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ASPECTS OF THE PATHOGENS CONTROL IN FALL-SUMMER FIERLD TOMATO (*LYCOPERSICON ESCULENTUM* MILL.,) CROPS IN THE REGION VIDRA, ILFOV

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Abstract
The research undertaken was aimed to identify the combinations of fungicides for the control of the complex of pathogenic agents which manifest themselves in tomato crops in the field. A monofactorial experiment was organized, placed in randomized blocks with five different experimental variants in four repetitions. Pontica tomato was used. During the growing season the treatments applied were correlated with the appearance and development of the attack of pathogens, depending on climatic factors. The appearance and development of attack are favored by the annual precipitation, humidity and temperature. The following pathogens have been identified and their degree of attack on the foliage: Pseudomonas tomato, Alternaria spp., Fulvia fulva, Phytophthora infestans, the degree of attack is 5.3% (variant 1), 6.8% (variants 2 and 3) and 8.2% (variant 4), compared to 49.5% in version of the untreated control fruits was identified Phytophthora parasitica, Alternaria spp and Colletotrichum coccodes.
The highest yield 6.834 kg/m2 was recorded to variant 1, followed by variant 3 with 6.674 kg/m2 and variant 2 with 6.420 kg/m2 compared to the yield obtained from the untreated control variant 5.064 kg/m2. From the therapeutic modalities tested, variant 1 and 3 showed the most positive results in terms of production and efficiency.

Keywords: fungicides, pathogens, tomato, yield.

1. INTRODUCTION

The Tomato (*Lycopersicon esculentum* Mill,) is one of the most widely cultivated vegetables in the word. Tomates are rich in minerals, vitamins,essential amino acids, sugar and dietory fibers which contribute to a healthy diet (Xiaodan et al., 2016).
The largest areas cultivated with tomatoes are in China, India, Nigeria, Turkey, Egypt and USA. In Romania, in 2014, there were grown 43852 hectares, with a production of 161042 t/ha yield (FAO, 2014).
More than 20 fungal diseases commonly occur on tomato plants. Nine of the fungal diseases are more common and prevalent on tomatoes, which include gray mold (*Botrytis cinerea*), *Septoria* leaf spots (*Septoria lycopersici*), early blight (*Alternaria solani*), anthracnose (*Colletotrichum coccodes*), *Fusarium* wilt (*Fusarium oxysporum* f. sp. *lycopersici*), pustular staining fruit (*Pseudomonas tomato)*, late blight (*Phytophthora infestans*), leaf mold (*Fulvia fulva*), and root rot, stem and fruit (*Phytophthora parasitica*). Leaf mold occurs mainly in indoor (greenhouse and high-

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tunnel) production. The other eight diseases are most common in open-field production (Babadoost, 2011).

Alternaria sp. is a heterogenic group of fungi, widespread distributed in nature (G. YAMH). Although host affinity is variable often they may be found in conjunction (Nowicki et al., 2012). Species of the genus *Alternaria* colonize the seeds of different species of culture, for some species of *Alternaria* there was also a distribution of the attack in different areas of Romania (Berca et al., 2015). A description of the genres *Alternaria* and *Phytophthora* is made by Gheorghies and Cristea (Gheorghies et al., 2001). Forecasting and warning methods have been developed for *Phytophthora infestans* and *Alternaria porri* f.sp, *solani* under field conditions (Cristea, 2001). The influence of abiotic factors on the development of *Alternaria* species under laboratory conditions has been studied (Mardare et al., 2015).

The research untertaken to RDIVFG Vidra aimed at identifying combinations of fungicides for the simultaneous control of the complex of pathogens depending on the phenological stage of the tomato plants and the alternation of these treatment variants to prevent the occurrence of the phenomenon of resistance to various active substances of fungicides.

2. MATERIALS AND METHODS

A monofactorial experience was organized with 5 experimental variants, placed in randomized blocks in 4 repetitions. Tomato variety *Pontica* was used, created at RDIVFG Vidra. The planting was done on May 23, 2016 on molded land, with polyethylene black foil. There were planting in bands by two rows at a distance of 50 cm, with 35 cm between plants on the row and 100 cm between bands. Climate date was recorded during vegetation (temperature average, minimum, maximum, atmospheric humidity average, minimum, maximum and the precipitations amount; table 4). To prevent the occurrence of the attack and to control the pathogens, the fungicides present in Table 1 and the experimental variants in Table 2 were used. During the vegetation period, 6 treatments related to the occurrence and evolution of the pathogen attack were applied depending on the climatic factors.

