Effect of presowing treatment of seeds with Flavobacterin on development of diseases, pests and weeds in oil flax crops

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Abstract. Increase in oil flax seed production largely depends on the effectiveness of the integrated protection of crops. In this regard, in 2017 and in 2018, studies were conducted to investigate the development of diseases, pests and weeds in crops depending on seed treatment with the bacterial preparation Flavobacterin at the small experimental field of the Department of Plant Production named after I.A. Stebut. The study results showed that inoculation with the biofungicide Flavobacterin is recommended before sowing for effective control of diseases in oil flax crops and in order to obtain a stable yield of high quality seeds at the level of 2.0 t/ha. This agrotechnical technique increases biological effectiveness by 72% against white rot, 87% against verticillium wilt and by 51% against blackspot. The biological preparation does not affect the development of pests and weeds in oil flax crops. In this regard, a system of weed and pest control in oil flax cultivation in the conditions of Leningrad region should be developed.

1. Introduction

Oil flax is a valuable multipurpose industrial crop. The oil flaxseed is unique due to high content of polyunsaturated α-linolenic acid, which is found in almost all cell membranes, is essential fatty acid in the human diet, it participates in regeneration of the cardiovascular system, and growth and development of the brain [1, 2, 3].

In global agricultural production, the area under flax crops is 2.5–3.2 million hectares, and the gross harvest of seeds reaches 1.9–2.7 million tons, less than 1% of the total sowing area of vegetable crops in the world [4]. The main countries producing flax seeds are India, China, Canada, Argentina, and the USA [5].

According to the Federal State Statistics Service, in 2019, the sown area for oilseeds in the country amounted to 814.7 thousand hectares (+69.1 thousand hectares or 9.3% to the sown area of the previous season), and the gross harvest reached 651.3 thousand tons [6]. The main regions of crop cultivation are Omsk and Chelyabinsk regions, and the Altai Territory, where the average seed yield varied from 0.6 to 1.2 t/ha [7].

Oil flax, like other crops, suffers from weeds, pests and diseases. Loss of seed yield from harmful organisms can reach 30–40%. This is caused primarily by violation of crop rotation, soil cultivation systems, reduced volume of fertilizers and plant protection agents. An increase in the production of seed-bearing seed largely depends on the efficiency and integrated protection of its crops [8].

Oil flax, as an object of research, is well studied by scientists from Canada, USA, China, Czech Republic, Poland, India, Argentina, etc. [9, 10, 11, 12, 13, 14].
The strategy of modern plant protection is based on phytosanitary stabilization in agroecosystems. To achieve the target plant growing in general and flax growing in particular, the principles of integration (various methods of plant protection) and the system (measures) of phytosanitary control of the agricultural crops cultivation are employed. Phytosanitary stabilization of flax cultivation helps to achieve its basic indicators: along with the growth of crop quantity and quality, the provision of resource efficiency and environmental safety of flax cultivation technology.

The aim of the study was to evaluate agrotechnical measures for prevention of diseases and pests in oil flax crops.

The objectives of the study were to reveal and identify diseases and pests in oil flax crops, to determine the degree of harmfulness of pathogens and evaluate the productivity of the culture depending on inoculation with a biological preparation and pathogenic harmfulness.

2. Materials and methods
The study was conducted in the small experimental field of the Department of Plant Industry named after I.A. Stebuta FSBEI HE SPbGAU in 2017–2018.

The object of the field experiment was the oil flax of LM 98 variety and the biological preparation Flavobacterin.

Flavobacterin (30) is a biological preparation of the ULTRAFIT group, biofungicide, with Flavobacterium sp. strain as an active base.

The protective effect of the preparation implies the strain ability to synthesize a number of phenazine antibiotics, which suppress the growth and development of phytopathogenic fungi and bacteria. The strain produces siderophores, which bind trivalent iron and make it unavailable for soil pathogens, thereby depriving them of a food source.

Bacteria in the composition of the drug produce a highly active antibiotic flavocine with a wide spectrum of action on phytopathogenic fungi and bacteria. The preparation hinders development of root rot in the range from 3- to 20-fold, that of anthracnosis from 1.5- to 3-fold, late blight and scab from 2- to 6-fold. Flavobacterin improves mineral and water nutrition of plants, increases resistance to diseases, accelerates early production, increases the yield, and reduces the amount of nitrates.

A one-factor experiment was performed. The experimental scheme included 2 options: without inoculation (control) and the option for sanitary and preventive protection of oil flax from diseases with Flavobacterin used.

