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Control of Thrips on Apples in the Hood River Valley of Oregon

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ABSTRACT

Field tests for 11 years have indicated damage to apples by Western flower thrips can be reduced as much as 90 percent by a well-timed application of an effective insecticide. Formetanate, (Carzol®), applied at or near full bloom, was the most effective insecticide tested in preventing pansy spotting on Newtown, and pitting and marking on Golden Delicious fruit. Pre-and post-bloom applications were ineffective in preventing apple injury regardless of the insecticide used. A full-bloom application of formetanate was safe to honeybee pollinators if the spray was allowed to dry at least three hours before bees began to forage. Trapping thrips in orchards to determine if preventive sprays were necessary proved unreliable.

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CONTROL OF THRIPS ON APPLES IN THE HOOD RIVER VALLEY OF OREGON

G. J. Fields and R. W. Zwick

INTRODUCTION

Thrips are minute, slender-bodied insects measuring from 0.5-5. mm(ca.1/64 to 13/64 inches) in length. They belong to the insect order Thysanoptera, or "fringe-wing". Wings of adults are modified into nearly solid bars with few or no distinct veins and fringed with long hairs. Thrips have rasping-sucking mouth parts and feed on flowers, leaves, fruit, twigs, fungus spores, and other small arthropods. Some even may bite man. A few species may transmit plant diseases (Borrow and DeLong, 1954). Female thrips lay eggs on or in host plant tissue. Species with ovipositors make small punctures in flowers, fruit, leaves, or other tissue and insert the egg flush with or just below the surface.

Fruit of MacIntosh, Spartan, Transparent, Northern Spy (Venables, 1925; Childs, 1927), Red and Golden Delicious (Swift and Madsen, 1956), and Newtown apples are susceptible to damage by thrips oviposition. The fruit can develop either an irregular-shaped, whitish blotch called a "pansy spot" or, in the case of Red and Golden Delicious varieties, develop a misshapen, pitted form.

E. J. Newcomer (1921) correctly diagnosed thrips as the cause of pansy spotting of apple fruit. He identified thrips eggs within the central puncture of the spots and showed eggs laid in the fruit at bloom could cause an irregular, off-colored blotch by harvest. Venables (1925) popularized the term "pansy spot" to describe thrips injury, determined the critical injury occurs prior to petal-fall, and identified the Western flower thrips, Frankliniella occidentalis, as the major pest species in British Columbia. Childs (1927), working in the Hood River Valley, also found Western flower thrips the major pest species. He noted not all the egg punctures develop the pansy spot but, instead, may scar over leaving a small, russetted spot free of other blemishes on the fruit skin.

Seven species of thrips have been identified from Hood River Valley apple orchards during or just prior to bloom. Three species are predaceous. Childs (1927) reported one laid more eggs in the midrib of young leaves than in the fruitlets. Swift and Madsen (1956) found another species, the madrone thrips, Thrips madroni, caused fruit pitting on Red and Golden Delicious apples in California. Since 1966, thrips collections in the Hood River Valley repeatedly have shown Western Flower thrips the most numerous species found in apple orchards.

THRIPS CONTROL

Control of Western flower thrips has been poor for three reasons: (1) lack of an effective insecticide, (2) need to determine the best spray time, and (3) lack of an adequate sampling technique to predict need for control measures.

Polupation densities of Western flower thrips vary. The density usually is high one year, low the next. However, highs and lows may repeat for a second year before the opposite extreme occurs. Since 1972, boards painted white and coated with Stikem Special® have been used to trap thrips in apple trees during the bloom period. Trap catches and related fruit injury are recorded in Table 1. The critical period lasts from about one week before until one or two days after full bloom. However, even when very few or no thrips were caught during this period, damage ranged from 7.6 percent to 25.1 percent (1974 data, Table 1). Because considerable damage may occur even though no thrips are trapped, sticky boards provide only a base for a general estimate of thrips densities and potential crop injury. Other, more complicated methods of sampling population densities are available and may prove more useful in predicting the need for sprays.

