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BIOLOGICAL CONTROL OF NAVEL ORANGEWORM

SEMI-ANNUAL REPORT

Jul 1 - Dec 31, 1983

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Objectives:

To control navel orangeworm (and carob moth) with new species of natural enemies imported from outside the State of California.

Interpretive Summary:

The parasite Goniozus legneri Gordh became established in every almond tree in which liberations were made in 1983, verifying the persistence of this species. This parasite also carried-over in orchards where releases were conducted in 1979, proving persistence over the years. Almond reject data from carry-over orchards, and in 1983 release orchards at Chico, Stockton, Ripon, Chowchilla, Wasco and Arvin areas varied between 4 and 8.5%, with ca. 2/3rds of the damage being caused by navel orangeworm, and most of the remainder by peach twig borer. There was a higher than usual percentage of rejects due to physiological causes (ca. 1% avg. from inadequate fruit set). One 40-year old orchard at Chico sustained a 30% reject, which can be explained by immigration from surrounding neglected orchards, as examination of almond mummies right after harvest showed an almost 100% parasitism of N.O.W. This orchard will not remain on the biological control program because of the influence of neighboring orchards where neither biological control, chemical control nor orchard mummy removal are adequately practiced. Orchards that used both biological control and mummy removal (less than 2 mummies remaining per tree), sustained the lowest rejects (under 1%).

Mass production of Goniozus legneri has been improved, and liberations facilitated by use of a filter paper liberation disc. Unlike gelatine capsules, these discs are simply tacked into the lower tree limbs where they will not blow away with the wind. This enables parasites to move at their own gait to other portions of the tree, and tends to retain most of them in the release orchard.

Another parasite, Goniozus sp. near emigratus, has been reacquired from South Texas, and will be mass produced for permanent establishment in California in 1984. Other tested species, Bracon brevicornis, Bracon gelechiae, Scambus simulator and Chelonus curvimaculatus, have thus far not been field recovered. A Diadegma nov. sp. from carob moth in South Australia has been detected in a Chico orchard, but culture was not attained.

Data was gathered during cool seasons (May and October) to measure the performance of Pentalitomastix plethorica, which will require further incubation for results.

New acquisitions of parasites from Australia and Flroida and Baja California are currently being tested in quarantine at Riverside. Mass liberations of all proven parasites will be emphasized in 1984 from a newly acquired production laboratory at the University of California Parlier Experiment Station.

Experimental Procedure:

The experimental procedure is similar to that begun in 1979 except that entire orchards instead of individual trees are being used for parasite establishment. New species of parasites will continue to be tested on individual trees until data shows that they merit widespread releases. Laboratory tests to improve parasite species involve producing hybrids from crosses between geographically distant strains. Studies are performed to test the effects of inbreeding and loss of alleles in culture. Parameters used to make judgements on a strain's fitness are the net reproductive rate, intrinsic rate of natural increase and longevity and sex ratio.

Results:

Preliminary tests with strains of Goniozus sp. nr. emigratus have shown expressions of hybrid vigor in the F-1 through F-3 generations of crosses between strains from geographically isolated portions of Texas and California. Practical advantages might be realized in biological control, where one strain is established in an orchard followed by the introduction of a second distinct strain. Succeeding generations may be expected to show compounded heterosis in their attack intensity against N.O.W. Crosses with a tropical strain of G. emigratus from Hawaii have thus far not been possible as the latter is uniparental, producing only adventitious ♂♂. The latter are used in crosses but are difficult to achieve. Treatment with 90°F. temperatures during critical developmental periods is being made as this has shown to produce ♂♂ from such uniparental organisms.

Prolonged culture studies comparing the reproductive potentials of cohorts of long-cultured and inbred stocks with recently reacquired wild stocks indicated the possible loss of some genotypes for high reproductive capacity in the long-cultured stock. Inbred clones derived from single ♀ mated to their ♂ offspring performed differently, suggesting separate genotypes. Some mechanism other than the single locus, multiple allele system for sex-determination was operative. The results indicated the importance of the founder effect in selection of stocks of parasitic insexts imported for biological control. Heterogeneity may be retained in culture by originally cloning separate individuals at importation time. Mixing such individuals in mass culture causes laboratory selection for a certain type adapted to laboratory conditions and a loss of wild-type alleles.

