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Short communication

Covering of peach (*Prunus persica*) flowers for early spring frost protection

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Abstract The aim of this study was to investigate the covering of peach (*Prunus persica*) flowers by single and double layered polyethylene foil bag, foam (starch-based foam), thin vermiculite, perlite, or sawdust as methods of protection from early spring frost. Compared with uncovered flowers, the results showed that using a double bag or foam significantly reduced the percentage of damaged flowers caused by low temperatures. In contrast, no significant differences in damaged flowers were found between flowers covered with thin vermiculite, perlite, a single bag, or sawdust compared with those uncovered (control). The existence of the ice nucleation bacterium *Pseudomonas syringae* pv. *syringae* in the peach flowers of four cultivars was also investigated. It was not found in any peach flowers of 'ArmKing', 'Silver King', 'May Grand', or 'Andross' examined by ELISA.

Keywords covering; early spring frost; peach; protection

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INTRODUCTION

Flowers of fruit trees are often injured by spring frosts. Frost damage of plant cells is caused by growth of ice crystals causing disruption of cell structures and leaking of cell sap, and/or by dehydration of plant tissue as a result of withdrawing water from cells during ice crystal formation. Plants can survive under freezing conditions by avoidance of ice crystal formation (supercooling). Covering of flower bulbs or plants has been used to protect some crops from frosts (Poling et al. 1991; Meeldijk 1992; Bordelon 1996; Nestby et al. 2000), but this method has not been investigated yet in fruit crops. This method produces little pollution compared to other methods such as the use of chemicals or fossil fuels.

It is now generally accepted that certain bacteria associated with plants can contribute to frost damage by serving as nuclei for ice nucleation; the most common bacterium *Psudomonas syringae* pv. *syringae* (Olive & McCarter 1988).

The purpose of this study was to evaluate covering of peach (*Prunus persica* (L.)) flowers by foam (starch-based foam), single or double layer black polyethylene bags, thin vermiculite, perlite, or sawdust as methods of early spring frost protection. In addition, the existence of the ice nucleation bacterium *P. syringae* pv. *syringae* in the flowers of peach trees was investigated.

MATERIALS AND METHODS

Ten-year-old peach trees ('ArmKing') were used in all experiments. Shoots, c. 50 cm in length, in full bloom stage, were collected from trees and immediately transferred to the laboratory of the Pomology Institute, Naoussa, Greece. The following treatments were applied: (1) covering shoots with a single-layered black polyethylene bag; (2) covering shoots with a double-layered black polyethylene bag; (3) covering shoots with foam (starch-based foam); (4) covering shoots with sawdust; (5) covering shoots with thin vermiculite; (6) covering shoots

with perlite; and (7) untreated shoots used as control. For treatments 4, 5, and 6, molasses (2%; as an adherent material) was first applied by spraying. Shoots were then placed in an appropriate freezer. Temperatures were gradually reduced from 10°C (room temperature) to –5°C (recorded by data logger) after placing the shoots in the freezer. Incubation of shoots at –5°C was for 30 min as preliminary studies showed these conditions resulted in 100% flower damage (unpubl. data). Temperatures inside the flowers were recorded by using temperatures sensors. After incubation, shoots were placed in a growth chamber at 20°C for 2 days, and then the number of damaged flowers per shoot was recorded.

The examinations were undertaken in three similar experiments. The experimental design used was completely randomised block with five replications of each of 10 shoots (50 cm in length). Data were analysed by one-way analyses of variance and treatment means were separated by Duncan's multiple range test ($P = 0.05$). Results of repeated experiments were similar according to Bartlett's test of homogeneity of variance; so data from all experiments were combined.

To investigate the existence of the bacterium *P. syringae* pv. *syringae* in the flowers of peach trees, 4000 peach flowers, randomly collected from 'ArmKing', 'Silver King', 'May Grand', and 'Andross' (1000 flowers each) in March, were examined by using ELISA (Adgen kits) as described by the manufacturer (Adgen).

