WALNUT BLIGHT CONTROL INVESTIGATIONS TEHAMA 2005

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ABSTRACT

Walnut blight bacteria, *Xanthomonas campestris pv juglandis* have the potential to cause huge crop losses for California Walnut growers. Untreated Chandler trees in the 2005 Tehama test plots had 65.76 percent blight compared to 38.60 percent for trees treated with 6 lbs. of Kocide 2000 alone compared to 15.60 percent blight when 58 oz. of Manex was included with the copper. Even under severe blight pressure our flagship treatments provided relatively good control.

2005 was the third year for using over tree sprinklers to simulate rainfall. In previous years we used the Ashley variety for blight research because it offered the highest probability for infection. For the 2005 research, we abandoned Ashley and moved the rain simulator and test treatments to Chandler. Pre-test bud samples showed high pathogen population, trees were smaller which allowed better spray coverage and improved rainfall uniformity and Chandler is a more important commercial cultivar in Tehama County.

The search for alternative materials to control walnut blight does not look very promising. We have been testing new materials since 1992 and, so far, nothing has out-performed a copper/Manex tank mix. Two liquid formulations of Famoxadone (DuPont) were tested in the 2005 Tehama plot and neither showed efficacy. Nordox 30/30, a copper/zinc formulation from Monterey Chemical, remains a possibility. Agriculture discharge issues are going to have a large impact on walnut blight control programs particularly where copper/Manex applications are made in and around rainfall events and runoff probability is high. Since we don't have a good chance of finding an alternative material, our best chance of maintaining our current spray program is to document environmentally good use of the copper/Manex mix. We can try to reduce the amount of applied copper/Manex by reducing the spray rate and/or the number of applications. Kocide 2000 spray rates were tested at the 2005 Tehama blight plot. Kocide 2000 was applied with Manex at 6lbs/Ac, 4lbs/Ac and 3lbs/Ac. Blight control was 15.62%, 15.60% and 36.73% respectively suggesting that 4 lbs is about as low as we can go using that copper formulation.

To look closely at first spray timing, we (Lindow et.al.) tagged thousands of walnut buds at specific developmental times and applied a single spray. A spray was applied to closed buds, open buds with 1 inch of growth, buds 7 days after 1 inch growth and buds 14 days after 1 inch growth. Our first year of experience using this technique (see Lindow report) suggests that sprays applied shortly after flower buds opened did the best job of reducing pathogen populations.

OBJECTIVES

1) Determine efficacy of early season bactercides applied at different stages of bud break and shoot elongation. Develop tagged bud experiments (Lindow report) to evaluate disease control based upon bud/shoot development. Cooperate with Lindow using rainfall simulation.
2) Verify if applied copper can be reduced from the 6 lb. rate of Kocide 2000.
3) Evaluate alternative materials for walnut blight control (Nordox 30/30, GX569 and Famoxadone).
4) Continue to evaluate genetic resistance to walnut blight.

PROCEDURES

OBJECTIVE 1: Treatment timing, tagged buds and rainfall simulation.

For the 2005 season, the Tehama rainfall simulator was relocated to the Chandler variety. The ability to simulate rainfall plus the pre-treatment X.campestris bud populations (Figure 1) suggested adequate disease for treatment evaluation.