The area of the test plot was 10 m², in 4-fold repetition. The plots are arranged in a systematic two-tiered manner.

The experimental predecessors were spring grain crops, barley and wheat. The treatment included mainly plowing to a depth of 20 cm (MTZ-82+PLN – 3-35), and in spring, double treatment with a disk cultivator (MTZ-82 + BDN-160) was followed by harrowing. Flax sowing weeds were killed mechanically.

Flax sowing in 2017 and 2018 was carried out on May 19 and 20, respectively. The method used for flax sowing was narrow-row (10 cm row spacing), with a seeding rate of 8.0 mln pcs/ha in terms of sowing capacity and 1,000 seeds weight. Seeds were inoculated using the standard method [15] immediately prior to sowing.

Stripping and towing of oil flax bolls was carried out in the phase of full ripeness, in 2017 from September 24, and in 2018 from September 18.

The effectiveness of treatment with various compositions of oil flax crops against fleas was determined by the formula of All-Russian Institute of Plant Protection:

\[ E = \frac{100-V}{A} \times 100, \]

where

- \( E \) is efficiency expressed as the percentage of flea beetle population suppression relative to the control;
- \( V \) is flea beetle population in the experiment on the day of count,
- \( A \) is flea beetle population in the control on the day of count.
The prevalence of diseases (P) was calculated using the formula:

\[ P = \frac{n}{N} \times 100\% \]

where

- \( P \) is the prevalence of diseases,
- \( N \) is the total number of plants,
- \( n \) is the number of diseased plants.

Biological effectiveness is calculated using the formula:

\[ C = \frac{100(a - b)}{a} \]

where

- \( C \) is biological efficiency, %;
- \( a \) is the degree of development or the number of diseased plants in the control;
- \( b \) is the degree of development or the number of diseased plants in the treated area [16].

To diagnose pathogens on oil flax plants, two methods were used: identification of phytopathogenic fungi by external signs of the disease and microscopic technique.

To grow microorganisms and study their properties in laboratory conditions, an artificial nutrient medium for fungi (Czapek agar) was used.

To prepare Czapek agar, 1000 ml of distilled water was measured, and the ingredients of sucrose – 30.0 g, sodium nitrate – 2.0 g, monosubstituted potassium phosphate – 1.0 g, magnesium sulfate – 0.5 g, potassium chloride – 0.5 g, and ferrous sulfate – 0.01 g were added and dissolved. Next, 15 g of agar-agar was added to the flask. The medium was boiled until complete dissolution. All the procedures were performed under a disinfecting lamp operating in the laboratory to destroy various pathogens [17].

Prior to its cooling down, 1 ml of the medium was measured with a sterile pipette and transferred to a sterile Petri dish. Further, for the analysis of epiphytic microflora, 1 g of plant mass (stem) was taken, placed in a flask with 99 ml of sterile water and shaken for 5 minutes. From this flask, 1 ml of the mixture was measured with a sterile pipette, transferred to a Petri dish with agar, then the mixture was spread over the medium with a spatula. The experiment was repeated simultaneously in three Petri dishes.

The experiment used the live preparation technique. For live preparation, a drop of water was applied to a clean, dry glass slide with a calcined microbiological loop. Culture was introduced into the drop and mixed with water. The specimen is covered with a cover glass and examined under a microscope at 40x magnification (figure 1).

The live preparation technique was used twice. First, the technique was used a week after filling Petri dishes with epiphytic microflora, and then two weeks after filling.

The soil of the experimental plot is soddy-carbonate and leached; it is buried in the depths of eluvial carbonate rocks and is medium clayey. The test plot has a well-leveled relief. The profile is typical of carbonate soil. It consists of a humus-accumulated horizon with a thickness of 15 to 30 cm and carbonate rock underlying it; it is dark grey in color and boils during the reaction with surface acid. The water mode is of a washout type. The humus content was 3.3%, the soil was well saturated with bases – 87%, the soil solution acidity was pH 5.2, the mobile forms of phosphorus were very high – 392, and exchangeable potassium was high – 213 mg per kg soil you.
Figure 1. Preparing a live preparation: 1 – grasping the microbial mass with an inoculation loop; 2 – application of the investigated pathogenic culture on a cover glass (photo by A.P. Spiricheva).

