78-15

Title: Project 78-I5. Fumigation.

Prepared by: Howard D. Nelson

I. Objectives:

Methyl Bromide

To complete the organic and inorganic bromide analyses of inhull almonds that were fumigated during the fall of 1977 with methyl bromide applied at the rates of 2 and 4 lbs/M cu ft for 24 hrs. This data to be summarized and forwarded through IR-4 to EPA in the form of a petition to obtain a tolerance for the use of methyl bromide as a fumigant for almond hulls and shells.

Malathion

Although the research on the use of malathion as a protectant for inshell almonds was not funded by the Almond Board, the industry will be interested to know that this laboratory is working through IR-4 and EPA to establish a tolerance for the use of this material on almond shells.

Hydrogen Phosphide (Phosphine)

This material continues to be the only approved fumigant for use on almond hulls and shells if the hulls and shells are to be used for cattle feed. The object of this years study was to obtain additional information on the effectiveness of aluminum phosphide tables against eggs and pupae of the NOW present in stacks of inhull almonds stored on the farm.

Revision of Fumigation Manual

The time has come to revise this manual since the supply of the original issue is exhausted and in the meantime new information has become available.

Aeration Systems for the Use in Stacks of Inhull Almonds

As indicated in the 1977 report the grain industry for a number of years been using the passage of air through bulk grain as a means of controlling temperature and moisture in the grain also as a means of applying, circulating

and exhausting fumigants from the grain mass. Considerable time was spent in preparation for this project.

II. Interpretive Summary:

Methyl Bromide

As you know, we have been trying with the help of the IR-4 Coordinator to obtain a tolerance from EPA for the use of methyl bromide as a fumigant for almond hulls and shells. As a result of our work in 1977 and 1978 we supplied the additional residue information that EPA requested. A petition was prepared and presented by IR-4 Coordinator to EPA on Sept. 25, 1978. Baring unforeseen problems, the petition could be approved by early summer 1979.

Malathion

On the basis of studies done at this laboratory on the use of malathion as a protectant for inshell almonds a petition was prepared and submitted to EPA by the IR-4 Coordinator on July 24, 1978 for tolerance for the use of malathion on almond shells. There is a tolerance of the use of malathion on almond meats, but since malathion may be sprayed on inshell almonds entering storage, residues are present on the shells. Shells are now being used for animal feed hence the need for a tolerance on the shells.

Hydrogen Phosphide (Phosphine)

In cooperation with the Brenda Mesa Farming Company, 39 stacks of inhull almonds were fumigated with aluminum phosphide in tablet form. Dosages used were 20, 30 and 40 tablets per 1000 cu ft and the exposure period was 72 hrs. Each stack was covered with clear 6 mil polyethylene sheeting. Twenty-seven of the stacks were Nonpareils and twelve were Merceds.

A complete kill of the test pupae was obtained at each dosage. Satisfactory kills for the test eggs were obtained in tests 1 and 2 at the 20 and 30 tablet dosages. This was not true in the other tests due probably to the low temperature of the almonds in the bottom area of the stacks.

Revision of Fumigation Manual

More than 2,000 revised copies of this manual were printed in cooperation with Mr. Bill Hambelton and Mr. Bill Barnett of the University of Calif. Cooperative Extension, Fresno County. Most of the copies have been distributed throughout the Almond Industry.

Aeration Systems for Use in Stacks of Inhull Almonds

In view of the scarcity of inhull almonds during the past harvest season it was not possible to begin the study this year.

III. Experimental Procedure:

Methyl Bromdie (1977 & 1978 Activities)

The procedures used to fumigate the stacks of almonds were the same as those used in fumigating similar stacks of almonds with hydrogen phosphide (see 1976 Annual Report). The latter included application of the fumigant and conducting inorganic and organic bromide residues.

Malathion

This research was conducted a few years ago by Mr. Garth H. Spitler, Research Entomologist on our staff. Those interested in the procedures for applying malathion as a protectant for inshell almonds should contact him. Phone (209) 487-5310.

Hydrogen Phosphide (Phosphine)

The procedure used to fumigate the 39 stacks of inhull almonds was the same as described in the 1976 report. Twenty-seven of the stacks were Nonpareils and twelve were Merceds. The volume of the stacks averaged about 2.5 thousand cu ft. Aluminum phosphide tablets were used and were applied at the rates of 20, 30 and 40/M cu ft and the exposure period was 72 hrs.