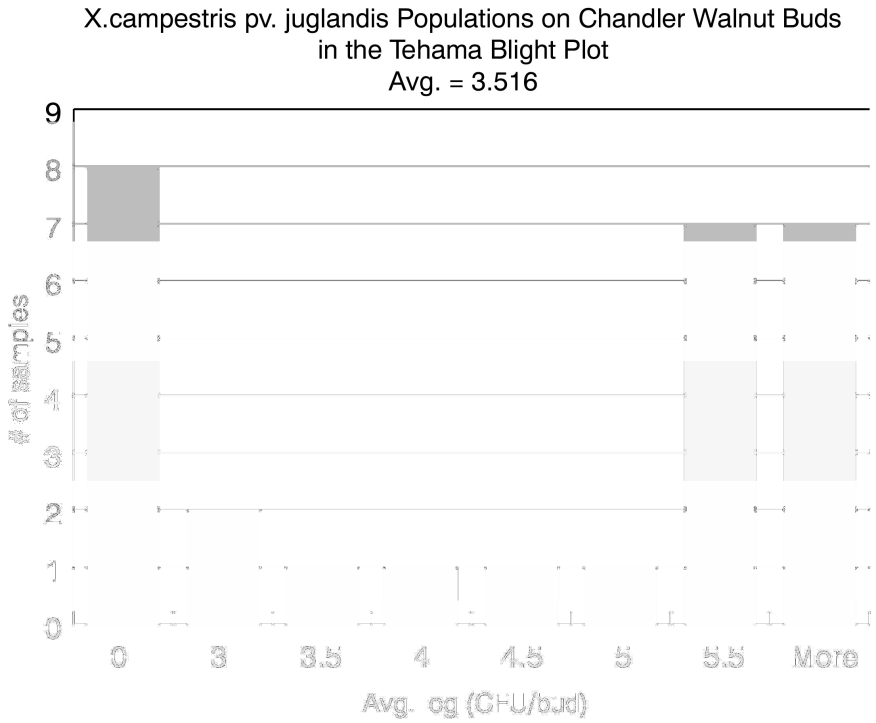

Figure 1. Pre-treatment bud populations for the 2005 Chandler Tehama plot.

The rainfall simulator used over-tree Nelson R-30 sprinklers to apply sprinkler water above the canopy. Sprinklers were placed 30 feet above ground and operated 10 hours following each spray application. Natural and simulated rainfall are shown in Figure 2.

For the bud spray timing work (see Lindow report) we used colored twist ties to tag individual buds when closed, terminal bud break, 7 days after terminal bud break and 14 days after terminal bud break. At each growth stage, a single Kocide 2000 + Manex + Breakthru spray was applied and Lindow evaluated spray treatment on blight populations. In all, over 5,000 individual buds were tagged.

RAINFALL – TEHAMA BLIGHT PLOT

Date	Estimated Amount	Condition
3/18	0.07”	Nat.[1]
3/19	0.58”	Nat.
3/20	0.11”	Nat.
3/21	0.46”	Nat.
3/22	0.22”	Nat.
3/23	0.41	Nat.
3/27	0.12”	Nat.
3/28	0.01”	Nat.
4/3	0.17”	Nat.
4/7	0.24” +10 hrs (0.40”)	Nat. & Sim.[2]
4/8	0.32”	Nat.
4/13	0.04”	Nat.
4/16	10 hrs (0.40”)	Simulated
4/22	0.08” +10 hrs (0.40”)	Nat. & Sim.
4/23	0.24”	Nat.
4/24	0.41”	Nat.
4/30	0.01” +10 hrs (0.36”)	Nat. & Sim.
5/3	0.02”	Nat.
5/4	0.54”	Nat.
5/5	0.47”	Nat.
5/8	0.93”	Nat.
5/9	0.04	Nat.
5/13	10 hrs (0.46”)	Sim.
5/15	0.01”	Nat.
5/16	0.03”	Nat.
5/17	0.08”	Nat.
5/18	0.57”	Nat.
5/24	10 hrs (0.44”)	Sim.

[1]Natural rain — 25 events for 6.18 inches. Measured off site using the local CIMIS station.
[2]Simulated rain — 6 events, 10 hours per simulated rainfall, 2.46 inches. Average applied water was calculated using flow meters on individual risers.

Figure 2. Natural and simulated rainfall for the Tehama Blight plot.

OBJECTIVE 2: Reduced Rates of Kocide 2000.

Reduced rates of Kocide 2000 were evaluated in a young Tehama County Chandler orchard. Treatments were applied to individual trees sprayed by handgun to simulate a dilute application (400gpa). The experiment was a randomized complete block design with seven treatments and five replicates. All treatments were under rainfall simulation. Percent blighted walnuts were evaluated 6/6/05 by visually inspecting 300 to 500 walnuts per tree for blight symptoms. Counts were made randomly throughout the tree canopy roughly 6-12 feet above ground. Phytotoxicity was visually rated using a 0-5 scale where "0" represents no observable phytotoxicity. Spray treatments and application dates are shown in Figure 3.

REDUCED RATES OF KOCIDE 2000

Treatment	Rate
1. Kocide 2000 + Manex	6 lbs. + 58 oz./Ac.
2. Kocide 2000 + Manex	4 lbs. + 58 oz./Ac.
3. Kocide 2000 + Manex	3 lbs. + 58 oz./Ac.
4. Kocide 2000 + Manex	2 lbs. + 58 oz./Ac.
5. Kocide 2000	6 lbs./Ac.
6. Kocide 2000 + Manex	1 lb. + 32 oz./Ac.
7. Control (simulated rainfall)	—
8. Control (natural rainfall)	—

Figure 3. Spray treatments and material rates for evaluation of reduced rates of Kocide 2000. Spray application dates were 4/5, 4/15, 4/21, 4/29, 5/12 and 5/23. Pistillate bud break 4/5, full bloom 4/18.

