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Research article

STUDY ON HETEROSIS FOR YIELD AND YIELD CONTRIBUTING CHARACTERS IN HORSEGRAM (*Macrotyloma uniflorum* [Lam.] Verdc.)

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ABSTARCT: Nine lines, three testers and twenty seven F_1 crosses derived through line x tester mating system including one check were evaluated to study the magnitude of heterosis for yield and yield contributing characters. With respect to seed yield per plant, the heterosis was recorded to the extent of 70.30%, 58.45% and 63.14% over mid parent, better parent and standard check, respectively. The maximum amount of heterosis, heterobeltiosis and standard heterosis were recorded for number of pods per plant (138.95%, 128.06% and 134.84%) followed by number of clusters per plant (91.88%, 87.49% and 51.67%). For seed yield per plant the maximum average heterosis, heterobeltiosis and standard heterosis were recorded by HGP-67 x Palem-2. HGP-67 x Palem-2, HGP-40 x AK-42, HGP-67 x AK-42, HGP-44 x Palem-2 and HGP-80 x AK-42 were the top five crosses based on mean *per se* performance and heterosis.

Key words: Heterosis, horsegram and yield components.

Abbreviations: g- grams, kg- kilograms, ha- hectares, %- per cent and cm- centimeters.

INTRODUCTION:

In Horse gram (*Macrotyloma uniflorum* [Lam.] Verdc.) the low productivity is due to several reasons like cultivation in low productive soils, low input application and unavailability of superior varieties/hybrids. The heterosis was not studied extensively in this crop since now. In plant breeding, heterosis studies are very important tool in finding the best crosses. From heterosis studies, estimation of magnitude of heterosis and isolation of crosses with high heterotic potential will become easier and also helpful in evaluation and commercial cultivation of these crosses. Yield component characters play important role in the magnitude of heterosis. So, in this study, all the component characters are included with reference to assess the hybrids for high heterotic potential. Estimation of magnitude of heterosis over mid parent, better parent and standard check is the main objective of this experiment.

MATERIAL AND METHODS

The experimental material used for the present investigation comprised of 9 lines (PDM-1, HGP-80, VZM-1, HGP-43, TLR-646, HGP-44, HGP-67, TLR-811 and HGP-40), 3 testers (Palem-1, Palem-2 and AK-42) and 27 F_1 crosses derived through line x tester mating system using the above lines and testers and one check. Each entry was sown in two rows of 5 m length with a uniform spacing of 45 x 15 cm in a randomized block design, replicated thrice at College Farm, College of Agriculture, Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad and evaluated during *kharif* 2013. Recommended cultivation practices were adopted and necessary prophylactic measures were adopted to raise a healthy crop. The data were recorded on five randomly selected plants in each entry in each replication for 11 characters *viz*., days to 50 per cent flowering, days to maturity, plant height (cm), number of primary branches, number of clusters per plant, number pods per cluster, number of pods per plant, pod length (cm), number of seeds per pod, hundred seed weight (g) and seed yield per plant (g). Heterosis was estimated over mid parent (Average heterosis/Heterosis), better parent (Heterobeltiosis) and standard check (Standard heterosis).