Table 1. Products used to control pathogens to the tomato crop (Vidra, 2016)

Product	*Activ substance*	*Pause time (days)*
Dithane M 45 WP	*mancozeb 80 %*	*14*
Topsin 500 SC	*thiophanate methyl 500 g/l*	*14*
Bravo 500 SC	*chlorothalonil 500 g/l*	*3*
Polyram DF WP	*metiram 80 %*	*4*
Cabrio Top	*piraclostrobin 5 % + metiram 50 %*	*7*
Melody Compact 49 WG	*iprovalicarb 8,4 % + oxychloride Cu 40 %*	*7*
Acrobat MZ 69 WG	*dimethomorph 9 % + mancozeb 60 %*	*7*
Ridomil Gold Plus 42,5 WP	*mefenoxam 2,5 % + copper 40 %*	*7*

When the pests appeared, general treatments with the following insecticides were applied: Mavrik 2F 0,05% şi Mospilan 20 SG 0,0175% for *Macrosiphum euphorbiae (green hawthorn of solanaceae)* Mavrik 2 F 0,05% şi Laser 240 SC 0,05% for (*Thrips tabaci the trip of the tobacco*); Coragen 20 SC 0,0175 %, Alverde 24 SC 0,1% and Affirm 95 SG 0,15% for *Helicoverpa armigera (bollworm).*

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Table 2 .Variations to combat the culture of tomato pathogens in field (Vidra, 2016)

Variant	*July*	*August*	*September*
	Treatment 1	*Treatment 2, 3, 4*	*Treatment 5, 6*
1.	*Dithane M 45 0,2 % + Topsin 500 SC 0,1 %*	*2. Dithane M 45 0,2 % + Cabrio Top 0,2 %* *3, 4.Melody Compact 49 WG 0,2 %*	*5,6. Melody Compact 49 WG 0,2 % +Cabrio Top 0,2 %*
2.	*Bravo 500 SC 0,2 % + Topsin 500 SC 0,1 %*	*2. Bravo 500 SC 0,2 % + Cabrio Top 0,2 %* *3, 4. Acrobat MZ 69 WG 0,2 %*	*5,6. Acrobat MZ 69 WG 0,2 % + Cabrio Top 0,2 %*
3.	*Polyram DF 0,2 % + Topsin 500 SC 0,1 %*	*2. Polyram DF 0,2 % + Cabrio Top 0,2 %* *3.4. Ridomil Gold Plus 42,5 WP 0,3 %*	*5,6. Ridomil Gold Plus 42,5 WP 0,3% +Cabrio Top 0,2 %*
4.	*Cabrio Top 0,2 % + Topsin 500 SC 0,1%*	*2. Bravo 500 SC 0,2 % + Cabrio Top 0,2 %* *3,4. Bravo 500 SC 0,2 %*	*5,6. Bravo 500 SC 0,2 % + Cabrio Top 0,2 %*
5.	*Untreated control*	-	-

The efficacy of the treatment was assessed on the variants based on the frequency of attacks (in fruit) or according to the degree of attack (the foliage). Efficacy % was calculated using the formule E% = (M-Vt)/M×100 (where M = untrated control and Vt = variant of tratament). There has been also the variations and repeatable production. Observations were made on the frequency and intensity of the attack of pathogens both in plant leaves and fruits. The production data was processed by the variance analysis method. For this purpose a rating scale was used from 0 at 6 (0=no attack; 1=>0-3%the foliage symptoms; 2=>3-10%the foliage symptoms; 3=>10-25%the foliage symptoms;; 4=>25-50%the foliage symptoms; 5=>50-75%the foliage symptoms;6=> 75-100%) on the basis of which the intensity of the attack was calculated.

3. RESULTS AND DISCUSSIONS

During 2016, the following pathogens were identified in the tomato culture (variety *Pontica*) *Pseudomonas tomato, Alternaria spp, Fulvia fulva, Phytophthora infestans* on the leaves, *Phytophthora parasitica, Alternaria spp*, *Colletotrichum coccodes* si *Phytophthora infestans* on the fruit. The symptoms produced by pathogens to the foliage or fruits are shown in figures 1, 2, 3, 4, 5, 6, 7 and 8.

