.38(17.00)**	**1.80(0.98)**	**-5.37(-13.29)**	**17.50(6.83)**
Av. +/-	MP	5.37	16.68	5.92	25.05
	BP	0.90	-1.63	-7.14	13.92
	TP	-4.45	-24.02	-13.10	0.31

MP- mid parent, BP- better parent and TP- top parent values.
The reciprocal effects are in the parenthesis.

The results for 100-seed weight revealed that 16 hybrids excelled over mid parent, 9 over better parent and 6 over top parent (S 58). The hybrid NARC 87 X 535 produced highest values which was followed by the hybrid S 60 X S 535. The heterotic effects in 100 - seed weight were moderate which also imposed restriction on improving 100- seed weight in existing mash germplasm, therefore, bold seeded mash lines should be imported to increase seed size in mash.

Fourteen crosses produced positive heterosis over mid parent, 8 over better parent and only 1 over top parent (S 222) in case of biological yield per plant. Eight hybrids gave positive average heterosis for this character. The hybrid S 535 X S 60 produced the highest heterosis and heterobeltiosis with values of 73.43 and 58.51%, respectively whereas the cross S 222 X S 58 gave the highest values (18.06%) for top parent. Maximum average heterotic effect (41.94%) was produced by the hybrid S 535 X S 60 followed by S 222 X S 58 with heterotic value of 32.67%. Shinde & Deshmukh (1989) reported much higher heterosis for biological yield.

The results regarding harvest index showed that 12 hybrids excelled over mid parent, 5 over better parent and only 2 over top parent (S 535). Seven crosses gave positive average heterosis for harvest index. NARC 87 X S 222 produced the highest heterosis over mid value followed by S 60 X NARC 87 which was top in case of increase over better and top parental values alongwith average heterotic value.

Fourteen hybrids produced positive heterosis over mid parent, 12 over better parent and 9 over top parent (NARC 87) in case of grain yield per plant. Thirteen hybrids gave positive average heterosis with values ranging from 0.66 to 102.01 %. The hybrid S 222 X S 58 produced the highest values which were followed by S NARC 87 X S 58. The heterotic effects for grain yield were much higher than other characters which indicated that grain yield can be improved in existing mash material. Singh *et al.*, (1973), Singh *et al.*, (1975) and Malik *et al.*, (1987) and Shinde & Deshmukh (1989) reported similar results.

The extent of heterosis varied bi-directionally (for crosses and characters), maximum being for pods and grain yield in the hybrid S 222 X S 58 which was equally good in reciprocal case for both important traits. NARC 87 was top for both characters among parents. The hybrid S 222 X S 58 gave maximum heterotic effects for plant height, branches per plant, pods per plant and grain yield. It was followed by S 60 X NARC 87 (for plant height), S 58 X S 60 (for branches per plant, S 535 X NARC 87 (for pods per plant) and NARC 87 X S 58 (grain yield). A critical study of hybrid vigour in the present crosses revealed that increase in plant height, branches and pods influenced grain yield to some extent. It is evident that the hybrids involving S 222, S 60 and NARC 87 as one of the parent proved better in cross combinations. The extent of heterosis for pod length, seeds per pod and 100-seed weight was very low which restrict improvement of mash plant for these traits in existing genetic stock. Therefore diversified parents are required to be imported for utilization in hybridization programme to improve number of seeds per pod and seed size in mash.

The present study indicates that the crosses viz., S 222 X S 58 and NARC 87 X S 58 which produced high heterotic effects for grain yield might be exploited for developing high yielding mash cultivars.

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