WALNUT BLIGHT CONTROL INVESTIGATIONS TEHAMA 2007

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ABSTRACT

Depending on weather conditions, pathogen population and walnut variety, walnut blight bacteria, *Xanthomonas campestris pv juglandis* can cause significant crop loss. During the 2007 season, untreated Chandler trees under simulated plus natural rainfall had 32.05% blighted walnuts in the mid canopy and almost 70% damage on tagged walnuts reachable from the ground. Untreated trees under natural rainfall had 4.04% blighted walnuts. Over tree sprinklers operated to simulate rainfall worked well for insuring disease pressure. Shoot tagging demonstrated early opening buds are more fruitful compared to late opening buds and blight sprays applied closest to prayer stage had the greatest effect on reducing pathogen populations. Kocide 101, Kocide 2000 and Kocide 3000 all performed well at controlling walnut blight when tank mixed with Manex. Adding Manex to copper continues to result in improved disease control and Manzate 75DF did a good job as well.

Attempts to evaluate five rates of Breakthru in the initial bud-break spray of Kocide+Manex all resulted in very good blight control with no differences between treatments. The aggressive five spray program subsequently applied throughout the spring most likely masked any effects or reductions on pathogen population. Finally, kernel copper analysis showed no statistical difference in kernel copper content between trees sprayed with copper and untreated controls.

OBJECTIVES

1) Tag individual shoots and determine efficacy of early season bactericides applied at different phenological stages.
2) Evaluate bud break and shoot development related to cropping and first spray timing decisions.
3) Evaluate copper formulations, Manex, Manzate and Breakthru.
4) Evaluate kernel copper levels for sprayed and unsprayed trees.

PROCEDURES AND RESULTS

Bactericide application relative to bud break timing is particularly important for good disease control. Bactericides applied very early (when most buds are closed) will not access the pathogen while bactericides applied after the majority of buds have opened are too late to prevent early contamination. Breakthru is used to improve bactericide penetration to buds as they open. Again in 2007, we continued a very ambitious experiment in which we tagged thousands of buds as they opened and applied a single bactericide spray at strategic times relative to bud opening. Different colored wire tags indicated how open buds were relative to spray timing (Figures 1 and 2).

Figure 1. Schematic illustrating when prayer stage shoots were tagged and a single spray applied.

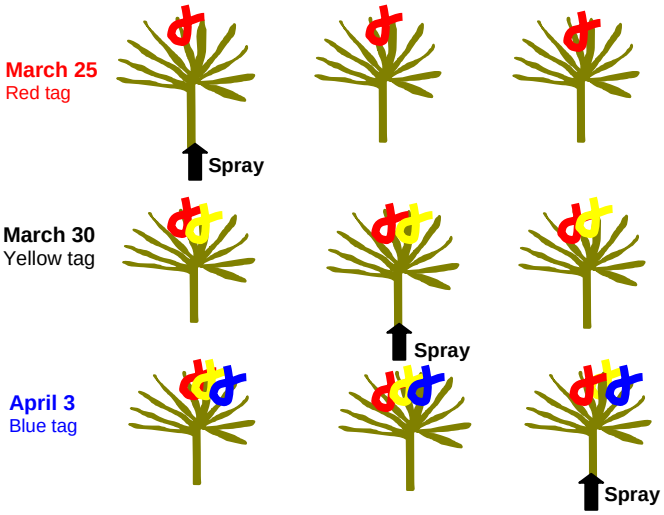


Figure 2. Tagged walnut branch showing a closed bud, prayer stage in the center and a shoot with expanding leaves.

Colored tags were also used to evaluate bud/shoot fruitfulness. One hundred tags were applied at "prayer stage" on 3/30/07, 4/2/07, 4/6/07 and 4/9/07. The total number of walnuts per timing was counted on 5/29/07.

