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ANNUAL REPORT--1987

Project No. 87-C10--Insect and Mite Research Insect Monitoring

Project Leaders:	Dr. Frank Zalom	Dr. Robert Van Steenwyk
	Cooperative Extension	Cooperative Extension
	IPM Implementation Group	28 Giannini Hall
	University of Califonria	University of California
	Davis, CA 95616	Berkeley, CA 994720
	(916) 752-8350	(415) 642-5565

Cooperators: W. Bentley, J. Connell, R. Coviello, J. Edstrom, M. Freeman, J. Hasey, L. Hendricks, W. Krueger, W. Reil.

Objectives: (1) Monitor levels of navel orangeworm, peach twig borer, San Jose scale and oriental fruitmoth in impacted growing areas of the state on an ongoing basis in order to develop and/or refine phenology models. (2) Make information available to growers in a timely manner through local Cooperative Extension Farm Advisors. (3) Summarize flight activity data on a yearly basis in relation to degree-days. (4) Compare efficacy of commercially available traps and lures for peach twig borer. (5) Test the field version of the completed navel orangeworm model against past and current orangeworm monitoring data.

Additional Work on Almonds: Tested efficacy of the parasitic nematode *Neoaplectana carpocapsae* against navel orangeworm and peach twig borer in the dormant season, and against navel orangeworm during the season:

Funding:		
	Almond Board	$ 2260
	Other sources	$11090

RESULTS:

Population Monitoring: Pheromone traps were provided to eight Cooperative Extension Farm Advisors in seven counties. The total number of traps and lures purchased for their use was 100 NOW traps and bait, 75 wing style traps, 200 wing style trap liners, 100 tent traps, 600 PTB lures, 200 SJS lures, and 25 OFM lures.

The data obtained by the Advisors will be summarized using the UC "Trap Counts" program, and will become a part of our database on the phenology of these pests. These summaries appear as an appendix to this report.

Pheromone Lure and Trap Efficiency: Several companies are marketing lures for peach twig borer and oriental fruit moth (Table 1). Further, several trap designs are being marketed for "small moths." Most growers and PCA's currently use Zoecon lures and Zoecon wing-style traps for these insects, and most of the University's research data has been based on these lures.

Tests were conducted on peach twig borer in 1986 and both peach twig borer and oriental fruit moth in 1987 to compare lures and commercially available traps to each other and to the standard Zoecon lure and wing trap.

Peach twig borer lures tested in 1987 included commercial ones from Biolure, Hercon, Scentry, and Zoecon. In addition, a new wafer design from Scentry was included. Each lure was placed in an orchard in a randomized complete block which was replicated four times. A second Zoecon lure was placed in each block one week later. The lures were rerandomized within each block following each sampling date. Once a week new Zoecon lures replaced the previous weeks new Zoecon lures. Actual trap counts were converted to mean proportion of total adults caught per trap to standardize counts across weeks. An arc sine transformation was performed prior to analysis. The lures from the first trial remained in the orchard for seven weeks. All lures except the Biolure were replaced after the seventh week sample, and the trial was continued for eight additional weeks. The original Biolure was permitted to remain in the orchard for the additional eight weeks, however, a new Biolure treatment was added after the seventh week sample.

The results from the first trial (Figure 1) showed that there was no difference (P=8846; F=0.28) between lures after one week. After two weeks, the number of moths caught in the Biolure baited traps were significantly higher than those in all other traps. For the third week and thereafter, moth catches in the Biolure baited traps were equivalent to those observed from the new Zoecon lures. The Hercon, Scentry, Scentry wafer and Zoecon lures performed similarly in all weeks of the trial. Mean separations of moth catches on each week are presented in Table 2.

The results from the second trial (Figure 2) showed that, in general, the Hercon, Scentry, Scentry wafer, and Zoecon lures performed similarly in all weeks of the trial. The new Biolure caught more moths than the new Zoecon lure and all others in the second week of the trial, and moth catches remained similar to a new Zoecon lure throughout all eight weeks. The seven week old Biolure caught the same number of moths as the new Zoecon lure in weeks eight through fifteen of its trial.

The results of these trials will lead to different conclusions depending on what the observer was asking of a specific lure. Further, there is no way of assuring that the same results would be obtained in subsequent years.

Some crude generalities that I have made in assessing these results include:

Biolure--The Biolure caught a greater proportion of moths in the second week of its exposure in each trial than did the other lures, although most lures caught equivalent numbers in the first week of each trial. It has been observed that, in general, more moths are attracted to a lure in the first week of exposure than in subsequent weeks, and that appears to be the case in this trial for all lures except the Biolure which appears to do the same for two weeks. This can be both an advantage and a disadvantage. If an individual wished to trap the first moth of a flight (when densities are lower) a more attractive lure would be advantageous.

It was interesting to note that the Biolure caught as many moths as a new Zoecon lure for at least eight weeks in one trial and fifteen weeks in another.

Hercon--The Hercon lure performed similarly to a new Zoecon lure for five weeks in the first trial and for only three weeks (with the exception of week 4) in the second trial. In 1986, our results also showed that the Hercon lure performed similarly to a new Zoecon lure for five weeks. In neither 1987 trial did the Hercon lure significantly outperform the Scentry, Scentry wafer, or Zoecon lure in terms of moth catch.

Scentry--Both Scentry lures performed similarly to the Hercon and Zoecon lures in terms of moth catch. The Scentry septa lure performed similarly to a new Zoecon lure for five weeks (with the exception of week 3) in the first trial, and for only 3 weeks in the second trial. In 1986, the Scentry septa performed similarly to a new Zoecon lure for only 2 weeks, but performed similarly to a Zoecon lure in terms of moth catch. The Scentry wafer lure is not commercially available.

Zoecon--The Zoecon lure performed similarly to Hercon, Scentry, and Scentry wafer in terms of moth catch. The Zoecon lure caught as many moths as a new Zoecon lure for five weeks in the first trial and for three weeks in the second trial. It only performed as well as a new Zoecon lure for two weeks in 1986.

Oriental fruit moth lures tested in 1987 included commercial ones from Biolure, Scentry and Zoecon. In addition, a new wafer design from Scentry and a Hercon wafer (not available comestically) were included. The experimental design was identical to that previously described in the peach twig borer lure comparison.

The results of this test (Figure 3) showed that the Biolure caught significantly more moths than did the other lures including the new Zoecon lures for the first three weeks with no significant difference between the other lures (Table 4). In weeks 4 through 6 of the trial there was no significant difference between any of the lures. In weeks 7 through 9, the Scentry and Zoecon lures performed similarly and better, although not always significantly better, than the other lures. When compared to a new Zoecon lure, all performed similarly after week 3 except for Hercon in week 4, Biolure in week 5, and Scentry in weeks 7 through 9 which were significantly better.

As was the case for PTB, the high moth catches in the Biolure traps for an extended period after placement can be advantageous or disadvantageous. More moths caught would possibly permit the first moth to be trapped sooner, however, there would be less consistency in trap catch over a period of time. This is especially true of the OFM Biolure in contrast to the PTB Biolure. In general, all OFM lures tested appeared to be fairly equivalent except for the Biolure. No trial was conducted in 1986, therefore it is not possible to draw meaningful conclusions from this trial.

Commercial efficiency for both peach twig borer and oriental fruit moth was tested in a similar manner to the lure comparison. Traps included a Zoecon wing, Hercon wing, Pherocon II, Delta, Multipher (with vapona as killing agent), and Multipher (with soapy water as killing agent) for both species. Additionally, a red Biolure wing trap was tested for OFM. All traps contained a Zoecon lure changed every two weeks for PTB and every six weeks for OFM. The traps were checked twice a week for eight weeks (peach twig borer) and twelve weeks (OFM). Analysis was performed as for the lure experiment except that the results from each date were combined and analyzed across weeks.

The results of this study show that the Delta, Hercon, and Zoecon wing traps were significantly better than the other traps in catching peach twig borers (Table 5). These results are similar to those obtained in 1986 except that the Delta trap in that year was ranked third and caught significantly fewer moths than the two wing traps. The results also show that the Multipher trap with vapona caught significantly more oriental fruit moths than did the other traps (Table 6).

Navel Orangeworm Model Testing: A considerable amount of work has been done in the last decade by Dr. Martin Barnes and his students to determine the developmental rate of navel orangeworm, and to develop a degree-day phenology model for the insect. A modelling effort has also been conducted by Dr. Keith Oddson to develop a more detailed simulation. Concurrently, work has been done by several Cooperative Extension Farm Advisors and Specialists to confirm the research that has been conducted by the aforementioned researchers.

In 1985, Dr. Gary Smith of the UC IPM Project began to work with all of these individuals to try to determine which elements of the various efforts could have utility in predicting moth flights and navel orangeworm development.

Basically, five different approaches have evolved. Four involve degree-day approximations of development and a fifth utilizes developmental rate data developed by Dr. John Sanderson directly in determining navel orangeworm development.

The basic differences in the degree-day models are the way upper thresholds are considered, either using a vertical cutoff or a horizontal cutoff, and whether or not overlap in generations are considered, either a deterministic model or a stochastic model. Vertical degree-day cutoffs assume no development occurs when temperatures exceed some upper developmental threshold (see Figure 4). Horizontal degree-day cutoffs assume constant development when temperatures exceed some upper developmental threshold (see Figure 4). Both of these methods are considered linear approximations because they do not consider the exact developmental pattern of the insect in relation to temperature but instead provide an approximation of the pattern.

