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## Integrated management for Apple scab {*Venturia inaequalis* (Cooke) Wint} in the region of Puka in Albania

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**Abstract:** The fungus *Venturia inaequalis* infects members of the Maloideae, and causes the disease apple scab, the most important disease of apple worldwide. With the cultivation of susceptible commercial apple cultivars, apple scab control is becoming more difficult, such that losses caused by apple scab would be about 70% if no control measures were taken. The experiment is carried out at Qerret (Puka region) Albania, during the years 2012 and are chemicals tested: - Armicarb®100 (85% KHCO<sub>3</sub> from Helena Chemical Company, USA), 2- Kresoxim-methyl, from BASF, Belgium), 3- Thiovit jet (80% micronized sulphur, from Syngenta Agro S.A.S., France) and 4-control (un treatments). The objective of this study was to evaluate the effectiveness of bicarbonates used alone or combined with horticultural oils for the control of apple scab in order to develop a successful strategy using environmentally friendly substances compatible with the organic production system.

**Key words:** Apple scab, aeciospores, orchards, Integrated Pest Management, fungicides.

## INTRODUCTION

Scab is the most important disease of apples. Its primary effect is reduction of the quality of infected fruit. Scab also reduces fruit size or results in premature fruit drop, defoliation, and poor fruit bud development for the next year, and it reduces the length of time infected fruit can be kept in storage. Losses from apple scab may be 70% or more of the total fruit value. In most apple-producing areas, no marketable fruit can be harvested if scab control measures are not taken<sup>1</sup>,

Apple tree is one of the most importance fruit tree and at least 55 million ton has been the yield of apple in the world, with a value by 10 milliard dollars for the year 2005. Between the countries, USA are the first one with 7.5 % of the world apple production Turkey, France, Italia, Iran are the most importance apple production exporter in the world<sup>2</sup>. In Puka region, comparing with the other fruit trees, apple tree is the most importance. Based on the data of Regional Directorate of Agriculture, Food and Consumer Protection in Albania in this region are planted 16800 apple trees. In blocks there are about 122 ha with 9400 plants. The most importance apple varieties are Golden Delicious, Starching, Jonathan, Idaret, Rennet, Granysmith etc. In fruit trees, besides of other problems, plants protection is the main, especially in the apple tree, because of it can be infected by many diseases such are apple scab, powdery mildew, fire blight, as well as by codling moth, aphids, mites. Comparing with the other diseases, apple scab (*Venturia inaequalis*) is more problematic<sup>3,4</sup>.

Apple scab *Venturia inaequalis* (Cook) Wint (perfect form) as well as conidial (imperfect) form *Fusicladium dentriticum* Wall. Fuck is the key disease for apple trees. Two forms of apple scab are spread in the all apple trees region cultivation, but especially at Nord East part of Albania there is more suitable condition apple trees cultivation because of optimal temperatures and humidity as well as for apple scab<sup>4</sup>.

## MATERIAL AND METHODS

**Experimental field:** The experiment is carried out at Qerret (Puka region), during the years 2012 at the Islam Djaloshi farm. The super faces of the parcel were 2.6 ha. The distance from the city of Puka is 5 km and the distance from the main axe of the road is 1.8 km. The parcel is at these geographic coordinates: 42° 07' 03'' Nord and 19° 49' 36'' East as well as 465 m above the level sea. Average annual temperatures are from 2.8° C on January at 17.7° C on June.

**Table- 1:** Fungicides used on apple scab (*Venturia inaequalis*) controlling.

No	Commercial name	Active ingredient (%) and Manufacturer	Rate of application
1	Armcarb® 100	85% KHCO <sub>3</sub> from Helena Chemical Company, USA	600gr/100 l
2	Kresoxim-methyl (Stroby WG)	Methyl(E)-2-methoxyimino-2-[2-(o-tolyloxymethyl) phenyl] acetate. BASF, Belgium	250gr/100 l
3	Pencozeb DG	Etilenbisditioarbamat of Zinkut and Magnezit from UNITED PHOSPHORUS LIMITED UK	250gr/100 l
4	Control	No treatments	-

The experiment is set up in randomized block where the main effects factor (Factor A is the cultivar) are seen in two levels (cv. Starching and Golden Delicious). Second factor (application time- the factor B) in two levels (taking in consider traditional treatments and table of Mills). Third factor (fungicidal treatment – the factor C) in four levels (1.Amicarb 100; 2.Kresoxim – metil; 3.Pencozeb DG; 4.Control).