RESULTS AND DISCUSSION

The mean sum of squares due to genotypes (parents and crosses) was highly significant for all the traits studied in this investigation represented in Table 1. It reveals the presence of significant variability in the material studied. Considering earliness, HGP-40 was the best for days to 50 per cent flowering and HGP-80 and HGP-43 were the best for days to maturity. With respect to mean performance, line HGP-80 recorded high mean performance for number of pods per cluster and number of pods per plant. Among the lines, VZM-1, HGP-43, and HGP-44 were the best for number of clusters per plant, pod length and 100 seed weight respectively. The line HGP-67 was the best for seed yield per plant. Among the testers, Palem-2 was recorded high mean performance for seed yield per plant. Among the crosses, HGP-44 x Palem-2 and HGP-80 x AK-42 were recorded high mean performance for number of clusters per plant and number of pods per plant respectively. HGP-67 x Palem-2 was best for number of pods per cluster and seed yield per plant. The negative heterosis was considered to be desirable for days to 50 per cent flowering and days to maturity. In other words, earliness in hybrids was desirable. The cross VZM-1 x Palem-2 showed significant negative heterosis over mid parent, three crosses over better parent and VZM-1 x Palem-2 over standard check for days to 50 per cent flowering. For days to maturity, HGP-67 x AK-42 recorded negative significant heterosis over mid parent, four crosses over better parent and HGP-67 x AK-42 over standard check. Similar results reported by Natarajan and Rathnasamy (1999) [1] and Kuldeep Tyagi Tomer *et al.* (2006) [2].

Table 1. Analysis of Variance for yield and yield contributing characters in horse gram.

Source	d.f	Days to 50 % flowering	Days to maturity	Plant height (cm)	Number of primary branches	Number of clusters per plant	Number of pods per cluster	Number of pods per plant	Pod length (cm)	Number of seeds per pod	100 seed weight (g)	Seed yield per plant (g)
Replications	2	1.78	0.72	3.84	0.001	0.92	0.03	0.65	0.11	0.05	0.02	1.46
Treatments	38	5.56**	18.21**	281.29**	1.12**	74.11**	0.70**	5631.68**	0.21**	0.34**	0.50**	44.01**
Parents	11	9.64**	29.66**	245.53**	0.10**	10.52**	0.05	871.02**	0.04	0.08	0.07**	12.70**
Parents vs Crosses	1	9.50**	0.24	38.92	28.79**	1428.31**	19.27**	67786.90**	3.61**	3.31**	11.03**	364.86**
Crosses	26	3.68**	14.06**	305.73**	0.49**	48.92**	0.26**	5255.22**	0.15*	0.34**	0.27**	44.91**
Lines	8	5.56	28.37*	509.29	0.39	80.49	0.31	6168.61	0.18	0.54	0.3	85.27*
Testers	2	2.12	4.98	156.88	0.59	26.09	0.44	5034.82	0.11	0.34	0.16	28.44
Lines x Testers	16	2.94**	8.03*	222.56**	0.53**	35.99**	0.22**	4826.08**	0.15	0.24	0.27**	26.80**
Error	76	0.96	3.66	9.89	0.03	1.56	0.03	44.09	0.09	0.14	0.01	1.61

Table 2. Estimates of heterosis (H), heterobeltiosis (HB) and standard heterosis (SH) for yield and yield contributing characters.

