Annual Report - 1989

Project No. 89-T15 - Epidemiology and Control of Shot Hole, Brown Rot, Leaf Rust, Scab, and Green Fruit Rot

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Abstract

Shot hole and Scab: A forecasting system for shothole disease was studied using field trials in commercial orchards in cooperation with Farm Advisors in Kern County (M. Viveros), Merced County (L. Hendricks and W. Asai), Butte County (J. Connell), and Fresno County (M. Freeman). In the fall 1988, a lack of conducive wetness periods resulted in very few leaf infections, thus reducing inoculum available for spring infections. Spring and summer 1989 were also relatively dry except for Butte County where five rains, >2 cm (3 rains during bloom and 2 rains 2-weeks after petal fall), and Merced County where two rains, >1 cm during bloom, were recorded in the spring. In Butte county plot, leaf samples collected periodically throughout the spring, showed only a few new leaf infections with a minimal production of sporodochia. After monitoring wetness periods, leaf infections, and sporodochial formation, no appreciable differences were observed between nonsprayed treatments, grower sprayed treatments (two ziram sprays), or our forecasted single-spray treatments (ziram). In the Merced plot, a fall application of zinc sulfate to defoliate trees and lower inoculum, significantly reduced shothole disease in the spring from 14.1% to 6.0% in the control plot with no spring application of fungicides. Further, no differences were observed between two recommended spray applications (pink and petal fall blossom sprays) and one timing spray (1 wk after petal fall) based on weather and disease monitoring data. In these tests, scab, green fruit rot, and leaf rust symptoms were so scarce, data were not recorded.

Studies on control of shot hole using various fungicides applied at different stages of flowering were repeated in the 1989 season. Results of the 1989 season were similar to and support the results from the 1988 season. Bloom sprays provided significantly better disease control than the dormant copper or captan treatments.

Brown rot blossom blight: Laboratory studies with radioactive labelled iprodione (Rovral) and an experimental fungicide E-0858 were conducted on Drake and Ne Plus Ultra almond blossoms. Labelled compounds placed on the sepal or petal at the pink bud stage of bloom were shown to move into the anthers and pistil. The amount of radioactive compound translocated for E-0858 was higher than that of iprodione. Bioassay tests made on detached blossoms, using benomyl-sensitive isolate of Monilinia laxa showed equivalent disease control between benomyl and iprodione. Chemical assay of anthers and pistils to confirm the presence of parent iprodione is in progress. In almond orchards (Mission and Ruby cultivars) with 100 percent benomyl-resistant strains (1 ug a.i./ml benomyl) both iprodione and E-0858 provided effective control of brown rot blossom blight but not benomyl. In an orchard (Drake

cultivar) with only benomyl-sensitive strains of M. laxa and high disease pressure based on inoculum level, benomyl provided better disease control than iprodione in comparisons of a single spray treatment at pink bud or two spray treatments (pink bud and full bloom). Evidence of systemicity of iprodione when applied at pink bud stage of bloom supports data on benefits derived in blossom blight control from a single spray treatment. While application of a systemic fungicide at full bloom (80% of blossoms open) provides good coverage of the most susceptible blossom parts (anthers and stigma) and further offers protection of all blossom parts (sepals, petals, anthers, and stigma) of those bloom showing pink bud. This is the first report showing movement of the fungicide iprodione from sepals and petals into anthers and pistil of almond blossoms.

A survey of wood decay fungi was completed and indicated that decay fungi were mainly from 8 different genera. Species collected were associated with wounds from various cultural practices including mechanical harvesting and pruning, as well as from wounds formed from sunburn.