Figure 1. Attack by Pseudomonas syringae pv.tomato on the leaves

Figure 2. Attack by Alternaria spp.,on the leaves

Figure 3. Attack by Alternaria spp., on the fruit

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Figure 4. Attack by Fulvia fulva on the leaves

Figure 5. Attack by Phytophthora infestans on the leaves

Figure 6. Attack by Phytophthora infestans on the fruit

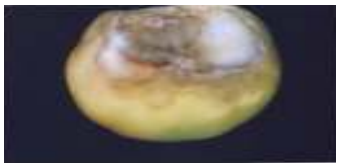

Figure 7. Attack by Phytophthora parasitica on the fruit

Figure 8. Attack by Colletotrichum coccodes on on the fruit

Table 3. Factors that favor the appearance and evolution of tomato attack pathogens (Costache et al., 2007)

The pathogen	Factors favoring		
	T (^{0}C)	UR (%)	Water on foliage
Pseudomonas tomato	19– 23	>85	–
Alternaria spp.	25– 28	>95	+
Fulvia fulva	21 – 26	>95	+
Phytophthora infestans	15 – 18	100	+
Phytophthora parasitica	20 – 25	100	water film
Colletotrichum coccodes	25 – 27	>95	+

Table 4.Climate data in the field (Vidra, 2016)

Period	Temperature (^{0}C)			Atmospheric humidity (%)			The precipitations amount (mm)	Soil temperature at hour 8(^{0}C)
	min	max	avarage	min	max	avarage		
01-10 July	16.6	28.8	22.4	56.0	85.1	66.9	0	23.0
11- 20 July	16.4	31.2	28.4	46.8	77.5	59.1	0	23.3
21-31 July	18.0	32.6	24.9	43.1	76.3	54.4	2	24.0
01-10 August	18.8	32.9	26.2	44.4	73.6	56.1	0	23.8
11-20 August	16.0	29.8	22.6	58.0	79.8	62.6	34.5	22.1
21-31 August	17.8	30.0	23.2	52.3	77.5	62.1	72.5	22.2
01-10 Sept.	15.7	29.7	21.9	45.3	75.5	56.5	0	20.1
11-20 Sept.	15.4	28.7	21.1	52.6	78.7	62.3	31.0	19.9
21 - 30 Sept.	8.2	20.9	13.9	55.0	86.6	67.4	3.0	12.6

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Climatic data was recorded during the vegetation period. In the experimental field it was installed a precipitometer to record the precipitations. In the summer of 2016, recorded low rainfall in June recorded 2 mm, August 107 mm.

In Table 5 is presented the influence of climatic factors on the appearance and evolution of the attack of pathogens in tomato crops in the field.

Table 5. Influence of climatic factors on the occurrence and evolution of the attack pathogens to tomato field cultivation (Vidra, 2016)

Pathogenic agents and climatic factors	*Month/decade*					
	July		*August*			*September*
	II	*III*	*I*	*II*	*III*	*I*
	The degree of attack on the foil (%)					
Pseudomonas syringae pv.tomato	*0.1*	*0.3*	*0.8*	*7.7*	*11.1*	*13.2*
Alternaria ssp	*0*	*0.1*	*0.6*	*2.4*	*12.3*	*16.5*
Fulvia fulva	*0*	*0*	*0.6*	*4.2*	*6.9*	*10.6*
Phytophthora infestans	*0*	*0*	*0*	*1.8*	*7.5*	*8.8*
	Frequency of attacked fruits (%)					
Phytophthora parasitica	*0*	*0*	*0*	*4.4*	*14.8*	*19.7*
Alternaria solani	*0*	*0*	*0*	*2.0*	*6.4*	*9.8*
Colletotrichum coccodes	*0*	*0*	*0*	*0.3*	*4.2*	*6.7*
Phytophthora infestans	*0*	*0*	*0*	*0.6*	*3.4*	*4.9*
Temperature minimum (ºC)	*16.5*	*18.0*	*18.7*	*15.8*	*19.6*	*15.8*
Temperature avarage (ºC)	*28.0*	*29.6*	*30.9*	*25.6*	*30.1*	*25.1*
Temperature maximum (ºC)	*31.3*	*35.9*	*32.6*	*29.3*	*33.0*	*29.9*
Minimum relative humidity (%)	*46.9*	*43.1*	*43.3*	*52.7*	*57.5*	*45.0*
Avarage relative humidity (%)	*59.7*	*57.6*	*57.3*	*67.2*	*72.3*	*50.5*
Maximum relative humidity (%)	*77.7*	*73.6*	*72.8*	*81.2*	*85.3*	*74.2*
Precipitation (mm)	*0*	*2.0*	*0*	*37.5*	*72.3*	*34.0*