Character	Days to 50 % flowering			Days to maturity			Plant height (cm)			Number of primary branches			Number of clusters per plant			Number of pods per cluster		
Crosses	H	HB	SH	H	HB	SH	H	HB	SH	H	HB	SH	H	HB	SH	H	HB	SH
PDM-1 x Palem-1	0.63	-3.03 *	2.56	3.76 *	2.22	1.85	-5.53	-25.02 **	-33.63 **	25.58**	14.89**	-7.69 *	37.52**	35.42 **	9.06	30.61**	28.00 **	6.67
PDM-1 x Palem-2	2.52	-1.21	4.49 **	0.19	0.00	-0.37	36.68 **	17.43 **	-15.03 **	38.46**	38.46**	-7.69 *	26.81**	24.32 **	0.13	41.18**	38.46 **	20.00 **
PDM-1 x AK-42	0.32	-3.64 *	1.92	-1.48	-1.48	-1.85	54.53 **	28.76 **	0.44	42.31**	42.31**	-5.13	26.32**	23.61 **	-0.45	46.94**	44.00 **	20.00 **
HGP-80 x Palem-1	0.31	-4.71 **	3.85 *	2.27	1.50	-0.37	3.30	-2.94	-14.08 **	43.02**	30.85**	5.13	77.84**	76.57 **	37.87 **	42.31**	32.14 **	23.33 **
HGP-80 x Palem-2	0.31	-4.71 **	3.85 *	1.68	1.12	0.37	20.48 **	16.24 **	-9.52 **	43.59**	43.59**	-4.27	81.97**	81.50 **	40.43 **	14.81**	10.71 *	3.33
HGP-80 x AK-42	-1.24	-6.47 **	1.92	-1.12	-1.85	-2.21	16.99 **	16.86 **	-8.84 *	58.97**	58.97**	5.98	76.96**	76.84 **	36.30 **	46.15**	35.71 **	26.67 **
VZM-1 x Palem-1	-0.96	-3.13 *	-0.64	-0.19	-2.55	-1.11	8.00 *	-0.80	-12.19 **	39.53**	27.66**	2.56	13.52**	0.70	1.56	34.69**	32.00 **	10.00 *
VZM-1 x Palem-2	-4.79 **	-6.88 **	-4.49 **	-1.47	-2.55	-1.11	21.17 **	19.75 **	-11.27 **	26.92**	26.92**	-15.38 **	22.64**	8.36	9.29	15.03**	12.82 *	-2.22
VZM-1 x AK-42	2.56	0.00	2.56	-0.55	-1.45	0.00	-9.57 *	-11.84 *	-31.23 **	75.64**	75.64**	17.09 **	30.71**	15.30 **	16.29 **	38.78**	36.00 **	13.33 **
HGP-43 x Palem-1	2.56	0.63	2.56	4.55 **	3.76 *	1.85	-20.89 **	-22.40 **	-31.31 **	36.05**	24.47**	0.00	44.32**	38.07 **	18.03 **	44.00**	38.46 **	20.00 **
HGP-43 x Palem-2	2.56	0.63	2.56	2.43	1.86	1.11	-24.48 **	-30.15 **	-40.52 **	56.41**	56.41**	4.27	15.24**	9.77	-6.16	38.46**	38.46 **	20.00 **
HGP-43 x AK-42	6.11 **	3.77 *	5.77 **	5.60 **	4.81 **	4.43 *	-29.93 **	-32.87 **	-42.84 **	53.85**	53.85**	2.56	18.86**	13.01 *	-3.40	48.00**	42.31 **	23.33 **
TLR-646 x Palem-1	4.85 **	3.85 *	3.85 *	0.53	-5.69 **	4.06 *	-34.58 **	-35.38 **	-42.80 **	34.86**	25.53**	0.85	40.44**	28.02 **	-0.05	44.74**	37.50 **	22.22 **
