the true Key Lime flavor and aroma. Such plants could be grown year-round in a glasshouse in areas too cold for outdoor citrus culture. In the main commercial citrus-growing areas of central Florida where alternate long periods of warm and short periods of subfreezing temperatures are characteristic, winters are consistently too cold for field survival of Key Lime. Container-grown plants could be moved to a protected area during the periods of damaging freezes that would otherwise destroy outdoor or field grown trees.

Literature Cited

1. Barrett, H. C. 1974. Colchicine-induced polyploidy in Citrus. Bot. Gaz. 135(1):29-41.

Fruit Varieties Journal 46(3):170-174 1992

Effects of Debudding and Defruiting on Alternate Bearing in Pistachio (*Pistacia vera* L.)

T. CARUSO, L. DI MARCO, A. MOTISI AND A. RAIMONDO[1]

Abstract

Dormant and swelling inflorescence buds, inflorescences and infructescences were removed from both whole and half the canopy of cv. 'Bianca' pistachio female trees in order to investigate their role on alternate bearing. Summer inflorescence bud drop was almost totally avoided in the whole-canopy treated trees whereas in the non-bearing side of the half-canopy treatments, removing after full bloom still promoted a low percentage (about 20%) of inflorescence bud abscission. The latter treatment showed that the influence of the bearing half-canopy on the non-bearing one depended on the stage of the reproductive organs (inflorescence bud, inflorescence, infructescence) at removal time. The research also pointed out the importance of studying alternate bearing in pistachio by whole-tree treatments, because results from scaffold treatments can be affected by the crop load of other parts of the tree.

Introduction

The pistachio is a dioecious plant with male and female organs born in separate trees. Most of the axillary buds, formed during shoot's elongation, are inflorescence buds. Inflorescence buds are producd every year in large amount but, in the course of the development, are subjected to the competition effect of crop load on 1-year-old wood so that in a heavy crop year they abscise copiously during the summer season (1).

The mechanism which causes the phenomenon has not yet been completely determined. Even though bud abscission is related to a well defined phase of embryo development (7), it has been shown that this relationship of competition and/or correlative inhibition in some cases gives a partial explanation of the phenomenon. The early removal of infructescences did not eliminate the phenomenon but only reduced it (2, 3, 6, 7).

A partial explanation was given by Crane and Iwakiri (4), who, while comparing heavily bearing trees to those which had their inflorescence buds removed during the prebloom period, observed that the drop of inflorescence buds occurred in two distinct phases. The first, which precedes the phase of embryo growth, was also found in the non-bearing trees. It was assumed that the first wave of abscission was caused by a stimulus from the roots. The second phase, which affected only the bearing trees, oc-

[1]Istituto di Coltivazioni Arboree, Università di Palermo, Viale delle Scienze, 90128 - Italy.

curred during the rapid embryo growth and was attributed to competition effects.

It was observed however, in an experiment on trees with high fruit loads (5), that by removing the inflorescence buds from single branchlets 20 days before bloom, abscission of the inflorescence buds formed on the new shoots was reduced. Removal at bloom or later resulted in total inflorescence bud abscission.

The purpose of this study was to define the role of several stages of reproductive organs (dormant and swelling inflorescence bud, inflorescence and infructescence) on newly formed inflorescence bud abscission and subsequent alternate bearing.

Method

Research was carried out in 1989, an "on" year, at Racalmuto (Sicily—37° 41′ N.), in a commercial pistachio orchard. Sixty-five cv. 'Bianca'/*P. terebinthus* L. 80-year-old trees, spaced 8 x 8 m, 3.5 m tall and with a canopy 5 m wide, were chosen from those having the greatest load of inflorescence buds (800 to 1500). Beginning on 20 March, and every 15 days thereafter, for a total of six times, the reproductive organs on 5 trees for each period were removed completely. The same treatments were made on half the canopy of other 5 trees. Five trees were left untouched as controls. Flowering took place on the 20 April, therefore the treatment period ranged from 30 days before flowering, when the buds were dormant, to 45 days after flowering, when the endocarp had developed in the fruit. Shoot length, the number of inflorescence buds formed and the number of inflorescence buds that dropped were taken from 4 branchlets per treatment from each tree.

