top soil, and below which the underlying soil was a sandy loam. This texture change was the cause of the seepage area.

At both sites, holes were augered into the soil so that rate of water movement into the holes could be observed and soil hydraulic conductivity measured. After at least five hours of observation, no appreciable volume of water had flowed into the auger holes, even though the water table of the surrounding soil was at or near the surface. Hydraulic conductivity measurements were not possible because of the slow water movement.

It is believed that the low hydraulic conductivity of these soils is due to presence of reduced iron and high organic matter content. Under these conditions, ferrous hydroxide is formed and precipitates out of the water. The reaction is described by:

$$Fe^{2+} + 2HCO_3^- \rightarrow Fe(OH)_2 + 2CO_2$$

In laboratory experiments relating to reclamation of salt-affected soils conducted at U. C., Davis, by M. A. El-Nahal, the formation of gelatinous substances under reducing conditions similar to those at the sites was observed in many cases. The gelatinous substance in those experiments, accompanied by reduction of ferric iron to the ferrous state and presumed to be $Fe(OH)_2$, markedly reduced percolation through soil columns. The conditions at these sites indicate that this precipitate probably was forming and was a major contributing cause of the poor soil hydraulic conductivity.

A second factor also believed to be caused by the precipitate is compaction of the reduced soil. This compaction was evident while jetting observation wells into the soil. It is believed that the precipitate may have a lubrication effect, allowing soil particles to compact more readily than they would normally. This compaction would also reduce pore dimensions, thus lowering the hydraulic conductivity.

To correct this problem, it is necessary to drain the soil and oxidize the reduced iron. However, drainage is not possible because of the poor drainage characteristics and the periodic wetting by irrigation and rainfall. Thus, if a problem soil underlies a good top soil, a shallow drainage system installed only in the top soil, coupled with good irrigation management, may be the only feasible means of providing a suitable root environment.

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Insecticides enhance spider mite reproduction

Thomas F. Leigh □ Paul F. Wynholds

Organophosphorus insecticides stimulated egg laying of mites reared on the treated cotton plants.

Spider mites are perennial pests of cotton and many other crops in the San Joaquin Valley. They occur annually in most or all cotton fields, and severe infestations commonly follow application of an insecticide to control one or more insect pests. These outbreaks have been related by many scientists to population explosions after destruction of natural enemies of the mites. Most insecticides are broad spectrum, meaning they kill not only the pests, but also many spider mite predators. The most common predators in cotton that are so affected are thrips, bigeyed bugs, pirate bugs, and soft-winged flower beetles.

While conducting experiments on the effect of certain organophosphorus insecticides on growth and fruiting of cotton, we found that a miticide would hold spider mites in check on untreated plants but not on plants that had been sprayed with methyl parathion. Experiments indicated mites reared on plants treated with methyl parathion were no more resistant to the miticide dicofol (Kelthane) than spider mites from untreated plants. We began experiments to determine whether pesticide treatment influenced development rate, survival, or reproductive potential of the mites.

