

Project Number 75-13

Project Title: On-Farm Fumigation of Almonds for Navel Orangeworm

TITLE : Project 75-I. Fumigation.

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I. OBJECTIVES & GOALS:

Methyl Bromide

To continue to work with the Environmental Protection Agency (EPA), through the IR-4 program, to obtain a use tolerance and a label that will permit the use of methyl bromide as a fumigant for almond hulls and shells.

Hydrogen Phosphide (Phosphine)

Hydrogen phosphide continues to be the only fumigant approved for use on inshell almonds and for inshell almonds if the hulls and shells are to be used for animal feed. Studies were conducted to obtain more specific information on the effective dosage level and exposure periods for hydrogen phosphide when applied in pellet or tablet form. To evaluate the relative effectiveness when pellets were placed in phostrays or scattered over the surface of the stack and when the tablets were broadcast over the surface of the stack.

Influence of Various Stack Coverings Upon the Temperature build up within the Covered Almonds

There is some evidence that when almond meats are subjected to high temperatures (around 130°F), significant damage to the almond meats can occur. Temperatures exceeding 130°F have been obtained within stacks of almonds covered with clear polyethylene sheeting. In view of this potential problem, four different kinds of material were evaluated relative to the amount of temperature build up under each.

Preparation of Fumigation Manual

A manual was prepared and made available to the almond industry that described the procedure for the use of hydrogen phosphide as a fumigant for inshell almonds stored on the farm.

II. INTERPRETIVE SUMMARY:Methyl Bromide

Before the Environmental Protection Agency will act upon the petition now before them, regarding the use of methyl bromide on almond hulls and shells, additional information is needed. The agency is asking for levels of organic and inorganic bromide present in in-hull almonds fumigated with methyl bromide at the rate of 2 and 4 lbs per 1000 cu ft for 24 hours. This information will be obtained next summer.

Hydrogen Phosphide (Phosphine)

In cooperation with the Superior Farming Co., Bakersfield, CA. a number of stacks of in-hull almonds were fumigated with hydrogen phosphide as pellets and as tablets. The pellets were applied at rates of 75, 100 and 165 per 1000 cu ft for 48 hours and the tablets at 15, 20 and 33 per 1000 cu ft for 72 hours. The results indicated that in 3 tests from 96.7 - 100% mortality of the navel orangeworm eggs was obtained by the lowest dosage of both pellets and tablets, and from 99 - 100% by the higher dosages. Whether the pellets were placed in phostrays or scattered over the stacks seemed to make little difference in the results. It was observed the temperature levels within the stacks of in-hull almonds produced varying amounts of mortality of the eggs and pupae of the NOW. In the other 4 tests poorer results were obtained due to the lower concentration of fumigant and reduced temperatures of the almonds.

Influence of Different Coverings Upon Temperature within Stacks

A test was conducted where four stacks of in-hull almonds were covered with four different coverings. Temperature measurements were taken within each stack. One stack was covered with clear 6 mil polyethylene, one with 6 mil black polyethylene, one with 4 mil white polyethylene, one with mylar coated with aluminum (emergency blanket) and one stack remained

uncovered. The temperature range within the stack covered with clear plastic was 48-160 °F, covered with black plastic 46-160 °F, white plastic 44-139 °F, and coated mylar 57-80 °F. Temperature in the uncovered stack ranged from 51-106 °F.

Preparation of Fumigation Manual

In cooperation with the Fresno County Farm and Home Advisors office a manual on the fumigation of in-hull almonds with hydrogen phosphide was prepared. This manual was made available to the almond industry at the beginning of the 1976 almond harvest season.

