

Effect of Fusarium blight, Phoma rot, and Sclerotinia blight on rapeseed and mustard plant productivity

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Abstract. The article presents the research data on the effect of Fusarium blight, Phoma rot, and Sclerotinia blight on the plant productivity of winter and spring rapeseed, brown mustard, and white mustard. As a result of studies, we found that Fusarium blight (the pathogens are fungi of the genus *Fusarium* Link) was the most harmful for the spring rapeseed, brown and white mustard – affection by it significantly decreased plant productivity. At 4 points of affection degree of plants, the harmfulness of the disease reached 71.2, 82.4, and 87.2 %, respectively. On winter rapeseed and mustard, plant productivity was considerably decreased by affection by Phoma rot in the form of a stem cancer (the pathogen is a fungus *Leptosphaeria maculans* (Desm.) Ces. et. De Not) and the stem form of Sclerotinia blight (the pathogen is a fungus *Sclerotinia sclerotiorum* (Lib.) De Bary.). The harmfulness of these diseases at 4 points of affection degree of plants reached 56.7 % and 66.7 % on rapeseed, and 56.6 % and 70.7 % on mustard, respectively.

1 Introduction

Spring and winter forms of rapeseed (*Brassica napus* L.), brown mustard (*Brassica juncea* L.), and white mustard (*Sinapis alba* L.) are grown throughout the world to produce from high-quality edible and industrial oils and high-protein meal from their seeds [1-4].

Plant infestation during the growing season by a complex of different diseases is a problem for these crops in all countries of cultivation. The species composition of pathogens and the harmfulness of diseases on rapeseed and mustard may differ depending on the agroecological area of cultivation. However, some diseases significantly reduce the quality and quantity of yield in all crop regions. These diseases include Fusarium blight in the form of tracheomycosis wilt, Phoma rot in the form of a stem cancer, and stem form of Sclerotinia blight.

The pathogens of Fusarium blight penetrate through the root system into the stems, where the mycelium develops and blocks the conducting vessels causing plants to dry out prematurely, sometimes without forming the seeds [5, 6].

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The stem cancer form of Phoma rot on rapeseed and mustard plants leads to deep ulcers (necroses) of varying diameters on a stem. The stem tissues in this area as well as above and below the necroses become rotted, the stem breaks at this point and the plant becomes lodged. And even if the seeds are formed, they will fall out of the pods or rot inside them [7, 8].

When the infectious matter of Sclerotinia blight gets on rapeseed and mustard plants, the stem surface becomes ulcerated, the ulceration rapidly increases in depth and width, the whole affected tissue eventually becomes discolored and fiberized, the stems break in the affected areas, and the seeds ripen prematurely and fall out. Sclerotia are formed on the surface and inside the affected discolored stem in large numbers [9, 10].

The purpose of the research was to determine the harmfulness of Fusarium blight on spring rapeseed, brown and white mustard, as well as Phoma rot and Sclerotinia blight on winter rapeseed and mustard in the Krasnodar region.

2 Materials and methods

We conducted the research in 2018-2021 at V.S. Pustovoit All-Russian Research Institute of Oil Crops under field conditions on spring rapeseed variety Tavriion, spring brown mustard variety Nika, white mustard variety Ruslana and winter rapeseeds variety Sarmat, winter mustard variety Dzhuna. The pathogens of Fusarium blight, Phoma rot, and Sclerotinia blight were the research objects. We used visual scales determining the degree of plant affection during the recording: from 0 to 4 points (from minimum to maximum development of the disease on a plant). The stem form of these diseases was taken into account. At the yellow-green pod stage of each crop, we labelled 15 plants affected by the same disease to varying degrees. After maturation, we made a selection of these plants (3 plants for each affection point). The plants were manually threshed, we took into account the seed yield per plant, the number of pods per plant, we calculated the average seed weight per pod of each plant and then the average seed weight of three plants of each point.

We calculated the seed yield losses (disease harmfulness) by the following formula (1):

$$B = \frac{(mh - ma)}{mh} 100 \% \quad (1)$$

where mh – is the average seed weight per pod of a healthy plant, g;

ma – is the average seed weight per pod of an affected plant, g.

We calculated the harmfulness for each affection point of disease and subdivided it into:

- low harmfulness – up to 15.0 %,
- medium harmfulness – 15.1-30.0 %,
- high harmfulness – above 30.0 %.

We identified the isolated pathogens under laboratory conditions by microscopic examination using a Motic BA300 microscope, at 400x magnification.

3 Results

Weather conditions during the growing season of spring and winter rapeseed and mustard in the research years had a favorable effect on development of many pathogenic fungi: the average daily air temperature from May to July exceeded the average annual temperatures by 0.5-4.0 °C, the amount of precipitation for this period was 40-110 mm, the average relative air humidity during the whole growing season of crops exceeded 58 %.

The annual survey of the phytosanitary state of sowings of spring rapeseed, brown and white mustard revealed the following diseases with prevalence exceeding 10.0 %:

- Peronosporosis, or downy mildew (the pathogen is *Hyaloperonospora brassicae* Gäum. Göker, Voglmayr, Riethm., Weiss & Oberw.);

- powdery mildew (the pathogen is *Erysiphe communis* Grev. f. *brassicae* Hammar L.);
- Fusarium blight in the form of tracheomycosis wilt (the pathogens are fungi of the genus *Fusarium* Link);
- Alternaria blight (the pathogens are fungi of the genus *Alternaria* Nees).

