Research

Increasing Pistachio Yield with Foliar Urea and Cytokinin

A Preliminary Report on a Strategy to Decrease Pistachio Floral Bud Abscission in an On-Year to Increase Yield the Next Year

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The production of alternating heavy versus light pistachio (Pistacia vera L., cv. Kerman) crops is a problem of increasing significance in California. Alternate bearing in pistachio results from the excessive abscission of floral buds for next year's crop during the on (heavy crop) year. The excessive abscission of floral buds begins in June and intensifies at the time of seed growth (nut fill) in July. Despite the fact that the mechanism leading to alternate bearing in pistachio is known, the physiological basis for bud abscission and a means of preventing it has not been identified.

There is convincing evidence that the floral buds fail to compete successfully against the developing nuts for available carbohydrate, nitrogen and other nutrients, and thus abscise (Crane and Nelson, 1971; Crane and Nelson, 1972; Crane et al., 1973, 1976; Weinbaum et al., 1944a, b). Additionally, a leaf-produced "anti-abscission" hormone and/or fruit-produced "abscission-promoting" hormone were proposed (Crane et al., 1973). In on-years there is a strong reproductive demand for nitrogen (Weinbaum et al. 1994a, b). Leaflet nitrogen concentration was observed to decrease during the period from seed growth (nut fill, early July) to fruit maturation (early September). Leaflets at the base of nut clusters senesce early in on-years (L. Ferguson, personal communication). Premature leaflet senescence would cause a further loss in photosynthesis, carbohydrate and nutrient availability, and leaf-produced hormones. At harvest, the amount of nitrogen removed in mature fruit plus that lost from senescent leaflets was 1.0 kg N per tree during an on-year versus only 0.2 kg N per tree in an off-year.

Thus, we attempted to increase floral bud retention with canopy applications of nitrogen as low-biuret urea combined with a cytokinin (Accel and Binary CQ). The foliar application of urea was designed to supply extra nitrogen during the critical period of nut fill. The foliar application of cytokinin was used to increase floral bud "sink strength," or the ability of the buds to compete for resources to prevent leaf senescence, to compensate for the loss of a leaf "anti-abscission" hormone, and to counter the effect of an "abscission-promoting" hormone exported from the nuts. This strategy proved successful in reducing bud abscission on branches bearing heavy nut clusters (more than 70 nuts per cluster). Foliar application of urea combined with a cytokinin in early June and again in early July increased bud retention approximately three-fold and two-fold for two successive years. Based on the results of these branch studies, we established a field experiment at S&J Ranch to test the efficacy of applying nitrogen combined with a cytokinin to the foliage of pistachio trees during the on-year to increase yield the following off-year. The goal was to increase cumulative pistachio yield.

Procedures

The treatments were replicated on 16 individual trees located at S&J Ranch; the orchard was entering an on-year and only trees with a heavy crop were used in the experiment. The treatments included: (1) the control; (2) 0.25 percent N as urea (Unocal Plus, <0.1 percent biuret) in combination with 25 ppm 6-benzyladenine (25 mg BA/L, Accel®, a product of Abbott Laboratories) applied to the foliage

June 1 and July 1; and (3) 0.25 percent N as urea plus Binary CQ (1 quart/100 trees/acre, a product of Helena Chemical Company). All applications were in 11.4 L of water (approximately 300 gallons per acre), which was sufficient to provide full canopy coverage to the point of run-off.

Yield was determined at the time of commercial harvest. Commercial shaking and catching equipment was used to harvest the plots. Yield (kg fruit/tree) was determined in the field using portable bin scales. Subsamples (100 nuts/tree) were collected, and nut quality was analyzed for blank nuts (no evidence of embryo growth), aborted nuts (terminated embryo growth), unsplit nuts, split nuts, and fresh and dry weights of nut components (hulls, shells and kernels).

