January 20, 1987

Memo to: PEAR ZONE 1 PEAR GROWERS
P.O. Box 255383
Sacramento CA 95925

From: Louis A. Falcon, Project Leader

Subject: 1986 Progress report on research grant AES/CE Project No. 3855-RR, entitled: "Developing the codling moth granulosis virus"

SUMMARY OF ACTIVITIES AND RESULTS (by objectives)

Objective 1 - Complete the safety tests and obtain the registration of CMGV with USEPA and CDFA.

In collaboration with the Western Region IR4 Project and the Microbial Pesticide Development and Use Committee, funding was obtained from the California State Environmental License Plate Fund, via the California Department of Food and Agriculture, to help finance safety testing of the codling moth granulosis virus(CMGV). EPA registration is targeted for mid-1988. Our lab is providing the virus to be tested and will participate in doing bioassays, etc. We will maintain a reference CMGV and insect culture. The animal testing will be done under the direction of D. Brookes, Animal Resources Services, University of California, Davis.

Microgenesys, Inc., demonstrated the usefulness of its product Decyde(TM) on several acres of apple and pear in California and Washington. Included was the W. Hooper Bartlett pear orchard in Mendocino Co. Decyde contains the "Mexican-Berkeley" isolate of CMGV. We provided Microgenesys with the virus and technology to produce, process, formulate, field test and market CMGV.

Objective 2 - Continue to demonstrate the benefits of our "Improved Pest Management" approach at the Runyon and Dorsey Ranch, Courtland, CA.

As in the past at the Runyon and Dorsey Ranch, our CMGV based "Improved Pest Management" (CMGV/IPM) program resulted in yields and quality of fruit that were not significantly different than were found in the blocks under chemical pest management (Table1). The basic difference in 1986 from our program in previous years was that decisions to treat for pest control were made in cooperation with both the grower and the grower's pest control advisor. Also, on several occasions, sampling of fruit and foliage was done in conjunction with the grower's pest control advisor or the local Farm Advisor to help standardize procedures. From this

experience it was clear to us that our program can be easily carried out by growers in conjunction with the same people who are currently involved in other types of pest control programs.

Codling Moth Control -

1. Pheromone Traps:

Male codling moth flight activity was monitored with sex pheromone traps. In keeping with our objective of involving many segments of the agricultural community, Greg Vogel, Sacramento Co. Farm Advisor placed and maintained one trap in our 5 acre test block on March 27. On March 25, Jim Dahlberg, a private pest control advisor, placed and maintained traps in several blocks maintained under chemical pest management. All traps showed increased male flight in mid-April. By April 16, the trap in the CMGV/IPM test plot had accumulated 100 moths, and the trap in the adjacent chemical block("A" block) had accumulated 89 moths indicating high codling moth pressure in the orchard prior to the first cover spray. Season total moth catches were 204 in "A" block (Dahlberg) and 245 (Vogel, estimated).

2. Application Timing:

The pheromone traps indicated the likely presence of enough female moths to require treatment. Appropriate conditions for mating and egglaying (sunset temperatures 60 degrees F or higher) occurred on March 18. The actual timing of the first codling moth application in the CMGV test block was determined by the use of the codling moth computer model, BUGOFF2(see Appendix). The model was started on March 18. An automated weather monitoring system (AWMS), as described in our report to Pearzone of December 28, 1985, fed hourly temperature (from which we were able to determine temperature at sunset) and wetness data to the main-frame computer at U.C. Berkeley where a new program written in our lab used the data to automatically run BUGOFF2. A weekly update of the BUGOFF2 output was sent to a local computer at the test site for use by the grower and others. According to BUGOFF2, the appropriate timing of the first application was between April 14 and April 17. Following our standard method, applications of CMGV were made every 7 days until the egg hatch of the Spring generation was covered. The BUGOFF2 output in the Appendix indicates the application dates with the letter "V".

3. Conclusion:

No damage by codling moth was detected in the packing shed. Codling moth population pressure was high. The protection of the fruit was accomplished with 5 applications (as compared to 8 in 1985) of CMGV: 4 applications of 15 ml/acre

each (half the usual dosage) were made against the first generation of larvae (Table 2). 1 application of 30 ml/acre was made against the second generation larval generation. We used BUGOFF2 to predict that, given the early ripeness of the fruit and the relatively cool summer in 1986, only one treatment would be necessary before harvest. One advantage of CMGV is that had it been necessary to continue applications, we could have done so through harvest without any waiting or reentry periods. Harvest and packout data are shown in Table 1.