Table 1 Protection from low temperature injury of peach (*Prunus persica*) flowers. Values are given in percentage of control, where all flowers are damaged (100), when letters are different the values are significantly different ($P = 0.05$), according to Duncan's multiple range test.

Treatment	Damaged flowers (%)
Uncovered (control)	100a
Thin vermiculite	100a
Sawdust	100a
Perlite	97.5a
Single plastic bag	100a
Double plastic bag	69.8b
Foam	66.7b

RESULTS AND DISCUSSION

The results showed that shoots covered with foam or a double plastic bag had a lower percentage of damaged flowers than the controls (Table 1). In contrast, no significant differences in damaged flowers were found between shoots covered with thin vermiculite, perlite, a single plastic bag, or sawdust in comparison to the control. Apart from the flowers covered with foam, temperatures inside the flowers dropped to –4.5°C, whereas temperatures in flowers covered with foam dropped to fluctuating levels of –1 to –1.5°C. Perhaps the two-layer bag improved the conditions for supercooling and no formation of ice, in contradiction to the other treatments. Nestby et al. (2000) found that covering strawberry plants with fleece, bubble plastic, and brown-plastic-laminated bubble plastic gave a better result in freezing protection than straw. Meeldijk (1992) covered flower bulbs with a layer of straw to protect them from frost. Bordelon (1996) used closed cell polyethylene (PE) foam sheeting to protect cold-tender grapevines from frost. A developed aqueous foam was found to be ideal for freeze and frost protection in agriculture (Choi & Giacomelli 1999a,b; Choi et al. 1999). Finally, floating row covers composed of extruded polypropylene (Agrinet), spunbonded polypropylene, and spunbonded polyester were used for cold protection of strawberries ('Chandler') (Poling et al. 1991).

In this study, the bacterium *P. syringae* pv. *syringae* was not found in the peach flowers examined. In contrast, Olive & McCarter (1988) could isolate *P. syringae* pv. *syringae* from peach flowers. Proebsting & Gross (1988) found that natural ice nucleators on peaches were much more significant than ice nucleation-active bacteria.

Generally, this study showed that covering peach flowers with foam or a double plastic bag could be a method to reduce damage from early spring frost, though the results could be different from this experiment since freezing in nature occurs at a slower rate.

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REFERENCES

Bordelon B 1996. Winter protection of cold-tender grapevines with insulating materials. Proceedings of the Fourth International Symposium on Cool Climate Viticulture & Enology, Rochester, New York, United States, 16–20 July 1996. I–32–I–35.

Choi CY, Giacomelli G 1999a. Freeze and frost protection with aqueous foam—field experiments. HortTechnology 9: 662–667.

Choi CY, Giacomelli G 1999b. Development and evaluation of aqueous foam for cold protection in greenhouses. ASAE/CSAE-SCGR Annual International Meeting, Toronto, Ontario, Canada, 18–21 July 1999.

Choi CY, Zimmt W, Giacomelli G 1999. Freeze and frost protection with aqueous foam—foam development. HortTechnology 9: 654–661.

Meeldijk BP 1992. Bulbs and keeping them warm. Machines for depositing a layer of straw on flower bulbs. Landbouwmechanisate 43: 38–39.

Nestby R, Bjorgum R, Nes A, Wikdahl T, Hageberg B 2000. Winter cover affecting freezing injury in strawberries in a coastal and continental climate. Journal of Horticultural Science and Biotechnology 75: 119–125.

Olive JW, McCarter SM 1988. Occurrence and nature of ice nucleation-active strains of *Pseudomonas syringae* on apple and peach trees in Georgia. Plant Disease 72: 837–843.

Poling EB, Fuller HP, Perry KB 1991. Frost/freeze protection of strawberries grown on black plastic mulch. HortScience 26: 15–17.

Proebsting EL, Gross DC 1988: Field evaluations of frost injury to deciduous fruit trees as influenced by ice nucleation-active. Journal of American Society of Horticultural Science 113: 498–506.