10^{-4}M (dilute) to 10^{-3}M (strong), depending on plant species. Plants differ considerably in their sensitivity to these chemicals so it is advisable to make visual observations of a few test leaves prior to any extensive use. Film-forming and reflecting materials are not likely to pose problems of phytotoxicity, although some browning may occur on leaf tips if high concentrations of emulsions flow to the leaf tip and congeal there. When seedlings are dipped in a film-forming emulsion, it is important to see that the roots are not coated by the solution since water uptake may then be retarded.

Stomata

Stomata-closing sprays are effective in extremely dilute concentrations. Thus, they may be expected to be less expensive to use than other antitranspirants if their unit costs do not appreciably exceed those of other types of materials. For example, PMA at 10 cents per gram used at the rate of 15 grams per acre (diluted in 100 gallons of water) would cost only $1.50 per acre. The volume of spray to be used per acre will depend on the nature of the vegetation since the primary consideration (at least for the film-forming and stomata-closing antitranspirants) is coverage of the *stomata-bearing surfaces* of the leaves. On the 15-foot almond trees, about 1 gallon of spray per tree was applied with a mist blower, ensuring that the lower leaf surfaces were wetted (there are no stomata on the upper surface of an almond leaf). In one of the treatments the trees were sprayed a second time, about one hour after the first spray had dried (see graph). This resulted in less trunk shrinkage than in the control or single spray treatment because more complete coverage by the spray was obtained, and perhaps because thicker films were formed on the leaves.

The duration of antitranspirant effectiveness determines the frequency with which respraying is necessary and its economic usefulness. The duration depends on the efficiency and durability of the material, effectiveness of the spraying operation, environmental conditions, and the amount of new foliar growth produced by the plant after spraying. Thus, the effect may last from only a few days to several weeks.

Complete coverage of the stomata-bearing surfaces of leaves is impossible to achieve on a field scale, partly because of difficulties in wetting the leaves (which can be overcome by the use of surfactants) and partly because of crop geometry. It is not likely that all the lower and inner leaves of a crop will be hit by the spray. Since the highest rates of transpiration occur from leaves in the outer periphery of the plant where radiation and ventilation are greatest, these leaves should receive most of the spray.

The most obvious use of antitranspirants is to conserve soil water and thereby reduce irrigation frequency. However, applications for this purpose would be justified only if water costs are sufficiently high and if possible water savings are relatively large in comparison with application losses during irrigation. Antitranspirant treatment of watersheds or grassed areas where plant growth is not a prime factor is being investigated. Other possibilities include their use to aid survival of established and valuable plants in drought situations, to increase survival of transplanted seedlings, to extend the range of environments in which favorable growth and yield can be obtained from plant types sensitive to water deficits, to reduce winter kill, to treat plant material for shipping, and to reduce the rate of desiccation of cut Christmas trees. There is some evidence that an antitranspirant film on foliage may provide a physical barrier against fungus and insect attack and that it may also reduce injury from smog and salt spray. Incorporation of an antitranspirant in a pesticide spray, assuming there is no incompatibility between the two materials, would greatly reduce application costs. Some film-forming sprays polymerize slowly on the leaf surface, thereby increasing the residual effect of the incorporated insecticide or fungicide. Numerous potential uses of antitranspirants are yet to be investigated.

This information is not to be considered a recommendation of University of California. Continued research is necessary to determine which materials offer the maximum reduction in transpiration with minimum reduction in photosynthesis, as well as optimum concentrations and application methods.

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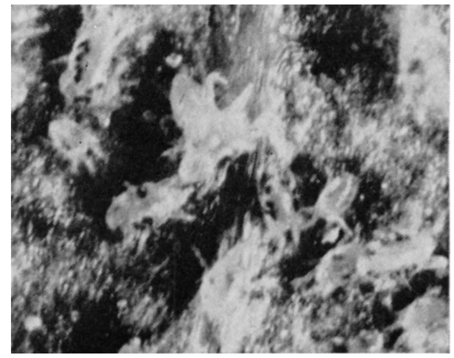
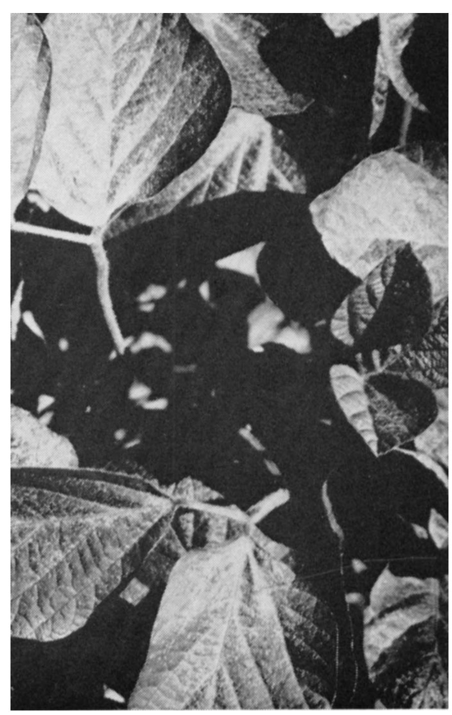
ELMER C. CARLSON



SPIDER

Photo magnification (above) of the Pacific mite, Tetranychus pacificus McG. White-stippled type of injury shown in photo below resulted from light to moderate spider mite infestation on soybean leaves.



