Efficiency of cultivation of oil flax varieties in the conditions of the southern Trans-Urals

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Abstract. Oilseed flax is a valuable multi-use oilseed crop. The Ural region is favorable for growing flax and has great prospects in the development of this direction. Producers of flax products need to know how profitable this crop is, and how the crop can behave when organisms or populations of the same species influence each other; what is the interaction of individuals or populations of different species, etc. To increase production and obtain high-quality flax products, it is necessary to increase the level of flax production culture through the use of science-based cultivation technologies. When creating a new variety, breeders take into account the needs of two categories of consumers - flax producers and flax processors. Some require flax varieties with high productivity (for seeds and fiber) and fiber quality, resistant to diseases and lodging, adapted to the conditions of the TRANS-Urals and Siberia. Others are varieties of flax that meet the numerous requirements of textile, construction, automotive, aviation, medical, and other industries, and are suitable for processing on modern flax processing equipment. In other words, the approach to creating a variety has now changed - it becomes targeted, for a specific order.

The formation of a developed system of the agri-food market is associated with the cultivation of various types of agricultural crops, their processing and sale. The oilseed market is the most important component and integral part of the agri-food market, forming a relatively large segment of it both in terms of capacity and the number of its participants. Oilseeds and products of their processing are of great importance both for the individual and for the entire economy of the country. This is also due to the fact that interest in oilseeds production has increased in recent years due to the high demand for oilseeds and their products on the world and Russian markets. In recent years, all over the world there has been an increase in interest in the cultivation of oil flax, the use of flax oil in food due to its medicinal properties. In the Kurgan region, flax areas increased from 2,750 hectares in 2012 to 65,586 hectares in 2019 [7].

1. Materials and methods

The research on the study of new varieties of oil flax in the adaptive phytosanitary technology of flax cultivation was carried out in 2019 by the Department of Land Management, Agriculture, Agrochemistry and Soil Science at the experimental site of the Kurgan State Agricultural Academy. The field experiments were carried out according to the methods of experimental work. The plot size was 6 m², 6-fold replication, randomized placement, the predecessor was fallow land. Mineral fertilizers were applied in spring before sowing flax. When using herbicides against weeds in experiments, the accepted recommendations were followed [13]. Varieties in the experience of
domestic breeding Severny, Uralsky, Uralsky Zheltiy, Itil, VNIIMK 620 and foreign varieties Raciol and Lirina [4]. The soil on the experimental site of the Kurgan State Agricultural Academy is represented by leached medium thick medium humus and medium loamy chernozem. The data was statistical processed by variance and correlation-regression analysis [11].

2. Efficiency of cultivation of oil flax varieties in the southern Trans-Urals

Oilseed flax is the most important agricultural crop in world agriculture. The main flax seed producing countries are Canada, India, China, Ethiopia and the United States. The increased attention of Russian agricultural producers to oil flax in recent years is associated with the economic attractiveness of culture. However, not only economic feasibility is the reason for the intensive spread of oil flax. This crop is also attractive for the biological value of its seeds as a source of high-quality vegetable oil and protein, as well as for its simple cultivation technology and a good environment improving role. All this testifies to the fact that in recent years, a favorable environment has been developing in Russia for a further increase in the production of oilseed flax [9].

The growing season of 2019 was cold in June and hot in July and August, precipitation in June fell in the amount of 83% of the norm; in July, 67% of the norm; dry winds from 13 to 17 July contributed to the partial death of flax inflorescences. Precipitation of 186% of the norm fell in August, which influenced the prolongation of the growing season of oil flax [10]. The causative agents of flax fusarium are imperfect fungi from the genus Fusarium Link. Their species composition is unstable, but flax is especially often affected by *F. oxysporum* Schl. f. *lini* Snyd. et Hans (*F. lini* Bolley) (Figure 1). *F. oxysporum f. lini* is an optional parasite. It has physiological races that are virulent. In soil on organic residues, it can develop for more than 5 years, forming conidia and chlamydospores, which infect flax plants. Thus, the primary source of fusarium infection can be represented by affected plant debris, contaminated soil and seeds [14, 15]. During the growing season, the fungus spreads through the soil and conidia with the help of the fungus.

