A single spray application of carbaryl (Sevin) provided control of the elm leaf beetle for an entire season in tests at Bishop in Inyo County. Effective control is believed to be contingent upon timing the application after the majority of the eggs have been laid in the spring, and the young larvae have begun to feed.

A progress report of cont

ELM LEAF

MANY MUNICIPALITIES in California have experienced heavy damage to elm trees as a result of the elm leaf beetle, *Galerucella xanthomelaena* (Schrank). Although this insect is not new to the state, for reasons yet unknown, populations of the beetle have increased to damaging levels in a number of areas during recent years.

The damage is caused primarily by larvae feeding on the lower side of the leaves. Foliage of entire trees is often skeletonized. The adult beetles also feed on the foliage, causing some damage, but under ordinary circumstances they are of far less importance than the larvae and can be usually overlooked. However, the adults sometimes create a nuisance when they seek the shelter of homes and other buildings for overwintering.

Investigations on control of the elm leaf beetle were conducted in 1964 with the cooperation of the city of Bishop. The tests were directed toward an immediate alleviation of the serious beetle damage which has occurred there in recent years.

Seasonal activity

Observations on the seasonal history of the beetle were made during the growing season for the purpose of associating various phases of insect activity with specific dates. Beetles were also placed in cages attached to branches of elm trees to determine certain aspects of insect development.

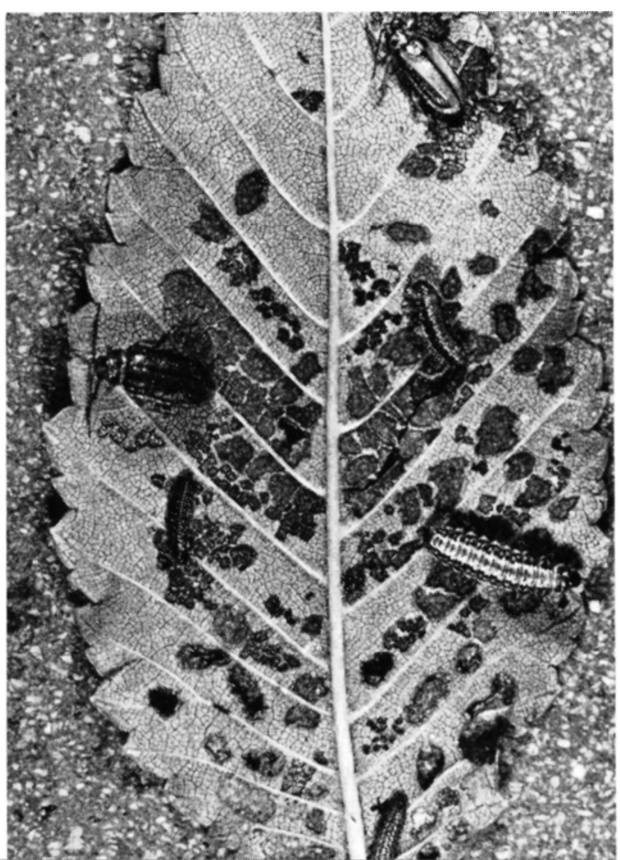
Chemical control trials were conducted in two different parts of the city on Chinese elm, *Ulmus parviflora*, and Siberian elm, *U. pumila*. Each experiment was set up in a completely randomized design with four replications of each treatment. Application of sprays was made with a high pressure hydraulic unit operated at 75 to 150 lbs pressure. Although higher pressure could have been used, the lower pressure tended to minimize drift to adjacent trees. No tree was treated more than once during the season.

The effectiveness of the sprays was determined in one experiment by examining 50 shoots on each tree and counting the number of elm leaf beetle eggs and larvae. In both experiments, each tree was examined several times during the season and given an independent rating by several observers. The rating system used numbers from 1 to 4, with 1 representing no injury or only light injury and 4 representing severe injury. Intermediate damage was rated 2 or 3 depending on severity.

