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The effect of evaporative cooling on pistachio bloom delay

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SUMMARY – The aim of this research was to delay pistachio blooming by means of evaporative cooling that included the use of water sprinkling to cool fruit buds and delay their development. Water was supplied to each block using mini sprinklers over trees of Uzun, Siirt and Ohadi cultivars. Water application to trees was started at a time when 600 chill units were accumulated for rest completion. The effects of evaporative cooling on bud swell, first bloom, full bloom and bloom termination of pistachio cultivars were determined. In all of the three cultivars, differences between watered treatments and unwatered treatments were apparent as regards the criteria investigated. The minimal delay was achieved in bud swell. In the cultivars tested, bud swell was delayed only for up to 5 days. However, water sprinkling to trees was more effective in delaying the further blooming stages. First bloom of trees was delayed for 7 days in Uzun, 9 days in Ohadi and 11.5 days in Siirt cultivar. Similarly, full bloom was delayed for 7 days in Uzun, 8.5 days in Ohadi and 12.5 days in Siirt. Bloom termination was delayed for 4.5 days in Uzun, 8.5 days in Ohadi and 9.5 days in Siirt cultivar.

Key words: Pistachio, bloom delay, evaporative cooling, water sprinkling.

RESUME – "Effet de l'évaporative cooling sur le retard de floraison des pistachiers". Le but de cette étude est de faire retarder les floraisons des pistachiers par la méthode d'évaporative cooling. Selon cette méthode, l'eau est pulvérisée pour faire retarder le développement des bourgeons et les rafraîchir. L'eau a été pulvérisée par aspersion sur les arbres des variétés d'Uzun, de Siirt et d'Ohadi qui sont situés de pareille façon. La pulvérisation d'eau a commencé après la période dormante d'hiver de 600 unités de froid. Dans cette étude on a déterminé les effets de la méthode d'évaporative cooling sur les gonflements des bourgeons, la floraison initiale et la fin de floraison. On a montré que les différences entre les arbres de trois variétés pulvérisées et non pulvérisées sont très évidentes, sous le rapport de caractères étudiés. Le moindre retard a été obtenu au gonflement des bourgeons. Le gonflement des bourgeons des variétés étudiées a été retardé 5 jours de plus. Mais la pulvérisation d'eau sur les arbres a un grand effet dans les autres périodes de la floraison. La date de première floraison des variétés d'Uzun, d'Ohadi et de Siirt est retardée de l'ordre de 7, 9 et 11,5 jours. De même, la date de pleine floraison des variétés d'Uzun, d'Ohadi et de Siirt est retardée de l'ordre de 7, 8,5 et 12,5 jours. On a obtenu un retard de 4,5 jours pour la date de fin de floraison de la variété Uzun, 8,5 jours pour la variété Ohadi et 9,5 jours pour la variété Siirt.

Mots-clés : Pistachier, retard de la floraison, evaporative cooling, pulvérisation d'eau.

Introduction

The use of water sprinkling to cool fruit buds and delay their development can be considered as an alternative method to conventional freeze protection techniques such as orchard heating, fogging, etc.

Phenological development of flower buds on fruit trees is related to number of degree hours above 4.5°C accumulated after the chilling requirement is completed. Evaporative cooling of flower buds by water sprinkling during the period of degree-hour accumulation in late winter can slow the rate of bud development and delay bloom sufficiently to reduce the risk of freezing injury (Rieger, 1989).

Previous works on some pome fruits (Anderson *et al.*, 1975; Wolfe *et al.*, 1976; Collins *et al.*, 1978; Hamer, 1983; Matthews and Magein, 1996) and stone fruits (Chesness *et al.*, 1977) proved that evaporatively cooled trees delayed their bloom for few days to two weeks.

In Turkey, pistachio tree which favours hot climate not only grown in the hotter part of the country but also found in different ecological conditions where its flowers may be exposed to late spring freeze as in other deciduous fruit species. The objective of this study was to determine the effect of evaporative cooling on pistachio bloom delay.

