

The effect of presowing treatment of seeds of winter rapeseed (*Brassica napus* L.) and winter brown mustard (*Brassica juncea* L.) with modern fungicides on their sowing qualities and biometric characteristics of seedlings

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Abstract. The aim of the research was to study the effect of chemical and biological fungicidal disinfectants on the sowing qualities of seeds, the length of stem and root of seedlings of winter rapeseed (*Brassica napus* L.) and winter mustard (*Brassica juncea* L.). We carried out the research in 2018-2020 in the laboratory conditions on the seeds of rapeseed cultivar Sarmat and mustard cultivar Dzhuna. We tested the following fungicidal disinfectants: chemical – a contact preparation with the active ingredient thiram 400 g/l (standard); systemic preparation with the active ingredient fludioxonil 25 g/l; complex biological contacts consisting of fungi of the genus *Trichoderma Pers.* and of bacteria of the genus *Pseudomonas Migula*: biopreparation 1 (1 g/l+2x10⁸ CFU/ml); biopreparation 2 (2 g/l+2x10⁸ CFU/ml). All studied disinfectants suppress seed infections on rapeseed and mustard. They do not have negative effect on the stem length of rapeseed seedlings, but in the variant with thiram, the number of seedlings with a short root increases by 13 % compared to the control. When rapeseed seeds are treated with Fludioxonil and biopreparations, the number of seedlings with a root length of 56-70 mm increases, which contributes to better rooting and optimal overwintering of plants. When seeds of winter mustard are treated with thiram, the number of seedlings with a very short root (up to 25 mm) increases. Fludioxonil and biopreparation 1 contribute to an increase in the number of seedlings with a root length of 41-55 mm, which favorably affects the development of the plant's root system and contributes to an increase in winter hardiness.

1 Introduction

Winter rapeseed (*Brassica napus* L.) and winter brown mustard (*Brassica juncea* L.) are oil crops of the Brassicaceae family with high potential yield. High quality oil is obtained from

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seeds, which is used for purposes and as biofuel. Rapeseed and mustard meals are a source of high-protein feed for farm animals [1-3]. Mustard seeds and cake are also widely used for medical purposes and as a seasoning [4].

During the entire growth season, rapeseed and mustard plants, as well as other oil crops, for example, sunflower, soybean, black mustard, false flax, are affected by various diseases: fusarium, verticillium wilt, Alternaria blight and others [5-9]. The infestation of seeds with pathogens can lead to a rapid decrease in their sowing qualities, in the first place, germination. Seed germination is one of the most important factors through which rapeseed and mustard demonstrate their yield potential.

The results of research carried out on different oil crops show that an effective way of disinfecting seeds from infection and obtaining healthy seedlings is the presowing treatment of seeds with fungicidal disinfectants [5-7, 10-12]. In modern agricultural production, disinfectants of different kinds are used: chemical and biological, which are characterized by different mechanisms of action and allow preserving the potential of plant productivity. But in the process of initial growth and development, plants react differently to the action of preparations up to the loss of viability, or subsequent lessen ability of adaptation to environmental conditions. There was no data on the reaction of germinating seeds to the action of disinfectants in the available literature.

The aim of the research was to study the effect of chemical and biological fungicidal disinfectants on the sowing qualities of seeds, the length of the stem and root of seedlings of winter rapeseed and winter brown mustard.

2 Materials and methods

We carried out the research in 2018-2020 in the laboratory conditions at V.S. Pustovoit All-Russian research Institute of Oil Crops. The objects of study were seeds of winter rapeseed variety Sarmat, seeds of winter mustard variety Dzhuna, and fungicidal disinfectants of various kinds:

1. chemical: contact preparation with active ingredient thiram, WSC 400 g/l (standard) with the application rate of 5.0 l/t; systemic preparation with active ingredient fludioxonil, SC 25 g/l with the application rate of 4.0 l/t;
2. complex biological contact (preparation form of LC), which include fungi of the genus *Trichoderma* Pers. (concentration of 1-2 g/l) and bacteria of the genus *Pseudomonas* Migula (concentration of $2-3 \times 10^8$ CFU/ml): biopreparation 1 (1 g/l + 2×10^8 CFU/ml) with the application rate of 5.0 l/t; biopreparation 2 (2 g/l + 3×10^8 CFU/ml) with the application rate of 3.0 l/t.

The experiment scheme also included a variant with seeds of rapeseed and mustard without treatment with disinfectants – control (without treatment – w/t).

We treated the seeds of rapeseed and mustard with fungicidal disinfectants at the rate of 15 liters of working fluid per ton of seeds. We germinated the treated seeds and seeds of control variant (w/t) in a moist chamber of Petri dishes at an air temperature of 20 °C. We recorded the laboratory germination of seeds and measured the length of stem and root of mustard seedlings on the 6th day of germination. We recorded the laboratory germination of seeds and measured the length of stem and root of rapeseed seedlings on the 7th day of germination. We grouped the data on biometric characteristics of seedlings into classes and determined the most common (modal) class.