In 2018, during the period from the germination phase to the oil flax herringbone, the conditions for flax flea were favorable. The hydrothermal coefficient in May was at 0.57 level, which accounted for arid conditions. The air temperature during this period was at the level of 14.7°C, which is 3.4°C higher than the norm, and the precipitation was 25.8 mm, i.e. below the average annual value by 53%.

3. Results and discussion

The results of the studies showed that during the vegetation period of oil flax in 2017 plant growth was found in the option without Flavobacterin treatment of white rot bacterium.

The causative agent of the disease is the ascomycete fungus Wetzelinia ascerotiorum (d.By.), class Euascomycetes, order Helotiales.

In spring, the sclerotia subjected to freezing sprout and form apothecia, saucer-shaped fruit bodies on cylindrical legs (Fig. 2). Depending on the magnitude of sclerotia, 1–5 apothecia can be formed on it, and on the reticulate sclerotia its number is 10–40 [18].

Sclerotia can sprout in spring and summer, which means that plants can be infected throughout the growing season.

Sclerotia not exposed to freezing sprout into the fungus, which can penetrate into the root collar and the lower part of the flax stem.

From one growing season to another, white rot can spread by means of fungi. It is resistant to drying. Its dried-out debris is easily dispersed by the wind and can cause new infection of plants, when falls with precipitations [18].

The fungus first settles on dead plant parts, and then infects living organs. During vital activity, it produces oxalic acid and pectolytic enzymes. Oxalic acid causes necrosis of plant cells and creates an acidic environment that activates pectolytic enzymes that split pectin substances of plants [18].

The disease is most intense in warm humid years. The optimum temperature for plant infesting is 15–18 °C. At average daily temperatures above 30 °C, no infection occurs [18].

In plants, the disease manifested itself as wet brown spots. By the end of the growing season, the affected stems were discolored, and white felt pruinose appeared on their surface, which was found on the surface of the roots (Figure 3). The oil flax roots were soft and wet. The flax stem in places covered with pruinose was of brownish brown color. For the harvesting time, the cortical tissue of some plants was destroyed in the lower part of the stem and root. Such plants were macerated, as they exhibited conductive bundles in the form of thin laces, and easily broke.
Figure 2. Apothecia on stipes, with bags containing maturing ascospores (photo by M.A. Nosevich).

Figure 3. Oil flax plants of LM 98 variety affected by white rot, 2017 (photo by M.A. Nosevich).

In dry weather, discolored spots were found on oil flax stems affected by white rot.

In the control, the prevalence of plant disease was 59%, and in the option with seeds inoculated with Flavobacterin before sowing, the proportion of affected plants did not exceed 17% (table 1).

Table 1. Effect of the prevalence of white rot on the yield and sowing quality of oil flax seeds, 2017.

| Version                          | Disease prevalence, % | Seed yield, tons/hectare | Weight of 1000 seeds, g | Seed purity, % |
|----------------------------------|-----------------------|--------------------------|-------------------------|---------------|
| Control (without biological preparation) | 59.1                  | 1.81                     | 5.21                    | 93            |
| Flavobacterin                    | 16.8                  | 2.65                     | 5.27                    | 97            |
| LSD0.05                          | 2.4                   | 0.11                     | 0.03                    | -             |

The disease had a significant effect on the seed yield, because in the option with Flavobacterin, a significant increase attained 0.8 t/ha, or by 32% with LSD of 0.11 t/ha.

The weight of 1000 seeds and seed purity were also significantly higher by 0.06 g when the culture was inoculated with Flavobacterin.

In 2018, in oil flax crops, plants were found damaged by verticillium wilt and alternaria in the option without Flavobacterin treatment.

The causative agents of verticillium wilt are imperfect fungi of the species Verticillium albo-atrum and Verticillium dahlia that belong to the class Hyphomycetes, order Hyphomycetales. The experiments showed was that the oil flax of LM 98 variety was affected by Verticillium dahliae.

Conidial sporulation and microsclerotia are formed on the colorless multiply branched mycelium [18].

Conidial sporulation is represented by erect conidiophores. They are shorter than those in Verticillium albo-atrum, whorled, with septa, sometimes with second branches. Their length is 80–160 µm. The whorls on the conidiophoid are arranged in a spiral, from one to three in numbers. The distance between the whorls is 30–40 µm. The whorl contains from 1 to 5 sterigma. At the base of the apical whorl, the conidiophores narrow from 3–5 µm to 2.0–2.5 µm. Conidia are formed on the whorls.
Conidia are unicellular, sometimes with one septum, mononuclear, elliptical, and colorless. Their size is 3–6×1.5–2 µm, they are formed on top of the sterigma singly often spherical-capitate.

