12TH ANNUAL ALMOND RESEARCH CONFERENCE, DECEMBER 4, 1984, SACRAMENTO

Project No. 84-E11 - Navel Orangeworm, Mite and Insect Research
Biological Control of Navel Orangeworm

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Objectives: To mass produce and establish natural enemies of navel orangeworm. To acquire additional natural enemies from abroad when the opportunity is presented.

Interpretive Summary:

The parasitic species, Trichogrammatoidea annulata, Goniozus sp. nr. emigratus, Goniozus legneri-strain #1, G. legneri-strain #2, were mass produced and disseminated throughout almond, walnut and date growing areas of California where two pests, navel orangeworm and carob moth, were present. Field recovery after releases was made of all species. Overwintering was recorded for all species except the 2nd strain of Goniozus legneri.

Orchards were sampled monthly from May through September. Recoveries of T. annulata were made in July and September at one out of three release orchards. Parasitism by Pentalitomastix plethorica introduced earlier, was present in all orchards. Goniozus legneri demonstrated the highest persentage parasitism, ranging from 35.2% to 59.0% of collected larvae. Evaluation of the impact of these parasites cannot presently be made accurately due to the thorough mummy-removal practiced in most experimental orchards. It is impossible to decide whether low rejects at harvest is due to parasites, sanitation or both. Thus, once the distribution of the current parasitic species is completed (probably by end of 1985), studies to allow greater numbers of mummied almonds in test orchards are planned. The aim would be to reduce control costs by allowing a greater number of mummies to remain in orchards over winter if parasites were capable of killing a significant number of the orangeworms developing therein. A typical pattern of gradually lower rejects exists since 1980 when new parasitic species were introduced, as shown by the following data from the Chowchilla area where only limited sanitation was practiced (no insecticides during the growing season):

Year	Total Nonpareil rejects
1980	10.53%
1981	4.71%
1982	3.34%
1983	0.61%
1984	0.85%

The carob moth, which was recently discovered widespread in California south of the Tehachapi Mountains, is currently being slated for biological control. Natural enemies specific to this insect are being considered for importation from India, Pakistan and Australia. There is some doubt about how long this insect has resided in the State, but reject data from date groves showing a steady increase in pink worms since 1981 points to a possible recent invasion. The probability that the carob moth will invade Central and Northern California almonds is great; however, the severity of the new pest in the north is still in doubt. High relative humidity in date groves and almonds overseas seems to favor a higher incidence of this pest. Parasites currently being imported for navel orangeworm are being established on carob moth in the south in an effort to slow its spread north.

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Biological Control of the Navel Orangeworm
A Progress Report to the Almond Board of California

by

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Work reported herein is being conducted under Agricultural Experiment Station Project 1983-H, and it is an integral part of Almond Board Project No. 84-E11: E. F. Legner and L. E. Caltagirone, Project Leaders

Report for the Period 1 April - 31 December 1984

During the period covered by this report the following personnel participated in the research indicated:

Denis W. Meals, Staff Research Associate: parasite mass culture, colonization, evaluation.

Mabel Fong, Staff Research Associate: host and parasite mass culture

Grace Loria: Laboratory Assistant: host mass culture.

Objectives

a) To mass culture the egg parasite Trichogrammatoidea annulata, and to colonize this and other natural enemies of the navel orangeworm in almond orchards.

b) To evaluate the impact of natural enemies on field populations of navel orangeworm.

Interpretive summary

The egg parasite Trichogrammatoidea annulata, from Argentina, was mass produced at UCB (Albany). Field releases by UCB personnel began in May and continued through September in the following orchards: Hennigan (Chico, Butte Co.), Crepps (Winters, Solano Co.), Burris (Ripon, San Joaquin Co.), and Jardine (Paso Robles, San Luis Obispo Co.). UCB personnel also released Goniozus legneri

in the Hennigan orchard, and Goniozus sp nr. emigratus in the Creppsorchard. These last two parasites were mass produced at UC Riverside. The total parasites released by UCB personnel were: Goniozus legneri 6200, Goniozus sp, nr. emigratus 7940, Trichogrammatoidea annulata 4620200; in addition 436800 T. annulata were sent to Riverside, and 1055400 to Parlier for release in those areas by UCR personnel.

