S. endius which finally dominated the warmer and drier months (August to October). Laboratory experiments using differential temperatures indicated that final-stage larvae and adults of *S. endius* are more resistant, and demonstrate greater activity, at higher temperatures than *M. raptor.*

All parasite as well as fly activity was sharply reduced with the advent of very cold weather in the middle of November 1964. A simultaneous decline of the fly population in the same month cannot be correlated with parasite activity, but was probably also the result of the sudden drop in temperature to below freezing—mean minimum below 33° F. Subsequent recovery and tremendous build-up of this fly was shown in December 1964 and January 1965 when the mean minimum temperature rose to above 35° F.

During the warm part of the year, fly pupae and larvae were generally more numerous in the central portion of the Demler Ranch where manure was more moist than near the ranch periphery. Moisture favors *Fannia* development and it was in these moist areas of higher fly infestation that parasites were released.

Introduced wasps

Parasitized pupae were more prevalent in release areas than in check areas throughout the season (see graphs 1 and 2). As expected, increased parasitization of fly pupae corresponded with the release of introduced parasite species. For example, the build-up of *Muscidifurax raptor* in the check sections of the Demler Ranch did not begin until after June 1964, whereas a significant increase was noticeable in the release sites after April of that year. Also, the incidence of *Spelangia endius* in the check sections was low before July, whereas greater activity of this species was evident two months earlier in the release sites.

Ophyra larvae are predaceous upon the larvae of both *Fannia* and *Musca* species, and were particularly abundant on the Demler Ranch directly following large populations of *F. femoralis.* It was assumed that *O. leucostoma* was feeding mainly on larvae of *F. femoralis* since other suitable prey appeared to be largely absent. *O. leucostoma* will feed on *Fannia* spp. in the laboratory, but it apparently prefers larvae of *M. domestica* when these are available.

Parasitization of *Ophyra* at any time was well below 50%, and there was no appreciable increase noted in the parasite release sites. This was considered fortunate since these flies are beneficial as predators and therefore might well be favored in biological control.

Generalizations on parasites

Results of this study and those conducted at other fly breeding sites in southern California during the past three years on all principal species of dung inhabiting flies show that the three principal parasite species involved in natural control in this area are *Muscidifurax raptor*, *Spalangia endius*, and *Stilpnus anthomyidiperda.* Other species, as previously noted, occur at extremely low population densities over most of the year throughout this subtropical region.

Both *Muscidifurax raptor* and *Spalangia endius* at other sites demonstrate an activity similar to that shown in the present study, although the periods of activity are related to phenological events in each separate locality. For example, in the inland areas where mean temperatures are higher earlier in the year than on the coast, *S. endius* supplants *M. raptor* correspondingly earlier (apparently a climatic influence), the latter species preferring a more humid, cool season. The principal host species in the inland areas of southern California is *M. domestica* and parasitization never reaches the same high average as demonstrated with *Fannia* in the present study. The effectiveness of these two species appears proportional to the availability of host pupae in the breeding site—*M. domestica* pupae, which are generally found deeper in manure deposits than *Fannia* pupae, are not attacked to as high a degree. Modifications of poultry house construction and bird caging could help to enhance the effectiveness of these parasites against *Musca* by using a concrete base to eliminate pupation in the soil and disperse the droppings over a wider area. *Stilpnus anthomyidiperda* activity on *Fannia canicularis* appears to be restricted to the cool spring and late fall months, with parasitization figures often exceeding 90%.

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Water In

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Planting grain in furrows of strawberry fields counteracted compaction and increased water penetration in Riverside County tests. Adequate irrigation of the strawberries was maintained—along with frequent picking schedules—without holding water in the furrows for extended periods of time.

Furrows in strawberry fields are continually being compacted by foot traffic and the movement of machinery. With labor becoming scarce, the wider use of machinery will further increase the amount of traffic in each furrow. This surface compaction reduces water infiltration and can aggravate a salt problem.

