Promising varieties of black currant in the phytosanitary technology of the Trans-Urals

V A Morkovina, I N Porsey, A V Sozinov, V V Polovnikova and M V Karpova

Federal State Budgetary Educational Institution of Higher Education “Kurgan State Agricultural Academy named after T.S. Maltsev”, Lesnikovo vil., Kurgan region, 641300, Russian Federation

E-mail: savrey@ya.ru

Abstract. Currant is a light-loving and moisture-loving plant. Under natural conditions, it grows on moist soils along the banks of rivers and streams. In collective and private gardens, black currant takes a leading place. On average, over three years of research, a different distribution of the most harmful diseases on currant varieties was noted, which led to a decrease in yield for the Sybille variety to 5.95 t / ha, the variety was in the control group, the Venera variety - 6.09 t / ha, the average yield of the Rusalka variety - 6.76 t / ha, Slavyansk - 7.23 t / ha, Vologda - 7.79 t / ha. A high yield was obtained for the varieties Kushnarenkovskaya - 8.19 t / ha, Dachnitsa - 8.27 t / ha, Relay - 9.26 t / ha. A decrease in the yield of varieties, in addition to weather conditions, is due to different resistance to pests and diseases. Currant varieties were affected to varying degrees by American powdery mildew, anthracnose, septoria blight, goblet and columnar rusts.

1. Introduction

The situation with black currants in Russia does not cause alarm, since its areas are constantly increasing, and their slight fluctuations are quite natural, for example, due to a change in the assortment or the development of pests and diseases [1-2].

Easy recoverability after extreme conditions, the possibility of quick replacement, for example, when renewing the assortment, early maturity, high yield, relative adaptability to harsh conditions, sophisticated cultivation technologies make it possible to obtain a biological yield of promising currant varieties of 10 t / ha and more. Black currant berries are a storehouse of vitamins, so they also have medicinal value. They are a valuable dietary food product, serving as a source of organic acids, sugars, nitrogenous, tannins, aromatic substances [3-5].

The aim of the research was to find the most promising varieties on the basis of competitive variety testing and to study the most dangerous and common diseases of black currant and to develop methods of combating them.

2. Materials and methods

The experiment was carried out at the Kurgan State Agricultural Academy on the basis of the Kurgan Fruit and Berry State Administration. The experiment was laid in 2013 in four replications, according to the methodology of the state variety testing of fruit and berry crops. The varieties entered fruiting in 2016. All observations and counts were carried out in 2018, 2019 and 2020.

The soil of the experimental plot is light gray forest solodized thin sandy loam soil [6].
The research was carried out on 8 varieties of black currant - Venus, Vologda, Dachnitsa, Rusalka, Sybille, Slavyanka, Kushnarenkovskaya, Relay [3]. The weather during the growing season in 2018 and 2019 was typical for the study area (GTR = 1.0), 2020 was dry (GTR = 0.6).

3. Results

The yield value of berries can characterize the resistance of varieties to biotic and abiotic environmental factors. Table 1 shows the yield of varieties in the experiment on average for three years of research. As can be seen from the table, the decrease in the yield of varieties in 2019 was caused by the development of pests and diseases, and in 2020 by unfavorable weather conditions and diseases.

On average, over three years of testing, a different distribution of the most harmful diseases on currant varieties was noted, which led to a decrease in yield for the Sybille variety to 5.95 t / ha, the variety was in the control group, the Venera variety - 6.09 t / ha. A good harvest was obtained for the varieties Rusalka - 5.76 t / ha, Slavyanka - 7.23 t / ha, Vologda - 7.79 t / ha. The promising varieties Dachnitsa - 8.27 t / ha, Kushnarenkovskaya - 8.19 t / ha, Relay - 9.26 t / ha yielded a high yield (table 1).

Table 1. Yield of black currant varieties in the Trans-Urals, t / ha (Kurgan State Agricultural Academy).

| Variety               | Productivity, t / ha | Deviation from the standard |
|-----------------------|----------------------|-----------------------------|
|                       | 2018 year | 2019 year | 2020 year | Average |
| Venus (standard)      | 8.96      | 4.76      | 4.56      | 6.09    | -        |
| Vologda               | 12.31     | 5.71      | 5.34      | 7.79    | +1.70    |
| Summer resident       | 14.87     | 4.47      | 5.46      | 8.27    | +2.18    |
| Mermaid               | 10.72     | 4.94      | 4.62      | 6.76    | +0.67    |
| Sybille               | 8.83      | 4.20      | 4.83      | 5.95    | -0.14    |
| Slav                  | 11.50     | 5.04      | 5.15      | 7.23    | +1.14    |
| Kushnarenkovskaya     | 9.72      | 7.21      | 7.63      | 8.19    | +2.10    |
| Relay race            | 10.52     | 9.72      | 7.55      | 9.26    | +3.17    |
| HCP 0.95              | 0.53      | 0.57      | 0.55      |         |

