

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Administration
Bureau of Entomology and Plant Quarantine

ORIENTAL FRUIT FLY INVESTIGATIONS

QUARTERLY REPORT

July 1 - September 30, 1949

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This, the first quarterly report of the Oriental Fruit Fly Investigations, necessarily covers a period of organization and the coordination of activities of all agencies engaged in work on the oriental fruit fly. The foundation for this latter has been laid through the medium of a Memorandum of Understanding among the following agencies:

The Hawaii Agricultural Experiment Station
The Regents of the University of California and the
California Agricultural Experiment Station
The Board of Commissioners of Agriculture and Forestry, T. H.
The Pineapple Research Institute of Hawaii
The Experiment Station of the Hawaiian Sugar Planters' Ass'n.
The Bureau of Entomology and Plant Quarantine, Agricultural Research
Administration, United States Department of Agriculture.

The Project has been singularly fortunate in these cooperative arrangements, which have already demonstrated their value and which will, without a doubt, continue to do so in an increasing measure.

The cooperation of the Washington Bureau must also be recorded at this time, because it is only through this that the gathering of a competent staff in such a short time has been achieved.

The problem of space was an acute one but this has been greatly relieved through the cooperation of the Administration of the University of Hawaii in purchasing a large surplus building and moving it to an appropriate site near the established fruit fly laboratory.

The Project has also had the advantage of taking over a small but well trained staff from the Division of Fruit Fly Investigations, so that actually three of the projects of the Investigations, namely Commodity Treatments, Biological Control and Chemical Control, were taken over as going concerns. All of these projects have been considerably strengthened and their facilities increased. The two newest projects, namely Area Control and Ecology-Biology, are necessarily in an early stage of organization, but even with these two projects considerable progress has been made in establishing fundamental concepts and the accumulation of essential preliminary data.

The Personnel Chart as of September 30, 1949, which is attached herewith, illustrates the present organization of the investigations into five major projects. The Ecology-Biology Project is in two divisions necessitated by the physical separation of the synecological work on the islands of Maui and Hawaii. For all but the last named, line projects are available and are reported on by the division leaders on the pages that follow. The synecological work had not been organized to the point where formal division into line projects was feasible by September 30, and in this case the report is made on the basis of the working outline which heads the project leader's report.

These reports follow in the order given below:

Commodity Treatments

Biological Control

Chemical Control

Area Control

Ecology-Biology

COMMODITY TREATMENTS, Work Project I-o-5 - J. W. Balock, Project Leader

I-o-5 COMMODITY TREATMENTS FOR THE ORIENTAL FRUIT FLY

Line Project I-o-5-1 Investigations to develop mortality time--temperature curves under vapor--heat sterilization.

.1 Vapor-heat sterilization at 116° F.

A complete mortality regression curve has been established at this temperature using an 8 hour saturated approach period. Further work at 110° F. will be confined to: (1) Determining the mortality curve under the shortest approach curve that can be obtained in commercial rooms. This would permit vapor-heat rooms to operate at full capacity and result in a saving of time. At the present time there is only one commercial vapor-heat room in operation in the territory, that of J. J. Holzman and from available data it is estimated that this room has a heating capacity to meet a 4 hour approach period. It is doubtful whether a shorter approach would be possible, especially with full loads. It would appear logical on the basis of a complete regression line using a 4 hour conditioning period to set a minimum of 4 hours and a longer period for those unable to meet these requirements. This shortened approach could be used for all commodities which tolerate vapor-heat without conditioning at reduced humidity. (2) For commodities such as papayas, egg plants and cucumbers which require conditioning at reduced humidity to prevent injury, present treatment calls for 6 - 8 hour conditioning period at reduced humidity and in addition an 8 hour approach plus 8 3/4 hours at 110° F. under saturation. Conditioning should be considered as part of the approach period, but since this would affect mortality a new curve should be established employing an 8 hour approach-conditioning curve at reduced humidity followed by a holding period at 110° F.

.2 Vapor-heat quick run-up.

The object here is to shorten treatment time under vapor-heat by eliminating the holding period at 110° F. This is accomplished by running the fruit temperature as rapidly as possible under a wide heat differential. Vapor mixture is maintained at 120° to 121° F. and mortalities determined at 1° intervals between 111° F. and 120° F. Treatment is stopped as soon as the fruit reaches the desired level. To determine the effect on mortality of a conditioning period preceding quick run-up, tests reported in this report were conducted using

- (1) Quick run-up without conditioning
- (2) Quick run-up preceded by 6 hour conditioning at reduced humidity (40-50% R. H.) and air temperature of 110° F.

Twenty-five experiments were conducted under each of the above procedures. The data are presented in Table 1 and in Fig. 1

Fig. 1. Mortality of D. Dorsalis eggs and larvae in ripe field infested papayas subjected to vapor-heat quick run-up.

Curve A - Fruits conditioned for 6 hours at 110° F. and 40-50% R.H. before quick run-up.
Curve B - Fruits treated without conditioning.