Two cultivars are included in the study; Starching and Golden Delicious. Data about the fungicides used are in the **Table.1**

**Scab severity assessment:** Each year, disease assessments on the leaves and fruits were made. For leaf severity assessments, 10 shoots per tree were recorded about 60 days after flowering. Observations were made on 10 older leaves per shoot. A 1-9 global scab intensity scale was used whereby: 1 = no scab lesions; 2 =  $\leq 1\%$  infected leaves with at least one lesion; 3 =  $\leq 5\%$  infected leaves with at least one lesion; 4 = 5-50% infected leaves with at least one lesion; 5 =  $\geq 50\%$  leaves with lesions and with  $\leq 5\%$  leaf area spotted; 6 = 5-25% leaf area spotted; 7 = 25-50% leaf area spotted; 8 = 50-75% leaf area spotted; and 9 = maximum infection, leaves black with scab<sup>5</sup>

Severity and diffusion of infection were obtained by resorting to the McKinney index <sup>6</sup>modified from Cooke, B. M<sup>7</sup>. The McKinney index (Imc in %) was obtained by using the following formula:

$$DI (Imc) \% = \frac{\sum (f \times v)}{N \times X} \times 100$$

where: f = infection class frequencies; v = number of plants of each class; N = total of observed plants; X = highest value of the evaluation scale.

**Statistical analyze of the data:** For all the experiment data variance analyze (ANOVA) is used. Three factorial analyze (MANOVA) is done using statistical program ASSISTAT (2013) – Website <http://www.assistat.com> by Francisco de A.S. e Silva DEAG-CTRN-UFC<sup>8</sup>

Comparisons of averages of the disease index with control plot (without treatment) is done using Turkey Kramer<sup>9</sup> for two levels of probability p=0.05 and p= 0.001. For this aim statistical program SAS 2009 is used<sup>10</sup>

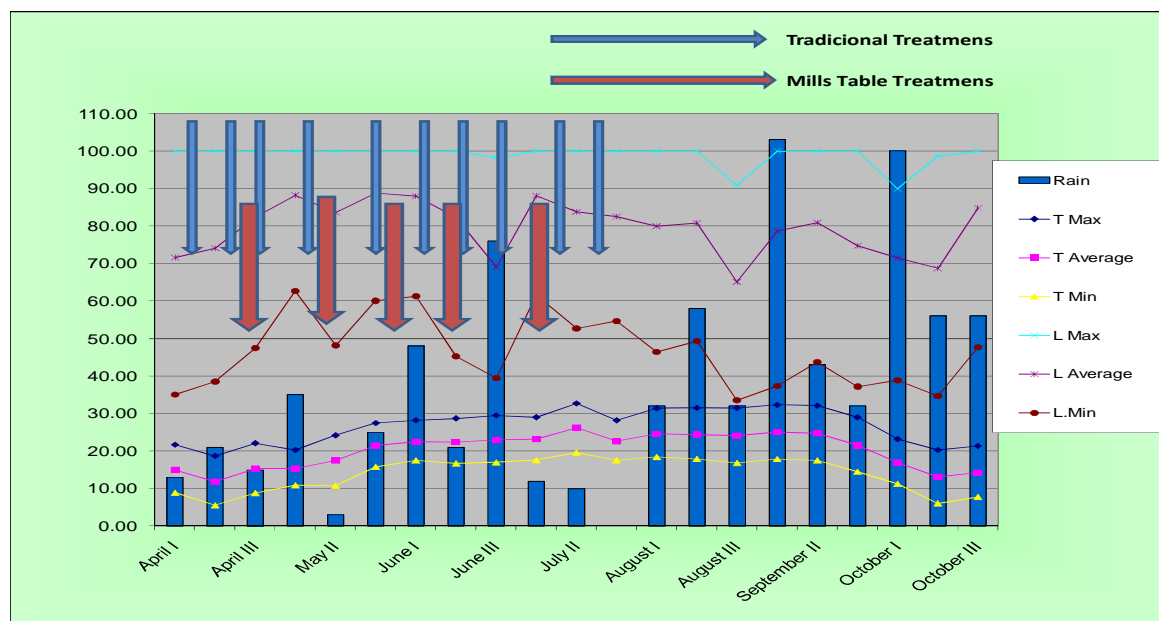
## RESULTS AND DISCUSSION

Average climatic data, temperature and rainfall, for the year 2012 which have happened at the Querret, Puke Albania are at the **Figure.1**.