Phytopathological evaluation of sowings of winter rapeseed and mustard revealed that the plant were affected by the following diseases:

- Peronosporosis, or downy mildew (the pathogen is *Hyaloperonospora brassicae* Gäum. Göker, Voglmayr, Riethm., Weiss & Oberw.);
- powdery mildew (the pathogen is *Erysiphe communis* Grev. f. *brassicae* Hammar L.);
- Alternaria blight (the pathogens are fungi of the genus *Alternaria* Nees);
- Phoma rot in the form of a stem cancer (the pathogen is *Leptosphaeria maculans* (Desm.) Ces. et. De Not);
- Sclerotinia blight, or white rot, in the stem form (the pathogen is *Sclerotinia sclerotiorum* (Lib.) De Bary).

Observations showed that necroses of varying sizes caused by *H. brassicae* were present only on the lower and middle leaves without spreading to the stem of plants in all studied crops. The mycelium of *E. communis* covered all plants as a white cobweb but it did not penetrate the tissues of their organs. Infectious matter of fungi of the genus *Alternaria* Nees was isolated in all studied crops only from the pod membranes. In addition, we observed single plants of rapeseed (spring and winter) and winter mustard affected by phytoplasma (the pathogens are phytoplasmas *Aster yellows*).

Thus, the infestation of plants of these crops with peronosporosis, powdery mildew, Alternaria blight and phytoplasma in the research years at the experimental plots did not lead to a decrease in the quality and quantitative indicators of seed yield.

Fusarium blight was the most harmful on spring rapeseed, brown and white mustard; Phoma rot in the form of a stem cancer and the stem form of Sclerotinia blight were the most harmful on winter rapeseed and brown mustard.

In the result of research, we established that infestation of plants by Fusarium blight caused, on average, a considerable decrease in productivity of spring crops: spring rapeseed – by 46.8 %, white and brown mustard – by 54.7-54.8 %. The harmfulness of Fusarium blight on rapeseed ranged from low (12.6 %) when plants had 1 point of affection degree to high (43.2-71.2 %) when plants had 2-4 points of affection degree. The infestation of brown and white mustard plants by affection degree of 1 point led to a decrease in their productivity by 16.6-22.7 % (medium harmfulness), the affection degree of 2-4 points led to a considerable decrease in productivity: 50.1-82.4 % on brown mustard and 44.8-87.2 % on white mustard (Table 1).

Table 1. Harmfulness of Fusarium blight on spring rapeseed and mustard, 2018-2021.

Crop	Disease harmfulness, % by affection points				
	1 point	2 points	3 points	4 points	average
Spring rapeseed	12.6	43.2	60.4	71.2	46.8
Brown mustard	16.6	50.1	70.1	82.4	54.8
White mustard	22.7	44.8	64.1	87.2	54.7

We noted that diseases infestation of winter rapeseed and brown mustard resulted in fewer yield losses compared to spring crops. The affection of winter rapeseed and mustard plants by Phoma rot decreased their productivity by an average of 36.1-37.1 %. The least harmfulness of the disease on both crops was observed when the degree of plant affection

was 1 point, i.e. 13.2-14.1 %. We noted the differences at 2 points of plant affection degree: the harmfulness was moderately high (26.5 %) on rapeseed and high (32.5 %) on mustard. The infestation of rapeseed and mustard plants with 3-4 points of affection degree resulted in a considerable yield decrease (by 48.1-56.7 % and 45.1-56.6 %, respectively) (Table 2).

Table 2. Harmfulness of Phoma rot on winter rapeseed and mustard, 2018-2021.

Crop	Disease harmfulness, % by affection points				
	1 point	2 points	3 points	4 points	average
Winter rapeseed	13.2	26.5	48.1	56.7	36.1
Winter mustard	14.1	32.5	45.1	56.6	37.1

The harmfulness of Sclerotinia blight on winter rapeseed and mustard also depended on the degree of plant affection, increasing from low at 1 point (9.7 % and 14.8 %, respectively) to high at 4 points of affection (66.7 and 70.7 %, respectively). On average, rapeseed yield losses due to the disease were lower compared to mustard – 35.3 and 43.9 %, respectively (Table 3).

Table 3. Harmfulness of Sclerotinia blight on winter rapeseed and mustard, 2018-2021.

Crop	Disease harmfulness, % by affection points				
	1 point	2 points	3 points	4 points	average
Winter rapeseed	9.7	26.5	38.3	66.7	35.3
Winter mustard	14.8	34.7	55.4	70.7	43.9

4 Discussion

Visual evaluation of sowings of spring rapeseed, brown and white mustard and winter rapeseed and brown mustard in the research years showed that plants were affected by harmful diseases: Fusarium blight, Phoma rot, and Sclerotinia blight with varying degrees, from 0 (a healthy plant) to 4 (a completely infected plant) points. We observed the biggest decrease in plant productivity of all the studied crops at the affection degree of 4 points. Nevertheless, the harmfulness of Fusarium blight on spring rapeseed, brown and white mustard, Sclerotinia blight and Phoma rot on winter mustard at the plant affection of 2 and 3 points was also high, which indicates a significant negative impact of these diseases on plant productivity of the studied crops in the conditions of the central area of the Krasnodar region.

5 Conclusion

Under the conditions of the central area of the Krasnodar region, the disease affection of winter rapeseed and mustard resulted in a smaller decrease in plant productivity compared with spring crops.

The Fusarium blight affection significantly decreased the plant productivity on spring rapeseed, brown and white mustard. The maximum harmfulness of the disease reached 71.2, 82.4, and 87.2 %, respectively, and the plant affection degree was 4 points.

The plant productivity of winter rapeseed and brown mustard significantly decreased after infestation with Phoma rot in the form of a stem cancer and a stem form of Sclerotinia blight, reaching 56.7 and 66.7 %, respectively, on rapeseed, and 56.6 and 70.7 % on mustard.

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