The appearance and evolution of the attack on the fruit (*Phytophthora parasitica*, *Alternariaspp*, *Colletotrichum coccodes*, *Phytophthora infestans*) was favored by the fall of the decade II (37.5 mm) and decade III (72.3 mm) of August.In decade I of September, the degree of attack of follicular pathogens was of 13.2% (*Pseudomonas syringae* pv. *tomato*), 16.5% (*Alternaria spp*), 10.6% (*Fulvia fulva*) and respectively 8.8% (*Phytophthora infestans*) to the untreated control (table 5). The degree of total attack (%) on the foil, of patogens *Pseudomonas syringae pv. tomato*, *Alternaria spp*, Cladosporium fulvum şi *Phytophthora infestans (table 6)*, has been of 5.3 (variant 1), 6.8% (variants 2 and 3) and respectively 8.2% (variant 4; table 6), compared to 49.5% to the untreated control.The efficacy of the treatment variants experienced was, in terms of foil protection, over 80.0%: 89.3% (variant1; place I), 86.3% (variants 2 and 3; place II) and 83.4% (variant 4; place III).

The frequency of the attacked fruit was, at the end of the decade I of September 19.7% (*Phytophthora parasitica*), 9.8% (*Alternaria spp)*, 6.7% (*Colletotrichum coccodes*) and respectively 4.9% (*Phytophthora infestans*) to the untreated control (table 7). The highest frequency of attacked fruits (19.7%) was recorded for the pathogen *Phytophthora parasitica,* to the untreated control and was favored by the heavy rainfall in the decades II and III of August (109.8 mm).Total frequency (%) of the attacked fruit was of 6.2 % (variant 1), at variant untreated control was by 41.1% (table7). The best efficacy with regard to fruit protection was provided by variant 1 (84.8%) followed by variants 3 (79.6%) and 2 (79.3%).If we refer both to the protection of foliage and fruit, the average efficacy has been 87.1% (variant 1; place I), of 84.8 % (variant 3; place II) and 82.8% (variant 2; place III). The frequency of the attacked fruit was at the end of the first decade of

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September 19.7% (*Phytophthora parasitica*), 9.8% (*Alternaria spp),* 6.7% (*Colletotrichum coccodes*) and respectively 4.9% (*Phytophthora infestans*) at the untreated control (table 7). The highest frequency of attacked fruits (19.7%) was recorded for the pathogen *Phytophthora parasitica* to the untreated witness was favored by the heavy rainfall of the second and third decades of August (109.8 mm). The total frequency (%) of the attacked fruit was 6.2% (variant1), and 41.1%to the untreated control variant. The best efficacy with regard to fruit protection was provided by variant 1 (84.9%) followed by variants 3 (79.6%) and 2 (79.3%). If we refer both to the protection of foliage and fruit, the average efficacy was 87.1% (variant 1, place I), 84.8% (variant 3, place II and 82.8% (variant 2; place III).

Table 6. The efficacy of treatment with fungicides variants of the tomato crop in the field (Vidra, 2016)

Variant	*The degree of attack on the leaves (%)*					
	Pseudomonas syringae pv. Tomato	*Alternaria spp*	*Fulvia fulva*	*Phytophthora infestans*	*Total*	*Effectiveness (%)*
1.	*1.1*	*1.8*	*1.4*	*1.0*	*5.3*	*89.3 (I)*
2.	*2.2*	*2.0*	*1.3*	*1.3*	*6.8*	*86.3 (II)*
3.	*2.0*	*2.2*	*1.5*	*1.1*	*6.8*	*86.3 (II)*
4.	*1.8*	*1.6*	*1.2*	*3.6*	*8.2*	*83.4 (III)*
5.	*13.3*	*16.6*	*10.7*	*8.9*	*49.5*	*-*

