Single citrus budwood treatment against insects and mites

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The primary source of budwood for commercial citrus varieties is the foundation block at the University of California Lindcove Field Station in Tulare County. From here, citrus scion wood is released in accordance with state laws under the Citrus Clonal Protection Program of the University. Along with this program, county agricultural commissioners enforce the mandatory nursery inspection laws that regulate the sale and handling of nursery stock within the state.

Procedures for the protection of scion wood from insect and mite pests have usually been determined by the county receiving the propagative material. This was necessary, in the past, when budwood came from counties with pest species that were not established in the receiving county. Established pests could also be carried on budwood and infest new nursery stock.

Insect and mite pests presently found in the Lindcove Field Station area also prevail in most of the citrus-growing areas of California. One exception is the Comstock mealybug, *Pseudococcus comstocki* (Kuwana), which is difficult to find on citrus in Tulare County, and is presently under quarantine restriction in isolated citrus-growing areas of the San Joaquin Valley. The economically important pests of citrus crops in this valley that might potentially be present on budwood are: Scale insects—California red scale, *Aonidiella aurantii* (Maskell); brown soft scale, *Coccus hesperidum* L.; and cottonycushion scale, *C. pseudomagnoliarum* (Kuwana). Citrus mites—citrus red mite, *Panonychus citri* (McGregor); and twospotted spider mite, *Tetranychus urticae* Koch. Thrips—citrus thrips, *Scirtothrips citri* (Moulton). Citrus worms—citrus cutworm, *Xylomeges curialis* Grote; and fruittree leafroller, *Archips argyrospilus* (Walker).

Yellow scale, *A. citrini* (Coquillett), and citrus flat mite, *Brevipalpus lewisi* McGregor, were major pests of citrus in the central valley before the extensive use of organic pesticides that seem to have virtually eradicated these two species.

Budwood releases from the Lindcove Field Station are now disinfested from insect and mite pests either by dipping scion budsticks in a solution of chlorobenzilate-malathion-water or by fumigating with hydrogen cyanide gas. Chlorobenzilate, however, is not an effective acaricide for eliminating citrus red mite; it was originally included in the dip solution because of other mite species, which are not established in the San Joaquin Valley. Malathion is not an effective scalicide, except at high dosages, and hydrogen cyanide fumigation is both difficult to use and dangerous to the operator.

Many of the new organic pesticides are more effective and safer at considerably lower dosages for control of California red scale and other established scale insect pests in the valley. A single method is needed that will eradicate insect and mite pests from budwood releases from the Lindcove Field Station as well as propagative material from valley nurseries and registered field trees. Our studies were conducted to develop an effective, safe, and easy dipping method for treating scion budwood from the San Joaquin Valley destined for release to the citrus-growing areas of California. It is anticipated that such a method would be accepted by the Citrus Clonal Protection Program and by county agricultural commissioners.

Procedure

Insecticides in combination with petroleum oil were tested as a dipping solution for their effectiveness in eradicating California red scale, citrus red mite, and Comstock mealybug. Field experiments have shown that dosages of pesticides effective against

Above: Budwood sticks infested with California red scale.

Right: Budwood dipping pail.

these three species exceed those necessary to control the other pests of citrus in the Central Valley.

The following scalicides were used for California red scale at the rate of 0.5 pound active ingredient per 100 gallons of water: methidathion (Supracide), azinphos-methyl (Guthion), phosmet (Imidan), dimethoate (Cygon), methomyl (Lannate), parathion, and malathion. These seven compounds are registered for use on citrus in California and are effective scalicides. Chlorpyrifos (Lorsban) was also included, although not presently registered for use on citrus in California, because it is an effective scalicide as well as one of the more effective materials tested in field trials for the control of mealybugs. Narrow-range 415 oil at 0.5 percent by volume was added to these scale tests for compatibility information and for further testing of this combination for toxicity to citrus red mite.

For the California red scale tests, 20 navel orange terminals (8 inches long, simulating budwood cuttings) with a high density of the scale were cut for each of the eight pesticide dip formulations and the untreated tap-water control. A 1-gallon emulsion of each pesticide-oil combination was prepared in a bucket.

Four replicates of five sticks each were submerged in this emulsion for 2 minutes; the oil was kept in suspension by agitation. Replicates were removed for a 1-minute drain period, then resubmerged for an additional minute. After air-drying for 5 to 30 minutes (until surface moisture appeared to be gone), the budsticks were sealed in plastic bags, by replicate, and stored at 55° F.