III. EXPERIMENTAL PROCEDURES:

Methyl Bromide (1976 Activities)

Near the end of the 1976 almond harvest word was received from Dr. Comptom, Coordinator of IR-4 Program, that EPA had requested additional information before the petition for the use of methyl bromide as a fumigant for almond hulls and shells could be processed. The request stated that information was needed on the amount of organic and inorganic bromide residues present in in-hull almonds when fumigated with methyl bromide in stacks covered with plastic sheeting. To obtain this data 3 stacks are to be fumigated at the rate of 2 lbs of methyl bromide/M cu ft and 3 stacks at the rate of 4 lbs/M cu ft for 24 hours. Samples of in-hull almonds for residues analysis are to be taken before fumigation and at intervals after fumigation. From these samples the level of organic and inorganic bromide residues will be determined to which will include the hulls, shells and nutmeats.

Hydrogen Phosphide (Phosphine) 1976 Studies

Seven tests were conducted during the 1976 almond harvest season and each test included 12 stacks of in-hull almonds. In each test the stacks of almonds were placed on clean, smooth soil and covered with 6 mil clear

polyethylene sheeting. Nonpareil almonds were used in the first six tests and the Mission variety in the last test. In five tests pellets were used and applied at rates of 75-100 and 165 per 1000 cu ft of space with an exposure period of 48 hours. In three of the tests pellets were placed on phostrays and in two of the tests they were broadcast over the side of the stacks.

In two tests tablets were used and were scattered over the sides of the stacks at the rates of 15-20 and 33 per 1000 cu ft. The exposure period was 72 hours. The dosage rates of pellets and tablets were the same since 5 pellets are equal to one tablet.

In each of the seven tests fumigant sampling tubes and temperature probes were placed in the same four locations within each. The first location was in the air space between the top of the stack and the plastic covering, the second approximately 1 ft from top and 1 ft in from the edge in top corner of each stack. The third location was in the center of almond mass and the fourth 1 ft from the ground and 1 ft in from the side of the opposite corner as location 2. Laboratory reared test insects were used to determine the effectiveness of the tests. The insect samples were the early egg and pupae stages of the navel orangeworm. They were placed at locations 2, 3 and 4 in each stack. Fumigant and temperature readings were taken at the end of 1, 2, 4, 8, 12, 24, 36 and 48 hours during the 48 hour exposure period and at intervals of 1, 2, 4, 8, 12, 24, 36, 48, 60 and 72 hours during the 72 hour exposure period. Concentrations of hydrogen phosphide were determined by the use of auer tubes and the temperature readings by temperature probes attached to a portable telethermometer.

In each test three of the twelve stacks were used as controls. These control stacks were covered with plastic and test insects and temperature probes were placed in the same manner as in previously mentioned stacks.

In all but one test an additional representative sample of insects was held at the laboratory under controlled conditions to measure the effect of temperature levels existing in the stacks on insect mortality.

Samples of almonds were taken from the stacks in three of the tests. These samples were used to determine the moisture content of the almond hulls, shells and nutmeats. The standard toluene distillation method was used in making the moisture determinations.

The steps to follow in fumigating stacks with hydrogen phosphide are presented in the fumigation manual mentioned earlier.

Effect of Various Stack Coverings Upon Temperature of Almonds

Six stacks of inshell almonds of the Mission varieties were used. In general the stacks were prepared in the same manner as those previously described. One stack was covered with clear 6 mil polyethylene sheeting, one with black 6 mil polyethylene sheeting, one with 4 mil white polyethylene sheeting, one with mylar coated on one side with aluminum (emergency blanket) and one stack was not covered. Temperature probes were placed at five locations in each stack eg. in air space between top of stack and sheeting on almond surface at top of stack, top corner 1 ft below surface of almonds and 1 ft in from edge, center of stack and opposite bottom corner 1 ft above sail and 1 ft in from edge of stack. Temperature readings were taken at 9:00 a.m. and at hourly intervals through 5:00 p.m. the same day.