Data in Tables 2-5 give the results of insecticide and application-timing trials conducted from 1966 through 1977. Except for years when sprays were applied during bloom (Table 3), control proved ineffective. Figure 1 shows the reduction in fruit damage related to spray application timing. Pink bud stage applied sprays are too early and petal fall sprays are too late to prevent or significantly reduce fruit damage. Even the best thrips insecticide, formetanate (Table 6), is ineffective in preventing thrips damage, when applied at any time other than bloom (Tables 2 and 4). If a bloom spray of formetanate is used, additional sprays for thrips are unnecessary and give very little return for the investment (Fig. 1). Our data show the optimum rate of formetanate application is 1.25 to 1.33 pounds per acre. Formetanate now is registered on apples as an acaracide only; thrips are not listed on the label.

Spraying insecticides during bloom can be very hazardous to pollinators. Formetanate is relatively nontoxic to honeybees if adequate time is given for the spray to dry before bees begin to forage or applied late in the day after foraging activity has ceased. Formetanate has proven to be the most effective insecticide for preventing thrips injury and is considerably less toxic to honeybee pollinators than other compounds evaluated in our tests.

Economic Value of Thrips Control

Childs (1927) estimated the apple crop grade in the Hood River Valley was reduced 20 percent by thrips in 1926. In 1975, a dollar value was determined for thrips damage to Newtown and Golden Delicious apples from Orchard "A" listed in Tables 1-5. Table 7 shows the analysis of packed fruit and the dollar loss caused by thrips. Newtowns showed greater economic loss than did Golden Delicious because pansy spots on Newtowns are more noticeable on the green fruit.

Figure 2 shows the number of thrips marks per fruit counted in the two fresh-packed grades of Newtown apples. Three or more pansy spots can cause fruit to be downgraded from Extra Fancy to Fancy.

Usually, the small russetted oviposition scars formed on Golden Delicious fruit do not cause downgrading. Only pitted fruit or the most severly russetted apples are downgraded. Pitted Golden Delicious fruit was generally hand-thinned from trees early in the summer. Samples of Golden Delicious fruit taken to determine overall percentage of injury by thrips were taken prior to hand-thinning, and show a higher injury level than fruit sampled at harvest. Injury levels on Newtowns were determined at harvest.

Fruit was graded as U. S. Extra Fancy, Fancy and Cull (cannery) grade in the packing house during normal operations. Culls listed are from all causes. Thrips caused 32.1 percent of all Newtown cullage and 7.5 percent of all Golden Delicious cullage. Loss in grade and dollar value shown in Table 7 refer only to downgrading caused by thrips.

The cost per acre for effective thrips control is $12.95 per pound for formetanate (1977 price), and approximately $5 per acre for application costs (Doran et al. 1977). Orchard "A" contained seven acres of Newtown and three acres of Golden Delicious trees. Thrips control on Newtowns would have cost about $17.85 per acre or approximately $300 per acre less than the loss suffered because of downgraded fruit (Table 7). Control costs on Golden Delicious would have been only $16.67 per acre less than the calculated loss because of thrips injury. However, special hand thinning costs and size loss due to late thinning have not been taken into account, so actual savings achieved by control on Golden Delicious would total considerably more than the $50 cost of thrips control.

Conclusions

In the Hood River Valley, thrips can be a serious economic pest in some apple orchards. Three important conclusions concerning thrips control are:

1. Formentanate SP is the most effective insecticide,
2. The optimum rate is 1-1.33 pounds formulated material per acre, and
3. The only effective time to spray is at or very close to full bloom.

In years when the population density is high, thrips can cause a real and measurable economic loss. Thrips oviposition in fruit at bloom can result in pansy spots on Newtown apples and scars or pits on Golden Delicious fruit. Both varieties can be severly downgraded or culled because of thrips injury.

The total cost of chemical control for thrips on Newtown apples can be as little as five percent of the total dollar loss due to downgraded fruit without thrips control. Thrips control on Golden Delicious can eliminate the cost and size loss problem caused by special late-season hand thinning as well as reduce fruit downgrading from thrips injury.