Chlamydiospore-like cells emerge through a chain of rounded pigmented cells formed of hyphae (during sclerotia formation).

Microsclerotia (pseudosclerotia) are formed as a result of intensive division of cells of the vegetative mycelium in different directions.

Dormant stage of fungi. Moniliform, ovate-oblong, consist of clusters of thick-walled hyaline or weakly pigmented cells. Length 212–225 µm. Microclerotia are formed in dead parts of plants, regardless of the vegetation stage. They are dark brown or almost black. This dormant stage of fungi can persist in the soil for up to one year. At the appropriate humidity and temperature, microclerotia easily germinate, forming either mycelium or conidial hyphae, the conidia of which germinate to give rise to a new vegetative mycelium [18].

From the soil, the vegetative mycelium penetrates mainly through various root injuries.

A week after initiation of the experiments, a light white fluffy pruinose could be visually detected in Petri dishes. Two weeks after initiation of the experiments, imperfect fungus Verticillium dahliae was observed in Petri dishes when examining a live specimen under a microscope (figure 4).

The minimum temperature for V. dahliae development is 6 °C, the optimal temperature is 23–25 °C, and the maximum temperature is 31°C. This explains the fact that the disease development slows down in the middle of summer due to high temperatures, and increases towards the end of summer [18].

The fungus begins to develop at 20% soil moisture, 60–70% moisture is considered optimal.

The mycelium develops in a different manner in the system of water transport in the stem, mainly in the root crown. Often, fungus can spread throughout the entire vascular system of plant and penetrate into leaves [18].

The main source of disease is contaminated soil. Continuous cultivation of flax and other affected crops causes accumulation of infection in the soil. The pathogen can spread with soil particles through agricultural tools, planting material, insects, especially nematodes, and during watering [18].

Wood browning is clearly visible on oil flax plants, and browning of vessels can be observed in the form of separate dark dots on the sections of leaf petioles (figure 5).
Figure 4. *Verticillium dahliae*: 1 – Petri dish with fungal colonies, 2 weeks after the experiment initiation; 2 – *Verticillium dahliae* with microsclerotia; 3, 4 – conidiophores with conidia (photo by A.P. Spiricheva).

Figure 5. Oil flax plants of LM 98 variety affected by Verticillium wilt (photo by M.A. Nosevich).
As a result of laboratory studies, a disease was revealed in oil flax in the option without treatment with Flavobacterin – blackspot, which is caused by imperfect fungus Alternaria alternata, class Hyphomycetes, order Hyphomycetales.

Mycelium is airless or moderate aerial, dark olive-green, almost black, mostly with intense sporulation.

Conidiophores are short, dark olive, simple or branched, 15–20 µm long. Conidia form in long, often branched chains. Obclavate, oblique, ovoid or elliptical in shape. Neck short, conical or cylindrical, sometimes up to one third of the length of the conidium, not exceeding its full length. Color is pale to moderate golden brown. The surface is smooth or finely warty. Up to 8 transverse partitions, several longitudinal and oblique partitions. Size 20.0–63.0 x 9.0–18.0 µm. Neck thickness 2.0–5.0 µm.

A. alternata grows and develops in a large temperature range, the lower limit is +1 °C and the upper limit is +40 °C. Plants are infected at high relative humidity and temperatures from +5 to +35 °C. The optimum temperature is from +25 to +30 °C. The pathogen enters the plant within 12 hours. The incubation period lasts from 2 to 12 days.

Fangi overwinter as mycelium and conidia on infected post-harvest residues. They are capable of infecting healthy plants not weakened by the impact of unfavorable factors. The affected leaves that remain in the field and in the seed material are considered the source of infection.

The laboratory experiment carried out on a live specimen two weeks after filling the Petri dishes revealed a colony of imperfect fungi A. alternata (figure 6).

![Figure 6. Alternaria alternata conidia (photo by A.P. Spiricheva)](image)

The disease is most often found in older plants, but sometimes it can be observed on seedlings in the form of a velvety pruinose on leaves and stems. The pathogen enters the stem, causes tissue discoloration (to brown) and damages vascular and conducting tissues. As a result, the supply of nutrients and minerals to the seeds is ceased. They remain frail and underdeveloped. At high humidity, the seeds are covered with dark velvety mycelium.