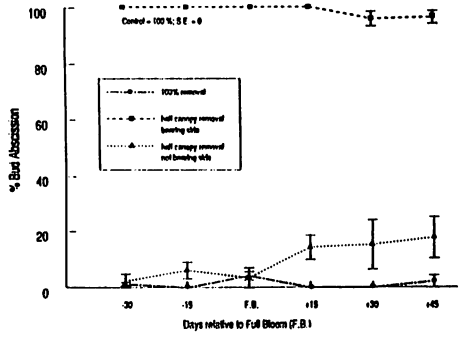

Figure 1. The effect of time of the removal of reproductive organs on the percentage of inflorescence bud abscission. Vertical bars denote standard error of mean (n = 5). F.B.: Full Bloom (20 April 1989).

Results

Inflorescence bud drop was almost total in the control trees and in the bearing halves of the 50%-treated trees. In the trees where the reproductive organs had been totally removed, inflorescence bud drop was almost nil for each removal date. In the non-bearing side of the canopy of the 50%-treated trees, when the treatments were made 30-days-before to full bloom, inflorescence bud drop was very low (approximately 5%) whereas a moderate level of drop (less than 20%) resulted from post-bloom treatments (Fig. 1).

Shoot length was strongly influenced by the crop load and the time of treatment (Fig. 2). In the 100%-treated trees shoot length was higher than the control. In the removal treatments before or at full bloom shoot length was higher than post-bloom treatments.

For the removal treatments until full bloom, on the non-bearing side of the 50%-treated trees shoot length was similar to that of the 100%-treated trees. On the bearing side the length of the shoots was intermediate between control and 100%-treated trees. In the post-bloom treatments shoot length was similar to the control.

Until the full-bloom treatment, the number of inflorescence buds formed was influenced both by the time of removal and by the level of the crop load (Fig. 3). In the 100%-treated trees, the number of inflorescence buds

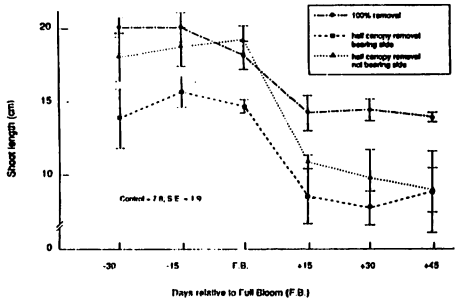

Figure 2. The effect of time of tne removal of reproductive organs on current season's shoot length. Vertical bars denote standard error of mean (n = 5). F.B.: Full Bloom (20 April 1989).

formed was higher than the control. However, differently to what observed for shoot growth, the later the treatment the lower the number of flower buds formed.

In the 50%-treated trees the number of inflorescence buds formed in the non-bearing side was similar to the 100%-treated trees whereas in the bearing side the values were lower but still higher than the control. The number of inflorescence buds formed was similar to the control in all the post-bloom treatments.

The effect of the treatment carried out in 1989 lasted until the following year. In 1990 greater development of new vegetation and a greater number of inflorescence buds was found in trees which in 1989 had been deprived of the reproductive organs before or at full bloom (Fig. 4).

Discussion

It is interesting to observe how, apart from the time of treatment, total removal of the reproductive organs avoided inflorescence bud drop almost completely. This is in contrast with what was generally observed (1, 3, 6, 7). The differences found could be due to the cultivar or, probably, to the scion/rootstock combination used and the cultural environment where the work took place.