Monitoring thrips densities with sticky board traps to determine the need for chemical control has not proven reliable. Further research on the use of other sampling techniques may prove more satisfactory in achieving this goal.

Table 1. Thrips trap catches and related apple injury on unsprayed trees, 1972 - 1977

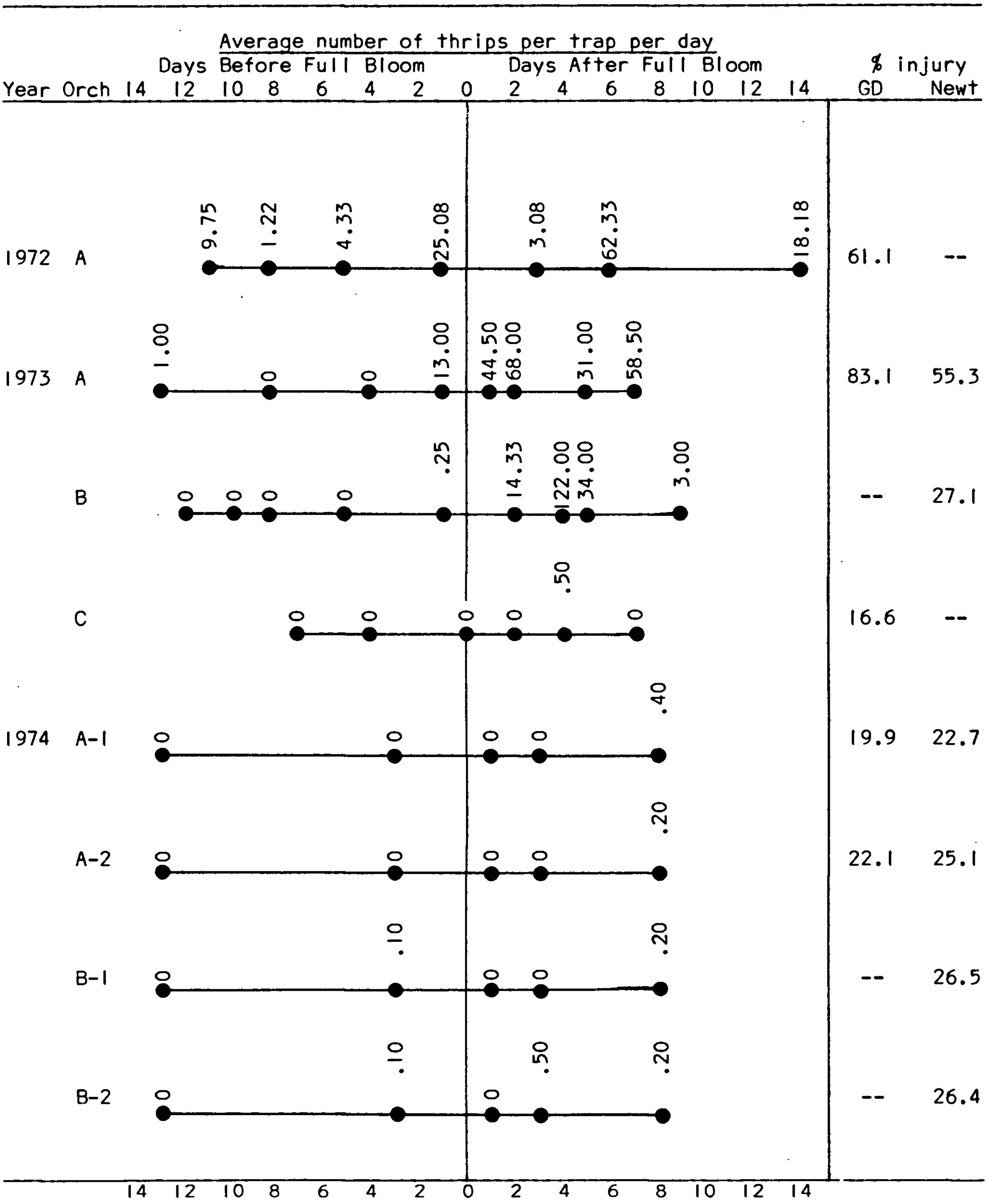


Table I (cont.)

