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COMBINING ABILITY IN SOME VARIETIES OF WINTER OIL RAPE (*BRASSICA NAPUS* L.)

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ABSTRACT

Five winter oil rape varieties (Falcon, Banaćanka, Sremica, Jet Neuf and Samuray) have been studied for general and specific combining abilities, mode of inheritance and gene effects for the number of leaves per plant and stem diameter. The varieties were examined in a diallel set of crosses excluding reciprocals. Falcon was the best general combiner for the number of leaves per plant, Banaćanka for stem diameter. Samuray was the poorest general combiner for both traits. Dominance of the better parent and heterosis were expressed in the inheritance of the number of leaves per plant. Heterosis for stem diameter was registered in one cross. Genes with additive effect predominated in the inheritance of the number of leaves per plant, genes with dominant effect in the inheritance of stem diameter. The variety Falcon may be used as a component of synthetic varieties for improvement of the number of leaves per plant, the variety Jet Neuf for improvement of stem diameter.

Introduction

Because of its high adaptability to a wide range of environmental conditions, the oil rape is grown in all parts of the world. According to FAO statistics (2), the oil rape acreage in the world increased from 21,780,675 ha in 1995 to 27,827,006 ha in 1998 and it is counted among the four most important oil crops. Presently, the oil rape is perhaps the only crop that could serve as an alternative for the sunflower in providing further increases in edible oil production. Due to its robust root system, rapid growth of the aboveground part, early harvest and favorable cultivation technology, oil rape is a good previous crop for a number of agricultural plants.

Further increases in oil rape acreage, both in regions where it is already grown and in regions where it has not been extensively cultivated, depend on the oil rape genetic potentials for seed yield and oil content in

seed. Quantitative traits are important for the genetic potential for seed yield in oil rape varieties and hybrids. Knowledge of the mode of inheritance and gene effects for seed yield is the basis for successful development of high-yielding genotypes of oil rape.

The objective of this study was to assess the general and specific combining abilities, mode of inheritance and gene effects for the number of leaves per plant and stem diameter in five winter oil rape varieties.

Materials and Methods

The genetic material used in this study were five winter oil rape varieties: Falcon, Banaćanka, Sremica, Jet Neuf and Samuray. The varieties were examined in a diallel set of crosses excluding reciprocals. The plants that served as females were emasculated manually in early morning hours to prevent self-pollination.

The trial with the parent varieties and their

combinations was established at Rimski Šančevi Experiment Field of Institute of Field and Vegetable Crops, Novi Sad. Planting was done by hand in the first half of September. The experimental material was planted in four 5-meter rows in three replicates, after the system of random blocks. The distance between rows was 25 cm, the distance between plants in the row 5-6 cm. The experimental plot was hoed during growing season in order to remove weeds that remained after herbicide treatment. Thinning was performed at the development stage B3-B4.

The size of sample for the analysis of the studied traits was 33 plants per treatment. The analysis of variance was conducted according to (4), the analysis of combining ability of the diallel crosses according to (3), method 2, model 1. Mode of inheritance was analyzed by the test of significance of mean values in the F_1 generation compared against the parents' mean (1).

Results and Discussion

Number of leaves per plant. The studied varieties of winter oil rape differed significantly in the number of leaves per plant. The largest number of leaves (10.31) was found in the variety Falcon, the lowest (6.34) in Samuray. In the F_1 generation, only the cross Jet Neuf x Samuray had a significantly higher value of this trait (10.21) than the better parent. This cross was heterotic for the inheritance of this trait. Dominance of better parent was expressed in seven crosses. For two crosses it was not possible to determine the mode of inheritance because the parents' values were not significantly different (**Table 1**). The analysis of variance showed highly significant differences for the general and specific combining abilities, which was an indication that this trait was controlled by both additive and non-additive genes (**Table 2**). However, when the variance components were transformed into genetic components, it was seen that the dominant component ($\delta D = 0.86$)

was larger than the additive one ($\delta A = 0.86$), i.e., it was seen that the dominant component prevailed in the expression of this trait.

