parasite destroys the reproductive organs of the host weevil. Thus, in parasitized weevil females, egg production is prevented. In the eastern U. S. where *M. aethiops* is widely established on the alfalfa weevil (*H. postica*), the parasite appears to have played a key role in the recent decline of the weevil populations there.

*Microctonus aethiops* was also rather heavily colonized in Southern California and to a lesser extent in the central and northern parts of the state in the 1960's. However, it has not yet been possible to carry out an intensive survey to determine whether it has become established, and if so, the extent of its impact on *H. brunneipennis*.

### Microctonus colesi

*Microctonus colesi*, a native of the eastern U. S., has only been colonized in small numbers and is not believed to be established in the field. The unidentified *Microctonus* species has only recently been received from Italy, and has not yet been colonized. The egg parasite, *Patasson* sp. was colonized in very small numbers several years ago, and has not been recovered. The larval parasite, *Bathyplectes stenostigma* was released in very small numbers last year and no effort has been made to recover it. Only very limited colonizations of the Middle-Eastern larval parasite, *B. curculionis*, have been made, but more extensive liberations are planned for the spring of 1971.

Progress in the biological control of *H. brunneipennis* has been slow, but the prospects for future benefits are encouraging. The speed with which maximum pressure of the introduced parasites can be brought to bear against the weevil will depend directly upon the amount of effort devoted to the program—and this in turn will be affected by the amount of internal and extra-mural support given the project.

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# EGYPTIAN ALFALFA WEEVIL ... breeding resistant alfalfa

W. F. LEHMAN · E. H. STANFORD

THE USE OF ALFALFA VARIETIES resistant to the alfalfa weevil (*Hypera brunneipennis* (Boh.)) offers a sure, inexpensive means of controlling this pest. Results of work conducted at the University of California and elsewhere show that development of varieties resistant to the alfalfa weevil is possible. However, unlike resistance to the spotted alfalfa aphid, where wide differences in reactions were found among plants tested, only relatively small differences in the levels of resistance have been found among plants tested for the alfalfa weevil. These small increments in the levels of resistance will probably have to be combined into a higher level through generations of cross breeding and selection. The number of generations necessary is not known, but a lower number may be possible if use of such varieties is combined with an adequate level of biological control and good crop management.

A program designed to develop varieties resistant to the alfalfa weevil has been in progress for over 10 years in the eastern United States under the leadership of the U. S. Department of Agriculture's Agricultural Research Service. This program was successful in developing good selection techniques, and a resistant variety, "Team," which is too dormant for maximum production in most areas of California.

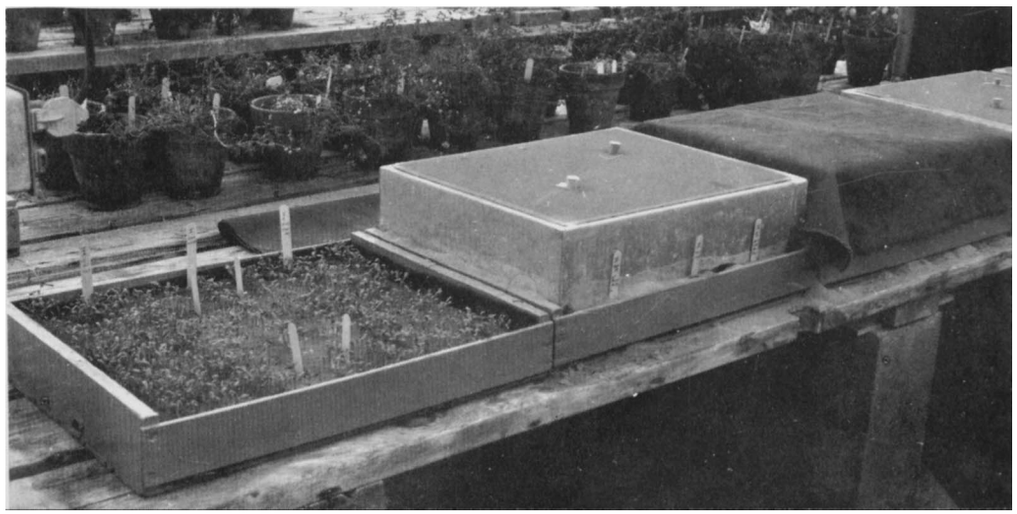
The first weevil resistance work in California was begun in 1965 with plant selections made in San Diego County and crosses between California varieties and non-adapted, weevil-resistant plants. Plant testing and selection were accelerated in 1968 as successful methods developed by USDA in the eastern United States were applied. However, since the weevil species, its associated behavioral patterns, and other factors were different in the East, it was found that weevil collection and storage and other methods had to be modified.

### Imperial Valley

In the Imperial Valley, where the weevil has been an important pest for many years, adult weevils are collected in large numbers around homes and in trees as they leave the fields in the spring looking for a suitable place to aestivate. These spring-collected weevils are stored at room temperature until about December after which they are stored at 40°F and used for testing until June. Fall collections have also been made. These weevils are usually harder to find, but their mortality is lower and, in early tests, have proven to be more reliable.