Introduction

Benefits of a forecasting program would forewarn growers of high risk orchards based on the amount of inoculum formed during the previous fall season. Timing of sprays for the following spring would be based on the disease incidence during the previous fall season. Preliminary and on-going studies on spore survival indicate that spores can survive several months in an orchard during unfavorable environmental conditions for infection. If disease was limited in the fall and spring, based on disease monitoring techniques, spray treatments may not be required until after the first infection and sporodochial development period. Using this system, spray treatments (ziram or captan) could be delayed until after petal fall. At this time, spray treatments would benefit in controlling shothole, scab, and leaf blight. When severe outbreaks of shothole occur in the fall, control practices would begin as soon as leaves emerge in the spring. Additional spray treatments could be governed by wetness period and disease outbreak for individual orchards being monitored. In forecasting shot hole disease (2), the critical points in the epidemiology of the pathogen (Wilsonomyces carpophilus) was outlined as: a) the overwintering inoculum is produced on leaves (necrotic lesions with sporodochia) in the fall-winter months; b) leaf infections are favored by moisture periods of over 10 hrs; c) infections on leaves form necrotic tissue which drop out (shot holing symptom) at high temperatures (22 C); and under low temperatures (8 C) and free moisture the necrotic lesions tend to remain in place and form sporodochia. This minformation indicates that if leaves are removed (by possibly using a zinc sulphate spray) before the fungus can produces sporodochia, the inoculum for spring infection could be significantly reduced. Thus during the following spring the primary infections would be minimal and that the shot hole control spray(s) would be applied only after the emergence of the fruiting structure (sporodochia) on the leaves. Such a disease management strategy would require a shot hole spray only when necessary. In spring 1988, research conducted on either trees with little to no shot hole disease or trees defoliated with zinc sulphate in fall 1987 showed essentially no disease as with trees receiving no shot hole sprays. Whereas, an orchard with high incidence of shot hole infections and sporodochia on leaves during fall 1987 developed high incidences of shot hole affecting both leaves and fruit during

the 1988 season. For the 1988-89 season, test plots comparing fall defoliation and nondefoliation have been established in Butte, Merced, and Kern counties and the requirements for spraying fungicides during spring 1989 will be forecasted using the weather monitoring equipment and observations by the farm advisors and growers on the shot hole infection and sporodochial development.

For brown rot blossom blight caused by benomyl-resistant M. laxa, both iprodione and E0858 (SC0858) provided effective control when applied at the green bud stage of bloom (stigma protruding) on the cultivar ruby. Application of the radio-active parent E0858 fungicide showed translocation of the labelled compound from the sepal and petals into the anthers and stigma. This compound further supressed disease development on the cultivar Drake even when applied 24 hrs after inoculation and incubation.

Data obtained by Dr. Adaskaveg on the identification of the wood rot fungi on almonds will be published in a research paper and in the book by Ogawa and English to be published by the University of California during summer 1990.

Objectives: (1) Shot hole and scab: Develop a minimal but effective protective spray program for shot hole and scab through forecasting and disease monitoring procedures; (2) Brown rot and green fruit rot: Develop efficacy data on alternative, systemic fungicides; and (3) Identification of wood decay fungi and associate disease incidence with cultural practices.

Materials and Methods

1. Biology of the fungus: Mycological studies were made using bright field and electron microscopy.

2. Shot hole disease forecasting: Techniques are included in the manuscripts which are in press in Plant Disease and Phytopathology.
Methods for fall application of zinc sulfate, timing of spring applications of ziram, and monitoring of weather conditions and disease development are previously described in the introduction.

Studies on chemical evaluation for control of shothole include comparisons of single dormant copper and captan sprays followed by captan, ziram or iprodione were completed during the 1989 season. Two test plots was located in Fresno County and in Merced County. All treatments were made with a handgun sprayer except the dormant copper spray at the Merced plot. Disease evaluations were made by collecting leaves and making isolations or observing lesions for presence of Wilsonomyces.

3. Alternative fungicides for control of benomyl-resistant Monilinia: Carbon^{14} labelled experimental fungicide E-0858 and registered iprodione were applied on almond blossom obtained from nonsprayed trees on the University of California campus. Proprietary fungicide formulations of E-0858 and iprodione were were compared to that of benomyl on an almond orchard in Fresno County by spraying during various blossoming period.

