Utilization of RIMpro cloud services for managing of Apple scab in Kosovo

Edmond Rexhepi[1], Harallamb Paçe[2], Hekuran Vrapi[2], Arbenita Hasani[3]

[1]Department of Plant Protection, Agricultural University of Tirana, Tirana, Albania, e-mail: rexhepiedmond@yahoo.com
[2]Department of Plant Protection, Agricultural University of Tirana, Tirana, Albania, e-mail: ha.pace@yahoo.com; hvrapi@gmail.com
[3]Department of Food Technology, University of Prishtina, Prishtina, Kosovo, e-mail: arbenitahasani@gmail.com

Abstract. The fungus disease of Apple scab caused by *Venturia inaequalis* (Cooke) G. Wint remains the major problems for apple and pear farmers in Kosovo. In order to find out the best fungicide application timing intervals for managing of this fungus disease, for the first time in Kosovo it was used the decision support system RIM-pro (relative infection measure program) developed in Holland. This cloud services platform simulates the development of pseudothecia, ascospore maturation, discharge and infection development based on hourly received weather data and leaf wetness data from meteorological station sensors which are set up in the orchard. The experiment work was performed in one experimental apple orchard in region of Gjilan in Kosovo, during two years of research 2015-2016. Besides the finding of most appropriate treatment intervals this study emphasizes the importance of reducing of the number of fungicide seasonal treatments.

Keywords: Severity, RIMpro, apple scab, infection, treatments.

1 Introduction

Apple scab is the most serious fungal disease, affecting apple and pear trees. Its causal agent attacks foliage, blossoms and fruits, resulting in the defoliation of trees and making the fruits unmarketable (Meszka 2015). If the disease is not controlled, over 80% of fruits of susceptible cultivars can be damaged. Depending on the risk of disease, 10 to 15 or even more fungicidal applications are usually needed for efficient control (Meszka 2015). The number of treatments depends on cultivar susceptibility, the amount of source infection and weather conditions, mainly air temperature, leaf wetness, relative humidity and rainfall (Gadoury et al. 1998, Stensvand et al. 1998). In the IT software market, there are some software programs for agriculture or cloud platforms such as APPLESCAB (Blaise.1987), VENTEMTM (Butt. 1992), RIMpro

Proceedings of the 8th International Conference on Information and Communication Technologies in Agriculture, Food and Environment (HAICTA 2017), Chania, Greece, 21-24 September, 2017.

(Trapman. 1994), WELTE (Aalbers et al. 1998), A-scab (Rossi et al. 2007) NEWA (Cornell University), SkyBit (www.skybit.com), AgRadar (University of Maine), Field-Climate (Pessl Instruments) and Ranch systems (CA, USA) whose provide information for infection development based on estimation for severity infection of apple scab depending on climatic conditions in the cultivated zone, development stages of the pathogen provided by the researcher and the type of apple cultivar being monitored or cultivated in terms of pathogen resistance. In this research work is used RIMpro which is cloud services platform developed in Holland (Trapman 1994) and improved throughout the years with many upgrades and additional disease and pets models.

Fig. 1. Login session of RIMpro platform for individual user/grower account.

The Relative Infection Measure Program (RIM-pro) as decision support system estimates the infections caused by ascospores and conidias. This program utilizes the meteorological data's received from the weather station and for this work the data's are provided by station model i-Metos 200 developed by Pessl Instruments from Austria. This program also interacts directly with the researcher or farmer for data inputs such as bio-fix (green tip), cultivars, type of fungicides used, amount of fungicides used, frequency of treatment times, tree's height and distance, rows distance, etc. On the figure 2 is provided a simple scheme of interaction between the all components of this system.

The aim of this work was to determine the best fungicide application timing intervals to control the Apple scab on apple Starking cultivar as susceptible cultivar and to see the possibility for reducing the number of fungicide treatment times.

2 Material and Methods

This research work was conducted in location of Zhegra at region of Gjilan in Kosovo during the years 2015-2016 at one experimental apple orchard which has four apple cultivars in cultivation: Starking, Golden delicious, Granny Smith and Gala. The experiment was designed as one factorial for fungicide treatment timing intervals with 8 different levels (variants). On the month of August of both years, for every apple tree which was used in randomized block were picked randomly by 50 leaves on all sides of the tree for observation. In the laboratory were analyzed 3200 leaves.

On the month of October of both years, are harvested all the fruits from same trees for observation. The apple scab severity (Imc %) was evaluated based on leaf/fruit surface infected area on the Starking cultivar. The infection level was assessed based on 6-degree scale as per EPPO standard PP1/5 (3).