TLR-646 x Palem-2	2.27	1.28	1.28	-1.76	-6.69 **	2.95	-16.78 **	-23.53 **	-33.96 **	20.75**	18.52**	-17.95 **	41.65**	29.65 **	0.31	24.05**	22.50 **	8.89
TLR-646 x AK-42	3.25 *	1.92	1.92	-1.58	-6.35 **	3.32	-6.38	-10.90 **	-23.06 **	23.27**	20.99**	-16.24 **	41.84**	30.04 **	0.23	26.32**	20.00 **	6.67
HGP-44 x Palem-1	5.19 **	4.52 **	3.85 *	0.56	-0.74	-1.48	12.29 **	-7.97	-18.54 **	18.60**	8.51	-12.82 **	30.02**	27.76 **	3.35	29.33**	24.36 **	7.78
HGP-44 x Palem-2	3.90 **	3.23 *	2.56	2.23	2.23	1.48	13.74 **	1.34	-26.68 **	57.69**	57.69**	5.13	91.66**	87.49 **	51.67 **	3.85	3.85	-10.00 *
HGP-44 x AK-42	2.93 *	1.94	1.28	-0.93	-1.11	-1.48	-7.77	-20.44 **	-37.94 **	30.77**	30.77**	-12.82 **	82.47**	78.16 **	44.12 **	46.67**	41.03 **	22.22 **
HGP-67 x Palem-1	5.13 **	3.14 *	5.13 **	0.00	-2.19	-1.11	-18.34 **	-18.37 **	-27.68 **	9.71*	2.13	-17.95 **	18.13**	15.62 *	-5.73	48.61**	48.61 **	18.89 **
HGP-67 x Palem-2	1.28	-0.63	1.28	-1.66	-2.55	-1.48	23.47 **	12.16 **	-0.64	54.72**	51.85**	5.13	83.58**	78.89 **	45.86 **	58.67**	52.56 **	32.22 **
HGP-67 x AK-42	0.96	-1.26	0.64	-4.41 **	-5.11 **	-4.06 *	0.59	-5.42	-16.21 **	72.33**	69.14**	17.09 **	55.25**	51.01 **	23.13 **	48.61**	48.61 **	18.89 **
TLR-811 x Palem-1	-0.32	-2.50	0.00	2.96	0.00	2.58	-4.57	-9.02 *	-19.47 **	11.63**	2.13	-17.95 **	28.11**	24.41 **	-2.86	37.41**	34.67 **	12.22 *
TLR-811 x Palem-2	1.60	-0.63	1.92	0.18	-1.44	1.11	29.86 **	23.46 **	-0.90	38.46**	38.46**	-7.69 *	46.04**	42.45 **	10.22 *	25.49**	23.08 **	6.67
TLR-811 x AK-42	2.56	0.00	2.56	4.38 **	2.88	5.54 **	23.71 **	21.97 **	-2.09	46.15**	46.15**	-2.56	40.67**	37.47 **	5.96	29.25**	26.67 **	5.56
HGP-40 x Palem-1	6.19 **	5.84 **	4.49 **	5.64 **	4.07 *	3.69 *	-11.84 **	-12.85 **	-21.05 **	33.70**	30.85**	5.13	64.92**	57.72 **	23.14 **	30.56**	30.56 **	4.44
HGP-40 x Palem-2	4.89 **	4.55 **	3.21 *	1.30	1.11	0.74	-21.38 **	-29.29 **	-35.95 **	14.29**	6.67	-17.95 **	23.28**	18.40 **	-8.39	25.33**	20.51 **	4.44
HGP-40 x AK-42	7.84 **	7.14 **	5.77 **	-1.85	-1.85	-2.21	14.38 **	6.43	-3.58	42.86**	33.33**	2.56	91.88**	84.63 **	42.31 **	54.17**	54.17 **	23.33 **

