New ways to control the development of sugar beet leaf pathogens

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Abstract. Increasing the yield of sugar beet is a strategic goal of modern agricultural production. The area under crops in the south of Russia makes it possible to fully provide sugar production with raw materials. However, changes in climatic conditions in recent years have a negative impact on plants development. Extreme conditions of 2020, when dust storms gave way to torrential rains, contributed to the repeated reseeding of the culture. Sugar beet is a demanding crop. Production efficiency is possible with the right combination of breeding, seed and plant protection. Sugar beet leaf diseases negatively affect the formation of quality indicators. The article presents research results of effectiveness of using new fungicides on sugar beet crops based on active substances from chemical classes: triazoles, strobilurins and carboxamides, under irrigation conditions.

1. Introduction
Sugar beet requires a high level of farming culture. Modern approaches to plant protection testify to effectiveness of an integrated approach [1, 2]. Optimization of selection of processing technology, nutrition system, protection system contributes to the increase in the quantity and quality of the crop [3].

Development of sugar beet plants during growing season is influenced by biotic and abiotic stresses [4]. Beet growers in the field deal with complex impact of negative factors on the crop (diseases, pests, drought, high air temperatures) [5].

In the Stavropol Territory, various diseases affect the leaf apparatus of sugar beet, the main of which is cercospora (Cercospora beticola Sacc.). Development of a disease is facilitated by the alternation of dry warm and cool rainy weather. Optimal conditions for active development of cercospora is a temperature regime of +15-35°C and optimal humidity for development of pathogen [6].

Premature losses of assimilation area of the leaf apparatus cause the consumption of plastic substances of the root crop for the formation of new leaves, which entails a decrease in yield [7].

With the risks of epiphytotic spread of cercosporosis, it is especially important to develop a tactic for the use of fungicides, which allows obtaining maximum protection of the leaf apparatus of sugar beet from fungal spots, which, in future, will affect the yield and quality of crystalline sugar [8].
2. Materials and methods
The experience was started in LLC "Agrosakhar" in Novoizobilny settlement, Izobilnensky urban district of Stavropol Territory, according to the predecessor - winter wheat, hybrid - Recordina (KWS). Field No. 26IZB166 with an area of 155.8 hectares, including under irrigation - 105 hectares. The layout of the options is presented by the method of randomized repetitions, in 4 repetitions according to the method of B.A. Dospekhov. (1985).

### Table 1. Scheme of the experiment (Agrosakhar LLC).

| №  | Variant            | 1st processing – 06.19.2020 consumption rate – 1 (kg)/ha | 2nd processing – 07.01.2020 consumption rate – 1 (kg)/ha | 3rd processing – 07.15.2020 consumption rate – 1 (kg)/ha | 4th processing – 08.13.20 consumption rate – 1 (kg)/ha |
|----|--------------------|----------------------------------------------------------|----------------------------------------------------------|----------------------------------------------------------|----------------------------------------------------------|
| 1  | Standard           | Amistar Gold 1.0+ Manil 1.5                              | Abacus Ultra 1.5 + Manil 1.5                             | Alto Turbo 0.7 + Manil 1.5                               | Bamper Super 1.5 + Manil 1.5                             |
| 2  | Alternative        | Rex Plus 1.0+ Manil 1.5                                  | Piktor Aktiv 0.7 + Topsis M 1.0 + Manil 1.5              | Abakus Ul'tra 1.5 + Manil 1.5                           | Bamper Super 1.5 + Manil 1.5                             |
| 3  | New                | Rias 0.6+ Manil 1.5                                     | Elatus Ria 0.8 + Manil 1.5                               | Alto Turbo 0.7 + Manil 1.5                               | Bamper Super 1.5 + Manil 1.5                             |

3. Results and discussion
The growing season was characterized by an acute deficit of precipitation, against long-term average - less than 50%, there were rains from May to mid-June and in the third decade of July. The required amount of productive moisture for normal plants development was fully provided due to irrigation - from June to September, irrigation provided 400 mm of precipitation in this area. The most intensive development of leaf spots (both bacterial and cercospora) was noted in the second or third decades of August. An intensive dumping of tops began in the third decade of September.

The season is marked by a high temperature regime with typical for the region periods of maximum temperature above 36-39°C. Accounts of the development and distribution of cercosporae began to be carried out after the second treatment.

14 days after the second treatment (table 2), the largest percentage of the spread of cercosporosis (60%) had the Alternative option, in this regard, the number of forming leaves is also higher.