IV. RESULTS AND DISCUSSION:

Hydrogen Phosphide (Phosphine) 1976 Studies Results

The results of this study are summarized in tables 1 through 9. Table no. 1 contains the average concentration of hydrogen phosphide found at each sampling period during the 48 hour exposure period for each test, dosage, and whether the pellets were placed in phostrays or broadcast over

the surface of the stacks. In table 2 the temperature readings are presented. Table no. 3 contains average fumigant concentrations and temperatures for locations in stacks that were fumigated with pellets. The average fumigant concentrations derived from each dosage of tablets for each sampling period during the 72 hour exposure period are found in table 4. The average temperature readings are presented in table 5. Table 6 contains the average fumigant concentrations where tablets were used also temperatures summarized by location in stacks. Summary of the effect on the navel orangeworm eggs and pupae in the tests where pellets were used table 7, and in those where tablets were used table 8. The average percent moisture found in inshell almonds from three tests is summarized in table 9.

Discussion:

The results show that a 100% kill of the test pupae of the NOW was obtained in all but test no. 4 (table 7) and even then only one pupa survived at the lowest dosage. The early egg stage (less than 24 hrs old) was more difficult to kill. High mortality of the NOW eggs was obtained in tests no. 1 & 2 (table 7) and in test no. 3 (table 8). In test no. 1 the average temperatures were extremely high, 112.5-138.4 (table 2), within the stacks. The maximum air temperature during the tests was 109°F. The almonds were also low in moisture (table 9). The concentration of hydrogen phosphide was at a high level 102.5-212.5 ppm (table 1) at the end of 36 hrs. Extremely high mortality occurred in the controls (table 7) which was a result of the high temperatures. In test no. 2 the pellets were broadcast over one side of the stack. This resulted in a more rapid generation of hydrogen phosphide (table 1) though in test no. 1 (table 1) and at the end of 24 hours a high concentration 179.2-322.9 ppm (table 1) of fumigant remained. The average temperature readings were also high 110.3-128°F (table 2). A high mortality of the eggs resulted from all

three dosage levels 98.5-99.6% (table 7). In test no. 3, where tablets were used, high fumigant concentrations 154.6-304.2 ppm (table 4) were present at the end of 36 hrs at the 20 and 33 tablet dosage levels the temperatures were also high 94-114^oF (table 5). High mortality of the egg stage was obtained at all three dosage levels 96.7-99.3 and 100% (table 8).

In the remaining tests 4, 5, 6, (table 1) and 7 (table 4), a poor kill of the eggs was obtained. This was probably a result of lower fumigant concentrations and a decrease in temperature of the almonds.

As previously mentioned, the almonds were lower in moisture at the beginning of the study but as a result of the rains there was an increase in the amount of moisture present (table 9).

Effect of Various Stack Coverings on the Temperature of Almonds

Results:

This preliminary study indicated that, of the material tested, the clear and black plastic produced the highest temperatures (average of 99.1 and 95.9^oF respectively) within the stacks of almonds. The average temperature in the stack of almonds covered with white plastic was 82.5^oF, in the stack covered with mylar coated with aluminum 67.5^oF and in the uncovered stack 66.6^oF (table 10).

Discussion:

Since there is some evidence that temperatures around 130^oF and higher can cause damage to the almond meats it is important to find a material that will contain fumigants and not cause dangerously high temperature build up in the almonds.

V. CONCLUSIONS AND RECOMMENDATIONS:

Conclusions:

Hydrogen Phosphide

Under normal conditions that exist during the almond harvest seasons, it would appear that stacks of inshell almonds can be successfully fumigated with hydrogen phosphide applied as pellets at a dosage of 75-100 per 1000 cu ft with an exposure of 48 hrs. It would also appear that the pellets can be placed in phostrays or broadcast over the surface of the stack with equal effectiveness. Preliminary studies with the use of tablets also seems promising. In order to fumigate inshell almonds effectively with hydrogen phosphide it would seem that the temperature of the almonds should not be lower than 80°F and the fumigant concentrations at the end of 24 hrs into the exposure period, should be greater than 100 ppm.