Private almond growers who have and are participating in the parasite distribution program are the following:

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(Mr. Richard Baldy)
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California State University
Chico, CA 95926

Clement, A. J. F.
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McFarland, CA 93250

Covalde Date Company
Mecca, CA

Dietrick, E. J.
6349 Riverside Ave.
Riverside, CA 92506

Dighiera, T. A.
4225 E. Kamm Ave.
Selma, CA 93662

Edelbacher, A.
17297 Ave. 16 1/2
Madera, CA 93637

Fisher, T. W.
34443 Fisher Lane
Hemet, CA 92343

Foster, A.
Superior Farming Co.
3501 Stockdale Hwy.
Bakersfield, CA 93309

Gaddie, R. L.
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Bakersfield, CA 93388

Gliddon, G.
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Gothilf, S.
Institute of Plant Protection
The Volcani Center
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Beit Dagan, ISRAEL

Jardine, W.
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Paso Robles, CA

Nottelmann, F. H.
Route 3, Box 60
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Rust, M.
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Kubo Orchards (L. Bowen)
54 S. Bear Creek Dr.
Merced, CA 95340

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1937 Beverly Dr.
Modesto, CA 95351

Selzer, W. R.
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Spalding, P.
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Arroyo Grande, CA 93420

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Zinke, H.
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California State Extension Participants in the parasite distribution program are the following:

Barnett, W. W.
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Curtis, C.
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Parlier, CA 93648

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Trinidad, CA 95570

Hendricks, L. C.
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Merced, CA 95340

Newhouse, W.
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McFarland, CA 93250

Rough, D.
Cooperative Extension
420 S. Wilson Way
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Parasites Distributed by Division of Biological Control Personnel:

Ojai Area, Ventura Co. (wild walnuts)

Paso Robles area, San Luis Obispo Co. (wild walnuts)

San Diego--Oceanside (carob trees and carob moth + N.O.W.)
San Diego Co.

Walnut area (wild walnuts)
Los Angeles Co.

Tracy area (domestic almonds)
San Joachin Co.

Porterville-Visalia area (backyard almonds)

U.C.R. campus (domestic almonds and wild walnuts)

Discussion:

Three species of parasites, Goniozus legneri, Goniozus sp. nr. emigratus and Diadegma nov. sp., have shown considerable promise in controlling N.O.W. Efforts to spread these parasites to all almond producing areas in California should be made. The already-established Pentalitomastix is at the stage where careful season-wide studies should reveal its role in N.O.W. regulation. Such information is desirable to enable an integration of other control methods, especially insecticide sprays. This parasite by persisting in orchards where broad-spectrum insecticides are used, probably contains considerable insecticide resistance. However, its maximum potential should be allowed to take effect without interference of sprays. Various other species of parasites tested have not yet shown the capacity to reproduce on N.O.W. in the field.

The carob moth has been collected throughout the southern 1/3rd of the State, but based on seasonwide sampling, has not been found north of the Tehachapi Mountains. The suspected origin of this insect in Australasia suggests that it requires a tropical and subtropical climate to exercise its maximum destructive potential. However, in Southwest Australia and Uruguay and Argentina, it occurs widespread, although in South America its interaction with native parasites (Goniozus legneri, Trichogrammatids and others in the family Ichneumonidae and Braconidae) keeps it to relative low numbers. Therefore, it could be expected to invade into the Central Valley of California eventually, unless the parasite introduction program in the south minimizes this threat.

There are additional species of natural enemies present on N.O.W. in South America which exert control pressure on this insect and the carob moth. Although comparatively low in abundance during sample periods, these species could be essential to the overall control. The species involved are Temelucha sp., Coccygonimus sp. Venturia canescens, Bracon sp., and Copidosoma sp. Their ultimate acquisition should be sought. Similarly, there are forces, probably biotic, maintaining carob moth at low densities in South Australia. Dr. E. R. Oatman will begin a 6-months survey in that area beginning January, 1984, while on sabbatical leave. Searches for carob moth are currently underway by Commonwealth Institute of Biological Control Personnel in Pakistan.

As inbreeding effects of acquired parasites has been shown experimentally, and heterosis between crosses of certain strains is possible, there will be some effort to use this knowledge to our advantage. Additional field acquisitions of parasites will allow for special cultural handling to minimize allele loss, and different strains will be mixed in the field to produce genetic improvement by heterosis.

Publications:

Legner, E. F. 1983. Influence of residual Nonpareil almond mummies on densities of the navel orangeworm and parasitization. J. Econ. Entomol. 76(3): 473-475.

Legner, E. F. & A. Silveira-Guido. 1983. Establishment of Goniozus emigratus and Goniozus legneri [Hym: Bethylidae] on navel orangeworm Amyelois transitella [Lep: Phycitidae] in California and biological control potential. Entomophaga 28(2): 97-106

Legner, E. F. 1983. Patterns of field diapause in the navel orangeworm (Lepidoptera: Phycitidae) and three imported parasites. Ann. Entomol. Soc. Amer. 76(3): 503-506.

Legner, E. F., G. Gordh, A. Silveira-Guido & M. E. Badgley. 1982. New larvicidal wasp to attempt control of navel orangeworm. Almond Facts 47(3): 56-58.

Legner, E. F., G. Gordh, A. Silveira-Guido & M. E. Badgley. 1982. New wasp may help control navel orangeworm. California Agriculture 38 (5-6): 1, 3-5.