Revision of Fumigation Manual

Before the manual was revised a careful study was made of the original manual regarding the organization, clarity, etc. Following that study an outline was prepared which included new information that should be included.

Aeration Systems for Use in Stacks of Inhull Almonds

In view of the scarcity of stacked almonds, it was not possible to get the experimentation under way.

IV. Results:

Methyl Bromide

This study has been completed and as indicated in the 1977 Annual Report the results of the organic and inorganic residue analyses have been summarized and submitted as an addendum to that report.

Malathion

Those interested in the results of the malathion protectant study for inshell almonds should contact Mr. Garth H. Spitler, Research Entomologist at this lab. Phone (209) 487-5310.

Hydrogen Phosphide (Phosphine) 1978 studies

The results of this study are presented in tables 1, 2 and 3 and in Figures 1, 2, 3 and 4. Table 1 contains the concentrations of hydrogen phosphide in p.p.m. and temperatures of the almonds in ^{o}F at four positions in each stack, for each of 4 tests and dosage. In test no. 4 concentrations and temperature determinations were obtained from 5 positions in each stack. In table 2 may be found the percent of hatched and unhatched eggs, percent dead and alive pupae arranged by test no. dosage and location within stacks. The controls are also included. Table 3 contains data in which percent unhatched and hatched eggs and dead and alive pupae are grouped according to dosage and test number. Controls are also included. The figures show the fumigant concentration pattern throughout the 72 hour exposure period by test and by dosage.

Revision of Fumigation Manual

This manual was revised and over 2,000 copies were printed. Most of these were distributed to members and to those interested in the almond industry. Those cooperating in this effort were Bill Hambelton and Bill Barnett of the University of Calif. Cooperative Extension, Fresno County.

Aeration Systems for Use in Stacks of Inhull Almonds

There are no results to report at this time.

V. Discussion:

Methyl Bromide

The methyl bromide petition was submitted to EPA by the IR-4 Coordinator on Sept. 25, 1978. The Coordinator feels that the petition could be approved by early summer 1979..

Malathion

A petition for the use of malathion as a treatment for almond hulls was submitted to EPA by the IR-4 Coordinator on July 24, 1978. The Coordinator feels that the petition could be approved by early spring 1979.

Hydrogen Phosphide (Phosphine)

Upon reviewing the tables and figures it would appear that tests 1 and 2 gave the best results re the kill of the eggs. All tests produced 100% kill of the test pupae. It is quite apparent that the temperature of the almonds had considerable effect on the level of mortality in the eggs. For example the lower temperatures (in the 60^{o} range) for example resulted in incomplete kill of the eggs where as the temperatures of the almonds higher in the stacks were warmer thus complete kills of the test eggs were obtained.

Revision of Fumigation Manual

This manual was revised and published on Aug. 21, 1978. Mr. Bill Hambelton, Mr. Bill W. Barnett, Farm Advisors and Mr. Curtis A. Ferris, Farm Advisor Emeritus University of Calif. Cooperative Extension, Fresno County cooperated in this effort. More than 2,000 copies were printed most of which have been distributed to the almond industry.

Aeration Systems for Use in Stacks of Inhull Almonds

No studies were conducted in this area of research due primarily to the scarcity of stacks of almonds.

ble No. 1 - Average concentrations of hydrogen phosphide & temperature readings in ound at four locations in each stack of inhull almonds included in tests 1, 2 & 3 and at ive locations in each stack of almonds used in test 4. These studies were nducted in cooperation with the Brenda Mesa farming Co. from 9/2-10/13/1978. he hydrogen phosphide was applied in tablet form.

