Study on heterosis and inbreeding depression in agronomic and oil quality characters of summer rape (*Brassica napus* L.)

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ABSTRACT

Heterosis is the superior performance of the F_1 to its parents, while inbreeding depression is reduction in vigour of plants due to inbreeding. The maximum of inbreeding depression is from the F_1 to the F_2 generation. This investigation was carried out to measure the level of heterosis in some agronomic and oil quality characters and to determine the degree of inbreeding depression in some agronomic characters of summer rape (*Brassica napus* L.). Seven lines of *B. napus* were crossed in all possible combinations (including reciprocal crosses) and 42 F_1 hybrids and 7 parents were compared in RCBD with 2 replications in 3 environments. Inbreeding depression was measured in F_2 plants for 14 agronomic characters through inbreeding of F_1 hybrids. Better parental heterosis (Heterobltosis) in F_1 hybrids was calculated for the mean of the 3 environments for different characters. Heterosis was calculated for 14 agronomic and oil quality characters including 7 fatty acids and total glucosinolate content. The results showed that TERI(OE)R-15 × TREI(OE)R–983 hybrid had the highest level of heterobeltosis in days to flowering and physiological maturity with 44.3 and 5.1%, respectively . This hybrid can be used to improve early maturity. Maximum negative heterosis for plant height was 19.2 % with -1.3% inbreeding depression. The semi-dwarf varieties can be improved through this hybrid. The range of heterobeltosis for seed yield was - 41.4 to 118.1%, the maximum heterobeltosis and inbreeding depression (57.2%) was found in the GSC3A00 × HNS9801 hybrid. It showed that heterosis breeding is a successful way to increase the seed yield of *B. napus*. The range of heterosis for seed oil content was 11.5 to 4.6% and maximum of inbreeding depression for this character was 6.1%. These results indicated that increasing oil content is less and heterosis breeding is not successful in oil content improvement. The average heterosis for total glucosinolates ranged from 43.3 to 28.7%. Heterosis for erucic acid was less and showed that heterosis breeding is not a suitable technique to improve erucic acid in summer rape.

INTRODUCTION

The term Heterosis was coined by Shull in 1914. According to Allard (1960), "heterosis is hybrid vigour such the F_1 falls outside the range of parents with respect to some character(s). Rieger et al. (1976) defined heterosis as the superiority of heterozygous genotypes with one or more characters in comparison with the corresponding homozygotes. Heterosis in quantitative genetics terminology, is usually measured as the superiority of a hybrid over the average of its parents, and has been reported for a wide range of crops species, which include both self- and cross-pollinators. Rapeseed (*B.napus*) is considered to be largely self-pollinating, the average out-crossing rate is found to be 20–30%. For this reason, breeding procedures for development of rapeseed cultivars are those used by breeders of self-pollinating crops but heterosis for seed yield and other characters exists in oilseed rape (*B. napus*) significantly The environmental conditions play an important role in the expression of heterosis, so this expression should be tested over number of seasons and environments (Knobel et al. 1997). Inbreeding depression is reduction in vigour of plants due to inbreeding. The maximum of inbreeding depression is from the F_1 to the F_2 generation. The present investigation was carried out to study heterosis and inbreeding depression in rapeseed (*Brassica napus L.*).

MATERIALS AND METHODS

The experimental material consisted of seven diverse parents (HNS9802, GSC3A00, HNS9801, NPN01, NPN2, TERI(OE)R983 and TERI(OE)R15) crossed in all possible combinations (including reciprocal crosses). 42 F_1 hybrids and 7 parents were compared in randomized complete block design with two replications over three set of environmental conditions viz. normal sowing during 1999-2000 (E_1) and 2000-2001(E_2), late sowing during 2000-2001(E_3) at Crop Research Center, G. B. Pant University of Agriculture and Technology, Pantnagar, India. Inbreeding depression was measured in F_2 plants for 14 agronomic characters through inbreeding of F_1 hybrids. Better parental heterosis (Heterobltosis) in F_1 hybrids was calculated for 14 agronomic and oil quality characters including 7 fatty acids and total glucosinolate content. In study of heterosis The observations recorded on twenty-one quantitative and oil quality characters. The extent of inbreeding depression in F_2 generation was calculated for quantitative characters in two environments (E_2 , E_3). Inbreeding depression expressed as mean of two environments in per cent.