One of the most harmful diseases of black currant is American powdery mildew. The causative agent is the mushroom Sphaerotheca morsuvae (Schw.) Berk et Curt.). The harmfulness of the disease is manifested in the termination of the growth of shoots, internodes are shortened, the leaves become small, yellowish, the berries are inedible, small, and fall prematurely [7].

The prevalence of the disease was noted in 2018 for the varieties Rusalka, Relay, Sibylla. The maximum degree of damage by powdery mildew on the Dachnitsa variety. In 2019, the fungal disease spread to all varieties, except for the standard Venus variety and the disease-resistant variety Kushnarenkovskaya. According to the results of three years of study, we noted a low spread of the disease for the varieties Venus - 3.3% and Relay - 8.3%. The high degree of distribution on the varieties Sybille - 35.0 and Dachnitsa - 41.7% (table 2).

We were forced to study the possibility of protecting the plantings of the most affected black currant varieties Dachnitsa and Sibylla with chemical and biological preparations in phytosanitary cultivation technology.

From table 3, it can be concluded that spraying with the biological preparation Fitosporin M, P - 0.3 kg / ha in the experiment, which was carried out during the growing season, the first before flowering, the second after harvesting. A decrease in the spread of the disease was noted for the Dachnitsa variety compared to the control by 5 times, for the Sybille variety - 5.2 times (table 3).
Table 2. The prevalence of powdery mildew on black currant varieties (Kurgan State Agricultural Academy).

| Currant varieties | Disease         | 2018 year | 2019 year | 2020 year | Average |
|------------------|-----------------|-----------|-----------|-----------|---------|
| Venus (standard) | Powdery mildew  | -         | -         | 10        | 3.3     |
| Vologda          | Powdery mildew  | -         | 20        | 20        | 13.3    |
| Summer resident  | Powdery mildew  | 20        | 50        | 55        | 41.7    |
| Mermaid          | Powdery mildew  | 5         | 25        | 25        | 18.3    |
| Sibylla          | Powdery mildew  | 15        | 55        | 35        | 35.0    |
| Slav             | Powdery mildew  | -         | 25        | 25        | 16.7    |
| Kushnarenkovskaya| Powdery mildew  | -         | -         | -         | -       |
| Relay race       | Powdery mildew  | 5         | 10        | 10        | 8.3     |
| HCP<sub>0.95</sub> |                 | 2         | 3         | 5         |         |

Table 3. Protection of black currants from powdery mildew (Kurgan State Agricultural Academy).

| Option                                      | 2018 year | 2019 year | 2020 year | Average |
|---------------------------------------------|-----------|-----------|-----------|---------|
| Control (without treatments)                | 20        | 50        | 55        | 41.7    |
| Fitosporin M, P - 0.3 kg / ha               | 5         | 10        | 10        | 8.3     |
| Topaz, EC - 0.3 l / ha                      | -         | -         | 5         | 1.7     |
| Soda ash with soap (50 g of baking soda and 50 g of soap per 10 L of water / 100 m2) | 5         | 5         | 10        | 6.7     |
| HCP<sub>0.95</sub>                          | 3         | 4         | 2         |         |

| Option                                      | 2018 year | 2019 year | 2020 year | Average |
|---------------------------------------------|-----------|-----------|-----------|---------|
| Control (without treatments)                | 15        | 55        | 35        | 35.0    |
| Fitosporin M, P - 0.3 kg / ha               | 5         | 10        | 5         | 6.7     |
| Topaz, EC - 0.3 l / ha                      | -         | 5         | -         | 1.7     |
| Soda ash with soap (50 g of baking soda and 50 g of soap per 10 L of water / 100 m2) | 5         | 10        | 5         | 6.7     |
| HCP<sub>0.95</sub>                          | 2         | 3         | 5         |         |

The use of chemicals Topaz, EC - 0.3 l / ha and soda ash with soap (50 g of soda and 50 g of soap per 10 l of water / 100 m2) was more effective in suppressing the pathogen of powdery mildew. So, for the Dachnitsa variety, on average for three years, the spread of the disease in the control was 41.7%, the decrease in the Topaz preparation, EC - 0.3 l / ha to 1.7%, when using Soda ash with soap (50 g of soda and 50 g of soap per 10 l of water / 100 m2) - 6.7%, the same trend can be seen in the Sybille variety.