Materials and methods

This experiment was set up on the pistachio trees (20-25 years old) planted with a spacing of 2 x 7 m. Experimental design was factorial randomized block with 3 replications (5 trees in each replication) (Bek and Efe, 1995). Three pistachio cultivars (Uzun, Siirt and Ohadi) were included in the study.

Chilling accumulation during the rest period from November to March was calculated using daily minimum and maximum temperature values by a computer program developed by Küden and Miller (Küden and Ka_ka, 1992). At the time of rest completion (average 600 chill units for local varieties), which was coincided with the 1st of March, over tree water sprinkling was started. A thermocouple inserted on a fruit bud automatically initiated the sprinkling when the fruit bud internal temperature exceeded 6°C and stopped below this value.

Number of days from 1st of March to the bud swell, first bloom, full bloom and bloom termination of watered trees of pistachio cultivars were determined and then they compared to unwatered trees.

Results and discussion

The results of evaporative cooling on the bloom stages of pistachios trees were in favour of the watered trees. In all of three cultivars used, differences between watered treatments and unwatered treatments were apparent.

The delay achieved by evaporative cooling in the trees of Uzun cultivar in comparison to unwatered trees was 4.5 days in bud swell, 7 days in first bloom, 7 days in full bloom and 4.5 days in bloom termination (Fig. 1). The delay in the trees of Ohadi cultivar was 5.2 days in bud swell, 9 days in first bloom, 8.5 days in full bloom and 8.5 days in bloom termination (Fig. 2). Similarly, the delay in the trees of Siirt cultivar was 4.3 days in bud swell, 11.5 days in first bloom, 12.5 days in full bloom and 9.5 days in bloom termination (Fig. 3).

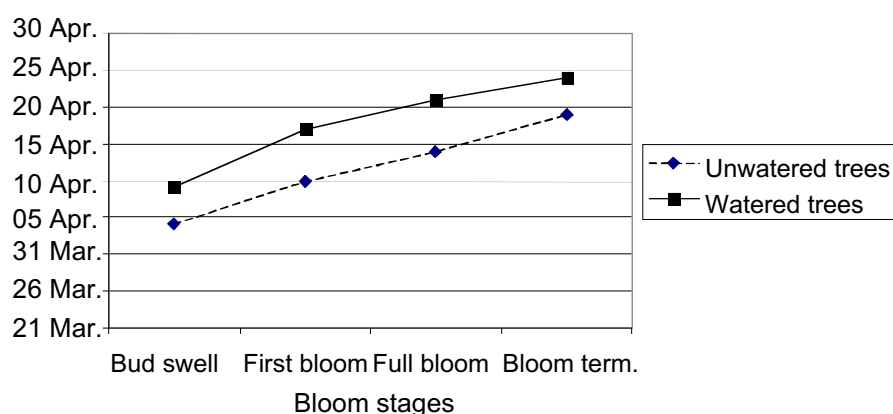


Fig. 1. Calendar dates and bloom stages of watered and unwatered trees of Uzun cultivar.

The minimal delay achieved in bud swell was only for up to 5 days. However, water sprinkling to trees was more effective in delaying the further bloom stages. The delays achieved at first bloom and full bloom stages were over 7 days with a maximum of 12.5 days in Siirt cultivar.

Although the bloom delays by evaporative cooling were reported as much as 15-17 days in some fruit species (Anderson *et al.*, 1975; Hamer, 1980), it usually ranged between 6 and 10 days in most of previous studies (Wolfe *et al.*, 1976; Stang *et al.*, 1978). In a recent study on apples bloom delay was reported as low as 4 days (Matthews and Magein, 1996). Therefore our finding is in accordance with above mentioned previous studies.