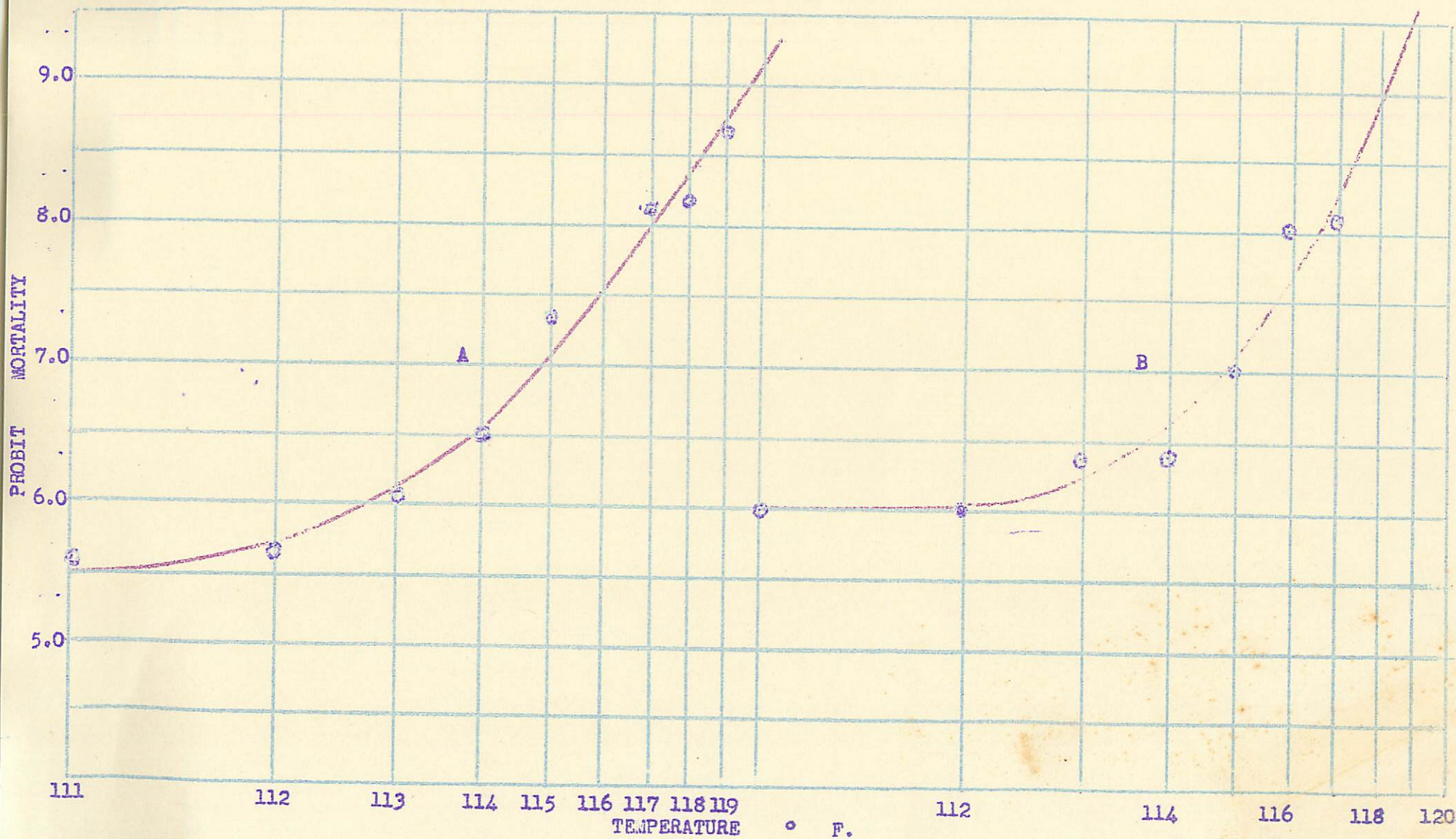


Table 1

Mortality of D. dorsalis eggs and larvae in ripe field-infested papayas exposed to vapor-heat quick run-up in saturated atmosphere of 120° F. with and without conditioning for 6 hours at 40-50% R. H. and 110° F. (Expts. 60-98)

Temp. °F.	<u>CONDITIONED</u>					<u>NON-CONDITIONED</u>				
	No. Fruits	Est. Pop.	No. of surv.	Mort. Percent	Probit	No. Fruits	Est. Pop.	No. of surv.	Mort. Percent	Probit
111	75	3370	887	73.68	5.63	145	2570	400	84.44	6.01
112	131	4490	1098	75.55	5.69	215	7069	1087	84.62	6.02
113	80	1074	145	86.50	6.10	290	5867	479	91.83	6.39
114	126	4998	318	93.64	6.52	280	8537	671	92.14	6.41
115	70	811	7	99.14	7.38	280	5604	115	97.95	7.04
116	180	3610	107	97.04	6.88	430	14327	17	99.88	8.04
117	256	15658	13	99.92	8.16	290	5651	5	99.91	8.12
118	550	6818	4	99.94	8.24	290	8625	0	100.00	—
119	610	8131	1	99.988	8.72	750	8131	0	100.00	—
120						70	918			
	2,078	48,960				3,040	67,299			

Line Project I-o-5-2 Investigations to develop mortality-time-temperature curves under low temperatures.

Five experiments were conducted at temperatures from 32° F. to 36° F.

Experiment 1 - Field-infested pineapples were used. These were hybrid fruits obtained from P. R. I. experimental farm at Wahiawa.

Table 2

Mortality of D. dorsalis eggs when removed from pineapple after refrigeration at 34° F.

No. Fruits	Exposure (days)	No. of eggs	No. Hatch	Percent Mortality
4	2	406	62	84.73
4	4	1242	74	94.04
4	6	1028	29	97.18
4	8	695	0	100.00
3	Control	1338	216	83.86

Experiment 2 - Pineapple fruits were obtained from the same location as in experiment 1 (Fields 3-A and 10). The fruits were very ripe and souring. Fruits held at 34° F. Eggs removed by separating and examining each individual eye of the fruit. Eggs were incubated by holding on moist blackened filter paper.

Table 3

Mortality of D. dorsalis eggs in pineapple after holding at 34° F.

<u>No. Fruits</u>	<u>Exposure (days)</u>	<u>No. of eggs</u>	<u>No. Hatch</u>	<u>Percent Mortality</u>
4	8	558	4	99.28
4	9	178	0	100.00
4	10	591	2	99.66
4	12	340	4	98.82
4	13	611	1	99.84

Experiment 3 - Field infested papayas were used. Holding temperature was 35° F. ± 1°. Fruits were held in trays over sand to determine mortality.

Table 4

Mortality of D. dorsalis in field infested papayas held at 35° F.

