

POSSIBILITIES OF COMPLEX CONTROL OF PATHOGENS AND PEST ON TOMATO CROPS UNDER HIGH PLASTIC TUNNELS

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ABSTRACT

The experiment was carried out in 2020, under high plastic tunnels conditions, using the tomato hybrid Prekos F1 and aimed to evaluate the efficacy of different combinations of fungicides with insecticides for complex control of pathogens *Alternaria solani* (early blight), *Fulvia fulva* (leaf mold) and pests *Tuta absoluta* (tomato leaf miner) and *Helicoverpa armigera* (cotton bollworm). The experimental variants were: 1. Cabrio Top 0.2% + Coragen 0.0175%; 2. Cabrio Top 0.2% + Voliam Targo 0.08%; 3. Dagonis 0.1% + Coragen 0.0175%; 4. Dagonis 0.1% + Voliam Targo 0.08%; 5. Cidely Top 0.1% + Coragen 0.0175%; 6. Cidely Top 0.1% + Voliam Targo 0.08%; 7. Ortiva Top 0.1% + Coragen 0.0175%; 8. Ortiva Top 0.1% + Voliam Targo 0.08%; 9. Untreated control. Six foliar treatments were applied at 10-days intervals. The efficacy of these combinations of fungicides with insecticides was assessed according to the degree of attack (%) for *Alternaria solani*, *Fulvia fulva* and *Tuta absoluta* or according to the frequency of the attacked fruits (%) for *Helicoverpa armigera* and was between 85.0% and 90.7%. The highest yields were registered in variants 1 (Cabrio Top 0.2% + Coragen 0.0175% - 5,535 kg/m²), 3 (Dagonis 0.1% + Coragen 0.0175% - 5,440 kg/m²) and 2 (Cabrio Top 0.2% + Voliam Targo 0.08% - 5,362 kg/m²) as compared to 4,490 kg/m² in the untreated control variant. The differences of yield, obtained in addition to the untreated control variant, were very significant in all cases.

Keywords: fungicides, insecticides, combinations, efficacy, yields

INTRODUCTION

Among the vegetable species cultivated in Romania, tomatoes occupy the first place, with 40,734 ha (FAO, 2018). From this area ≈8000 ha are occupied with crops under areas (high plastic tunnels and glasshouses). Also, in this case, tomatoes are the predominant species, their cultivation being practiced on ≈70% of the surface in cycle I, cycle II or extended cycle. The climatic conditions under protected areas, necessary for the growth and development of tomato plants are, at the same time, favorable for the appearance and evolution of the attack of harmful agents of economic importance, among which we mention: *Alternaria solani* (early blight), *Botrytis cinerea* (gray mold), *Fulvia fulva* (leaf mold), *Erysiphe* sp. (powdery mildew), *Colletotrichum coccodes* (anthracnose), *Phytophthora infestans* (late blight), *Tuta absoluta* (tomato leaf miner), *Helicoverpa armigera* (cotton bollworm), *Macrosiphum euphorbiae* (tomato aphid), *Thrips tabaci* (common thrips), etc. Studies undertaken worldwide and in Romania have led to the establishment of elements of epidemiology and

bioecology of harmful organisms and, at the same time, to the development of the most appropriate control measures. In connection with foliar pathogens that attack tomato crops, strategies have been established to control them with fungicides (Miller et al., 2002; Costache et al., 2018). Regarding the *Tuta absoluta* and *Helicoverpa armigera* pests, there are numerous studies on bioecology and economic importance and the measures and means of its integrated control have been established (Desneux et al., 2010; Bratu et al., 2015; Hoge, 2020; Sene et al., 2020). The experiments carried out at ICDLF - Vidra aimed to identify combinations of fungicides with insecticides designed to control the complex of pathogens and pests present at the same time in tomato crops under high plastic tunnels.

MATERIALS AND METHODS

The experiment was carried out in 2020, under high plastic tunnels, protected with “insect proof” net, in the first cycle of crop, using the tomato hybrid Prekos F1 and included 9 experimental variants, placed according to the method of randomized blocks.

The experimental variants were:

1. Cabrio Top 0.2% + Coragen 0.0175%
2. Cabrio Top 0.2% + Voliam Targo 0.08%
3. Dagonis 0.1% + Coragen 0.0175%
4. Dagonis 0.1% + Voliam Targo 0.08%
5. Cidely Top 0.1% + Coragen 0.0175%
6. Cidely Top 0.1% + Voliam Targo 0.08%
7. Ortiva Top 0.1% + Coragen 0.0175%
8. Ortiva Top 0.1% + Voliam Targo 0.08%
9. Untreated control.