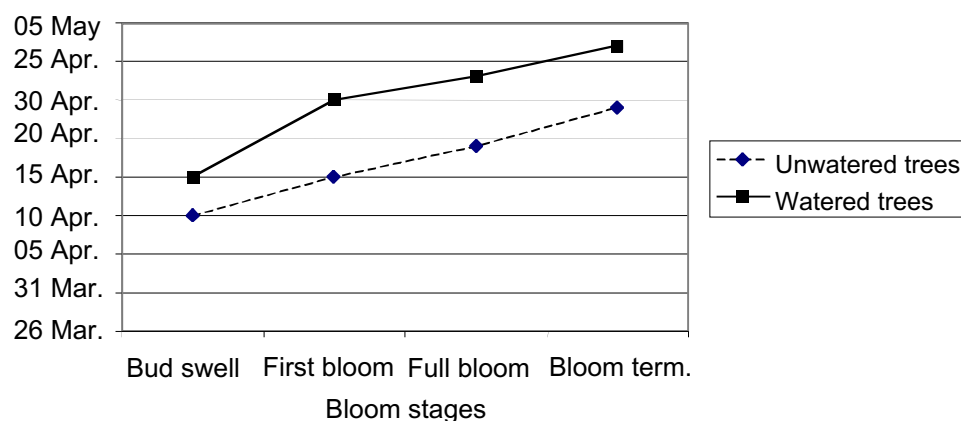


Fig. 2. Calendar dates and bloom stages of watered and unwatered trees of Ohadi cultivar.

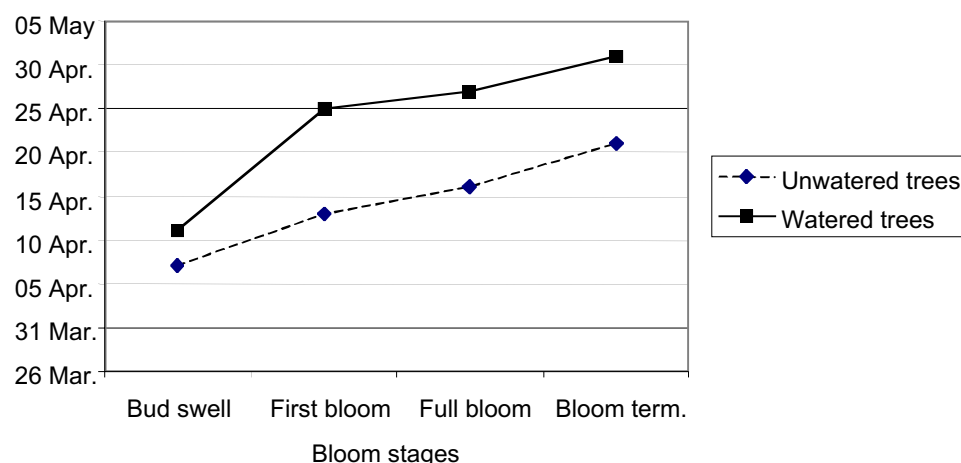


Fig. 3. Calendar dates and bloom stages of watered and unwatered trees of Siirt cultivar.

The effect of evaporative cooling was pronounced in the cultivars tested. The maximum full bloom delay was achieved in Siirt cultivar (12.5 days), followed by Ohadi (8.5 days) and Uzun (7.0 days) cultivars. "Experimental year" may have had an impact on bloom delay of a given species or cultivar. Chesness *et al.* (1977) reported that bloom delay of peach trees was 14 days for the first year and 7 days for the second year. Therefore long years' data will be of great value.

Conclusion

The delays achieved by evaporative cooling especially in first bloom and full bloom of pistachios (7 to 12 days) may be sufficient for reducing risk of spring freeze. But this should be confirmed by a field study where spring freeze occurs frequently.

Some workers who indicated its some adverse effects on trees or fruits criticized evaporative cooling (Rieger, 1989). However, in our study we haven't noted any phytotoxicity to trees or nuts. The water used in this study which was 900 mm throughout the experiment could be considered rather high in comparison to some previous work (Hamer, 1983). But this should be taken fairly reasonable for arid condition where pistachio is grown. Fortunately, the water sprinkling to the pistachios in our arid conditions can surely have contributed to an increase of soil water content, which in turn, improved plant water status. This was proven by the quality of nuts of watered trees (unpublished data).

Total cost of establishing such a system which was about 80 US\$ per dekar could be considered rather high for freeze protection by many. In that case, considering the fact that the bloom time is the same for watered Uzun trees and unwatered Ohadi trees, one may prefer to use the later cultivar to reduce the risk of freeze in a given location.

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