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COMMON DISEASES OF SNAP BEAN (*PHASEOLUS VULGARIS* L.) FOR BIOLOGICAL PRODUCTION

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Abstract

The main diseases of snap bean (*Phaseolus vulgaris L.)* for organic production and the possibilities for control have been studied. The strategic directions of the experimental work included: monitoring of diseases; study of pathogens' variability; the field resistance of the Bulgarian bean varieties "Evros" and "Tangra" to the diseases in organic farming; optimization of the phytosanitary state of the crop through the authorized plant protection products. It has been established that seed-borne diseases are of predominant importance for organically grown garden beans. These are bacterial blight *Xantomonas axanopodis* pv. *phaseoli*, halo blight *Pseudomonas syringae* pv. *phaseolicola* and anthracnose *Colletotrichum lindemuthianum*. The screening of Bulgarian bean varieties for disease resistance showed that the "Evros" variety is relatively resistant to bacterial blight and anthracnose, which makes it suitable for growing by biological technologies. The development of bacterial blight and anthracnose after five treatments with the fungicide Bordeaux Mix 20VP (Bordeaux mixture 200 g/kg Cu +) with an interval of 10-14 days, starting from the flowering phase, is in the range up to 12.5%.

Keywords: organic farming, *Phaseolus vulgaris,* diseases, field resistance, fungicides.

INTRODUCTION

The development of diseases is one of the main reasons for reduced yields of snap bean. Snap bean are attacked by a large number of fungal, bacterial, viral diseases and a number of pests, but depending on soil, climatic and production conditions, not all are of economic importance. The most economically important for our country diseases of snap bean are common bean mosaic virus (BCMV), yellow bean mosaic virus - Bean yellow mosaic virus (BYMV), cucumber mosaic - Cucumber mosaic virus (CMV); bacterial blight - *Xantomonas campestris* pv. *phaseoli* (Smith), halo blight - *Pseudomonas syringae* pv. *phaseolicola* (Burkhoider) Dowson., anthracnose - *Colletotrichum lindemuthianum*, rust - *Uromyces appendiculatus* and root rot, caused by *Fusarium solanum* sp. *phaseoli* (Burkholder) (Sofkova et al., 2014). In the areas with irrigated agriculture, the causes of bacterial blight - *Xanthomonas axanopodis* pv. *phaseoli* (Xap) (Vauterin et al., 2000) and the halo blight of *Pseudomonas savastanoi* pv. *phaseolicola* (Psp) (González et al., 2004; Petrenkova et al., 2009). According to literature data, inheritance of resistance to Xap is horizontal (Kiryakov, 1999). Regarding the cause of halo *Pseudomonas savastanoi pv. phaseolicola* is known to have been found a resistance oligogen Prg., and among the crosses of tolerant and resistant bean varieties a recessive ppt gene has been identified controlling tolerance to races 1 and 2 of the *Pseudomonas savastanoi pv. phaseolicola*. Resistance to anthracnose *Colletotrichum lindemuthianum* Saccardo et Magnus is a monogenic dominant trait that is controlled by the Are gene, responsible for resistance to 6 of

the 8 known races of the pathogen. In Bulgaria, 7 races of the pathogen have been identified, of which race 8 is the most common (Kiryakov, 2000; Kiryakov and Genchev, 2004), and the Bulgarian varieties of field beans Danube 1, Biser and Trudovets (Kiryakov and Genchev, 2002) are resistant to it.). Growing beans as a monoculture leads to the accumulation in the soil of the pathogen *Fusarium solani* f. sp. *faseoli* (Burkholder), causing dry *Fusarium* rot. Two dominant genes, Fop1 and Fop2, have been found to determine the resistance of beans to the Brazilian and American races of the pathogen (Kling, 2010). Rust *Uromyces appendiculatus* (Strauss) on beans has limited economic importance for Bulgaria due to its later manifestation. The fungus is characterized by significant pathogenic diversity, with 7 races found in the country (Kiryakov and Genchev, 2003). The varieties "Halo", "Tarnovo"13, "Abritus", "Prelom", "Dunav 1" and others are resistant to the races widespread in Bulgaria (Kiryakov & Genchev, 2004). In recent decades, the practice adopted so far for chemical plant protection has been replaced by a biological direction for growing vegetables. In plant protection technologies, the importance of the biological method for disease control is growing, which is a set of measures aimed at maintaining optimal conditions for development and increasing plant immunity through the use of ecological methods and tools: sustainable varieties, biopreparations, growth regulators and biofertilizers (Akhter et al., 2015; Latorre & Jones, 1979; Pakhnenko, 2001). Growing of vegetable crops by biological technology is characterized by low stability of the phytosanitary condition of the crops, accompanied by the mass multiplication of diseases, due to the limited set of possible authorized means for their control (Gent & Schwartz, 2005; van Bruggen & Semenov, 2000; Semenov et al., 2016). The monitoring of diseases in agrosystems and the diagnosis of soil, seeds and crops is of principal importance in the choice of plant protection products (Finck & van Bruggen, 2015; van Diepeningen et al., 2006). In the present work we set the goal of identifying the main diseases of beans for organic production and assessing the potential of Bulgarian varieties for growing by biological technology.

