

ACTIVE INGREDIENTS COMBINATIONS FOR PATHOGENS AND PESTS CONTROL ON EGGPLANT CROPS IN THE FIELD

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ABSTRACT

The present study aims to identify combinations of active substances for the complex control of pathogens and pests on eggplant crops in the field. The experiments were conducted between 2016 - 2017, in field conditions, using the variety of eggplant Luiza and the following experimental variants: V 1 - Acrobat MZ 69 WG 0.2% + Mospilan 20 SG 0.04%; V 2 - Acrobat MZ 69 WG 0.2% + Vertimec 1.8 EC 0.1%; V 3 - Acrobat MZ 69 WG 0.2% + Laser 240 SC 0.05%; V 4 - Melody Compact 49 WG 0.2% + Mospilan 20 SG 0.04%; V 5 - Melody Compact 49 WG 0.2% + Vertimec 1.8 EC 0.1%; V 6 - Melody Compact 49 WG 0.2% + Laser 240 SC 0.05%; V 7 - Ortiva Top 0.1% + Mospilan 20 SG 0.04%; V 8 - Ortiva Top 0.1% + Vertimec 1.8 EC 0.1%; V 9 - Ortiva Top 0.1% + Laser 240 SC 0.05%; V 10 - untreated control. The average efficacy of the treatment variants experienced in 2016 and 2017 varied between 83.2% (V4) and 85.0% (V8) depending on the combinations of products pathogens and pests control. Analyzing the yields obtained (34.6 -44.0 t / ha in 2016 and 33.5 - 43.1 t / ha in 2017), compared to the untreated control variant (30.4 t / ha in 2016 and 31.1 t / ha in 2017), it is found that the yield differences obtained in addition to the untreated control variants were in all cases, very significant.

Keywords: early blight, gray mold, fruit rot, Colorado potato beetle, the common red spider, green nightshade lice, fruit caterpillar

INTRODUCTION

Eggplants (*Solanum melongena* L.) are among the most cultivated vegetable species worldwide, including in Romania. According to statistical data provided by FAO (2020), the area cultivated with eggplant in Romania was in 2018 of 9025 ha, and the total yield of 152719 tons. Eggplants are attacked by numerous pathogens and pests (Costache M., Roman T., 2007) of which we mention *Alternaria porri* f.sp.*solani* (early blight), *Botrytis cinerea* (gray mold), *Phytophthora parasitica* (fruit rot; Buzatu et. al., 2017) and *Leptinotarsa decemlineata* (Colorado beetle), *Macrosiphum euphorbiae* (green nightshade lice), *Tetranychus urticae* (the common red spider) and *Helicoverpa armigera* (fruit caterpillar). *Alternaria porri* f. sp. *solani* occur frequently in eggplant crops, especially in

years with high average temperatures and heavy rainfall. Disease symptoms are characteristic dark brown to black lesions with concentric rings, which produce a 'target spot' effect (Cristea, 2005). *Botrytis cinerea* occurs frequently in crops of eggplants in protected areas, but also in the fields in years with abundant precipitation or if the culture is irrigated by sprinkling irrigation. On fruits, at different stages of development, the attack usually begins at the site of insertion of the peduncle and from here progresses to their tip. The attacked tissues discolor and turn purple, with a gray tinge. *Phytophthora parasitica* usually attacks mature fruits in the basal part that touch the ground or are close to it. On their surface appear large, brown spots, concentrically zoned, bordered by an obvious area of lighter color. Although the whole plant may be susceptible, fruit rot is the main symptom caused by *Phytophthora parasitica* in eggplants (Roberts & al., 2008). *Leptinotarsa decemlineata* (Colorado potato beetle) attacks in the larval and adult stages, affecting all the aerial organs of the plants, with preferential location on the foliage. The common red spider (*Tetranychus urticae*) affects all the aerial organs of the plants and preferably the foliar leaves, being located on the lower part. Hossain et al. (2006) and Naher (2005) observed that by applying acaricides, the population of *T. urticae* in the field was drastically reduced. Sayed et al. (2006) found that Vertimec is more effective than Actellic and Biofly against *T. urticae*. *Macrosiphum euphorbiae* (green nightshade lice) is common in dry and hot years, forming colonies clustered on the underside of leaves and scattered on flowers. The young larvae of *Helicoverpa armigera* (fruit caterpillar) develop on leaves and flowers, after which they enter into the fruit where they consume the seeds and leave numerous droppings. The attacked fruits become unfit for consumption.