Stack Coverings for Almonds

On the basis of a preliminary study it would appear that a suitable material could be found that would keep the temperature at levels that would not damage the almonds and also contain the fumigants.

Recommendations:

1. Provide the organic and inorganic residue data requested by EPA.
2. Conduct additional studies on the use of hydrogen phosphide in tablet form.
3. Conduct preliminary studies using fumicels should they become available.
4. Follow up studies regarding coverings for stacks of almonds that would not escalate temperature but would contain fumigants.
5. Begin working on a procedure to circulate air within stacks of inshell almonds.
6. Revise the hydrogen phosphide fumigation manual if necessary.

Table No. 1. Summary of the average concentrations of hydrogen phosphide found in stacks of in-hull almonds taken at intervals during the 48 hr. exposure period. The almonds were fumigated with hydrogen phosphide applied in pellet form at three dosage rates. Tests were conducted at the Superior Farming Co., Bakersfield CA, Sept-Oct-1976

Dosage Pellets per M cu ft	Test NO.	Average concentrations of hydrogen phosphide present in stacks of in-hull almonds at indicated intervals during the 48 hr. exposure period. Superior Farming Co. Sept-Oct. 1976							
		1 hr	2 hrs	4 hrs	8 hrs	12 hrs	24 hrs	36 hrs	48 hrs
		PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM

Pellets Placed on phostrays

75	1	8.0	10.3	16.2	63.3	111.7	102.9	102.5	60.0
100	1	15.4	24.1	65	200	198.3	270.6	197.7	79.1
165	1	32.1	51.6	110.4	231.3	489.6	441.7	212.5	154.6
75	5	25.4	50.4	79.6	212.5	187.5	25.8	0.7	0.0
100	5	32.0	62.5	102.1	300	325	59.6	1.5	0.0
165	5	48.8	92.1	160.8	533	508	88.3	9.2	0.0
75	6	9.1	21.7	39.6	150	225	92.9	34.2	12.3
100	6	12.5	20.9	57.5	203.3	272.9	93.8	35.4	8.5
165	6	9.6	25	50	142.7	345.8	133.3	55.8	21.7

Pellets broadcast over side of stack

75	2	52.5	97.5	109.2	308.3	354.2	179.2	27.1	12.1
100	2	72.5	132.9	125.8	350	337.5	200	53.8	15.9
165	2	170.8	162.5	175.0	250	366.7	322.9	191.7	44.6
75	4	29.6	29.2	90.4	133.3	241.7	36.2	4.0	0.0
100	4	34.6	47.9	162.5	212.5	220.8	36.7	5.0	0.0
165	4	70.0	142.1	325	425	375	88.9	13.3	0.3

Table No. 2. Summary of the Average Temperature in °F found in stacks of in-hull almonds at intervals during the 48 hr. exposure period. The almonds were fumigated with hydrogen phosphide applied in pellets form at 3 dosage levels. Superior Farming Co. Bakersfield Cal. Sept-Oct 1976

