months even in areas where dense populations sometimes develop. Such variations are apparently the result of predators and parasites, climatic differences, varying tree conditions such as tree vigor and the plant growth cycle, all of which affect the feeding mites.

The effects of temperature and humidity were the only considerations in the study reported here. Climatological conditions were found to vary from grove to grove and from locality to locality. The microclimate affecting individual mites might, even if the parasite-predator complex were not a factor, explain mite population differences that occur from place to place. Numerous attempts at gathering information on the relationship of temperature and humidity to populations under field conditions were abandoned after two seasons because of the difficulty in studying this small mite in various citrus groves where different irrigation, pest control and other cultural practices were used.

Yuma spider mites have not been found near Phoenix, Arizona, nor in some areas in California where their presence could be expected since environmental conditions there are similar to those of areas where this mite is prevalent. Laboratory tests showed that certain predacious mites and thrips, often found on citrus, prey on the Yuma spider mite, and in some areas may prevent their populations from increasing. Populations of the Yuma spider mite near Yuma, Arizona, and in portions of the Coachella and Imperial Valleys may exist because of the absence of predators and parasites, but the principal reason for the mites' choice of habitat area is probably temperature and humidity conditions.

Laboratory tests

Yuma spider mites were colonized on green lemon fruits and were held in laboratory isolation boxes where temperature and humidity were controlled. The normal range of relative humidities found in most citrus growing areas was covered. The mites were allowed to live under various combinations of temperatures between 50° and 110°F and at humidities of 10, 50 and 78 per cent. A comparison of the mites exposed to these different environmental conditions established that at humidities of 50 per cent or below, the optimum temperature for this mite is between 80° and 90°F.

The effect of varying environmental conditions was also observed on egg production, egg mortality, length of the egg stage, and life cycle. No eggs were produced at a temperature of 50° F, regardless of the humidity. Eggs produced at all three humidities and at 60° F failed to hatch within 60 days. However, after 60 days at 60° F those eggs exposed to 50 per cent and 78 per cent humidity did hatch when removed to a room temperature of 80° F.

Temperatures in the areas where Yuma spider mite does not exist often remain below 60° F for 60 days or more and when these temperatures rise they are not accompanied by a rise in humidity. In areas where this mite thrives, daytime temperatures never stay below 60° F for any period of time even though the humidity is generally low. Mites exposed to a temperature of 110° F produced a few eggs which failed to hatch after 60 days and did not hatch when moved to a temperature of 80° F. Adults exposed to a temperature of 110° F survived only four days. This extreme temperature probably does not exist for any period of time in the micro area where these mites exist, but the 100 to 120° F temperatures that do occur for short daytime periods probably explain the near absence of adult populations during the summer months.

Control

Yuma spider mite on citrus can be controlled with a fall application of sulfur used as a dust at 50 to 100 pounds per acre or with a thorough outside coverage spray application of wettable sulfur at 4 lbs per 100 gallons of water. A second application of sulfur some time before bloom in early spring may be applied to reduce populations of both the Yuma spider mite and the citrus flat mite, *Brevipalpus lewisi* McGregor. Citrus flat mite is also of primary concern on all citrus except grapefruit at petal fall time in the spring. Sulfur should not be applied during the warmer months when temperatures are likely to exceed 100° F within two weeks following application. Numerous new acaricides have been used sucessfully to control Yuma spider mite but none have proven to be superior to sulfur. However, if it is necessary to reduce Yuma spider mite populations during the time when the temperature is too high to use sulfur, either dicofol (Kelthane) or chlorobenzilate may be used as recommended by local agriculture authorities.