From the figure 1 results that the weather has been warm during April as well as with a considerable rainfall at the second decade of the month, while it is reduced during the third decade of the April. At the first decade of May there was not rainfall while at the second decade of this month there was a lot of rainfall. Less rainfall there were at first part of June.

On the figure 1 are also data about temperatures (min, max, aver) as well as period treatments for the two used methods, Traditional and Mills table during the months April- October, 2012.

**Results about disease index:** Data about disease index for the year 2012 are presented at **Table 2**. The data on the Table 2 show that at the traditional treatment, for the cv. Starching, disease index (%) was from 18.5 % at the plot treated with Armicarb to 11.5 % at the plot treated with Kresoxim-methyl.



**Figure 1:** The data about temperatures (min, max, aver) as well as period treatments for the two used methods, Traditional and Mills table during the months April - October, 2012.

At the plot treated with Pencozeb disease index was 13.2 % while at the Control plot it was 52.5 %. For the Golden Delicious cultivar disease index was 22.25 % at the plot treated with Armicarb while at the plot treated with Kresoxim-methyl it was 10.89 %. At the plot which was treated with Pencozeb disease index was 13.9 % while at the control it was 48.25 %. Looking on the table.2, for the treatments by means of the Mills prediction table also for the year 2012, disease index for Starching cultivar at the plot treated with Armicarb was 17.5%, while it was 9.75 % at the plot treated with Kresixim –methyl. At the plot treated with Pencozeb, disease index was 12.5 % while at control it was 52.5 %. For the Golden Delicious cultivar, disease index, at the plot treated with Armicarb was 17.5 % while at the plot treated with Kresoxim –methyl was 9.5 %.

Differences between fungicides treatments used on apple scab controlling for the year 2012 are at the **Figure 2**, where for the traditional variant on Starching cultivar is showed on the left of the books plots diagram. Fungicides, blue rings, have significant differences for the probability  $P=0.05$  (Tukey Kramer test) and they are under the average value, in our case it is 23.9%.

Similar differences, between fungicides treatments on apple scab controlling for Golden Delicious cultivar is showed on the right of the above diagram (**Figure 2**). Fungicides (Kresoxim-methyl, Pencozeb and Armicarb), blue rings, have statistical significant differences (Tukey Kramer test) for a probability by 23.81 %. Differences between fungicides treatments used on apple scab controlling by means of table of Mills, for the year 2012, at Starching cultivar, are on the diagram **Figure 3**.

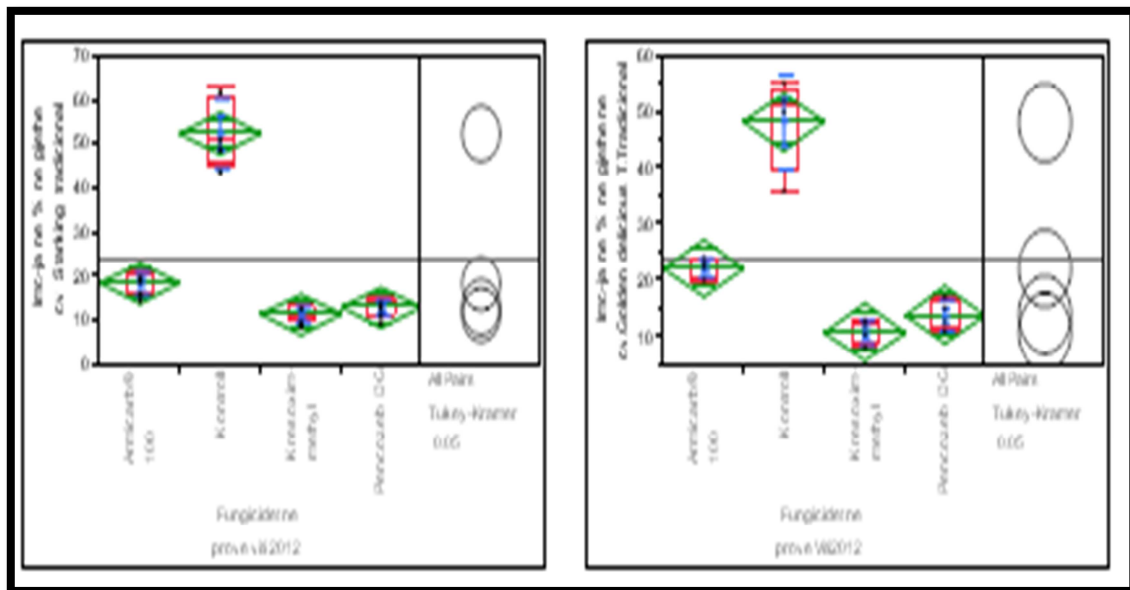
On the left of the diagram (**Figure 3**), used fungicides, blue rings, have statistical significant differences for the level of the probability 0.05 (Tukey Kramer test) which are under the general average value, 23 %.