Character	Number of pods per plant			Pod length (cm)			Number of seeds per pod			100 seed weight (g)			Seed yield per plant (g)		
Crosses	H	HB	SH	H	HB	SH	H	HB	SH	H	HB	SH	H	HB	SH
PDM-1 x Palem-1	36.01 **	30.72 **	26.49 **	4.52	2.55	-2.50	11.13 *	9.64	9.16	23.82 **	22.38 **	2.60	27.89**	22.25 **	8.85
PDM-1 x Palem-2	64.34 **	63.43 **	59.91 **	7.32	7.07	-1.57	7.60	6.05	2.74	27.04 **	23.84 **	1.41	15.60**	3.38	6.44
PDM-1 x AK-42	30.54 **	30.25 **	26.59 **	5.98	4.81	-1.93	9.55	8.04	4.67	21.66 **	17.18 **	3.58	-6.72	-15.00 *	-16.11 **
HGP-80 x Palem-1	83.96 **	46.69 **	120.09 **	5.90	5.26	0.07	0.00	-0.94	-1.37	34.26 **	31.51 **	14.97 **	9.91	3.69	-7.68
HGP-80 x Palem-2	48.88 **	22.98 **	84.53 **	9.45	8.29	1.71	13.13 *	11.03	8.47	7.03 *	1.12	-11.61 **	16.01**	2.49	5.52
HGP-80 x AK-42	89.98 **	56.52 **	134.84 **	14.97 **	14.75 **	7.79	5.39	3.51	1.12	24.86 **	24.17 **	9.76 **	45.20**	30.68 **	28.98 **
VZM-1 x Palem-1	47.44 **	46.68 **	30.90 **	4.24	4.04	-0.71	-1.39	-4.69	-5.11	33.79 **	25.74 **	5.42	18.75**	4.85	-6.65
VZM-1 x Palem-2	3.16	-1.86	-3.97	13.92 **	11.83 *	6.71	17.69 **	16.95 **	10.03	23.55 **	20.36 **	-6.40	-9.69	-24.94 **	-22.72 **
VZM-1 x AK-42	124.85 **	114.60 **	108.56 **	15.72 **	14.60 **	9.36	11.16 *	10.38	3.99	30.70 **	19.88 **	5.97	7.04	-9.50	-10.68
HGP-43 x Palem-1	77.36 **	58.32 **	79.93 **	15.08 **	13.52 *	10.93 *	2.10	1.88	1.43	28.38 **	26.39 **	5.97	41.28**	24.68 **	11.00
HGP-43 x Palem-2	39.39 **	29.70 **	47.40 **	9.68 *	6.43	4.00	3.32	0.69	-0.19	29.74 **	26.97 **	3.15	7.62	-10.60	-7.95
HGP-43 x AK-42	9.65 *	1.71	15.59 **	0.52	-1.61	-3.86	-7.83	-10.12	-10.90	15.47 **	10.80 **	-2.06	33.98**	13.22 *	11.75
TLR-646 x Palem-1	39.27 **	33.50 **	29.90 **	11.01 *	8.34	3.00	16.58 **	13.95 *	13.46 *	18.28 **	17.67 **	-0.33	-9.62	-12.23	-21.86 **
TLR-646 x Palem-2	40.03 **	39.65 **	36.64 **	11.59 *	10.72	1.79	20.03 **	19.40 **	13.52 *	27.10 **	21.90 **	3.25	-5.44	-14.20 *	-11.65
TLR-646 x AK-42	43.92 **	43.83 **	39.95 **	6.87	5.11	-1.64	9.55	9.04	3.68	20.30 **	17.79 **	4.12	1.87	-5.77	-6.99
HGP-44 x Palem-1	61.95 **	60.95 **	43.64 **	6.48	5.48	0.29	7.95	6.63	6.17	18.11 **	13.79 **	2.93	33.56**	28.61 **	14.50 *
HGP-44 x Palem-2	125.28 **	114.12 **	109.50 **	3.66	2.91	-4.00	13.59 *	11.80 *	8.60	48.42 **	38.01 **	24.84 **	44.64**	30.21 **	34.07 **
HGP-44 x AK-42	44.72 **	38.00 **	34.11 **	5.81	5.65	-1.14	2.90	1.35	-1.56	12.19 **	10.91 **	0.33	-0.76	-8.94	-10.13
HGP-67 x Palem-1	4.30	3.76	-7.40	11.28 *	8.19	2.86	2.90	2.55	2.80	23.09 **	21.38 **	4.66	25.54**	25.26 **	11.52
HGP-67 x Palem-2	127.73 **	116.65 **	111.98 **	17.06 **	15.70 **	6.36	18.95 **	15.29 **	15.58 **	51.59 **	44.15 **	24.30 **	70.30**	58.45 **	63.14 **
HGP-67 x AK-42	138.95 **	128.06 **	121.63 **	19.75 **	17.33 **	9.79	17.59 **	14.05 *	14.33 *	45.09 **	43.31 **	26.68 **	56.00**	48.04 **	46.12 **
TLR-811 x Palem-1	31.76 **	31.12 **	17.02 **	2.65	1.80	-3.21	2.22	-0.63	-1.06	21.58 **	19.53 **	0.22	-4.60	-12.55	-22.14 **
TLR-811 x Palem-2	31.08 **	24.74 **	22.05 **	6.55	5.65	-1.21	5.47	5.43	-0.81	21.45 **	19.01 **	-3.58	27.35**	9.56	12.80 *
TLR-811 x AK-42	34.94 **	28.82 **	25.19 **	7.90	7.86	0.93	8.97	8.86	2.55	19.85 **	14.85 **	1.52	10.47	-3.25	-4.51
HGP-40 x Palem-1	33.66 **	33.16 **	18.84 **	2.08	0.73	-1.64	-1.20	-3.01	0.25	18.95 **	15.13 **	3.15	17.71**	10.89	11.67
HGP-40 x Palem-2	0.73	-4.04	-6.11	0.68	-2.27	-4.57	-0.41	-4.88	-1.68	17.30 **	9.56 *	-1.84	13.51*	12.27 *	15.59 *
HGP-40 x AK-42	124.34 **	114.42 **	108.38 **	16.43 **	14.00 *	11.31 *	4.95	0.30	3.68	41.26 **	40.31 **	25.70 **	47.88**	46.40 **	47.44 **

