Yield of winter rape in Ryazan region

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Abstract. The scientific work presents the experimental data on growing varieties and hybrids of winter rape in Ryazan region. The experiment studied the action of fungicide Caramba having a growth stimulating effect on winter rape plants. Weather conditions in 2018-2020 were satisfactory for the development of winter rape, which contributed to its rather good overwintering. During the years of winter rape monitoring, the development of diseases was not marked significantly. On average, according to experiments, the development of Alternaria blight on winter rape was recorded over the entire surveyed area, with a degree of development of 1.5-3.2 % and prevalence of 1 to 6 %, gray rot with a degree of development of 0.3-0.5 % and prevalence of 0.2-0.3 %, on variants without treating with Caramba. Rokhan F, Citro F, Visby F and Zorny were the best in terms of the yield structure. In the experiments, on average, the most productive were the hybrid of the German selection Rokhan (26.8-27.8 dt/ha), Citro (23.9-24.7 dt/ha), Belarusian cultivar Zorny (22.7-23.3 dt/ha). On average, a high survival rate was recorded when treating with fungicide Caramba according to variants with Safran (78.7 %), Rokhan (80.9 %), Zorny (75.5 %).

1. Introduction

The cultivation of winter rape on the territory of the Russian Federation has been actively carried out for the last twenty years. The sown areas are mainly located in the Siberian and North Caucasian Federal Districts, since weather conditions of these territories are most optimal for the development and overwintering of winter rape. The Central Federal District, which includes Ryazan region, is not the main zone for growing winter rape, despite the fact that spring rape grows well in the soil and climatic conditions of the regions that make up the District.

Despite a number of advantages of winter rape as compared with spring rape, its cultivation in the region is primarily associated with the risk of losing most of the harvest in case of unsuccessful overwintering and rotting in spring due to a large amount of moisture [1-3]. It is possible to solve this problem by introducing new cultivars and hybrids of winter rape plants suitable for particular soil and climatic conditions. When introducing new cultivars and hybrids, it is necessary to grow a crop using an intensive cultivation technology with an innovative plant protection system, which, along with insecticides and herbicides, includes fungicidal treatments, the use of growth regulators and trace elements [4].

An important role in solving the problem of plant preservation by spring is played primarily by cultivars and hybrids of winter rape [5-7].

Now there are more than 110 cultivars and hybrids of winter rape and 147 cultivars of spring rape in the State Register of Breeding Achievements approved for use throughout the territory of the Russian Federation. It is worth noting that of all cultivars and hybrids, only six ones are approved for
use in the Central Region, which in turn limits farmers in the selection and preparation of seed material.

Basically, at present almost all registered in the world cultivars belong to the first-generation hybrids of "00" or "00+" types [8].

Another limiting factor when choosing winter rape for cultivation is the poor diversity of non-erucic cultivars, that limits the use of the resulting crop.

There is a need to introduce various lines of winter rape into the Non-Black Earth Zone of Russia. If the introduction of new cultivars and hybrids of winter rape to this region is successful, then there is a possibility to increase overwintering of plants, which in turn will have some favorable effect on the yield and quality of seeds. It should be noted that cultivars and hybrids of winter rape, which are recommended for other agroclimatic zones of Russia, are successfully cultivated on the territory of Ryazan region: Jumper, INV-1033, Vectra, Sitro, and others. In turn, such hybrids of Belarusian and German selection as Zorny, Kronos, Harnet, Titan and others are grown on the territory of Tula region [9-10].

Since 2015, the research has been carried out at the experimental agro-technological station of FSBEI HE RSATU in Ryazan region to improve the technology of growing winter rape and introduce new cultivars and hybrids of domestic and foreign selection.

2. Materials and methods

This experimental work took place in 2018-2020 at an experimental agricultural station of Ryazan region.

It should be noted that areas with dark gray forest soil are typical soils for the region and, in general, for the Non-Black Earth Zone of Russia.

The soil content of experimental plots was as follows: humus (according to Tyurin) was 3.7-3.8 %, mobile phosphorus (according to Kirsanov) was 168-179 mg/kg, potassium was 145-152 mg/kg and exchangeable acidity pH (extract of potassium chloride) was 5.65-5.73.

Agrotechnical measures were generally accepted in the Non-Black Earth Zone of Russia [11]. The predecessor in the years of experiments was winter wheat.

Sowing was to a depth of 2-2.5 cm by continuous row method.