The prevalence of diseases and the biological effectiveness of Flavobacterin are shown in table 2.
Table 2. The prevalence of diseases and the biological effectiveness of Flavobacterin in oil flax of LM 98 variety, % over the years of study.

| Version                   | White rot (P) | Verticillium wilt (P) | Blackspot (P) |
|---------------------------|---------------|-----------------------|---------------|
| Control (without biological preparation) | 59.1          | 0                     | 62.1          |
| Flavobacterin             | 16.8          | 4.8                   | 30.7          |

*Note: P – prevalence of diseases, %; C – biological efficiency, %.

Flavobacterin treated plants showed a significant decrease in the disease development over two years of study: white rot (3.5-fold), verticillium wilt (7.5-fold), and blackspot (2.0-fold). The biological effectiveness of the biological preparation against white rot ranged from 50.6 to 86.7% in 2018 and amounted to 71.6% in 2017.

Thus, the use of Flavobacterin in oil flax crops increased the effectiveness of protective measures against diseases.

In 2017, a copse snail was found in crops of LM 98 variety (figure 7), which was due to excessive moisture during crop growth.

![Figure 7. Arianta arbustorum L. in crops of oil flax of LM 98 variety, 2017 (photo by M.A. Nosevich).](image)

This snail belongs to class Gastropoda → order Stylommatophora → family Helicidae → genus Arianta → species Arianta arbustorum.

Shell size is 12–22 mm high and 18–25 mm wide. Shell is heliciform with a blunt conical or rounded conical whorls, the height of which is greater than the height of the aperture, shiny, unevenly striated; in the intervals between the transverse striae or folds, a very thin and dense spiral striation can be observed.

The color pattern varies greatly, but most individuals are light brown with dark spots and transverse stripes. There is usually a narrow brown spiral stripe over the shell periphery.

In autumn, copse snails burrow into the soil and fall into anabiosis. In mid-spring and in summer, snails feed on leaves and shoots of both forest plants and garden flowers, as well as agricultural crops.

During the first decade of this century, the snail population density in some places increased to 1,000 snails per square meter. They have spread throughout Leningrad region. Snails prefer wet habitats [19].

A copse snail is an example of rapid expansion of species invaded from sunny Portugal.

Unfortunately, no reliable method exists to guarantee plant protection against this pest. As before, one of the most effective ways is to collect snails by hand.
In our experiment, there were from 8 to 17 snails per square meter, which affected a high yield of oil flax seeds in the second year of study.

In 2018, the period from the germination to the herringbon stage of oil flax was characterized by dry conditions (the hydrothermic factor was at the level of 0.57). Air temperature in this period was 14.7 °C, which is 3.4 °C higher than the norm, and precipitation amounted to 25.8 mm, that is by 53% below the average annual precipitation. The prevailing weather conditions were favorable for the development of crucifer flea beetles.

Crucifer flea beetles belong to kingdom Animalia → type Arthropoda → class Insecta → order Coleoptera → family Chrysomelidae → subfamily Galerucinae → genus Phyllotreta → species Phyllotreta cruciferae. Crucifer flea beetles are small jumping beetles with thickened thighs of the hind legs and eleven-segmented antennae.

Imago are small beetles with a body length of 2–4 mm. Similar to all representatives of the family Chrysomelidae, their body is short, the upper side is mostly hairless. Antennae are usually no longer than half the body. Legs are jumping, like those in many other flea beetles. The color pattern indicates the species. Eggs are light, small, oval or elongated. Larvae are very small. The body is thin, yellowish, with three pairs of legs. The pupa is yellow, open or in a cocoon [20].

A large number of crucifer flea species exist in nature, but in our experiment, black flea beetles were noted on oil flax crops.

Black flea beetle (Phyllotreta atra) are of black or black with metallic green color. Head with coarse punctures, elytra with punctures arranged in regular rows. Body length is 1.8–3.0 mm.

Beetles overwinter in the soil. In spring, before the seedlings emerge in the fields, black flea beetles eat wild crucifer species, including wild turnip, white mustard, wild radish and other weeds. When seedlings emerge, beetles move to the fields. Feed on hot days [20].

Warm and dry weather increases the damage to flax plants by crucifer flea beetles. Flea beetles are most active and glutinous on sunny days, from 10 am to 1 pm and then from 4 pm to 5–6 pm.

The imago gnaws out small through holes on cotyledonous and true leaves, often damage the growing point. The harmfulness of flea beetles increases strongly in conditions of spring–summer drought. A numerous population of flea beetles in the fields causes mass death of seedlings, especially of late flax crops.