The experiments organized at R.I.V.F.G Vidra aimed to prevent the occurrence and control of the attack of pathogens and pests in the crop of eggplant by using combinations of active substances.

MATERIALS AND METHODS

The experiments were carried out in 2016 and 2017, in field conditions, using the Luiza eggplant variety. The products used to control pathogens and pests in eggplant field crops are shown in table 1.

Table 1. Products used for pathogens and pests control of eggplant crop in the field (Vidra, 2016 - 2017)

Product and concentration	Active ingredients	Mode of action	Break time (days)
Fungicides			
Acrobat MZ 69WG 0,2 %	dimethomorph 9% + mancozeb 60%	translaminar, local systemic + contact	7
Melody Compact 49 WG 0,2 %	iprovalicarb 8.4% + Cu as oxchloride Cu 40.6%	systemic, contact	7
Ortiva Top 0,1 %	azoxystrobin 200 g / l + diphenconazole 125 g / l	contact, local systemic, translaminar	7
Insecticides - acaricides			
Mospilan 20 SG 0,04 %	acetamiprid 20 %	systemic	3
Vertimec 1,8 EC 0,1 %	abamectin 18 g/l	systemic, translaminar, penetrating, ingestion	3
Laser 240 SC 0,05 %	spinosad 240 g/l	contact, ingestion	3

The organized experience was of a single-factor type, placed in randomized blocks, with 10 variants, in 3 replications. The crop was established on May 16, 2016 and on May 12, 2017, on land mulched with black polyethylene foil. The size of the repetition plot was 7.5 m², having a number of 24 plants, arranged in 2 rows, 70 cm apart and 40 cm between plants on the row. The experimental variants were the following: V 1 - Acrobat MZ 69 WG 0.2% + Mospilan 20 SG 0.04%; V 2 - Acrobat MZ 69 WG 0.2% + Vertimec 1.8 EC 0.1%; V 3 - Acrobat MZ 69 WG 0.2% + Laser 240 SC 0.05%; V 4 - Melody Compact 49 WG 0.2% + Mospilan 20 SG 0.04%; V 5 - Melody Compact 49 WG 0.2% + Vertimec 1.8 EC 0.1%; V 6 - Melody Compact 49 WG 0.2% + Laser 240 SC 0.05%; V 7 - Ortiva Top 0.1% + Mospilan 20 SG 0.04%; V 8 - Ortiva Top 0.1% + Vertimec 1.8 EC 0.1%; V 9 - Ortiva Top 0.1% + Laser 240 SC 0.05%; V 10 - untreated control.

The physical compatibility of the product mixtures was determined in the laboratory. Three treatments were performed during the growing season. The first treatment was done at the beginning of the risk of infection and infestation and the others at intervals of 7-10 days. During the vegetation period, observations were made regarding the occurrence and evolution of the attack of pathogens: frequency (%) and severity (%) of the attack and the degree of attack (%) and efficacy (%) were calculated. The degree of attack was calculated with the formula $(F \% \times S \%) / 100$ and the efficacy with the formula $(\text{untreated DA} \% - \text{treated DA} \%) \times 100 / \text{untreated DA}$. Observations were also made on the yield, by weighing the fruits on variants and repetitions at harvest.

Yield data were statistically processed by analysis of variation (ANOVA), and the level of significance of yield differences was interpreted with the Fisher test: °°° = Non significant; ° = significant; * = distinct significant; *** = very significant.

RESULTS AND DISCUSSIONS

In the experimental crops of eggplant in the field, the attack of the following pathogens and pests was manifested in 2016 and 2017: *Alternaria porri* f.sp. *solani* (early blight), *Botrytis cinerea* (gray mold), *Phytophthora parasitica* (fruit rot), *Leptinotarsa decemlineata* (Colorado beetle), *Macrosiphum euphorbiae* (green nightshade lice), *Tetranychus urticae* (common red spider).