Table 1. Categories and levels of classification for Apple scab severity assessment

Category	Intensity level	Infection level
0	Nothing noticed	0 % of leaf or fruit surface infected
1	Light intensity	0.1 - 10 % of leaf or fruit surface infected
2	Medium intensity	10.1 - 25 % of leaf or fruit surface infected
3	Strong intensity	25.1 - 50 % of leaf or fruit surface infected
4	Very strong intensity	50.1 - 75 % of leaf or fruit surface infected
5	Destructive intensity	> 75 % of leaf or fruit surface infected

The severity of infection (Imc %) is calculated with McKinney's index (McKinney 1923), which is modified by B.M Cooke (Cooke at al. 2006).

$$\mathrm{I} = \frac{(\mathrm{ni\ x\ ki})}{\mathrm{N\ x\ K}}\ \mathrm{x}100$$

I = disease severity index; ni = number of leaves or fruits in respective category; ki = number of each category; N = total number of leaves/fruits analyzed; K = total number of categories.

Table 2. Treatment timing intervals and used fungicides

Level	Treatment Time Intervals	Fungicides
L1	Phenological phases of apple	Copper hydroxide 50WG, Dodine 400SC
L2	Local Farmers treat. times	Copper hydroxide 50WG, Mancozeb 80WP
L3	Control tree's	No treatment with fungicides
L4	Program 1	Copper hydroxide 50WG, Tebuconazole 250EW, Captan 80WG
L5	Program 2	Copper hydroxide 50WG, Propineb 70WP, Difenconazole 250EC
L6	Program 3	Copper hydroxide 50WG, Trifloxystrobin 50WG Chlorothalonil 720SC
L7	Program 4	Copper hydroxide 50WG, Cyprodinil 50WG, Dithianon 700WG
L8	RIMpro time intervals	Copper hydroxide 50WG, Dodine 400SC

Level 1 is performed as per Phenological phases of apple. L2 is performed in same time as local farmers in the zone. L3 had no treatment. L4 to L7 are based on fungicide manufacturer's recommendation. L8 is as per timing intervals provided by RIMpro.

The weather data's are obtained from meteorological station i-METOS 200 developed and prepared by Pessl Instruments (www.metos.at), which is set up on the experimental orchard. Hourly records of rainfall, temperature, dew point, relative humidity and periods of leaf wetness inside and outside the tree were obtained from this station and provided to RIMpro, which then analyzes and prognoses the warnings. RIMpro provides the data's to the user or farmer every hour within 24hr period on the situation and is considered by most users to be a very reliable platform.

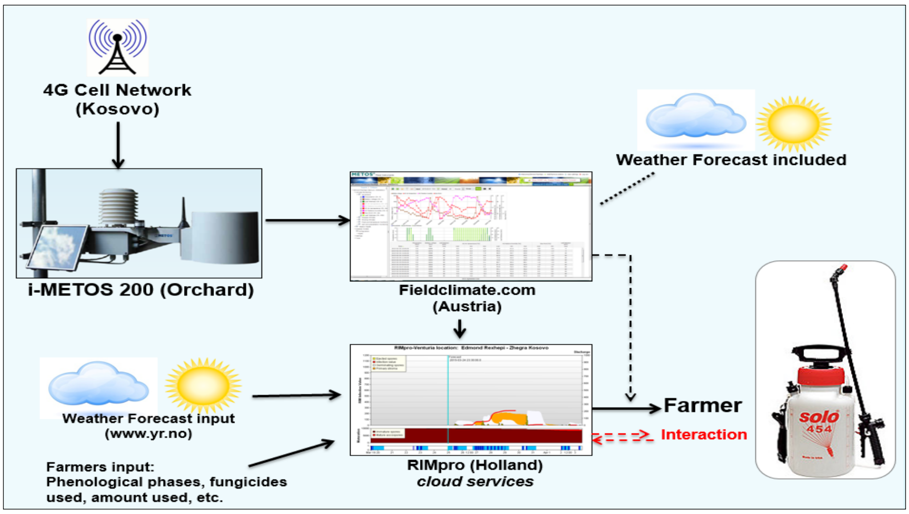

Fig. 2. The scheme of communication and interaction between i-Metos, RIMpro and farmer.

The statistical data analysis: all data processing for this research work with one way Anova for averages, variance and standard deviation is used SAS 2013 University edition. The comparison of averages of the disease severity is performed with Tukey-Kramer test and additional comparison of levels with the control trees is performed with Dunnett's test.

Fig. 3. i-METOS 200 meteorological station and one of the leaf wetness sensors set-up in experimental orchard in Zhegra, Kosovo.

