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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, Banacanka 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 is 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 Fi 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 Fi 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 ($\delta si$ ) value than the variety Banaćanka, 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 Banaćanka, 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 ($\delta Si$ ) variance for the number of leaves per plant was high.
The crosses Falcon x Samuray and Banaćanka x Samuray had the highest SCA values (**Table 4**). These crosses involved the best general combiners. Falcon and Banacanka, 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 Banaćanka 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 Banaćanka, the smallest (1.01 cm) in Samuray. In the Fi 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 | Banaćanka | 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** | $9.88^{d+}$ | $9.36^{h+}$ | $8.12^{d+}$ |
| | Stem diameter (cm) | | **1.15** | 1.03 | 0.93 | 1.05 |
| Banaćanka | Leaf number/plant | | | **8.94** | 8.33 | $10.21^{h+}$ |
| | Stem diameter (cm) | | | **1.16** | 1.32 | 0.99 |
| Jet Neuf | Leaf number/plant | | | | **8.43** | $8.76^{d+}$ |
| | Stem diameter (cm) | | | | **1.06** | $1.32^{h+}$ |
| 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 differenc-

TABLE 3

**Estimates of general combining ability effects for two traits in rapes**

| Parent | Leaf muber per plant | Stem diameter (cm) |
|---|---|---|
| Falcon | 1.00 | -0.013 |
| Sremica | -0.324 | -0.025 |
| Banaćanka | 0.131 | 0.0225 |
| Jet Neuf | -0.194 | 0.019 |
| Samuray | -0.614 | -0.006 |
| S.E.($g_i$-$g_i$) | 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 |

| | Leaf number per plant | Stem diameter (cm) | Limitation |
|---|---|---|---|
| S.E. ($S_{ij}$-$S_{ik}$) | 0.397 | 0.094 | i≠j, k; s≠k |
| S.E. ($S_{ij}$-$S_{kj}$) | 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 | $\delta g_i^{2*}$ | $\delta s_i^{2*}$ | Individual basis ($\delta e^2$) | Mean basis ($\delta^2$) |
|---|---|---|---|---|---|
| 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 $\delta g_i^2 = (g_i)^2 - \frac{p-1}{p(p+2)}\delta^2$ $\quad \delta s_i^2 = \frac{1}{n-2}\Sigma s_{ij}^2 - \frac{p^2+p+2}{(p+1)(p+2)}\cdot\delta^2$

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 ($\delta s_i^2$) 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.

## REFERENCES


1.**Borojević** (1956) Savremena poljoprivreda, **13** (7-8), 587-606.

2. **FAO STAT** (2003) Statistics database. Agriculture, Agriculture production. Crops primary web adress: http/apps.fao.org.

3. **Griffing B.** (1956) Aust. J. Biol. Sci., **9,** 463-493.

4. **Hadživuković** S. (1973) Statisticki metodi (udzbenik), 134-168. R. Cirpanov, Novi Sad.

5. **Kraljević-Balalić Marija** (1978). Genetika, **10** (1), 31-42.

6. **Marinković R., Joksimović J., Dozet B.** (1994) J. Sci. Agric. Res., **55** (197), 3-9.

7. **Marjanović-Jeromela A., Marinković R.** (1998) Inheritance of plant height and lowest plant height in oil rape *(Brassica napus* L.). Proc. of the 3rd Inter. Symposium Interdisciplinary Regional Research (Hungary, Romania, Yugoslavia), 611-614, 24-25 September 1998. Novi Sad, Yugoslavia.