Elite breeding clones, already containing resistance to other important pests in California, were the first material to be classified with the new breeding techniques. If resistance could be found in this material, the time needed to develop a new variety could be reduced. To classify plants ¼-inch disks were punched from leaves, weighed, fed to weevils, weighed again, and the percentage of

Greenhouse plant resistance screening test where adult alfalfa weevils are feeding on young alfalfa seedlings. Flats (left to right) are: seedlings ready for testing; weevil cage on flat; and cage with cover to darken the cage for uniform feeding.



feeding loss was calculated. Of the plants tested by this leaf-disk test, 16 were selected and combined into two experimental varieties, UC63 and UC68. None of the selected plants had high resistance to weevil feeding, but they all suffered less feeding than the plants tested with them.

### Plant selections

Selections were also made by subjecting seedling plants to adult weevil feeding. In 1969–70 over 94,000 seedlings from superior seed lines were treated in this manner and about 450 plants were saved and intercrossed to form a germplasm pool called UC67. The 450 selected plants will be subjected to the more rigid leaf disk test later to identify the plants with the highest resistance to weevil feeding. UC67 seed will be used in tests with other varieties for further seedling selection, intercrossing, and plant testing.

Work on crosses between California varieties and non-adapted, weevil-resistant plants has been deferred for the present because progress in breeding a new variety will be more rapid if resistance can be found within adapted varieties, as now appears possible. An early source of a low level of weevil resistance used in crosses was associated with reduced egg laying but also with the undesirable characters of decumbent growth and small stems. The variety, Team, is another source of resistance. It is winter dormant, susceptible to the spotted alfalfa aphid, moderately resistant to the alfalfa weevil, and resistant to anthracnose, leaf spot, and pea aphid. Crosses with Team would be valuable and will be made as soon as possible.

### Limited testing

Limited testing of new experimental varieties has been conducted by personnel at the University of California Imperial Valley Field Station and by farm advisors in Tulare and San Diego Counties. Results of these tests to date show reduced feeding or larval counts on the four experimental seed lines tested, two of which appear to be of good agronomic type. Although these preliminary results are encouraging, they have not been exacting enough to definitely prove an increased level of weevil resistance or to indicate how these seed lines might perform in large-scale field tests.

Variety tests containing all seed lines which might be adapted to California conditions are being conducted throughout California. Some of these tests should provide information on the level of resistance now available in seed lines and whether this resistance will be useful to alfalfa growers. In addition to seed line testing, continued seedling selection, plant testing, and recombination will be conducted on material from all areas in California. This type of program (called "recurrent selection") is expected to increase weevil resistance from its present low level to progressively higher levels with each cycle. Germplasm from the variety Team will be introduced into the program when possible to add new genes for weevil resistance and other characters.

### Future program

In the future, the program to develop varieties resistant to the alfalfa weevil will be carried out under a four-point plan involving: (1) selection within adapted seed lines; (2) crosses with non-adapted weevil resistant materials; (3) testing of materials; (4) improvement of techniques. Selections of weevil-resistant plants will be made within a broad base of germplasm adapted for all regions of California where the alfalfa weevil is a problem. Resistance, which is expected to be low in the initial selections, will be increased to higher levels through a recurrent selection program. Crosses of California materials with non-adapted, weevil-resistant materials will be made, when possible, to provide new genes for weevil resistance, other plant characteristics, and a second approach to the problem.

### Seed lines

Seed lines will be produced at all important stages in the improvement program and tested over a geographic area broad enough to provide rapid and reliable information. Seed lines judged superior to existing varieties will be released as they are identified even though more improvement in weevil resistance is possible. New techniques and procedures such as use of juvenile hormones, non-aestivating strains of weevil, rearing chambers, and evaluation methods will be modified, if necessary, and incorporated into the program as conditions permit. The improvement program is designed for flexibility and can proceed as rapidly as conditions will permit.

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# AIR POLLUTIO IN SWEET CO

H. JOHNSON, JR. · J. W. C

**A research project in southern California originally aimed at seeking resistance to sugar cane mosaic virus in sweet corn has also shown that genetic resistance to air pollution also exists in certain varieties. This was not entirely unexpected, since air pollution resistance is known to exist within other plant species. Tobacco varieties, for example, vary widely in susceptibility to ozone; and petunia varieties vary widely in susceptibility to PAN (a photo-chemical pollutant). Smog-resistant varieties of sweet corn should be of particular interest to growers for the summer and fall harvest periods in Los Angeles, Orange, and western Riverside counties.**

ON MAY 14, 1969, 34 sweet corn hybrids from six seed companies were planted in replicated trial at Riverside. Twenty-nine of these hybrids were also planted in a commercial grower's field west of Los Angeles on April 26. The month of June was cool at both locations, but temperatures increased at the end of the month and July was generally hot. Air pollutants (total oxidants) rose to high levels in late June and early July, and remained variably high throughout the month (graph 1). Oxidants were measured daily at the University of California Air Pollution Research Center, Riverside, and temperatures were recorded at a weather station about 200 yards from the planting area. From these records maximum daily levels were charted to show the conditions prevailing when damage occurred.

The appearance of water-soaked areas between the leaf veins was the first damage observed (July 3) at Riverside and new damage occurred on two subsequent occasions during the month of July. The first damage occurred as the earliest varieties were beginning to tassel. The water-soaked leaf areas (the initial symp-