The total dosage of CMGV applied for the 1986 season was 120 ml per acre. In 1985, 280 ml per acre per season were used. This experience at the R & D Ranch has not only re-confirmed our confidence in the ability of CMGV to control codling moth, but has demonstrated to us that more research is required to determine the minimum dosage of CMGV necessary to achieve control. We also continued to demonstrate that BUGOFF2 is sufficiently sensitive to fluctuations in seasonal temperature patterns to allow it to be used to good advantage.

The cost for pest control was $208/acre in the CMGV/IPM block (Table 2) compared to $267/acre for the chemical treated block (Table 3). Also, 14 applications were made in the CMGV/IPM block compared to 12 in the chemical block.

Other pests -

Pear scab and pear rust mite were the only other pests found. Sulfur was used to control both pests. The sulfur controlled the rust mite well. Scab proved to be more difficult to control, but damage at harvest was very low. The sulfur product used was Thiolux, a brand of micronized, wettable sulfur. This product "burned" fruit in spite of precautions to use in only in cool weather, and was the single greatest factor in reducing the amount of packable fruit. In 1987, we will attempt to control rust mite and scab by applying lime-sulfur 2 or 3 times during the period between green-tip and bloom.

Objective 3 - Establish "IPM" demonstration-study plots at 2 other Bartlett pear orchards in the Courtland area.

1. Steamboat Orchards -

Plots were established in an area immediately adjacent to the Steamboat Slough levee in the s.w. corner of the orchard. The block contained approximately 976 pear trees (Bartlett and Bosc) in 2.7 acres. The block was monitored for codling moth activity, other pests, and for beneficial species to obtain background information in preparation for

conversion to our "Improved Pest Management" program. The block was also used for a frost/fireblight control test (in conjunction with S.E. Lindow) using non-ice nucleating bacteria (native, non-engineered variety). A preliminary, non-randomized, small block test of the necessity of using Stop Drop (NAA) was also conducted.

A. Codling Moth Control:

Male codling moth flight activity was monitored with pheromone traps placed and serviced by Jim Dahlberg, a private pest control advisor. Temperatures were monitored with an AWMS station purchased and installed by Steamboat Orchards. The hourly data were uploaded to the U.C. Berkeley mainframe computer in the manner already described. Summaries of the output from this station can be found in the Appendix.

8 moths were caught in the test plot during 1986 (only 2 moths caught prior to harvest). This is an insufficient number of moths to have warranted treatment for codling moth control.

B. Frost/fireblight plots:

On March 7, 1986, personnel from Dr. Falcon's lab sprayed non-ice nucleating bacteria on 4 blocks of 16 trees each (ca. 0.17 acres). A steady rain began 1 hour after application. Periodic samples of buds, flowers, leaves and small fruit were taken for analysis to Lindow's lab at Berkeley.

Neither frost nor fireblight occurred in 1986. However, from the samples taken to the laboratory for analysis Dr. Lindow was able to make the following observations: 1) Non-ice nucleating bacteria survived in great numbers. They survived both drift of Terramycin/Streptomycin and 2 weeks of steady rain. 2) These bacteria were present in high enough numbers to have competitively displaced Erwinia amylovora, the fireblight bacterium. 3) Buds taken from sprayed trees showed good frost tolerance in lab studies. For full details on this test see S.E. Lindow's report to Pearzone for 1986.

C. NAA:

The results of the preliminary test of the necessity of using NAA were inconclusive.

2. Elliot Ranch -

A 3 acre, flood irrigated block of Bartlett pear trees was selected for use as an "IPM" demonstration plot. Our

role in this plot for the first year was limited to sampling for pest and beneficial species in preparation for eventual conversion of the plot to our "IPM" program.

The plot was begun late in the season (May 15) and the immediate problem was a heavy and intractable population of pear psylla. First samples indicated that the population was made up almost entirely of nymphs. Under these circumstances, it was important to expose the nymphs by removing the "honey-dew" in which they lived. With this in mind, the grower applied 500 gals of water per acre plus surfactant (Kleen-Aid). This was followed within 3 days by Volck Supreme oil. This combination provided good knock-down of the psylla. Oil treatments were needed to maintain control. Pear and bean aphids were the only other pests found in large numbers in the plot.

Codling moth control was not needed in the demonstration plot. The Elliot Ranch purchased and had installed an AWMS station which became part of the network of stations uploading hourly temperature, wetness and wind data to Berkeley. Output from this station is included in the Appendix.

Comments on the Automatic Weather Monitoring System (AWMS) stations.