Table 7. The efficacy of treatment with fungicides variants of the tomato crop in the field (Vidra, 2016)

Variant	*Frequency of attack (%) on fruit*						*Effectiveness avarage (%)*
	P. parasitica	*A. spp*	*C. coccodes*	*P. infestans*	*Total*	*Effectiveness (%)*	
1.	*3.4*	*1.6*	*0.6*	*0.6*	*6.2*	*84.9(I)*	*87.1*
2.	*4.9*	*1.9*	*0.8*	*0.9*	*8.5*	*79.3 (III)*	*82.8*
3.	*4.6*	*1.7*	*1.0*	*1.1*	*8.4*	*79.6 (II)*	*84.8*
4.	*8.2*	*2.4*	*1.8*	*2.3*	*14.7*	*64.2(IV)*	*73.8*
5.	*19.7*	*9.8*	*6.7*	*4.9*	*41.1*	*-*	*-*

The highest production – 6.834 kg/m2 was also recorded for variant 1 (place I), followed by variant 3 with 6.674 kg/m2 (place II) and variant 2 with 6.420 kg/m2 (place III) compared with the production obtained at the untreated control variant of only 5.064 kg/m2 (Table 8). Relatively high production of the untreated control variant is due to the fact that the pathogen attack was late and evolved in the second and third decades of August and the first decade of September.

Table 8. Production of tomatoes in the field (Vidra, 2016)

Variant	*Productions*		
	kg/m^2	*t/ha*	*%*
1.	*6.834*	*68.340*	*134.9 (I)*
2.	*6.420*	*64.200*	*126.8 (III)*
3.	*6.674*	*66.740*	*131.8 (II)*
4.	*5.430*	*54,300*	*107.2*
5.	*5.064*	*50.640*	*100.0*

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Of the experimental treatment variants, the production achieved has also been remarked variants 1 and 3. Variant1:

- July - treatment 1: Dithane M 45 0,2% + Topsin 500 SC 0,1%;
- August
  - treatment 2: Dithane M 45 0,2 % + Cabrio Top 0,2%;
  - treatments 3 and 4: Melody Compact 49 WG 0,2%;
- September - treatments 5 and 6: Melody Compact 49 WG 0,2% + Cabrio Top 0,2%

Variant 3:

- July - treatment 1: Polyram DF 0,2 % + Topsin 500 SC 0,1 %;
- August
  - treatment 2: Polyram DF 0,2 % + Cabrio Top 0,2 %;
  - treatments 3and 4: Ridomil Gold Plus 42,5 WP 0,3 %;
- September - treatments 5and 6: Ridomil Gold Plus 42,5 WP 0,3% + Cabrio Top 0,2 %

Table 9. Production of field tomatoes in the field

Variant	*Production*			
	kg/m2	*%*	*The difference from untreated variant kg/mp)*	*Signification*
1.	*6.834*	*134.9 (I)*	*1.770*	***
2.	*6.420*	*126.8 (III)*	*1.356*	***
3.	*6.674*	*131.8 (II)*	*1.610*	***
4.	*5.430*	*107.2*	*0.366*	*
5.	*5.064*	*100.0*	*-*	*-*

DL 5%=0.337; DL 1% =0.466; DL 0,1%=0.644

Analyzing the data presented in Table 8 it is found that the production differences obtained in addition to the untreated control variant are very significant for variants 1, 2 and 3 and significant for variant 4.

4. CONCLUSIONS

During fall-summer tomatoes croping, pathogens that frequently attacked are *Pseudomonas tomato*, *Alternaria spp., Fulvia fulva*, *Phytophthora infestans*, *Phytophthora parasitica, Colletotrichum coccodes.* The occurrence and evolution of the attack are favored by annual rainfall,of atmospheric humidity >90% under conditions where the temperature may vary within larger limits(20 -30^{0}C). Among the tested treatment variants, the outputs of variants 1 and 3 were also marked by efficiency: Variant 1 - with a production of 6.834 kg/m2, variant 3 - with a production of 6.674 kg/m2. During the harvesting period it is mandatory to observe the recommended break time.

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