3 Results and Discussion

One way Anova of disease index shows the statistical differences between the treatment time intervals used for controlling of the disease severity on the leaves and fruits for the year 2015 as shown in Fig. 4 with leaves on upper box plot and fruits on lower box where are presented the standard deviation, average of disease severity per variant and variations. The variants rings have significant differences for the probability of p=0.05 as per Tukey-Kramer test as well as per Dunnett's test comparing to the control variant with red ring. All variants of treatment times are below overall average value, which is 24.88% for leaves and 13.27% for fruits, except for the local farmer's variant which is above the overall avg.

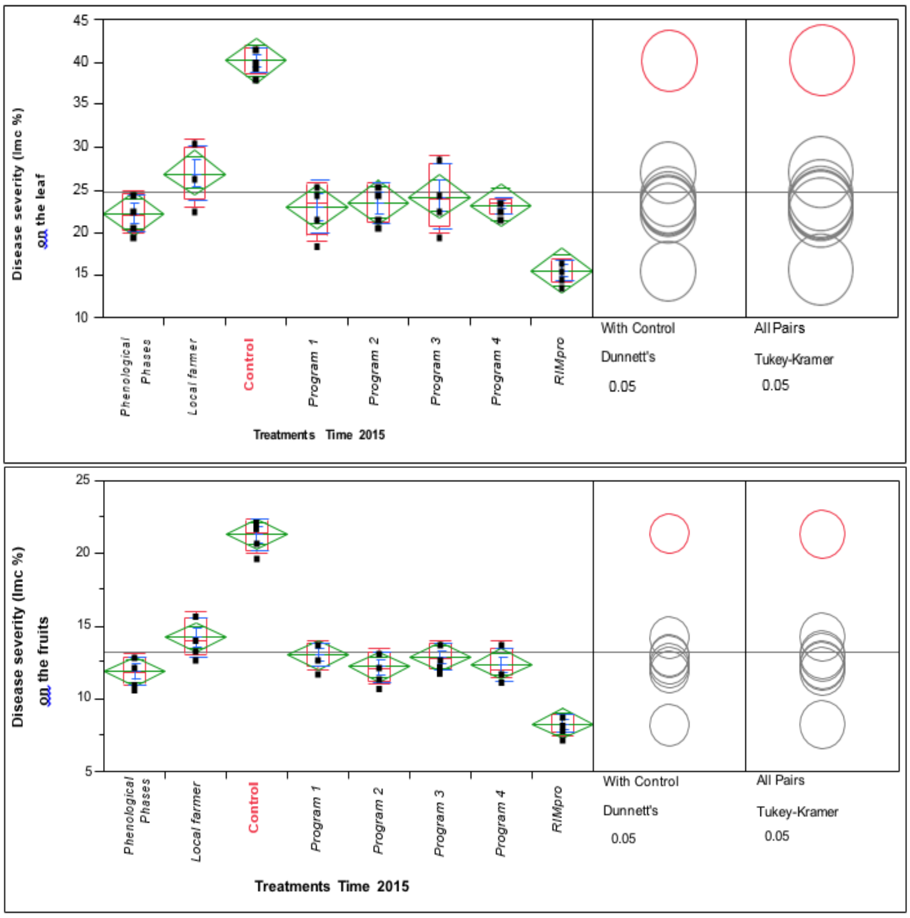

Fig. 4. The diagrams of box plots for variance, standard deviation and average of disease severity for apple scab on leaves (upper box) and for fruits (lower box) for year 2015.