Similar differences between the fungicidal treatments used for apple scab controlling at the Golden Delicious cultivar can be seen on the right of the diagram (**Figure 3**). Fungicides (Kresoxim –methyl, Pencozeb and Armicarb), blue rings, have statistical significant differences for the probability 0.05 % (Tukey Kramer test) which are under the general average value, 22.65 %.

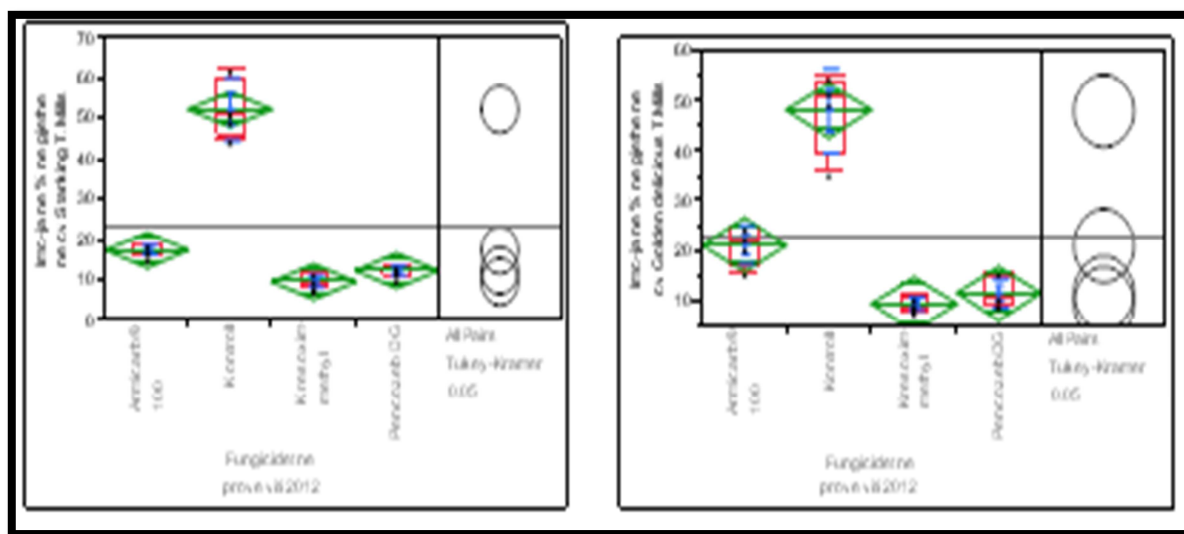
**Table 2:** Disease index (%) on leave caused by *V. inaequalis* (Cook) Wint for the year 2012