The results of the removal of the reproductive organs from half the canopy show that, as pointed out by other

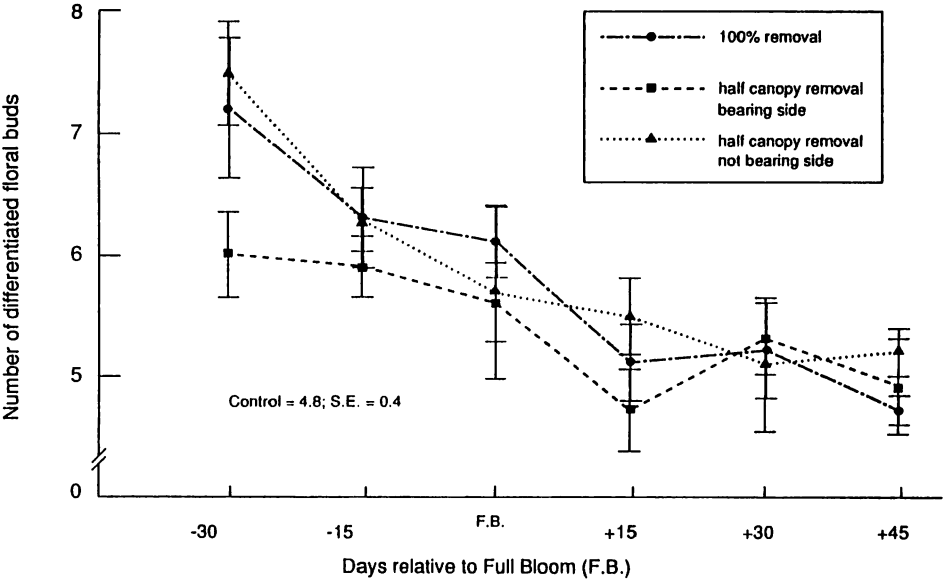

Figure 3. The effect of time of the removal of reproductive organs on the number of inflorescence buds differentiated on current season's shoot. Vertical bars denote standard error of mean (n = 5). F.B.: Full Bloom (20 April 1989).

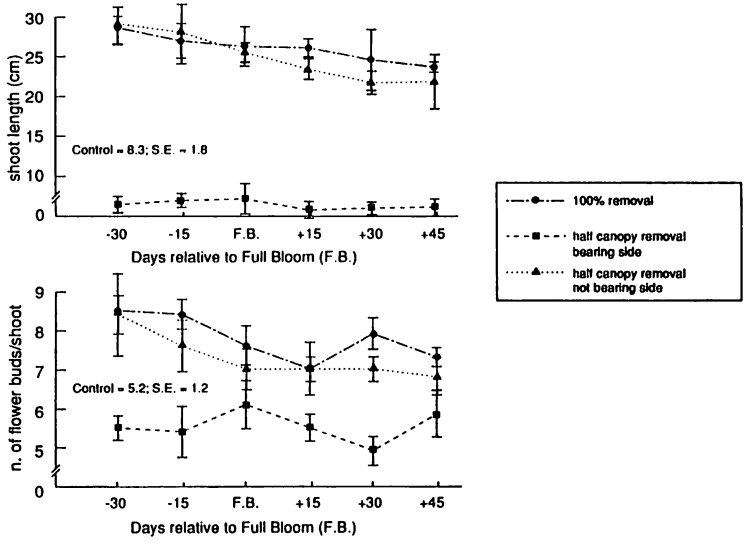

Figure 4. The effect of time of the removal of reproductive organs on shoot length and the number of inflorescence buds per shoot one year after the treatments (1990). Vertical bars denote standard error of mean (n = 5). F.B.: Full Bloom (20 April 1989).

authors (7), abscission of the inflorescence buds in response to the competition given by growing fruits is a phenomenon which mainly affects the part of the plant where the fruit load is concentrated, However, the different drop level observed on the non-bearing side of the trees with the reproductive organs removed before and after full bloom points out that the abscission of inflorescence buds formed on current season's growth is affected by blooming. This confirms the findings of a previous work (5).

The development of new shoots and floral induction were notably influenced by the earliest stages of development of inflorescences. In particular, the removal of inflorescence buds which were still resting considerably increased the following year's bearing potential. This phenomenon was also found on the bearing side of the trees.

The lack of effect of the post-bloom treatments lead us to hypothesize that the process of inflorescence bud initiation ended soon after full bloom.