The combinations of products tested were noted for their good efficacy in controlling the following harmful organisms (Tables 2 and 3):

1. Acrobat MZ 69 WG + Mospilan 20 SG: for *Alternaria porri* f.sp. *solani*, *Botrytis cinerea*, *Phytophthora parasitica*, *Leptinotarsa decemlineata* and *Macrosiphum euphorbiae* (average E = 83.6% - 2016; 83.4% - 2017; 83.5% - average value 2016-2017);

2. Acrobat MZ 69 WG + Vertimec 1.8 EC: for *Alternaria porri* f.sp. *solani*, *Botrytis cinerea*, *Phytophthora parasitica* and *Tetranychus urticae* (average E = 85.3% - 2016; 84.4% - 2017; 84.8% - average value 2016-2017);

3. Acrobat MZ 69 WG + Laser 240 SC: for *Alternaria porri* f.sp. *solani*, *Botrytis cinerea*, *Phytophthora parasitica* and *Helicoverpa armigera* (average E = 84.2% - 2016; 84.2% - 2017; 84.2% - average value 2016-2017);

4. Melody Compact 49 WG + Mospilan 20 SG: for *Alternaria porri* f.sp. *solani*, *Botrytis cinerea*, *Phytophthora parasitica*, *Leptinotarsa decemlineata* and *Macrosiphum euphorbiae* (average E = 83.1% - 2016; 83.4% - 2017; 83.2% - average value 2016-2017);

5. Melody Compact 49 WG + Vertimec 1.8 EC: for *Alternaria porri* f.sp. *solani*, *Botrytis cinerea*, *Phytophthora parasitica* and *Tetranychus urticae* (average E = 84.2% - 2016; 84.37% - 2017; 84.2% - average value years 2016-2017);

6. Melody Compact 49 WG + Laser 240 SC: for *Alternaria porri* f.sp. *solani*, *Botrytis cinerea*, *Phytophthora parasitica* and *Helicoverpa armigera* (average E = 83.7% - 2016; 83.4% - 2017; 83.5% - average value 2016-2017);

7. Ortiva Top + Mospilan 20 SG: for *Alternaria porri* f.sp. *solani*, *Botrytis cinerea*, *Phytophthora parasitica*, *Leptinotarsa decemlineata* and *Macrosiphum euphorbiae* (average E = 83.7% - 2016; 85.0% - 2017; 84.35% - average value 2016-2017);

8. Ortiva Top + Vertimec 1.8 EC: for *Alternaria porri* f.sp. *solani*, *Botrytis cinerea*, *Phytophthora parasitica* and *Tetranychus urticae* (average E = 85.5% - 2016; 85.0% - 2017; 85.0% - average value 2016-2017);

9. Ortiva Top + Laser 240 SC: for *Alternaria porri* f.sp. *solani*, *Botrytis cinerea*, *Phytophthora parasitica* and *Helicoverpa armigera* (average E = 84.1% - 2016; 83.2% - 2017; 83.6% - average value 2016-2017);

The average efficacy of the treatment variants experienced in 2016 and 2017 varied between 83.2% (V4) and 85.0% (V8) depending on the combination of products pathogens and pest control.

Table 2. The efficacy of some combinations of fungicides with insecticides - acaricides in controlling of pathogens and pests in the eggplant crop in the field (Vidra, 2016)