Within a population, genetic diversity can be observed in the developmental time of insects. Because of the range of developmental time inherent in a population, a certain amount of overlap occurs in subsequent generations to the first. This overlap often results in increasing difficulty in discerning population cycles. Most degree-day phenology models used to monitor pests are strictly deterministic. That is the beginning of one generation to the beginning of the next generation is assumed to be constant, and the emergence pattern is assumed to follow a normal distribution. The use of such models is a matter of convenience. Adding a stochastic element to account for different population distribution patterns should improve the ability to predict events, but it also complicates the calculation of the predictions.

The four degree-day models tested consisted of 1) a vertical deterministic model, 2) a vertical stochastic model, 3) a horizontal deterministic model, and 4) a horizontal stochastic model. In both vertical threshold models, thresholds used were 55 and 94 degrees Farenheit. Developmental time (DD) on mummy nuts totaled 623 while developmental time (DD) on green nuts totaled 425. In both horizontal threshold models, developmental threshold used were also 55 and 94 degrees Farenheit. In this case, developmental time (DD) on mummy nuts totaled 1000 while developmental time (DD) on green nuts totaled 675. The stochastic parameter for both variations assumed a developmental rate so that 4% of the population completed development before 85% of the total degree-days in a generation had elapsed. This parameter was derived by Dr. Smith from Sanderson's thesis.

The fifth model uses the navel orangeworm developmental data determined by Dr. Sanderson for mummy nuts and green nuts directly (Figure 5). This method divides a sine wave drawn through the maximum and minimum temperature on a given day into 24 hourly increments. The temperatue on each hour is related to the percentage development which would occur at that temperature. The percentage development for each hour is summed over the day, and the daily percentage development is summed until 100% development occurs (the length of one navel orangeworm) generation. Using developmental rate information directly in this manner is a nonlinear approach, therefore it is less convenient to utilize than a strictly deterministic degree-day approach. In theory, this method should be quite accurate assuming the developmental rate curve developed is accurate.

Egg trap counts taken by Farm Advisors in 10 counties (Kern, Tulare, Merced, Madera, Fresno, San Joaquin, Yolo, Colusa, Butte, and Sutter) since 1978 were used in testing the 5 methods of predicting moth flights. Only data sets which had complete trap records, nearby weather records, and hullsplit date (to determine development on mummy and green nuts) were used. In all, 36 data sets met these criteria.

For each orchard data set, the date of initiation of the first generation flight and the initiation of the second generation flight was predicted for each method. These observations are plotted on Figures 6 through 15. The line on each graph corresponds to the forced regression of the points through the origin. The assumption is that a slope of 1000 would indicate a perfect prediction of the observed initiation of each flight. The spread of points about the line would indicate how much variation there would be in a given prediction using the model indicated. Table 7 gives the slope of the forced regressions for each of the methods.

Results of this study would indicate that all of the methods do an excellent job on average of predicting the initiation of the first generation flight and the second generation flight. As expected, however, the spread of the first generation flight is less than the spread of the second generation flight, probably due to overlap of generations. The spread of the data about the regression line is least when using the nonlinear method, but is roughly equivalent when using any of the linear methods.

The UC IPM IMPACT computer system permits the calculation of degree-days using either a vertical or a horizontal cutoff, and either method may be used given the parameters for developmental thresholds and time presented previously. A program for the nonlinear method is also on the UC IPM Prime computer, but is not currently accessible. If programming resources can be diverted from other projects, we hope to make the program available to UC Farm Advisors on the Prime and on IBM compatible microprocessors for testing next year.

Parasitic nematode efficacy: Studies were conducted in Merced County to determine the efficacy of the parasitic nematode *Neoaplectana carpocapsae* against the peach twig borer and the navel orangeworm in the dormant season, and against the navel orangeworm at hullsplit.

Individuals involved in this study included Lonnie Hendricks, Cooperative Extension Farm Advisor, Merced; Jim Lingren, USDA Entomologist, Fresno; and Fernando Agudelo-Silva, BIOSIS, Palo Alto. Scientific Methods, Inc., Chico assisted in cracking nuts and evaluating damage, and independently conducted a test of the nematodes at hullsplit.

Dormant Sprays--

Efficacy of nematodes against navel orangeworms in the dormant season was conducted in a commercial orchard near Le Grand in Merced County. Treatments included 1.5 million *N. carpocapsae* per tree and 3 million *N. carpocapsae* per tree in 100 gallons of water applied with an orchard sprayer, 3 million *N. carpocapsae* per tree in 100 gallons of water applied to 20 trees by helicopter, and an untreated control. Each treatment was replicated four times. Applications were made on 13 January, 1987. WHAT WAS WEATHER?

Mummy nuts (100 per treatment) were collected three weeks after the treatment and cracked to determine mortality. No significant difference was detected between the untreated control plots and any of the nematode treatments.

Efficacy of *N. carpocapsae* for dormant season control of peach twig borer was tested in a 2 year old almond orchard near Cortez, Merced Co. Treatments consisted of diazinon, 0.5 million *N. carpocapsae* and 1.5 million *N. carpocapsae*, applied in 15 gallons of water at 90-105 psi with a handgun sprayer, and a water check. Each one tree treatment was replicated in 19 complete block. Treatments were applied in clear, mild weather on 20 January, 1987.

Each treatment tree was evaluated on 27 March, 1987 for total number of twig strikes. Trees treated with the standard diazinon dormant treatment had the fewest twig strikes (Table 9) although the trees treated with both rates of nematodes had significantly ($P>0.05$; DMRT) on fewer twig strikes than the untreated check.

Hull Split Spray--

The trial was conducted on a solid planting of Le Grand variety almond trees. Hullsplit occurred on 25-26 July, 1987. Treatments consisted of Guthion at a dosage rate of 2 lbs. A.I/acre plus Vendex on 3 August, 1987.

N. carpocapsae at a rate of 3 million per tree on 8/6/87, *N. carpocapsae* at a rate of 5 million per tree on 8/6/87, *N. carpocapsae* at a rate of 3 million per tree on 8/11/87, *N. carpocapsae* at a rate of 5 million per tree on 8/11/87 and an untreated control. All materials were applied in 100 gallons per acre of water using an orchard sprayer. Each treated plot was 1/2 acre in size. Each treatment was included in a randomized block and replicated 5 times across the orchard. On 25 August, 1987, nuts were knocked from the 5 center trees in each treatment onto tarps laid under the trees. The nuts were placed into bags and returned to Davis and to Chico where they were kept in cold storage until cracking. A sample of 200 nuts was cracked from each of the 5 trees in each treatment. The number of small larvae, large larvae, pupae, and NOW damaged kernals recorded. The grower harvested the plot on 3 September, 1987, by shaking the nuts to the ground. Five 200 nut samples were gathered from the center of each plot and placed into bags. The nuts were then cracked and evaluaded as on the previous date. Mean number of each navel orangeworm developmental stage and of kernal damage was determined for each treatment, and means were separated by Duncan's multiple range test.

Means for the treatments on the 2 sampling dates are presented in Tables 10 and 11. As expected, fewer navel orangeworms and less damage were observed in the 25 August harvest than the 3 September harvest.

No significant difference (P>0.05) was observed between any of the treatments and the untreated control for any of the variables measured from the 28 August harvest, however, there were some interesting trends which might indicate that the nematodes affected the navel orangeworm populations. Both the early and late nematode applications at the 5 million per tree rate were similar to Guthion with respect to small larvae (4.4±3.2, 7.0±1.4; 5.6±5.1), large larvae (10.2±10.6, 11.2±7.5, 9.6±10.9), and kernal damage (17.4±8.6, 26.0±12.5, 24.2±19.7) per 1000 nut sample (Table 10). All of these treatment and variable combinations were lower than those observed for the early and late nematode applications at the 3 million per tree rate and the untreated control. More pupae were found in the Guthion (7.2±4.9) and the untreated control (6.0±3.5) treatments than in the early and late nematode treatments at the 3 million per tree rate (4.0±3.7, 5.6±7.4) and the 5 million per tree rate (2.4±1.8, 3.2±2.7). While not significant (P>0.05), it is possible that these pupae were small larvae at the time treatments were applied and that the nematodes inherant mobility permitted enhanced control at that time.

No significant difference (P>0.05) was observed between any of the treatments and the untreated control for any of the variables measured from the 3 September harvest except kernal damage. Mean Kernal damage in the Guthion treatment and the later nematode treatment at the 5 million nematode per tree rate were both significantly (P<0.05) lower than mean kernal damage in the untreated control treatment (Table 12). The earlier nematode treatment at the 5 million nematode per tree rate was not significantly different (P>0.05) from either the untreated control or the Guthion treatments. The trends in numbers of small larvae in the various treatments (Table 11) generally followed the patterns observed in the 25 August harvest, with both application timings at the 5 million nematode per tree rate and the Guthion treatment being lower (although not significantly ($P>0.05$)) than the untreated control treatment and both nematode treatments at the 3 million per tree rate.

Conclusion.

The results of the dormant applications of N. carpocapsae for control of navel orangeworm and peach twig borer were disappointing. Although N. carpocapsae applications did reduce the number of twig strikes, it is unlikely that this will be a substitute for standard dormant spray materials.

The results of the hullsplit trial were encouraging. The nematode treatments at the 5 million per tree rate tended to be comparable to Guthion and better than, although not significantly different from the untreated control treatment. In fact, kernal damage in one of the two 5 million nematode per tree treatments in the late harvest was equivalent to that of Guthion and significantly better ($P<0.05$) than the untreated control treatment. It is possible that had the experimental design included more replicates or had there been a greater navel orangeworm infestation in relation to crop size, our results might have been less ambiguous. It is also possible that the plot size of each treatment (1/2 acre) was too small to preclude migration effects in spite of our attempts to mitigate this factor by sampling only the center trees of each plot.