Accurate and timely weather data are essential to good pest management, and to pest management research (in addition to the 3 stations in the Sacramento River area, we have included in the Appendix weather data output from 2 additional pear stations). For this reason we continued to support the 7 AWMS stations currently operating in pear orchards. Pearzone specifically removed from our grant in 1986 all funds for support and continued development of the AWMS stations. This places us in a dilemma. In the future, we can only justify supporting those stations operating at our research sites and those only for the time we are actually conducting research. To support a station means paying computer costs, trouble-shooting, updating software programs, testing new probes, installing new technology, etc. In any event, we obviously cannot support all the stations indefinitely. And yet, the importance of these stations (and others that may follow) cannot be overestimated. This in a sense is a positive situation because it offers Pearzone the opportunity to decide whether or not it, in some way, should and will offer this weather monitoring and information service as a service to its member growers. We strongly believe that the AWMS or AWAAX system is the most useful (and least expensive) system currently available and would urge that Pearzone carefully consider its position and the needs of its members.

Table 1.

Runyon and Dorsey Orchard 1986
Pear Harvest Summary

Treatment-Sample[1] Type		% codling moth damage	% fruit with live larvae	% packout[4]
CMGV/IPM	cut[2]	4.60	0	
CMGV/IPM	uncut[3]	0.44	0	
USDA		0	0	25.9 (30.1)
Chemical	cut	1.00	0	
Chemical	uncut	0.13	0.06	
USDA		0	0	36.7

1. Harvest sample on July 18, 1986.
2. 400 fruit per treatment all cut open.
3. 1600 fruit per treatment examined and cut only if codling moth suspected.
4. Fruit examined in the orchard showed 17% damage by sulfur which was not used in the chemical blocks. The number in parenthesis is the estimated % packout when sulfur burn was factored out as the sole cause of downgrading.

Table 2.

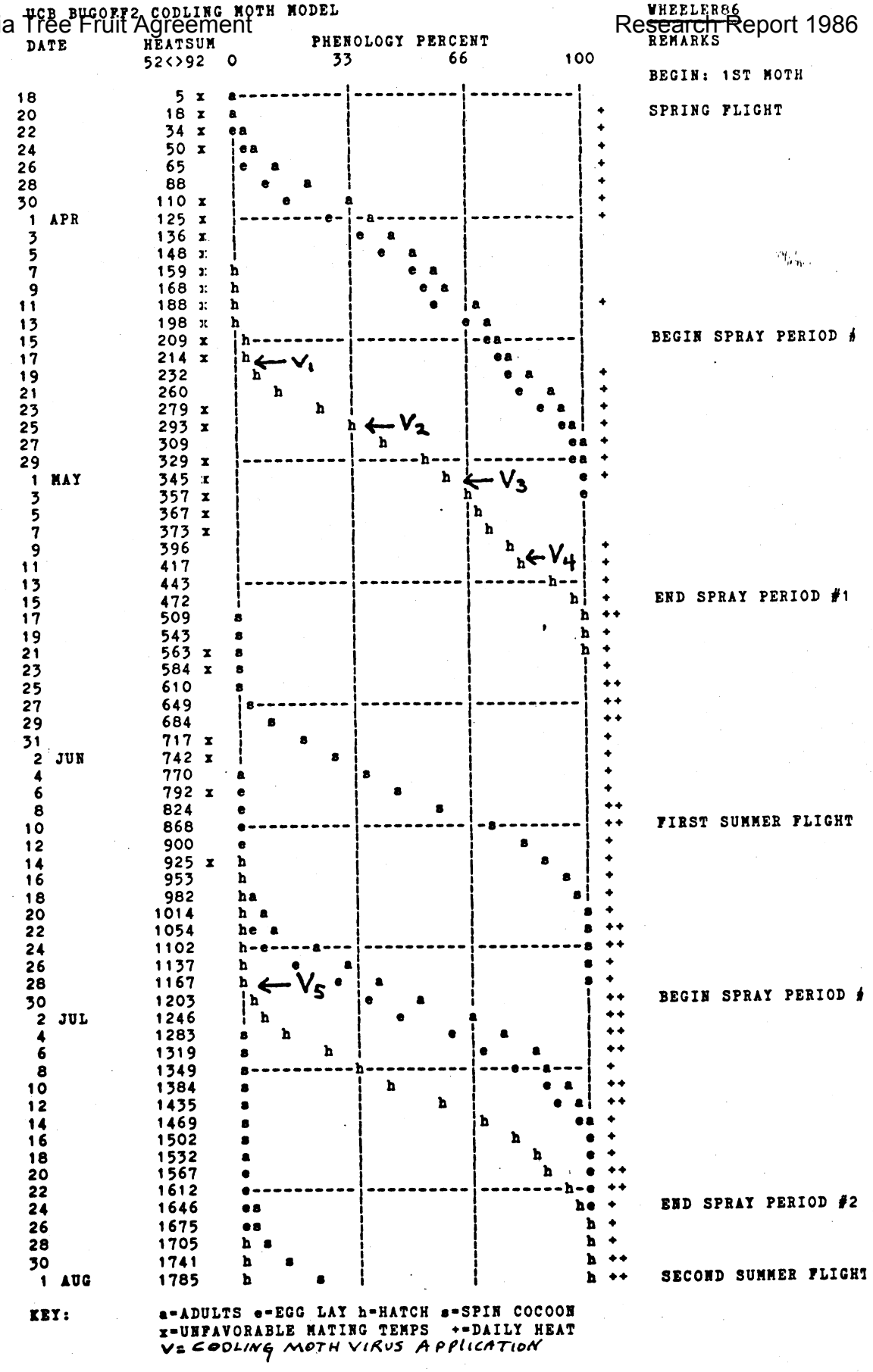
MATERIAL APPLIED TO CMGV - IPM BLOCK, R&D ORCHARD, 1986.