Spider mites are the most destructive of the economic pests found on soybean plants in our hot interior valleys. Destructive species are the two-spotted mite, Tetranychus urticae K., and the Pacific mite, T. pacificus McG. High population densities of several hundred to over a thousand per leaflet may build up. The light to moderate white-stippled type of injury intensifies so that leaves turn yellowish, then brown, and drop prematurely. This causes a reduction of pod set and yield of seed. The studies have indicated that mite numbers should be kept at or below 4 to 6 per unit count to obtain any sort of satisfactory seed yield. After pod set commences, it appears necessary to have some type of mite control in or on the soybean plants or serious damage and seed loss will occur. Superior mite control has been obtained by chiseling a granular pesticide, such as Thimet, into the soil at planting time and again as a side-dressing in the seedling stage. Kelthane has afforded the best control of the foliage sprays tested. Trithion was fair but multiple sprays were needed. Pesticides discussed in this article have not been registered for use on soybeans and are not recommended for use at this time.

TABLE 2. MEAN REDUCTION OF SPIDER MITES AND SEED YIELD OBTAINED FROM CHEMICAL SIDE-DRESS TREATMENTS OF SOYBEANS, 1967

Materials and amounts of active ingredient per acre	Average number of mites counted during 49 and 36 days of test period		Average yield of clean seed	
	No. per ½ inch unit area per leaflet	per cent reduction	Grams per 100 ft of row	Pounds per acre
U.C. West Side Field Station, Five Points, July 6 to August 24				
Thimet (phorate) 2 lb	9.3 a	59	184.7 b	79
Thimet (phorate) 4 lb	8.5 a	64	717.0 a	275
Temik* 2 lb	21.1 b	54	2.1 c	1
Check, untreated	37.3 c	..	0.0 c	0
U.C. Davis, July 17 to August 21				
Thimet (phorate) 2 lb	5.62 a	77.7	795 b	305
Temik* 2 lb	3.76 a	85.1	1161 a	446
Check, untreated	37.6 b	. . .	652 c	249

* An aliphatic carbomoyloxine, used as a 10% granular material.

MITES ON SOYBEANS

. . . injury and control

A RECENT REVIVAL of interest in the evaluation and breeding of soybean varieties in California has been broadened to include studies of the various insect pests affecting this crop. This renewed interest in soybean culture has resulted from (1) the need of cotton seed oil processors for a supplemental oil seed crop; (2) a lack of California-grown soybean seed (any now used in this state has to be imported); and (3) the possibility that world demand for additional protein food may soon increase.

Observations recorded several years ago indicated that spider mites are the most destructive pests attacking soybeans planted in the Sacramento and San Joaquin valleys. The present investigations were undertaken to determine the amount and kind of damage caused by varying infestations of differing severity. This research also included trials of promising acaricides and how to apply them.

The two species of spider mites chiefly responsible for damage to soybeans are the two-spotted spider mite, *Tetranychus urticae* K., and the Pacific spider mite, *T. pacificus* McG. (see photo). These very small leaf-feeding mites have a high growth potential in the interior valleys during the summer. Several hundred to more than a thousand mites may develop on each leaflet. Leaflets under severe attack first show a white-stippled type of injury (see photo). They become yellow and then, somewhat later, turn brown, and finally dry up and drop. Partial or complete defoliation reduces pod set and seed yield. The loss may range from light to severe, according to the earliness and intensity of the mite build-up.

TABLE 1. AVERAGE NUMBERS OF MITES AND YIELD OF SEED FROM SOYBEAN PLANTS TREATED FOR SPIDER MITE CONTROL, WEST SIDE FIELD STATION, FIVE POINTS, 1966*

Materials and amonuts of active ingredient per acre	Average number of mites per ½-inch unit area per leaflet†	Yield of clean seed		Weight of 100 seeds
		grams/ ft of row	lbs/ acre	grams
Thimet (phorate) 2 lb—side-dress‡	7.6 ab	15.1 a	580	8.8 a
Trithion (carbophenothion) 1 lb —2 sprays	5.4 a	12.6 a	484	7.5 bc
Kelthane (dicofol) 1 lb—1 spray	4.4 a	12.4 a	476	8.0 ab
Tedion (tetradifon) 1 lb—1 spray	6.6 a	8.3 b	319	6.8 c
Trithion (carbophenothion) 1 lb —1 spray	9.7 b	7.1 b	272	6.5 c
Morocide (binapacryl) 1 lb—1 spray	19.4 c	3.0 c	115	6.0 cd
Di-Syston (disulfoton) 2 lb—side-dress‡	25.5 d	2.3 c	88	5.6 cd
Check, untreated	29.6 e	1.5 c	58	5.3 d

* All treatments in this and following tables that do not have a letter in common are significantly different at 5% level.

