High-value crops such as strawberries, broccoli, and iceberg lettuce often receive "preventive" or "insurance" pesticide treatments, which may result in weekly scheduled applications of insecticides. Many times such treatments are unwarranted economically and may reduce yields by detrimental effects on the plants. Decreases in strawberry yields due to preventive insecticide treatments in the absence of economically significant pest populations have been reported. Research supported by the California Iceberg Lettuce Research Advisory Board indicated that head lettuce plots kept insect pest-free were generally not the highest yielding plots. Further analysis of the data indicated that a high number of insecticide applications before lettuce head formation may reduce lettuce yields. We report here on the effects of certain classes of insecticides on lettuce photosynthesis, transpiration, and productivity.

**Insecticides**

Insecticides in the various “classes,” such as chlorinated hydrocarbons (DDT, endrin, and methoxychlor), organophosphates (guthion, parathion, and methyl-parathion), carbamates (malathion and methomyl), and synthetic pyrethroids (fenvalerate and permethrin), differ in their effects on plants. Additionally, the rates, number, and timing of applications may alter a compound’s effect upon the plant, for either a short time or several days.

Many compounds are phytotoxic when applied at high rates or under certain environmental conditions, such as extreme heat or moisture. Resulting damage to the plant is usually clearly visible. Insecticides applied at normal rates and under the right environmental conditions may subtly damage a plant but remain unobserved, because symptoms are not visible.

During the last few years, plant physiologists at University of California, Riverside, have developed the dual isotope porometer, which provides accurate, simultaneous measurements of a plant’s photosynthesis and transpiration rates in the field. Entomologists have used the instrument to measure effects of mite feeding on almond, cotton, avocado, and strawberry foliage. In this study, we used the porometer to measure the effects of certain insecticides on the lettuce plant’s photosynthesis and transpiration rates.

In the 1979 investigation, Climax variety lettuce was winter-grown at the U.C. South Pesticides may reduce lettuce yield

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Dual isotope porometer developed by plant physiologists at U.C., Riverside, simultaneously measures effects of insecticides on lettuce photosynthesis and transpiration.

Mean weights of lettuce heads harvested from plots treated with one of three insecticides once and twice weekly.
In 1980, Great Lakes and Mesa lettuce varieties were planted at the Citrus Research Station (CRS), Riverside, and effects of three compounds on lettuce head productivity were studied. Experimental plots were divided into two groups, which received treatments either once or twice weekly. The following amounts of active ingredient per acre were applied at each application: methomyl at 0.9 pound, methyl-parathion at 1 pound, and fenvalerate (Pydrin) at 0.2 pound. In each group, half of the plots were sprayed during the entire growing season from germination to harvest, and the other half were treated from germination to thinning and harvest. Plant responses

All insecticides examined at SCFS adversely affected photosynthesis and transpiration rates but differed in their relative effect and severity of injury (see table). On both sample dates, untreated plants had highest rates. Methoxychlor-treated plants did not have significantly different photosynthesis and transpiration rates than untreated plants. Transpiration and photosynthesis declined 9 and 8 percent, respectively, 24 hours after plants were treated with methomyl. One week after treatment, overall photosynthesis had decreased to 20 percent of the normal rate. Similar trends were observed with the other insecticides investigated. Methyl-parathion induced an initial 17 percent reduction in transpiration and 10 percent reduction in photosynthesis, which decreased to 27 and 18 percent reductions, respectively, after one week.

Permethrin had the most detrimental effects on transpiration on both sample dates. Photosynthesis rates of permethrin-treated plants were reduced most significantly on the first sample date. By the second date, high variation among samples due to leaf age obscured statistical significance of the insecticides' influence on photosynthesis.

No significant differences were detected when chemicals were applied in darkness or sunlight, nor did the two rates of each chemical applied after responses measured.

Data collected at the CRS indicated that neither variety nor number of insecticide applications per week appeared to reduce lettuce head weight and diameter significantly. However, lettuce sprayed weekly during the entire growing season weighed significantly less (22.1 ounces) than that not treated during the growth period from thinning to head formation (23.7 ounces).

Photosynthesis rates of methyl-parathion in the absence of economic significance may become essential. Our results indicate that the dual isotope technique is useful in measuring subtle changes in photosynthesis and transpiration rates in the field and in quantifying recovery over time. Development of a "pesticide threshold" that would indicate the maximum number of applications at recommended rates on designated crops may thus be desirable.

Conclusions

Methyl-parathion (organophosphate) and permethrin (pyrethroid) had the greatest effects on photosynthesis and transpiration rates. Methyl-parathion significantly reduced lettuce head yields. Studies on other crops have shown that parathion reduces transpiration, possibly inhibiting certain processes in the chloroplast where photosynthesis takes place.

Unwarranted insecticide treatments with methyl-parathion in the absence of economically significant insect populations may reduce yields by reducing photosynthesis and transpiration. However, although methoxychlor least adversely affected lettuce plants, and permethrin and methyl-parathion caused the greatest reductions in physiological processes, when relative effectiveness in regulating a pest population is considered, the latter compounds are more desirable.

As more data are obtained on the effects of pesticides, systematic screening of new compounds for their impact on photosynthesis and consequences on yield may become essential. Our results indicate that the dual isotope technique has great potential in instantaneously measuring subtle changes in plant photosynthesis and transpiration rates in the field and in quantifying recovery over time. Development of a "pesticide threshold" that would indicate the maximum number of applications on designated crops may thus be desirable.

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