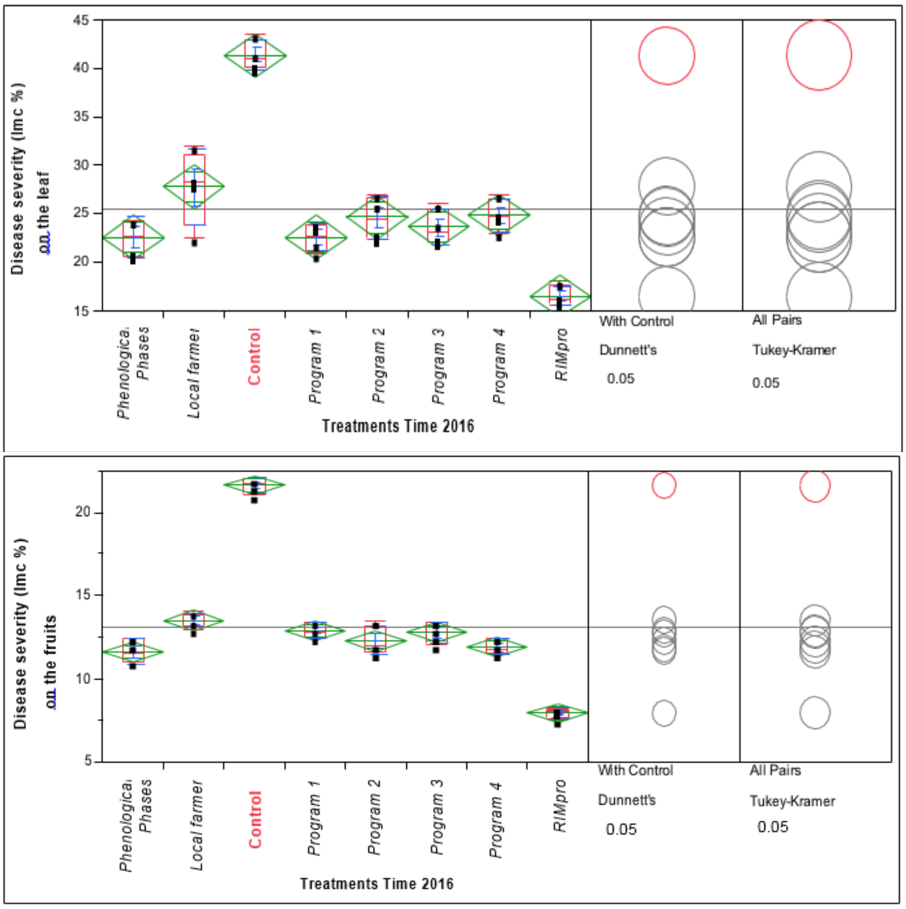

Fig. 5. The diagrams of box plots for standard deviation, variance and disease severity average for apple scab on leaves (upper box) and fruits (lower box) for year 2016.

The statistical differences between the treatment time intervals used for controlling of the disease severity on the leaves and fruits for the year 2016 as shown in Fig. 5 with leaves on upper box plot and fruits on lower box, where are presented the standard deviation, average of disease severity per variant and variations. The variants rings on same diagrams have significant differences for the probability of p=0.05 as per Tukey-Kramer test as well as per Dunnett's test comparing to the control variant. All treatment times (variants) are below overall average value, which is 25.49% for leaves and 13.05% for fruits, except for the local farmer's variant which has higher average than overall average.

4 Conclusions

The timing intervals for treatment with fungicides prognosed by decision support system RIMpro, it proves to be the best treatment plan for controlling of the fungus of Apple scab (Venturia inaequalis) comparing to other treatment time intervals for this research work.

The combination of two fungicides such as Copper hydroxide 50WG than followed with Dodine 400SC, it resulted to provide the best fungicides effectiveness for controlling of the Apple scab comparing to other variants which have one additional fungicide in their combination.

References

1. Aalbers P., Balkhoven M.K., van Burg W.L., (1998) The WELTE scab model. Obstbau 23: 198-202.
2. Assistat 2016, version 7.7. Website http://www.assistat.com by Francisco de Silva.
3. Blaise Ph., Arneson P.A., Gessler C., (1987) APPLESCAB A teaching aid on microcomputers. Plant Dis. 71(7): 574-578.
4. Cooke B.M, Jones D.G, Kaye B., (2006) Disease assessment and yield loss. In: The Epidemiology of Plant Diseases (Eds.) Second edition. Springer.p.61.
5. Gadoury D.M., Stensvand A., Seem R.C., (1998) Influence of light, relative humidity, and maturity of populations on discharge of ascospores of *Venturia inaequalis*. Phytopathol. 88(09): 902-909.
6. i-METOS 200 weather station and Field Climate platform –Website http://www.fieldclimate.org; Austria.
7. McKinney H. H., (1923) Influence of soil temperature and moisture on infection of wheat seedlings by Helminthosporium sativum. Journal of Agricultural Research 1923, 26:195-217.
8. Meszka B., (2015) Folia Hort. 27/2: 107-114 Research Institute of Horticulture Pomologiczna 18, 96-100 Skierniewice, Poland. DOI: 10.1515/fhort-2015-0020
9. Rossi V., Giosue S., Bugiani R. (2007) A-scab a simulation model for estimating risk of *Venturia inaequalis* primary infections. EPPO Bul. Vol. 37. Iss.2.p 300-308.
10. Trapman M.C., (1994) Development and evaluation of a simulation model for ascospore infections of *Venturia inaeq*ualis. Norweg. J. Agric. Sci., Suppl. 17:55-67.