![Figure 1- Mycelium and microconidia of *Fusarium oxysporum*](image)

The development of Fusarium by harvesting time was noted below the threshold of damage (15%) on varieties VNIIMK 620 and Raciol, as well as within the threshold on variety Severny. The highest yield was noted for the Severny variety. The decrease in yield for varieties VNIIMK 620 and Raciol is due to soil and air drought in mid-July 2019, when some of the ovaries and buds of flax died due to high temperature and heat (Table 1).
Table 1. Development and prevalence of fusarium on oil flax varieties before harvesting, experimental site of the Kurgan State Agricultural Academy, 2019

| №/n  | Variety          | Development (%) | Ka    | Dissemination (%) |
|------|------------------|-----------------|-------|-------------------|
| 1    | Severny (standard) | 17.3            | 2.54  | 44.0              |
| 2    | Uralsky          | 36.6            | 1.96  | 72.0              |
| 3    | Uralsky Zhelty   | 55.3            | 1.44  | 90.0              |
| 4    | Itil             | 29.1            | 1.97  | 50.0              |
| 5    | Lirina           | 38.0            | 2.2   | 60.0              |
| 6    | Raciol           | 9.3             | 3.0   | 28.0              |
| 7    | VNIIMK 620       | 11.3            | 3.0   | 34.0              |
| 8    | LM-98            | 6.6             | 3.0   | 31.0              |

The excess of the harmfulness threshold for the development of Fusarium was noted for varieties Itil by 1.94 times; Uralsky, 2.44 times; Lirina, 2.53 times and 3.4 times for variety Uralsky Zhelty. The high coefficient of adaptability of the varieties made it possible to avoid a decrease in seed yield. However, to make a decision about the quality of seed and the need for dressing, it is necessary to carry out a phytoexamination of the resulting culture [1, 2].

The elements of the yield structure and the biological yield of oil flax seeds are presented in Table 2.

Table 2. Elements of the yield structure and biological yield of oil flax seeds (Kurgan State Agricultural Academy, 2019)

| No. | Variety          | Number of plants (pcs/m²) | Number of bolls per plant (pcs.) | Number of seeds in a boll (pcs.) | Weight of 1000 seeds (g) | Biological seed yield (t/ha) |
|-----|------------------|---------------------------|---------------------------------|---------------------------------|--------------------------|-----------------------------|
| 1   | Severny (standard) | 652                       | 16.6                            | 5.0                             | 7.0                      | 3.79                        |
| 2   | Uralsky          | 680                       | 15.0                            | 5.4                             | 7.1                      | 3.91                        |
| 3   | Uralsky Zhelty   | 582                       | 13.8                            | 5.1                             | 6.8                      | 2.78                        |
| 4   | Itil             | 578                       | 14.9                            | 5.6                             | 5.2                      | 2.51                        |
| 5   | Lirina           | 622                       | 14.8                            | 4.6                             | 6.5                      | 2.75                        |
| 6   | Raciol           | 551                       | 12.6                            | 5.3                             | 5.2                      | 1.91                        |
| 7   | VNIIMK 620       | 633                       | 13.7                            | 4.7                             | 5.0                      | 2.04                        |
| 8   | LM-98            | 675                       | 14.3                            | 6.0                             | 5.1                      | 2.70                        |

LSD0.95 16 1.1 0.2 0.3 0.13

Reproduction conditions influenced the density of the plant stand, the number of bolls per plant, the number of seeds per capsule, and the weight of 1000 seeds. At a seeding rate of 8 million germinating grains per ha or 800 pcs./m², the survival rate of plants for harvesting differed by flax varieties in the years of the study, which influenced the yield level. As noted above, the drought events in mid-July affected the number of bolls on flax varieties. The height of flax plants varied: 42 cm for VNIIMK 620 and Uralsky; 48 cm for Raciol; 51 cm for the Severny variety; 53 cm for Itil and Lirina varieties and up to 62 cm for Uralsky Zhelty variety. Thus, the domestic variety of oil flax, Uralsky, bred by the Ural Research Institute of Agriculture, showed a high yield of 3.91 t/ha. Among the foreign varieties, the Lirina variety stood out, being inferior to the standard Severny variety in yield. VNIIMK 620 and Raciol cultivars reduced yields in response to unfavorable weather conditions in the middle of summer [5, 8].