Year	Orch	Average number of thrips per trap per day (Days Before Full Bloom 14 12 10 8 6 4 2 0 Days After Full Bloom 2 4 6 8 10 12 14)	% injury GD	% injury Newt
1974	B-3	0, 0, 0, 0, 0	--	15.9
	C	0, 0, 0, 0, .25	7.6	--
1975	A-I	9.88, 14.00, 1.00, 1.33, 15.11, 17.17	70.7	--
	A-2	3.50, 12.00, .80, 1.17, 17.11, 22.33	94.6	--
	C	.25, 2.67, 1.00, .17, 2.92	31.6	--
	E	1.33, .60, .88, 11.77	69.1	--
	F	2.00, .40, 2.86	45.2	--
1976	A-I	1.25, 0, 1.00, 0, 0, 2.43, .86	34.5	

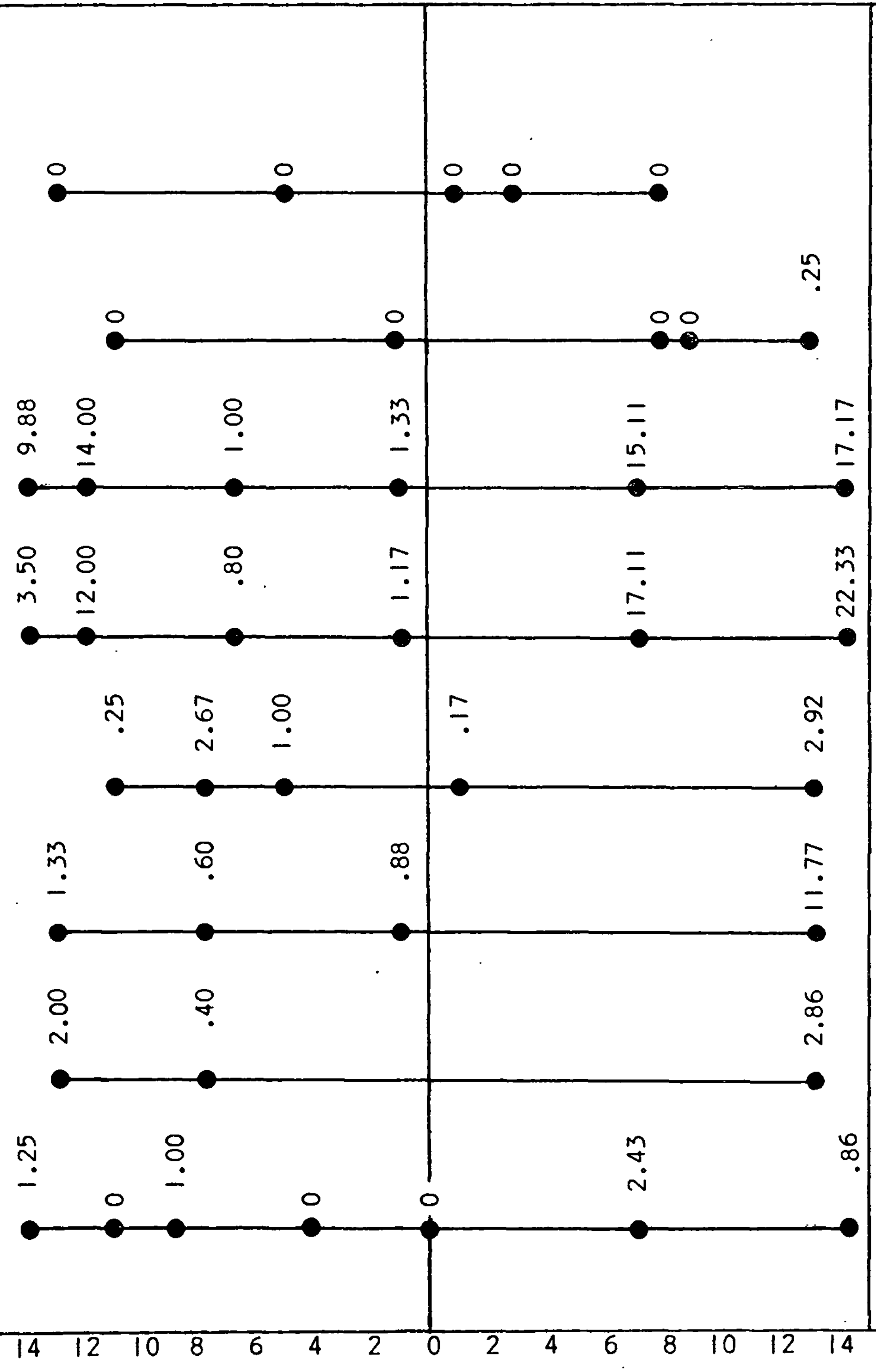


Table I (cont.)

