Range Mgmt. & Agroforestry 30 (1) : 49-53, 2009
ISSN 0971-2070

Expression of heterosis for forage and grain yield in oat (*Avena sativa* L.)

A. S. Prajapati, S. R. Vishwakarma, D. N. Vishwakarma and H. P. Singh
Department of Genetics and Plant Breeding
N.D. University of Agriculture and Technology, Kumarganj, Faizabad-224229 (U.P.)
Received : 19th April, 2008 Accepted : 20th January, 2009

Abstract

The *per se* performance of parents may not be reliable indicator of their genetic worth, which can be judged by their heterotic crosses or response. 21 F_1s involving 10 diverse parents (7 lines used as female x 3 testers) of oat were evaluated in randomized block design with three replications during *Rabi* 2005-06 to compare the extent of heterosis over better parent (BP) and standard variety (SV) *i.e.* Kent. For green forage yield plant^{-1}, maximum significant heterosis over BP was observed in cross OL 1389 x OS 6 followed by JHO 2000-4 x Kent and Sabzar x Kent while, maximum standard heterosis was found in OS 311 x Kent. The highest heterobeltiosis for grain yield plant^{-1} and dry matter yield was recorded in cross JHO 2000-4 x Kent followed by OS 311 x Kent and JHO 2000-5 x Kent. Likewise, standard heterosis also follow similar trends of hybrids which were identified as potential crosses for both green forage as well as grain yield, thus these high heterotic crosses may be utilized in future crop breeding.

Key words : Forage yield, Heterobeltiosis, Oat (*Avena sativa* L.), Standard heterosis

Introduction

Oat is a highly nutritious, fast growing green fodder of *Rabi* season and capable of tolerating biotic and abiotic stresses. It is cultivated worldwide for both grain and green forage. At national level, deficiency of green fodder is about 36 per cent, dry forage 67 per cent and crude concentration of 42.5 per cent. So, there is an urgent need of exploiting new research technologies to boost forage yield in terms of green fodder, dry matter and crude protein yield. Exploitation of heterosis is one such tool of plant breeding. In general, old genetic stock provides more heterotic effect and salt tolerance. To judge such assumption the present investigation was carried out under partially reclaimed saline-sodic soil.

Materials and Methods

The experimental materials for the present investigation consisted of 21 F_1s derived from the crosses between selected lines namely, OL 1389, OS 315, JHO 2000-6, JHO 2000-4, Sabzar, OS 311 and JHO 2000-5 as females and three testers namely, Kent (National check), OS 6 and JHO 2002-4 as males. These experimental materials of oat including 21 F_1s, 7 female lines and 3 testers were sown in randomized block design with three replications during *Rabi* 2005-06 under partially reclaimed soil condition at Genetics and Plant Breeding Research Farm of N.D. University of Agriculture and Technology, Kumarganj, Faizabad. Each treatment was sown in 3.0 m row length spaced 30 cm apart. Distance of 10 cm between plants was maintained by hand thinning. All recommended agronomic cultural practices were adopted to raise a good normal crop. Observations were recorded on five randomly selected plants for ten quantitative characters. The means of five plant's observations were used for further analyses. Data were subjected to analyze heterosis over BP (heterobeltiosis) and standard heterosis (check variety-Kent) as described by Singh and Chaudhary (1979).

Results and Discussion

The analysis of variance for treatment, parents and crosses were highly significant for all the characters indicating that considerable variability existed in the materials for all the traits studied (Table 1). Although economic heterosis is usually expressed as an increase or decrease of F_1 value over BP (heterobeltiosis) but from practical point of view, an increase of F_1 value over the best commercial variety (SV) is more relevant. In present study, the relative magnitudes of heterosis over BP and SV (Kent) have been studied for ten characters in 21 hybrids. The results suggested that the magnitude of hybrid vigour differed from character to character depending upon hybrid combinations. The hybrids OS 315 x Kent, JHO 2000-4 x Kent, OS 311 x OS 6 showed desirable heterosis over SV.

Table 1: Analysis of variance for parental lines and crosses for 10 characters in Oat

S. No.	Source of variation	Replications	Treatments	Parent (P)	P vs C	Crosses	Error
1.	Degree of freedom (Df)	2	30	9	1	20	60
2.	Days to 50% flowering	7.94**	25.33**	46.44**	12.50**	16.48**	0.52
3.	Plant height (cm)	52.06*	530.66**	498.61**	1237.02**	509.77**	11.71
4.	Number of tillers plant^{-1}	7.48**	56.29**	11.64**	953.03**	31.55**	0.54
5.	Green fodder yield plant^{-1}(g) at 50 DAS	23.49**	6923.30**	5695.74**	123823.36**	1630.70**	3.19
6.	Dry matter yield plant^{-1}(g)	7.86**	604.72**	545.77**	10664.74**	127.80**	1.49
7.	Biological yield plant^{-1}(g)	4.51*	3163.26**	639.96**	66088.54**	1152.49**	1.35
8.	Grain yield plant^{-1}(g)	4.33	831.91**	22.79**	13815.82**	546.82**	1.51
9.	Number of grains panicle^{-1}	5.33	1562.72**	797.08**	18550.13**	1057.89**	2.17
10.	Leaf:stem ratio	0.72	0.10**	0.04**	1.64**	0.05**	0.38
11.	Flag leaf length (cm)	2.61	49.60**	38.50**	51.33**	54.50**	0.99

*, ** Significant at 5 and 1% probability levels, respectively.