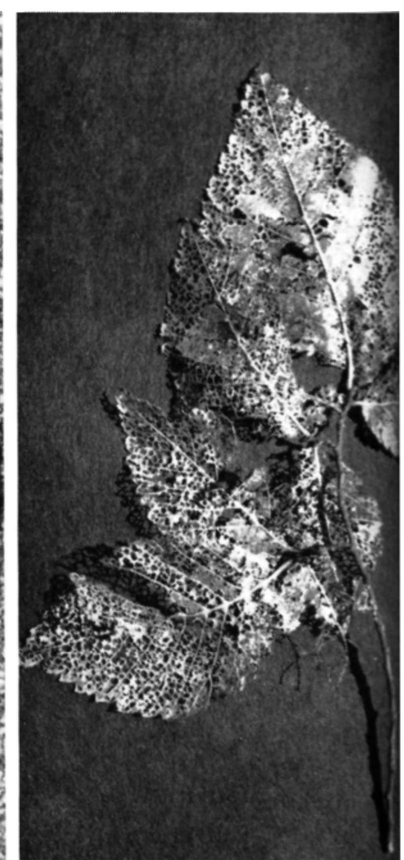
First observations

The first adult beetles were observed on trees in Bishop on April 13. Egg production by beetles placed in cages reached maximum proportions in mid-

A cluster of elm leaf beetle eggs (below and on cover) as typically laid on the undersides of elm leaves. The eggs are yellow.



Larvae and adults of the elm leaf beetle seen in photo below feeding vigorously on the underside of an elm leaf.



Skeletonizing of foliage caused by the larvae of the elm leaf beetle. Damaged leaves turn brown and often drop from the tree.

rol methods for BEETLE

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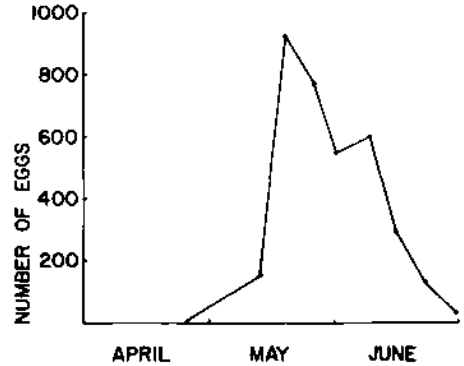
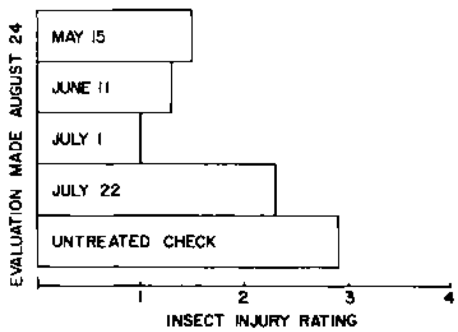
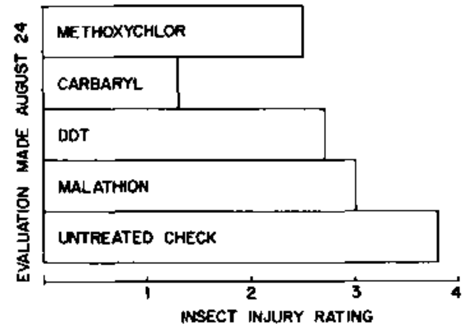






May (graph 1). Numbers declined rapidly thereafter, and by late June, eggs produced by the overwintered adults were difficult to find. It should be pointed out that since eggs in the cage were destroyed after each periodic counting, the cumulative count of eggs on trees reached a peak somewhat later than the period shown in graph 1—and was estimated to occur around the end of May.

The first larvae were found on trees in Lone Pine on May 20 and in Bishop on May 26. On June 1, many larvae were hatching out and light larval feeding was beginning to appear in some sections. In late June, pupae were found at the base of trees in the Bishop area, indicating that the first generation of the beetle was nearing completion. By early July the appearance of new adults and newly laid egg masses indicated the start of a second generation. By the third week in August the second larval generation was essentially complete; but it was evident that even in unsprayed sections of the city, this generation caused considerably less damage than the first.

