Khapra Beetle in California

eastern hemisphere insect destructive to stored grain, cereal products and foodstuffs established in state

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Discovery of the Khapra beetle—*Trogoderma granarium* Everts—in barley stored in warehouses in Tulare County, in December 1953, was the first record of this insect occurring in the United States.

In 1954 the Khapra beetle has been found in Madera, Fresno, Kern, Los Angeles, Riverside, and Imperial counties, and in Arizona and New Mexico.

Reported by other research workers to be native to India where it is considered the most destructive insect of stored wheat, the Khapra beetle is in Europe, Asia, Egypt, and Australia.

Because the larvae of the insect can withstand long periods of starvation and live in foodstuffs with low-moisture content and because of the rapid rate of reproduction and habit of collecting in large numbers in cracks and crevices, control is difficult.

Activity

Studies made by various workers throughout the world have shown that the beetle remains active from April through September and is dormant in the larval stage from October to March—depending upon climatic conditions. During April, larval activity is resumed, pupation occurs, the adults appear, mate and lay eggs. There are approximately four to five generations per year. A single fertilized female may lay as many as a hundred eggs in a few days to several weeks.

Although the Khapra beetle generally restricts its activity to the top 12″ of grain, it has occasionally been found to depths of six feet and may penetrate—along the walls and in the corners of elevators and warehouses—as deep as nine feet. The presence of these larvae and their gregarious habit may cause heating of the grain which in turn creates a more favorable environment for larval development.

Besides being a serious pest of wheat, the Khapra beetle has been recorded from bran, malt, seeds of various leguminous crops, rice, oats, barley, and rye. Larval duration has been reported by other workers to be shorter on wheat, maize and rice, and comparatively longer on barley, with the percentage of viability highest on rice.

In March 1954, the University of California at Riverside was authorized by the state to conduct rearing and control experiments on the Khapra beetle under quarantine conditions.

Effect of Temperatures

Life history studies now being made at constant temperatures of 70°, 80°, and 90°F on various food materials—such as whole sound wheat and ground dog food—indicate the possibilities for buildup and survival in central and southern California. At 90°F, it was found that a generation can be completed in approximately 30 days—the eggs hatch in five to six days, the larvae reach maturity and pupate in 18 to 20 days, and the pupal stage lasts four to five days. The adults live from one to four weeks, during which time they mate and lay eggs.

At 80°F, the eggs hatch in eight to 10 days, the larvae do not reach maturity in less than 46 days, and the pupal stage lasts eight to ten days. This indicates that at 80°F, it is possible for the Khapra beetle to complete its life cycle in 64 days.

At 70°F, the eggs hatch in 13 to 15 days and at the time of this report, the larvae were 90 days old and had not pupated. There is some larval mortality at this temperature.

Control Tests

Results of preliminary experiments at Riverside—which agree with findings of previous studies by other research workers—indicate the larvae of the Khapra beetle to be relatively resistant to the several insecticides and fumigants tested. Practically no kill was obtained when larvae were exposed for two hours to a

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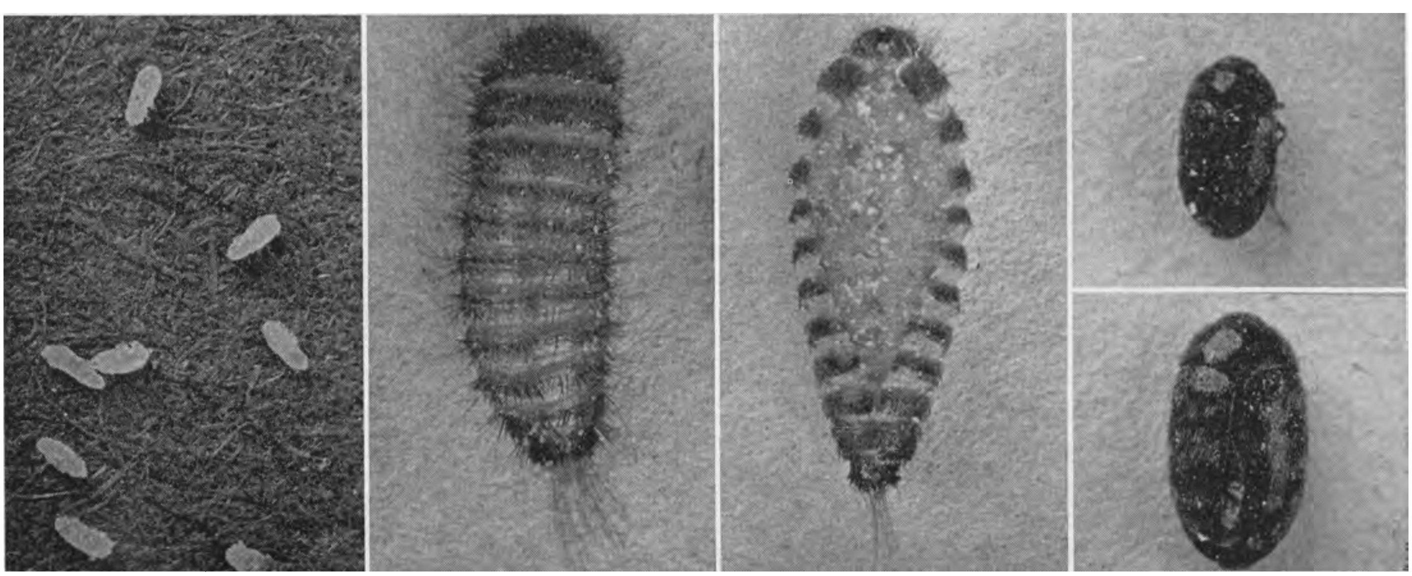
The Khapra Beetle, *Trogoderma granarium* Everts. *Left to right:* Egg, full-grown larva, pupa, and adults. *Greatly magnified.*



of the collapsed trees—100%—may actually have lost some of their mineral content through leaching and therefore have a lower sodium content than the trees 75% declined.