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Chemical

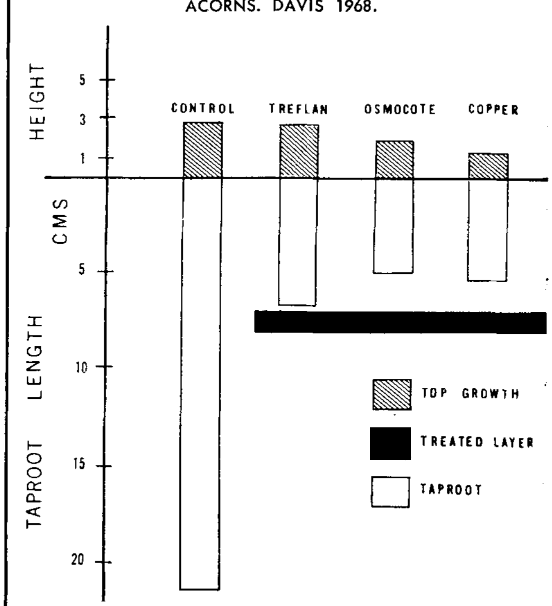
JAMES J. NUSSBAUM

A more branched, fibrous root system is possible by chemically pinching the roots of young container-grown nursery plants. Copper naphthenate painted on the bottom of the seedbed was effective and easy to use. Treated seedlings formed more lateral roots than untreated plants. Root pruning to prevent roots from being kinked and twisted when transplanted was minimized. This technique should be particularly adapted to taprooted plants.

RECENT STUDIES have indicated that kinked, circled, or twisted root patterns frequently formed when nursery plant seedlings were not root pruned and carefully transplanted. Plants of low vigor and short life often resulted. Better branching patterns on tap rooted species were obtained by pinching the root tip. Lateral roots formed above the pinched root tip. The resulting well-branched root system should provide improved anchorage and support as the plant matures.

Manual root pruning is time consuming and easily skipped. An easier method, which would allow for differential root growth rates from plant to plant, would be to pinch the roots as they reach the

INFLUENCE OF TREFLAN, OSMOCOTE, AND COPPER NAPHTHENATE ON TOP AND ROOT LENGTH OF CORK OAK SEEDLINGS THREE WEEKS AFTER PLANTING GERMINATED ACORNS. DAVIS 1968.



* Osmocote is a controlled release fertilizer produced by Sierra Chemical; Treflan is a preemergence herbicide produced by Eli Lilly and Company; and copper naphthenate is a wood preservative prepared by Gilbreath Chemical Company as Coppernate "55".

pinching for roots of container plants

bottom of the seedbed. This method would be preferable, since the seedling would suffer less than if a large portion of its roots are removed when it is transplanted. These tests were conducted to study these possibilities, especially with chemical treatments.

Chemical treatments

Cork oak, *Quercus suber,* acorns were planted in flats 7 cms (3 inches) above layers of osmocote, treflan, and perlite soaked in copper naphthenate. The acorns were germinated in vermiculite and uniform seedlings selected. The radicles were all less than 1 cm long at the time of transplanting. The transplanted oak seedlings were grown in a growth chamber with 80°F day temperatures and 70°F night temperatures, and a 14-hour day length. One-half-strength Hoagland nutrient solution was used for watering.

All three chemical treatments were effective in preventing the taproots from elongating through the chemical layer. Three weeks after planting the germinated acorns, the treated taproots were less than one-third as long as the control roots (see graph). None of the treatments appeared to be injurious to top growth.

The cork oaks were transplanted from the flats into six-inch clay pots. Roots of one-half of the control plants were pinched by hand when transplanted. The plants were potted in a UC soil mix and grown under long-days for six weeks.

A more fibrous, compact root system was formed when the primary root was pinched with one of the chemicals. The average length of the primary roots of the control plants was over 57 cms (table 1). The depth of a one-gallon container, normally used at this stage of development, is 15 cms. The primary root would be coiled around the can several times under these conditions.

The taproot lengths of the chemically treated plants in the same experiment were approximately 6 cms. These plants had more secondary roots per unit length of taproot than those of the control plants. The chemically treated plants also had three to four times as many tertiary roots. Their top growth was almost equal to the control oaks with no sign of detrimental effects. The treated plants were superior to the control plants in that the root system was more branched and adaptable to container growing.