Field trials

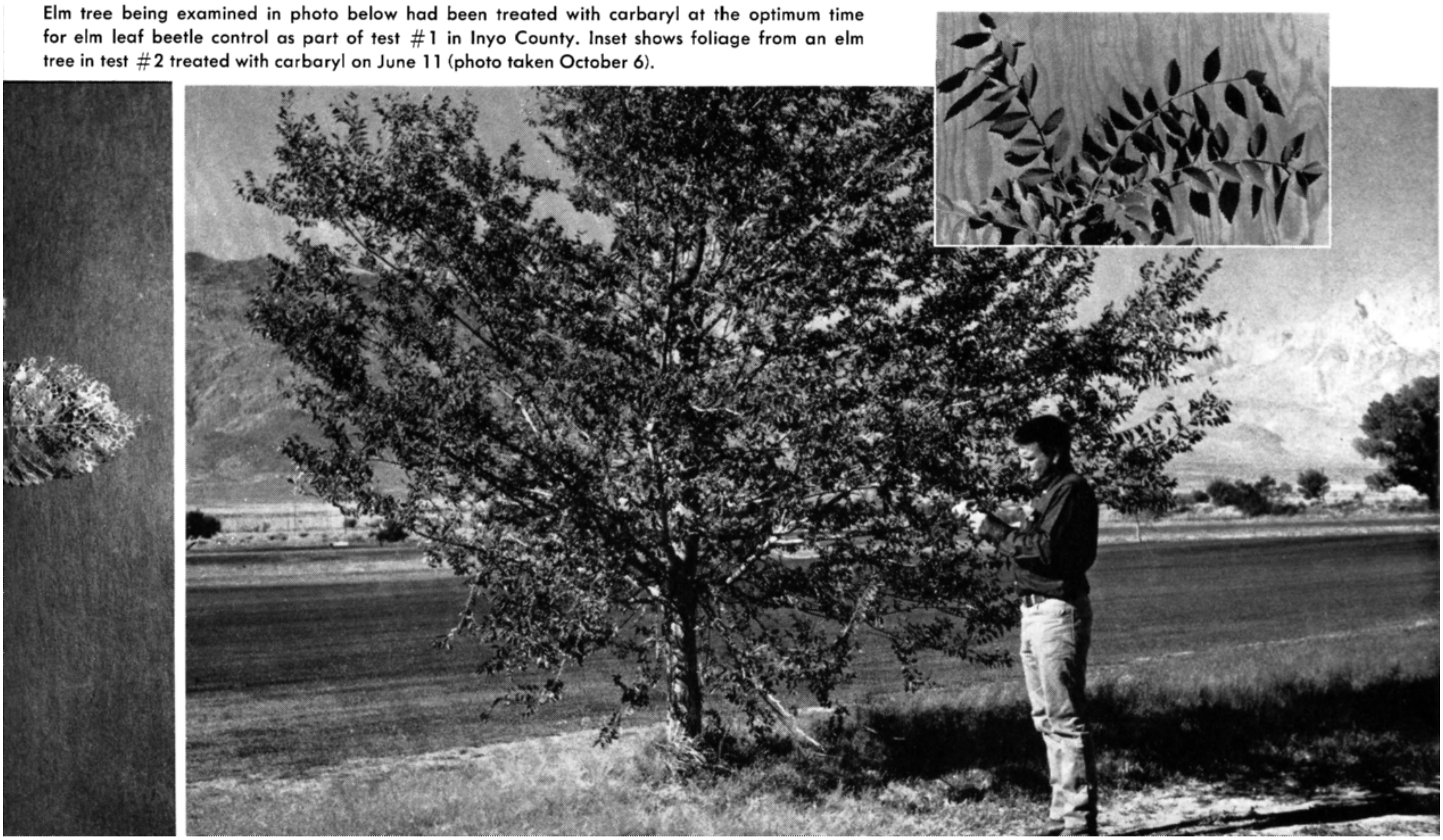
In the first experiment, carbaryl and methoxychlor were each applied using 1 lb of active material per 100 gallons of water in complete-coverage sprays. Treatments were made on four different dates

Graph 1 (top)—Counts of eggs of elm leaf beetle deposited on caged foliage (eggs were destroyed after each counting).

Graph 2 (center)—Injury ratings August 24 on elm trees in test #1 treated on dates indicated with carbaryl at a dosage of 1 lb active material per 100 gallons of water.

Graph 3 (bottom)—Injury ratings August 24 on elm trees in test #2 treated June 11 with different insecticides, all at a dosage of 1 lb active material per 100 gallons of water.

Elm tree being examined in photo below had been treated with carbaryl at the optimum time for elm leaf beetle control as part of test #1 in Inyo County. Inset shows foliage from an elm tree in test #2 treated with carbaryl on June 11 (photo taken October 6).



in an attempt to bracket the optimum time for spraying. Although the trees were rated for injury more than once during the season, only the data collected on August 24 are shown in graph 2. The major objective of this experiment was to determine whether one properly timed application could effectively control the insect for the entire season. The August 24 injury ratings best present these findings, since they were made after insects had completed feeding for the year.