Likewise JHO 2000-5 x Kent exhibited negative heterosis over BP for days to 50% flowering. For plant height, the majority of the hybrids were taller than their BP, as well as SV, hence they exhibited significant positive heterosis. The present observations are in conformity with the finding of Rastogi *et al.* (1991). Heterosis in positive direction is desirable for oat crop as it provides extra fodder yield. Most of the hybrids possessed positive and significant heterosis over BP and SV. The hybrids namely, JHO 2000-4 x Kent, OS 311 x Kent and JHO 2000-5 x Kent manifested significant positive heterosis for dry matter yield. All the crosses showed significant heterosis over BP and SV for biological yield. All hybrids expressed heterotic estimates with positive and significant values over BP and standard heterosis for number of grains panicle^{-1}. heterosis for leaf: stem ratio was high for green forage quality. All the hybrids studied expressed high heterotic estimates with positive and significant values over respective BP and SV except only one cross combination *i.e.* OS 315 x JHO 2002-4. Higher length of flag leaf contributes to higher forage yield. Only two heterotic combinations namely, OS 311 x Kent and JHO 2000-5 x Kent showed heterosis over standard heterosis. These results are in conformity of the findings of Rastogi et al (1991); Verma and Mishra (1991); Babbar *et al.* (1997); Dogra *et al.* (2003) and Thukral and Verma (2003). All hybrids showed significant heterosis over BP and standard heterosis for grain yield. The cross combination JHO 2000-5 x Kent showed high heterotic response for grain yield plant^{-1}.

Hybrids *viz.,* OL 1389 x OS 6, OS 315 x Kent, JHO 2000-6 x Kent, Sabzar x OS 6, Sabzar x JHO 2002-4, Sabzar x Kent, OS 315 x OS 6, OS 311 x JHO 2002-4, OS 311 x Kent, JHO 2000-5 x OS 6, JHO 2000-5 x JHO 2002-4 and JHO 2000-5 x Kent exhibited high heterotic response for yield and its component traits (Tables 2 and 3). These hybrids having high yielding ability as compared to check were selected for carrying forward to advanced generations wherein the chances of getting homozygous selection for high yield are possible.

Since exploitation of hybrid vigour in autogamous crop like oat is questionable as to how it can be used commercially or economically. However, it can be used commercially if some suitable genetic system involving economically feasible mass hybridization techniques are discoursed in time. The better performing heterotic F_1s may provide certain recombinants of economic worth in later generations to produce superior homozygous lines as varieties. It may also be desirable to cross these better performing F_1s among themselves or with other parents in obtaining multiple crosses using combination breeding for developing suitable cultivars. The randomly selected individual F_2 plants from these better crosses may also be mated *inter se* to obtain more desirable segregates in later generations. Crossing between diverse parents having high specific combining ability values may further be exploited through pedigree methods of selection to derive desirable segregants for different traits for evolving superior genotypes.

Table 2: Estimates of heterosis over better parent (BP) of 21 hybrids for 10 characters in 0at