Two varieties had a positive value of GCA, three varieties had a negative value (**Table 3**). The variety Falcon had the highest GCA value, which was significantly higher than those of the other varieties. Also, Falcon had the highest mean value for this trait. This variety, because it had a slightly lower SCA (δsi) value than the variety Banačanka, which in its turn had a positive but slightly lower GCA value, may be used for improvement of this trait in synthetic varieties. The variety Banačanka, in spite of the positive and highly significant GCA value in relation to the remaining three varieties, cannot be recommended as a component of synthetics because its SCA (δSi) variance for the number of leaves per plant was high.

The crosses Falcon x Samuray and Banačanka x Samuray had the highest SCA values (**Table 4**). These crosses involved the best general combiners. Falcon and Banačanka, and the poorest general combiner, Samuray. These results are in agreement with the results of (5, 6, 7), etc. Namely, the crosses that exhibit high SCA values typically include one parent with a high GCA value and another parent with a low GCA value. It means that the combining ability of a variety is valid only for individual combinations, i.e., a variety may be a poor combiner with one variety and a good combiner with another.

Highly significant SCA values were also registered in the crosses Falcon x Jet Neuf, Sremica x Banačanka and Sremica x Jet Neuf. One cross had a non-significant negative SCA value, two crosses had highly significant negative SCA values.

Stem diameter. The largest stem diameter (1.16 cm) was found in the variety Banačanka, the smallest (1.01 cm) in Samuray. In the F_1 generation, the highest mean values for this trait were registered in the crosses

TABLE 1

Mean leaf number per plant and stem diameter of parents (in bold) and their Fi hybrids in a 5 x 5 diallel cross of winter rapes

Parent	Character	Falcon	Sremica	Banačanka	Jet Neuf	Samuray
Falcon	Leaf number/plant	10.31	10.15 ^{d+}	9.79 ^{d+}	10.51 ^{d+}	11.12 ^{d+}
	Stem diameter (cm)	1.15	1.03	1.04	0.96	1.10
Sremica	Leaf number/plant		7.70	9.88 ^{d+}	9.36 ^{ht}	8.12 ^{d+}
	Stem diameter (cm)		1.15	1.03	0.93	1.05
Banačanka	Leaf number/plant			8.94	8.33	10.21 ^{ht}
	Stem diameter (cm)			1.16	1.32	0.99
Jet Neuf	Leaf number/plant				8.43	8.76 ^{d+}
	Stem diameter (cm)				1.06	1.32 ^{ht}
Samuray	Leaf number/plant					6.34
	Stem diameter (cm)					1.01

LSD	Leaf number per plant	Stem diameter (cm)
0.05=	0.88	0.21
0.01=	1.18	0.28

TABLE 2

Analysis of variance for general (g.c.a.) and specific combining ability (s.c.a.) effects in rapes

Source	d.f.	Leaf number/plant			Stem diameter (cm)		
		SS	MS	F	SS	MS	F
Gca	4	10.76	2.69	29.28**	0.01	0.00	0.61
Sea	10	11.81	1.18	12.87**	0.18	0.02	3.44**
Error	28	2.57	0.09		0.14	0.01	

Jet Neuf x Samuray (1.32 cm) and Banačanka x Jet Neuf (1.32 cm), the lowest in the crosses Sremica x Jet Neuf (0.93 cm) and Falcon x Jet Neuf (0.96 cm). The null hypothesis on the absence of genetic differences among the Fi genotypes had to be rejected in light of the significant values of F ratios obtained for all variables. Heterotic effect for the inheritance of this trait was exhibited in only one combination Jet Neuf x Samuray.