	Average fumigant concentration and Temperature							
	Average concentration				Average temperature			
	Location in stack				Location in stack.			
Stack	1	2	3	4	1	2	3	4
No	PPM	PPM	PPM	PPM	°F	°F	°F	°F
				Test No. 1 - 20 tablets/M cu ft.				
1	54.1	51.1	—	36.7	96.1	89.6	90.4	72.1
2	40.4	44.0	—	39.0	96.4	88.0	88.0	72.2
3	43.8	51.0	—	44.3	96.9	94.2	86.8	70.8
			"	- 30 tablets/M cu ft.				
4	48.7	55.7	—	47.8	—	89.0	89.2	74.0
5	44.7	56.3	—	46.7	88.6	90.8	95.8	72.1
6	57.8	59.1	—	46.9	92.6	93.3	91.9	71.5
				Test No. 2. - 20 tablets/M cu ft				
1	47.8	51.3	53.3	49.8	93.1	80.9	76.7	63.1
2	49.7	55.3	55.2	55.3	84.4	86.4	83.7	74.1
3	58.7	60.2	59.5	63.9	94.1	94.8	81.4	68.1
			"	- 30 tablets/M cu ft				
4	77.3	77.7	79.2	78.8	88.6	83.6	82.7	70.6
5	69.2	73.4	69.8	71.8	76.6	83.3	90.7	72.3
6	79.5	77.4	79.4	76.1	74.3	87.4	84.8	68.3
				Test No. 3 - 20 tablets/M cu ft.				
1	72.0	62.2	48.8	51.9	112.7	99.0	90.8	70.7
2	64.1	68.9	51.1	53.3	110.1	103.9	91.9	72.4
3	88.9	84.4	70.1	90.6	110	115.5	88.4	76.7
				- 30 tablets/M Cu. ft.				
4	83.9	71.6	75.8	78.9	113.4	102.9	89.2	72.2
5	104.4	103.9	92.2	88.3	117.7	103.6	85.7	73.8
6	78.8	82.2	49.2	72.2	105.9	99.6	84.5	72.3

Table No. 1 - (Cont'd.)

Stack No.	Average Fumigant Concentration — Average Concentration — Location in stack 1 P.P.M.	2 P.P.M.	3 P.P.M.	4 P.P.M.	5 P.P.M.	Average Temperature — Location in stack 1 °F	2 °F	3 °F	4 °F	5 °F
				Test No. 4 - 20 tablets / M cu. ft.						
1	63.6	57.5	54.5	57.0	62.5	85.9	88.5	81.5	66.5	68.3
2	67.5	81.6	58.5	59.0	66.5	90.0	88.4	77.5	67.1	68.0
3	71.5	69.0	58.5	71.5	75.0	86.7	87.6	83.1	68.9	67.0
				- 30 tablets / M cu. ft.						
4	109.5	118.0	98.5	95.5	123.5	80.2	87.2	77.4	66.3	68.5
5	113.5	120.5	101.5	103.0	117.0	82.3	87.6	74.0	67.9	68.1
6	89.5	93.5	82.5	83.0	91.0	80.5	54.8	97.1	66.6	68.8
				- 40 tablets / M cu. ft.						
1	140.0	141.5	125.5	132.5	145.5	74.4	90.0	88.0	66.2	70.1
8	127.5	120.5	109.0	105.0	111.0	78.4	89.3	81.3	68.2	68.3
9	134.5	146.5	124.0	135.0	115.0	81.3	87.9	78.9	66.9	70.7

eble No. 1 - (Contd.)

	Average fumigant Concentration and Temperature								
	Average Concentration Location in Stack				Average Temperature Location in Stack.				
Stack	1	2	3	4	1	2	3	4	5
No.	PPM	PPM	PPM	PPM	°F	°F	°F	°F	°F
					Test No 1				
7	Untreated				86	87	—	—	—
8	"				91.8	—	—	—	—
9	"				93.2	—	—	—	—
					Test No 2				
7	Untreated						85.8	73.6	—
8	"				97.6	92.8	77.2	73.7	—
9	"				88.6	92.3	82.6	75.0	—
					Test No. 3				
7	Untreated				103.6	102	95.6	72.2	—
8	"				110.4	102.4	95.4	73.2	—
9	"				117.2	101.1	91.6	73.3	—
					Test No. 4				
10	Untreated				90.0	89.0	80.5	65.3	68.7
11	"				87.2	90.1	84.3	70.8	70.9
12	"				90.7	93.6	81.5	61.3	68.8

hen exposed in stacks of inhull almonds to 3 dosages of aluminum phosphide tablets for 72 hours
sages of 20+30 tablets/Mcuft. were used in tests 1,2+3 while dosages of 20,30+40 tablets were used in tes
. 4. The summary shows the avg. percentage survival + mortality for egg + pupae for each test, dosage + at
ch location. –

Brenda Mesa Farming Co. 9/2-10/13/78.