The emulsifiable formulation of methoxychlor used resulted in injury characterized by a yellowing of the elm leaves and premature leaf drop. Because of the chemical injury, it was difficult to exclude personal bias from the injury ratings; for this reason the ratings on methoxychlor are not shown in graph 2.

From graph 2 it is apparent that the severity of beetle injury decreased as the date of spraying progressed from May 15 to July 1, but increased thereafter. Treatments made too early do not appear to leave sufficient residue to last until needed for effective control of the larvae. There may also be insufficient foliage on the trees at that time to allow effective insecticidal deposits. Treatments made too late, on the other hand, do not protect trees from early larval injury. The low level of beetle injury found on the trees treated July 1 show that a single application, properly timed, will effectively control the first generation of insects and will adequately protect the trees from serious injury by the second generation.

In the second test, four different insecticides were applied on June 11. Beetle larvae were present and their feeding damage was beginning to appear. The table presents counts of insects of the first generation made on June 30. At that time there were no statistically significant differences between methoxychlor, carbaryl, and DDT or between DDT and malathion. All treatments, however, were significantly better than the untreated check. In this experiment, methoxychlor again caused injury to the foliage.

The beetle injury ratings on trees in the second test (made on August 24) as shown in graph 3 indicate that carbaryl performed better than any of the other compounds tested. Since these ratings were made after beetle injury had subsided for the season, it is clear that a single application of carbaryl—made after the majority of the eggs had been laid in the spring and at the time the young larvae were beginning to feed—had satisfactorily protected the trees from injury for the entire season.

EVALUATION OF INSECTICIDES FOR CONTROL OF THE ELM LEAF BEETLE. BISHOP, INYO COUNTY, 1964

Material*	Active toxicant in lbs/100 gals.	Average number eggs and larvae per 50 shoots on June 30†
Methoxychlor	1.0	0.25a
Carbaryl (Sevin)	1.0	0.75a
DDT	1.0	5.5 ab
Malathion	1.0	22.0 b
Untreated	..	96.75c

* Sprays applied June 11.
† Means followed by the same letter are not significantly different at the 5% level.

Other considerations

A single spray, applied at the optimum time from the standpoint of insect development, did not prevent all elm leaf beetle damage. However, the feeding of the adults early in the season and the feeding of the newly hatched larvae, were relatively unimportant and did not justify the application of additional sprays. Results of the field experiments indicate that it is both possible and practical to protect individual trees with carbaryl, and that it is not essential that all trees in an area be treated. Only the sprayed trees will be protected, however.

Some variations in insect development occurred from one section of Bishop to another and were believed to influence the proper spraying date. In the first test, where the beetle infestation was not heavy, the optimum time for spraying was near the end of June or the beginning of July. In the second test, where very heavy elm leaf beetle populations were encountered, the proper spraying date was near the middle of June.

Unlike Bishop, some areas of the state have more than two generations of the elm leaf beetle each year. In such areas, it is not known whether a single spray application will adequately control the insect. In some cities in California where carbaryl has been applied to elm trees for the control of other insects, serious spider mite infestations developed on the trees following the spraying. However, this problem was not encountered in the experiments conducted in Bishop.

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Photos of the elm leaf beetle larvae and adults feeding and of the eggs on the underside of a leaf are by L. R. Brown.

Grape leafhopper nymph on grape leaf.

INTEGRATED CONTROL

Properly timed applications of Thiodan or Dibrom are currently effective for use in controlling the grape leafhopper. However, the past record of resistance problems that have developed with other insecticides indicates that it is only a question of time until the same difficulties occur with these materials. Saving these insecticides for emergency use, rather than preventive treatment, and further reliance on an integrated control program appears to offer the best solution.

RECOMMENDED INSECTICIDES for control of the grape leafhopper have changed with the development of resistance and the availability of newer materials—in accordance with results from field trials conducted every year since 1952. Before the integrated control project started in 1961, the benefits of insecticide treatment were evaluated by comparing treated and untreated rows at intervals of one and two weeks after application. With the beginning of the project, leafhopper populations were followed for several weeks after application and for the entire season if possible. The