Results

We now have three years of field data. In year one, treatments were made when trees were producing a heavy on-year crop. The trees were harvested that same year to determine if the treatments had any positive or negative effect on the current crop. There were no statistically significant effects from any treatment on yield or percent split nuts. In addition, there was no significant difference between the fresh weight and dry weight of the pistachio embryos or hulls from the control trees versus treated trees. Thus, there were no negative effects of the treatments on the crop that would preclude their further use.

In year two, we harvested the crop produced by the previous year's buds to determine if we were successful in preventing bud abscission when the trees were carrying an on-year crop and in increasing yield in the off-year. Foliar application of low-biuret urea (0.25 percent N) combined with 25 ppm 6-benzyladenine (Accel) in early June and again in early July significantly increased yield compared to the untreated control (Table 1). Foliar applications of urea (0.25 percent) combined with Binary CQ made in early May, early June and again in early July did not significantly increase yield compared to the untreated control trees. We need to determine if this is due to the use of three foliar applications (May, June and July). When three applications of low-biuret urea (0.25 percent N) combined with 25 ppm 6-benzyladenine (Accel) were used instead of two, efficacy was reduced (data not shown).

In year three, we harvested the crop produced by the previous year's buds. These were the buds produced when the tree was carrying the off-year crop. Foliar applications of urea (0.25 percent N) combined with 25 ppm benzyladenine (Accel) made in early June and again in early July also significantly increased yield in the on-year. Foliar applications of urea (0.25 percent) combined with Binary CQ made in early May, early June and again in early July, which did not significantly increase yield compared to the untreated control trees in the off-year, did significantly increase yield in the on-year (Table 1). Both treatments significantly increased cumulative yield as kg split nuts (dry weight)/tree (Table 1).

Conclusion

Foliar applications of low-biuret urea (0.25 percent N) combined with 25 ppm 6-benzyladenine (Accel, Abbott Laboratories) made in early June and again in early July significantly increased yield for both the

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Table 1. Effect of foliar low-biuret urea and a cytokinin applied in an on-year and then in an off-year on annual and cumulative yield.

Treatment[1]	Date of Application	Kg Split Nuts (Dry Weight)/Tree Off-year	On-year	Cumulative
Control		2.7 b	16.9 b	17.8 b
0.25% N as urea[2] + 25 ppm BA (Accel)[3]	June 12 + July 8	5.9 a	21.8 a	28.5 a
0.25% urea + Binary CQ (1 qt/acre)[4]	May 12, June 12 + July 8	4.2 a	24.0 a	28.0 a
Significance		(P=0.03)	(P=0.002)	(P=0.001)

[1] All treatments were applied to the point of run-off, which required 11.4 L per tree, approx. 300 gallons per acre.
[2] Unocal PLUS (<0.1% biuret); a gift from Unocal Corp.
[3] 6-Benzyladenine (Accel), a gift from Abbott Laboratories.
[4] A gift from Helena Chemical Company.

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off-year and on-year as kg fruit (fresh weight)/tree and kg split nuts (dry weight)/tree compared to the untreated control trees. At this time in California, the plant growth regulator Accel can be used only on apples. Abbott Laboratories is working towards adding pistachios to the label. Three foliar applications of urea (0.25 percent N) combined with Binary CQ (1 quart/100 trees/acre, Helena Chemical Company) in May, June and July did not significantly increase these two yield components in the off-year but did in the on-year. Binary CQ is a bio-stimulant, not a plant growth regulator and can be used on pistachios. For the first complete cycle of alternate bearing, the results are promising but yield data for additional alternate bearing cycles and orchards are required. Specifically, we need to determine whether the treatments can be used annually or should only be applied when the trees are carrying a heavy on-year crop to increase the off-year yield. Using the treatments when the trees are carrying an off-year crop to increase the on-year yield might be counterproductive to reducing alternate bearing. ❑

Agristructure B.W.
Drop Key Lines

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Drop Key Lines

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