OBJECTIVE 3: Alternative Materials for Walnut Blight Control (Nordox 30/30, GX569 and Famoxadone.

Experimental design and evaluation was the same as described in Objective 2 except the Famoxadone/GX569 comparisons had 10 treatments with 5 replicates and the Nordox 30/30 comparison had 5 treatments with 5 replicates. Test materials and rates are shown in Figure 4 and Figure 5.

FAMOXADONE AND GX569 COMPARISON

Treatment	Rate
1. JE874-425 (famoxadone)	39 fl. oz./Ac.
2. JE874-426 (famoxadone)	6 fl. oz./Ac.
3. JE874-425 + Kocide 2000	39 fl. oz.+6 lbs./Ac.
4. JE874-426 + Kocide 2000	6 fl. oz.+6 lbs./Ac.
5. Kocide 2000	6 lbs./Ac. (2.1 lbs. ai-cu)
6. GX569 (copper) + Manex	3.5 lbs.+58 oz./Ac. (1.05 lbs. ai-cu)
7. Kocide 2000 + Manex	3.0 lbs. + 58 oz./Ac. (1.05 lbs. ai-cu)
8. Kocide 2000 + Manex	4.0 lbs. + 58 oz./Ac. (1.40 lbs. ai cu)
9. Kocide 2000 + Manex	6 lbs. + 58 oz./Ac. (2.1 lbs. ai-cu)
10. Control (simulated rainfall)	—
11. Control (natural rainfall)	—

Figure 4. Spray treatments and material rates for Famoxadone and GX569. Spray application dates were 4/5, 4/15, 4/21, 4/29, 5/12 and 5/23. Pistillate bud break 4/5, full bloom 4/18.

NORDOX 30/30 COMPARISON

Treatment	Rate
1. Control (natural rainfall)	—
2. Control (simulated rainfall)	—
3. Kocide 2000	6 lbs./Ac. (2.1 lbs. ai-cu)
4. Nordox 75WG + Manex	2.8 lbs. + 58 oz./Ac. (2.1 lbs ai-cu)
5. Nordox 30/30 (copper/zinc)	7 lbs./Ac. (2.1 lbs ai-cu)
6. Kocide 2000 + Manex	6 lbs. + 58 oz./Ac. (2.1 lbs. ai-cu)

Figure 5. Spray treatments and material rates for the Nordox 30/30 evaluation. Spray application dates were 4/5, 4/15, 4/21, 4/29, 5/12 and 5/23. Pistillate bud break 4/5, full bloom 4/18.

OBJECTIVE 4: Genetic Resistance to Walnut Blight.

Paradox seedlings were planted in 1996 and grafted to selected genotypes May 9th and 10th 1996. Grafting wood was selected from the repository blocks at UC Davis. First year graft success was 64%. Re-grafts on 5/3/97 brought the plot up to 93% complete. Remaining grafts were completed by 1998 so the plot is relatively uniform in tree age and cropping. Varieties were selected based upon their potential for blight resistance or as comparisons in terms of sensitivity.

Plot design is a randomized complete block with fifteen treatments and five replicates. Each treatment is an individual tree. Test trees are located in a Tehama County Chandler orchard in a production area susceptible to walnut blight. Under tree solid set sprinklers are used for irrigation and the trees were trained, pruned and managed using commercial techniques. Walnut blight was evaluated on 6/7/05 by visually inspecting 300 to 400 walnuts for disease symptoms. Counts were made randomly throughout the tree canopy roughly 6-12 feet above ground level. Dropped walnuts per tree were counted on 5/26/05. Evaluated varieties are listed in Figure 6.

VARIETIES IN THE TEHAMA BLIGHT RESPONSE PLOT

1. Adams
2. Sinensis 5
3. Serr
4. PI 159568
5. PI 18256
6. 76-80
7. Tulare
8. Hartley
9. Payne
10. 90028-30
11. Chandler
12. Franquette
13. 91028-1
14. Chase D-9
15. Cheinovo 85043-1

Figure 6. The fifteen varieties under evaluation in the Tehama blight response test planting. Individual tree planting, RCB design with 15 treatments and 5 replicates.

RESULTS/DISCUSSION

OBJECTIVE 1: Treatment timing, tagged buds and rainfall simulation.