In the conditions of the Trans-Urals, columnar and goblet rust can be harmful. Columnar rust is a very common disease. Only leaves are affected. On their upper side, in the middle of summer, many small yellowish spots appear, which then merge. On the underside of the leaves, in places corresponding to these spots, at the beginning yellowish or orange and then brown areas of sporulation of the fungus are formed. According to the results of three years of observations, the varieties Venus - 18.3%, Rusalka - 28.3%, Relay - 16.6% were moderately affected (table 4).
Table 4. The prevalence of columnar rust on black currant varieties (Kurgan State Agricultural Academy).

| Currant varieties | Disease               | 2018 year | 2019 year | 2020 year | Average |
|-------------------|-----------------------|-----------|-----------|-----------|---------|
| Venus (standard)  | Columnar rust Cronartium ribicola | 10.0      | 30.0      | 15.0      | 18.3    |
| Vologda           | Columnar rust Cronartium ribicola | -         | 15.0      | 10.0      | 8.3     |
| Summer resident   | Columnar rust Cronartium ribicola | -         | -         | -         | -       |
| Mermaid           | Columnar rust Cronartium ribicola | 25.0      | 35.0      | 15.0      | 28.3    |
| Sibylla           | Columnar rust Cronartium ribicola | 10.0      | 20.0      | 10.0      | 13.3    |
| Slav              | Columnar rust Cronartium ribicola | -         | -         | -         | -       |
| Kushnarenkovskaya| Columnar rust Cronartium ribicola | 15.0      | 35.0      | 10.0      | 20.0    |
| Relay race        | Columnar rust Cronartium ribicola | 15.0      | 25.0      | 10.0      | 16.6    |

Goblet rust is especially dangerous in areas where sedge grows - an intermediate host, without which the pathogen of goblet rust cannot develop. In spring, on sedge, where the mushroom hibernates, spores appear, which are carried by the wind to leaves, young ovaries or to currant flowers, infecting them. The varieties Slavyanka - 35.3%, Venus - 36%, Dachnitsa, Sibylla - 51.7% were greatly amazed by the results of three years (table 5).

Table 5. Prevalence of goblet rust on black currant varieties (Kurgan State Agricultural Academy).

| Currant varieties | Disease                | 2018 year | 2019 year | 2020 year | Average |
|-------------------|------------------------|-----------|-----------|-----------|---------|
| Venus (standard)  | Puccinia ribesii caricis | 33.0      | 60.0      | 15.0      | 36.0    |
| Vologda           | Puccinia ribesii caricis | 25.0      | 45.0      | 10.0      | 26.7    |
| Summer resident   | Puccinia ribesii caricis | 50.0      | 90.0      | 15.0      | 51.7    |
| Mermaid           | Puccinia ribesii caricis | 55.0      | 65.0      | 10.0      | 43.3    |
| Sibylla           | Puccinia ribesii caricis | 60.0      | 80.0      | 15.0      | 51.7    |
| Slav              | Puccinia ribesii caricis | 35.0      | 56.0      | 15.0      | 35.3    |
| Kushnarenkovskaya| Puccinia ribesii caricis | 10.0      | 10.0      | 5.0       | 8.3     |
| Relay race        | Puccinia ribesii caricis | 10.0      | 5.0       | 5.0       | 6.7     |
| HCP₀.₉₅           |                        | 8.0       | 5.0       | 3.5       |         |
Anthracnose on currants in the Trans-Urals appears in the form of small dark brown rounded spots, mainly on the upper side of the leaf. With a strong defeat, the anthracnose spots merge, the leaves, starting from the lower old ones, turn brown, dry out and fall off prematurely. The accounting data for anthracnose over the years of research are shown in (table 6). The variety Sibylla was severely affected - 15%.