<u>No. of Fruits</u>	<u>Exposure (days)</u>	<u>Estimated population</u>	<u>No. Survivors</u>	<u>Percent Mortality</u>
140	7 1/2	2500	0	100
28	0 (control)	500	500	---

1/2 Experiment terminated due to refrigeration breakdown

Experiment 4 - Field infested guavas were used. Holding temperature was 32° F. ± 1.5°. Fruits held in trays over sand to determine mortality.

Table 5

Mortality of D. dorsalis in field infested guavas held at 32° F. ± 1.5°.

<u>No. of Fruits</u>	<u>Exposure (days)</u>	<u>Estimated population</u>	<u>No. Survivors</u>	<u>Percent Mortality</u>
80	3	517	117	77.37
80	4	517	45	91.29
80	5	517	21	95.94
80	6	517	2	99.61
80	7	517	1	99.81
80	8	517	0	100.00
80	9	517	0	100.00
80	10	517	0	100.00
80	11	517	0	100.00
80	12	517	0	100.00
160	0 (control)	1034	1034	---

Experiment 5 - Field infested mangoes were used. Holding temperature was $34^{\circ} \text{ F.} \pm 1^{\circ}$. Fruits were held in trays over sand to determine mortality.

Table 6

Mortality of D. dorsalis in field infested mangoes held at $34^{\circ} \pm 1^{\circ} \text{ F.}$

<u>No. of Fruits</u>	<u>Exposure (days)</u>	<u>Estimated population</u>	<u>No. of Survivors</u>	<u>Percent Mortality</u>
60	1	54	5	90.74
60	2	54	13	75.93
60	3	54	8	85.19
60	4	54	0	100.00
60	5	54	3	94.44
60	6	54	0	100.00
60	7	54	0	100.00
60	8	54	0	100.00
60	9	54	0	100.00
60	10	54	0	100.00
120	Ø (control)	107	107	—

The data in the foregoing five low temperature experiments are very fragmentary and no conclusions should be drawn. However, it appears that at least for fresh pineapple low temperature sterilization offers little hope. Dorsalis eggs from pineapple refrigerated at 34° F. hatched after an exposure of 13 days at this temperature. According to Mr. Kazanteno, one of the small producers interested in shipping fresh fruit, pineapple would not tolerate such treatment.

Four reefer boxes have been purchased as surplus from the Navy and are now being set up at the Dole St. laboratory. This will enable the immediate acceleration of the low temperature line project.

Line Project I-c-5-3 To develop a time-dosage mortality curve under methyl bromide fumigation

Experiments with methyl bromide have been confined mostly to develop satisfactory mortality curves for Vanda Joaquim and pineapple. Much of the data obtained has been scattered through weekly progress reports and memorandums. It would be desirable to have this information consolidated so that we can have a clearer picture of what has been done and what yet remains to be done, and this has been done below.

a) Vanda Joaquim - As a result of finding eggs of D. dorsalis on vanda blooms, the shipment of these blooms was restricted by quarantine on March 23rd, and fumigation studies with methyl bromide were started immediately to develop a satisfactory treatment. Assistance in these studies was furnished by the Hawaii Agriculture Experiment Station and the Territorial Board of Agriculture and Forestry as well as the entire laboratory staff. Because it was impossible to obtain naturally infested vandas in any quantity, approximately 15,000 vanda blossoms were hand innoculated with eggs of D. dorsalis and fumigated. The infestation was made by making a transverse slit in the upper part of the column just back of the anthers and inserting 2 eggs in each bloom. Infested blooms were held 24 - 36 hours before fumigation to allow the eggs to hatch. Mortality determinations were made by examination of the flowers under a binocular microscope 48 hours after fumigation to allow for any delay in killing action.

It has been observed that most of the oviposition in vandas occurs on the surface of the petals, and very rarely in the column which is the most fleshy part of the bloom. For this reason in most cases eggs would be almost entirely naked if naturally infested blooms were fumigated. For this reason eggs obtained from field collected flies using the orange skin technique were fumigated in open petri dishes lined with ink-dyed filter paper. The results are presented in Tables 7 and 8 and Fig. 2

Table 7

Mortality of eggs and larvae of D. dorsalis in Vanda Joaquim blooms artificially infested and fumigated with methyl bromide at 2 lbs. per 1000 cu. ft. at atmospheric pressure and at room temperatures from 23 to 27° C.

<u>Hours Exposure</u>	<u>Eggs & larvae fumigated</u>	<u>Survivals</u>	<u>Percent Mortality</u>	<u>Probit</u>
1/2	2340	132	94.36	6.59
1	2400	27	98.83	7.28
1 1/2	2880	3	99.90	8.09
2	10080	2	99.98	8.54
2 1/2	1800	0	100.00	
2 3/4	1620	0	100.00	
3	1200	0	100.00	
4	211	0	100.00	
5	360	0	100.00	
	<u>22,891</u>			

1/ No allowance for mortality in unfumigated controls.

