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Combining ability analysis in intervarietal crosses of Oat (*Avena sativa* L.)

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Abstract

To sort out better parent and best crosses for crop improvement, combining ability was studied in forage oat using line x tester analysis with 10 parents namely, OL 1389, OS 315, JHO 2000-6, JHO 2000-4, Sabzar, OS 311 and JHO 2000-5 as females and Kent, OS 6 and JHO 2002-4 as males. The estimates of variances due to specific combining ability ($ó^2$ sca) was higher than general combining ability ($ó^2$gca) and their ratio ($ó^2$ sca : $ó^2$ gca) indicated predominance of non-additive *i.e.* non-fixable type of gene action of these characters. Parents namely, JHO 2000-5, OS 311, Sabzar as females and Kent as male were found good general combiners. The crosses *viz.,* OS 315 x Kent, JHO 2000-6 x Kent, JHO 2000-4 x Kent, OS 311 x Kent, JHO 2000-5 x Kent and JHO-6 x Kent exhibited high sca effects. Hence, these cross combination could throw desirable recombinants in the subsequent generations having high seed yield per plant as well as green forage.

Key words : General combining ability, Line x tester analysis, Oat (*Avena sativa* L.), Specific combining ability.

Introduction

Oat is an important green fodder crop during *Rabi* season of north India. It is being grown mainly as animal feed, specially favoured for horses in India whereas it is used as human food in parts of northern Europe. Oat is highly nutritious, succulent and has stoleniferous growth due to profuse tillering. The choice of an appropriate breeding procedure for amelioration in productivity depends upon the nature and magnitude of variability present in the materials. The combining ability for yield and its component traits in oat may be very useful in selection of appropriate parents for the development of superior hybrids. The line x tester analysis is one, which is employed in study of genetic components of variance for yield attributes. It is also used in estimating general combining ability (gca) of parents and specific combining ability (sca) of the hybrid and their effects. The present investigation was laid out for judging the better general combiners and superior crosses of economic importance.

Materials and Methods

The experimental material consisting of 21 F_1s and 10 parents involving seven diverse lines used as females *viz.,* OL 1389, OS 315, JHO 2000-6, JHO 2000-4, Sabzar, OS 311 and JHO 2000-5 and three testers namely, Kent, OS 6 and JHO 2002-4 as males evolved by line x testers mating design were grown in randomized block design with three replications under partially reclaimed soil during *rabi* 2005-06 at Genetics and Plant Breeding Research Farm of N.D. University of Agriculture and Technology, Kumarganj, Faizabad. Each entry was sown in 3.0 m row length spaced 30 cm apart. Distance of the 10 cm between plants was maintained by hand thinning. All recommended agronomic practices were followed during the entire cropped period for raising a good crop. Five competitive plants were randomly selected for recording observations on 10 quantitative traits such as days to 50% flowering, plant height (cm), number of tillers plant^{-1}, green fodder yield plant^{-1}(g), dry matter yield plant^{-1}(g), biological yield plant^{-1}(g), grain yield plant^{-1}(g), number of grains panicle^{-1}, leaf: stem ratio and flag leaf length (cm). The genetic analysis was carried out using line x tester analysis (Singh and Chaudhary, 1979).

Results and Discussion

The analysis of variance for combining ability (Table 1) revealed that variance due to line x tester were highly significant for all the characters. Variance due to testers was found significant for number of tillers plant^{-1}, green fodder yield plant^{-1}, dry matter yield plant^{-1}, biological yield plant^{-1}, grain yield plant^{-1} and number of grains panicle^{-1} . Variance due to lines was also found significant for all the characters except days to 50% flowering, number of tillers plant^{-1} and flag leaf length. The interaction between line x

Table 1: Analysis of variance for line x tester mating design and degree of dominance for 10 characters in Oat

Source of variation	df	Days to 50% flowering	Plant height (cm)	Number of tillers plant^{-1}	Green fodder yield plant^{-1} (g)	Dry matter yield plant^{-1} (g)	Biological yield plant^{-1} (g)	Grain yield plant^{-1} (g)	Number of grains panicle^{-1}	Leaf:stem ratio	Flag leaf length (cm)
Replications	2	7.94**	52.06*	7.48**	23.49**	7.85**	4.51*	4.33	5.33	0.72	2.61
Lines (L)	6	17.00	1180.56**	27.71	2008.77**	158.43*	1763.95**	954.03**	3024.84**	0.12*	17.49
Testers (T)	2	41.19	172.52	138.53**	6166.84**	490.92**	5459.24**	2244.23**	709.70*	0.38	163.07
L x T	12	12.10**	230.58**	15.64**	685.65**	51.96**	128.97**	60.31**	132.44**	0.03**	54.93**
Error	60	0.52	11.71	0.54	3.19	1.49	1.35	1.51	2.17	0.38	0.99
Degree of dominance $(ó^2s/ ó^2g)^{1/2}$	-	4.11	2.24	2.46	2.15	2.06	0.89	0.88	0.95	2.47	29.08