The analysis of variance of combining ability showed that highly significant differences

TABLE 3

Estimates of general combining ability effects for two traits in rapes

Parent	Leaf number per plant	Stem diameter (cm)
Falcon	1.00	-0.013
Sremica	-0.324	-0.025
Banačanka	0.131	0.0225
Jet Neuf	-0.194	0.019
Samuray	-0.614	-0.006
S.E.(g _i -g _j)	0.162	0.038

TABLE 4

Estimates of specific combining ability effects for leaf number per plant and stem diameter in rapes

Parent	Character	S.C.A. effects			
		Sremica	Banaćanka	Jet Neuf	Samuray
Falcon	Leaf number/plant	0.274	-0.538	0.511	1.534
	Stem diameter (cm)	-0.015	-0.058	-0.132	0.033
Sremica	Leaf number/plant		0.873	0.685	-0.139
	Stem diameter (cm)		-0.059	-0.150	-0.002
Banaćanka	Leaf number/plant			-0.800	1.496
	Stem diameter (cm)			0.190	-0.115
Jet Neuf	Leaf number/plant				0.368
	Stem diameter (cm)				0.221

S.E. (S _{ij} -S _{ik})	Leaf number	Stem diameter	Limitation
S.E. (S _{ij} -S _{ki})	per plant	(cm)	
	0.397	0.094	i≠j, k; s≠k
	0.362	0.085	i≠j, k l; j≠k, l; k≠l

TABLE 5

Estimates of general and specific combining ability variances in rapes

Parent	Variable	δg_i^{2*}	δs_i^{2*}	Individual basis (δe^2)	Mean basis (δ^2)
Falcon	Leaf number/plant	0.99	0.9244	0.28	0.09
	Stem diameter (cm)	-0.0098	-0.0611	0.02	0.01
Sremica	Leaf number/plant	0.0950	0.3734	0.28	0.09
	Stem diameter (cm)	-0.0094	-0.0597	0.02	0.01
Banaćanka	Leaf number/plant	0.0072	1.2414	0.28	0.09
	Stem diameter (cm)	-0.0094	-0.0497	0.02	0.01
Jet Neuf	Leaf number/plant	0.0276	0.4334	0.28	0.09
	Stem diameter (cm)	-0.0096	-0.0389	0.02	0.01
Samuray	Leaf number/plant	0.3669	1.5135	0.28	0.09
	Stem diameter (cm)	-0.0100	-0.0474	0.02	0.01

$$*Where \delta g_i^2 = (g_i)^2 - \frac{p-1}{p(p+2)} \delta^2 \quad \delta s_i^2 = \frac{1}{n-2} \sum s_{ij}^2 - \frac{p^2+p+2}{(p+1)(p+2)} \delta^2$$

es existed only for SCA, i.e., non-additive genes prevailed in the inheritance of this trait (Table 2). This conclusion was further supported by the values of genetic components ($\delta^2A = -0.01$; $\delta^2D = -0.01$).

Two varieties had positive GCA values and three varieties had negative GCA values for this trait. Banacanka had the highest GCA value, Samuray the lowest value, just like for the previous trait (Table 3). The GCA value of Samuray was significantly lower than the values of the other four varieties. The variety Jet Neuf, which had a positive GCA value and a lower variance of SCA (δs_i^2) than Banačanka, may be used for improvement of this trait in synthetic varieties.

Seven crosses had negative SCA values and three had positive values. The cross Jet Neuf x Samuray had the highest SCA value, which was significantly higher than the values of the other crosses (Table 4). It should be mentioned here that this cross included the two poorest general combiners, which is a further confirmation that the combining ability of a variety or a line is valid only for individual combinations. The cross of the two best combiners, Banacanka and Jet Neuf, had a somewhat lower SCA value than the former cross but it was still highly significant in relation to the other crosses (Table 4). Similar results were reported by (7).

Conclusions

Additive genes prevailed in the inheritance of the number of leaves per plant, dominant ones prevailed in the inheritance of stem diameter.

The cross Sremica x Jet Neuf exhibited heterosis for the number of leaves per plant while the cross Jet Neuf x Samuray exhibited heterosis for stem diameter although the respective parents were not significantly different regarding these traits. It was an indication that the parents differed in a number of other traits and the heterosis was manifested in consequence to favorable non-allelic interactions (epistasis).

Inheritance of quantitative traits is more complex and more specific than the inheritance of qualitative traits. The inheritance of quantitative traits may be intermediary, dominant, superdominant or heterotic. Differences are exhibited not only in crosses with genetically different parents but also in crosses sharing a common parent.

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