S. No.	Hybrids/characters	Days to 50% flowering	Plant height (cm)	Number of tillers plant^{-1}	Green fodder yield plant^{-1} (g)	Dry matter yield^{-1} (g)	Biological yield^{-1} (g)	Grain yield^{-1} (g)	Number of grains panicle^{-1}	Leaf: stem ratio	Flag leaf length (cm)
1.	OL 1389 x OS 6	2.04**	12.66**	92.91**	217.29**	220.90**	143.70**	172.36**	95.32**	30.26**	3.68
2.	OL 1389 x JHO 2002-4	4.77**	2.86	62.67**	115.36**	118.85**	66.40**	51.94**	79.35**	32.89**	-0.20
3.	OL 1389 x Kent	0.13**	4.16	162.77**	153.38**	167.78**	163.38**	184.24**	71.36**	51.56**	-8.98**
4.	OS 315 x OS 6	5.53**	-7.13**	103.68**	149.02**	160.66**	112.20**	162.18**	74.26**	50.37**	1.91
5.	OS 315 x JHO 2002-4	6.07**	-11.14**	123.31**	83.29**	94.02**	77.23**	95.91**	63.49**	-0.74	-11.80**
6.	OS 315 x Kent	-2.09**	-0.77	226.38**	144.42**	155.23**	135.80**	244.77**	68.66**	37.50**	-2.97
7.	JHO 2000-6 x OS 6	2.70**	-2.67	95.80**	172.31**	176.77**	168.94**	307.35**	82.43**	90.60**	-22.42**
8.	JHO 2000-6 x JHO 2002-4	2.29**	-2.67	88.29**	163.42**	166.67**	134.60**	153.58**	64.15**	109.40**	-12.02**
9.	JHO 2000-6 x Kent	1.65**	-7.75**	63.41**	178.78**	182.76**	210.76**	413.87**	75.17**	106.84**	5.71*
10.	JHO 2000-4 x OS 6	-0.71	-19.44**	69.03**	182.20**	190.25**	134.81**	217.52**	64.55**	89.29**	0.28
11.	JHO 2000-4 x JHO 2002-4	2.63**	-17.66**	92.48**	132.34**	146.63**	118.85**	157.29**	79.53**	102.14**	-21.86**
12.	JHO 2000-4 x Kent	-8.79**	-8.53**	187.96**	205.62**	215.66**	200.33**	438.44**	102.45**	74.22**	-16.37**
13.	Sabzar x OS 6	4.28**	-16.18**	99.57**	153.70**	172.18**	181.03**	278.17**	115.49**	32.39**	34.30**
14.	Sabzar x JHO 2002-4	4.85**	-17.18**	86.27**	147.03**	170.54**	143.29**	176.89**	136.04**	29.94**	21.93**
15.	Sabzar x Kent	4.94**	3.68	118.20**	191.78**	209.61**	189.02**	258.08**	91.68**	116.41**	25.69**
16.	OS 311 x OS 6	-1.24*	-1.55	90.82**	78.39**	53.38**	107.68**	337.31**	201.47**	127.27**	-14.94**
17.	OS 311 x JHO 2002-4	4.31**	6.91**	175.36**	73.56**	49.12**	77.74**	226.51**	112.87**	115.70**	-7.85*
18.	OS 311 x Kent	-0.98	18.53**	228.50**	115.81**	83.77**	152.16**	493.24**	136.50**	92.56**	37.87**
19.	JHO 2000-5 x OS 6	-0.45	27.55**	116.07**	53.41**	48.24**	104.52**	311.44**	171.42**	126.79**	-4.97
20.	JHO 2000-5 x JHO 2002-4	3.97**	5.73**	168.19**	40.73**	40.43**	87.18**	259.54**	166.51**	160.71**	-18.84**
21.	JHO 2000-5 x Kent	-6.99**	12.58**	238.76**	56.74**	49.85**	93.79**	397.75**	143.28**	118.75**	25.08**
	Mean heterosis (%)	1.37	-0.86	128.12	133.74	136.82	133.50	254.21	104.57	80.71	0.63
	SE ±	0.59	2.79	0.60	1.46	1.00	0.95	1.00	1.20	0.02	0.81
	Range	-8.79 to 6.07	-19.44 to 27.55	62.67 to 238.76	40.73 to 217.29	40.43 to 220.90	66.40 to 210.76	51.94 to 493.24	63.49 to 201.47	-0.74 to 160.71	-22.42 to 37.87

*, ** significant at 5% and 1% probability levels, respectively.

Table 3: Estimates of heterosis over standard variety (Kent) of 21 hybrids for 10 characters in oat