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

testers were highly significant for all the traits which provides a direct evidence that the combining ability contributed heavily in the expression of these traits and thus non-additive gene action would play pivotal role for appearance of trait. On the other hand, average degree of dominance value was greater than the unity for all the characters except biological yield plant^{-1}, grain yield plant^{-1} and number of grains panicle^{-1} indicating the presence of higher sca variance which was higher than gca variance. These finding showed that dominant gene action had greater role in the inheritance of these traits. These findings are fully supported by Machan (1989) and Gupta *et al.* (2001). They found that yield traits were governed by non-additive gene action.

The information regarding general combining ability (gca) effects of parent is of prime importance as it helps in successful prediction of genetic potential of crosses, which yield desirable individuals in segregating populations of self pollinated crops. Among male parents Kent was the best general combiners for most of the characters (Table 2). Among female parents JHO 2000-5 and OS 311 were found best general combiners for most of the characters. Similar findings were also reported by Manga and Sidhu (1984); Machan (1989) and Gupta *et al.* (2002). The gca effects together with relative *per se* performance is useful for selecting desirable parent with favourable genes for different components of yield.

In general, specific combining ability (sca) is associated with interaction effects, which may be due to dominance and epistatic component of variation that are non-fixable in nature. Hence, it can be utilized in developing good F_1 hybrid. Cross combinations OL 1389 x OS 6, OS 311 x last and JHO 2000-4 x Kent exhibited high SCA effect for green fodder yield plant^{-1} and dry matter yield plant^{-1}. The Kent two crosses also displayed high per se performance. The favourable *per se* performances and desirable transgressive segregants obtained by intervarietal crosses owing enough additive genetic components of variation should be taken into consideration either simultaneously or alone for selecting high fodder and grain yield contributing oat genotypes.

Crosses involving high x average combiners may throw agronomically superior segregants giving rise to new population if the additive genetic system present in the good combiner and the epistatic effect in the crosses act in the complementary fashion. For effective utilization of these cross combination, it is suggested to make *inter*

Table 2: Estimates of general combining ability (gca) effects of parents (line & testers) for 10 characters in Oat

Parental lines	Days to 50% flowering	Plant height (cm)	Number of tillers plant^{-1}	Green fodder yield plant^{-1} (g)	Dry matter yield plant^{-1} (g)	Biological yield plant^{-1} (g)	Grain yield plant^{-1} (g)	Number of grains panicle^{-1}	Leaf: stem ratio	Flag leaf length (cm)
Females										
1. OL 1389	0.38	13.31	-1.06**	-17.18**	-4.85**	-13.95**	-6.14**	-6.63**	-0.11**	0.69*
2. OS 315	-0.42	-2.00	0.60*	-22.51**	-6.34**	-18.29**	-9.26**	-15.19**	-0.22**	0.32
3. JHO 2000-6	0.32	-13.27**	-1.77**	2.90**	0.70	-1.00**	-3.81**	-12.40**	0.02	-0.83*
4. JHO 2000-4	-1.33**	-14.93**	2.07**	8.31**	3.52**	-3.98**	-5.85**	-20.09**	0.08**	-0.48
5. Sabzar	2.76**	-1.51	-1.63**	-1.74**	-0.49	2.03**	-3.13**	6.90**	0.02*	2.59**
6. OS 311	-0.75**	13.40**	0.38	15.40**	3.04**	15.87**	8.79**	21.28**	0.08	-1.80**
7. JHO 2000-5	-0.95**	5.00**	2.60**	14.83**	4.42**	19.34**	19.41**	26.15**	0.11**	-0.50
SE (gi)	0.24	1.14	0.25	0.60	0.41	0.39	0.41	0.49	0.01	0.33
SE (gi-gj)	0.34	1.61	0.35	0.84	0.58	0.55	0.58	0.69	0.01	0.47
CD (1%)	0.64	3.03	0.65	1.58	1.08	1.03	1.09	1.31	0.03	0.88
CD (5%)	0.48	2.28	0.49	1.19	0.82	0.78	0.82	0.98	0.02	0.66
Males										
1. OS 6	0.97**	1.85	-1.98**	6.39**	1.68**	0.05	-0.60*	-5.01**	0.01*	0.13
2. JHO 2002-4	0.64**	-3.30**	-0.92**	-19.41**	-5.45**	-16.15**	-10.03**	-1.37**	0.00	-2.85**
3. Kent	-1.61**	1.45	2.90**	13.03**	3.77**	16.10**	10.62**	6.37**	-0.01*	2.72**
SE (gi)	0.16	0.75	0.16	0.39	0.27	0.68	0.27	0.32	0.01	0.22
SE (gi-gj)	0.22	1.06	0.23	0.55	0.38	0.51	0.38	0.45	0.01	0.31
CD (1%)	0.42	1.99	0.43	1.04	0.71	0.25	0.71	0.85	0.02	0.58
CD (5%)	0.31	1.49	0.32	0.78	0.53	0.36	0.54	0.64	0.01	0.43