Water infiltration rates decrease as the season progresses. Thus, the greatest demand for water by the plants comes at a time when the weather is hottest and water infiltration is slowest. Some growers cultivate before each irrigation to help increase infiltration. Leveling soil, shortening irrigation runs, and increasing the length of irrigation time are other methods used. However, with sloping runs, growers are reluctant to increase the length of irrigation time because of excess runoff.

Experiments aimed at increasing infiltration rates were conducted in a commercial strawberry field near Chino, San Bernardino County, during the 1964 and 1965 growing seasons. The first experiment was of a preliminary nature, while the second was more extensive in design.

1964 field test

About the middle of March, wheat of the Ramona variety was seeded at ½ lb per acre in randomly selected furrows 100 ft long. Both the planted furrows and

Penetration Strawberries *aided by seeding grain in furrows*

check furrows were lightly scraped with a hand cultivator. The wheat was killed with a directed oil spray after it reached a height of 6 to 7 inches about one month later.

Nine weeks later, water infiltration was determined by placing tube orifice plates at the top and bottom of each 100-ft treatment. The head loss at each plate was measured with an electric point gauge developed by B. L. Grover, formerly of the Citrus Research Center, U. C., Riverside. The difference in rate of water flow between the two plates, calculated as infiltration rate in cubic ft per minute per 100 ft of furrow, was .19 for the wheat-seeded furrows as compared with .14 for the bare furrows. These figures were averages of 10 replications. Readings were taken when the wheat straw was almost gone.

1965 field test

For the 1965 field tests, wheat was again seeded in furrows at the same rate used in the first experiment. A third treatment was added by cutting the wheat to keep its height below 6 inches. All treatments were duplicated in furrows, compacted and not compacted by tractor wheels. There were 5 replications of each variable.

The infiltration rates (see table) were determined by the same method used in 1964. The first reading was taken 30 days (May 21, 1965) after the grain had been killed or clipped. A second reading was obtained 26 days later (June 17).

In both readings, unplanted furrows absorbed significantly (1% level) less water than furrows with wheat killed with oil. In both readings, the furrows with live wheat absorbed significantly (1% level) more water than furrows with dead wheat. Regardless of treatment, all furrows absorbed significantly (1% level) less water in the second reading, as compared to the first reading. At neither reading were the compacted rows significantly different from those without compaction.

WATER INFILTRATION RATE IN CUBIC FEET PER MINUTE PER 100 FEET OF FURROW

	Not planted		Wheat killed		Wheat clipped	
	1*	2*	1*	2*	1*	2*
Reading I	.48a**	.38a	.66b	.59b	.86c	.67c
Reading II	.09d	.13d	.18e	.18e	.23f	.25f

1* Furrow without tractor wheel compaction.
2* Furrow with tractor wheel compaction.
** Means followed by a common letter are not significantly different.

Grain planted in furrows of strawberry fields proved beneficial in increasing water infiltration. In the first reading in 1965, infiltration rates were approximately 33% higher in furrows with wheat killed and 44% higher in furrows with live wheat, as compared with check furrows.

The ability to adequately irrigate strawberries without holding water in the furrows for extended periods of time is essential to maintain frequent picking schedules.

The grower-cooperator learned the advantages during the 1964 trials, and in 1965 planted all his furrows to wheat except in the experiment. He believes the practice aided his production materially although measurements of yield were not made during the experiment.

In the second reading, taken late in the strawberry season, the average of all infiltration measurements showed a 70% decrease compared to the first reading. This type of decrease with time generally occurs, and creates a problem for growers in the latter part of their harvest. However, compared with the check plot in the second reading, the infiltration rates were approximately 63% higher in furrows with wheat killed and 120% higher in furrows with live wheat. This improvement relative to the check is a big help late in the season, even though absolute values have diminished.

A difference between furrows with, and without, tractor wheel traffic had been anticipated, but there were no significant differences in this experiment. No effort was made to control foot traffic of pickers, which may have masked any differences from the presence or absence of wheel traffic.

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Checking water penetration in unplanted strawberry furrows as compared with furrows planted with grain, to left.