S. No.	Hybrids/characters	Days to 50% flowering	Plant height (cm)	Number of tillers plant^{-1}	Green fodder yield plant^{-1} (g)	Dry matter yield^{-1} (g)	Biological yield^{-1} (g)	Grain yield^{-1} (g)	Number of grains panicle^{-1}	Leaf: stem ratio	Flag leaf length (cm)
1.	OL 1389 x OS 6	-6.63**	16.80**	6.66**	2.42**	1.32	34.58**	138.00**	47.17**	54.69**	-6.83**
2.	OL 1389 x JHO 2002-4	-6.33**	6.65**	-10.06	-30.48**	-30.90**	-8.11**	40.76**	54.38**	57.81**	-11.11**
3.	OL 1389 x Kent	-8.37**	4.16*	45.29**	-18.21**	-15.45**	45.44**	184.24**	71.36**	51.56**	-17.94**
4.	OS 315 x OS 6	-5.72**	-0.15	-4.30	-9.66**	-9.24**	20.70**	95.44**	31.30**	58.59**	-6.43**
5.	OS 315 x JHO 2002-4	-5.24**	-4.46*	4.93	-33.51**	-32.45**	0.81	46.03**	40.73**	4.69	-21.44**
6.	OS 315 x Kent	-12.53**	-0.77	53.36**	-11.33**	-11.13**	34.13**	157.00**	47.51**	37.50**	-10.92**
7.	JHO 2000-6 x OS 6	-6.02**	-8.29**	15.71**	-4.78**	-4.92**	38.86**	146.57**	37.45**	74.22**	-26.90**
8.	JHO 2000-6 x JHO 2002-4	-8.49**	-8.29**	11.27*	-7.89**	-8.39**	21.13**	53.49**	41.30**	91.41**	-21.64**
9.	JHO 2000-6 x Kent	-6.99**	-13.08**	-3.43	-2.52**	-2.86	60.45**	211.03**	58.17**	89.06**	-0.39
10.	JHO 2000-4 x OS 6	-7.17**	-13.32**	10.12	0.88	1.63	27.46**	90.80**	17.12**	107.03**	0.97
11.	JHO 2000-4 x JHO 2002-4	-8.19**	-11.40**	25.40**	-16.95**	-13.64**	18.79**	54.61**	27.78**	121.09**	-30.41**
12.	JHO 2000-4 x Kent	-10.66**	-8.53**	87.60**	9.25**	10.53**	63.02**	223.56**	44.10**	74.22**	-16.37**
13.	Sabzar x OS 6	-4.64**	-2.78	-8.10	-11.12**	-11.34**	49.20**	170.62**	62.36**	82.03**	-1.17
14.	Sabzar x JHO 2002-4	-6.20**	-5.23*	0.89	-13.46**	-11.87**	29.16**	98.14**	103.19**	59.38**	-10.27**
15.	Sabzar x Kent	-4.04**	3.68	18.19**	2.22**	0.85	53.44**	156.24**	91.68**	116.41**	-7.50**
16.	OS 311 x OS 6	-8.98**	0.33	-8.91	-4.44**	-6.62**	57.54**	212.94**	127.15**	114.84**	-34.50**
17.	OS 311 x JHO 2002-4	-6.69**	8.95**	31.45**	-7.02**	-9.22**	34.83**	133.65**	83.24**	103.91**	-29.04**
18.	OS 311 x Kent	-8.73**	18.53**	56.82**	15.61**	11.88**	91.28**	324.52**	136.50**	82.03**	6.16*
19.	JHO 2000-5 x OS 6	-6.93**	14.22**	14.73**	3.85**	3.40	61.89**	259.54**	104.50**	98.44**	-19.88**
20.	JHO 2000-5 x JHO 2002-4	-6.99**	-5.32*	42.40**	-6.69**	-5.96**	51.98**	233.07**	129.41**	128.13**	-31.58**
21.	JHO 2000-5 x Kent	-11.02**	0.81	79.88**	6.10**	5.74**	82.79**	397.75**	143.28**	91.41**	5.45*
	Mean heterosis (%)	-7.46	0.36	23.15	-6.56	-6.60	41.40	163.24	71.41	80.88	-13.88
	SE ±	0.59	2.79	0.60	1.46	1.00	0.95	1.00	1.20	0.02	0.81
	Range	-12.53 to -4.04	-13.32 to 18.53	-10.06 to 87.60	-33.51 to 15.61	-32.45 to 11.88	-8.11 to 91.28	40.76 to 397.75	17.12 to 143.28	4.69 to 128.13	-34.50 to 6.16

*, ** significant at 5% and 1% probability levels, respectively.

References

Babbar, A., S. K. Rao and S. B. Agrawal. 1997. G x E interaction in genetic diversity for grain yield in oats (*Avena sativa* L.) *Advances in Agricultural Res. in India,* 7: 29-38.

Dogra, R. K.; V. P. Gupta; B. C. Sood and D. C. Katock. 2003. Gene effects and interaction analysis for forage yield and quantitative traits in genus *Avena. Indian J. Genet.,* 63 : 215.

Rastogi, R., S. N. Mishra and J. S. Verma. 1991. Heterosis for certain plant traits in *Avena sativa* X *Avena sterilis* oat crosses. *Golden Jubilee Symposium on Genetic Research and Education: crosses. Golden Jubilee Symposium on Genetic Research and Education : Current trends and the next fifty years* held during February 12-15, 1991 New Delhi.

Singh, R.K. and B. D. Chaudhary. 1979. *Biometrical Methods in Quantitative Genetic Analysis*. Kalyani Publisers, Ludhiana, New Delhi.

Thukral, A.K. and J. S. Verma. 2003. Heterosis and inbreeding depression in five crosses of Oat (*Avena sativa* L.). *Forage Res.* 29 : 155-157.

Verma, J. S. and S. N. Mishra. 1991. Gene effects for fodder yield in *Avena sativa* L. x *Avena sterilis* L. oat crosses. *Golden Jubilee Symposium on Genetic Research and Education: Current trends and the next fifty years*. Feb. 12-15, 1991 New Delhi. Abstract Vol. II, 425.