Dosage Pellets Per M cu ft		Average temperature readings in °F taken within stacks of in-hull almonds at indicated intervals during fumigation period								
Test No.	Test No.	1 hr °F	2 hrs °F	4 hrs °F	8 hrs °F	12 hrs °F	24 hrs °F	36 hrs °F	48 hrs °F	
Pellets placed on Phostrays										
75	1	123.7	124.0	123.7	122.3	116.1	128.4	124.3	131.9	
100	1	122.9	123.3	121.1	117.5	112.5	127.9	116.6	132.7	
165	1	125.9	128.1	124.3	123.1	114.9	133.1	120.5	134.8	
Untreated	1	126.4	126.8	126.0	123.7	118.6	132	128.3	138.4	
75	5	101.7	105.2	106.1	100.1	95.0	114.8	102.2	127.7	
100	5	116	114	115	100.6	95.3	121.3	100	123	
165	5	111.4	112.9	107.1	101.6	97.2	124.3	100.7	128.1	
Untreated	5	123.5	127.4	119.0	111.8	100.6	144.8	102	138.4	
75	6	83.6	82.2	78.4	74.9	70.7	87.2	55.5	99.8	
100	6	88.9	88.3	82.7	76.5	72.9	95.5	57.2	93.1	
165	6	83.1	80.3	78.1	73.5	69.1	93.7	54.5	86.2	
Untreated	6	86.8	86.0	80.6	76.5	71.5	67.4	55.1	97.4	
Pellets broadcast over side of stack										
75	2	126.3	127	126.8	123.1	119.5	114.6	152.9	112	
100	2	120.4	122.2	121.7	121.8	116.8	113.5	113.1	110.3	
165	2	123.5	123.2	122.9	117.5	114.4	114.5	110.3	112.2	
Untreated	2	124.4	127.4	128	124.1	117.2	116.2	116.9	114.2	
75	4	—	—	—	96.7	88.9	107.1	101.5	117.6	
100	4	—	—	—	98.2	96.4	116.3	106.2	122	
165	4	—	—	—	93.7	89.7	117.0	105.0	123.8	
Untreated	4	—	—	—	112.7	99.6	123.7	110.1	126.9	

Table No. 3 summary of the avg. concentrations of hydrogen phosphide at 4 locations in each stack during the 48 hr exposure period. The stacks were fumigated with hydrogen phosphide applied in pellet form at three dosage rates. Superior Farming Co., Bakersfield CA - Sept + Oct 1976.

Dosage	Pellets per M. Cuft.	Test No.	Average Fumigant Concentration at each location in stack				Average temp. readings taken at each location in stack			
			1 ¹¹	2 ²¹	3 ³¹	4 ⁴¹	1 ¹¹	2 ²¹	3 ³¹	4 ⁴¹
			P.P.M	P.P.M	P.P.M	P.P.M	°F	°F	°F	°F

Pellets placed on phostrays

75	1	60.4	57.8	58.9	60.4	-	132.7	122.4	117.8
100	1	142.5	145.9	135.2	165.8	-	134.6	120.6	111.8
165	1	201.3	271.2	227.6	236.3	120.1	141.4	126.1	113.5
untreated	1	-	-	-	-	139.6	130.9	127.5	116.9

75	5	67.9	87.1	68.3	67.7	-	130.2	115.7	85.5
100	5	108.5	143	95.6	94	-	128.5	121.9	86.8
165	5	168.3	185	203.1	164	125.9	129.1	124.0	82.0
untreated	5	-	-	-	-	-	133.2	126.6	110.0

75	6	70.9	72.0	81.3	74.8	-	88.1	83.1	69.6
100	6	69.6	109.7	87.6	85.0	-	90.4	86.3	71.5
165	6	84.4	125.2	110.4	104.8	83.4	87.5	76.6	68.9
untreated	6	-	-	-	-	-	85.8	82.3	67.3

Pellets broadcast over side of stack

75	2	116.9	119.4	129	221.5	-	128.2	118.4	111.1
100	2	170.0	133.5	138.3	172.7	-	126.7	117.3	108.0
165	2	203.5	188.6	220	232.1	126	124.2	116.7	109.1
untreated	2	-	-	-	-	125.9	128.1	119.7	113.2

75	4	80.3	44.4	60.3	102.5	-	129.3	110.1	79.9
100	4	62.8	73.4	82.9	104.9	-	127.7	113.4	82.3
165	4	155.8	153.8	187.9	222.3	128.1	125.1	111.3	81.9
untreated	4	-	-	-	-	125.9	130.9	122.5	84.4

Table No. 4. Summary of the average concentrations of hydrogen phosphide found in stacks of inshell almonds taken at intervals during the 72 hr. exposure period. The stacks were fumigated with hydrogen phosphide applied in tablet form at three dosage levels. Tests were conducted at the Superior Farming Co. Bakers Field CA. Sept + Oct. 1976.