Control plants that had been mechanically pinched at transplanting were superior to the unpinched control plants. However, they did not have root systems as well developed as the chemically pinched oaks. The chemically treated plants had a significantly larger primary root cross-sectional area at 2 cms below the soil level. This could be important in strengthening the trunk and root of the developing seedlings so that they could better stand upright.

Copper naphthenate

Jeffrey pine (*Pinus jeffreyi*), roundleaf eucalyptus (*Eucalyptus polyanthemos*), and mesquite (*Prosopis tamarugo*) seeds were sown in 2.5-inch-deep flats with the following treatments: copper naphthenate painted on the bottom of the flat; a 1-cm layer of perlite soaked in copper naphthenate placed on the bottom of the flat; and an untreated control. UC-type soil mix was used for the seedbed. The plants were grown in the greenhouse and watered with one-half strength Hoagland solution.

The primary-root length of all three species was significantly reduced by both copper naphthenate treatments (table 2) (similar to the results obtained with cork oaks planted above a chemical layer). The pines were the fastest growing species and one control plant had a taproot over 46 cms long 30 days after planting. By comparison the longest treated pine

TABLE 1. INFLUENCE OF ROOT PINCHING ON CONTAINER-GROWN CORK OAK SEEDLINGS SIX WEEKS FOLLOWING TREATMENT*

Root pinching treatment	Primary root length†	Pri. root cross-sect. area‡	No. sec. roots/cm pri. root	Average length sec. roots	Height of top growth
	cm	mm^2		cm	cm
Cop Naph	7.3a	9.61c	2.8c	11.3b	12.0a
Osmocote	5.0a	7.06b	1.5a	22.8c	15.6a
Treflan	6.4a	8.54bc	2.1b	14.4b	17.3a
Mech. Pinch	13.5a	4.90a	1.5a	7.0ab	17.1a
Control	57.4b	4.90a	1.0a	1.0a	15.8a

* Test of significance by Duncan's multiple range test. Means for each column followed by the same letter are not significantly different at the 5% level.
† Each value is the mean of three replications, each containing one or two plants.
‡ Primary root cross-sectional area 2 cms below the soil level.

TABLE 2. INFLUENCE OF COPPER NAPHTHENATE PAINT, AND PERLITE SOAKED IN COPPER NAPHTHENATE ON ROOT DEVELOPMENT OF EUCALYPTUS, PINE AND MESQUITE 30 DAYS AFTER PLANTING.*

Treatment	Pri. root length†	No. sec. roots/cm pri. root	Average length sec. roots	Height of top growth†
Pine	cm		cm	cm
Cop Naph/painted	6.2a	2.1b	5.9a	8.0b
Cop Naph/perlite	5.4a	1.2a	5.2a	6.9a
Control	23.8b	1.4a	5.2a	9.4c
Eucalyptus				
Cop Naph/painted	5.7a	4.7b	2.8a	4.5a
Cop Naph/perlite	5.6a	4.4b	3.3a	4.9a
Control	13.6b	2.4a	1.9a	4.8a
Mesquite				
Cop Naph/painted	5.9a	3.3b	2.2a	6.2a
Cop Naph/perlite	5.4a	3.8b	3.1a	4.4a
Control	14.6b	1.7a	1.8a	6.5a

* Test of significance by Duncan's multiple range test. Means for each column followed by the same letter are not significantly different at the 5% level.
† Each value is the mean of four replications, each containing two to five plants.

Cork oak seedlings six weeks following treatment at Davis, 1968. Treatments were from left to right: perlite soaked in copper naphthenate, osmocote, mechanically pinched, control, and treflan.

root was only 6.6 cms. Compared with the controls, seedlings growing in the flat painted with copper naphthenate had 50 per cent more secondary roots per unit length of primary root in all three species, as well as substantially more secondary roots on the upper 6 cms of the primary root.