One must be cautious in drawing generalizations from this trial. Conditions for both application and nematode survival were very good. Temperatures were moderate in comparison to those that often occur during the hullsplit period, and it might be anticipated that nematode efficacy could be reduced under more extreme conditions. It is also possible that the Le Grand variety of almond was exceptionally well-suited for the nematode treatment. Shell strength is greater in this variety than in nonpareil. Therefore, navel orangeworms likely feed longer on the hulls before entering the kernals, giving the nematodes a better opportunity to seek out the larvae in the hulls before the larvae would enter the kernals.

Table 1. Commercial sources and style of peach twig borer and oriental fruit moth lures.

Peach Twig Borer		Oriental Fruit Moth	
Source	Style	Source	Style
Biolure	Wafer	Biolure	Wafer
Hercon	Wafer	Scentry	Fibers
Scentry	Septa	Trece (Zoecon)	Septa
Trece (Zoecon)		Septa	

Table 2. Results of Duncan's MRT ($P<0.05$) for comparison between lure treatment means in first PTB trial, 1987.

	WEEKS						
LURE	1	2	3	4	5	6	7
Biolure	A	A	A	A	A	A	A
Hercon	A	B	AB	AB	B	B	B
Scentry	A	B	B	B	B	B	B
Scentry Wafer	A	B	B	AB	AB	B	B
Zoecon	A	B	AB	AB	B	B	B
Zoecon (new)		B	A	AB	AB	A	A

Table 3. Results of Duncan's MRT ($P<0.05$) for comparison between lure treatment means in second PTB trial, 1987.

	WEEKS							
LURE	1	2	3	4	5	6	7	8
Biolure (7 week old)	AB	B	B	BC	B	ABC	AB	BC
Biolure	A	A	A	A	A	A	AB	A
Hercon	AB	B	BC	C	BC	BC	AB	BC
Scentry	AB	B	BC	C	D	C	B	C
Scentry Wafer	B	B	C	C	CD	BC	B	C
Zoecon	AB	B	BC	C	D	BC	B	C
Zoecon (New)	A	B	BC	AB	B	AB	A	AB

Table 4. Results of Duncan's MRT ($P<0.05$) for comparison between lure treatment means for OFM trial in 1987.

	WEEKS								
LURE	1	2	3	4	5	6	7	8	9
Biolure	A	A	A	AB	A	A	B	B	ABC
Hercon	B	B	B	A	AB	A	B	AB	BC
Scentry	B	B	B	AB	AB	A	A	A	A
Scentry (Wafer)	B	B	B	AB	AB	A	B	AB	AB
Zoecon	B	B	B	AB	AB	A	AB	AB	ABC
Zoecon (New)	--	B	B	B	B	A	B	B	C

Table 5. Proportion of total PTB moths caught per trap, 1987. Means with same letter designation are not significantly different (P>0.05) by Duncan's multiple range test.

Trap	$\bar{x} \pm SD$ Moths per Trap	DMRT
Delta	0.0853 ± 0.0574	A
Hercon Wing	0.0838 ± 0.0604	A
Zoecon Wing	0.0722 ± 0.0123	A
Pherocon II	0.0121 ± 0.0065	B
Multipher w/Vapona	0.0086 ± 0.0142	B
Multipher w/Water	0.0030 ± 0.0308	B

Table 6. Proportion of total OFM moths caught per trap, 1987. Means with same letter designation are not significantly different ($P>0.05$) by Duncan's multiple range test.

Trap	$\bar{x} \pm SD$ Moths per Trap	DMRT
Multipher w/Vapona	0.0887±0.1143	A
Multipher w/Water	0.0468±0.0658	B
Red Wing	0.0333±0.0400	BC
Hercon Wing	0.0292±0.0319	BC
Zoecon Wing	0.0228±0.0323	BC
Delta	0.0223±0.0300	BC
Pherocon II	0.0068±0.0140	C

Table 7. Slopes of the forced regressions of the 5 models tested for the first flight of navel orangeworms in the northern, central, and southern counties of California. A value of 1.000 indicates a perfect fit of predicted and observed events.

	METHOD				
	Horizontal		Vertical		
Location	Determ.	Stoch.	Determ.	Stoch.	Nonlinear
Central	0.985	0.981	1.019	1.000	0.990
Northern	1.026	0.987	0.947	0.973	0.991
Southern	0.978	0.960	0.951	0.982	0.971
Combined	0.997	0.978	0.980	0.987	0.986

Table 8. Slopes of the forced regressions of the 5 models tested for the second flight of navel orangeworms in the northern, central, and southern counties of California. A value of 1.000 indicates a perfect fit of predicted and observed events.

	METHOD				
	Horizontal		Vertical		
Location	Determ.	Stoch.	Determ.	Stoch.	Nonlinear
Central	0.990	0.960	0.966	1.011	0.996
Northern	1.032	0.994	0.924	0.985	1.032
Southern	0.948	0.937	0.896	0.929	0.974
Combined	0.993	0.965	0.935	0.978	1.002

Table 9. Peach twig borer strikes counted in 2 year old almond trees following application of 2 rates of *N. carpocapsae*, diazinon, and water (n=19). Means followed by the same letter are not significantly different (P<0.05); DMRT.

Treatment	$\bar{x}$ Twig Strikes	
Water only	28.40	A
N. carpocapsae 1.5 million	22.25	B
N. carpocapsae 0.5 million	21.40	B
Diazinon	2.10	C

21.82

Table 10. Mean (±SD) observations of navel orangeworms or damage per 1000 nut sample (N=5). Le Grand orchard harvested August 25, 1987.

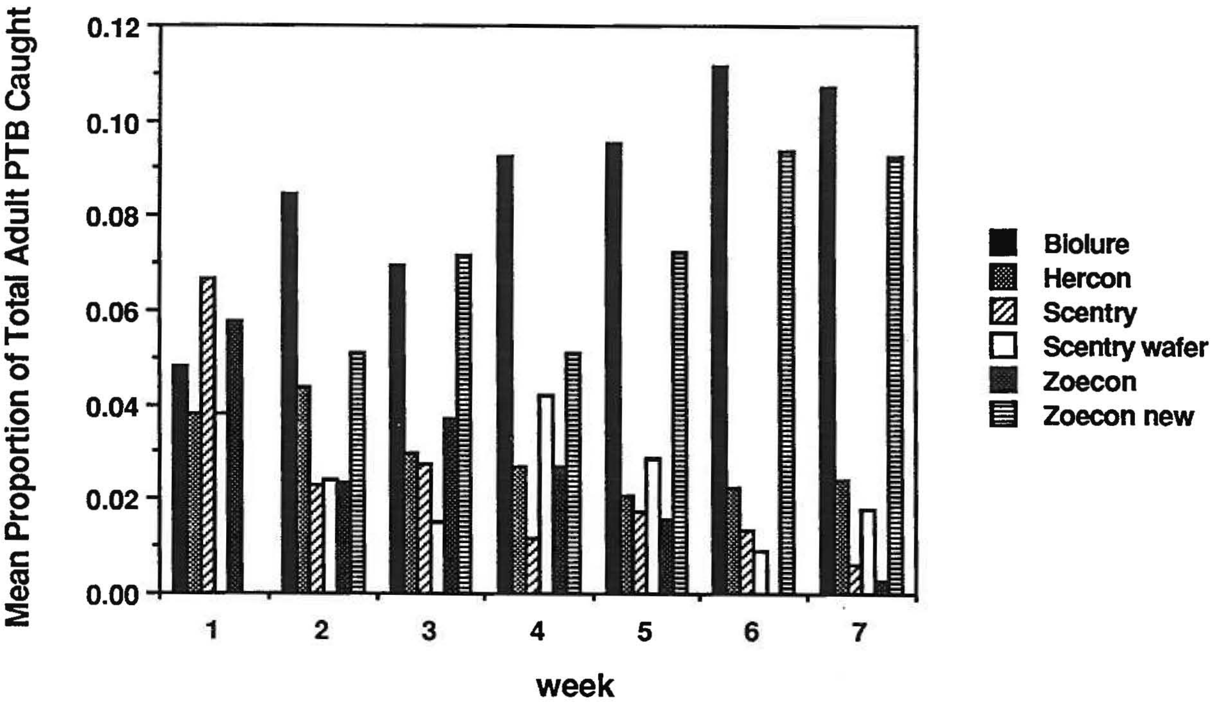
Variable	Mean	Standard Deviation
Control--Untreated		
Small larvae	10	8
Large larvae	19	11
Pupae	6	3
Meat damage	39	18
Total larvae	30	19
Nematodes--3 million treated August 6		
Small larvae	12	10
Large larvae	16	13
Pupae	4	3
Meat damage	32	25
Total larvae	28	21
Nematodes--3 million treated August 11		
Small larvae	12	11
Large larvae	19	16
Pupae	5	7
Meat damage	39	28
Total larvae	32	27
Nematodes--5 million treated August 6		
Small larvae	4	3
Large larvae	10	10
Pupae	2	1
Meat damage	17	8
Total larvae	14	12
Nematodes--5 million treated August 11		
Small larvae	7	1
Large larvae	11	7
Pupae	3	2
Meat damage	26	12
Total larvae	18	7
Guthion--2 lb A.I/acre treated August 3		
Small larvae	5	5
Large larvae	9	10
Pupae	7	4
Meat damage	24	19
Total larvae	15	15

Table 11. Mean (±SD) observations of navel orangworms or damage per 1000 nut sample (N=5). Le Grand orchard harvested September 3, 1987.