Material evaluations were done under over tree rainfall simulation. The test plot was plumbed with Nelson R-30 sprinklers (application rate: 0.06 inches/hour) to apply water above the tree canopy. Sprinklers were placed 30 feet above ground and were operated five times. Ten hours per application except on 4/18/07 when the system was operated for 1.5 hours for frost protection (Figure 3).

All treatments were applied by hand gun to individual trees. Applications were made at 250 psi to simulate a dilute (400 gal/ac.) application. Trees were sprayed (5gal/tree) to thoroughly wet all tissue. Spray applications were made 3/30, 4/9, 4/18, 4/30 and 5/10/07 (Figure 3).

Experimental design was a randomized complete block (RCB) with ten treatments and five replicates. Five additional trees were randomly sampled outside the rainfall simulator to measure percent blight under natural rainfall. Since those trees were not part of the randomized complete block design, they were not included in the statistical analysis.

Copper analysis was accomplished using five treatments with five replicates in a RCB design. One hundred walnuts per tree were harvested, immediately shelled (1.3 lb. sample weight) and the kernels frozen. Frozen samples were transported to an Ag lab for kernel copper content in ppm.

Data taken:

1) Percent blighted walnuts evaluated 5/28/07 by visually inspecting 300 to 500 walnuts per treated tree for blight symptoms. Counts were made randomly within the tree canopy roughly 6-12 feet above ground.

2) Phytotoxicity was visually rated using a scale of 0-5 where "0" represents no observable phytotoxicity.

3) Disease progression curve by tagging 150 nut pairs on 6 untreated trees under simulated rainfall and visually rating for walnut blight symptoms every 3-4 days.

4) Prayer stage bud development dates by visual inspection of over 1000 buds/shoots per count date.

5) Tagged buds were sampled and transported to the Lindow lab for population analysis.

6) Kernel copper content using an Agricultural lab experienced in analyzing tissue samples.

7) Counts of total nuts (5/28/07) on cohorts of shoots derived from buds that had been tagged at different opening dates.

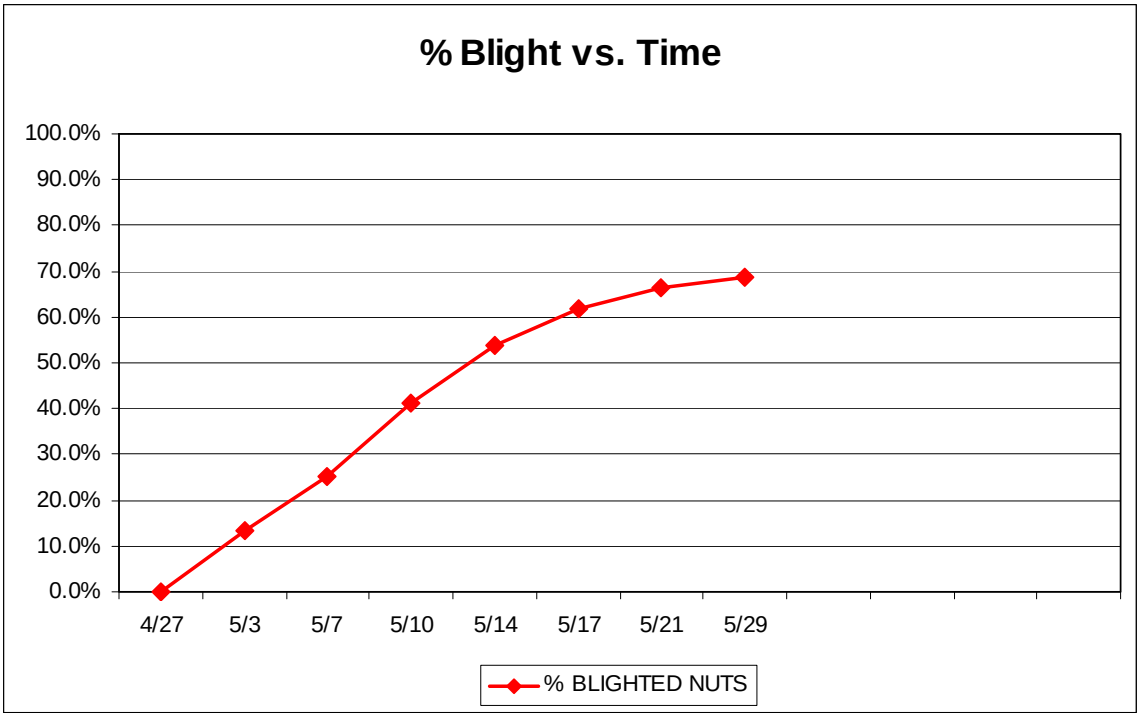
Figure 3. Rainfall, Stage of Growth and Spray Timing for the Tehama Walnut Blight Experiment