The 4 orchards mentioned above were sampled monthly from May to October. Recoveries of T. annulata were made in May (29% parasitization), July (traces) and September (traces) in the Hennigan orchard. No recoveries of this parasite were recorded at the Crepps and Burris orchards, although it had been recovered (traces) in 1983. Goniozus legneri was recovered at the Burris, and Jardine orchards. At the Jardine orchard 59% of the navel orangeworm populations (larvae and pupae) was parasitized by G. legneri. Additionally, in the Burris orchard 76.3% of the larvae were parasitized by Pentalitomastix plethorica; this parasite has been increasing its activity in this orchard since 1980 when only 17% of the larvae were parasitized.

Experimental Procedure

Mass culture of Trichogrammatoidea annulata was done using eggs of the Mediterranean flour moth, Anagasta kuehniella, as hosts. Prior to parasitization the host eggs were glued on paper strips at densities that yielded ca. 3000 adult parasites/ sq. in. Field releases were done by placing 1 or 2 sq. in. pieces of paper containing parasitized eggs in screened plastic cups which were hung in threes. The adult parasites completed their development and emerged in the field. Goniozus legneri and Goniozus sp. nr. emigratus were released as adults.

These three species of parasites were released in the following four orchards by UC Berkeley personnel in 1984:

PARASITE	GROWER	LOCATION	COUNTY	NO. RELEASED	
Trichogrammatoidea annulata	Hennigan	Chico	Butte	1,813,400	
	Burris	Ripon	San Joaquin	991,200	
	Crepps	Winters	Solano	552,000	
	Jardine	Paso Robles	San Luis Obispo	1,263,600	
			TOTAL		4,620,200
Goniozus legneri	Hennigan	Chico	Butte	6,200	
Goniozus sp. nr. emigratus	Crepps	Winters	Solano	7,940	

These orchards were sampled monthly from May through October. Data were gathered on the effect of the above three parasites on navel orangeworm populations, as well as the impact of previously released natural enemies and various native parasites and predators.

In addition, T. annulata (as parasitized Meditarranean flour moth eggs) were sent to UC Riverside personnel for field releases. About 440,000 individuals were released in Riverside Co., 755,000 in Tulare Co., and 300,000 in Fresno Co.

Results and Discussion

In the 1983 season Trichogrammatoidea annulata was released for the first time in Chico. The parasite's activity was monitored on navel orangeworm eggs on standard egg traps; 79% of the eggs were parasitized. In 1984 the results were not nearly as encouraging. At the Hennigan orchard, Chico, 29% of the NOW eggs were parasitized in May, but in July and September only insignificant parasitization was noticed. No recoveries were made from the other three orchards, although small numbers were recovered from the Burris, and Crepps orchards in 1983.

It should be noted that Trichogramma californicum was also not abundant in 1984. This egg parasite, native to California, fluctuates in its population levels from year to year; parasitization varies from about 35% to negligible levels. The same may well prove to be the case with Trichogrammatoidea.

Goniozus legneri was recovered from the Burris and Jardine orchards. At the Jardine orchard 59% of the navel orangeworm population (larvae and pupae) was parasitized in the new crop prior to harvest. The Burris orchard showed 10.5% parasitization in late 1983; lower levels were recorded in 1984.

Goniozus sp. nr. emigratus was not recovered from the Crepps orchard.

In those orchards where in-season navel orangeworm sprays have been avoided the predominant parasite continues to be Pentalitomastix plethorica. Work with this natural enemy has centered in the Burris orchard, San Joaquin Co. since late 1979. Sampling at that time revealed a small resident population of P. plethorica, probably from releases made in the area in the early 1970s. A no in-season spray and early harvest program was initiated in 1979, thus allowing population of P. plethorica to increase and shortening the period of exposure of the new crop to NOW. Results are summarized below.

YEAR	EARLY HARVEST	AVERAGE PERCENT PARASITIZATION SPRING MONTHS	% REJECTS
1978	no	?	18.3
1979	no	?	7.6
1980	no	17	12.0
1981	yes	44.5	1.6
1982	yes	38.1	3.2
1983	---	24.5	no harvest
1984	yes	76.3	not available

These results strongly suggest an alternative program to control NOW populations: adopting practices, such as no insecticides during the season and early harves, that will result in increase of Pentalitomastix populations and shortening the exposure of the new crop to ovipositing NOW females.

Native parasites and predators continue to use navel orangeworm as a host at various times of the year, however, in general their numbers are low and their impact on NOW populations is so far minimal.

Future work

Releases of Trichogrammatoidea annulata wil start in the experimental orchards as soon as the first NOW eggs are detected this coming season. Goniozus will be released starting probably in early March 1985. Monitoring oa the NOW populations and those of its natural enemies will start with the first releases of natural enemies and will continue until the onset of winter.