Date	Material	Dosage	Target	Cost/acre
12/20	Volck oil	8 gal		$23.20
2/5	lime-sulfur	4 gal	scab, rust mite	24.00
3/7	Terramycin	0.5 lb	fireblight	3.70
3/11	Terramycin	0.5 lb	fireblight	3.70
3/21	Terramycin	0.5 lb	fireblight	3.70
4/4	Terramycin	0.5 lb	fireblight	3.70
4/18	CMGV	15 ml	codling moth	12.00
	Thiolux(sulfur)	5 lb	rm, scab	5.00
	X -77	378 ml		1.65
4/25	CMGV	15 ml	codling moth	12.00
	Thiolux	5 lb	rm, scab	5.00
	X-77	378 ml		1.65
5/2	CMGV	15 ml	codling moth	12.00
	X-77	378 ml		1.65
5/9	CMGV	15 ml	codling moth	12.00
	Volck oil	1.5 gal	pear psylla	4.35
6/4	Thiolux	7.5 lbs	scab	7.50
	Soap	1 gal	scab	15.00
6/27	CMGV	30 ml	codling moth	24.00
	Volck oil	1.5 gal		4.35
8/12	Volck oil	4 gal	pear psylla	11.60
9/12	Volck oil	4 gal	pear psylla	11.60
		Total cost of materials		$208.63
		Cost of 14 applications @ 11.00 each		$154.00
		Total material and application costs		$362.00

Table 3.

MATERIALS APPLIED TO CHEMICAL BLOCK, R&D ORCHARD, 1986.[1]

Date	Material	Dosage	Target	Cost/acre
12/20	Volck oil	8 gal		$23.20
3/3	Pydrin	12 oz.	pear psylla	17.00
	Carzol	1 lb.	rust mite	25.00
3/7	Terramycin	0.5 lb	fireblight	3.70
3/11	Terramycin	0.5 lb	fireblight	3.70
3/17	COCS dust	20 lb	fireblight	5.40
3/21	Terramycin	0.5 lb	fireblight	3.70
4/4	Terramycin	0.5 lb	fireblight	3.70
4/17	Guthion 50%	2.5 lb.	codling moth	20.00
	Plictran	1.5 lb.	mites	34.50
	Terramycin	0.5 lb	fireblight	3.70
5/16	Imidan 50%	4 lb.	codling moth	14.00
	Volck oil	4 gal.	pear psylla	11.60
6/20	Guthion 50%	2.5 lb	codling moth	20.00
	Plictran	1.5 lb	mites	34.50
	NAA 800	4.0 oz	stop drop	1.75
8/12	Volck oil	4.0 gal	pear psylla	11.60
9/9	Thiodan 33.7%	85 oz	pear psylla	21.38
	Kleen Aid	80 oz	pear psylla	9.38
	Total costs of materials			$267.81
	Cost of 12 applications @ $11.00 each			$132.00
	Cost of materials and applications			$399.81


UCB BUGOFF2 CODLING MOTH MODEL
WHEELER86
DATE
HEATSUM
52<>92
PHENOLOGY PERCENT
0
33
66
100
REMARKS
BEGIN: 1ST MOTH
SPRING FLIGHT
BEGIN SPRAY PERIOD #
END SPRAY PERIOD #1
FIRST SUMMER FLIGHT
BEGIN SPRAY PERIOD #
END SPRAY PERIOD #2
SECOND SUMMER FLIGHT
V1
V2
V3
V4
V5
KEY: a=ADULTS e=EGG LAY h=HATCH s=SPIN COCOON
x=UNFAVORABLE MATING TEMPS +=DAILY HEAT
V=CODLING MOTH VIRUS APPLICATION