Insect Mortality

Dosage Tablets	Test No.	Eggs Hatched Location				Eggs Unhatched Location				Pupae Alive Location				Pupae Dead Location			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
		Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	per cent	per cent	per cent	per cent	per cent	per cent
20	1	–	0	0	11.5	–	100	100	88.5	–	0	0	0	–	100.0	100.0	100.0
30	1	–	0	0	40.7	–	100	100	59.3	–	0	0	0	–	100.0	100.0	100.0
20	2	–	0	0	0	–	100	100	100	–	0	0	0	–	100.0	100.0	100.0
30	2	–	0	0	13.6	–	100	100	86.4	–	0	0	0	–	100.0	100.0	100.0
20	3	–	0	0	67.3	–	100	100	32.7	–	0	0	0	–	100.0	100.0	100.0
30	3	–	0	0	58.0	–	100	100	42.0	–	0	0	0	–	100.0	100.0	100.0
Untreated placed in 3 stacks																	
	1	–	62.5	62.2	73.4	–	37.5	37.8	26.6	–	97.8	97.8	96.7	–	2.2	2.2	3.3
					66.0				34.0	–			97.4				2.6
	2	–	37.1	40.0	54.5	–	62.9	60.0	45.5	–	93.3	–	95.6	–	6.7	–	4.4
					43.5				56.5	–			94.4				5.6
	3	–	6.9	49.1	59.0(37.0)	–	93.1	55.9	40.7	–	6.7	15.6	43.3	–	93.3	84.4	56.7
									63.0				21.9				78.1
Untreated Placed in Holding Room (lab)																	
	1		66.0%				34.0%				100.0%				0.0%		
	2		57.4%				42.6%				97.9%				2.1%		
	3		81.8%				18.2%				94.4%				5.6%		

Table No. 2 – (contd)

Dosage Tablets Per/M cu. ft	Insect Mortality																			
	Eggs										Pupae									
	Hatched					Unhatched					Alive					Dead				
	Location					Location					Location					Location				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
No.	Per-cent	Per-cent	Per-cent	Per-cent	Per-cent	Per-cent	Per-cent	Per-cent	Per-cent	Per-cent	Per-cent	Per-cent	Per-cent	Per-cent	Per-cent	Per-cent	Per-cent	Per-cent	Per-cent	Per-cent
20	–	0	0	64.6	39.1	–	100	100	35.4	60.9	–	0	0	0	0	–	100.0	100.0	100.0	100.0
30	–	0	0	53.6	41.3	–	100	100	46.4	58.7	–	0	0	0	0	–	100.0	100.0	100.0	100.0
40	–	0.1	0	36.7	6.4	–	98.9	100	63.3	93.6	–	0	0	0	0	–	100.0	100.0	100.0	100.0
Untreated placed in 3 stacks																				
—	—	34.8	88.6	85.5	85.3	–	65.2	11.4	14.5	14.7	–	81.1	76.7	98.9	92.2	–	18.9	23.3	1.1	7.8
Untreated – Placed in holding room																				
—		89.5					10.5					96.4					3.6			
Untreated – held in insulated container																				
—		83.2					16.8					88.9					11.1			

ble No. 5 — Summary of the mortality and survival of the early egg + pupa stages of the
.O.W. ar nged by dosage and test numb r.

Brenda Mesa Farming Co. - 9/2-10/13/1978

	Dosage - 26 tablets/M cu. ft.				Dosage - 30 tablets/M cu ft				Dosage - 40 tablets/M cu ft			
	Eggs		Pupae		Eggs		Pupae		Eggs		Pupae	
Test	Unhatched	Hatched	Dead	Alive	Unhatched	Hatched	Dead	Alive	Unhatched	Hatched	Dead	Alive
Number	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
1	97.4	2.6	100.0	0.0	90.7	9.3	100.0	0.0				
2	96.0	4.0	100.0	0.0	94.2	5.8	100.0	0.0				
3	79.8	20.2	100.0	0.0	84.4	15.6	100.0	0.0				
4	76.1	23.9	100.0	0.0	76.2	23.8	100.0	0.0	90.0	10.0	100.0	0.0
	Untreated (Insects placed in untreated stocks)											
1	34.0	66.0	11.5	88.5								
2	56.5	43.5	5.6	94.4								
3	58.8	41.2	78.1	21.8								
4	26.8	73.2	12.8	87.2								

Table No. 3 - (Contd.)