Table 8

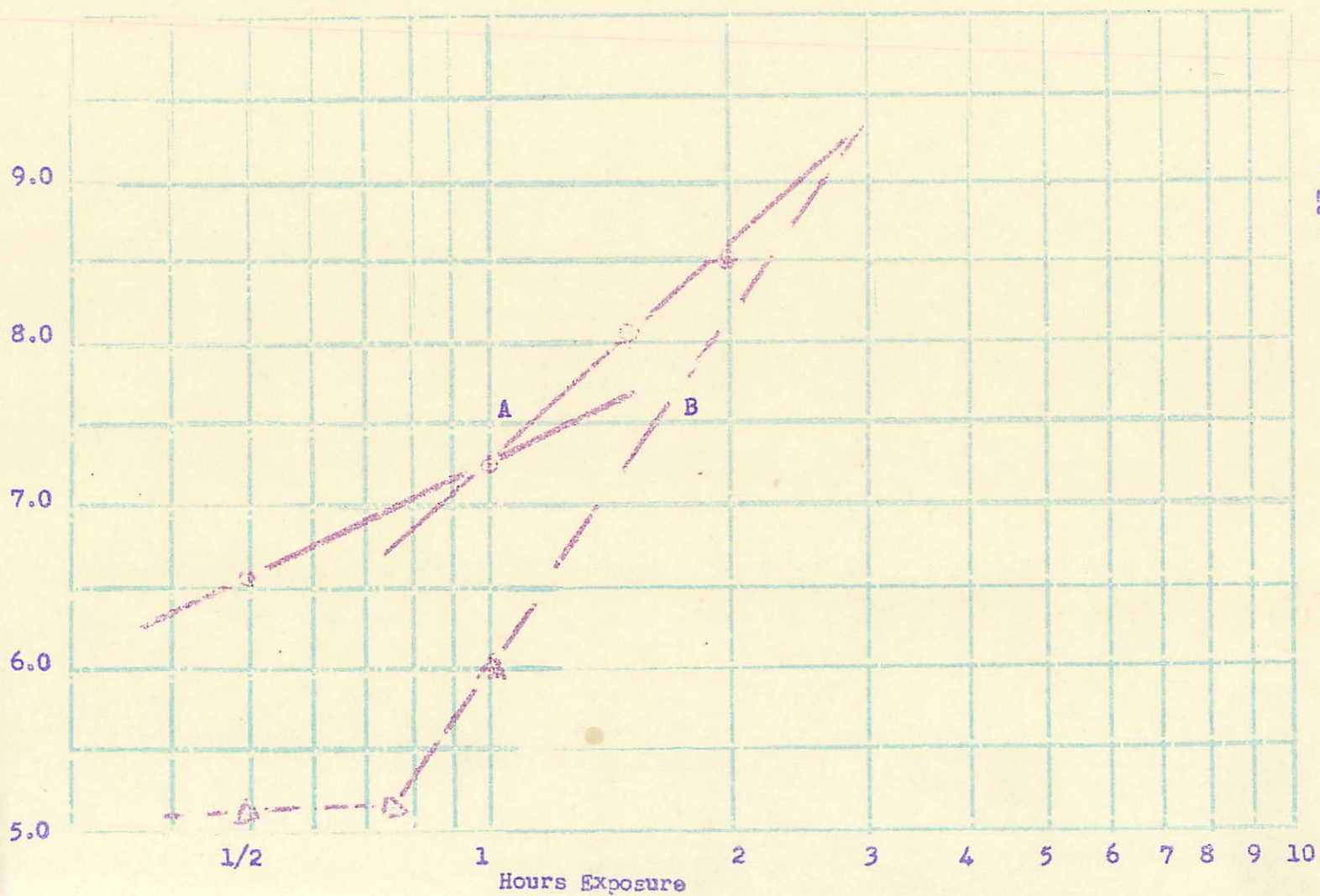
Mortality of D. dorsalis eggs fumigated with methyl bromide at 2 lbs. per 1000 cu. ft. in open petri dishes.

<u>Exposure</u>	<u>No. eggs fumigated</u>	<u>No. eggs hatching</u>	<u>Percent Mortality</u>	<u>Probit</u>
30 min.	6639	2993	54.92	5.12
45 min.	3990	1746	56.24	5.16
1 hour	5900	904	84.68	6.02
1 1/2 hours	6699	0	100.00	
2 "	11226	0	100.00	
2 1/2 "	4945	0	100.00	
3 "	1316	0	100.00	
4 "	1795	0	100.00	
5 "	1825	0	100.00	
	<u>44335</u>			

Resistance to fumigation seemed to increase with age. Eggs 3 to 5 hours old were much more susceptible than 24 hour old eggs in a limited number of tests where such comparisons were made.

Fig. 2. Mortality of D. dorsalis eggs and larvae following fumigation with Methyl Bromide at 2 lbs. per 1000 cu. ft. at atmospheric pressure and at temperatures of 23-27° C.

Line A - Eggs and larvae in artificially infested Vanda jocosum blooms.
Line B - Eggs in open petri dishes



As a result of the foregoing tests recommendations were made establishing a 2½ hour fumigation at 2 lbs. of methyl bromide per 1000 cu. ft. for Vanda blooms moving under quarantine.

b) Pineapple - Movement of pineapple was restricted by quarantine in the spring of 1948 after discovery of eggs and the rearing of dorsalis in badly decomposed pineapple by Mr. Fullaway of the Board of Agriculture and Forestry.

Preliminary tests with methyl bromide showed that pineapple would tolerate an exposure of 7 hours at 2 lbs per 1000 cu. ft. without serious damage. Mortality studies were slow and difficult because of the low infestation in pineapple. At first it was necessary to resort to the laborious process of caging individual pineapples in the field with field collected flies to obtain oviposition. In many cases the infestation obtained in this manner was very light and the method was finally discontinued. Later field-infested fruits were fumigated following an observation in the P. R. I. experimental plots at P. R. I. that high infestation developed in pineapples in the vicinity of fruits that were fermenting actively as a result of the crowns being cut off. These were non-commercial hybrid fruits. Pineapples infested by both means were used in a series of fumigation tests at the 2 lb. per 1000 cu. ft. dosage. Following fumigation the shells were cut from pineapple and the eggs removed by breaking and examining each individual eye and transferring the eggs to moist blackened filter paper in stender dishes for hatch. This method was used instead of the usual procedure of holding over sand since complete larvæ development in whole pineapple has never been observed. The other alternative would have been to remove the skin and hold over sand to determine survival since complete development from egg to mature larvæ occurs when the fruit is so handled.

Mortality data are presented in tables 9 - 11 and in Fig. 3

Table 9

Mortality of D. dorsalis eggs in pineapples infested in the field by caging and fumigated at the rate of 2 lbs. per 1000 cu. ft. (Expts. 15 - 26)

<u>Hours Fumigated</u>	<u>No. of Fruits</u>	<u>No. of eggs</u>	<u>No. hatch</u>	<u>Percent Mortality</u>	<u>Percent mortality corrected</u> ^{1/}	<u>Probit</u>
1	15	462	48	89.61	79.75	5.83
2	28	574	2	99.65	99.32	7.47
3	30	1045	1	99.90	99.86	7.99
4	16	222	0	100.00	100.00	—
	<u>89</u>	<u>2,303</u>				

^{1/} Corrected for natural mortality in controls.

