Characteristics and Control of Almond Dormant Bud Drop

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Dormant bud drop can be a serious problem in young San Joaquin Valley almond orchards growing in sandy soil. Floral buds fail to swell normally and then fall to the ground by bloom time. Terminal leaf buds grow normally which results in long areas of willowy, blind wood in these chronically affected orchards. Therefore, bud drop not only reduces the current season's yield, but also results in long term losses.

The exact cause of bud drop is still unclear but it appears in orchard conditions similar to those that favor bacterial canker. Bud drop is most severe in young trees (generally 4^{th} – 9^{th} leaf) growing in sandy soil in replanted orchards with high ring nematode numbers and / or other chronic root problems. Carmel appears to be the most severely affected variety, but bud drop can also be severe in Wood Colony, Price, Mission, Butte, Fritz, and Nonpareil. Isolations by Dr. Bruce Kirkpatrick's lab indicated that affected buds are colonized by *Pseudomonas syringae*, the bacterium associated with bacterial canker. Periodic sampling of buds from October through February indicated *P. syringae* numbers were generally higher in buds collected from trees with a history of severe bud drop than in older trees with mild bud drop (data presented in the 2000 Almond Conference Proceedings).

Beginning in 1997, field experiments have been conducted in Stanislaus County to determine the cause of bud drop and to formulate control strategies. Trials included a wide range of soil-applied fertilizers, foliar nutrient sprays, nematicides, copper sprays, microbiological soil additives, and organic and inorganic soil amendments. Data from these trials showed that monthly applications of CAN-17 (30 pounds of nitrogen per acre) plus foliar calcium chloride sprays significantly reduced bud drop as did nematode management with applications of Enzone® (results published in the 2000 Almond Conference Proceedings). However the best results were obtained when a combination of treatments were employed including a fall application of Bordeaux mix. It is unknown whether it is the nitrogen, calcium, or the combination that contributes most to the improvement. Trials conducted in 2000 / 2001 were designed to clarify the relationship between nitrogen, calcium and increased bud retention.

Methods

Two trials were established in 2000 in a second generation, fourth-leaf Nonpareil:Price:Fritz orchard with sandy soil, a high water table, and moderate-high ring nematode numbers (~175 nematodes per 250 cc of soil). Parts of the orchard suffered from severe bacterial canker and bud drop.

Trial #1 compared differing rates and forms of nitrogen fertilizers compared to trees treated with a nematicide (Enzone®), fall copper sprays and untreated trees. The rates and times of application are listed in Table 1 below. Nitrogen fertilizers were mixed into approximately five gallons of water and poured around trees 5-10 hours before the orchard was flood irrigated. Enzone® was tanked into basins at a rate of 500 ppm in 200 gallons per tree. The copper materials Kocide DF and Bordeaux mix (copper sulfate plus lime) were sprayed with a handgun sprayer in the equivalent of 200 gallons per acre.

Table 1. Rates and timing of materials applied to trees in bud drop trial number 1.

Material	(Rate per acre)	Frequency of Application
CAN-17	40 units of N	Monthly (May – Sept.)
CAN-17	80 units of N	Monthly (May – Sept.)
CAN-17	100 units if N	May & August
UN-32	40 units of N	Monthly (May – Sept.)
UN-32	100 units if N	May & August
Enzone®	500 ppm	October
Copper sulfate & lime	10:10:100 at 200 gallons	November 20
Copper hydroxide (Kocide DF)	12.5 lb. per acre	November 20
Untreated	---	---

Trial #2 was established to confirm previous positive results with applications of CAN-17 fertilizer, foliar calcium sprays, fall copper sprays and a combination of all three treatments. Twelve, five-tree replications were arranged in a randomized complete block design using all three almond varieties. CAN-17 was applied at a rate of 45 units of nitrogen each month from May through September in 2000. The nitrogen fertilizer was sprayed on the soil surface with a boom attached to an all terrain vehicle (ATV) 5-10 hours prior to a flood irrigation. Foliar calcium (Nutri-Cal®) was applied at four quarts per acre in 100 gallons of water with a handgun sprayer. The calcium was also applied monthly from May through September. Bordeaux mix (10 pounds of copper sulfate + 10 pounds lime per 100 gallons of water) was applied November 20. The Bordeaux was applied at 200 gallons per acre with a handgun sprayer.

On March 1-7, 2001, both trials were evaluated for bud drop. Three small limbs per tree with 75 – 150 bud positions per limb were examined. The number of open / opening flower buds were counted on each shoot. In addition, the number of buds that had fallen or were tightly closed (buds that were not going to open) were also counted. Percent bud drop was then calculated for each treatment

Results

The test orchard suffered from very severe bud drop in 2001. In Trial #1, Enzone improved bud retention on 'Fritz' trees by 45.6% and 28.6% on 'Price' compared to untreated trees. In the 'Fritz' variety, 84.5% of the buds dropped off untreated trees compared to 45.6% on Enzone treated trees. In the 'Price' variety, 99% of the buds fell off

untreated trees while 70.7% of the buds fell off Enzone treated trees. Although Enzone significantly increased pounds of nut meats per tree, yields were still not economically acceptable. None of the nitrogen treatments or copper sprays significantly reduced bud drop compared to untreated trees. Percent bud drop for each treatment and yield for untreated and Enzone treated trees are shown in Table 2.

Table 2. Percent bud drop and yield per tree for treated and untreated trees.

Material	(Rate per acre)	% Bud Drop		Yield (lb/tree)	
		'Fritz'	'Price'	'Fritz'	'Price'
CAN-17	40 units of N	81.7 a	95.0 a		
CAN-17	80 units of N	81.4 a	94.0 a		
CAN-17	100 units if N	91.1 a	92.4 a		
UN-32	40 units of N	91.9 a	92.4 a		
UN-32	100 units if N	88.0 a	92.2 a		
(Bordeaux mix)	10:10:100	93.6 a	94.8 a		
(Kocide DF)	12.5 lb. per acre	89.9 a	93.2 a		
Enzone®	500 ppm	45.6 b	70.7 b	5.8 b	4.0 b
Untreated	---	84.5 a	99.0 a	4.0 a	0.1 a

In Trial #2, bud drop was extensive in all treatments, ranging from 86.1% in the CAN-17 treatment to 95.1% in the untreated trees. None of the treatments significantly improved bud retention or increased yield.

Discussion

Although previous trials showed that monthly applications of CAN-17 and foliar calcium coupled with a fall spray of Bordeaux reduced bud drop, we did not have favorable results in this trial. In previous trials, nitrogen and calcium were applied together, making it impossible to determine which of the two nutrients were most responsible for improving bud retention. It is possible our nitrogen application technique in the 2000/2001 trials was inadequate, allowing significant amount of volatilization to occur before irrigation. It is also possible that the roots were too badly damaged from nematode feeding as well as salt accumulation from the fluctuating water table that they were not able to pick up the nitrogen adequately. Foliar calcium sprays did not reduce bud drop in these trials. This lack of response could not be explained by a compromised root system. It is possible it was nitrogen and not calcium that improved bud retention in the older trials. In 2001, both the nitrogen and calcium fertilizers were applied with foliar sprays to perhaps answer this question.

The nematicide Enzone significantly decreased bud drop and increased yield in both varieties. By reducing nematode numbers, perhaps we were able to improve uptake of nutrients vital to maintaining a healthy bud, making the bud more resistant to colonization by *Pseudomonas syringae*. Samples are currently being analyzed to compare nutrient contents of buds and one-year-old shoots of untreated trees and trees treated with Enzone. Both of these trials will be continued for one more year.