### Table 2. Indicators of the effectiveness of fungicidal treatments of sugar beet (07.14.2020).

| Accounting indicators, measurement units | Variant Alternative | New | Standard |
|-----------------------------------------|---------------------|-----|----------|
| Dead                                    | 12.6                | 10.2| 9.2      |
| Forming                                 | 2.8                 | 2.4 | 2.6      |
| Developed and functioning               | 14.2                | 22.4| 14.4     |
| Average weight, gram                    | 510                 | 582 | 412      |
| Root crops                              | 292                 | 362 | 292      |
| Halm                                    | 1.747               | 1.608| 1.411  |
| Mass ratio                              | 9.972               | 2.071| 3.222  |
| Development of bacterial spotting, %    | 60                  | 20  | 20       |
| Development of cercosporous spotting, % | 0.113               | 0.018| 0.028  |
14 days after the third treatment, according to Table 3, the development of cercosporosis reached 100% according to the variants - Alternative and Standard. The New variant provided the highest developed and functioning leaves and the largest root crop mass.

**Table 3.** Indicators of the effectiveness of fungicidal treatments of sugar beet (07.30.2020).

| Accounting indicators, measurement units | Variant                  |
|------------------------------------------|--------------------------|
|                                          | Alternative | New | Standard |
| Average number of leaves per plant, pcs: |            |    |          |
| Dead                                     | 15.8        | 11.8| 10.2     |
| Forming                                  | 6.0         | 5.4 | 5.6      |
| Developed and functioning                | 17.0        | 23.0| 18.2     |
| Average weight, gram:                    |             |    |          |
| Root crops                               | 640         | 1006| 656      |
| Halm                                     | 212         | 434 | 298      |
| Mass ratio                               | 3.019       | 2.318| 2.201   |
| Development of bacterial spotting, %    | 6.54        | 3.01| 6.18     |
| Distribution of cercosporous spotting, % | 100         | 60  | 100      |
| Development of cercosporous spotting, % | 0.19        | 0.12| 0.33     |

Pre-harvest crop surveys (Table 4) showed that New variant continued to provide the highest developed and functioning leaves and the largest root crop mass.

**Table 4.** Indicators of the effectiveness of fungicidal treatments of sugar beet before harvesting (09.22.2020).

| Accounting indicators, measurement units | Variant                  |
|------------------------------------------|--------------------------|
|                                          | Alternative | New | Standard |
| Average number of leaves per plant, pcs: |            |    |          |
| Dead                                     | 19.0        | 12.2| 17.0     |
| Forming                                  | 7.6         | 6.6 | 8.0      |
| Developed and functioning                | 10.4        | 25.8| 13.0     |
| Average weight, gram:                    |             |    |          |
| Root crops                               | 1006        | 1274| 944      |
| Halm                                     | 174         | 266 | 156      |
| Mass ratio                               | 5.782       | 4.790| 6.051   |
| Development of bacterial spotting, %    | 39.27       | 13.27| 27.72   |
| **HCP 05**                               | **9.76**    |    |          |
| Distribution of cercosporous spotting, % | 100         | 100 | 100      |
| Development of cercosporous spotting, % | 23.15       | 4.51| 14.49    |
| **HCP 05**                               | **8.61**    |    |          |

To confirm the effectiveness of protective measures, a study of productivity indicators was carried out, the results of which are presented in Table 5.
Table 5. Indicators of productivity of fungicide treatment options during combine harvesting 09.22.2020.

| Accounting indicators, measurement units | Variant | New     | Standard |
|-----------------------------------------|---------|---------|----------|
|                                        | Alternative |        |          |
| Plant density, thousand/ha              | 102.0   | 97.0    | 103.0    |
| Sugar content of root crops, %          | 16.44   | 17.2    | 17.53    |
| Biological yield of root crops, t/ha    | 65.45   | 68.12   | 57.20    |
| Loss of sugar in molasses, %            | 2.43    | 2.23    | 2.04     |
| White sugar yield, %                    | 13.91   | 14.89   | 15.39    |
| Total collection of white sugar, t/ha   | 9.104   | 10.143  | 8.803    |
| The ratio of the mass of root crops/tops| 8.528   | 7.324   | 5.109    |

Technological parameters of beet raw materials - millimole content per 100 grams of root vegetables:

|                           |       |       |       |
|---------------------------|-------|-------|-------|
| Potassium                 | 5.52  | 4.50  | 4.89  |
| Sodium                    | 2.33  | 2.68  | 1.92  |
| Alpha-amine NITROGEN      | 4.52  | 3.36  | 3.11  |

Under conditions of continuous re-infection of leaves on an irrigated area, it was confirmed that the main pathogen that forms spots is bacteriosis, cercospora only accompanies them, ensuring their penetration into tissues, but not having time to form spots on young, and even more so on forming leaves that are in phase of active growth.

4. Conclusions

All registered effects (a decrease in leaf death, an increase in number of working leaves, a decrease in the index of the mass ratio of root crops / tops due to an increase in the mass of leaves on a plant, an improvement in technological qualities of raw beets, yield and yield of white sugar) arose due to the containment of bacteriosis in the variant with Elatus Ria – New.

The variant with a demonstrable decrease in the development of cercospora shows the effect of using solatenol in overcoming the hypothetical resistance of the pathogen to active substances from the triazole class against the background of Standard variant.

References

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