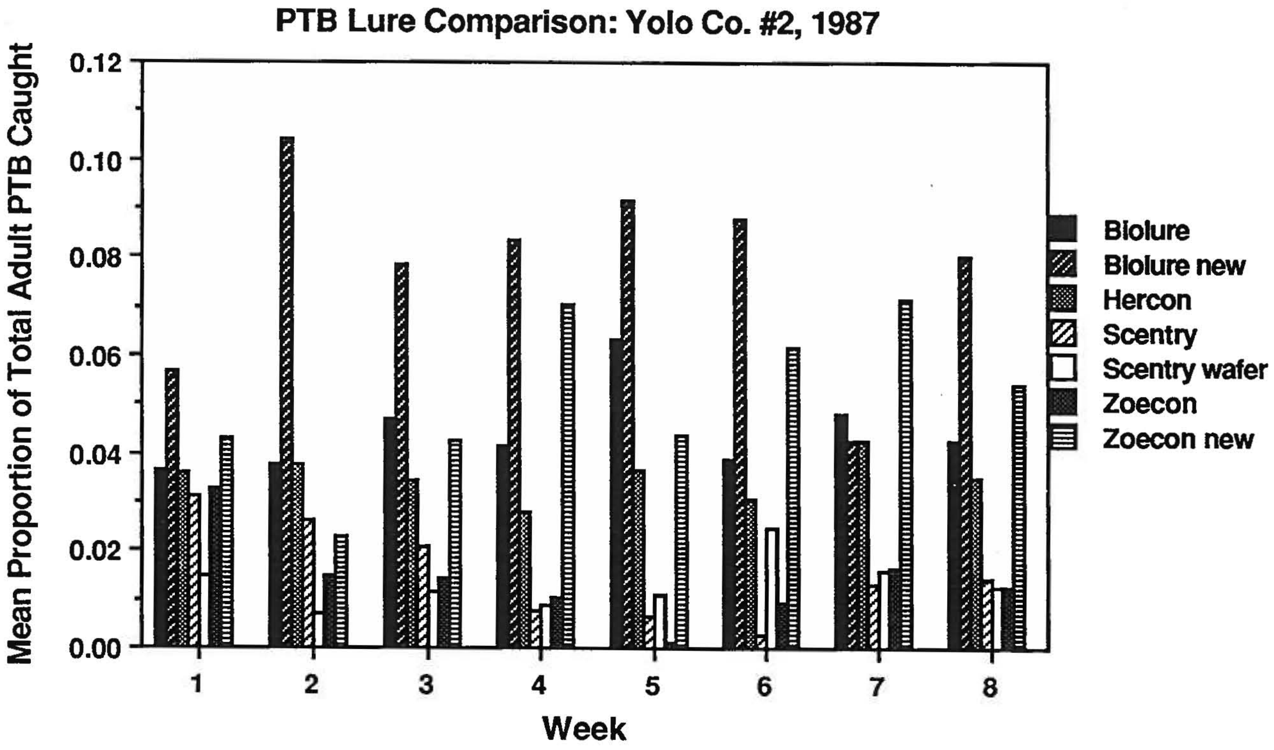
Variable	Mean	Standard Deviation
Control--untreated		
Small larvae	10	5
Large larvae	7	2
Pupae	6	1
Meat damage	47	13
Total larvae	18	6
Nematodes--3 million treated August 6		
Small larvae	10	4
Large larvae	7	5
Pupae	2	3
Meat damage	41	5
Total larvae	17	5
Nematodes--3 million treated August 11		
Small larvae	11	8
Large larvae	7	5
Pupae	4	3
Meat damage	46	25
Total Larvae	18	13
Nematodes--5 million treated August 6		
Small larvae	6	3
Large larvae	7	5
Pupae	6	4
Meat damage	30	10
Total larvae	13	7
Nematodes--5 million treated August 11		
Small larvae	9	2
Large larvae	5	2
Pupae	6	2
Meat damage	27	6
Total larvae	14	4
Guthion--2 lb. A.I/acre treated August 3		
Small larvae	7	5
Large larvae	7	2
Pupae	5	4
Meat damage	26	8
Total larvae	14	4

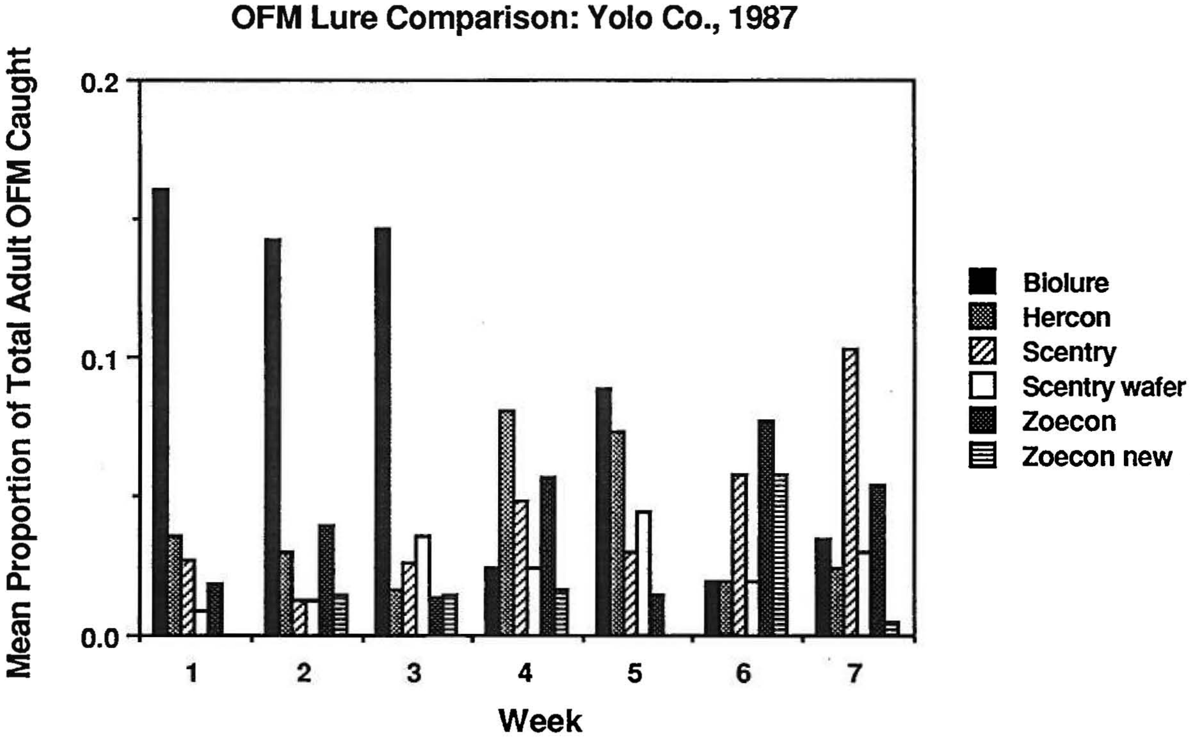
Table 12. Mean kernal damage from navel orangeworm per 1000 nut sample (N=5). Le Grand orchard harvested September 3, 1987. Means followed by the same letter are not significantly different (P<0.05; Duncan's multiple range test).

Treatment		Mean	DMRT
Control	4.7	47.000	A
Nematodes--3 million 8/11/87	4.6	46.800	A
Nematodes--3 million 8/6/87	4.1	41.000	AB
Nematodes--5 million 8/6/87	3.1	30.600	AB
Nematodes--5 million 8/11/87	2.7	27.200	B
Guthion--2 lbs A.I/acre 8/3/87	2.6	26.600	B