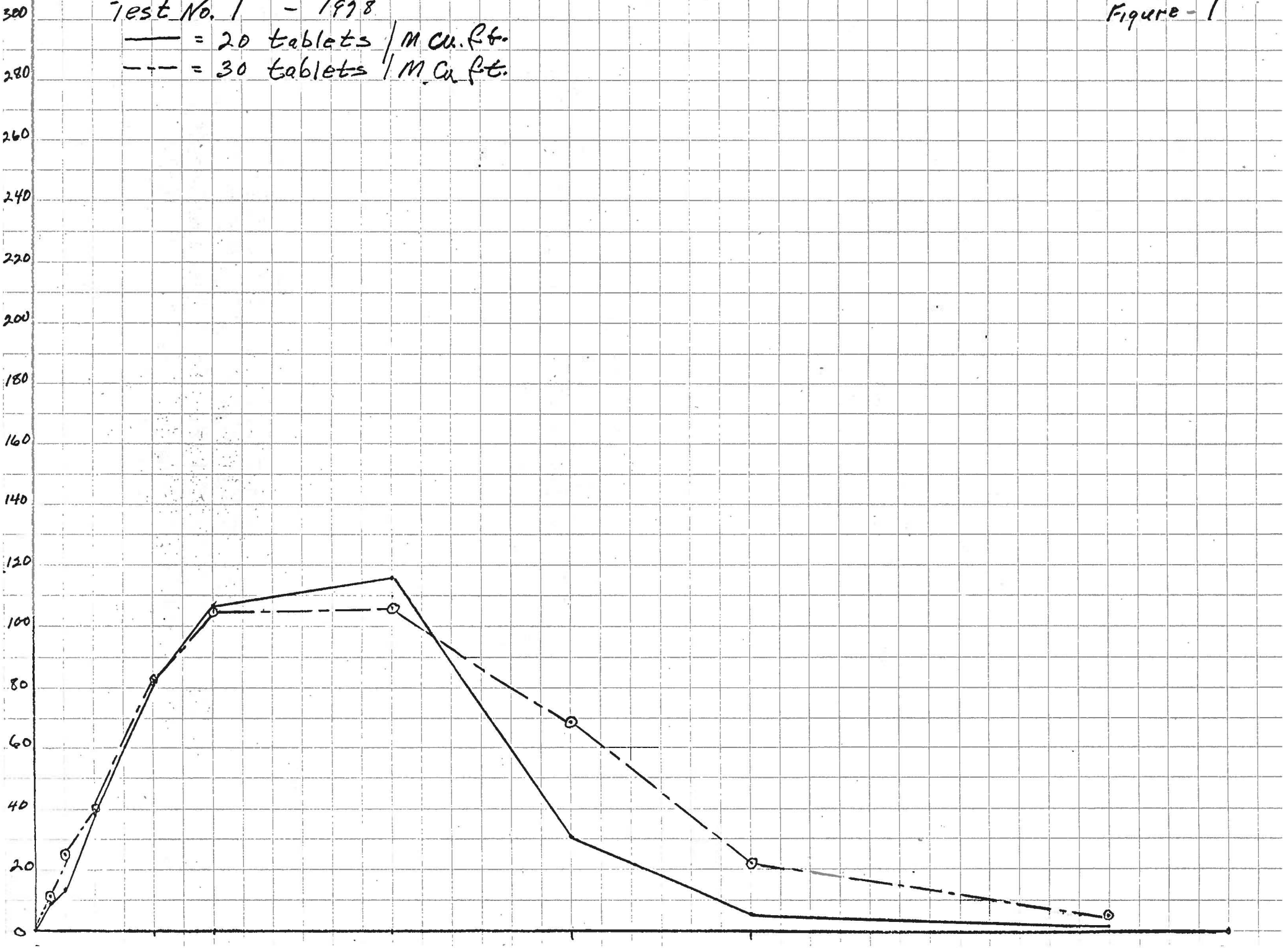
Test Number	Untreated Insects			
	Eggs		Pupae	
	Unhatched	Hatched	Dead	Alive
	Percent	Percent	Percent	Percent
	Insects Placed in holding Room			
1	8.0	92.0	0.0	100.0
2	42.6	57.4	1.9	98.1
3	18.2	81.8	5.6	94.4
4	10.5	89.5	3.6	96.4
	Insects held in Insulated Chest			
4	16.8	83.2	11.1	88.9

Test No. 1 - 1918

—— = 20 tablets / M cu. ft.