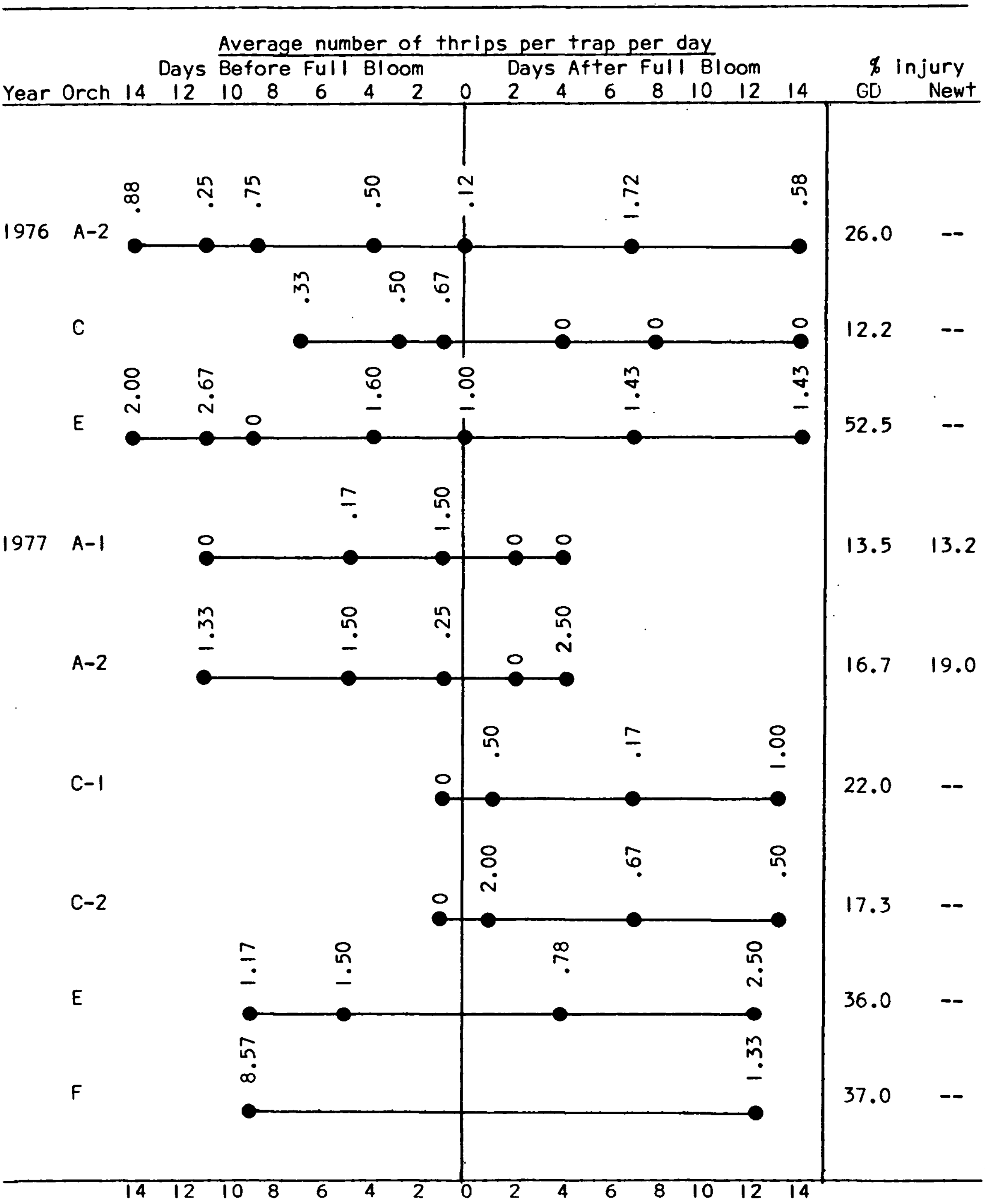

Average number of thrips per trap per day
Days Before Full Bloom
Days After Full Bloom
% injury
Year Orch 14 12 10 8 6 4 2 0 2 4 6 8 10 12 14
GD Newt
1976 A-2
.88 .25 .75 .50 .12 1.72 .58
26.0 --
C
.33 .50 .67 0 0 0
12.2 --
E
2.00 2.67 0 1.60 1.00 1.43 1.43
52.5 --
1977 A-1
0 .17 1.50 0 0
13.5 13.2
A-2
1.33 1.50 .25 0 2.50
16.7 19.0
C-1
0 .50 .17 1.00
22.0 --
C-2
0 2.00 .67 .50
17.3 --
E
1.17 1.50 .78 2.50
36.0 --
F
8.57 1.33
37.0 --
14 12 10 8 6 4 2 0 2 4 6 8 10 12 14

Table 2.--Insecticides used against thrips, pink bud stage applications.

Year	Orchard	Block	Material	Rate/acre	Variety	% Injury
1967	A	1	endosulfan WP	4.0 lb	Newt	4.3
		2	DDT WP	8.0 lb	Newt	2.2
	B	1	endosulfan WP	4.0 lb	Newt	2.4
		2	DDT WP ⌿	6.4 lb		
			parathion WP	4.0 lb	Newt	3.5
1968	A	1	endosulfan WP	4.0 lb	Newt	24.3
1969	C	1	DDT WP ⌿	8.0 lb		
			parathion WP	4.0 lb	GD	*38
