ARTIFICIAL FROST TREATMENT METHODS OF STONE FRUITS

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Abstract

Routine application of artificial frost treatment needs a detailed, exact technology, which would ensure the reliability of the results obtained. Buds being on spurs loose their frost resistance sooner because of their quick development. According to these results to examine samples containing both types of buds can lead to significant mistakes. Considering our experiences it seems that a sample containing 200 buds provides the reliable correctness. Further increasing of sample size decreases the value of deviation but it is not proportional to the work needed for the experiment. The following treatments are suggested: deep dormancy phase: -24 - -26°C, directly after deep dormancy:-21 - -24°C, beginning of February: -19 - -21°C, two weeks before blossoming -11- -12°C, two days before blossoming: -4 - -6°C.

1. Introduction

Apricot growing in Hungary is fundamentally determined by the rate of frost damage caused by low temperature during winter and early spring. Apricot breeders have been working for many years on improving apricot frost tolerance. It is a main breeding trend in Hungary as well. Variety or hybrid evaluation in this respect can not be based only on the description of natural frost damages. This method is too slow for systematic selection. At the same time routine application of artificial frost treatment needs a detailed, exact technology, which would ensure the reliability of the results obtained. Layne (1992) stated that examing of natural freezes is possible only in countries where frost damage is systematically expected. According to Childers, 1983 (in Faust, 1989) there were only 11 adequate test winters in this century. Accuracy of measuring methoths is emphasized by Scorza *et al.* (1983) and Crossa-Raynaud and Audergon (1991. Weaver *et al.* (1968) point out the complexicity of frost tolerancy in apricot. Different aspects of artificial frost treatment are discussed in the following publications Faust, 1989; (Weaver and Jackson, 1969; Quamme *et al.* 1972, 1975, 1982; Lamb 1976; Layne 1967, 1992; Cain and Andersen, 1980; Quamme and Stushnoff 1983).

In this article we try to consider the following questions: Which kind of flower bud is most appropriate for frost treatment? How big is a reliable sample of buds? What is the optimum temperature for frost treatment in the different stages of bud development during winter?

2. Materials and methods

Artificial frost treatment was carried out in a Fissons fitotron. Chamber temperature was regulated by computer programme control. The experiments took place in the last four years. To estimate how big the difference in frost sensitivity between flower buds located on the different parts of the canopy buds being on long one year old shoots and those on spurs were treated. The development stage of buds was determined by examining microsporogenesis (Solohov, 1984).

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To decide the optimal sample size of flower buds of 10 apricots, 5 plums (Prunus cerasifera) and 5 peach varieties were collected, 2000 of each. Natural frost damage was determined by observing the colour of the cross section of buds (green - unharmed; brownish - frost damaged). Every single bud condition was labelled by a number (0= unharmed, 1= frost damaged). Based on the above, computer databases describing all the buds of each variety were created. Using these databases and an adequate computer software (Quattro Pro for Windows) samples consisting of 50, 100, 150, 200 and 250 buds were created. The computer prepared 500-1000 samples from each type, choosing the buds at random and counted the ratio of frost damaged buds in each of them. Distribution of samples plotted against frost damage level was displayed in graphs. Making use of this practical distribution the normal distribution was fitted. With the help of this it was possible to draw the general conclusion.

Experiments to determine the optimum frost treatment temperature for the different stages of bud development were carried out every ten days during the winter. At each treatment three different critical temperatures were used. In this way it was possible to find the most adequate temperature, at which it was possible to state the real differences concerning frost tolerance of the varieties examined.

3. Results

Flower buds on an apricot tree can be divided into two groups: buds being on short spurs and on the long, one year old shoots. Considering productivity, the first one is more important in the case of Hungarian varieties. Difference in their frost sensitivity is shown in Figure 1. The difference is significant at P=0,95. The reason of this behaviour is the uneven rate of their development. Buds being on spurs lost their frost resistance sooner because of their quick development. According to these results to examine samples containing both types of buds can lead to significant mistakes.

Bud frost sensitivity continuously changes during winter. That is why the temperature used in the treatment must be suitable for the actual bud condition. However, at first attempt it is impossible to find the definite temperature which is most appropriate to show real differences in frost sensitivity of the varieties examined. Due to this fact it is advisable to use minimum three critical temperatures at each treatment time. Sometimes only one Celsius degree difference causes considerable divergence in frost damage Figure 2. To demonstrate significant differences among varieties the following temperatures were found to be optimal: deep dormancy phase: -24 - -26°C, directly after deep dormancy: -21 - -24°C, beginning of February: -19 - -21°C, two weeks before blossoming -11- -12°C, two days before blossoming: -4 - -6°C. It seems that for optimal results 4 hours long treatment at the critical temperature is needed.

Figure 3 and 4 show the obtained and normal distribution of computer created samples plotted against frost damage observed in the case of samples containing 50 and 200 buds. In case of increasing sample size the deviation between the above samples is continuously decreasing. According to that, the probability that the level of frost damage measured in one sample significantly deviates from the real value is lower in the case of a bigger sample. Figure 5. shows the decrease of deviation value plotted against the sample size. Considering the trends visible in the graph it seems that the sample containing 200 buds provides the reliable correctness. Further increasing of sample size decreases the value of deviation but it is not proportional to the work needed for the experiment.