The seed productivity of new varieties of oil flax, over the three years of study, has been noted by us at a high level (Table 3).
Among the new varieties of white-grain flax, the best seed yields according to the results of three-year research were the following varieties of oil flax: LM 98 (24.4 c/ha) and Itil (22.8 c/ha). The Raciol variety reduced the yield. Oil seeds obtained from yellow-colored flax seeds of varieties LM 98 and Itil are a source of low-pigmented vegetable oil and high-quality feed concentrate. Seeds of yellow-seed flax varieties have a thinner seed coat, due to this, the content of oil and protein increases, which determines a higher oil yield during processing and a high energy value of the meal [6, 12].

The northern variety, which occupies more than half of the area in the Kurgan region, showed a high yield level as a standard variety: 29.2 kg/ha. In 2019, high yields were shown by domestic varieties of oil flax Uralsky and Uralsky Zhelty bred by the Ural Research Institute of Agriculture. Among the foreign varieties, the Lirina variety stood out, which was inferior in yield to the standard Northern variety. VNIIMK 620 and Raciol reduced yields in response to adverse weather conditions in mid-summer.

Evaluation of economic indicators and efficiency of the cultivation of oilseed flax is one of the most important issues of interest to the heads of flax farms and especially those who are at the initial stage of production formation [5] (Table 4).

### Table 4. Economic efficiency of cultivation of promising varieties of oil flax (Kurgan State Agricultural Academy, 2019)

| Experimental variant | Yield (t/ha) | Production costs (rub) per 1 ha | Production costs (rub) per 1 c | Operating profit (rub) per 1 ha | Operating profit (rub) per 1 c | Cost payback (rub) |
|----------------------|-------------|---------------------------------|------------------------------|-------------------------------|-------------------------------|-------------------|
| Severny (standard)   | 3.79        | 10273                           | 271.1                        | 46238                         | 35965                         | 9489              |
| Uralsky              | 3.91        | 10357                           | 264.9                        | 47702                         | 37345                         | 9551              |
| Uralsky Zhelty       | 2.78        | 9566                            | 344.1                        | 33916                         | 24350                         | 8759              |
| Itil                 | 2.51        | 9377                            | 373.6                        | 30622                         | 21245                         | 8464              |
| Raciol               | 2.75        | 9545                            | 347.1                        | 33550                         | 24005                         | 8729              |
| VNIIMK 620           | 1.91        | 8950                            | 468.6                        | 23302                         | 14352                         | 7514              |
| LM-98                | 2.04        | 9048                            | 443.5                        | 24888                         | 15840                         | 7764              |

The best indicators of the economic efficiency of the yield of oil flax seeds were obtained on the varieties Severny and Uralsky. The prime cost of expenses for 1 centner was from 264.9 rubles (Uralsky variety) and up to 468.6 rubles (Raciol variety). Our calculations and analysis of the economic efficiency of promising domestic and foreign varieties of oil flax showed that the cultivation of oil flax in the conditions of the southern Trans-Urals is economically profitable for all the options under study, the cost payback was from 2.60 to 4.61 rubles.
3. Conclusion

A high yield was reached for the domestic oilseed flax variety Uralsky bred by the Ural Research Institute of Agriculture; the yield was 3.91 t/ha. Among the foreign varieties, the Lirina variety stood out, which was inferior in yield to the standard Severny variety. VNIIMK 620 and Raciol reduced yields in response to unfavorable weather conditions in the middle of summer. The best indicators of the economic efficiency of the yield of oil flax seeds were obtained on the varieties Severny and Uralsky. The prime cost of expenses for 1 centner was from 264.9 rubles (Ural variety) up to 468.6 rubles (Raciol variety). Our calculations and analysis of the economic efficiency of promising domestic and foreign varieties of oil flax showed that the cultivation of oil flax in the conditions of the southern Trans-Urals is economically profitable for all the options under study.

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