

Comparison of frost damages in apple plantations cultivated with environmental friendly growing technology

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Summary: The global changes in climate and meteorological conditions have many negative consequences, which may diminished with adequate measures. In our continental climate, the winter frosts but also the late spring frosts are always threatening. There are technologies to avoid late frost damages (with spray irrigation or with smoking), but against winter minima, we are nearly helpless. The different damages experienced recently called our attention on the question of optimal condition, which is a delicate balance between the vegetative activity and the provision of nutrients. The excesses on both ends are increasing the danger of damages (Zatykó, 1980). Our examination was performed in the plantation, which was cultivated according to ecological and integrated technologies. The variable condition of the trees gave opportunity to evaluate the effects of cold temperatures as frost damages. Our results will represent not only the differences between varieties but also the effects of the growing technologies – which influence the condition of the plants – consequently, the measure of frost damages.

Key words: environmental growing technology, integrated and ecological, frost damage, apple, varieties

Introduction

The information related to the global changes of climate is of high significance for the growers themselves. It is of special interest for us in Hungary because during the last 15 years many plantations have been established on explicitly unfavourable growing sites. There used to be heavy winter- and spring-frost damages more frequently than in the favourable plantings. To prevent frost damages of different type, our tools are rather modest. It is especially the case with the winter frosts, which depend almost entirely on the physical conditions of the site. In developed countries, apple growers are equipped with tools, which are really effective to moderate the accidental occurrence of spring frost (spraying above crown, smoking, heating the planting, etc.). Mohácsy (1946) dealt with the causes of damages and with the possibilities of their prevention, and his statements are still valid. Recently, new publications are occupied with the topic of frost and its consequences, moreover, the possibilities of its mitigation (Szabó, 2002; Soltész et al., 2004; Tóth, 2004).

The deleterious environmental and technological conditions alone are conspicuously influencing the heaviness of damage (weather, diseases, pests). American studies went to the conclusion that 70% of the deficiency are ascribed to the frosts (Rieger, 1989). Experiments as well as practical experiences prove the important role of the condition of trees, which has been expressed by Zatykó (1980) as a delicate balance between growing and provision with nutrients of the plants. The importance of technological elements is represented mainly by pruning, which is successfully influencing the condition of plants (Gonda, 2000; 2004; Holb, 2005). The thorough knowledge of the possible effects of growing technologies facilitates the

building up of a potent protocol prescribing adequate pruning, phytosanitation and fruit thinning as conditions of maximum exploitation of really existing possibilities.

In those two alternative growing technologies only officially approved preparations have been used for improving the soil and for phytosanitation. Based on experiences of earlier years, we state with conviction that adopted regulations of the integrated technology and the admitted materials, synthetic fertilisers and sanitary compounds are much more effective for maintaining optimal conditions of plants than those of the ecological technology, which emphasises the admission of naturally occurring materials with slow and moderate effectiveness.

The two alternative growing technologies, ecological and integrated, apple plantings are highly divergent in their possibilities, therefore the condition of the trees was substantially better in the integrated technology than in the ecological one. The other component of the differences observed was the apple variety. The present study analyses the role of the condition of the tree and the genetically determined susceptibility of the varieties in the winter of 2009–2010.

Materials and methods

In the University Farm of Debrecen University and Regional Experiment Station Pallag, the planting of a apple assortment started in 1997. The measurements have been made in the winter 2009/2010. The varieties examined were: „Rewena”, „Remo”, „Pilot” and the widely grown „Jonagold (Jonica)”. The planting design was: 4*1.5 m, which means 1666/ha. The rootstock was M 26. The yearly mean

temperature was 10–11 °C, sunny hour 1900-2050/year. The winter minimum was more than -30 °C, in the summer maximum trespassed often +35–38 °C. Precipitation 500–600 mm/year with uneven distribution. The soil contains 1% humus, the soil is sandy slightly acid, heaviness about (Arany) around 25. It is of interest that the examined year was particularly variable in temperature, which contributed to the frost damage observed on some varieties (Figure 1). Special interest deserve the sudden cold spell of December 20–23, when the daily amplitude attained 30 °C.