† Average number of mites for all counts made during 28-day test period in spray plots and during a 42-day test period in side-dress plots.

‡ *Side-dressed with 10% granular material through chisel at 5 inches from seedlings and 5 inches deep 33 days after planting.*

Field tests

Standard plot procedures were used in the field tests of acaricides. However, an attempt to obtain high and uniform spider mite populations was made, by using extra rows and by hand-placing infested leaflets in the plots prior to treatment. The test sprays were applied with a CO_2-powered back-pack sprayer. Dry, granular insecticides were applied by chiseling them into the soil before planting, or placement below the seeds when they were being planted. In other trials the granular materials were placed as side-dressings adjacent to seed rows or to

Good control of spider mites (center) was obtained with a Thimet side-dress treatment.

emerged seedling plants—about 5 inches from the plants and 5 to 6 inches deep.

Treatments were evaluated in terms of average numbers of mites counted within a circular "window" one-half inch in diameter drilled into a steel template.

A sample consisted of 20 "infested" leaflets picked rapidly from each test plot. Each 20-leaf sample was placed in a one-pint jar and refrigerated until processed. In the process of counting mites, each leaflet was clamped between the halves of a flattened 6-inch strap hinge with a ½-inch hole or window drilled near the base and another at the center of one of its halves. The window exposed a circular area (unit area) of the underside of each leaflet. The number of active mites trapped within each unit area was counted with the aid of a microscope and recorded—two such counts being made for each of the 20 leaflets per plot sample.

Mite counts

The average number of mites per ½-inch unit area was determined from all the leaflets counted from each plot of a particular treatment. The results are generally given as a composite average of 5 or 6 counts made during an extended test period (unless only one count for a specific date is cited). Differences between plots in terms of seed yield were calculated from seeds harvested in 30 to 100 ft of row per plot.

A series of tests performed at the West Side Field Station, Five Points (1966), showed that a plot in which mites were controlled with Thimet (see photo) applied as a side-dressing 33 days after planting yielded about 10 times as much soybean seed as the untreated check plot (table 1). In this series of tests, Kelthane was the best of the foliar sprays as tested, and only one spray was applied. Two sprays of Trithion were required to control the mites throughout the period of attack and to produce a good seed increase as compared with the check plot. The treatments with Morocide and Di-Syston resulted in poor mite suppression and very little seed increase. The best of the treatments in this series also appeared to increase the size of the seeds.

The amount of mite damage appearing in the test plots of soybeans planted in 1966 was estimated to be moderately severe. The data obtained indicated that the seed yields were satisfactory only when the average number of mites for the entire test period did not exceed 5.4 mites per unit area, at any sampling date after the beginning of pod set. Mites multiply very rapidly in the hot, interior valleys and the light leaf stippling noticeable when counts show about 5.4 mites per inch of area can worsen rapidly within a short period thereafter. When any sample count approaches an average of 25 to 30 mites per unit area, leaflets change from yellow to dry brown. This marks the onset of defoliation.

TABLE 3. REDUCTION OF SPIDER MITE INFESTATIONS ON CHIPPEWA SOYBEANS BY THIMET GRANULAR TREATMENTS, DAVIS, 1968*

Amounts of active pesticide per acre	Mites Counted in ½-inch template area			
	32 Days—Aug. 27		47 Days—Sept. 11	
	Average number	Per cent reduction	Average number	Per cent reduction
Check, untreated	8.9 c	. . .	20.4 b	. . .
Thimet, 2 lb at planting time	1.9 b	78.6	5.4 a	73.5
Thimet, 2 lb side-dressed —37 days	2.5 b	71.9	6.3 a	69.1
Thimet, 2 lb at planting + side-dressing 37 days later	0.3 a	96.6	3.6 a	82.3

* This pesticide was chiseled into the soil at planting time on June 19 and as a side-dressing on July 26.

Experimental fields

The experimental fields of soybeans became infested early in the seedling stage during 1967 and the subsequent mite attack became much more serious than during the previous season. Two test materials were applied as granular side-dressings to soybeans planted in two localities during 1967 (table 2). Applications of Thimet to beans planted at the West Side Field Station did not adequately control the heavy outbreak of spider mites, even at a rate of 4 lbs active material per acre. Under these stressed conditions, the yield of seed in treated plots was judged to be unsatisfactory even though yields were significantly increased over the check plot. The untreated plot in this series produced no pods or seeds. Side-dressing applications of Thimet and Temik were repeated about 10 days later at Davis. In the second series, the Temik side-dressing performed somewhat better than the Thimet side-dressing but the improvement in seed yield was disappointing in both treatments.

During 1968, Thimet was applied to infested soybeans on 2 different dates (table 3). A plot receiving one 2-lb-per-acre application on the date of planting, and another plot receiving a 2-lb-per-acre side-dressing 37 days after planting were indistinguishable in respect to mite control at the 47th day. Significant improvements in mite control were obtained when the two treatments were combined.

The pesticides employed in these tests on soybeans are not yet approved for use on this crop and cannot be recommended until registrations are obtained by the manufacturers.

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