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RESEARCH ON EFFECTIVENESS OF SOME FUNGICIDES TREATMENTS ON JONATHAN APPLE VARIETY FOR APPLE SCAB CONTROL IN VOINEȘTI AREA

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Abstract

The Voineşti production basin is one of the most important fruit growing areas for apple crop. The load of pathogens in these plantations is very high due to climatic conditions and monoculture for a long period of time in the area. Venturia inaequalis is one of the main diseases affecting apple orchards. A major challenge in commercial apple orchards within humid production regions is the available fungicide options for apple scab (Venturia inaequalis (Cooke) Wint.) management. The objectives of this study were to compare the efficacy of five potential alternative fungicides for management of apple scab and to evaluate their effectiveness. Pest incidence, pest severity of the attack and yield of the Jonathan apple variety, one of the most sensitive in the area, were also analyzed by ARM software. The standard products Score 250 EC (0.225 l/ha) and Syllit 400 SC (2.0 l/ha) treatments resulted in the best scab control and consequently, high economic productivity.

Key words*: apple scab, fungicides, effectiveness, pest incidence, pest severity, yield.*

INTRODUCTION

The apple tree, one of the oldest fruit tree species (being mentioned even in Genesis), has a high adaptability to the climate conditions. It is grown from the plain to the mountains on every continent except the Arctics.

Due to the role that fruits play in human nutrition and its ecological plasticity, it occupies an important place in world fruit production, ensuring, together with banana and orange, 2/3 of the global fruit harvest (Popescu et al., 1992).

Being very well adapted to the temperate climate, whose extremes bear better than the other species of fruit trees and considered the dominant species in this area (Hoza, 2000), it also ensures in our country the highest percent in fruit crops.

Depending on the environmental conditions and the measures taken, the apple is yearly attacked by a large number of diseases and pests which, if not controlled, compromise the production of susceptible varieties and weaken the trees vigor. The most widespread and perhaps the most harmful pathogen agent is apple scab, which, for sensitive varieties much demanded on the market (Delicious gold, Starkinson, Jonagold), the yield of the current year decreases by 70-80%, the remaining fruits will be of inferior quality, useful only for processing, and production of next year will be 10-20% of the potential (Tomşa & Tomşa, 2003).

The apple scab, caused by the fungal pathogen *Venturia inaequalis* (Cooke) G. Wint., is responsible for significant economic losses in apple orchards in the Voineşti Area. Research on apple scab is associated with other pathogens of major importance for apple crop and which are key diseases for this crop, such as moniliosis, which causes significant damage e and for which the varieties' reaction and treatments are always appropriate in apple protection research (Chitulescu & Cristea, 2017; Cristea et al., 2017).

If not managed, the disease can cause extensive losses following humid and cool weather conditions during the spring months. Direct losses result from fruit infections and indirect losses from defoliation, which can reduce tree

vigor, winter hardiness, and subsequent yield (Carisse & Rolland, 2004).
Farmers strive for preventing and counteracting the impact of this disease with fungicides treatments along with other agro technical practices (Jinga, 2013).
For apple scab management, fungicide programmes are widely used, specially targeting critical periods during the growing season: beginning of shoot growth, mouse-ear stage, green bud stage, flowering, fruit fall after flowering, beginning of ripening.
On the basis of these realities, this paper aims to highlight the importance and the opportunity of fungicide treatments for combating rapine in the Voineşti fruit basin during the vegetation period to ensure safe and qualitatively and quantitatively stable crops (Petre et al., 2000).

MATERIALS AND METHODS

The research was carried out between April and September 2018, at the Tree Growing Research and Development Station Voineşti, in a 16-year-old apple orchard, the Jonathan variety, with rows of free-weed trees alternating with grass covered intervals. During the period of vegetative rest, autumn tillage was carried out by ploughing on the intervals between rows. Pruning works for growth and bearing control were carried out early spring, before the growing season began.
The trial was conducted using the randomized complete block method in four repetitions. Each plot had 5 trees. During the vegetation period, depending on climatic conditions, 4 foliar treatments were applied at 12-16 days.
In May, June, July and August, the assessments aimed at determining the evolution of pathogen attack *V. inaequalis* (apple scab). The 4 treatments were applied in the following stages: 1st - end of flowering (BBCH 69); 2nd - second fruit fall (BBCH 73); 3rd - fruit about 80% of final size (BBCH 78); 4th - beginning of ripening - first appearance of cultivar - specific colour (BBCH 81).
The application equipment was a mist blower Solo 423 atomizer, suitable for fungicide treatments in orchards (Figure 1).
The tested variants (commercial products, active ingredients and application dose rate) are presented in Table 1.