RESULTS

Cross combination HNS9801 × TERI(OE)R983 exhibited high negative heterobeltiosis in three environments with mean performance of 46.3 days. Two crosses NPN01 × TERI(OE)R15 and TERI(OE)R15 × TERI(OE)R983 showed the lowest mean performance 43.0 and 43.2, respectively. Early genotypes did not show necessarily negative heterobeltosis. Negative heterosis in days to maturity is also desirable for development of early maturing genotypes. Cross combination GSC3A00 × TERI(OE)R983 exhibited high negative heterobeltiosis in three environments with mean performance of 131.7 days. Two crosses TERI(OE)R15 × TERI(OE)R983 and TERI(OE)R983 × TERI(OE)R15 showed the lowest mean performance 126.5 and 127.2 days, respectively. Cross combination TERI(OE)R983 × HNS9801 exhibited high negative heterobeltiosis in three environments with mean performance of 154.0 centimeters. Two crosses TERI(OE)R983 × HNS9802 and TERI(OE)R15 × HNS9802 were dwarf cross combinations with mean performance 146.0 and 147.5 centimeters over three environments, respectively. Dwarf genotypes did not show necessarily negative heterobeltosis. The highest positive heterobeltiosis for seed yield/plant over three environments was observed in GSC3A00 × HNS9801 with mean performance of 14.3 grams. This cross combination along with NPN01 × HNS9801 with mean performance 16.2 grams also showed maximum seeds yield per plant. In most of hybrids oil content showed negative heterobeltiosis and there was no cross with positive and significant heterobeltiosis over three environments. However, maximum mean of heterobeltiosis over three environments for TERI(OE)R15 × NPN01 was 1.39% with mean performance 43.3% oil content. This cross combination along with HNS9801 × NPN2 showed maximum oil content.

The highest negative heterobeltiosis for glucosinolate concentration over three environments was observed in GSC3A00 × NPN2 with mean performance of 88.6 μmol/g,. Two cross combinations GSC3A00 × TERI(OE)R983 and GSC3A00 × TERI(OE)R15 showed minimum glucosinolate concentration with mean performance 80.6 and 84.8μmol/g, respectively.The highest negative heterobeltiosis for erucic acid content over three environments was observed in TERI(OE)R983 × GSC3A00 with mean performance of 2.3%. This hybrid along with its reciprocal cross (GSC3A00 × TERI(OE)R983) with 4.7% had minimum erucic acid content over three environments. There was not a hybrid with positive and significant heterobeltiosis over three environments.

Low inbreeding depression was observed for oil content (2.2%), days to maturity (2.8%), 1000-seeds weight (6.7%), plant height (7.3%), siliqua length (12.3%), days to 50% flowering (13.4%) and number of seeds per siliqua (19.4%). High inbreeding depression was observed for number of secondary branches (53.9%), seed yield/plant (45.6%), number of primary branches (40.1%), harvest index (24.7%), length of main shoot (22.3%) and number of siliquae on main shoot (20.12%).

DISCASION AND CONCLUSION

Hybrid TERI(OE)R15 × TERI(OE)R983 showed high negative heterobeltiosis for days to 50% flowering and days to maturity hybrid and it is suitable hybrid for development of early varieties. Negative heterosis for days to flowering and maturity also reported by Engqvist and

Becker (1991) in *B. napus*. Cross combination TERI(OE)R983 × HNS9801 exhibited high negative heterobeltiosis in three environments. It is suitable hybrid for development of dwarf varieties. The highest positive heterobeltiosis for seed yield/plant observed in GSC3A00 × HNS9801. Positive heterobeltiosis in seed yield was also reported by Engqvist and Becker (1991), Wos et al. (1997) and Wang et al. (1999). Negative heterosis for oil content was reported by Thakur and Sagwal (1997) in *B. napus*.. In most of hybrids oil content showed negative heterobeltiosis and there was no cross with positive and significant heterobeltiosis over three environments. The highest negative heterobeltiosis for glucosinolate concentration over three environments observed in GSC3A00 × NPN2 with mean performance of 88.6 μmol/g, Wojciechowski (1995) also reported negative heterosis for this character in *B. napus*. The highest negative heterobeltiosis for erucic acid content over three environments was observed in TERI(OE)R983 × GSC3A00 with mean performance of 2.3%.