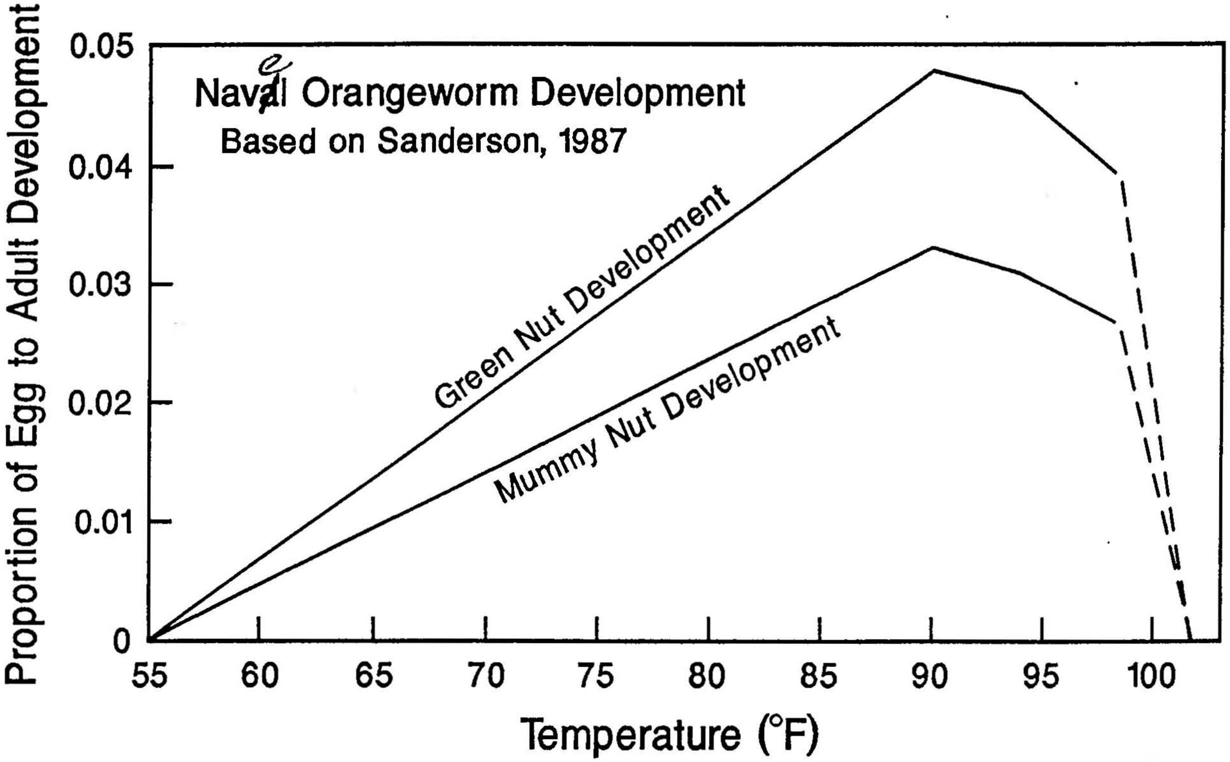


PTB Lure Comparison: Yolo Co. #1, 1987

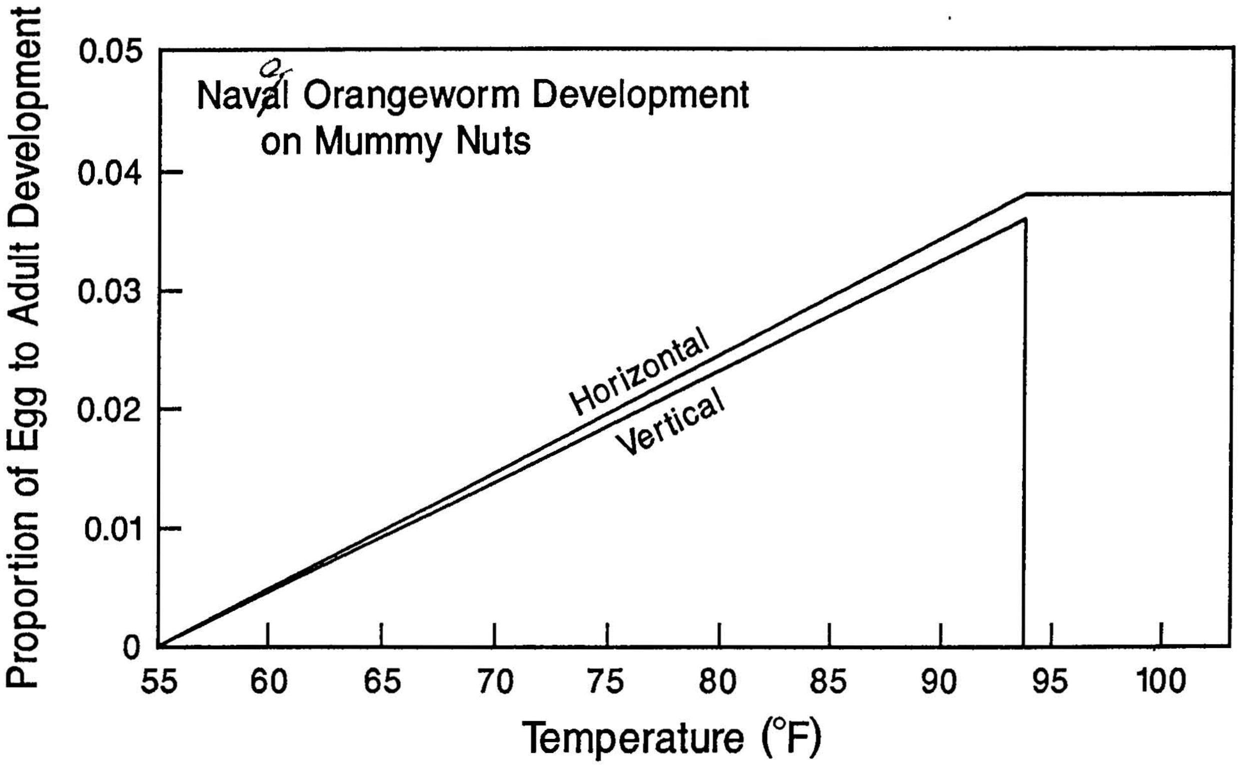

PTB Lure Comparison: Yolo Co. #2, 1987
Mean Proportion of Total Adult PTB Caught
0.12
0.10
0.08
0.06
0.04
0.02
0.00
1
2
3
4
5
6
7
8
Week
Biolure
Biolure new
Hercon
Scentry
Scentry wafer
Zoecon
Zoecon new