MATERIALS AND METHODS

During the vegetation 2019-20 the possibility for growing the varieties of garden beans "Euros" and "Tangra" from the selection - genetic collection of IZK Maritsa by organic (biological) technology was studied. The experiment is based on a randomized block map in two replications at a plot size of 4.2 m2. The plants are grown according to the technology adopted for garden beans on a high two-row bed and agricultural techniques. The experiment is set as a comparative experiment for growing beans using conventional and biological technology.

Phytopathological observations and reports of major bean diseases were performed. The degree of defeat from bacterial blight and anthracnose was reported on a 4-point scale on Chekalin (Chekalin, 2003): 0 - 10% without symptoms or very weak; 1 - from 11% to 25% of the surface with spots; 2- from 26 to 50% of the surface with spots; 3- from 51- to 75%, 4- over 75% of the surface with spots.

The attack index was calculated according to McKinney's formula. Resistance to the disease was determined by the following scale: BB - over 75%, highly susceptible, B - 51% -75%, susceptible, C - 26% -50%, moderately susceptible, Y - 11% -25%, stable, UU - 10%, highly stable. In dry *Fusarium* rot, the percentage of dried plants (%) was calculated.

Fungicide treatments

Conventional technology: Bordeaux Mix 20VP 300g / da 741 g / kg Bordeaux mixture (200 g / kg Cu) +, Fuguran OH 50VP

300 g / da Copper oxychloride, Topaz 100EK Penconazole 50ml / da, Ortiva Plus 200 g / l azoxystrobin and 125 g / l difenoconazole 100 ml / Ha with an interval of 10-14 days.

Biological technology: five treatments with Bordeaux Mix 20VP 300g / Da with an interval of 10-14 days.

RESULTS AND DISCUSSION

Monitoring and phytopathological diagnosis of diseases in garden bean crops over the years has shown that viral and bacterial diseases are of great importance in the cultivation of this crop (Table 1). Every year in the crops of garden beans appear bacteriosis - bacterial and halo blight. Bacteriosis causes a great damage to crop and seed production in this crop. Bacteria are stored in the seeds for many years; they reduce laboratory and field germination, cause rot and mass death of seedlings. The development of bacterial diseases not only reduces the yield of beans, but also degrades the quality of production. The degree of attack and their development depends on the climatic conditions during the growing season.

Most local varieties of garden beans are susceptible to attack by bacterial diseases (Georgieva & Sofkova, 2014). Of the two bacterial diseases, bacterial blight Xap is more harmful.

As a result of our research, it was found that bacterial blight is a major disease of organic garden beans. It is believed that halo blight is more widespread in the northern regions due to the resistance of the pathogen to lower temperatures (Luchnaya, 2010). The high summer temperatures during the reporting period and the use of genetic material with resistance to races 1 and 2 of *Pseudomonas savastanoi pv. phaseolicola* can be cited as reasons for the lower development of this disease in beans in our experiment.

The results of disease monitoring in snap bean crops for organic production showed that the first symptoms of the disease appear after the germination of beans and develop massively in the flowering phases - the beginning of bean maturation (table 2). The infestation index of bacterial blight during the vegetation varies in the range from 1.78% to 10% in both varieties.