Date	Rainfall (nat)[1]	Rainfall (sim)[2]	Event
3/20/07	.13 in	—	—
3/23/07	—	—	14% prayer
3/26/07	.11 in	—	—
3/27/07	—	—	41% prayer
3/29/07	—	—	first pollen
3/30/07	—	—	58% prayer, spray #1
3/31/07	—	.72 (10 hrs)	—
4/2/07	—	—	62% prayer
4/4/07	—	.72 (10 hrs)	—
4/5/07	—	—	61% prayer, 1st flowers
4/9/07	—	—	spray #2
4/10/07	—	.72 (10 hrs)	—
4/11/07	—	—	50% prayer, full bloom
4/17/07	.05 in	—	—
4/18/07	—	.11 (1.5 hrs)	spray #3
4/19/07	—	.72 (10 hrs)	—
4/22/07	.11 in	—	—
4/30/07	—	—	spray #4
5/1/07	.12 in	—	—
5/3/07	.33 in	—	—
5/4/07	.02 in	—	—
5/10/07	—	—	spray #5

[1]Natural rainfall – CIMIS (Gerber) 7 events for .90 inches
[2]Simulated rainfall – (overhead sprinklers) 5 events for 2.99 inches

Figure 4. Examples of walnut shoots at or close to prayer stage.

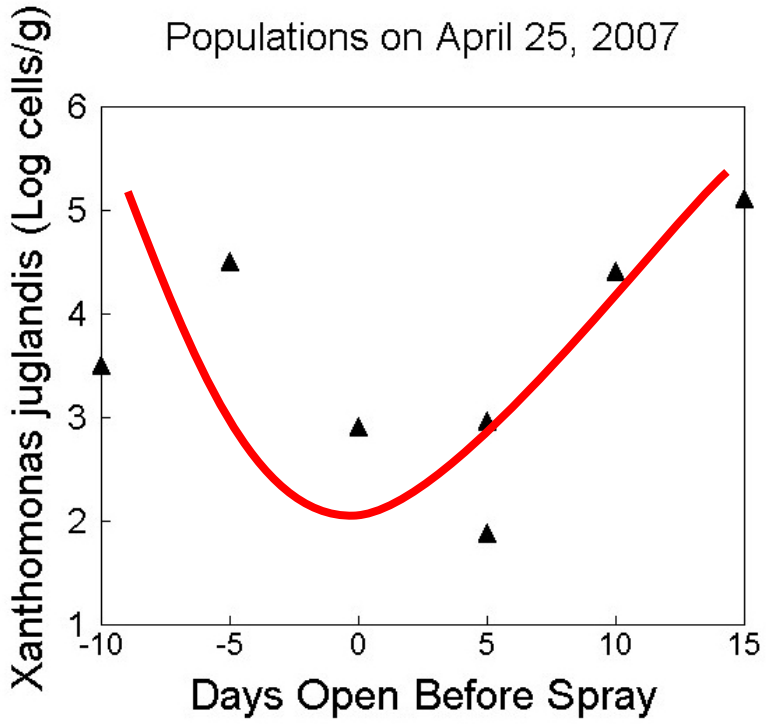
Figure 5. Blight Symptoms on Untreated Walnuts Under Simulated and Natural Rainfall. Tehama experiment 2007. Comparisons were made under significant disease pressure.



