RUSSETING ON APPLE FRUITS CAUSED BY PEST CONTROL

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Abstract: The use of pesticides in plant protection has positive and negative effects. The negative effects are known as side effects. One of them is russeting, and the other is early defoliation. Russeting usually appears on cultivars with yellow coloured fruits. Russeting on Golden Delicios apples may be caused by stress like unfavourable weather conditions, especially low temperatures in fruit setting, pesticide application at high temperatures, incompatible pesticide mixtures, etc. Many fungicides, especially those with copper ingredients, can also increase russeting on apple fruits. This paper presents our two-year observations of russeting effect on Golden Delicious cultivars, resulting from stress caused by different fungicides used against apple scab.

Keywords: apple, fungicides, russeting, side effects

Introduction

Russeting on apple fruits, especially yellow skin fruit variety occurs as a reaction to stress. The lack of water leads to the interruption of cuticle that cannot perform its protective function, and this causes the creation of suberin (Ciglar et all. 1979). The main causes in the imbalance in the supply peripheral parts of the fruit with water are mainly caused by the climatic conditions such as low temperature at the fruit setting, exposure to solar radiation and high humidity (Kanals et all. 2008). Fungicides used in the apple protection with primary fungicidal action may have side effects like russeting on fruits and early defoliation. Extended longer systemic action is often taken for the purpose of reducing the input of agrochemicals in the orchards to cut the costs, but in some cultivars it can have negative consequences. In the organic apple production the selection of fungicides is very limited, systemic fungicides are not allowed, while preparations on the copper basis are allowed. Copper basis products have an excellent fungicidal activity, however, copper like other heavy metals can cause unwanted undesired side-effects on the environment and the metabolism of plants and animals (Szabó et all. 2008). Active substances in fungicides can enhance fruit russeting. Additional substances in products can increase russeting or reduce russeting. Russeting on apple fruit can be reduced by using certain products such as fungicides with kaolin added as carrier of active ingredient. Kaolin in this case prevents the stress caused by UV radiation and is used in cosmetics. Russeting on apple fruit is most often caused by complex of unfavourable factors that may occur in pheno-phases fruit setting when the fruit and whole plant strongly reacts to stress.

Materials and methods

Two-years research of fungicide impact on Golden Delicious apple fruit russeting was carried out in the apple orchard at Kloštar Ivanić. The research was done in 2006 and 2007. Treatments are carried out with Solo knapsack sprayer with high volume of litre 1,200 ha^{-1} water. The experiment included 5 trees in each variety and was repeated 3 times. The timing of applications was based on the condition for primary scab infection. All treatments were curative. Fungicides were applied in recommended doses in scab suppressing. In order to research the impact of fungicides on Golden Delicious apple

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fruit russeting, each fungicide was used throughout the vegetation on the same area. The climatic condition necessary for the primary scab infection in the orchard was recorded by Agra meteorological station. Russeting fruits assessment was carried out at the time of ripening by picking all the fruits from trees and estimating the russeting on fruits from 0 to 5. The percentage of russeting was calculated by the Towsend-Heuberger formula. The results were statistically processed by F-test and the analysis of variance and differences was determined by Duncan test. In the two years of research six treatments of primary infection were carried out between 14 March and 10 June. Russeting estimation was carried out on 7 September in both years.

Table 1. Active ingredients of fungicides used in trials

2006		2007	
1.	Fenarimol	1.	Fenarimol
2.	Fenarimol + captan	2.	Fenarimol + captan
3.	Fenarimol + mancozeb	3	Fenarimol + mancozeb
4.	Miclobutanil	4.	Hexaconazol + captan
5.	Penconazol	5.	Difenconazol
6.	Hexaconazol + captan	6.	Captan
7.	Difenconazol	7.	Penconazol + captan
8.	captan	8.	Untreated
9.	Hexaconazol + captan	9.	Tebuconazol
10.	Miclobutanil + mancozeb	10.	Bitertanol + diclofluanid
11.	Untreated		

Results and discussion

Table 2. Percentage of russeting on Golden Delicious apple fruits (by Towsend-Heuberger) in 2006

Variant	1	2	3	4	5	6	7	8	9	10	11
I	8.9	11.5	10.8	10.5	11.4	9	9.3	9.1	7.5	7	8.8
II	8.2	5.7	5.4	5.9	4.9	6	6	7.8	6.6	7.9	10.3
III	10.1	9.8	10.8	10.7	9.3	8.4	7.2	8	8.2	8.8	8.4
Σx	27.2	27	27	27.1	25.6	23.4	22.5	24.9	22.3	23.7	27.5
average	9.1	9	9	9.03	8.5	7.8	7.5	8.3	7.4	7.9	9.2

Statistical analyses did not demonstrate statistically justified differences in apple fruits russeting between different fungicides. In this year russeting on untreated fruit trees was equal to russeting on treated trees.

Table 3. Percentage of russeting on Golden Delicious apple fruits (by Towsend-Heuberger) in 2007

Variant	1	2	3	4	5	6	7	8	9	10
I	12.8	10.5	10.7	12.1	11.0	15.5	16.4	12.6	14.6	10.0
II	13.0	10.3	11.9	11.3	20.7	13.6	10.4	12.3	21.0	12.0
III	18.6	17.3	14.7	9.3	14.5	12.0	18.5	7.3	15.2	13.0
Σx	44.4	38.1	37.3	32.7	46.2	41.1	45.3	32.2	50.8	35.0
average	14.8	12.7	12.4	10.9	15.4	13.7	15.1	10.7	16.9	11.7

Table 4. Results of Variance analysis

Results	n-1	SQ	s^2	F exp.	F tabl.
Total	29	320.75			5% 1%
Between	2	117.60	58.80	7.8	3.35 5.4
Residual	27	203.15	7.52		

F exp.> F tabl.
Duncan test: a>b>c

a- tebuconazol; difenconazol; fenarimol; penconazol + captan
ab – captan; fenarimol + mancozeb; fenarimol + captan; bitertanol + diclofluanid
b- hexaconazol + captan; untreated

In the year 2007 we can see that the russeting percentage was much higher than a year earlier. The smallest russeting percentage was on untreated trees and on trees where the mixture of fungicides hexaconazol + captan (Anvil + Captan) was applied. This is a mixture of SC and WP formulations.
Fungicides with EC formulation and mixtures of EC and WP formulations caused the stress that is fruit russeting. In the year 2007 there was a larger russeting phenomenon due to stronger insolation and greater temperature fluctuations at the time of fungicide applications.

Conclusions

Russeting on apple fruits can be caused by stress under the influence of bad weather conditions such as long retention of fog and dew in the orchards, low temperatures at the fruit setting, etc. However different fungicide formulations can also cause stress on the apple fruits of Golden Delicious variety, especially when UV radiation increases at the time of fungicide application.
EC formulations and mixture of EC and WP pesticide formulations can cause increased russeting on Golden Delicious apple fruits, which was proven in our two-year survey.

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