We identified the pathogens in the laboratory conditions using a Motic VA300 microscope, at 40x magnification.

3 Research results

As a result of research, we found that all tested fungicides did not have a negative effect on the laboratory germination of seeds of winter rapeseed, it was 96-100 % by variants. We observed the highest germination rate in the variant with fludioxonil (100 %).

Phytoexamination of rapeseed seeds showed that all disinfectants suppressed seed infection completely. Fungi of the genera *Alternaria* Nees., *Fusarium* Link. were identified in the rapeseed seeds of the control variant. The number of rapeseed seeds affected by these pathogens was 11 % (Table 1).

Table 1. The effect of fungicidal disinfectants on the laboratory germination and pathogen infestation of seeds of winter rapeseed

Variant	Application rate of preparation, l/t	Laboratory germination, %	Number of seeds affected by pathogens*, %
Control (w/t)	-	97	11
Thiram, WSC (standard)	5.0	96	0
Fludioxonil, SC	4.0	100	0
Biopreparation 1, LC	5.0	99	0
Biopreparation 2, LC	3.0	96	0

* - the pathogens noted on the seed coat of both germinated and non-germinated seeds

All tested fungicides did not have a negative effect on the laboratory germination of seeds of winter mustard, it was 97-99 %.

Phytoexamination of seeds of winter mustard showed that all disinfectants suppressed seed infection completely. Fungi of the genus *Alternaria* Nees. were identified in the mustard seeds of the control variant. The number of affected mustard seeds was 8 % (Table 2).

Table 2. The effect of fungicidal disinfectants on the laboratory germination and pathogen infestation of seeds of winter mustard

Variant	Application rate of preparation, l/t	Laboratory germination, %	Number of seeds affected by pathogens*, %
Control (w/t)	-	99	8
Thiram, WSC (standard)	5.0	97	0
Fludioxonil, SC	4.0	98	0
Biopreparation 1, LC	5.0	97	0
Biopreparation 2, LC	3.0	99	0

* - the pathogens noted on the seed coat of both germinated and non-germinated seeds

During the measurement of the biometric characteristics of rapeseed and mustard seedlings, we found that within each variant, including the control, the length of their stem and root varies significantly, therefore, we grouped all data in the variants into classes and determined a modal class.

The minimum stem length of rapeseed seedlings in the experiment was 10 mm, the maximum – 48 mm, we grouped all data into classes: “up to 20”, “21-30”, “31-40”, “41 and more” mm. In all variants, including the control, the class “21-30 mm” was modal (in 44-58 % of seedlings of the total number). The average length of the seedling stem was at the same level in all variants – 25-29 mm (Table 3).

Therefore, both chemical and biological disinfectants did not have a negative effect on the stem length of winter rapeseed seedlings.

Table 3. The effect of fungicidal disinfectants on the stem length of winter rapeseed seedlings

Variant	Application rate of preparation, l/t	Number of seedlings, % with stem length, mm				Average stem length, mm
		up to 20	21-30	31-40	41 and more	
Control (w/t)	-	12	58	28	2	27
Thiram, WSC (standard)	5.0	17	44	22	5	25
Fludioxonil, SC	4.0	19	44	32	5	29
Biopreparation 1, LC	5.0	22	56	22	0	27
Biopreparation 2, LC	3.0	15	54	30	1	28

As a result of measurements of the root length of rapeseed seedlings, we found that the minimum root length in the experiment was 20 mm, the maximum – 80 mm. We grouped all data into classes: “up to 25”, “26-40”, “41-55”, “56-70”, “71 and more” mm. We noted that in the control, the seedlings with a root length of 26-40 mm and 41-55 mm were the most common (35 and 37 % of the total number of seedlings). In the variant with thiram, most of the seedlings (48 %) had a root length of 26-40 mm, and the number of seedlings with a root length of up to 25 mm exceeded the control by almost 3 times. In other variant, the class of “56-70 mm” was modal (40-47 % of seedling of the total number). The average root length of rapeseed seedlings in the variant with thiram was 8 mm less than in the control, in other variants it exceeded the control by 10-13 mm, reaching 54-57 mm (Table 4).

This means that in case of treatment of winter rapeseed seeds with thiram, the number of seedlings with a root length of up to 25 mm increases, i.e. there is an inhibition of growth of the seedling root. This can negatively affect the normal development of winter rapeseed plants. In case of treatment of rapeseed seeds with fludioxonil and biopreparations 1 and 2, the number of seedlings with a root length of 56-70 mm increases, which contributes to better rooting and successful overwintering of plants.