RESULTS AND DISCUSSION

Bud tagging and pathogen populations are summarized in Figure 6. The graph represents how many days buds were open before a single Kocide 2000 @ 6 lbs. plus Manex @ 58 oz. plus Breakthru @ 64 oz./100 gal. spray was applied. Due to the difficulty of getting these data, the graph has only six points. However, the trend line suggests sprays applied close to prayer stage have the greatest chance of decreasing pathogen populations. If sprays are applied too early, buds are mostly closed and population reduction is not as effective. Conversely, waiting ten or more days after prayer stage to apply the first spray appears to allow time for the pathogen to increase and potentially colonize green tissue.

Figure 6. Walnut blight bacteria population reduction from a single spray applied relative to bud break and shoot elongation. Zero represents the "prayer stage" of shoot development.



The second part of the bud tagging experiment confirmed work by Lindow et.al. (Walnut Research Report 2007, page 221-236) evaluating walnut bud fruitfulness. Prayer stage shoots were tagged for identification in late March/early April and the total number of walnuts counted in late May (Figure 7). Clearly, many factors can affect fruitfulness but in this evaluation, buds that opened first had more crop. Prayer stage shoots tagged on 3/30/07 had 49 walnuts compared to only 6 walnuts on prayer stage shoots tagged on 4/9/07. If the early buds produce more crop it points to the importance of protecting those early buds/shoots from walnut blight bacteria.

Figure 7. Cropping Probability for Early vs Late Prayer Stage shoot development. Tagged trees were under a very good grower blight control program.

Growth Rate	#Shoots[1] Recovered	#Walnuts[2] Total	#Blighted Total
Prayer Stage 3/30/07	99	49	5
Prayer Stage 4/2/07	96	36	1
Prayer Stage 4/6/07	84	24	0
Prayer Stage 4/9/07	81	6	0

[1]100 shoots were tagged at each event.
[2]Number of Chandler walnuts counted 5/29/07.

Material evaluations included Kocide 101, Kocide 2000, Kocide 3000, Manex, Manzate and Breakthru. When tank mixed with 58 oz. Manex/ac., blight control was not statistically different between Kocide 101 @ 8 lbs, Kocide 2000 @ 6 lbs. and Kocide 3000 @ 4 lbs. (Figure 8). New copper formulations have reduced the amount of applied metallic copper without compromising disease control. As we have previously shown, the addition of Manex improved walnut blight control. 9.22 percent blight for Kocide 2000 alone compared to 3.98 percent blight for Kocide 2000 plus Manex (Figure 9). Manex and Manzate 75DF were compared using Kocide 3000 as the copper source. 7.80 percent blight with Manex compared to 4.01 percent blight using Manzate (Figure 9). Manzate 75DF appears to perform similar to Manex.

Figure 8. Formulation Comparisons for Kocide 101, Kocide 2000 and Kocide 3000. Spray application dates were: 3/30/07; 4/9/07; 4/18/07; 4/30/07 and 5/10/07.

Treatment	% Blight	Phytotoxicity[5]
Kocide 101[2] @ 8 lbs. + 58 oz. Manex/Ac	5.81 a[1]	0
Kocide 2000[3] @ 6 lbs. + 58 oz. Manex/Ac	3.90 a	0
Kocide 3000[4] @ 4 lbs. + 58 oz. Manex/Ac	7.80 a	0
Untreated (simulated rainfall)	31.98 b	0

[1]Duncan's multiple range test for treatment means at the 5% level
[2]Kocide 101 50% metallic copper
[3]Kocide 2000 35% metallic copper
[4]Kocide 3000 30% metallic copper
[5]Phytotoxicity rated on a scale of 0 to 5 with 0 as no 'phyto'

Figure 9. Comparisons of Kocide 2000 with and without Manex and Manex vs. Manzate 75DF. Spray application dates were: 3/30/07; 4/9/07; 4/18/07; 4/30/07 and 5/10/07.