Cultivars Factori (A)	TREATMENT Factori (C)	TIME OF TREATMENT Factori (B)									
		TRADICIONAL TREATMENT Imc in %					MEANS OF MILLS TABLE TREATMENT. Imc- in %				
		P1	P2	P3	P4	Mes	P1	P2	P3	P4	Mes
Starching	Armicarb® 100	21	17	20	16	18.5b	19	17	18	16	17.5b
	Kresoxim-methyl	10	11	11	14	11.5b	9	10	8	12	9.75b
	Pencozeb DG	14	12.5	15	11	13.12b	13	12	14	11	12.5b
	Control	45	63	52	50	52.5a	45	63	52	50	52.5a*
	Means	90	103.5	98	91		86	102	92	89	
	Average	22.5	25.8	24.5	22.75	23.9	21.5	25.5	23	22.25	23
		smd** =2.96880per @=0.05 %					smd =2.96880per @=0.05 %				
Golden delicious.	Armicarb® 100	24	23	20	22	22.25b	25	23	21	16	21.25b
	Kresoxim-methyl	8	10.5	12	13	10.87b	8	10	11	9	9.5bc
	Pencozeb DG	15	12.6	11	17	13.9b	10	9.5	11	16	11.62c
	Control	52	50	36	55	48.25a	52	50	36	55	48.25a
	Means	99	96.1	79	107		95	92.5	79	96	
	Average	24.75	24	19.75	26.75	23.81	23.75	23.1	19.75	24	22.65
		smd =2.96880per @=0.05 %					smd =2.96880per @=0.05 %				

\* a = Levels not connected by same letter are significantly different \*\*smd = Significant minimum difference the Tukey Test at a level of 5% of probability



**Figure 2:** The diagram of book plots (variance, standard deviation, average of disease index) of apple scab on leave the year 2012 for treatments traditional.



**Figure 3:** The diagram of book plots (variance, standard deviation, average of diseases index) of apple scab on leave the year 2012 for table of Mills treatments.

**Table3:** Three factorial analyze (MANOVA) on apple scab index disease (%) for the year 2012

VS	DF	SS	MS	F	Probability
Cultivars A	1	0.97516	0.97516	0.0495	>0.050
Time Treatments B	1	16.10016	16.10016	0.8172	>0.050
Treatments ( Fungicides) C	3	16344.5254	5448.17516	276.5184 **	<0.001
Interactions AxB	1	0.40641	0.40641	0.0206	>0.050
Interactions AxC	3	128.30047	42.76682	2.1706 ns	0.1037
Interactions BxC	3	6.07547	2.02516	0.1028	>0.050
Interactions AxBxC	3	2.45672	0.81891	0.0416 *	<b>0.0228</b>
Total	15	16498.8398	1099.92266	55.8258 **	<0.001
Error	48	945.73250	19.70276		
Total VS	63	17444.5723			

**\*\* Significant at a level of 1% of probability ( $p < .01$ ) \*Significant at a level of 5% of probability ( $.01 \leq p < .05$ ) ns Non-significant ( $p \geq .05$ ) VS = Variation Source, DF = Degree of freedom, SS = Square Sum, MS = Mean Square, F = Statistics of the test.**

Using Statistical Program ASSISSTAT (2013) there are the results of the three factorial analyse for the three factors on the study (**Table 3**): Cultivars at two levels (Cv. Starching and Cv. Golden Delicious), time of the treatments (traditional treatments and by means of table of Mills), and fungicides treatments at four levels. These data are showed at the above table. From these data it can be concluded that the effects of the fungicide factor statistically significant for the level  $p \leq 0.01$ . This is proved from the factice value “ F “ for the fungicides =276.51 84 which results to be higher than theorise value “F” taking in consider Fisher table, where 276.5184 is more than 4.2192 for the level  $< 0.01$ . Also for the probability level by 0.05 is statistical significant the interaction effect of Cultivar x Fungicide (BxC) as well as interaction AxBxC. Taking in consider that the fungicides effect as well as interaction BxC (treatment time x fungicide) and AxBxC are significant, it means different effect of the fungicides for cv. Starching and cv. Golden Delicious cultivar as well as treatment method (Traditional treatment and by means of Mills table).

## CONCLUSION

The data of the experiment we are studying bring the effects of two factors (Fungicides(C) and Interaction (AXC) are statistically proven high level of veracity ( $p \leq 0.01$ ). BxC interaction effect (Timex treatment Fungicides) confirmed the 5% level of probability ( $0.01 \leq p < 0.05$ ). From the results obtained for 2012 it appears that Fungicides (Kresoxim-methyl and DGP encozeb give good results against Apple scab (*Venturia inaequalis* (Cooke) Wint) by applying the method with Mills.table treatments.

The result has given Bio fungicides Armicarb®100(85% KHCO<sub>3</sub> from Helena Chemical Company which is able to control better Apple scab (*Venturia inaequalis* (Cooke).

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