The typology of frost damages in fruit trees has been established by Childers (1983). In each variety we analysed the different fruiting structures separately, the spears (with short internodes) (0–5 cm), the broaches (6–20 cm) and the bearing shoots (>21 cm). We took the samples in 2010 February and processed within 5 days. Each variety was represented by five trees, and the sample comprised 100 pieces, 100 spears, 100 broaches, 100 shoots. The damage has been recognised after keeping the objects on room temperature for some (1–2) days. The twig was cut especially near the base of buds (Figure 5–6).

Presentation of results

Figure 2 shows the frost damage in the 4 varieties. Although we could not state significant differences between the integrated and ecological growing technologies, however, the differences were conspicuous between varieties (Figure 1). The mean of varieties of the alternative technologies was negligible (31 and 32.4%), i.e. in ecological growing the damage was just a little more severe. The difference between the varieties was by all means significant. In “Rewena”, the difference was 13-fold in favour of the integrated technology, in „Pilot” two fold. Nevertheless, both varieties proved to be relatively resistant in the experiment. In „Jonagold (Jonica)” and „Remo” the trees of integrated technology suffered more damage than the ecological.

In integrated technology, the less damaged was „Rewena” (1.7%), and „Remo” was most susceptible (72.3% frozen buds).

In ecological technology „Jonagold (Jonica)” and „Remo” suffered most, but the same varieties were hardly hit in the integrated technology too.

The Figure 3 shows the distribution of damage according to the different fruiting structures, the spears (0–5 cm), broaches (6–20 cm) and fruiting shoots (>21 cm). The spears were clearly most susceptible. „Rewena” was less affected in integrated technology (2%), most damage was found in „Remo” spears (> 90%). Regarding the spears, three of the four varieties suffered more in the ecological technology, only „Remo” was excepted. In the broaches (6–20 cm long) the ecological technology was relatively most protected, moreover, “Rewena” and „Pilot” were completely exempt. It is remarkable that „Jonagold (Jonica)” and „Remo” were less damaged in the ecological technology than in the integrated. In the former was the difference almost 100%-os, in the latter about 60% between the technologies.

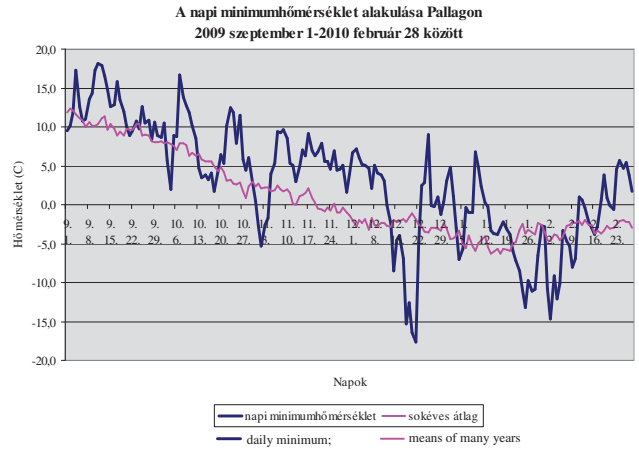


Figure 1. Daily minimum temperatures measured on the site of observations between 2009 September 1 and 2010 February 28 (Debrecen-Pallag, 2009–2010)

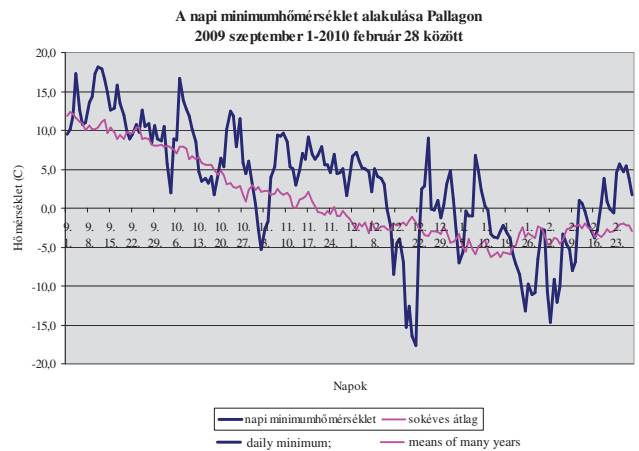


Figure 2. Frost damage of apple varieties in different growing technologies regarding the averages of different fruiting structures (%) (Debrecen-Pallag, 2009–2010.)