Table 10

Mortality of *D. dorsalis* eggs in field infested pineapple fumigated with methyl bromide at 2 lbs. per 1000 cu. ft. (Expts. 27 - 35)

<u>Hours Fumigated</u>	<u>No. of fruits</u>	<u>No. of eggs</u>	<u>No. hatch</u>	<u>Percent mortality</u>	<u>Percent mortality corrected</u>	<u>Probit</u>
2	26	1075	276	74.33	44.35	4.86
3	34	1315	48	96.35	87.06	6.13
4	23	1564	31	98.02	97.60	6.98
5	10	1993	0	100.00	100.00	
6	10	1307	0	100.00	100.00	
7	10	302	0	100.00	100.00	
	<u>113</u>	<u>7,556</u>				

^{1/} Corrected for natural mortality in controls (Abbott's formula).

During the latter part of February of this year, Dr. Anderson of the Pineapple Research Institute reported a high infestation of *dorsalis* in pineapple at the Wahiawa Station in one of their experimental plots. The report was unusual in that well-developed larvae were found alive in approximately 7 percent of nearly 300 pineapples. This plot was located in the vicinity of Dr. Collins' plots previously mentioned where unusually high adult populations had been attracted to actively fermenting pineapples. All previous observations had shown that larvae died very soon after hatching. Full grown 3rd instar larvae had been observed on one occasion in sound hybrid fruit by Dr. Linford. These fruits were much drier than Cayenne and had much larger intercellular spaces. With this discovery the problem of sterilizing pineapple was no longer restricted to eggs but should include information on the effect on larvae although such infestations are very unusual. It is impossible to determine larva infestation in pineapple without cutting and since larval infestation occurs very rarely, pineapples were infested artificially with 3rd instar larvae by inserting them in a small wedge shaped plug about 1-2 inches deep and about 1 1/2 inches in diameter and sealing the cut with paraffin. The plug was punctured 6 to 8 times with a needle to simulate egg punctures, but these closed up immediately with juice. Four plugs containing 25 larvae each were first tried, but later only 1 plug per fruit was used to facilitate sealing and handling. The results are presented in Table 11, and Fig. 3.

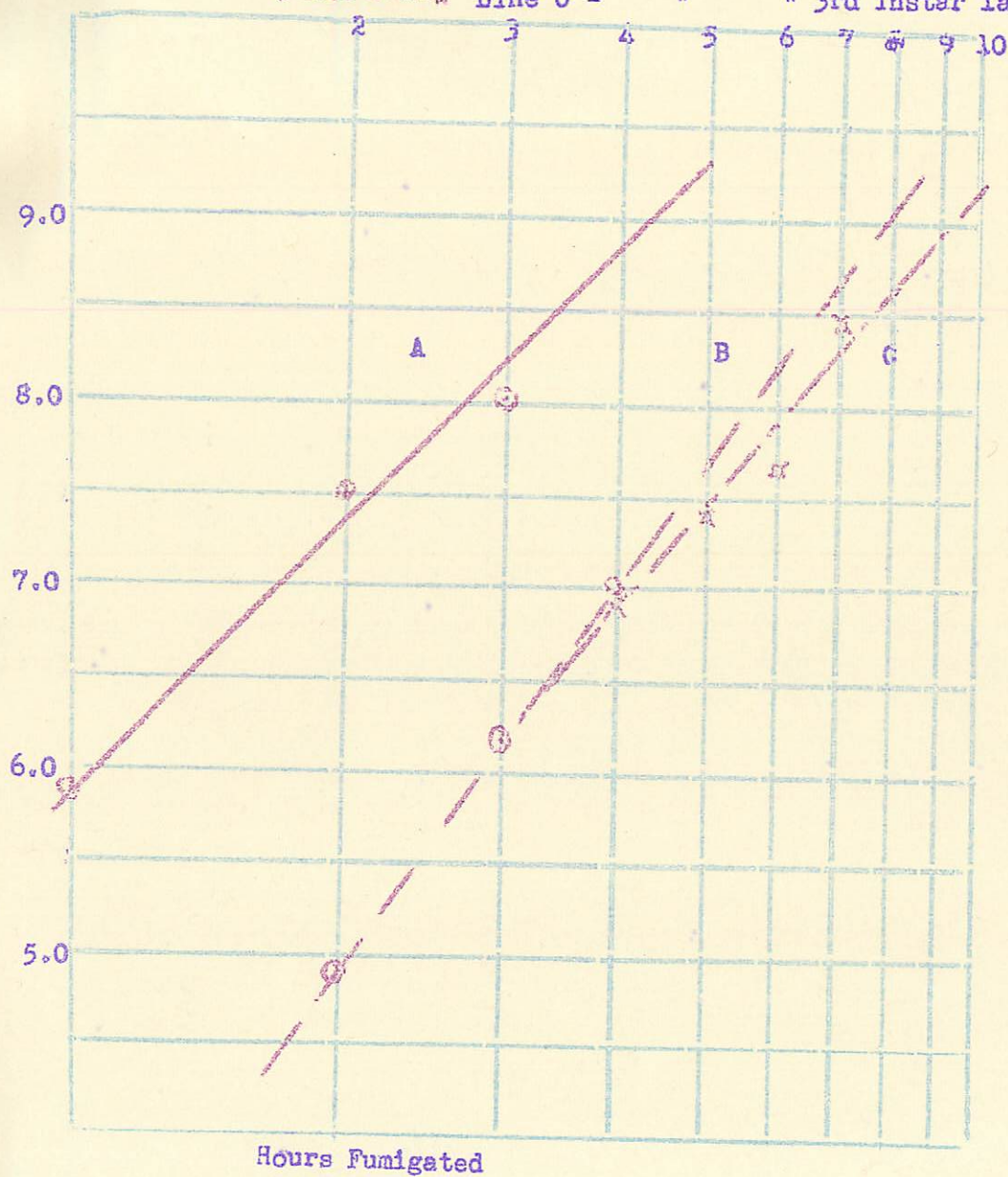
Table 11

Mortality of 3rd instar *D. dorsalis* larvae in pineapples artificially infested by the plug method and fumigated with methyl bromide at 2 lbs. per 1000 cu. ft. at temperatures of 25 to 29° C. (Expts. 81 - 89)