Weekly counts were made for three weeks. Pesticide effectiveness was assessed by piercing a scale insect with a needle under magnification; the presence of body fluid indicated a living scale. Only one stick from each pesticide treatment was examined at each count time until no scales were found alive after checking 100 scales. Then the remaining sticks were examined to confirm that all scales were dead—that is, contained no body fluid.

Citrus red mite and Comstock mealybug were exposed to the chlorpyrifos-oil emulsion only, because this dip in preliminary studies was most effective for eradicating California red scale. Twenty terminals that had all stages of citrus red mite were cut for dipping in the pesticide-oil emulsion and the tap-water control. After dipping and air-drying in the same manner as in scale tests, the sticks were stored by replicate in paper bags at 55° F until they were examined under magnification for the presence of living eggs and immature or adult mites after 11 days.

Four potatoes infested with all life stages of Comstock mealybug were dipped, two in the cholorpyrifos-oil emulsion and two in the tap-water control, and air-dried in the same manner as in the scale and mite tests. Then they were sealed in escape-proof mealybug rearing cages for eight days, after which living life stages were counted under magnification.

To test for viability, 20 budsticks representative of Lindcove Field Station budwood releases were cut from Washington navel, Olinda valencia, Lisbon lemon, Reed grapefruit, and Algerian tangerine trees. Ten budsticks of each variety were dipped in the chlorpyrifos-oil emulsion and ten in a tap-water control; all treatments were dipped for two minutes, removed for a one-minute drain period, and resubmerged for an additional minute followed by air-drying as in other tests, and storage in plastic bags at 55°F. When periodic examination showed that the petiole stubs had abscised from the budsticks, they were stored at 45° F until budding time. Dipping was done April 17, 1981, and budding to Troyer citrange rootstock seedlings was made on May 29, 1981.

Results

No live California red scales were present on any of the budsticks after dipping in the chlorpyrifos-, methidathion-, or parathion-oil emulsions and storage for three weeks (see table). No living mites of any stage were present on the pesticide dipped sticks, but all stages were alive on the tap-water-dipped sticks. No living stages of the Comstock mealybug were found on the chlorpyrifos-oil-dipped potatoes eight days after treatment. Eggs, immatures and adult mealybugs were living on the tap-water-dipped potatoes.

All five varieties budded to citrus seedlings proved viable after having been kept in a greenhouse for three months after budding. At this time, growth from each bud of all citrus varieties and control buds exceeded 8 inches, with the exception of a single navel bud and a grapefruit bud from pesticide-dipped budwood. These two exceptions appeared healthy but somewhat slower in producing growth.

Discussion

Although three pesticides were equally effective in producing budwood free of California red scale, the chlorpyrifos-oil emulsion was selected for further testing to eradicate citrus red mite and Comstock mealybug, because it was the safest for the dipping operator. (Mammalian toxicities of these insecticides to rabbits, as reported by their manufacturers in terms of oral and dermal LD_{50}, in milligrams per kilogram, are, respectively: chlorpyrifos 97-276, 2,000; methidathion 24-48, 375; parathion 9-24, 40-870.) Chlorpyrifos had an experimental use permit for California citrus in 1981 and is registered on some other crops, but its use in a citrus budwood dip will depend on label inclusion.

These experimental results show that living California red scale, citrus red mite, and Comstock mealybug can be eliminated from budwood produced in the San Joaquin Valley within three weeks following a single insecticide-oil emulsion dip. Other insect and mite pests probably will also be eliminated, since field experiments have shown that these three species require the highest pesticide dosages for effective control.

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Efficacy of pesticide formulations used as dips against California red scale infesting citrus budstick cuttings

Treatment 2/18/81*	Live adult female California red scale/replicate † 1-week 2/25/81	2-week 3/4/81	3-week 3/11/81
	%	%	%
Chlorpyrifos + oil	60	72	0
Methidathion + oil	66	81	0
Azinphos-methyl + oil	96	76	14
Methomyl + oil	100	82	24
Dimethoate + oil	100	70	12
Phosmet + oil	50	96	32
Parathion + oil	62	60	0
Malathion + oil	100	86	8
Oil	98	76	40
Tap water	100	94	98

*Budsticks dipped in 1 gal. pesticide-oil emulsion for 2 min., out 1 min., resubmerged 1 min., then air-dried and stored at 55° F until count time; pesticide at rate of 0.5 lb active ingredient per 100 gal. water, narrow-range 415 oil at 0.5% by volume.

†Live scale determination by the presence of body fluid when needle-pierced under magnification; four replications.