Low inbreeding depression was observed for 7 characters that showed these characters could be basically controlled by additive gene action. More or less similar results have been reported by Verma et al. (1998) and Singh (2000). High inbreeding depression observed for 6 characters, indicated that in these characters non-additive genetic variance could be more important than additive genetic variance.

The five high seed yield hybrids selected on the basis of mean performance and heterobeltiosis over 3 environments without consideration of oil quality were NPN01 × HNS9801, GSC3A00 × HNS9801, GSC3A00 × NPN2, GSC3A00 × NPN01 and HNS9801× GSC3A00. Among these hybrids NPN01 × HNS9801 had highest seed yield/plant (16.2 g), high number of primary branches (6.6), number of siliquae on main shoot (73.4), highest 1000-seeds weight (3.5 g), high oil content (43.1%) and highest harvest index (20.0%). The selection of best hybrid on the basis of most important oil quality character i.e. erucic acid content and other oil quality characters led to choosing hybrid TERI(OE)R15 × GSC3A00 had low erucic acid content (4.5%), 35.3% oleic acid, 14.7% linolenic acid content and 87.9 μmol/g glucosinolate concentration over three environments. Seed yield/ plant for this hybrid was 8.3 g that is high and expressed 33.4% heterobeltiosis over three environments with 39.9% oil content. This hybrid can be selected as single zero genotype with good seed yield.

REFERENCES

Allard, R. W. 1960. Principles of Plant Breeding, New York, John Wily and Sons, pp. 138-142

Engqvist, G.M. and Becker, H.C. 1991. Heterosis and epistasis in rapeseed estimated from generation means. *Euphytica*, 58, 1: 31-35.

Knobel, H. A., M. T. Labuschagne, C. S. Deventer and C. S. Van Deventer. 1997. The expression of heterosis in F1 generation of a diallel cross of diverse hard red winter wheat genotypes. Cearial Res. Commun. 25 (4): 911-915.

Rieger, R. A., Michaelis and M. M. Green. 1976. Glossary of genetics and cytogenetics. 4 th ed. Springer Verlag Berlin.

Singh, A.K. 2000. Studies on heterosis, inbreeding depression, combining ability and gene action in Indian mustard [*B. juncea* (L.) Czen & Coss.] Thesis, Ph.D., G. B. Pant Univ.of Agri. & Tech. Pantnagar, 169p.

Thakur,H.L. and J.C. Sagwal. 1997. Heterosis and combining ability in rapeseed (*Brassica napus L*.). Indian J. Genet. 57(2): 163-167.

Verma, O. P., H. P. Singh and V. P. Singh. `1998. Heterosis and inbreeding depression in Indian mustard. Cruciferae News letter, 20: 75-76.

Wang,W.R.; Liu,H.J.; Fang,G.H.; Zhao,H.; Li,Y.L.; Qian,X.F.; Sun,C.C. 1999. Analyses of heterosis and combining abilities of five rapeseed cultivars (lines) in *Brassica napus* L. *Acta Agriculture Shanghai.* 15, 2: 45-50.

Wojciechowski, A. 1995. Evaluation of the heterosis effect in F_1 hybrids from crosses of the synthetic winter Swede rape strain 207/8/3 with the variety jantar. Rosliny oleiste. 16(1): 25-34.

Wos, H.; Mackowiak, W. and Wegryn, S. 1997. General combining ability of related spring oilseeds rape inbred lines. *Rosliny Oleiste* 18, 1:171-178.