

which normally begins blooming between January 10 and 14. Under these conditions, supplemental feeding should be done between December 20 and 25 to prepare colonies for almond pollination in February. The date of the first natural bloom will vary with plant species growing in winter locations of colonies.

Feeding colonies with Beevert two weeks before they entered alfalfa seed fields for pollination in 1968 resulted in a 15 per cent increase in the amount of pollen collected during alfalfa bloom.

The consistency of results obtained in these four Fresno County bee feeding experiments suggests it is advisable for beekeepers in this area to feed weak colonies in the fall and to feed *all* colonies two and a half to three weeks before the first natural bloom after winter to increase the strength of bee colonies for almond pollination. When natural pollen supplies are not adequate, supplemental feeding of natural pollen or natural pollen mixed with drivert sugar has stimulated an increase in egg laying. Weak colonies should also be fed two and a half to three weeks before they move to alfalfa seed fields for pollination purposes.

Pollen or pollen and sugar supplemental foods have been readily accepted in the liquid syrup form; however, bees in these experiments have rejected the dry form of these same foods during warm dry weather.

Bob Sheesley is Farm Advisor, Fresno County; and Bernard Poduska is Senior Apiary Inspector, Fresno County. Financial assistance was received from Hy-Queen Research Inc., Fresno County Pure Seed League, and California Almond Growers Exchange.

By feeding pollen 2½ to 3 weeks prior to the occurrence of natural bloom in the area, repeated supplemental feedings were not needed to maintain the rapidly growing colonies.



YUMA SPIDER MITE ON CITRUS

H. S. ELMER

THE YUMA SPIDER MITE, *Eotetranychus yumensis* (McGregor), was first observed near Yuma, Arizona, in about 1928 by J. L. E. Lauderdale, and was described in 1934 by E. A. McGregor from specimens collected on lemon foliage by R. S. Woglum and H. C. Lewis. This mite occasionally becomes a serious pest on citrus in certain desert regions of the southwestern United States, but little information has been published on its life history, distribution, host range, and the means of reducing injurious populations.

Limited areas

The Yuma spider mite is evidently confined to very limited areas: the citrus areas around Yuma, Arizona, the Coachella and Imperial Valleys in California, and adjacent desert regions in northern Mexico. In the Coachella Valley it is further limited to citrus plantings within a 20-mile radius of the northern end of the Salton Sea—although citrus plantings extend much farther than this. The reason this mite has not become established in other desert citrus growing areas of California and Arizona with similar climatic conditions is not known, especially since there are few restrictions on the transportation of citrus fruit and nursery stock between mite-infested and noninfested areas. In addition to citrus, this mite has been found on grapes, castor beans, grain sorghum, puncture vine (*Tribulus terrestris* L.), brown-eyed primrose (*Oenothera clavaeformis* Torr. & Frem.), and on quail brush [*Atriplex lentiformis* (Torr.) Wats.]. The mites have been found on quail brush far removed from citrus trees, therefore suggesting that this

plant may be the native host of this mite species.

The body of the Yuma spider mite is usually pinkish but may become quite dark, particularly in older adults. It resembles the six-spotted mite, *E. sexmaculatus* (Riley), and the Lewis spider mite, *E. lewisi* (McGregor). Eggs vary in color from white to almost colorless but become light pink just prior to hatching. The mite feeds on the leaves, fruit, and green twigs of the citrus tree and produces a heavy webbing to which dust particles adhere. This dust-covered webbing facilitates detection of heavy infestations. The mites may produce a silvering of mature fruits similar to that caused by the Lewis spider mite, and they are believed to accentuate a tree condition known as "fall dieback," which may also be enhanced to a lesser degree by the citrus red mite, *Panonychus citri* (McGregor). Branches up to 1½ inches in diameter may lose their leaves and die due to the combination of mite injury, low humidity, wind, and lack of sufficient soil moisture.

Population increase

Yuma spider mite populations generally begin to increase in October and November and may remain high throughout the winter, then decreasing in the spring and early summer. The mites live through the summer as adults under the bark of the trunk or limbs and in cracks in shaded areas. Large populations remain alive later in the spring near the Salton Sea. At Yuma, Arizona, moderate infestations may be found throughout the summer. Mite population numbers may be quite variable during the winter

Chemical

JAMES J. NUSSBAUM

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 predaceous 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 pro-

duction, 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 successfully 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.

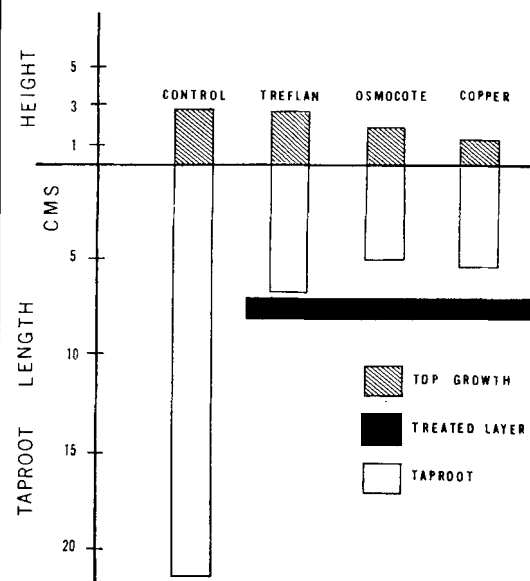
H. S. Elmer is Specialist, Department of Entomology, University of California, Riverside.

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 Coppenate "55".