Table 6. Prevalence of anthracnose in black currant varieties (Kurgan State Agricultural Academy).

| Currant varieties       | Disease      | 2018 year | 2019 year | 2020 year | Average |
|-------------------------|--------------|-----------|-----------|-----------|---------|
| Venus (standard)        | Anthracnose  | 10        | 15        | 10        | 11.7    |
| Vologda                 | Anthracnose  | 5         | 15        | 10        | 10.0    |
| Summer resident         | Anthracnose  | 5         | 20        | 10        | 11.7    |
| Mermaid                 | Anthracnose  | 10        | 15        | 5         | 10.0    |
| Sibylla                 | Anthracnose  | 10        | 20        | 15        | 15.0    |
| Slav                    | Anthracnose  | 10        | 15        | 5         | 10.0    |
| Kushnarenkovskaya       | Anthracnose  | -         | 5         | 5         | 3.3     |
| Relay race              | Anthracnose  | 5         | 15        | 10        |         |
| **HCP<sub>0.95</sub>** |              | 2         | 4         | 3         |         |

On the varieties of black currant, we observed during 3 years of observation a different distribution of septoria, a rather harmful disease. The varieties Venus, Vologda -10%, Dachnitsa and Sybille -11.7% were most affected by the disease. The massive development of the disease is observed in the second half of the summer, for example 2019.

Mass abscission of leaves is observed in August, infected shoots ripen poorly, growth decreases, buds are set weak. The harvest of the next year is reduced by 2-3 times (table 7) [8-10].

Table 7. The prevalence of septoria on black currant varieties (Kurgan State Agricultural Academy).

| Currant varieties       | Disease | 2018 year | 2019 year | 2020 year | Average |
|-------------------------|---------|-----------|-----------|-----------|---------|
| Venus (standard)        | Septoria| 10.0      | 15.0      | 5.0       | 10.0    |
| Vologda                 | Septoria| 5.0       | 10.0      | 15.0      | 10.0    |
| Summer resident         | Septoria| 5.0       | 15.0      | 15.0      | 11.7    |
| Mermaid                 | Septoria| -         | 10.0      | 5.0       | 5.0     |
| Sibylla                 | Septoria| 10.0      | 20.0      | 5.0       | 11.7    |
| Slav                    | Septoria| -         | 10.0      | 5.0       | 5.0     |
| Kushnarenkovskaya       | Septoria| -         | -         | -         | -       |
| Relay race              | Septoria| -         | 10.0      | 5.0       | 5.0     |
| **HCP<sub>0.95</sub>** |          | 1.0       | 2.0       | 4.0       |         |

The coefficient of similarity for ecological groups of pests on black currant in the Trans-Urals and Siberia is quite high, varying from 0.67 to 1.0, averaging 0.87 [3]. In both regions, in the structure of the community of pests, the ecological group of ground-air, or leaf-stemmed, predominates (figure 1).
To determine the cost of products, the actual sales prices are taken, since they take into account the qualitative differences of a particular product and the timing of their sale.

As can be seen from (table 8), the varieties in our experience can be divided into three groups according to the level of yield and profitability. The first group included varieties Dachnitsa - 8.27 t / ha; Kushnarenkovskaya - 8.19 t / ha and Relay - 9.26 t / ha; the second group included varieties Vologda - 7.79 t / ha, Rusalka - 6.76 t / ha, Slavyanka - 7.23 t / ha; in the third group with a yield of 5.95 t / ha, the Sybille variety and 6.09 t / ha, the Venera variety. At the same time, cultivated varieties from groups I and II of yields provided a good level of profitability.

### Table 8. Economic efficiency of cultivation of black currant varieties (according to the data of the Kurgan State Agricultural Academy).

| Variety            | Yield group | Productivity, t / ha | Cost of 1 ton, rubles. | Profit per hectare, rubles | Profitability level, % |
|--------------------|-------------|----------------------|------------------------|-----------------------------|------------------------|
| Venus (standard)   | III         | 6.09                 | 57284.1                | 381940                      | 109                    |
| Vologda            | II          | 7.79                 | 48863.9                | 554150                      | 146                    |
| Summer resident    | I           | 8.27                 | 47113.2                | 602774                      | 155                    |
| Mermaid            | II          | 6.76                 | 53459.9                | 449811                      | 124                    |
| Sibylla            | III         | 5.95                 | 58191.9                | 367758                      | 106                    |
| Slav               | II          | 7.23                 | 51200.3                | 497422                      | 134                    |
| Kushnarenkovskaya  | I           | 8.19                 | 47390.7                | 594670                      | 153                    |
| Relay race         | I           | 9.26                 | 44080.9                | 703061                      | 172                    |

### 4. Discussion

Modern industrial production of berries involves the use of the achievements of science and practice of advanced farms. In this regard, the introduction of progressive methods of agricultural technology, promising varieties, protection against diseases, and an increase in the culture of currant cultivation will greatly contribute to an increase in yields, reduce costs per unit of production, and reduce its cost.

The results obtained indicate a decrease in the spread of powdery mildew for all the drugs used in all studied varieties.