The objects of the research were the following cultivars and hybrids: Visby F, Citro F, Rokhan F, Safran F, Zorny, Severyanin.

Experimental conditions included the seeding rate of 1.0 million pcs/ha and the sowing period of the 2nd decade of August. The system of winter rape protection was as follows: 2 l/ha of Butizan star before germination and 1 l/ha of Caramba in the phase of 4-5 leaves. During the growing season of rape, there were three treatments with Fastak insecticide 0.15 l/ha.

Fungicide Caramba (active ingredient Metconazole or WL-136184, 60 g/l) is characterized by a sufficiently long protective effect of up to one and a half months. The fungicide works both ahead of time as a warning, and with already noted signs of the disease, stopping the development of an already fixed infection. It is also characterized by the properties of a plant growth regulator, causing leaf thickening in winter rape.

The mechanism of action of Metconazole is manifested in inhibition of ergosterol biosynthesis, disruption of the biosynthesis of cell membranes of the fungal pathogen. The active substance enters the winter rape plant and spreads in it acropetally.

In the experiment, for cultivation before sowing, mineral fertilizers were applied at a dose of N$_{100}$P$_{60}$K$_{60}$, as well as in spring in the form of top dressing, ammonium nitrate at a dose of N$_{60}$ was introduced.

The harvesting of winter rape in the experiment was by direct combining, when the pods of the plant acquired a lemon-yellow color and the moisture content of seeds was in the range of 9-13 %. The cutting height was 7-12 cm.

All agrotechnical techniques in the experiment were performed at the optimum time.
Necessary analyzes and records during the research period were based on "Methodology of state variety testing of agricultural crops" (1985) and mathematical data processing was carried out according to B.A. Dospekhov (1985) [12].

3. Results
All experimental variants of winter rape have relatively satisfactorily endured winter and early spring periods. Agrocenoses of rape with variants Severyanin (2019, 2020), Citro (2020), Visby (2020), Zorny (2020) emerged after the winter period sparse, with frequent fallouts on the plots. So, on average, during the spring renewal of rape vegetation, plant survival after overwintering was noted at the level of 70.5-84.3 % and in 2020 it was 74.3-80.6 % (figure 1).

![Figure 1. Survival of varieties and hybrids of winter rapeseed, %, average for 2019-2020.](image)

On average, a high survival rate was recorded when treating with fungicide Caramba in variants with Safran (78.7 %), Rokhan (80.9 %), Zorny (75.5 %).

The highest variants in terms of the yield structure were Rokhan F, Citro F, Visby F and Zorny (table 1 and figure 2).

4. Discussion
In the weather and soil conditions of the Non-Black Earth Zone of Russia, it is necessary to carry out clear agrotechnical measures for winter rape. All this is of decisive importance for a good and reliable overwintering and crop formation.

At present, new cultivars of various breeding are often recommended to be sown at a later date, in the 2nd and early 3rd decades of August, which is associated, among other things, with an increase in the frost-free period until the end of October - early November.

In the studies, the meteorological conditions of the growing seasons of winter rape in 2018-2019, 2019-2020 varied by significant fluctuations in temperature factors and inhomogeneity of precipitation by months and seasons. During the period of autumn crop development, rape developed quite well, having high foliage and a full diameter of the root collar. All this was favored by weather conditions in September - mid-October.

It is stated that the weather conditions turned out to be satisfactory for the development of winter rape, which favored a sufficiently good overwintering period.

Characterizing the winter period of 2018-2019, 2019-2020, one can note mild, relatively snowy winters, which favorably affected the plant overwintering.

For overwintering, rape had, on average, 7-10 stem leaves in the phase of rosette formation.
Table 1. Structural elements of the yield of winter rapeseed from factors, average 2019-2020.