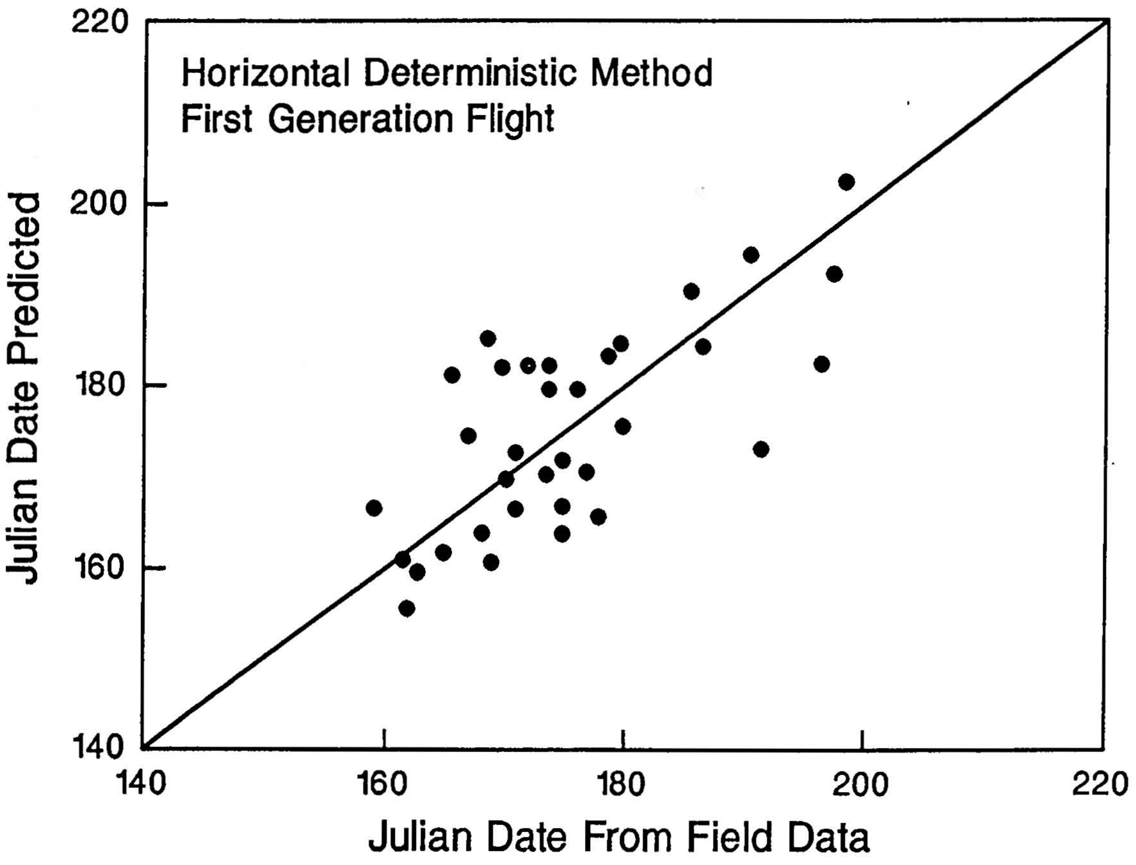


OFM Lure Comparison: Yolo Co., 1987

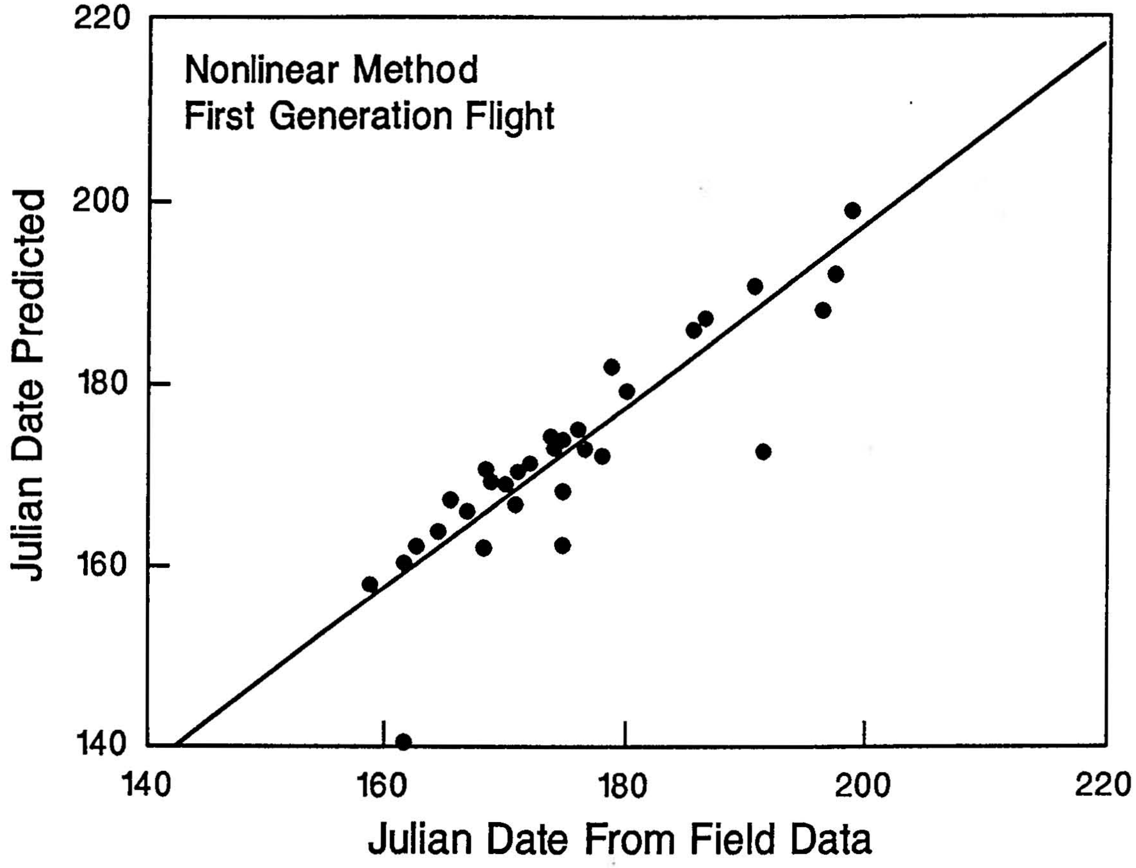

Nav~~a~~el Orangeworm Development
Based on Sanderson, 1987
Green Nut Development
Mummy Nut Development
Proportion of Egg to Adult Development
0.05
0.04
0.03
0.02
0.01
0
55
60
65
70
75
80
85
90
95
100
Temperature (°F)

15)

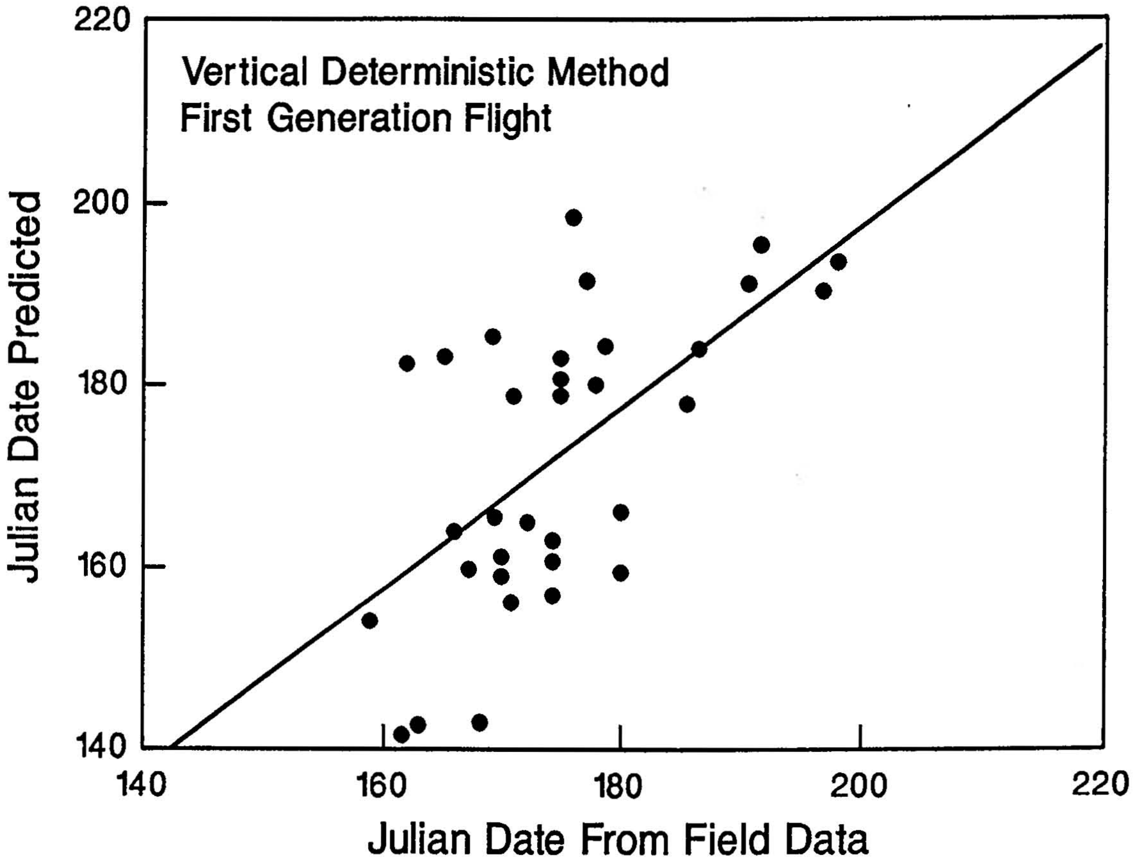

Nav~~a~~el Orangeworm Development
on Mummy Nuts
Proportion of Egg to Adult Development
0.05
0.04
0.03
0.02
0.01
0
Horizontal
Vertical
55
60
65
70
75
80
85
90
95
100
Temperature (°F)


Horizontal Deterministic Method
First Generation Flight
220
200
180
160
140
Julian Date Predicted
140
160
180
200
220
Julian Date From Field Data