The copper naphthenate in perlite made an impermeable layer that impeded water drainage. This could have accounted for the reduced top growth of the pines and also the smaller number of secondary roots on plants in this treatment. No injurious effects were seen on the top growth of any of the species, although the pines were reduced in top growth by the copper naphthenate.

Better container plants

Painting copper naphthenate on the bottom of the seed flat appears to be a simple and convenient method for chemically pinching roots. This material is normally used in nurseries as a wood preservative and disinfectant. The concentrated 55% copper naphthenate is easily painted onto the bottom of flats or seedbeds, is water-repellent, and does not leach into the soil. The copper naphthenate remains behind when the seedling is transplanted. Plants should be transplanted soon after the primary root is pinched to allow the secondary roots to elongate normally.

Chemically pinching roots of seedlings should prove an important aid in the production of container and field-grown plants having fewer kinked, circled and twisted root systems. Plants so handled will have more fibrous root systems with stronger trunks to support their developing tops.

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A practical aphid trap for field studies

N. F. MC CALLEY · W. H. LANGE

METHODS OF TRAPPING WINGED aphids in the field during studies of the incidence and spread of plant viruses have included sticky board traps, yellow painted open pans of water, and mechanical suction traps. Sticky board traps require the least attention, but collect fewer aphids than the other traps. The suction trap is the most efficient, but requires an electrical power source and is expensive. Although it collects more aphids of certain species which are attracted by yellow, the yellow pan trap has been favored by many researchers for the field survey of aphid vectors of plant viruses because of its overall efficiency in attracting known aphid vectors.

However, there are some disadvantages to the yellow water pan trap. It must be serviced at least once a week under ideal conditions and twice a week in windy weather. Most surveys require frequent collection of the aphids to determine the onset of aphid migrations, which is important in the study of the spread of plant viruses under field conditions. It is known that yellow water pan traps are more efficient when placed on bare soil, and that when they are elevated or placed against a background of vegetation their efficiency is reduced. During the field survey of aphid species, the traps are placed in fields where they are frequently driven over with tractors during cultural operations. Furthermore, winds regularly whip dirt and other debris into the water rendering the trap less attractive to aphids.

These disadvantages have largely been overcome by development of a water pan trap consisting of an open water-filled pan mounted in a stand as shown in the accompanying photograph. The enamelware pan used is 7½ inches in diameter and 3¼ inches in depth. The pan and stand are an integral unit both painted in Visibility Yellow 1524 (W. P. Fuller Co.). Addition of a sufficient amount of a wetting agent such as Vatsol 90 (American Cyanamid Co.) is suggested to break the surface tension of the water and aid capture of the aphids as they alight on the surface.

All parts of the stand other than the legs are made of ½ inch plywood. The specifications and number of pieces are as follows: top—12″×12″ with 8″ pan hole; top side rails—2½″×11½″ (2) and 2½″×12″ (2); lower side rails—3½″×11½″ (2) and 3½″×12″ (2); lower shelf—12″×12″ with corners notched for legs; and legs—2½″×2½″×20½″ (4).

The 21-inch height of this trap painted entirely yellow minimizes the background effect, yet it is not elevated enough to greatly reduce trapping efficiency. The trap's height and color cause it to stand out in fields of most row crops, including sugar beets, and make it easier for tractor drivers to see the trap. The trap is affected less by wind-blown soil and other debris dropping into the pan because it is off the ground.

This unit was developed in 1956 during studies of aphid vectors of lettuce mosaic virus in the Salinas Valley. It has been widely used throughout northern California and the San Joaquin Valley to survey the aphid vectors of the virus yellows complex of sugar beets. The trap has been useful in timing the application of insecticides to control the aphid vectors of sugar beet viruses. It has proven to be both inexpensive and practical.

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