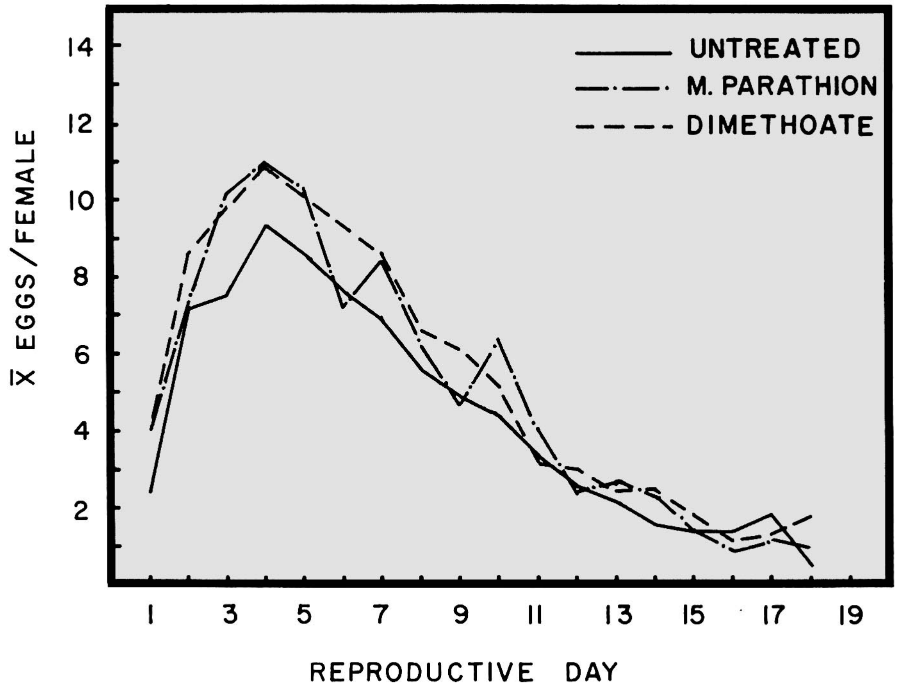
Methods

In greenhouse experiments cotton plants were treated three times at two-week intervals with normal dosage rates of either methyl parathion, toxaphene plus DDT, or dimethoate. Following the third application, twospotted mites (*Tetranychus urticae* Koch) were reared individually from the egg to the adult stage on plants so treated and on untreated plants. Females reared on these plants were mated and maintained on plants of the same treatment throughout either a 10-day period or the duration of their reproductive lives so that fecundity could be determined. Spider mites were monitored for developmental rate from the time eggs were laid until they reached the adult stage. In one experiment, reproduction by each of 16 females was ascertained as a gross value after 10 days of adult life. In the other experiments, daily egg-laying rates were followed throughout each mite's adult life.

Results

Treatment of plants with methyl parathion or dimethoate did not appear to affect egg hatch or the time required for mite development. However, the treatments significantly affected reproduction by spider mites.

In the first experiment, there were significantly more eggs and immature mites on plants treated with methyl parathion, so that the combined total of mite forms was greater on these than on untreated plants (table 1). Although significantly more spider mite eggs were produced on toxaphene-plus-DDT-treated plants, the total of all stages



Average daily egg production by twospotted spider mites reared on treated and on untreated plants, Shafter, California, 1976.

TABLE 1. Number of Twospotted Spider Mites per Developmental Stage and Total Mites per Cage on Untreated and Insecticide-treated Cotton Plants, Greenhouse, Shafter, California 1974

Treatment	Number per stage			
	Eggs	Immatures	Adults	Total
untreated	17	22	10	49
methyl parathion	29*	34*	16	79**
toxaphene + DDT	30*	21	11	62

NOTE: Counts, made 10 days after females became adults and were mated, are averages of 16 cages.
*Significantly different from untreated at 5 percent level.
**Significantly different from untreated at 1 percent level.

TABLE 2. Average Cumulative Numbers of Eggs Deposited by Twospotted Spider Mites During First Two Weeks of Adult Life on Treated and Untreated Cotton Plants, Greenhouse, Shafter, California, 1974

Reproductive day†	Cumulative no. of eggs/surviving female	
	Untreated	Methyl parathion
1	1.5	4.8**
2	5.3	11.2**
3	11.8	19.2**
4	20.5	28.8**
5	29.1	37.9*
6	39.2	45.7
7	48.5	52.8
8	55.4	58.5
9	59.2	62.4
10	64.0	65.2
11	70.1	68.6
12	73.5	71.6
13	75.9	74.2
14	78.4	76.7
Total‡	76.4	73.2

*Significantly different from untreated at p = 0.05 (Student's t-test).
**Significantly different from untreated at p = 0.01 (Student's t-test).
†Day of mite emergence as adult regarded as first reproductive day.
‡Average cumulative number of eggs per female based on all reproductive days of all adult females.

was not significantly different from that on untreated plants.

Daily egg counts in the second experiment showed that spider mites on plants treated with methyl parathion laid eggs at a measurably higher rate during the first five to six reproductive days than did those reared on untreated plants, even though the total number of eggs produced was approximately the same (table 2). This represents nearly a 30 percent increase in reproduction during the first five days.

In a third experiment, spider mites on plants treated with methyl parathion or the systemic organophosphorus insecticide dimethoate produced significantly more eggs through the first 5 to 11 reproductive days than did mites on untreated plants (see graph). The lifetime egg-production totals were 11 and 24 percent greater on the respective treatments than on the untreated plants.

Additional field and greenhouse trials have been undertaken to generate life tables for twospotted mite on treated as opposed to untreated plants.

From these studies we suggest that spider mite outbreaks in cotton are caused not only by release of the pests from predation by their natural enemies but also by stimulated reproduction of spider mites in their early adult life. This stimulation appears to reflect a physiological change in the plant and its suitability as a host of these spider mites.

Insects on cotton must at times be controlled with an insecticide. The combined effect of predator destruction and stimulated reproduction caused by some insecticides results in a rapid increase in mite numbers, giving the impression that (1) a miticide is ineffective and (2) an explosion in mites follows insecticide use. Several insecticides are suspected of causing this effect. Where growers must use organophosphorus insecticides, they should check fields frequently and be aware of the current spider mite situation. They should then be prepared to take remedial measures as necessary and recognize that a severe mite infestation can develop.

This research is being continued to develop more clearly defined information on the relationship of insecticide use to spider mite outbreaks. Such information will be used in developing pest management programs with the least harmful effects on the crop and the environment.

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