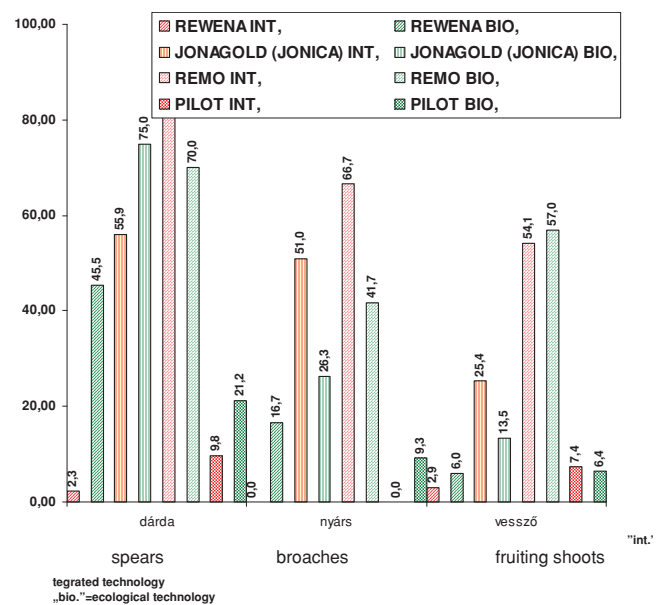


Figure 3. Frost damage (%) in different fruiting structures of apple varieties grown by integrated and ecological (bio) technologies (Debrecen-Pallag, 2009–2010)

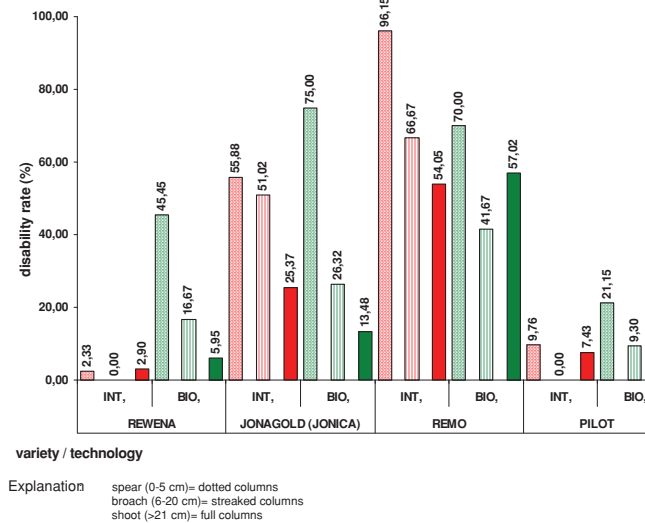


Figure 4. Frost damage (%) in the fruiting structures of apple varieties grown by different technologies (Debrecen-Pallag, 2009–2010)



Figure 5. A healthy spear of the „Jonagold (JONICA)” variety

The fruiting shoots of „Rewena” and „Remo” suffered more in the ecological technology but the former was the most resistant, the latter the most susceptible (6% and 54%).

In *Figure 4*, the varieties are compared with the three different fruiting structures and both growing technologies. „Rewena” was more resistant to frost in the integrated technology. With the increasing length of the fruiting structures the frost damage decreased. The same trend is observed in „Jonagold (Jonica)”. The differences depending



Figure 6. Frozen entire spear, where the transporting tissues are also damaged in variety „REMO”

on technology was though variable, but the length of structures and the varieties were more decisive. The trend in „Remo” was similar, but the damage was more severe. In „Pilot” again, the integrated technology was less affected, but in the ecological, the length of the structures was decisive.

Consequences

The following statements are attempted. Frost damage, generally, was not essentially modified differently by the alternative technologies. The overall mean damage was around 30%. Most resistant varieties were „Rewena” and „Pilot”, but in the ecological technology they too suffered more. The different parts of the fruiting capacity are affected variably depending on the length of the organ. Spears are most susceptible, broaches and shoots are more resistant. „Pilot” displayed the highest frost tolerance in both growing technologies, the most susceptible was in both growing technologies „Remo” with more than 50% damaged buds.

In general, the variety is the most decisive factor of frost tolerance, whereas growing technologies are less decisive in planning of new plantations, where frost damage is expected to occur.

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