Dosage Tablets per M. cu. ft.	Test No	Average phosphine concentrations in stacks of inshell almonds taken at indicated intervals during 72 hr exposure period									
		1 hr P.P.M.	2 hrs P.P.M.	4 hrs P.P.M.	8 hrs P.P.M.	12 hrs P.P.M.	24 hrs P.P.M.	36 hrs P.P.M.	48 hrs P.P.M.	60 hrs P.P.M.	72 hrs P.P.M.
Tablets broadcast over side of stack											
15	3	45.4	60.8	110.8	287.5	387.5	160.4	52.5	11.3	0.3	0.2
20	3	46.4	62.1	102.9	189.6	331.3	181.6	154.6	17.6	5.8	0.2
33	3	70.1	102.2	135	312.5	666.7	608.3	304.2	156.7	24.2	16.0
15	7	8.7	7.3	11.7	30.4	52.1	107.5	94.2	83.0	29.6	11.2
20	7	11.3	7.5	12.5	27.5	60	117.5	102.5	112.5	37.5	12.5
33	7	18.4	35	41.7	166.7	360.4	833.3	225	139.3	51.2	26.2

Table No: 5 Summary of average temperatures in °F recorded from stacks of in-hull almonds at specified intervals during the 72 hr exposure period. The almonds were fumigated with hydrogen phosphide in tablet form applied at 3 dosage levels. These tests were conducted in cooperation with the Superior Farming Co. Bakersfield CA - 1976.

Dosage Tablets	Average temperature readings in °F taken in stacks of in-hull almonds at indicated intervals during 72 hr. Exposure period.										
Per Mu ft.	Test	1 hr	2 hrs	4 hrs	8 hrs	12 hrs	24 hrs	36 hrs	48 hrs	60 hrs	72 hrs
<u>NO.</u>	<u>NO.</u>	<u>°F</u>	<u>°F</u>	<u>°F</u>	<u>°F</u>	<u>°F</u>	<u>°F</u>	<u>°F</u>	<u>°F</u>	<u>°F</u>	<u>°F</u>

Tablets broadcast over side of stack

15	3	129.7	120.4	123	115.1	114.2	124.7	100.8	128.3	100.9	139.8
20	3	121.1	119.7	123.1	117.3	116.8	125	94.3	109.5	96.9	133.6
33	3	120.5	121.9	117.3	111.2	111.1	122.2	105	118.1	108.3	136.1
Untreated	3	124.9	120.2	119.9	120.9	118.2	127	114	120.9	120.6	130.5
15	7	90.5	75.4	70.9	68.0	64.0	81.2	68.3	86.2	69.5	86.6
20	7	85.9	74.2	70.4	67.5	64.6	80.4	68.1	84.6	70.0	90.1
33	7	85.9	72.8	69.6	64.8	61.7	81.3	70.1	84.3	70.4	93.9
Untreated	7	82.5	71.9	67.8	64.6	61.9	77.3	66.4	80.8	68.0	85.0

Table No. 6 Summary of the average concentrations of hydrogen phosphide + temperature taken at 4 locations in each stack during the 72 hr. exposure period. The stacks of inshell almonds were fumigated with hydrogen phosphide applied in tablet form at three dosage rates. In cooperation with Superior Fumigation Co., Bakersfield CA. Sept + Oct 1976.

Dosage Tablets per Mcu ft.	Test No.	Average fumigant concentration at each location in stack				Average temp. readings taken at each location in stack.			
		1 ¹⁾	2 ²⁾	3 ³⁾	4 ⁴⁾	1 ¹⁾	2 ²⁾	3 ³⁾	4 ⁴⁾
<u>No.</u>	<u>No.</u>	<u>P.P.M.</u>	<u>P.P.M.</u>	<u>P.P.M.</u>	<u>P.P.M.</u>	<u>°F.</u>	<u>°F.</u>	<u>°F.</u>	<u>°F.</u>