These data lend support to previous results obtained at Riverside indicating that relatively high sodium content of roots was associated with a high degree of decline in lemon trees. Although a high sodium content of roots has been found to be associated with trees exhibiting severe decline symptoms, this is not critical evidence that sodium is the cause of decline.

A known direct cause of tree collapse is root deterioration resulting from the girdling action of sieve tube necrosis at or near the bud union. It is possible that increased sodium absorption by roots—instead of being the cause of sieve tube necrosis—may be a result of a change in the physiology of root cells. The root cells may have become depleted of reserve carbohydrates after the sieve tube necrosis—caused by unknown factors—has reduced the movement of carbohydrates from the leaves to the roots.

The question of the relationship of sodium to decline and collapse of lemon trees is being further investigated by observing the effect of varying the amount of sodium in the soil and by periodic analyses of roots in an orchard where collapse is occurring.

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STOCKS

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sium; the weight of the plants decreased and deficiency symptoms developed.

Stocks appear to be among those plants tolerant to sodium as well as those requiring moderate to large amounts of potassium and nitrogen.

A compilation of the information from the available experimental data suggests that 3.5% potassium in the dry leaf would appear to be a desirable amount for promoting optimum growth and flower production. However, the necessary concentration of potassium needed in the soil to maintain 3.5% potassium in the plant could not be easily determined. The reason for this seemed to be due to the influence of other cations, principally calcium, in the available fraction of the soil.

As shown by the table of correlation coefficients on page 10, calculated from the data of the field survey, the total potassium present in the plant was not correlated with the ammonium acetate extractable soil potassium—a coefficient of .050 in the top leaves; .094 in the bottom leaves. Thus it is possible for the extractable soil potassium to be high but the plant potassium to remain low or the extractable soil potassium to appear low and the plant potassium to be high.

The calcium-potassium ratio in the soil, however, produced a highly significant coefficient— –.708—as did the cation-potassium ratio— –.706—when compared with the potassium content of the lower leaves. These ratios, by comparison, greatly influenced the absorption of potassium by the plant. A high ratio—of calcium to potassium—was associated with low plant potassium and a low ratio with high plant potassium. Therefore, excessively high calcium in the presence of moderate to low potassium may decrease potassium absorption sufficiently to induce potassium deficiency. Under such circumstances as these, the soil potassium measurement alone would not necessarily reflect a true picture of the potassium needs of the plant. Sodium and calcium in the plant were found to be significantly correlated with sodium and calcium in the soil.

The value of soil analysis in predicting the availability of soil potassium for stocks appears to be indicated by the calcium-potassium ratio more than any other measurement used.

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BURNS

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character of incendiary fires in the foothill range area has changed somewhat in the last eight years.

Size acres	Costs of controlled burns per acre			Cost of wildfire suppression per acre
	To permittee	To state	Total cost	
40	$2.95	$.70	$3.65	$5.50
80	2.50	.55	3.05	4.60
120	2.10	.50	2.60	3.80
160	1.75	.40	2.15	3.10
200	1.45	.35	1.80	2.45
240	1.15	.30	1.45	1.95
280	.95	.25	1.20	1.55
320	.75	.20	.95	1.20
360	.60	.20	.80	1.00
400	.50	.15	.65	.85
440	.45	.15	.60	.80
480	.45	.20	.65	.85
520	.45	.20	.65	1.00
560	.55	.25	.80	1.25
600	.65	.30	.95	1.60
640	.80	.40	1.20	2.05

The study clearly demonstrated that firing of brushlands with no plan or effort thereafter to maintain an open cover to favor invasions of desirable herbaceous vegetation is likely to be wasteful of time and money. Moreover, burning of inferior sites, such as those occupied by chamise or manzanita where the soil is thin and the slopes are steep, as is often done, is seldom profitable for livestock grazing.

There is still much room for better management of burned areas, such as reseeding for soil protection and for increasing forage yield; proper grazing use; and treatment to control seedlings and sprouts, though there is a definite trend toward an improvement of this situation. As more information becomes available, through research presently in progress, the acreage of unmanaged burns should decrease.

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surface deposit of 1,000 micrograms per square centimeter of DDT, malathion, lindane, aldrin, dieldrin, parathion, chlordane, methoxychlor, DDD, and allethrin.

In the use of admixed dusts, 40 days were required to kill 90% of the larvae confined on wheat treated with eight ppm — parts per million — malathion dust, and at two ppm only 26% were killed. Similar experiments on the adults of rice weevil, granary weevil and lesser grain borer when exposed nine days to wheat treated with two ppm malathion dust resulted in 100% kill.

In the fumigation experiments, several times as much acrylonitrile or methyl bromide was required to kill 95% of the larvae as was required to kill adults of the rice weevil, granary weevil and lesser grain borer.

Both the contact and fumigation tests were conducted on larvae collected at Imperial in early March 1954, and these may have been overwintering larvae which are possibly more resistant to insecticides than the more active larval stages.

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