Table 1. Tested variants in the trial

Variant	Product	Active ingredient	Rate (l, kg/ha)
1	Untreated	-	
2	Systhane Forte	miclobutanil 240 g/l	0.2
3	Folicur Solo 250 EW	tebuconazol 250 g/l	0.75
4	Syllit 400 SC	Dodine 400 g/l	2
5	Shavit F72 WDG	triadimenol 20 g/kg + folpet 700 g/kg	2
6	Score 250 EC	difenoconazol 250 g/l	0.225

100 leaves per tree and 50 fruits per tree were assessed. Assessments were made on the frequency (F, %) and the intensity (I, %) of pathogen attack and the degree of attack (DA, %) and efficacy (E, %) were calculated. The degree of attack was calculated using the formula: F% x I%/100. The efficacy of fungicide was calculated according to Abbott`s formula: (degree of attack in untreated control - degree of attack in treated plot)/ degree of attack in untreated control x 100. All data were subjected to statistical analysis provided by ARM-8 software (V. Jinga, 2013). At harvest time, the yield/tree was also recorded by weighing all the fruits per tree.
Jonathan apple variety is recognized as susceptible to apple scab. Symptoms were assigned to apple scab if there were lighter green areas compared to the surrounding leaf tissue, or pale yellow or olive-green spots on the upper surface of leaves.
The lessions expand and become brown – olive colored as a of the asexual spores production (*Fusicladium* conidia) (Gheorghieş & Cristea, 2001).
Scab lesions that form on young leaves may expand to more than 1 cm in diameter. Ontogenetic resistance of older leaves, however, usually results in smaller lesions or no visible symptoms (Gessler & Stumm, 1983).
On branches and shoots one can see exfoliation and modified tissues that may endanger even the tree life (Dulugeac F.A., 2011).
The fruits have lesions similar to those on the leaves. They age on and may cause cracks. If assessed late in the summer or just before harvest, the late infected fruits had black, circular, very small (0.1-4 mm diameter)

lesions called 'pin-point scab' that would appear during storage (Carisse & Jobin, 2006).
The sexual phase of the fungus is characterized by oval or pyriform perithecia, immersed in the tissue, provided with a long neck, ending with an opening pore surrounded by brown, stiff bristles. In the perithecia, the fungus forms asci with bicellular ascospores, with two-row located unequal cells (Gheorghieş & Cristea, 2001).

Figure 1. Field treatment with mist blower Solo 423 atomizer suitable for fungicide treatments in orchards

RESULTS AND DISCUSSIONS

In the Voinesti fruit-growing Area, in 2018, the weather conditions were atypical, different from the normal ones. March began with very low negative temperatures (-18°C) and continued with high temperature fluctuations over the three decades. The amount of precipitation was high (126 mm). In April it approached the multiannual national average, then May, June and July were very rainy (111, 404 and 193 mm, respectively) (Table 2). This has led to increased incidence of foliar diseases in apple orchards, requiring phytosanitary treatments.
The need for these treatments is shown in Table 2 and Table 3 where it is observed that in the untreated control plot, the degree of attack of the pathogen reached 40.72% on the leaves and 32.30% on the fruit.
Also, fruit production of the variant without anti-fungal treatments was significantly diminished and of poor quality, as shown in Chart 1. There was a sudden increase of *V. inaequalis* incidence and severity in the second part of the experiment due to abundant rainfall.
The commercial products tested in this study showed high and very high effectiveness. This lays out the importance of these measures. Syllit 400 SC and Score 250 EC had performed best - 85.52% and 87.00%, respectively on attacked leaves. On fruits, their effectiveness was higher, namely 92.15% and 97.29%.
The Systhane Forte product did not reach the level of the other tested products, having the lowest values of efficacy: 67.70% and 65.06%, respectively.
Folicur Solo and Shavit F72 had a regular efficacy and could be recommended in scab control programs. These two products controlled apple scab in similar percent - 74.07 and 78.58, respectively on leaves while on fruits - 92.15 and 94.74%, respectively.
Fruit production was determined at the harvest time and varied across variants. This stressed the need for phytosanitary treatments. A mean of 16.3 kg of fruits per tree was recorded for the control sample. The fruits were small, deformed, suberified, cracked, spotted and inappropriate for commercialization. Highest value of yield per tree (31.2 kg) was recorded for the treatment with Score 250 EC.
Most infected fruits showed distinct brown or black spots with margins that were often irregular. When severe, the skin splits and irregularly shaped fruits resulted.
The organoleptic characteristics of the fruits in the control sample were significantly lower compared to the rest of the variants.
Variants 4 and 6 had the highest commercial value by size, weight, and color specific to the variety.
The yield values showed significant differences between the phytosanitary treatments and the control variant, as shown in Figure 2.

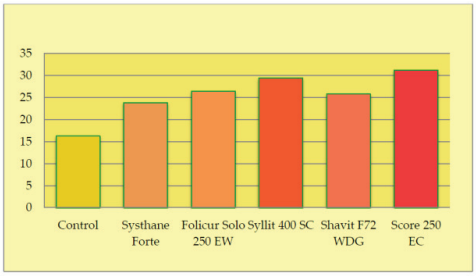

Figure 2. Mean yield (kg/tree) per treatment and control sample

The treatment with Score 250 EC recorded a nearly double-fruit yield per tree, increasing from 16.3 kg to 31.2 kg. A similar result was obtained with the treatment of Syllit 400 SC where the values reached 29.7 kg of fruit per tree. Variants 3 and 5 showed a fairly good productiveness, with yields of 26.5 and 25.8 kg of fruit per tree, respectively.