Tablets broadcast over side of stack

15	3	104	90.5	96.8	155.4	—	133.4	119.9	107
20	3	91	87.8	106.1	151.1	—	135.2	112.2	99.8
33	3	224.6	212.1	232.9	289	126	134.3	110.5	100.2
untreated	3	—	—	—	—	135	136.9	108.4	102.8

15	7	49	42.7	41.2	41.5	92.1	81.1	65.8	68.2
20	7	74	59.7	68.3	65.8	94	77	64.7	66.8
33	7	145	193	163.5	166.7	92.1	78.5	66.3	65.3
untreated	7	—	—	—	—	86.4	75.7	65.6	64.4

- 1) = Air space above almonds
- 2) = Top corner 1ft. below surface of almonds + 1ft in from side
- 3) = As close to the center of stack as possible
- 4) = Opposite bottom corner from (1) above - 1ft. from ground + 1ft. in from edge of stack.

Table No. 7 Summary of the mortality of Navel Orange worm eggs & pupae resulting from 5 tests in which stacks of in-hull almonds were fumigated with 3 dosages of hydrogen phosphide applied in pellet form. Superior Farming Co., Bakersfield CA. Sept + Oct. 1976.

Dosage pellets	Per. Mort. Test #	Navel orange worm fumigated in early egg stage			Navel orange worm fumigated in pupal-stage			
		Unhatched	Hatched	Hatched	Dead	Alive	Pupated	Alive + Pupated
	Number	Number	Number	Per Cent	number	number	Number	Per Cent

Pellets placed on phos trays

75	1	1090	0	0	90	0	0	0
100	1	913	0	0	90	0	0	0
165	1	869	0	0	90	0	0	0
untreated ^{1/}	1	869	135	13.4	169	2	25	13.8
75	5	658	100	13.2	270	0	0	0
100	5	493	400	44.8	270	0	0	0
165	5	1154	150	11.5	270	0	0	0
untreated ^{1/}	5	619	173	21.8	171	1	98	36.7
untreated ^{2/}	5	1	118	99.2	4	0	116	96.7
75	6	1000	577	36.6	270	0	0	0
100	6	1114	379	25.4	270	0	0	0
165	6	1007	537	34.8	270	0	0	0
untreated ^{1/}	6	560	762	57.6	108	2	160	60.0
untreated ^{2/}	6	73	374	83.7	19	0	161	89.4

Pellets broadcast over side of stack

75	2	1093	17	1.5	270	0	0	0
100	2	1185	12	1.0	270	0	0	0
165	2	1206	5	0.4	270	0	0	0
untreated ^{1/}	2	250	856	77.4	0	72	198	100
untreated ^{2/}	2	115	675	85.4	0	64	146	100

Table NO. 7 (contd)

Dosage Pellets	Per Mouth Test	Navel orangeworm fumigated in early egg stage			Navel orangeworm fumigated in pupal stage.			
		Unhatched	Hatched	Hatched	Dead	Alive	Pupated	Alive + Pupated
number	number	number	Number	Per Cent	Number	Number	Number	Per Cent
Pellets broadcast over side of Stack								
75	4	602	463	43.5	269	0	1	0.4
100	4	584	462	44.2	270	0	0	0
165 ¹⁾	4	868	489	36.0	270	0	0	0
Untreated ²⁾	4	667	656	49.6	118	14	138	56.3
Untreated ²⁾	4	32	795	96.1	21	96	157	92.3

1) = Insects were placed in stacks of inshell almonds covered with 6 mil. clear plastic sheeting but were not fumigated.

2) = Insects were held in the laboratory at a temperature of $80 \pm 1^\circ \text{F}$ + $60 \pm 2\%$ relative humidity.

Table No. 8 Summary of the mortality of Navel Orangeworm eggs and pupae resulting from 2 tests in which stacks of inshell almonds were fumig. with 3 dosages of hydrogen phosphide applied in tablet form. Superior Farming Co. Bakersfield CA, Sep. + Oct. 1976.