| Hybrids and cultivar | Variant of treatment | Density before harvest, pcs/m² | Seeds in one pod, pcs/plant | Pods per plant, pcs | Height of plants, cm | Weight of 1,000 seeds, g |
|----------------------|----------------------|-------------------------------|-----------------------------|---------------------|---------------------|------------------------|
| Visby                | Without treatment    | 69.0                          | 23.4                        | 119.5               | 126.3               | 4.55                   |
|                      | Caramba              | 73.9                          | 24.5                        | 122.9               | 121.7               | 4.55                   |
| Zorny                | Without treatment    | 70.0                          | 23.5                        | 117.8               | 109.7               | 4.40                   |
|                      | Caramba              | 75.5                          | 23.1                        | 121.1               | 107.4               | 4.45                   |
| Safran               | Without treatment    | 70.5                          | 24.3                        | 120.0               | 125.7               | 5.20                   |
|                      | Caramba              | 78.7                          | 24.5                        | 115.6               | 125.7               | 5.25                   |
| Severyanen           | Without treatment    | 66.0                          | 23.6                        | 113.9               | 119.2               | 4.85                   |
|                      | Caramba              | 71.9                          | 23.5                        | 111.3               | 119.8               | 4.95                   |
| Sitro                | Without treatment    | 62.8                          | 27.0                        | 133.9               | 119.0               | 4.20                   |
|                      | Caramba              | 70.9                          | 27.2                        | 137.3               | 119.8               | 4.20                   |
| Rokhan               | Without treatment    | 75.1                          | 26.1                        | 133.7               | 124.5               | 5.35                   |
|                      | Caramba              | 88.0                          | 27.1                        | 141.7               | 123.5               | 5.40                   |
| LSD<sub>05</sub> of factor interaction AV 2019 – 1.84 | 1.60 | 17.11 | 11.27 | 0.22 | 0.60 | 2020 – 1.70 | 2.05 |

Figure 2. Yield of variants of winter rape, average 2019-2020.

When treated with fungicide Caramba, the plant stems did not outgrow and did not elongate, they were noted by a low, up to 4.5 cm, location of the growth point with a root collar diameter of 8.5-12.0 m. In the control variants, the height of stems was 5-7 cm higher, which somewhat reduced the percentage of overwintering.

The experimental leaves of winter rape relatively actively covered the entire surface of the soil, due to this, the unproductive consumption of moisture was significantly reduced, on average, by 57.5-79.7% in variants and the development of weeds in the autumn-spring period of plant development was inhibited.
All studied lines were distinguished by intensive growth, early and intense flowering, followed by amicable and uniform maturation. No significant lodging was observed during the years of experiments.

In general, it was noted that there was a good genetic potential for yield due to high branching, podding and relatively high availability of seeds in the pod with an average weight of 1,000 seeds of 4.2-5.4 grams.

The most highly variable parameter depending on factors was the number of pods per plant. The maximum number of pods, on average, was noted on variants with fungicidal treatment with Caramba of foreign hybrids Rokhan (141.7 pcs/1 plant), Citro (137.3 pcs/1 plant), Visby (122.9 pcs/1 plant). The maximum number of pods was noted in 2020 on variants with Rokhan hybrids (130.0-133.2 pcs/1 plant).

On average, the tallest cultivar in the research was Safran (125.7 cm), Rokhan was 123.5-124.5 cm high and Visby was 121.7-126.3 cm high.

The number of seeds in the pod can be characterized as pronouncedly genetic, as a result of which, little change depending on agrotechnical factors. The number of seeds in a pod practically did not depend on applied fungicide Caramba.

During the years of monitoring on crops of winter rape, the development of diseases was not marked significantly. On average, according to experiments, the development of Alternaria blight (Alternaria spp.) on winter rape was recorded over the entire surveyed area, with a degree of development of 1.5-3.2% and prevalence of 1 to 6 %, gray rot (Botrytis cinerea) with a degree of development of 0.3-0.5% and prevalence of 0.2-0.3%, on variants without treating with Caramba. In variants with Caramba treatment, cases with Alternaria blight were rare, nevertheless, in autumn, black-brown concentric spots with yellow edges on the leaves were noted, up to 0.8 cm in diameter; and in the spring-summer period, in this regard, in some of the studied rape lines, pod cracking was noted resulting in yield loss.

5. Conclusion

On average, a high survival rate was recorded with the treatment with fungicide Caramba according to variants with Safran (78.7%), Rokhan (80.9%), Zorny (75.5%). In general, for all studied cultivars and hybrids there was a high adaptability to the agro-climatic conditions of Ryazan region, a relatively good winter hardiness, despite significant loss of leaves and an excellent ability to generate in spring.

Rokhan F, Citro F, Visby F and Zorny were the best in terms of the yield structure. So, the maximum number of pods, on average, was noted on variants with Caramba treatment of foreign hybrids Rokhan (141.7 pcs/1 plant), Citro (137.3 pcs/1 plant), Visby (122.9 pcs/1 plant).

In the conditions of Ryazan region, on average, the most productive were the hybrid of German selection Rokhan (26.8-27.8 dt/ha), Citro (23.9-24.7 dt/ha) and Belarusian cultivar Zorny (22.7-23.3 dt/ha).

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