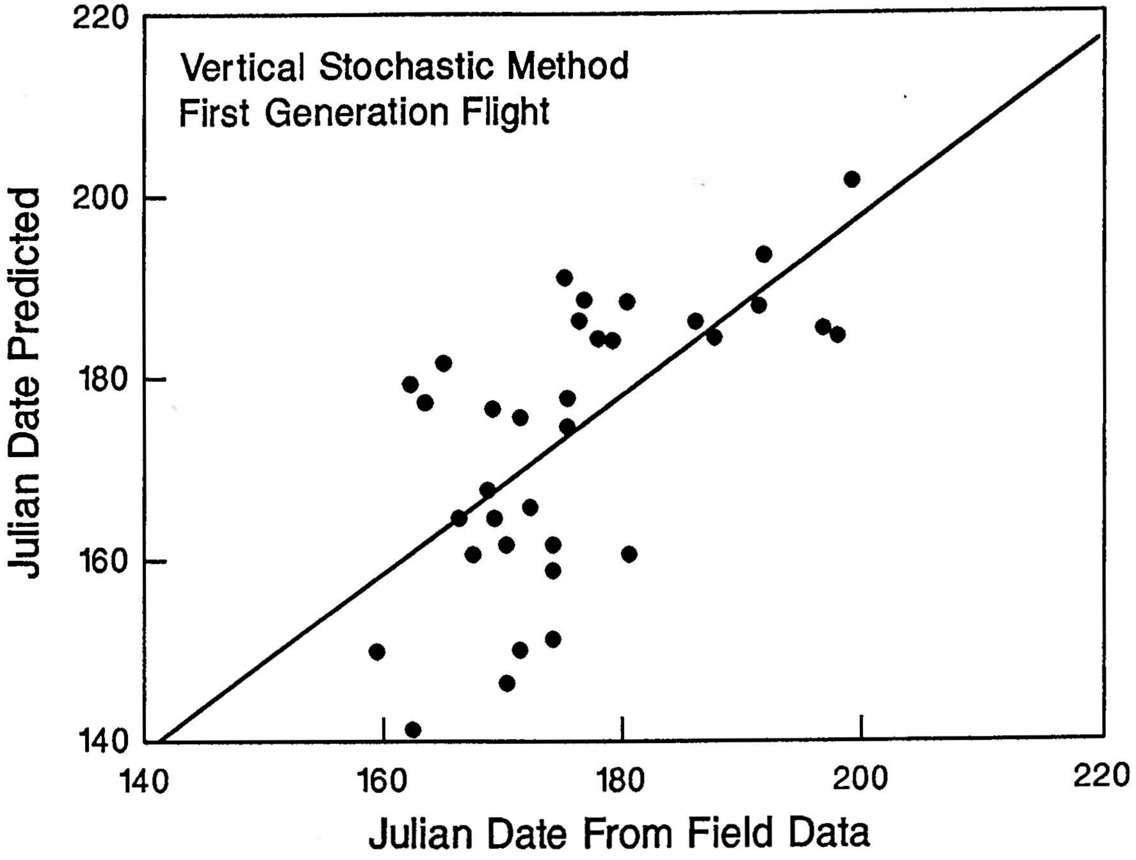
7

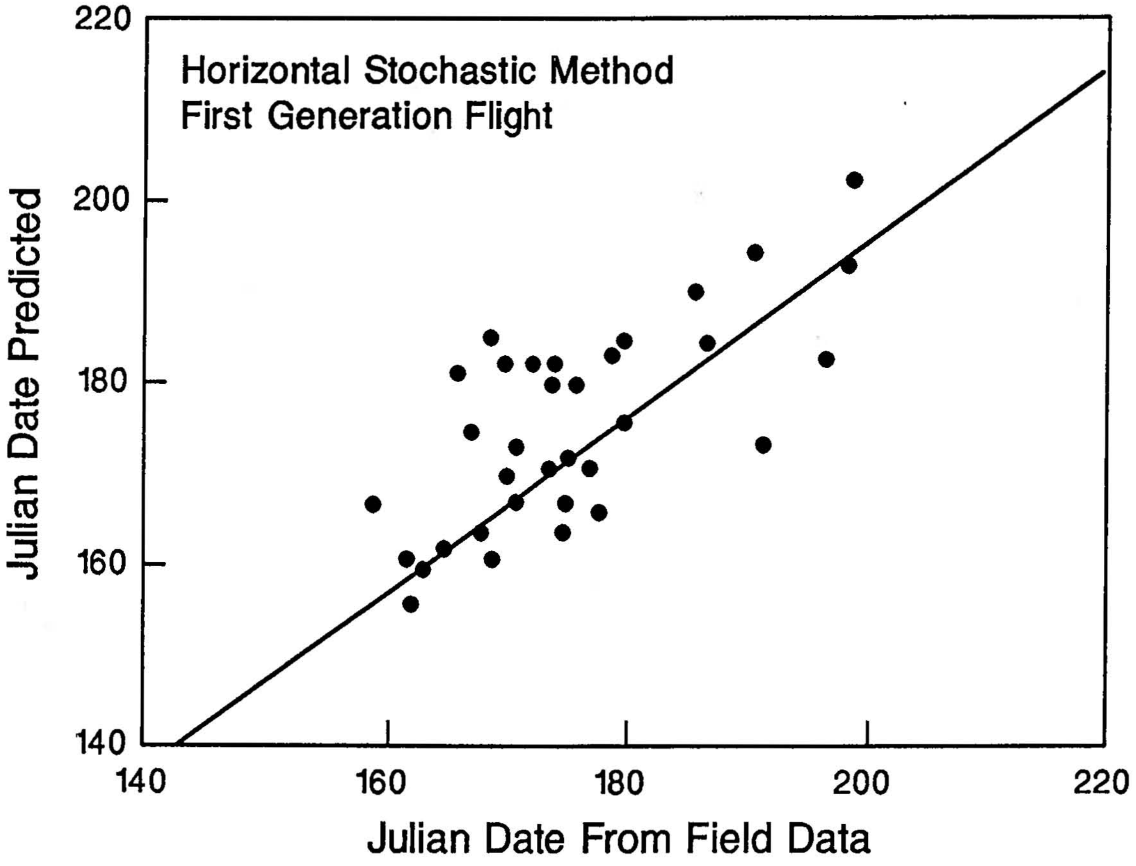

Nonlinear Method
First Generation Flight
Julian Date Predicted
220
200
180
160
140
140
160
180
200
220
Julian Date From Field Data

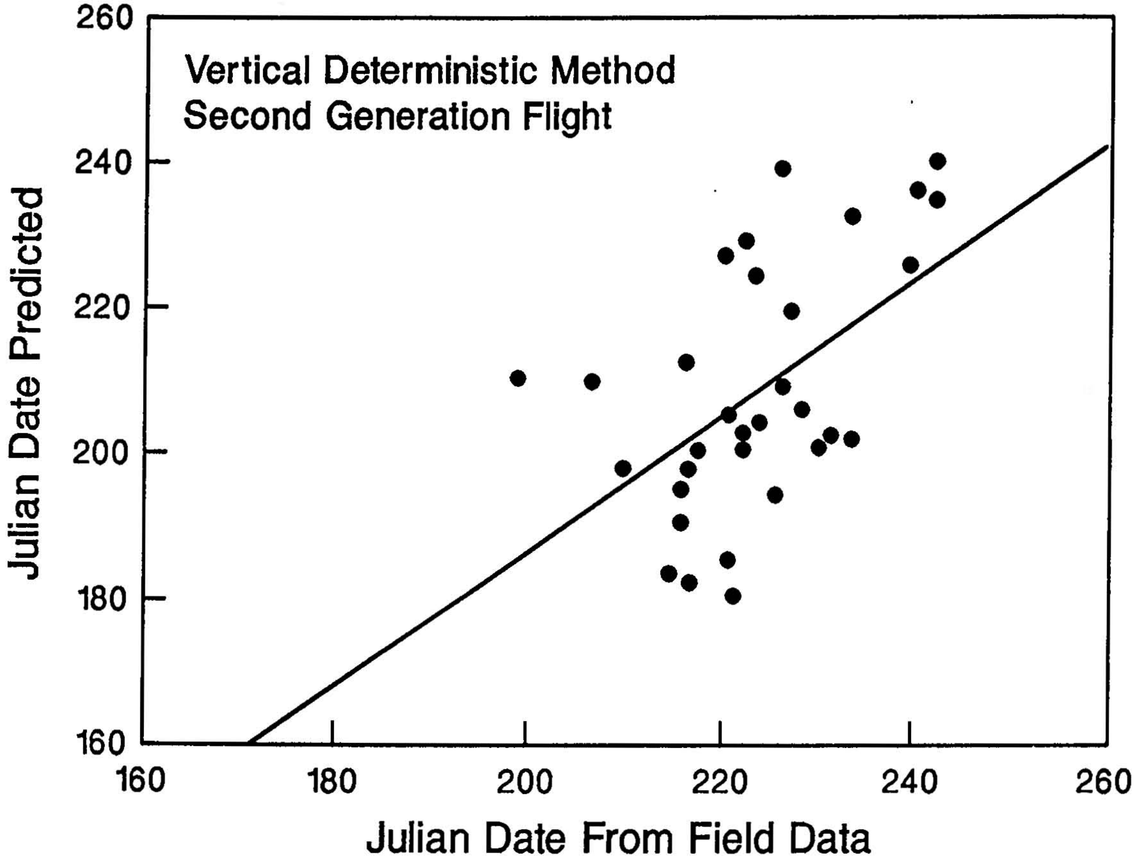
00

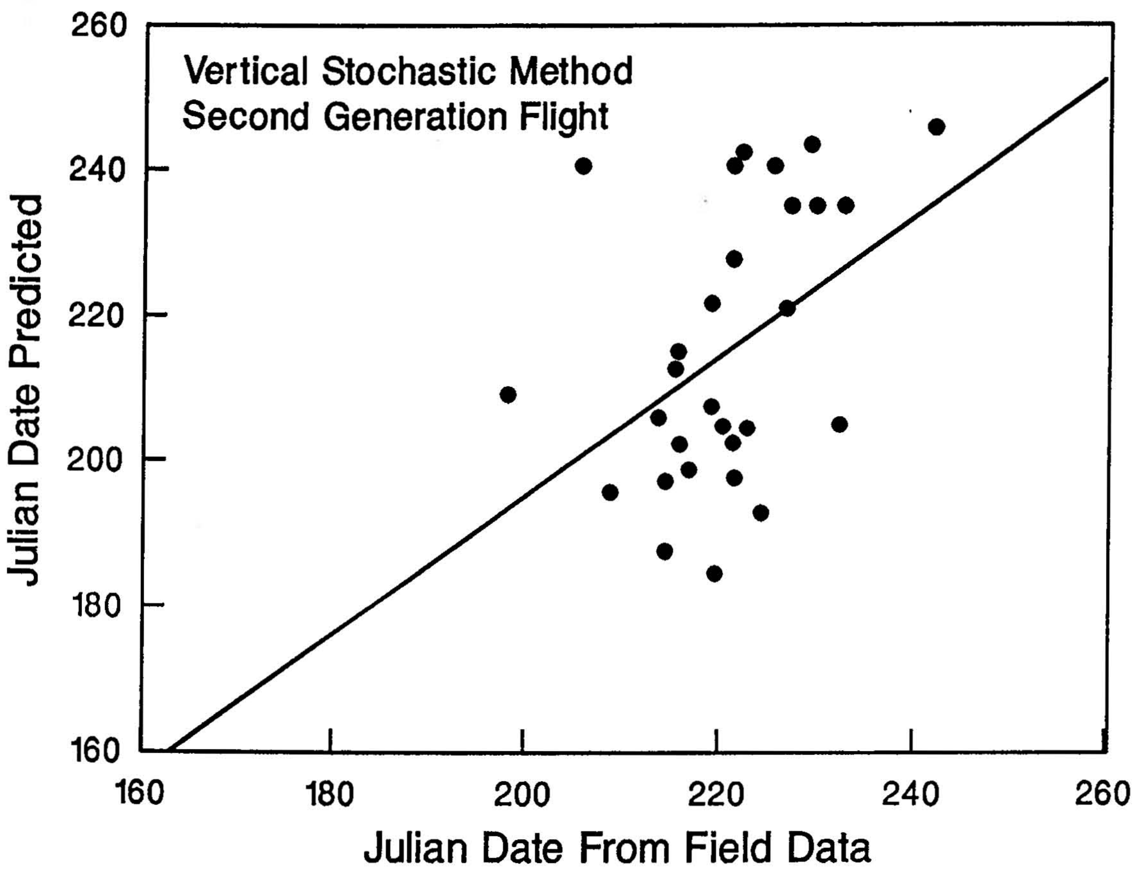

Vertical Deterministic Method
First Generation Flight
220
200
180
160
140
Julian Date Predicted
140
160
180
200
220
Julian Date From Field Data