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

Table 3 : Ranking of three best desirable hybrids based on *per se* performance, best specific combinations and sca effects for 10 characters in Oat

Characters	Desirable cross based on *per se* performance	Best specific combinations	Best crosses based on *per se* performance and sca effects
Days to 50% flowering	OS 315 x Kent JHO 2000-5 x Kent JHO 2000-4 x Kent	OS 315 x Kent JHO 2000-5 x Kent JHO 2000-4 x Kent	OS 315 x Kent (-6.81**) JHO 2000-5 x Kent (-4.61**) JHO 2000-4 x Kent (-3.81**)
Plant height (cm)	JHO 2000-4 x OS 6 JHO 2000-6 x Kent JHO 2000-4 x JHO 2002-4	JHO 2000-4 x JHO 2002-4 OS 311 x OS 6 Sabzar x JHO 2002-4	JHO 2000-4 x JHO 2002-4 (-3.75)
Number of tillers plant^{-1}	JHO 2000-4 x Kent JHO 2000-5 x Kent OS 311 x Kent	JHO 2000-4 x Kent OS 315 x Kent JHO 2000-5 x Kent	JHO 2000-4 Kent (8.29**) JHO 2000-5 x Kent (6.86**) OS 311 x Kent (6.41)
Green fodder yield plant^{-1} (g) at 50 DAS	OS 311 x Kent JHO 2000-4 x Kent JHO 2000-5 x OS 6	OL 1389 x OS 6 OS 311 x Kent JHO 2000-4 x Kent	OS 311 x Kent (40.61**) JHO 2000-4 x Kent (35.30**) OL 1389 x OS 6 (40.99**)
Dry matter yield plant^{-1} (g)	OS 311 x Kent JHO 2000-4 x Kent JHO 2000-5 x Kent	OS 311 x Kent OL 1389 x OS 6 JHO 2000-4 x Kent	OS 311 x Kent (11.38**) JHO 2000-4 x Kent (10.12**)
Biological yield plant^{-1} (g)	OS 311 x Kent JHO 2000-4 x Kent OL 1389 x Kent	OS 311 x Kent OL 1389 x Kent JHO 2000-4 x Kent	OS 311 x Kent (40.10**) JHO 2000-5 x Kent (29.90**) JHO 2000-4 x Kent (37 .39**)
Grain yield plant^{-1} (g)	OS 311 x Kent JHO 2000-5 x Kent JHO 2000-5 x OS 6	JHO 2000-5 x Kent OS 311 x Kent JHO 2000-4 x Kent	JHO 2000-5 x Kent (25.30**) OS 311 x Kent (25.28**) JHO 2000-4 x Kent (25.24**)
Number of grains panicle^{-1}	OS 311 x Kent JHO 2000-5 x Kent JHO 2000-5 x JHO 2002-4	OS 311 x Kent JHO 2000-5 x Kent JHO 2000- x Kent	JHO 2000-5 x Kent (14.82**) OS 311 x Kent (16.42**)
Leaf: stem ratio	JHO 2000-5 x JHO 2002-4 JHO 2000-4 x JHO 2002-4 Sabzar x Kent	OS 315 x OS 6 Sabzar x Kent JHO 2000-5 x JHO 2002-4	JHO 2000-5 x JHO 2002-4 (0.09**) JHO 2000-4 x JHO 2002-4 (0.09**) Sabzar x Kent (0.12**)
Flag leaf length (cm)	OS 315 x Kent JHO 2000-5 x Kent JHO 2000-4 x OS 6	OS 311 x OS 6 OS 311 x Kent JHO 2000-5 x Kent	OS 311 x Kent (11.30**) JHO 2000-5 x Kent (9.83**) JHO 2000-4 x OS 6 (5.69**)

se mating in the F_2 generation and between the crosses to have a multiple parents input in a central gene pool which will supplement genetic recombination and will break undesirable linkage, if present.

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