Columnar rust of black currant affects only leaves. In our experiment, the varieties were affected from 8.0 to 35.0%, which affected the productivity of the varieties. The parameters of pathogenesis, natural and anthropogenic factors that are significant for parasitic activity on varieties of different resistance have been established.
Based on the results of our research, it was noted that the prevalence of the disease in 2019 increased in all varieties in comparison with the previous year. The Relay variety turned out to be more stable.

To combat goblet and columnar rust, we recommend:

- Within a radius of up to 500 m in summer, periodically mow sedges, intermediate hosts of goblet rust; do not plant currants in very low and swampy places;
- Planting currants away from coniferous forests, Siberian cedar and pine are intermediate hosts of columnar rust;
- It is necessary in the early spring to spray black currant plants with 3% Bordeaux liquid, and before flowering and after flowering - with 1% Bordeaux liquid;
- Cut out the affected shoots and collect the affected fallen leaves and berries.

As measures to combat anthracnose and septoria, one can suggest:

- In autumn digging the soil with the incorporation of fallen leaves into it;
- Spraying before flowering and after harvesting with Tsikhom, SP (370 g / kg - copper oxychloride + 150 g / kg - Zineba) - 3-4 kg / ha; Propi Plus (250 g / l - propiconazole) - 0.5 l / ha; Chistoflor, EC - (250 g / l - propiconazole) - 0.5 l / ha [8];
- Bordeaux mixture - F, VPR (960 + 900 g / kg) - 100 g of copper sulfate + 100 g of calcium hydroxide / 10 l of water. Spraying during the growing season with 1% working solution.

5. Conclusion

Based on the foregoing:

- As a result of the research, it was revealed that the varieties of black currant formed a stable yield in all the years of the experiments. The first group in terms of productivity included varieties Dachnitsa - 8.27 t / ha; Kushnarenkovskaya - 8.19 t / ha and Relay - 9.26 t / ha; the second group included varieties Vologda - 7.79 t / ha, Rusalka - 6.76 t / ha, Slavyanka - 7.23 t / ha; in the third group with a yield of 5.95 t / ha, the Sybille variety and 6.09 t / ha, the Venera variety. At the same time, cultivated varieties from groups I and II of yields provided a good level of profitability.
- Differences were revealed in the spread of diseases (American powdery mildew, goblet and columnar rust, anthracnose and septoria blight) on currant varieties. The reaction of black currant varieties to biotic and abiotic factors during the growing season is expressed in the level of yield by years of study. The coefficient of similarity for ecological groups of pests on black currant in the Trans-Urals and Siberia is quite high, varying from 0.67 to 1.0, averaging 0.87.

References

[1] Stepanovskikh A S 2011 Scientific bases of protection of agricultural crops from pests, diseases and weeds in the Trans-Urals (Kurgan: Publishing house of the Kurgan State Agricultural Academy) 441
[2] Nemchenko V V 2011 Plant protection system in resource-saving technologies (Kurtamysh: Kurtamish printing house) 525
[3] Morkovina V A Porsev I N Polovnikova V V and Nemirova N A 2019 Species composition of harmful organisms on varieties of black currant in the southern Trans-Urals. Bulletin of the Kurgan SAA 4(32) 12-6
[4] Sorokopudov V N 2007 Selection of currants in Western Siberia. Collection of scientific works "Current state of currant and gooseberry crops" Michurinsk 164-81
[5] Sorokopudov V N and Melkumova E A 1992 Genetic nature of currant resistance to septoria
blight. Collection of articles “Genetic foundations of plant productivity” 183-201

[6] Komissarova I V and Miroshnichenko N V 2017 Structure of the soil cover of the territory of the Kurgan vegetable variety testing site. Actual problems of rational use of land resources 18-22

[7] Chulkina V A, Toropova E Yu and Stetsov G Ya 2010 Integrated plant protection: phytosanitary systems and technologies (terms and definitions) (Moscow: Kolos) 453

[8] Mikulic-Petkovsek M, Slatnar A, Schmitzer V, Stampar F, Veberic R and Koron D 2013 Chemical profile of black currant fruit modified by different degree of infection with black currant leaf spot. Scientia Horticulturae 150 399-409

[9] Toropova E Yu and Chulkina V A 2005 Ecological bases of plant protection from diseases in Siberia (Novosibirsk: Novosibirsk State Agrarian University Press) 370

[10] Chulkina V A, Toropova E Yu and Stetsov G Ya 2010 Integrated plant protection: phytosanitary optimization of agroecosystems (terms and definitions) (Moscow: Kolos) 482