Treatment	% Blight	Phytotoxicity[4]
Kocide 2000 @ 6 lbs. + 58 oz. Manex/Ac	3.98 a[1]	0
Kocide 3000 @ 4 lbs. + 58 oz. Manex/Ac	7.80 ab	0
Kocide 3000 @ 4 lbs. + 2.4 lbs. Manzate[2]/Ac	4.01 a	0
Kocide 2000 @ 6 lbs.	9.22 b	0
Untreated (simulated rainfall)	32.05 c	0
Untreated (natural rainfall)	4.04[3]	0

[1]Duncan's multiple range test for treatment means at the 5% level
[2]Manzate 75DF: Dupont Crop Protection, Zinc ion and Manganese ethylene-bisdithocarbamate
[3]Non replicated trees outside of the rainfall simulator
[4]Phytotoxicity rated on a scale of 0 to 5 with 0 as no 'phyto'

The addition of Breakthru at 8, 16, 32 or 64 ounces to the initial bud-break spray did not improve walnut blight control compared to Kocide plus Manex applied alone (Figure 10). The five spray program subsequently applied throughout the spring was most likely aggressive enough to result in good control masking any benefits from the Breakthru. Additional work needs to evaluate bacterial population decreases from a single Breakthru application at each rate.

Figure 10. Breakthru Rate Comparisons. Breakthru was applied in the first spray only and followed by four sprays of Kocide 2000 @ 6lbs. + 58 oz. Manex per acre. Spray application dates were: 3/30/07; 4/9/07; 4/18/07; 4/30/07 and 5/10/07.

Treatment	% Blight	Phytotoxicity[3]
Kocide + Manex[1] + 0 Breakthru	3.98 a[2]	0
Kocide + Manex + 8 oz. Breakthru	2.45 a	0
Kocide + Manex + 16 oz. Breakthru	5.19 a	0
Kocide + Manex + 32 oz. Breakthru	4.52 a	0
Kocide + Manex + 64 oz. Breakthru	2.97 a	0
Untreated (simulated rainfall)	32.05 b	0

[1]Kocide 2000 @ 6 lbs. + 58 oz. Manex
[2]Duncan's multiple range test for treatment means at the 5% level
[3]Phytotoxicity rated on a scale of 0 to 5 with 0 as no 'phyto'

Copper residue on kernels from walnut blight sprays have been questioned but little California data exists. Olson et al. (Walnut Research Reports 1987 page 148) investigated copper deficiency in walnuts. For the kernel fraction, kernels from deficient trees had 1.6 ppm Cu compared to 10.7 ppm Cu for good trees. The 2007 Tehama walnut blight plot presented an opportunity to evaluate kernel copper from four copper spray strategies versus an unsprayed control. Kernel copper analysis ranged from 11.88 ppm to 13.62 ppm with no statistical difference between applied copper and untreated trees (Figure 11). In addition, the copper levels

are relatively close to the adequate levels reported by Olson et al. Additional work is needed but five spray applications did not appear to increase kernel copper content.

Figure 11. Kernel Copper Analysis for Copper Treated Trees Compared to Untreated Trees. Spray application dates were: 3/30/07; 4/9/07; 4/18/07; 4/30/07 and 5/10/07.

Treatment	Kernel ppm Cu
Kocide 101 @ 8 lbs. + 58 oz. Manex/Ac.	13.62 a[1]
Kocide 2000 @ 6 lbs. + 58 oz. Manex/Ac.	11.76 a
Kocide 3000 @ 4 lbs. + 58 oz. Manex/Ac.	13.12 a
Kocide 2000 @ 6 lbs.	11.88 a
Untreated Control	13.38 a

[1]Duncan's multiple range test for treatment means at the 5% level