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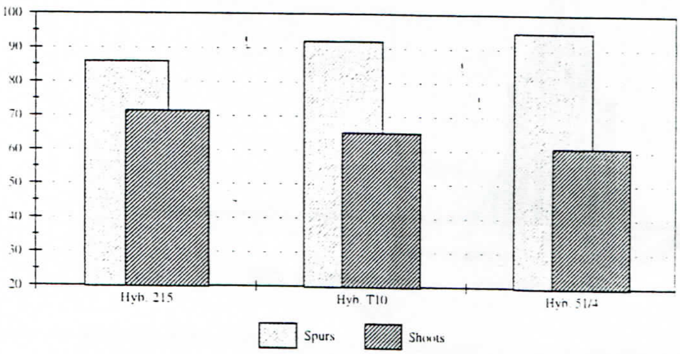

Figure 1. Frost damage of buds on spurs and one year old shoots

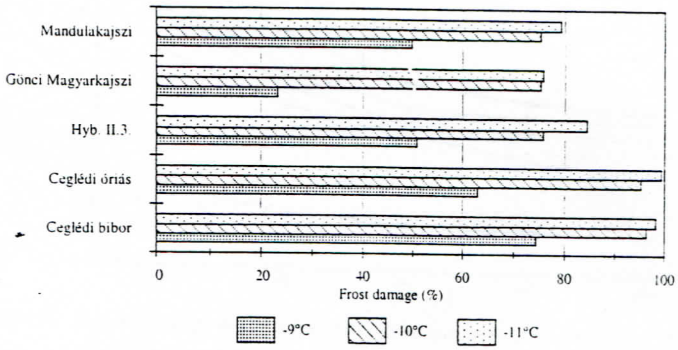

Figure 2. Frost damage caused by three different treatments (1995 March 9th)

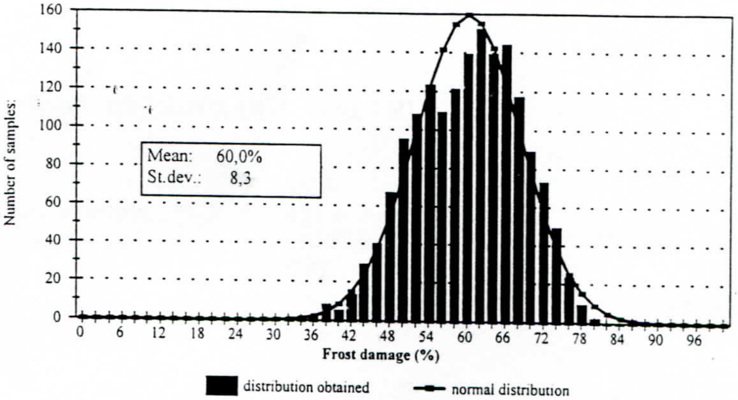

Figure 3. Distribution of 1000 samples containing 50 buds plotted against frost damage observed in them

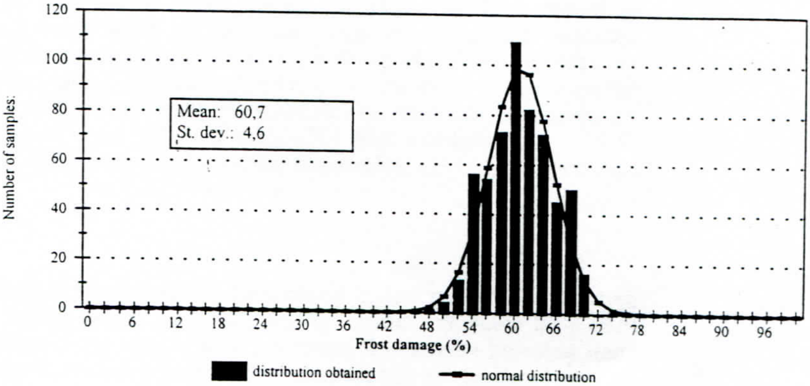

Figure 4. Distribution of 600 samples containing 200 buds plotted against frost damage observed in them

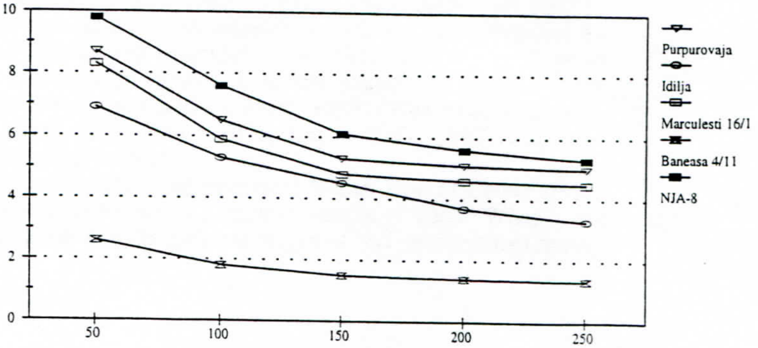

Figure 5. Relationship between simple size and standard deviation of frost damage observed in them