4. Survey of wood decay organisms: Observations and collections were made throughout the almond growing districts of California.

Results and Discussion:

1. Biology of the fungus: Studies led to a change in the nomenclature of the fungus (Stigmina carpophila) and a manuscript entitled, "Morphology and ontogengy of conidia in Wilsonomyces carpophilus, gen. nov. and comb. nov., causal pathogen of shot hole disease of Prunus species", on the taxonomy of the shot hole fungus is in press in the journal MYCOTAXON.

2. Shot hole disease forecasting: Title of the manuscript in press for publication in PLANT DISEASE reads as follows: "A mist generator and environmental monitoring system for field studies on shot hole disease of almond". The system produced localized conditions of free water on selected plant tissues and recorded environmental parameters during infection periods of Wilsonomyces carpophilus. A second manuscript entilted, "Influence of wetness period and temperature on infection and development of shothole disease of almond caused by Wilsonomyces carpophilus", which deals with describing the basic pathology of shothole on almond is also in press in PHYTOPATHOLOGY.

Three experimental plots were set up in November 1988 to determine if fall defoliation with zinc sulphate would reduce shot hole fungus populations to the point where spring sprays could be delayed until disease incidence is monitored. Plots are located in Kern, Merced, and Butte counties. Weekly monitoring for incidence of shot hole disease will be made starting from the time leaves emerge. Results indicated that in two of the three test plots, disese incidence in the spring was negligible and our forcast predicted that no additional chemical control measures for shot hole were required. No differences were observed between two, one, or no blossom sprays. In one test plot, disease levels in the spring were significantly lower in the fall defoliation treatment when compared to the non-defoliated treatment. In this field plot, our forcast system predicted that only one blossom spray was required for disease control and this was equivalent to two blossom sprays normally applied by a grower. Both of these sprays signifiacantly reduced disease from non-treated controls.

3. Shot hole disease management: In the same orchards used in the 1988 season, trials on control of shot hole using various fungicides applied at different stages of flowering were repeated in the 1989 season. Results of the 1989 season were similar to and support the results from the 1988 season. Bloom sprays provided significantly better disease control than the dormant copper or captan treatments. Examination of fruits for the shot hole disease after the petal fall stage of bloom, showed that sprays with copper or captan applied in January showed slight reductions in shot hole disease control on the fruit. Yet when a petal fall spray was applied, significant reductions in disease occurred. Two spray applications (at popcorn and petal fall) with ziram or captan did not provide better control than a single spray at popcorn or petal fall of either chemical. Furthermore, dormant copper or captan spray treatment plus popcorn and/or petal fall spray with captan, ziram, or iprodione provided no additional benefits.

3. Alternative fungicides for control of benomyl-resistant Monilinia: Comparisons in efficacy of registered fungicides, benomyl and iprodione were made with an experimental fungicide E-0858 (Stauffer Chemical Company, now

made with an experimental fungicide E-0858 (Stauffer Chemical Company, now ICI of England) in field plots established in an almond orchard with benomyl -resistant M. laxa (Fresno County on Ruby almond cv) and without benomyl-resistant isolates (Yolo County on cv. Drake) was repeated in the 1989 season. The fungicides tested were benomyl 50W, iprodione 50W, and an experimental fungicide formulation E-0858 50W at 8 oz per 100 gal spray applied with a handgun sprayer using 3-4 gal on each of five single tree replications. Fungicides were sprayed at the phenological blossom stages of early pink bud, full bloom, and pink bud plus full bloom. Disease control was evaluated 3-weeks after full bloom by obtaining the percentage of blossoms blighted out of 400 counted per tree. As expected in both years, benomyl spray at pink bud failed to control the disease while the full bloom treatment provided some control. Both E-0858 and iprodione provided significantly better control than the nonsprayed control trees. The pink bud spray of iprodione was not as effective as that of E-0858 which may indicate more systemic movement of the active compound than that of iprodione.