– – – = 30 tablets / M cu. ft.

Figure - 1

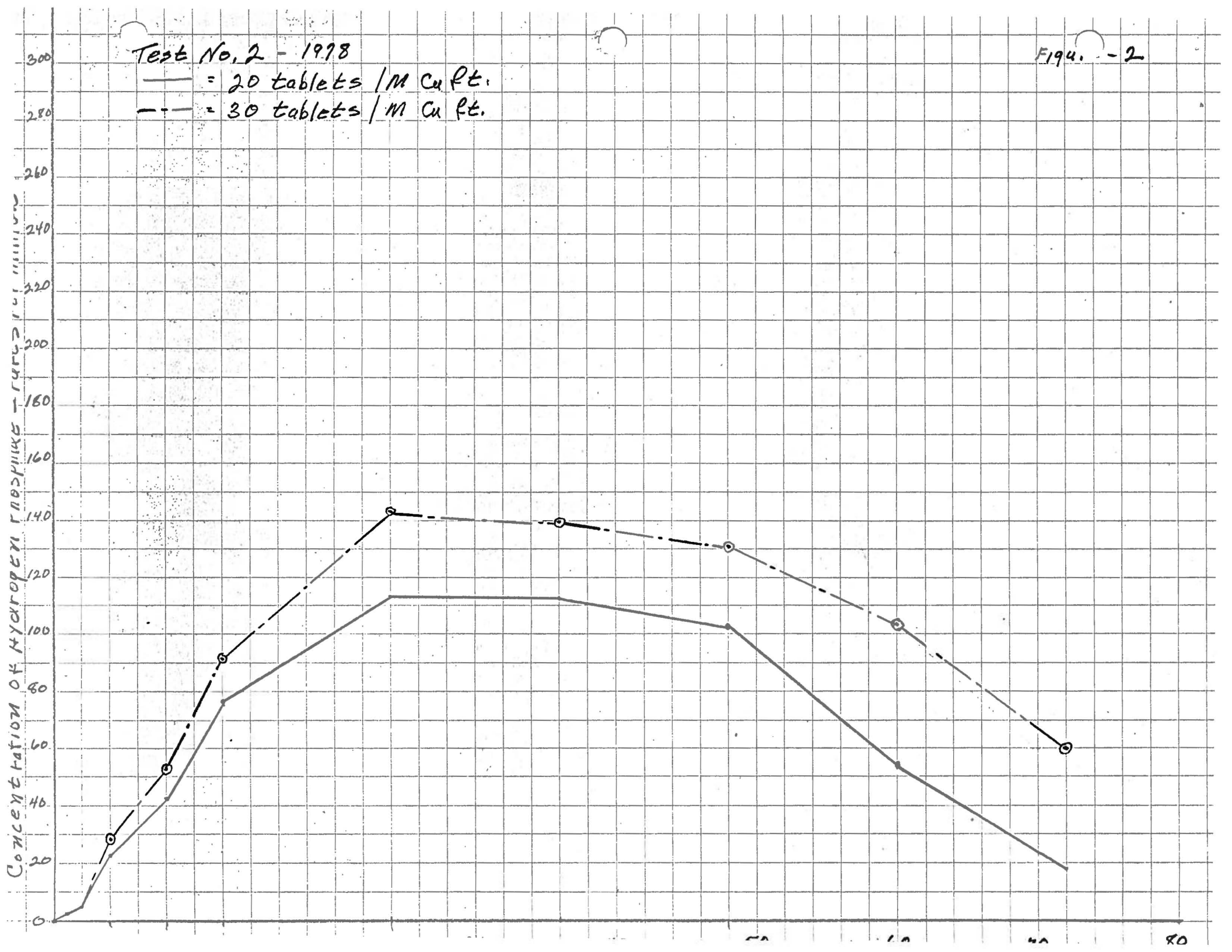


Test No. 2 - 1998

——— = 20 tablets / M Cu ft.