This was a cooperative project with Steve Lindow. To avoid repetition the results and discussion are covered in his Research Report.

OBJECTIVE 2: Reduced Rates of Kocide 2000.

For the 2005 season, six over-tree simulated rainfalls did not increase walnut blight damage compared to natural conditions (Figure 7). Untreated control trees under simulated rainfall had 58.16% blight compared to 65.76% for trees under natural rainfall. Kocide 2000 copper rates were tested under severe disease pressure.

Kocide 2000/Manex at the 4 pound copper rate controlled walnut blight equally well as the 6 pound rate. 15.60% blight for the 4 pound Kocide 2000/Manex treatment compared to 15.62% blight for the 6 pound Kocide 2000/Manex treatment (Figure 7). There is potential to reduce the amount of Kocide 2000 without compromising disease control as long as Manex is in the mix.

The one pound rate of Kocide 2000 plus a half rate of Manex failed to control walnut blight (Figure 7).

None of the treatments showed any observable phytotoxicity.

REDUCED RATES OF KOCIDE 2000

Treatment	% Blight	Phytotoxicity
8. Control (natural rainfall)	65.76[2]	0
6. Kocide 2000 (1 lb.) + Manex (32 oz.)	58.32 a[1]	0
7. Control (simulated rainfall)	58.16 a	0
5. Kocide 2000 (6 lbs.)	38.60 b	0
3. Kocide 2000 (3 lbs.) + Manex	36.73 b	0
4. Kocide 2000 (2 lbs.) + Manex	33.82 b	0
1. Kocide 2000 (6 lbs.) + Manex	15.62 c	0
2. Kocide 2000 (4 lbs.) + Manex	15.60 c	0

Figure 7. Percent blight damage and phytotoxicity for variable rates of Kocide 2000. Natural rainfall control trees were not part of the RCB design and are not included in the statistical analyis.

[1]Duncan's multiple range test for treatment means at the 5% level.
[2]Control (natural rainfall).

OBJECTIVE 3: Alternative Materials for Walnut Blight Control.

Famoxadone and GX569 Comparison

The famoxadone formulations did not improve walnut blight control compared to untreated trees. Control trees (simulated rainfall) had 58.16% blight compared to 68.54% for JE874-425 and 62.68% blight for the JE874-426 treatment. Adding Kocide 2000 improved control but not better than the Kocide 2000 alone, suggesting disease control is due to the copper and not the famoxadone (Figure 8).

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Blight control using GX569 plus Manex (3.5 lbs. + 58 oz./Ac.) was not statistically different than Kocide 2000 plus Manex (3.0 lbs. + 58 oz./Ac.). Applications of GX569/Manex resulted in 34.48% damage compared to 36.73% damage for the three pound rate of Kocide 2000/Manex. Both copper formulations performed about the same, however, neither worked as well as the four or six pound rate of Kocide 2000/Manex. A higher rate of GX569 may have improved its performance (Figure 8).

Adding Manex to Kocide 2000 significantly improved walnut blight control and four pounds of Kocide 2000/Manex controlled blight equally well as the six pound rate of Kocide 2000/Manex (Figure 8).

None of the treatments showed any observable phytotoxicity.

FAMOXADONE AND GX569 COMPARISON

Treatment	% Blight	Phytotoxicity
1. JE874-425	68.54 [1]a	0
11. Control (natural rainfall)	65.76 [2]	0
2. JE874-426	62.68 ab	0
10. Control (simulated rainfall)	58.16 ab	0
3. JE874-425 + Kocide 2000	49.29 bc	0
5. Kocide 2000	38.60 c	0
7. Kocide 2000 (3.0 lbs.) + Manex	36.73 c	0
4. JE874-426 + Kocide 2000	34.59 c	0
6. GX569 + Manex	34.48 c	0
9. Kocide 2000 (6 lbs.) + Manex	15.62 d	0
8. Kocide 2000 (4.0 lbs.) + Manex	15.60 d	0

[1]Duncan's multiple range test for treatment means at the 5% level.
[2]Control (natural rainfall) trees were not part of the RCB design and were not included in the statistical analysis.

Figure 8. Percent blight damage and phytotoxicity for Famoxadone and GX569.

Nordox 30/30 Comparison

The addition of Manex to Kocide 2000 significantly improved walnut blight control. Applications of Kocide 2000 alone resulted in 38.60% blight compared to 15.62% when Manex was included (Figure 9).