Highest positive significant heterosis among the 27 crosses, was recorded by PDM-1 x AK-42 over mid parent and better parent and it also recorded non-significant positive heterosis over standard check for plant height (cm). For the character number of primary branches, maximum average heterosis, heterobeltiosis and standard heterosis were exhibited by the cross VZM-1 x AK-42. These results are similar with the findings of Santha and Veluswamy (1999) [3] who reported the positive heterosis for plant height and number of primary branches. The highest heterobeltiosis and standard heterosis were recorded by HGP-44 x Palem-2 and average heterosis by HGP-40 x AK-42 for number of clusters per plant. HGP-67 x Palem-2 recorded maximum average heterosis and standard heterosis, while HGP-40 x AK-42 recorded maximum heterobeltiosis for number of pods per cluster. With respect to number of pods per plant and pod length, HGP-67 x AK-42 was recorded highest average heterosis and heterobeltiosis.

Among the 27 crosses, the maximum standard heterosis was exhibited by HGP-80 x AK-42 for number of pods per plant and by HGP-40 x AK-42 for pod length. TLR-646 x Palem-2 recorded highest average heterosis and heterobeltiosis, while HGP-67 x Palem-2 recorded maximum standard heterosis with respect to number of seeds per pod. With respect to 100- seed weight, HGP-67 x Palem-2 exhibited maximum average heterosis and heterobeltiosis, while HGP-67 x AK-42 recorded maximum standard heterosis. Andhale *et al.* (1997) [4] and Reddy (1998) [5] were reported that heterosis for grain yield was due to clusters per plant, pods per plant and seeds per pod in blackgram. For seed yield per plant, the maximum average heterosis, heterobeltiosis and standard heterosis were recorded by HGP-67 x Palem-2. Estimation of heterosis for yield per plant had also been conducted by Reddy (1998) [5], Neog and Talukdar (1999) [6], Patel *et al.* (2009) [7], Reddy *et al.* (2011) [8] and Ram *et al.* (2013) [9] who reported significant positive heterosis for yield per plant. Based on overall observation of the results of this investigation, the maximum amount of average heterosis, heterobeltiosis and standard heterosis were recorded for number of pods per plant (138.95%, 128.06% and 134.84%) followed by number of clusters per plant (91.88%, 87.49% and 51.67%).

CONCLUSION

The top five crosses, based on mean *per se* performance and heterosis were HGP-67 x Palem-2, HGP-40 x AK-42, HGP-67 x AK-42, HGP-44 x Palem-2 and HGP-80 x AK-42, had high seed yield and yield contributing characters. These crosses recorded high mean *per se* performance of 28.46 g, 25.72 g, 25.49 g, 23.39 g and 22.50 g respectively and standard heterosis of 63.14%, 47.44%, 46.12%, 34.07% and 28.98%, respectively for seed yield per plant (g). The exploitation of hybrid vigour could be done in these crosses and it might be helpful in the improvement of this crop.

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