Of the fungal diseases during the years of the experiment, Fusarium wilt and anthracnose were reported with *Fusarium solani* f. f*aseoli* and *Colletotrichum lindemuthianum* diagnosed by microscopy. The development of rust during the years of the experiment was not found.

The comparison of the two technologies for growing beans showed that timely spraying with Bordeaux Mix 20VP 300g / Da has an equivalent protective effect against the development of diseases transmitted by seed - bacteriosis and anthracnose. The results obtained from the monitoring of diseases in the crop treated with the fungicide Bordeaux Mix do not differ from those in the crop treated with the fungicides - Bordeaux Mix 20VP 300 g/Da, Fuguran 50VP 300 g/Da and Topaz 100 EK 50 ml/Da (table 3).

As a result of our assessment of the Bulgarian varieties of snap bean “Evros” and “Tangra”, no significant varietal differences were found in terms of resistance to seed-borne diseases. The “Euros” and “Tangra” varieties show relative resistance to the pathogens *Xantomonas axanopodis* pv. *phaseoli* and *Colletotrichum lindemuthianum* but are strongly attacked by viral diseases. The development of bacteriosis and anthracnose with the triple use of the fungicide Bordeaux Mix 20VP, approved in the organic cultivation of vegetable crops, with an interval of 14 days, starting from the flowering phase, is in the range of up to 12.5% in both varieties. The attack of viral diseases was significantly lower in snap bean grown using conventional technology, which involves the use of an

extended range of pesticides. This result is causally related to the effectiveness of the insecticides used to treat viral vectors.

The selection of a variety suitable for organic production is based on several main indicators. One of the most important indicators is yield. The biological potential for yield in modern indeterminate varieties is 4-5 Tn/Da, and in determinant - 2.5-3 Tn of green beans per acre (Poryazov, 1990). In our experiment the real yield of the variety "Tangra" was 2091 kg/Ha and 4296 kg/Ha for the "Evros" variety, respectively.

The productivity of the "Tangra" variety is 83.0 g per plant, of the "Evros" variety 143 g per plant respectively.

Early ripening is an important selection trait, which in temperate latitudes determines the ability of varieties to avoid high summer temperatures combined with low humidity - a major factor in the abortion of flowers in bean plants. The indicators of early maturity in the "Tangra" variety are 46 days and 51 days in the "Evros" variety.

According to the complex of valuable agro-ecological, economic characteristics and the resistance to bacterial blight and anthracnose, the "Evros" variety has shown stable adaptability to the growing conditions using the technology for organic production.

CONCLUSIONS

Seed-borne diseases - viral mosaics, bacterial blight and anthracnose are the main diseases of snap bean for organic production.

The timely use of copper fungicide - Bordeaux mixture for the treatment of plants during the growing season against bacterial blight and anthracnose gives satisfactory results.

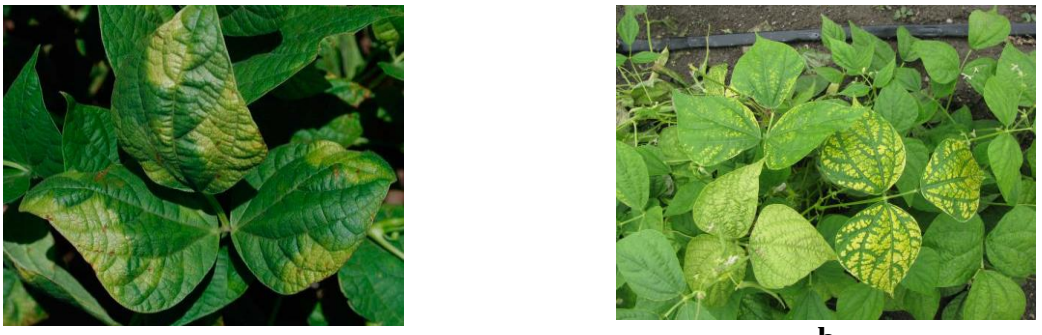
A comparison of conventional and biological plant protection systems for growing beans shows that the enrichment of the list of fungicides used does not significantly affect the degree of development of seed-borne diseases in beans.