During crop growth, treatment is carried out in dry and hot weather when the number of flea beetles is above the economic threshold of harmfulness, that is 10 beetles per 1 square meter. In our experiment, there were more than 20 flea beetles, therefore, on May 29, we carried out treatment with Karate KE insecticide at a rate of 0.15 l/ha.

This insecticide of contact action belongs to the class of pyrethroids and is highly effective in pest control.

The prevailing weather conditions contributed to the development of flax flea beetles and increased their amount. In this regard, it was necessary to carry out two more treatments with a 1-week interval.

We calculated the efficiency of treatment against crucifer flea beetles with Karate KE insecticide: after the first treatment it was E = 82.8%, after the second – 85.7, and after the third – 86.7%.

Despite the protective measures against pests in flax crops, characteristic morphological changes in the culture were observed in the form of damage to the growing point, and this factor did not depend on treatment of seeds with a bacterial preparation before sowing (figure 8).

In laboratory experiments, a morphological analysis of damaged and intact flax plants is presented in table 3. In laboratory experiments, a morphological analysis of damaged and intact flax plants was performed and data obtained are presented in table 3.
Figure 8. Morphological changes in oil flax depending on damage by crucifer flea beetles: 1 – intact growing point of oil flax of LM 98 variety; 2 – damaged growing point (photo by M.A. Nosevich).

The analysis of oil flax plants showed that intact plants had 73 bolls per plant, which is 7 bolls or 10% more compared to damaged plants.

A similar pattern was observed in the number of seeds, but the difference was significantly higher and amounted to 26% (624 versus 464 pcs/plant).

The weight of seeds per plant and the weight of 1,000 seeds in intact flax plants were also higher by 32 and 7%, respectively.

Table 3. Morphological analysis of flax stem depending on damage by crucifer black flea beetles, 2018.

| Plants  | Number of stems, pcs. | Number of bolls, pcs. | Number of seeds, pcs. | Seed weight per plant, g | Weight of 1000 seeds, g |
|---------|-----------------------|-----------------------|-----------------------|--------------------------|-------------------------|
|         | Main | Lateral | Main | Lateral | Main | Lateral | Main | Lateral | Main | Lateral |
| Intact  | 1    | 2       | 25   | 48      | 210  | 414     | 1.27 | 2.44     | 6.15 | 5.88    |
| Damaged | -    | 2       | 66   | -       | 464  | -       | 2.51 | -        | 5.62 |         |

Damage to the growing point of oil flax plants can decrease the yield of crop seeds to 32–34% or more.

Thus, the use of Flavobacterin did not affect the development of pests in oil flax crops, which was primarily dependent on meteorological conditions during crop growth.

In crops of LM 98 variety, a great number of weed species were observed, but the most harmful weed, in our opinion, was field bindweed (figure 9).

Field bindweed (Convolvulus arvensis L.) belongs to division Magnoliophyta, or Angiospermae, class Dicotylédones, order Solanaceae, family Convolvulaceae.
Field bindweed is a perennial plant with a creeping and twisting stem. In our observations, the length of the stem varied from 37 to 72 cm. Leaves are petiolate, smooth-edged, oblong-ovate with a cordate-scaphiform base. Flowers are funneled, pink-white.

In our experiment, field bindweed did not have a significant effect on seed productivity, since seeds were harvested manually. However, it should be noted that in production crops this weed significantly reduces the quality of harvesting and increases the cost of drying seeds, since the green mass of bindweed increases the moisture content of the seed heap. In this regard, it is necessary to develop a system of weed control in oil flax cultivation.

4. Conclusion
1. During the cultivation of oil flax of LM 98 variety for seed purposes, the following diseases were identified: white rot (disease prevalence 59%), verticillium wilt (disease prevalence 36%) and blackspot (disease prevalence 62%); and pests: copse snails and crucifer flea beetles.
2. Presowing treatment of flax seeds of LM 98 variety with Flavobacterin showed high biological effectiveness against white rot (72%), verticillium wilt (86.7%), and blackspot (50.6%).
3. The use of a biological preparation did not affect the development of pests and weeds, which primarily depended on meteorological conditions during crop growth.
4. For effective control of diseases in oil flax crops and a stable yield of high quality seeds at the level of 2.0 tons/ha, it is recommended to carry out presowing inoculation with the ULTRAFIT biofungicide.

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