During the vegetation period, 6 foliar treatments were applied at 10-days intervals, as follows: June 12 (T1), June 22 (T2), July 2 (T3), July 13 (T4), July 23 (T5)) and August 3 (T6). Table 1 summarizes the plant protection products used in this experiment.

Table 1. Phytosanitary products used in the experiment

Phytosanitary products	Active ingredients	Mode of action	Pathogens and pest controlled	Break time (days)
Cabrio Top	piraclostrobin 5% + metiram 55%	contact and translaminar	<i>Alternaria solani</i> , <i>Fulvia fulva</i> , <i>Phytophthora infestans</i> , <i>Leveillula taurica</i> , <i>Septoria lycopersici</i>	7
Dagonis	difenoconazol 50 g/l + fluxapiraxad 75 g/l	contact and systemic	<i>Alternaria solani</i> , <i>Fulvia fulva</i> , <i>Leveillula taurica</i>	3
Cidely Top	difenoconazol 125 g/l + ciflufenamid 15 g/l	contact and systemic	<i>Alternaria solani</i> , <i>Fulvia fulva</i> , <i>Leveillula taurica</i>	3
Ortiva Top	azoxistrobin 200 g/l + difenoconazol 125 g/l	contact and systemic	<i>Alternaria solani</i> , <i>Botrytis cinerea</i> , <i>Fulvia fulva</i> , <i>Phytophthora infestans</i> , <i>Leveillula taurica</i>	7
Coragen	cloranthraniliprol 20%	local systemic and translaminar	<i>Tuta absoluta</i> , <i>Helicoverpa armigera</i>	1
Voliam Targo	abamectin 18g/l + cloranthraniliprol 45 g/l	local systemic and translaminar	<i>Tuta absoluta</i> , <i>Helicoverpa armigera</i> , <i>Liriomyza</i> sp., <i>Tetranychus urticae</i>	3

During the vegetation period, dynamic observations were made on the appearance and evolution of the attack of pathogens and pests (frequency and intensity of attack) in correlation with climatic factors, and finally the degree of attack was calculated (%; for *Alternaria solani*, *Fulvia fulva*, *Tuta absoluta*) or frequency of fruits attack (%; for *Helicoverpa armigera*) and efficacy (%) of combinations of plant protection products used to control harmful organisms.

The yield was also harvested in dynamics, on variants and repetitions, and the obtained data were processed by the method of analysis of variance.

RESULTS AND DISCUSSIONS

The attack of the pathogens *Alternaria solani*, *Fulvia fulva* and the pests *Tuta absoluta* (fig. 1 and 2) and *Helicoverpa armigera* appeared and evolved in the tomato crop.

The attack produced by *Alternaria solani* appeared on May 22 and evolved slowly so that, in the first decade of August, the degree of attack reached 8.2% (Table 2). The *Fulvia fulva* attack started on May 28, the value of the degree of attack reaching 31.2% at the end of the first decade of August. The attack was favored by high average temperatures (27.9-29.9 °C) and maximum relative humidity over 90%.

Table 2. The appearance and evolution of the attack of pathogens and pests in correlation with climatic factors

Pathogens/Pests/ climatic factors	Date of attack appearance	Degree of attack (%) / attack frequency (%)								
		May		June			July			August
		Decade		Decade			Decade			Decade
		II	III	I	II	III	I	II	III	I
<i>Alternaria solani</i>	22.05	0	0.2	0.6	1.7	2.9	3.6	4.2	6.7	8.2
<i>Fulvia fulva</i>	28.05	0	0.4	0.8	1.7	3.9	9.6	15.8	23.3	31.2
<i>Tuta absoluta</i>	14.05	0.9	1.5	3.8	6.1	10.2	17.3	28.7	35.4	40.6
<i>Helicoverpa armigera</i>	22.06	0	0	0	0	0.6	1.2	2.9	4.7	7.8
Minimum temperature (°C)	-	14.5	10.4	12.2	16.8	16.3	17.9	15.5	18.1	17.6
Average temperature (°C)	-	26.1	20.2	23.5	24.9	27.9	29.7	27.0	29.6	29.9
Maximum temperature (°C)	-	39.4	34.5	37.2	37.8	40.6	41.7	39.6	43.0	42.2
Minimum humidity (%)	-	25.2	31.8	30.4	42.1	30.2	25.8	24.8	24.6	18.6
Average humidity (%)	-	54.6	66.1	64.3	74.8	62.7	55.9	54.8	58.7	44.4
Maximum humidity (%)	-	86.2	93.1	93.7	96.7	93.9	89.9	88.3	91.9	77.9

Among the pests was the earliest attack of *Tuta absoluta* (May 14) which evolved rapidly due to high average temperatures (27.9-29.9 °C), from the third decade of June - the first decade of August, reaching at 40.6%. The latest attack was the pest *Helicoverpa armigera* (June 22), the frequency of the attack reaching 7.8%, at the end of the first decade of August.