Dosage Tablets	Per Muft	Test	Navel orange worm fumigated in early egg stage			Navel orangeworm fumigated in pupal stage			
			Unhatched	Hatched	Hatched	Dead	Alive	Pupated	Alive + Pupated
Number	Number	Number	Number	Percent	Number	Number	Number	Percent	

Tablets broadcast over side of stack

15	3	1570	54	3.3	270	0	0	0
20	3	1429	10	0.7	270	0	0	0
33	3	1790	0	0.0	240	0	0	0
Untreated ¹	3	765	576	43.0	90	1	178	66.5
Untreated	3	67	1060	94.1	13	5	250	95.1
15	7	523	464	47.0	270	0	0	0
20	7	456	575	55.8	270	0	0	0
33	7	667	567	43.2	270	0	0	0
Untreated ²	7	165	715	81.2	47	44	146	80.2
Untreated	7	90	318	98.0	7	35	98	94.2

Table No.: 9

Average moisture content of in-hull almonds fumigated with hydrogen phosphide. The almonds were from those used in tests 1-2+3 conducted at the Superior Farming Co. Barkers Field CA. Sept + Oct. 1976.

		Average moisture content found in almond hulls, shells, nut meats + in composite of all three.			
<u>Test</u>	<u>Fumigated</u>	<u>Hulls</u>	<u>shells</u>	<u>Nut meats</u>	<u>Composite</u>
<u>Number</u>	<u>date</u>	<u>Per cent</u>	<u>per cent</u>	<u>Per cent</u>	<u>Per cent</u>
1	9/1-3/76	3.67	4.70	2.26	4.60
2	9/8-10/76	11.17	4.24	4.10	9.19
5	10/5-7/76	9.00	7.53	5.33	7.30

TEMPERATURE READINGS OBTAINED AT SIX LOCATIONS IN EACH OF FOUR STACKS OF INHULL ALMONDS COVERED WITH DIFFERENT MATERIALS AND IN ONE UNCOVERED STACK DURING A 24 HR PERIOD. BAKERSFIELD

LOCATION IN STACK	CLEAR PLASTIC		WHITE PLASTIC		BLACK PLASTIC		SPACE EMERGENCY BLANKET	
	RANGE	AVG.	RANGE	AVG.	RANGE	AVG.	RANGE	AVG.
LOCATION	°F	°F	°F	°F	°F	°F	°F	°F
1. AIR SPACE ABOVE STACK	80-160+	135.6	66-139	103	83-160+	136.5	61-80	73.3
2. SURFACE OF STACK OF ALMONDS	83-160+	135.6	68-125	104.1	75-149	117.8	62-76	70.8
3. TOP CORNER 1 FT BELOW SURFACE & 1 FT IN FROM EDGE	72-102	89.7	60-85	75.4	58-122	96.4	65-72	66.8
4. CENTER OF STACK	71-74	72.0	73-75	74.0	68-69	68.4	66-68	66.8
5. OPPOSITE BOTTOM CORNER FROM 3 ABOUT, 1 FT IN FROM SIDES & 1 FT FROM BOTTOM.	48-70	62.8	44-61	56.05	46.68	60.2	57-62	59.6

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76-13

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
Western Region
California-Nevada-Hawaii Area
Stored-Product Insects Research Laboratory
5578 Air Terminal Drive
Fresno, California 93727

December 30, 1976

Mr. Dale Morrison
Director, Special Projects
ALMOND CONTROL BOARD
P.O. Box 15920
Sacramento, CA 95813

Dear Dale:

Forwarded herewith are 3 cys of the Annual Report covering all projects except for Dr. Curtis' projects.

Each project report is separated by plain green paper for your convenience.

Dr. Curtis will be submitting his portion of the report early next week.

Sincerely,

D. K. Hunter
Acting-in-Charge

Enclosures

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