<u>Hours fumigated</u>	<u>No. of fruits</u>	<u>No. of larvae</u>	<u>No. pupating</u>	<u>No. flies</u>	<u>Percent mortality</u>	<u>Probit</u>
4	50	2357	73	6	96.90	6.87
5	35	1135	10	2 + 3opius	99.12	7.37
6	15	669	3	0	99.56	7.62
7	264	10242	3	0	99.97	8.43
Controls	60	1970	226	21 + 7opius	88.53	
Totals (fumigated)	<u>364</u>	<u>14,403</u>				

Fig. 3. Mortality of *D. dorsalis* in pineapples following fumigation with Methyl Bromide at 2 lbs. per 1000 cu. ft. at atmospheric pressure and temperatures of 25-29° F.

- Line A - Mortality of eggs in pineapples infested by caging in the field.
- Line B - " " " " " field infested.
- Line C - " " 3rd instar larvae in artificially infested fruits.



As shown in the preceding tables D. dorsalis eggs in pineapple survived 1 to 4 hours of fumigation with methyl bromide at a dosage of 2 lbs. per 1000 cu. ft. Mortality was complete at 5, 6, & 7 hours. Where pineapples were artificially inoculated with 3rd instar larvae by the plug method, 3 larvae out of 10,242 survived and pupated but did emerge as adults after fumigation with methyl bromide for 7 hours at the 2 lb. dosage.

Line Project I-o-5-4 To test new and previously untried fumigants for use in commodity treatments for D. dorsalis.

Reported injury to vanda orchids as the result of methyl bromide fumigation led to search for substitute fumigants. The aim is to screen as many fumigants as possible to determine their possible value for commodity treatments. Small chambers for pilot testing will be used since some of the materials are available only in small amounts. Tests will involve mortality in host fruits as well as tolerance to commodities. A few materials heretofore not tried against dorsalis were tested in 4 small chambers 24" x 24" x 30" loaned to us by the Pineapple Research Institute. The chambers were equipped with small fans for circulation of air but no provision was made for controlling temperature which for the 5 tests here reported varied from 80 - 83° F. Materials tested were Chloropicrin and Niran (liquid parathion 94% pure), but plans have been made to test others as they become available. In the following tables dosage is expressed as pounds per 1000 cu. ft. unless otherwise stated. Population estimates are based on puparial counts from unfumigated control fruits. Field infested kamani nuts were used in these studies.

Test 1 - Chloropicrin - Exposure 2 hours

<u>Dosage</u>	<u>No. fruits</u>	<u>Estimated infestation</u>	<u>Survivors</u>	<u>Percent Mortality</u>
1 lb.	170	981	0	100
2	170	981	0	100
Control	170	981	981	—

Test 2 - Niran - Exposure 2 hours

The small dosages used were measured into small shell vials 10 mm x 30 mm by means of a burette calibrated in 0.1 ml. Vials were immersed in boiling water for volatilizing the material, but only a small amount was volatilized at the end of the fumigation period.

<u>Dosage</u> ^{1/}	<u>Exp. no fruits</u>	<u>Estimated infestation</u>	<u>Survivors</u>	<u>Percent Mortality</u>
0.2 ml.	88	637	702	—
0.5 "	88	637	641	—
1.0 "	88	637	594	6.75
control	88	637	637	—

^{1/} Actual amounts used in 10 cu. ft. chamber.

Test 4 - Niran - Exposure 2 hours

Measured Niran from burette inserted through hole in cork into chamber, impinging Niran on heated porcelain crucible of 55 ml. capacity (temp. about 200° C.). Volatilization of 0.1 ml. dosage complete, others incomplete.

<u>Dosage</u>	<u>No. of fruits</u>	<u>Estimated infestation</u>	<u>Survivors</u>	<u>Percent Mortality</u>
0.1 ml	75	697	173	75.18
0.3	75	697	68	90.24
0.5	150	1394	212	84.79
1.0	150	1394	100	92.83
control	150	1394	1394	—

Test 5 - Niran - Exposure 2 hours

Method of volatilizing same as in Experiment 4 except that 90 ml. evaporating dish was used and heated to 250° C. with gasoline blow torch.

<u>Dosage</u> ^{1/}	<u>No. fruits</u>	<u>Estimated infestation</u>	<u>Survivors</u>	<u>Percent Mortality</u>
0.1 ml.	250	1194	9	99.25
0.2	250	1194	15	98.78
0.3	250	1194	96	91.95
control	250	1194	1194	—

^{1/} 0.1 ml. dosage volatilization complete. 0.2 & 0.3 ml. dosages left blackened residue in dish indicating possible decomposition.

Test 6 - Niran - Exposure 2 hours

Heated Niran in small glass retort over alcohol lamp and allowed fumes to pass off through tube into the fumigating chamber. Some decomposition occurred as indicated by black residue. Difficulty in passing fumes into chamber because of condensation.

<u>Dosage</u>	<u>No. fruits</u>	<u>Estimated population</u>	<u>Survivors</u>	<u>Percent Mortality</u>
0.1 ml	150	1309	1613	—
0.2	150	1309	1087	16.96
0.3	150	1309	393	69.98
control	150	1309	1309	—

In the one test conducted with Chloropicrin, complete mortality was recorded in field-infested kamani nuts fumigated for 2 hours at 1 lb. and 2 lbs. per 1000 cu. ft. Results with Niran were variable, depending to a great extent on the method of volatilization that was employed. Where volatilization was complete, mortalities of over 99% were recorded at a dosage equivalent to 10 ml. of Niran per 1000 cu. ft.