9

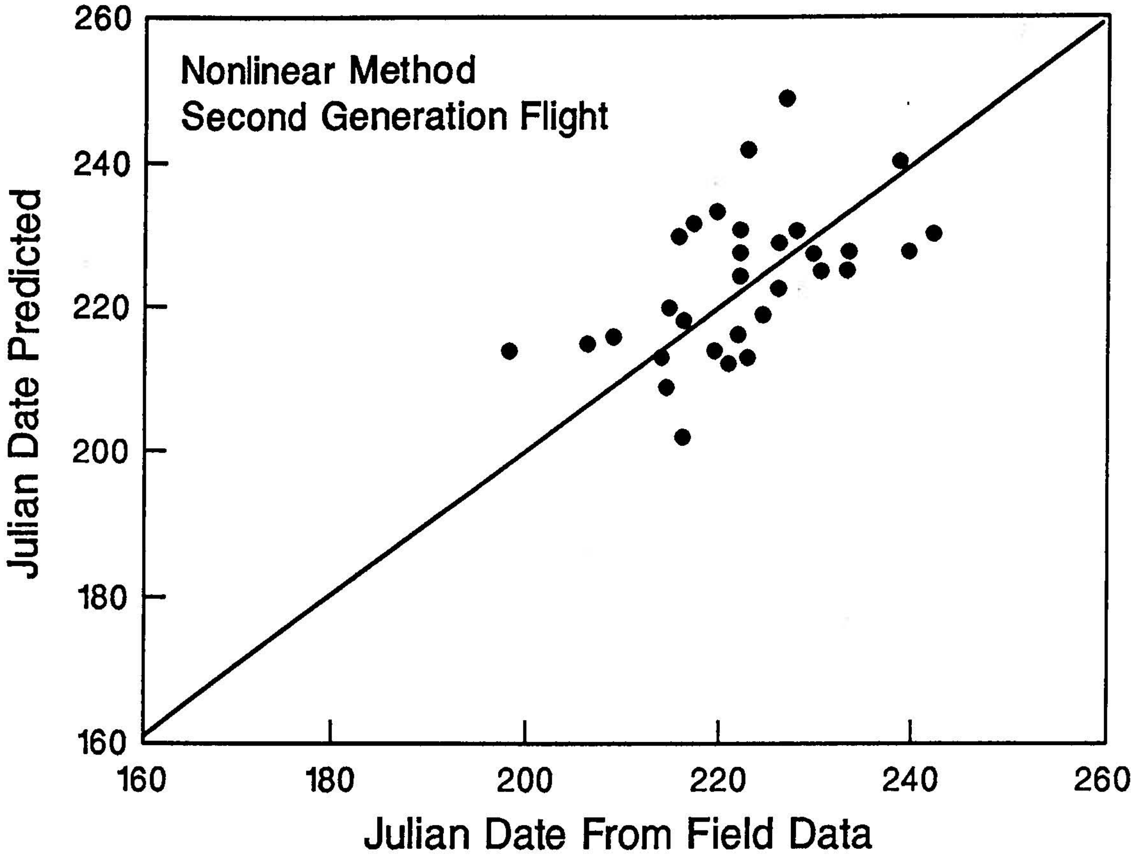

Vertical Stochastic Method
First Generation Flight
220
200
180
160
140
Julian Date Predicted
140
160
180
200
220
Julian Date From Field Data


Horizontal Stochastic Method
First Generation Flight
Julian Date Predicted
220
200
180
160
140
140
160
180
200
220
Julian Date From Field Data

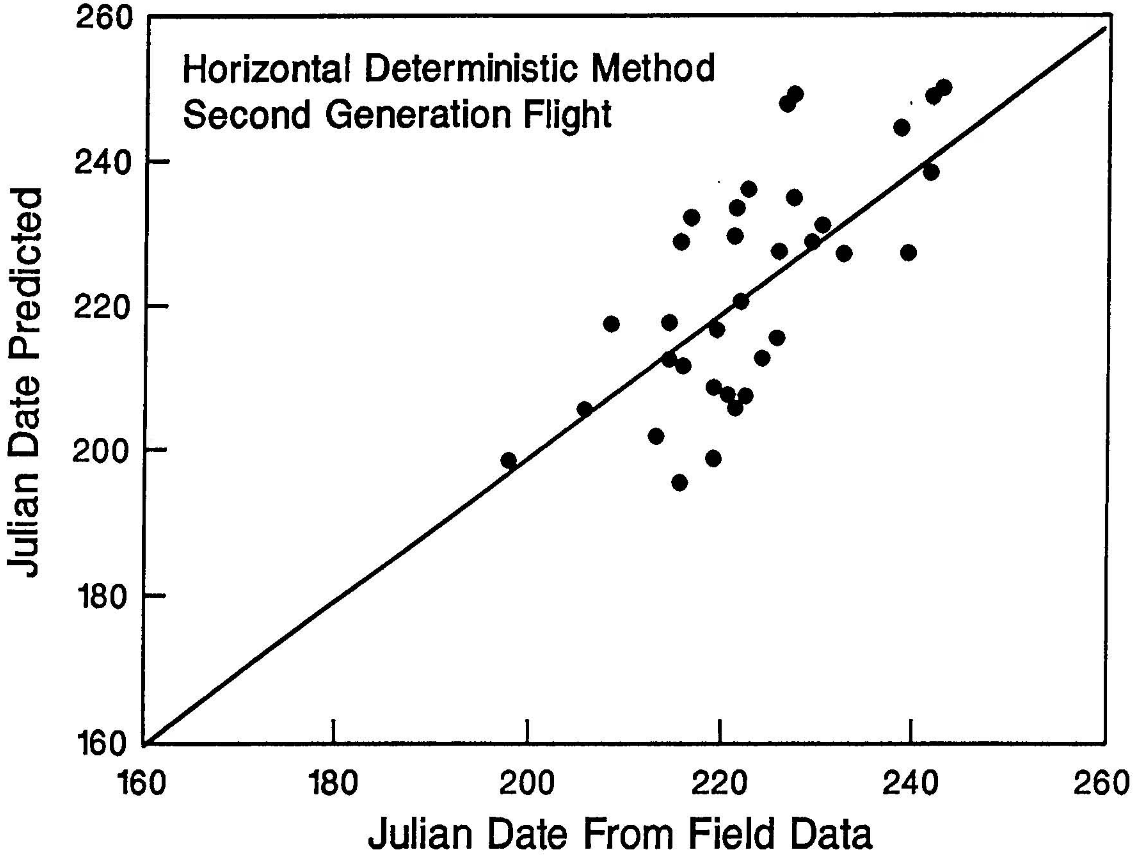

Vertical Deterministic Method
Second Generation Flight
Julian Date Predicted
Julian Date From Field Data
160
180
200
220
240
260
160
180
200
220
240
260

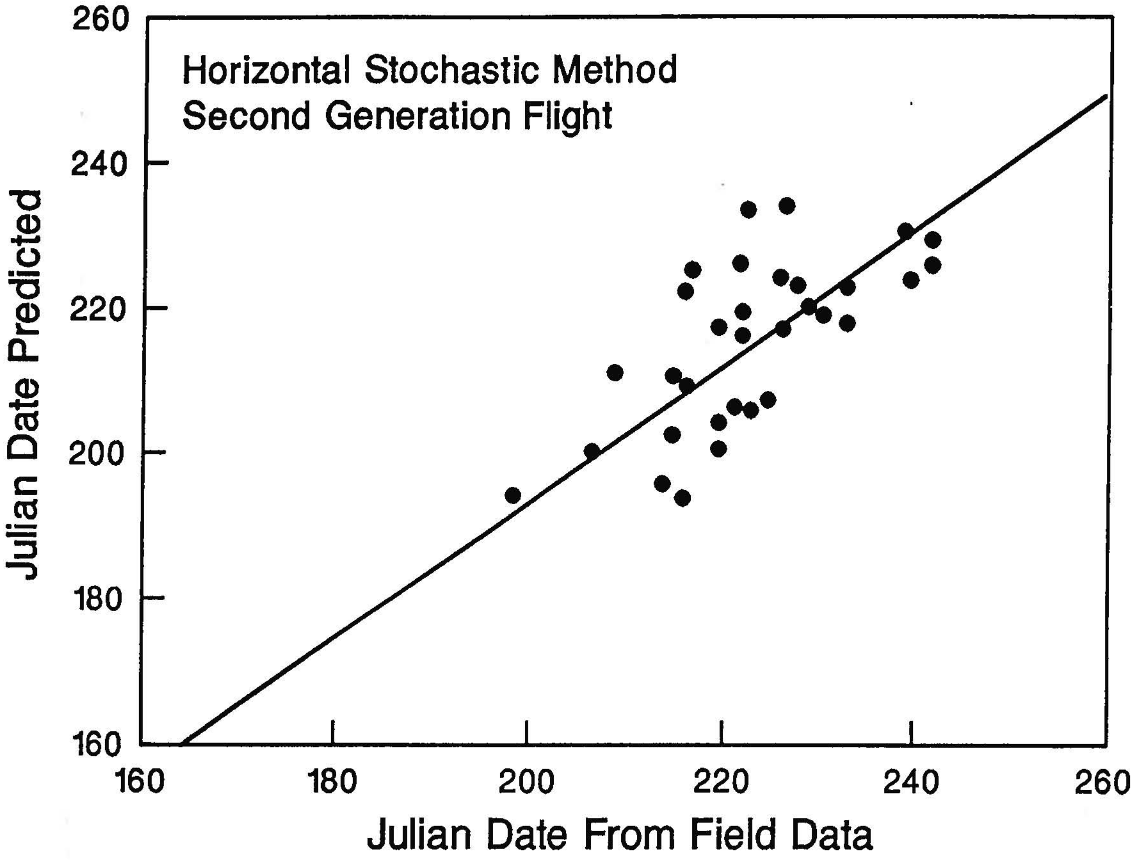

Vertical Stochastic Method
Second Generation Flight
260
240
220
200
180
160
Julian Date Predicted
160
180
200
220
240
260
Julian Date From Field Data

3



Nonlinear Method
Second Generation Flight
Julian Date Predicted
260
240
220
200
180
160
160
180
200
220
240
260
Julian Date From Field Data


Horizontal Deterministic Method
Second Generation Flight
Julian Date Predicted
260
240
220
200
180
160
160
180
200
220
240
260
Julian Date From Field Data


Horizontal Stochastic Method
Second Generation Flight
Julian Date Predicted
260
240
220
200
180
160
160
180
200
220
240
260
Julian Date From Field Data