The average efficacy of the combinations of fungicides with insecticides experimented for the complex control of pathogens and pests was between 85.2% (variant 8: Ortiva Top 0.1% + Voliam Targo 0.08%) and 90.7% (variant 1: Cabrio Top 0.2% + Coragen 0.0175%; table 3). Based on the results obtained, it can be appreciated that practically all the combinations tried ensured a good protection of the tomato plants against

the attack of the pathogens *Alternaria solani*, *Fulvia fulva* and the pests *Tuta absoluta* and *Helicoverpa armigera*.

Regarding the obtained yield, it varied between 5.105 kg/m² (V6) and 5.535 kg/m² (V1) as compared to 4.490 kg/m² in the untreated control variant (Table 4). The highest yields were registered at variants 1 (5.535 kg/m²), 3 (5.440 kg/m²) and 2 (5.362 kg/m²). The yield differences obtained in addition to the untreated control variant, varied between 0.615 kg/m² at V6 and 1.045 kg/m² at V1 are very significant.

Table 3. Efficacy of product combinations in the complex control of pathogens and pests on tomato crop under high plastic tunnels

Variant	Degree of attack (%)			Frequency of attack (%)	Efficacy (%)				Average efficacy (%)
	<i>A. solani</i>	<i>F. fulva</i>	<i>T. absoluta</i>		<i>A. solani</i>	<i>F. fulva</i>	<i>T. absoluta</i>	<i>H. armigera</i>	
1. Cabrio Top 0.2% + Coragen 0.0175%	0	3.5	3.2	1.4	100.0	88.8	92.1	82.0	90.7
2. Cabrio Top 0.2% + Voliam Targo 0.08%	1.2	3.8	5.2	1.6	85.4	87.8	87.2	79.5	85.0
3. Dagonis 0.1% + Coragen 0.0175%	0	3.6	3.8	1.6	100.0	88.5	90.6	79.5	89.6
4. Dagonis 0.1% + Voliam Targo 0.08%	0	4.0	4.6	2.2	100.0	87.2	88.7	71.8	86.9
5. Cidely Top 0.1% + Coragen 0.0175%	1.4	3.8	3.1	1.4	82.9	87.8	92.4	82.0	86.3
6. Cidely Top 0.1% + Voliam Targo 0.08%	0	5.1	4.5	1.3	100.0	83.6	88.9	83.3	88.9
7. Ortiva Top 0.1% + Coragen 0.0175%	1.6	6.1	3.9	0	80.5	80.4	90.4	100.0	87.8
8. Ortiva Top 0.1% + Voliam Targo 0.08%	1.2	5.4	3.3	1.5	85.4	82.7	91.9	80.8	85.2
9. Martor netratat	8.2	31.2	40.6	7.8	-	-	-	-	-

Table 4. The influence of treatments with combinations of fungicides and insecticides on tomato yield under high plastic tunnels (Prekos F1 hybrid)

Variant	Yield (kg/m ²)	Relative yield (%)	Difference from control (kg/m ²)	Significance
1	5.535	123.2	+1.045	***
2	5.362	119.4	+0.872	***
3	5.440	121.1	+0.950	***
4	5.308	118.2	+0.818	***
5	5.155	114.8	+0.665	***
6	5.105	113.6	+0.615	***
7	5.355	119.2	+0.865	***
8	5.260	117.1	+0.770	***
9	4.490	100.0	-	-

DL 5%=0.30; DL 1%=0.42; DL 0,1%=0.56

CONCLUSIONS

In the first cycle, the attack of the pathogens *Alternaria solani*, *Fulvia fulva* and the pests *Tuta absoluta* and *Helicoverpa armigera* was manifested in the tomato crop under high plastic tunnels.

The efficacy of the combinations of fungicides with experienced insecticides, used to complex control of harmful organisms varied between 85.2% (V 8: Ortiva Top 0.1% + Voliam Targo 0.08%) and 90.7% (V1: Cabrio Top 0.2% + Coragen 0.0175%).

The highest yields were registered for variants 1 (Cabrio Top 0.2% + Coragen 0.0175%; 5.535 kg/m²), 3 (Dagonis 0.1% + Coragen 0.0175%; 5.440 kg/m²) and 2 (Cabrio Top 0.2% + Voliam Targo 0.08%; 5.362 kg/m²).

The yield differences obtained in addition to the untreated control variant were, in all cases, very significant.



Figure 1. *Tuta absoluta* attack on the untreated control



Figure 2. *Fulvia fulva* and *Tuta absoluta* attack on the untreated control

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