Line Project I-c-5-5 Investigations of materials as dips for commodity treatments.

For the destruction of dorsalis eggs and larvae in commodities such as flowers where required tissue penetration would be slight, it was thought that the use of dips might be possible.

Four experiments were conducted with the following materials:

- Julius Hyman #118 (4.5% emulsifiable concentrate),
- Julius Hyman Octalox (24% #497 emulsion concentrate), and
- Octalene (24% #118 emulsion concentrate).

All dilutions were in water. Field-infested kamani nuts were used in all tests.

Test 1 - Julius Hyman #118 4.5% emulsifiable concentrate diluted 1 - 400 with water at 25° C. for 5 minutes.

<u>Dilution</u>	<u>No. of fruits treated</u>	<u>Estimated infestation</u>	<u>No. of survivors</u>	<u>Percent Mortality</u>
1-400	30	114	0	100
control	30	114	114	—

Test 2 - Julius Hyman #118 4.5% emulsifiable concentrate.

<u>Dilution</u>	<u>No. of fruits treated</u>	<u>Estimated infestation</u>	<u>No. of survivors</u>	<u>Percent Mortality</u>
1-800	25	49	0	100
1-1600	25	49	0	100
1-3200	25	49	6	87.76
control	25	49	49	—

Test 3 - Julius Hyman Octalox (24% #497 emulsion concentrate).

<u>Dilution</u>	<u>No. of fruits treated</u>	<u>Estimated infestation</u>	<u>No. of survivors</u>	<u>Percent Mortality</u>
1-300	50	62	0	100.00
1-600	50	62	12	80.65
1-1200	50	62	0	100.00
control	50	62	62	—

Test 4 - Julius Hyman Octalene (24% #118 emulsion concentrate)

<u>Dilution</u>	<u>No. of fruits treated</u>	<u>Estimated infestation</u>	<u>No. of survivors</u>	<u>Percent Mortality</u>
1-300	50	98	0	100
1-600	50	98	10	89.80
control	50	98	98	—

The results of the four dipping tests are very encouraging although the data are not extensive. Julius Hyman #118 45% emulsifiable concentrate gave complete kill of D. dorsalis eggs and larvae in field-infested kamani nuts at a concentration of 1 - 1600. However, populations were small and further tests should be run before any conclusions can be made.

Line Project I-o-5-6 Investigations of the application of radiation to commodity treatments.

.1 Use of high intensity electrons.

Studies have already been started by A. H. Yeomans, H. W. Allen, and D. W. Hamilton in cooperation with the Elsetronized Chemical Corporation of Brooklyn, N. Y., to test killing action of insects by means of the Capacitron, a machine designed to accelerate electrons. See Reports of September 21 and October 3 by D. W. Hamilton and A. H. Yeomans.

.2 Use of gamma rays

Investigations to determine the effect of gamma rays on D. dorsalis are being conducted in cooperation with Dr. George Burr of the Hawaiian Sugar Planters Experiment Station. The source of radiation is radio active cobalt 60 with a half-life of 5 years obtained by Dr. Burr from Oak Ridge. Because of aluminum and glass filters which are filtering out the Beta rays we are testing a practically pure gamma ray. The first test with this material was conducted on August 8 at the Hawaiian Sugar Planters laboratory. Since no information is available on effective intensities, dosages used were determined from work reported by Lea on the effect of X-rays on Drosophilla eggs. This first preliminary test was run with D. dorsalis eggs in orange skin sections fastened to glass plates with paraffin. Drosophilla eggs have been reported to be more susceptible to radiation as development progresses. For this reason dorsalis eggs of 4 different stages of development were used to determine possibility of differential reaction. The gamma ray intensity was controlled by varying the distance of the skin sections from the source. These sections were arranged in circles around the cobalt tubes so that eggs of four different age groups were exposed to the same intensity. The results are presented in the following table:

Table 12

The effect of exposing D. dorsalis eggs of varying ages to gamma ray radiation for 2 hours.

<u>Distance</u> <u>Inches</u>	<u>Intensity</u> <u>R.</u>	<u>Age of</u> <u>eggs</u>	<u>No. of eggs</u> <u>exposed</u>	<u>No.</u> <u>hatched</u>	<u>Percent</u> <u>Survival</u>
1.4	1000	5-7 hrs.	153	87	56.87
2.0	500	" "	150	65	40.67
2.8	250	" "	154	99	64.29
4.0	125	" "	132	80	60.61
control	0	" "	147	87	59.18
1.4	1000	10-12 "	35	28	88.57
2.0	500	" " "	38	32	94.74
2.8	250	" " "	40	1	67.50
4.0	125	" " "	40	10	45.00
control	0	" " "	40	28	82.50
1.4	1000	14-16 "	146	101	69.18
2.0	500	" " "	206	156	75.73
2.8	250	" " "	201	131	65.17
4.0	125	" " "	280	136	48.57
control	0	" " "	267	173	64.79
1.4	1000	20-22 "	87	61	70.11
2.0	500	" " "	115	90	78.26
2.8	250	" " "	112	60	53.57
4.0	125	" " "	102	94	92.16
control	0	" " "	97	63	64.95

The results of this preliminary test indicate that the intensities used were sub-lethal. On the basis of work reported by Lea the possibility exists that drosophila eggs are more resistant to radiation than those of D. dorsalis, or that gamma rays are less effective per Roentgen than X-rays. Dr. Burr plans to re-check his cobalt measurements after which further studies will be conducted at higher intensities.

Line Project I-c-5-7 Investigations to determine infestation indices in commercial grade fruits and vegetables.