The systemicity of the fungicide E-0858 was examined by applying C^{14} labelled E-0858 on the unopened blossoms of the Thompson cv (Table 7). Translocation of the active compound or its breakdown metabolite to stamens and pistil was shown when the mixture of proprietary and labelled E-0858 were applied to sepals or petals. For the 1989 season, the systemicity of iprodione was compared to that of E-0858. Iprodione was systemic in blossoms but less was translocated when compared to E-0858 (Osorio, Bostock, and Ogawa 1989).

4. Survey of wood decay organisms: Predominant fungal genera and their incidence in almond orchards in California include Armillaria (0.8%), Ganoderma (3.1%), Laetiporus (1.6%), Oxyporus (4.0%), Perenniporia (0.6%), Phellinus (1.0%), Stereum (0.4%), and Trametes (1.6%). Species in these genera were associated with wounds from various cultural practices including mechanical harvesting and pruning, as well as from wounds formed from sunburn (Adaskaveg and Ogawa 1990).

Publications

1. Adaskaveg, J. E. and J. M. Ogawa. 1990. Wood decay pathology of fruit and nut trees in California. Plant Disease. In press.

2. Ogawa, J. M. and W. H. English. 1990. Diseases of Temperate-Zone Tree Fruit and Nut Crops. University of California, Division of Agriculture and Natural Resources. Textbook in press to be published in 1990.

3. Osorio, J. M., R. M. Bostock, and J. M. Ogawa. 1989. Systemicity in almond blossoms and efficacy of E-0858 and iprodione for control of brown rot blossom blight. Phytopathogy 79: 911. (Abstr.).

4. Shaw, D. A., J. E. Adaskaveg, and J. M. Ogawa. 1988. Influence of moisture and temperature on shot hole disease of almond leaves. Phytopathology, In Press.

5. Adaskaveg, J. E., D. A. Shaw, and J. M. Ogawa. 1988. A mist generator for field studies of shot hole of almond caused by Wilsonomyces carpophilus. Phytopathology, In Press.

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March 6, 1990

Susan McCloud, Director of Research
Almond Board of California
1900 Point West Way, Suite 111
Sacramento, CA 95815

Dear Susan:

Please find enclosed Annual Report - 1989. Specific data have not been included as manuscripts for publications have been accepted or are being prepared. The following manuscripts have been accepted:

1. PLANT DISEASE: A mist generator and environmental monitoring system for field studies on shot hole disease of almond.

2. PHYTOPATHOLOGY: Influence of wetness period and temperature on infection and development of shot hole disease of almond caused by Wilsonomyces carpophilus.

3. MYCOTAXON: Morphology and ontogeny of conidia of Wilsonomyces carpophilus, gen. nov. and comb. nov., causal pathogen of shot hole disease of Prunus species.

4. PLANT DISEASE: Wood decay pathology of fruit and nut trees in California.

Manuscripts in preparation are those conducted by Juan Osorio, graduate student, who is expected to complete his Ph.D. program this spring. The subject is on systemic action of iprodione (registered) and an experimental fungicide in control of the brown rot blossom blight of almond.

We look forward to your visit to discuss our research projects on Tuesday, March 13 at my office (Hutchinson Hall Rm 386) at Noon. We can discuss the general goals of our research during lunch. We will then visit the Plant Pathology field where you will see the mist generator and the Davis test plot on forecasting of the shot hole disease of almond (similar to the other three located in Kern, Merced, and Butte counties). This will be followed by your examination of the manuscripts in press. Juan Osorio will be presenting his oral seminar to the Department faculty, students, and staff at 4:10 pm. We look forward to your accepting this schedule.

Sorry for our delay in submission of the Annual Report - 1989. We did place our efforts in completion of specific projects so that we can put our major effort now on management of almond diseases through our forecasting system. If we have time, I can also explain to you another forecasting system developed for control of fireblight of pears which was developed at University of Maryland. These forecasting systems are similar to the ones originally developed for control of scab of apples.

Sincerely,

J. M. Ogawa
Professor and Plant Pathologist

cc. J. E. Adaskaveg
J. M. Osorio