There was no statistical difference in blight control between Nordox 75WG/Manex, Nordox 30/30 or Kocide 2000/Manex suggesting all three may have a role in a walnut blight management program (Figure 9).

None of the treatments showed any observable phytotoxicity.

NORDOX 30/30 COMPARISON

Treatment	% Blight	Phytotoxicity
1. Control (natural rainfall)	65.76 [1]	0
2. Control (simulated rainfall)	58.16 a[2]	0
3. Kocide 2000	38.60 b	0
4. Nordox 75WG + Manex	32.85 bc	0
5. Nordox 30/30	28.09 bc	0
6. Kocide 2000 + Manex	15.62 c	0

[1]Control (natural rainfall) trees were not part of the RCB design and were not included in the statistical analysis.
[2]Duncan's multiple range test for treatment means at the 5% level.

Figure 9. Percent blight damage and phytotoxicity for the Nordox comparisons.

OBJECTIVE 4: Genetic Resistance to Walnut Blight.

Of the 15 varieties evaluated in the Tehama plot, commercial varieties Tulare, Hartley, Chandler and Franquette demonstrated low blight incidence; Chase D-9, PI 18256, Serr and PI 159568 could be considered intermediate; and 91028-1, Payne and Sinensis 5 were severely blighted (Figure 10).

TEHAMA VARIETY PLOT FOR BLIGHT RESISTANCE

Variety	% Blight[1] Canopy	Blighted Nut Drop[2]
Tulare	2.32 e[4]	90.4 b
76-80	2.43 e	28.2 d
Chenovo[3]	3.38 –	27.6 d
Hartley	4.44 de	23.0 d
Adams 10	5.40 de	57.8 bcd
Chandler	5.95 de	20.8 d
Franquette	6.62 de	27.4 d
90028-30	7.60 de	61.0 bcd
Chase D-9	15.07 de	56.6 bcd
PI 18256[3]	22.62 –	52.8 bcd
Serr	20.09 d	73.0 bc
PI 159568[3]	22.62 –	31.2 cd
91028-1	46.73 c	50.8 bcd
Payne	62.76 b	55.0 bcd
Sinesis 5	96.23 a	205.4 a

Figure 10. Blight counts and nut drop for unsprayed trees in the Tehama blight variety trial planted in 1996.

[1]Canopy counts 6/7/05
[2]Nut drop counted 5/25/05
[3]Not enough crop to get reliable counts for statistical analysis
[4]Duncan's multiple range test for treatment means at the 5% level

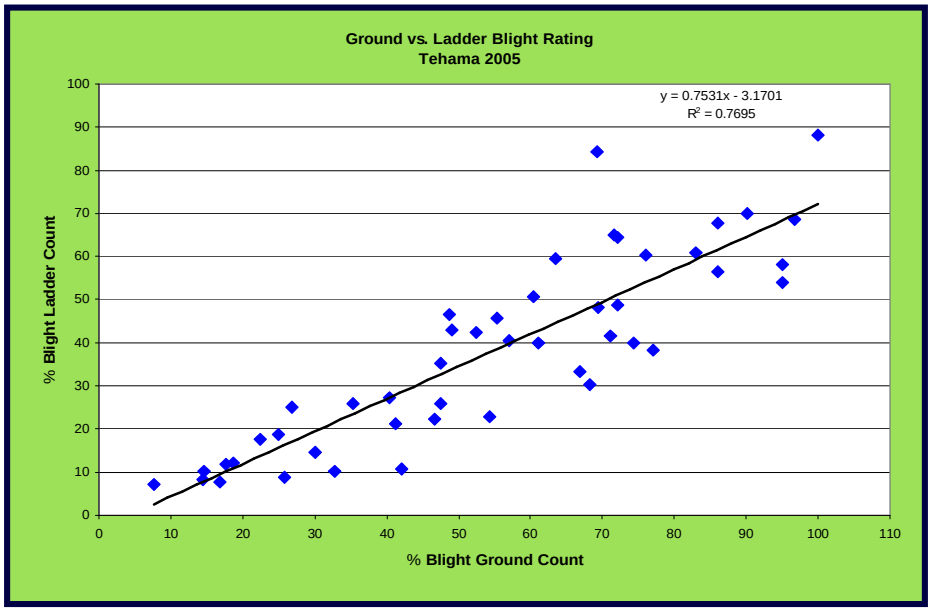

Figure 11. Comparison of percent blighted walnuts counted within ground reach and ladder counted 8-16 feet high in the canopy.