These studies were started in November of last year with papayas. Collections were made once or twice a month up to the present. Recently the following commodities have been added: tomatoes, cucumbers, bell peppers, egg plant, and avocado. Other potential export crops will be added as they become available. These studies are very important in order to determine the hazard these crops present to spreading the Oriental fruit fly to mainland areas. Sufficient data are needed to establish a sound basis for estimating populations fruit fly that could enter commerce from such sources. Treatment severity for all commodities can then be adjusted to take care of any desired level of security. The following table gives the results for papayas for fruit collections from Nov. 3, 1948 until Sept. 12, 1949:

Table 13

Intensity of D. dorsalis infestation in mature green, one-quarter ripe, and one-half ripe papayas collected during the period Nov. 3, 1948 to Sept. 12, 1949.

<u>No. of fruits</u>	<u>Degree of maturity</u>	<u>Infestation</u>
2538	mature green	1
135	1/4 ripe	0
75	1/2 ripe	31

The above figures indicate that fruit fly infestation is extremely light in the mature green stage, which is the commercial shipping stage. The data on the 1/4 ripe are not very extensive, but show that even at this stage infestation is probably very light. This would assure a margin of safety for grading since there is no clear-cut definition for maturity as each successive stage grades gradually into the next.

Line Project I-c-5-8 Investigations to determine commodity tolerance to methods of sterilization under study, and to determine ways and means of improving tolerance by appropriate pre- or post-fumigation techniques if found necessary. (Cooperative project with the Hawaiian Agricultural Experiment Station.)

The plan of investigation to date has been as follows: Commercial grade commodities have been included for tolerance tests under the following line projects: -

I-c-5-1 Vapor-heat. Papayas, tomatoes, bell peppers, Italian (Zucchini) squash, cucumbers, egg plant, string beans, and avocados were tested to determine tolerance to treatment.

I-c-5-3 Fumigation. Vanda joaquin blooms were tested to determine tolerance to all materials used for mortality determinations.

I-o-5-4 Dips. Vanda joaquim blooms were tested for tolerance to all dips under investigation.

The treatments were planned and executed under the above mentioned line projects, and the commodities were turned over to Mr. Ernest Akamine for tolerance determination.

SUMMARY

Thirty nine experiments have been completed with the vapor-heat quick run-up method. Five thousand one hundred and eighteen ripe field-infested papayas with an estimated D. dorsalis infestation of 116,259 eggs and larvae were treated by this method at temperatures from 111° F. to 120° F. Fruits were treated with and without conditioning for 6 hours at reduced humidity. In the conditioned fruits last survival was recorded at 119° F. where one survivor was obtained out of 8,131 individuals. In the non-conditioned lot last survival was recorded at 117° F, 5 out of 5,651 individuals, and none at 118, 119 and 120° F.

Low temperature studies were conducted at 32, 34, and 35° F. Five tests were run with field-infested pineapple, papaya, guava, and mango. At 32° F. mortality was complete in guava after 8 days. At 34° F. eggs in pineapple survived 13 days exposure at this temperature. One egg hatched out of 611 exposed. In mangoes held at 34° F. mortality was complete in 6 days. At 35° F. papayas gave no survivors after 7 days holding.

Approximately 15,000 Vanda joaquim blooms were artificially infested with D. dorsalis and fumigated with methyl bromide at the rate of 2 lbs. per 1000 cu. ft. and exposures from 1/2 hour to 5 hours. 22,891 eggs and larvae were involved in these tests. Two survivors were recorded out of 10,080 individuals exposed for 2 hours, but none beyond. Out of 44,335 eggs exposed in open petri dishes to the 2 pounds per 1000 cu. feet dosage survivors were recorded at 30 minutes, 45 minutes, and 1 hour, but beyond these exposures mortalities were complete.

Thirty tests were conducted with methyl bromide and pineapple. These tests involved fruits naturally infested in the field, fruits infested by caging with flies, and fruits artificially infested with third instar larvae by the plug method. Survival of eggs was recorded from fruits fumigated at the two pound dosage at exposures up to 4 hours but none at 5, 6, and 7 hours. A total of 9,859 eggs were involved in these tests. From 14,403 larvae fumigated with the plug method 3 larvae survived and pupated out of 10,242 fumigated at the seven-hour exposure.

In preliminary fumigation tests with Chloropicrin and Niran (liquid parathion), Chloropicrin was effective at 1 and 2 pounds. Tests with Niran showed great variability due to incomplete volatilization.

Julius Hyman compounds 118 and 497 were investigated as dips in the form of emulsions. Compound 118 - 45% emulsifiable concentrate showed most promise, and was effective at a dilution of 1-1600 with water.

The effect of gamma rays against D. dorsalis eggs was tested. Intensities of 125 Roentgens to 1,000 Roentgens were ineffective.

Results from holding mature green papayas to determine index of infestation showed one larva was obtained from 2,538 fruits collected during the past ten months.

Tests to determine tolerance of commodities to vapor-heat indicated that papayas, tomatoes, bell pepper and Italian squash could be treated successfully. Information on cucumber and egg plant are incomplete, but show promise of tolerating treatment with proper conditioning.

LINE PROJECTS

PROJECT I-o-5 (Commodity Treatments)

Proposed Line Projects

- I-o-5-1 Investigations to develop mortality - time - temperature curves under vapor-heat sterilization.
- I-o-5-2 Investigations to develop mortality - time - temperature curves under low temperatures.
- I-o-5-3 To develop a time - dosage - mortality curve under methyl bromide fumigation.
- I-o-5-4 To test new and previously untried fumigants for use in commodity treatments for D. dorsalis.
- I-o-5-5 Investigations of materials as dips for commodity treatments.
- I-o-5-6 Investigations of the application of radiation to commodity treatments.
- I-o-5-7 Investigations to determine infestation indices in commercial grade fruits and vegetables.
- I-o-5-8 Investigations to determine commodity tolerance to methods of sterilization under study, and to determine ways and means of improving tolerance by appropriate pre- or post- fumigation techniques if found necessary. (Cooperative project with the Hawaiian Agricultural Experiment Station)