Variant	Pathogens and pests														Average efficacy (%)*
	<i>Alternaria porri</i> f.sp. <i>solani</i>		<i>Botrytis cinerea</i>		<i>Phytophthora parasitica</i>		<i>Leptinotarsa decemlineata</i>		<i>Macrosiphum euphorbiae</i>		<i>Tetranychus urticae</i>		<i>Helicoverpa armigera</i>		
	DA (%)	E (%)	DA (%)	E (%)	DA (%)	E (%)	DA (%)	E (%)	DA (%)	E (%)	DA (%)	E (%)	DA (%)	E (%)	
V1.	2.0	85.8	2.3	79.5	1.5	88.2	2.0	79.2	1.3	85.4	4.1	49.4	3.6	63.3	83.6
V2.	2.1	85.1	2.4	78.6	1.6	87.4	4.5	53.1	3.5	60.7	0.8	90.1	4.1	58.2	85.3
V3.	2.3	83.7	2.6	76.8	1.3	89.8	4.7	54.0	3.0	66.3	4.5	44.4	1.3	86.7	84.2
V4.	2.5	82.3	2.4	78.6	1.1	91.3	1.7	82.3	1.7	80.9	4.4	45.7	3.9	60.2	83.1
V5.	2.7	80.8	2.6	76.8	1.4	89.0	4.8	50.0	3.8	57.3	0.8	90.1	4.2	57.1	84.2
V6.	2.4	83.0	2.7	75.9	1.5	88.2	5.1	46.9	3.4	61.8	4.5	44.4	1.2	87.7	83.7
V7.	2.2	84.4	1.5	86.6	2.1	83.5	1.9	80.2	1.5	83.1	3.9	51.8	3.7	62.2	83.7
V8.	2.5	82.3	1.6	85.7	1.9	85.0	4.7	51.0	3.9	56.2	0.9	88.9	4.4	55.1	85.5
V9.	2.3	83.7	1.8	83.9	2.4	81.1	5.3	44.8	3.3	62.9	4.6	43.2	1.2	87.7	84.1
V10.	14.1	-	11.2	-	12.7	-	9.6	-	8.9	-	8.1	-	9.8	-	-

* Only values above 75% were taken into account when calculating the average efficacy

Table 3. The efficacy of some combinations of fungicides with insecticides - acaricides in controlling of pathogens and pests in the eggplant crop in the field (Vidra, 2017)

Variant	Pathogens and pests														Average efficacy (%)*
	<i>Alternaria solani</i>		<i>Botrytis cinerea</i>		<i>Phytophthora parasitica</i>		<i>Leptinotarsa decemlineata</i>		<i>Macrosiphum euphorbiae</i>		<i>Tetranychus urticae</i>		<i>Helicoverpa armigera</i>		
	GA (%)	E (%)	FA (%)	E (%)	FA (%)	E (%)	GA (%)	E (%)	GA (%)	E (%)	GA (%)	E (%)	FA (%)	E (%)	
V1.	1.7	85.0	2.0	79.6	1.3	87.6	1.8	79.3	1.1	85.7	3.9	42.6	3.4	58.5	83.4
V2.	1.9	84.8	2.2	77.5	1.5	85.7	4.2	51.7	3.2	58.4	0.7	89.7	4.0	51.2	84.4
V3.	2.1	83.2	2.3	76.5	1.0	90.5	4.5	48.3	2.8	63.6	4.6	32.3	1.1	86.6	84.2
V4.	2.2	82.4	2.2	77.5	0.8	92.4	1.5	82.7	1.4	81.8	4.2	38.2	3.7	54.9	83.4
V5.	2.5	80.0	2.4	75.5	1.0	90.5	4.6	47.1	3.5	54.5	0.6	91.2	3.9	52.4	84.3
V6.	2.3	81.6	2.4	75.5	1.2	88.6	4.8	44.8	3.0	61.0	4.3	36.8	1.0	87.8	83.4
V7.	2.0	84.0	1.3	86.7	1.8	82.8	1.7	80.4	1.2	84.4	3.7	45.6	3.4	58.5	83.7
V8.	2.3	81.6	1.3	86.7	1.6	84.8	4.4	49.4	3.7	51.9	0.9	86.8	4.1	50.0	85.0
V9.	2.1	83.2	1.5	84.7	2.0	80.9	4.9	43.7	2.9	62.3	4.8	29.4	1.3	84.1	83.2
V10.	12.5	-	9.8	-	10.5	-	8.7	-	7.7	-	6.8	-	8.2	-	-

* Only values above 75% were taken into account when calculating the average efficacy

In 2016, the yield obtained from the eggplant crop in the field were between 33.5 t / ha (V 1) and 43.1 t / ha (V 6), and for the untreated control variant it was 30.4 t / ha (table 4). The highest yields were obtained at variants 6 (43.1 t / ha; 141.8%), 5 (38.9 t / ha; 127.9%) and 4 (38.1 t / ha; 125 ,3 %).