In organic bean cultivation, viral diseases have a significantly stronger development than conventional ones. This requires the use of highly effective biological insecticides against vectors of viral infection.

No significant varietals differences were found in the varieties "Evros" and "Tangra" on the grounds of resistance to bacterial blight and anthracnose in the cultivation of the crop by biological technology.

According to the complex of economic indicators and the degree of its resistance to major diseases, the "Evros" variety can be characterized as an adaptive Bulgarian variety for cultivation by biological technology.

The experiment shows that in organic crops, preventive control measures are the most important. They are aimed at complying with the following conditions: using certified disease-free seed, crop rotation, control volunteer beans and eliminate weeds that may act as reservoir hosts for the bacteria, fungicide/bactericide treatments, if the disease is present and weather conditions favor its development.



a **b**

Pict. 3. Diseases of snap bean– Bacterial blight (a) and Bean yellow mosaic virus (b)

a **b**

Pict. 4. Bacterial blight *Xantomonas campestris* pv. *phaseoli* - symptoms of bacterial blight on snap bean seeds (a) and damage leaves and beans (b).

a **b**

Pict. 5. Halo blight *Pseudomonas syringae pv. phaseolicola* and Anthracnose *Colletotrichum lindemuthianum.*

Table 1. Economically important pathogens of snap bean in the Plovdiv region.

Microorganism	Disease	Spread, harmfulness
Bean common mosaic virus-BCMV	Bean common mosaic virus	+++
Bean yellow mosaic virus-BYMV	Bean yellow mosaic virus	+++
Cucumber mosaic cucumovirus-CMV	Cucumber mosaic cucumovirus	++
Xantomonas campestris pv. *phaseoli* (Smith)	Bacterial blight	+++
Pseudomonas syringae pv phaseolicola (Burkhoider) Dowson.	Halo blight	++
Fusarium solani f. faseoli Burkholde	*Fusarium* root rot	++
Colletotrichum lindemuthianum Saccardo et Magnus	Antracnose	+++
Uromyces appendiculatus Strauss	Rust	+

Symbols: (+++) – causes damage almost every year; (++) – causes serious damage in some years; (+-) –occurs sporadically, only in the presence of conditions suitable for development; (-) – no disease has been identified for the region.

Table 2. Development of bacterial and viral diseases in the snap bean grown for organic farming (average indicators for two years).

Variety / Development phase	Two pairs of true leaves		Mass flowering		Mass formation of beans	
	Bacterial blight	Bean yellow mosaic virus	Bacterial blight	Bean yellow mosaic virus	Bacterial blight	Bean yellow mosaic virus
"Evros"	1,76	4,94	3,24	13,81	9,5	42,25
"Tangra"	2,86	5,39	3,38	15,67	16,75	41,00

Table 3. Development of bacterial and viral diseases in snap bean grown according to conventional technology (average values over two years).

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Variety / Development phase	Two pairs of real leaves		Mass flowering		Mass formation of beans	
	Bacterial blight	Bean yellow mosaic virus	Bacterial blight	Bean yellow mosaic virus	Bacterial blight	Bean yellow mosaic virus
"Evros"	1,25	2,5	2,89	2,96	6,56	11,33
"Tangra"	3,85	3,98	1,52	4,67	3,57	13,91

Table 4. Biological potential of snap bean varieties "Evros" and "Tangra".

Variety	Productivity, g/plant	Yield, kg/Ha	Early maturity, days
"Evros"	143,20	4296,00	51
"Tangra"	83,65	2091,25	46

Table 5. Development of symptoms of bacterial and fungal diseases on snap bean seeds.

Year	Variant/Variety	Diseased seeds, (%)		Non-standard seeds, (%)
		Bacterial blight	Antracnose	
Organic farming				
1	"Evros"	13,12	0,68	13,80
	"Evros"	25,00	3,00	4,00
	"Tangra"	10,25	1,25	11,50
	"Tangra"	14,00	0,00	5,00
Conventional cultivation				
2	"Evros"	48	14	18,53
	"Evros"	20,00	5,00	7,00
	"Tangra"	6,38	4,29	10,67
	"Tangra"	5,00	0,00	4,00

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