Table 4. The effect of fungicidal disinfectants on the root length of winter rapeseed seedlings

Variant	Application rate of preparation, l/t	Number of seedlings, % with root length, mm					Average root length, mm
		up to 25	26-40	41-55	56-70	71 and more	
Control (w/t)	-	7	35	37	21	8	44
Thiram, WSC (standard)	5.0	20	48	14	18	0	36
Fludioxonil, SC	4.0	0	17	26	47	10	57
Biopreparation 1, LC	5.0	2	17	36	40	5	54
Biopreparation 2, LC	3.0	0	18	29	46	7	55

The measurements of biometric characteristics of winter brown mustard seedlings of all variants showed that they differ significantly from winter rapeseed seedlings. The minimum length of the stem of mustard seedlings in the experiment was 10 mm, the maximum – 26 mm, therefore, we grouped the data into classes: “up to 13”, “14-20”, “21-26” mm. In all variants of preparations, except for thiram, 58-73 % of seedlings had the stem length of 14-20 mm, as in the control. In the variant with thiram, the class “up to 33 mm” was modal (57 % of mustard seedlings of the total number). The average stem length of mustard seedlings

in all variant (except for thiram) was 16-19 mm, and in case of thiram it was significantly less – 12 mm (Table 5).

Thus, the treatment of mustard seeds with thiram leads to an increase in the number of seedlings with a very short stem. Most likely, such plants will develop more slowly and will not have time to develop a leaf rosette of the necessary characteristics for a safe overwintering.

Table 5. The effect of fungicidal disinfectants on the stem length of winter mustard seedlings

Variant	Application rate of preparation, l/t	Number of seedlings, % with stem length, mm			Average stem length, mm
		up to 13	14-20	21-26	
Control (w/t)	-	22	63	15	17
Thiram, WSC (standard)	5,0	57	33	10	12
Fludioxonil, SC	4,0	3	73	24	19
Biopreparation 1, LC	5,0	30	58	12	16
Biopreparation 2, LC	3,0	22	68	10	16

As a result of measurements of the root length of winter mustard seedlings, we found that the minimum root length in the experiment was 18 mm, the maximum – 65 mm, we grouped the data into classes: “up to 25”, “26-40”, “41-55”, “56 and more” mm. In the control and in the variant with biopreparation 2, the modal class was “26-40 mm” (in 66 and 61 % of seedlings of the total number of seedlings). In the variants with fludioxonil and biopreparation 1, the root length of most seedlings was 41-55 mm (61 and 62 % of seedlings). In the variant with thiram, 57 % of seedlings had a root length of up to 13 mm, which exceeds the control by 4.4 times. The average root length of mustard seedlings in all variants, except for thiram, exceeds the control by 6-15 mm. In the variant with thiram, it is significantly less than the control (by 7 mm) (Table 6).

Table 6. The effect of fungicidal disinfectants on the root length of winter mustard seedlings

Variant	Application rate of preparation, l/t	Number of seedlings, % with root length, mm				Average root length, mm
		up to 25	26-40	41-55	56 and more	
Control (w/t)	-	13	66	21	0	35
Thiram, WSC (standard)	5.0	57	30	13	0	28
Fludioxonil, SC	4.0	0	13	61	26	50
Biopreparation 1, LC	5.0	0	32	62	6	45
Biopreparation 2, LC	3.0	1	61	36	2	41

Therefore, in case of treatment of winter mustard seeds with thiram, the number of seedlings with a short root (up to 25 mm) increases, which may lead to the unbalanced development and rooting of winter mustard plants. In case of treatment of mustard seeds with fludioxonil and biopreparation 1, the number of seedlings with a root length of 41-55 mm increases, which contributes to better rooting and successful overwintering of plants.

4 Conclusions

The chemical fungicide with the active ingredient fludioxonil does not have negative effect on the development of seedlings of winter rapeseed and winter brown mustard, contributing to an increase in the number of roots with a greater length than in the control. A fungicide

with this active ingredient can be effectively used in the presowing treatment of rapeseed and mustard seeds.

The chemical fungicide with the active ingredient thiram has an inhibitory action on the development of the root of seedlings of winter rapeseed and winter mustard due to the toxic effect of the products of its decomposition on plant cells. Therefore, the use of a thiram preparation for treating seeds of these crops is not advisable.

The biological preparations containing fungi of the genus *Trichoderma* Pers. and bacteria of the genus *Pseudomonas* Migula do not have a negative effect on the biometric characteristics of seedlings of winter rapeseed and winter brown mustard. Moreover, biopreparation 1 contributes to an increase in the number of seedlings of winter mustard with a longer root than in the control, which enables its usage for disinfection of rapeseed and mustard seeds as an alternative to chemical fungicides.

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