Table 2. Precipitation and temperature during 2018 growing vegetation season

	Month									
	Jan.	Febr.	March	Apr	May	June	July	Aug.	Sept	
Periods	The growing season 2018: Precipitation (mm) for 10-day periods									Sum
1-10	0.20	4.10	11.00	28.00	10.00	103.00	133.00	11.00	17.00	317.3
11-20	10.30	34.00	71.00	3.00	48.00	159.00	4.00	1.00	1.00	331.30
21-30	0.00	4.20	4400	9.00	53.00	142.00	56.00	40.00	7.00	355.20
Sum	10.50	42.30	126.00	40.00	111.00	404.00	193.00	52.00	25.00	1003.80
	The growing season 2018: Mean air (°C) for 10-day periods									Mean
1-10	4.27	4.45	2.30	13.75	21	22.6	20.8	24.3	22.25	15.08
11-20	0.25	2.4	7.65	17.6	17.15	22.8	22.6	24.25	20.50	15.02
21-30	-0.36	-3.81	4.73	18.85	20.45	19.35	23.86	24.41	14.95	13.60
Mean	1.39	1.01	4.89	16.73	19.53	21.58	22.42	24.32	19.23	14.57

Table 3. The assessments data of apple scab on leaves

Variant	1st Application				2nd Application				3rd. Application				4th Application			
Product	F%	I%	DA%	E%	F%	I%	DA%	E%	F%	I%	DA%	E%	F%	I%	DA%	E%
Control	21.00	10.75	2.26		28.50	15.50	4.42		59.50	24.75	14.73		91.50	44.50	40.72	
Systhane Forte	16	7	1.12	50.39	19.25	11.25	2.17	50.98	35.75	19.20	6.86	53.39	56.2	23.40	13.15	67.70
Folicur Solo 250EW	14.5	6	0.87	61.46	15.25	10.75	1.64	62.89	35.00	13.75	4.81	67.32	49.8	21.20	10.56	74.07
Syllit 400 SC	11.75	5.00	0.59	73.98	13.50	7.45	1.01	77.23	29.00	11.20	3.25	77.94	44	13.40	5.90	85.52
Shavit F72 WDG	12	5.5	0.66	70.76	13.20	8.80	1.16	73.70	31.40	11.60	3.64	75.27	46.4	18.80	8.72	78.58
Score 250 EC	11	5	0.55	75.64	12.50	7.80	0.98	77.93	28.80	10.40	3.00	79.66	43.4	12.20	5.29	87.00

Table 4. The assessments data of apple scab on fruits

Variant	1st Application				2nd Application				3rd. Application				4th Application			
Product	F%	I%	DA%	E%	F%	I%	DA%	E%	F%	I%	DA%	E%	F%	I%	DA%	E%
Control	20.5	11.8	2.42		29.6	16.8	4.97		54.25	28.6	15.52		82.4	39.2	32.30	
Systhane Forte	13.4	9.5	1.27	47.37	18.4	12.5	2.3	53.75	35.2	18.8	6.62	57.35	43	26.25	11.29	65.06
Folicur Solo 250EW	12.8	8	1.02	57.67	16.2	10.6	1.72	65.47	26.75	18.2	4.87	68.62	19.5	13	2.54	92.15
Syllit 400 SC	11.8	5.2	0.61	74.63	14.75	7.2	1.06	78.64	19.25	11.4	2.19	85.86	16.6	6	1.00	96.92
Shavit F72 WDG	12.2	7.5	0.92	62.17	15.6	10.2	1.59	68.00	24.4	13.8	3.37	78.30	19.4	8.75	1.70	94.74
Score 250 EC	11.4	5.5	0.63	74.08	13.8	7.4	1.02	79.46	18	11.6	2.09	86.54	16.2	5.4	0.87	97.29

CONCLUSIONS

Field trial conducted in apple orchard in Voinesti area demonstrated the importance of *Venturia inaequalis* control management. Apple crop is an ancient practice in Voinesti area which ensures the living for many inhabitants. Yet, the crops are damaged every year by a large number of pests and pathogens. These harmful agents may reduce the yields and even endanger the life of trees. *V. inaequalis* is the most dangerous disease for apple crop which may cause serious damages in orchards. High quality of fruits and yield is not possible without disease control management. A good level of efficacy and a significant reduction in
disease incidence and severity is possible when fungicides such as Syllit 400 SC or Score 250 EC are applied in critical stage. However, this practice has to be integrated with other agro technical measures in order to protect both the apple orchards and the environment.

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