– · – · – = 30 tablets / M Cu ft.

Fig. 4 - 2

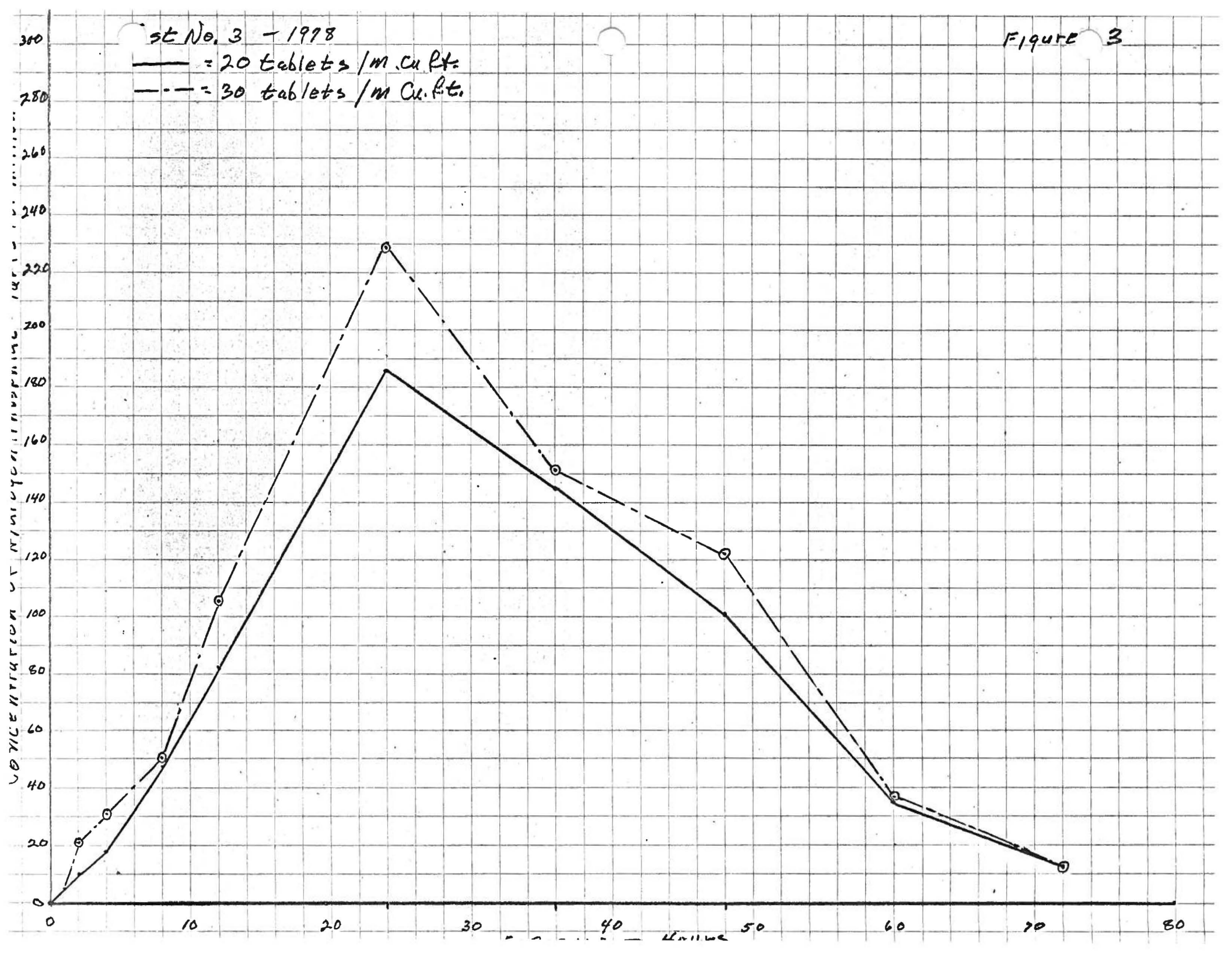


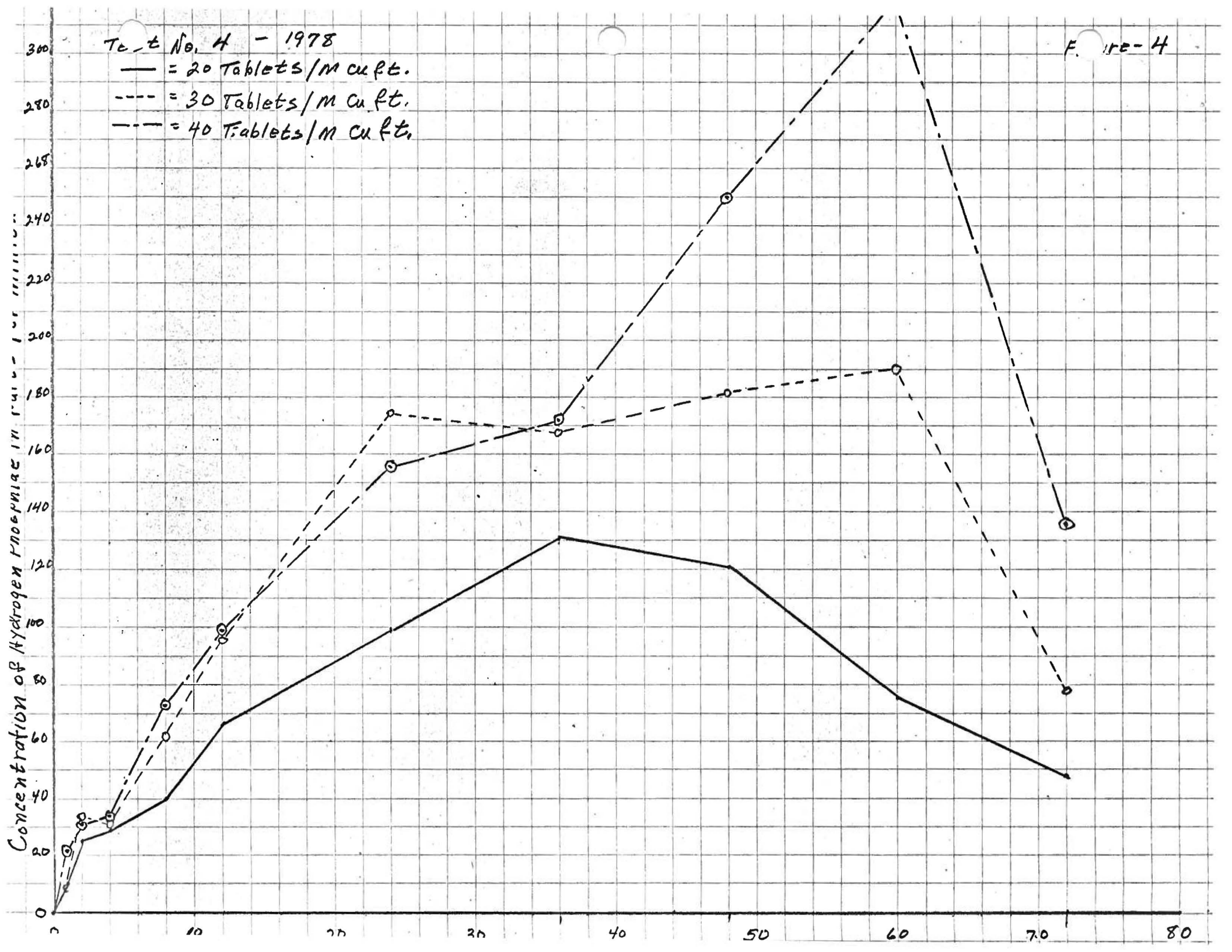
st No. 3 – 1978

——— = 20 tablets / m. cu ft.

– – – = 30 tablets / m Cu. ft.

Figure 3




Test No. 4 - 1978
—— = 20 Tablets/M cu ft.
---- = 30 Tablets/M cu ft.
—·— = 40 Tablets/M cu ft.
Figure-4
Concentration of Hydrogen Phosphide in Parts per Million
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
10
20
30
40
50
60
70
80