The difference in behaviour of the plants with different removal times can ony be partly explained by phenomena of competition. The response of the trees showed two patterns separated by flowering: in fact, the most important differences among the effects were observed between the earliest removals until full bloom and the post-bloom treatments. Apart the number of inflorescence buds formed, within each of these two periods no substantial differences were obtained among the removal dates.

References

1. Crane, J. C. and M. M. Nelson. 1971. The unusual mechanism of alternate bearing in pistachio. HortScience 6:3825.
2. Crane, J. C. and M. M. Nelson. 1972. Effects of crop load, girdling and auxin application on alternate bearing in pistachio. J. Amer. Soc. Hort. Sci. 97:337-339.
3. Crane, J. C., I. Al-Shalan and R. M. Carlson. 1973. Abscission of inflorescence buds as affected by leaf area and number of nuts. J. Amer. Soc. Hort. Sci. 98:591-592.
4. Crane, J. C. and B. T. Iwakiri. 1987. Reconsideration of the cause of inflorescence bud abscission in pistachio. HortScience 22:1315-1316.

5. Di Marco, L., A. Motisi, P. Inglese and I. Batlle. 1988. Alternate bearing control in pistachio (*Pistacia vera* L.). Proceedings of the 2nd International Meeting on Mediterranean Tree Crops, Chania, Greece, 2-4 November.
6. Porlingis, I. C. 1974. Flower bud abscission in pistachio (*Pistacia vera* L.) as related to fruit development and other factors. J. Amer. Soc. Hort. Sci. 99:121-125.
7. Wolpert, J. A. and L. Ferguson. 1990. Inflorescence bud retention in 'Kerman' pistachio: effects of defruiting date and branch size. HortScience 25:919-921.

Fruit Varieties Journal 46(3):174-182 1992

In Pursuit of a Better Pecan Cultivar

DARRELL SPARKS[1]

Abstract

Pecan [Carya illinoensis (Wangenh.) K. Koch] nut yields are low. Except for initial cultivar selections made in the early 1900's, a long-term increase in marketable yield by cultivar improvement has not been documented. Failure of most of the many pecan cultivars is proposed to be due to inadequate testing, overemphasis of precocity and prolificacy, and low market value of the nut. Because pecan fruits are not chemically or mechanically thinned, excessive prolificness and resulting poor nut quality is apparently the predominant reason for failure. The proposal is made that for long-term success, a cultivar should be precocious, but not prolific, and have maximum nut market value (large, early maturing nut, good cracking and shelling characteristics, and a light colored kernel). The vast gene pool in pecan offers the opportunity to engineer a cultivar that will produce nut yields greater than 'Desirable's' (an outstanding cultivar) and maintain the same market value of the nut, or maintain 'Desirable's' yield but increase market nut value, or both. Breeding strategies for obtaining these objectives are proposed.

Introduction

Pecan trees inherently produce low yields as evidenced by the fact that pecan is one of the very few tree crops in which yield per acre is measured in *pounds* instead of *tons*. The average yield is a paultry 850 pounds per acre in the world's center for pecan production located in a 50 mile-radius of Albany, Georgia (36). Although the low yield in the Albany area is partially due to poor tree stands (25), as well as lack of irrigation or inadequate irrigation, the fact remains that the maximum potential yield in pecan is low. Maximum long-term pecan yields range from about 1,500-2,000 pounds per acre depending on the climatic region. However, very few growers achieve these yields on a long-term average. Average yields of 3,000-4,000 pounds per acre are unrealistic with existing cultivars and production technology. Claims of yields of thousands of pounds per acre most often occur in a sale prospectus, in new cultivar releases, during the "on" year of production or in small plots. Such large yields have never been obtained in large acreage on a long-term average.

Attempts have been made to increase yields by cultivar improvement since the late 1800's (3, 18). However, a substantial and long-term increase in yield due to cultivar improvement has not been documented to be greater than that of initial selections ('Desirable,' 'Schley,' 'Stuart' and 'Western Schley') made near the turn of the century. Yield increases during the past 60 years appear to be mainly due, if not entirely, to improved cultural practices.

[1]Department of Horticulture, University of Georgia, Athens, GA 30602.