Table 4. Influence of treatments with different combinations of pesticides on the yield of eggplant in the field (Vidra, 2016)

Variant	Yield				Significance
	kg/m ²	t/ha	% compared to the untreated control variant	Difference from untreated control variant (t / ha)	
V1.	3.35	33.5	110.2	+ 3.1	***
V2.	3.43	34.3	112.8	+ 3.9	***
V3.	3.66	36.6	120.4	+ 6.2	***
V4.	3.81	38.1	125.3	+ 7.7	***
V5.	3.89	38.9	127.9	+ 8.5	***
V6.	4.31	43.1	141.8	+ 12.7	***
V7.	3.44	34.4	113.2	+ 4.0	***
V8.	3.55	35.5	116.8	+ 5.1	***
V9.	3.74	37.4	123.0	+ 7.0	***
V10.	3.04	30.4	-	-	-

LSD 5% = 0.771; LSD 1% = 1.051; LSD 0.1% = 1.423

In 2017 the yields obtained from the eggplant crop in the field were between 34.6 t / ha (V 1) and 44.0 t / ha (V 6), and in the untreated control variant it was 31.1 t / ha (table 5). The highest yields were obtained at variants 6 (44.0 t / ha; 141.5%), 5 (39.8 t / ha; 128.0%) and 4 (38.7 t / ha; 124 .4 %).

Table 5. The influence of treatments with different combinations of pesticides on the yield of eggplant in the field (Vidra, 2017)

Variant	Yield				Significance
	kg/m ²	t/ha	% compared to the untreated control variant	Difference from untreated control variant (t / ha)	
1.	3.46	34.6	111.2	+ 3.5	***
2.	3.48	34.8	111.9	+ 3.7	***
3.	3.74	37.4	120.2	+ 6.3	***
4.	3.87	38.7	124.4	+ 7.6	***
5.	3.98	39.8	128.0	+ 8.7	***
6.	4.40	44.0	141.5	+ 12.9	***
7.	3.52	35.2	113.2	+ 4.1	***
8.	3.61	36.1	116.1	+ 5.0	***
9.	3.82	38.2	122.8	+ 7.1	***
10.	3.11	31.1	-	-	-

LSD 5% = 1.157; LSD 1% = 1.578; LSD 0.1% = 2.136

CONCLUSIONS

- The application of three treatments with the combinations between Acrobat MZ 69 WG, Melody Compact 49 WG or Ortiva Top with Mospilan 20 SG ensured a good protection of the eggplant plants from the attack of harmful organisms like: *Alternaria porri* f.sp. *solani*, *Botrytis cinerea*, *Phytophthora parasitica*, *Leptinotarsa decemlineata* and *Macrosiphum euphorbiae*;
- The combinations between Acrobat MZ 69 WG, Melody Compact 49 WG or Ortiva Top with Vertimec 1.8 EC protected well the eggplant plants from the attack of pathogens of *Alternaria porri* f.sp. *solani*, *Botrytis cinerea*, *Phytophthora parasitica* and the pest *Tetranychus urticae*;
- The combinations between Acrobat MZ 69 WG, Melody Compact 49 WG or Ortiva Top with Laser 240 SC ensured a good protection of the eggplant plants from the attack of harmful organisms like *Alternaria porri* f.sp. *solani*, *Botrytis cinerea*, *Phytophthora parasitica* and *Helicoverpa armigera*;
- The best results in terms of yield were obtained in variants 6, 5 and 4 (V 6 - Melody Compact 49 WG 0.2% + Laser 240 SC 0.05 - 43.1 t / ha in 2016 and 44 t / ha in 2017; V 5 - Melody Compact 49 WG 0.2% + Vertimec 1.8 EC 0.1% - 38.9 t / ha in 2016 and 39.8 t / ha in 2017; V4 - Melody Compact 49 WG 0.2% + Mospilan 20 SG 0.04% - 38.1 t / ha in 2016 and 38.7 t / ha in 2017).
- In variant 6, the yield had increased from 12.7 t / ha in 2016 to 12.9 t / ha in 2017; in variant 5, the production had increased compared to the untreated control from 8.5 t / ha in 2016 to 8.7 t / ha in 2017 and in variant 4 the yield had increased compared to the untreated control from 7.7 t / ha in 2016 and 7.6 t / ha in 2017;
- We appreciate that the superior yield results obtained for these variants are due especially to the high efficacy of the fungicide Melody Compact 49 WG on the fungus *Phytophthora parasitica* (89.7%, respectively 89.5 on average over the two years).

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