		2	DDT WP ⌿	8.0 lb		
			toxaphene WP	8.0 lb	GD	* 2
		3	dimethoate WP	6.0 lb	GD	*30
		4	endosulfan WP	4.0 lb	GD	* 8
		5	control	-	GD	*15
1972	D	1	endosulfan WP	2.4 lb	GD	53.7
1973	A	1	formetanate SP	2.5 lb	GD	26.3
		2	endosulfan WP	5.0 lb	Newt	36.5
		3	endosulfan WP	5.0 lb	Newt	55.3
		4	endosulfan WP	5.0 lb	GD	83.1
		5	endosulfan WP	5.0 lb	GD	83.6
	B	1	endosulfan WP	5.0 lb	Newt	28.2
	E	1	diazinon WP	5.0 lb	GD	60.6
1975	A	1	endosulfan WP	4.0 lb	GD	89.7
		2	endosulfan WP	4.0 lb	GD	99.3
		3	endosulfan WP	4.0 lb	Newt	82.0
		4	methyl parathion F	4.0 qt	Newt	82.2
		5	methyl parathion F	4.0 qt	GD	70.7
		6	methyl parathion F	4.0 qt	GD	84.3
		7	dimethoate WP	4.0 lb	GD	82.0
		8	diazinon WP	4.0 lb	GD	98.0
		9	chlorpyrifos WP	4.0 lb	GD	81.0
		10	formetanate SP	1.0 lb	GD	90.0
		11	formetanate SP	2.0 lb	GD	67.7
		12	formetanate SP	2.0 lb	GD	96.0
		13	control	-	GD	94.6
	C	1	phosphamidon EC	1.0 pt	GD	21.5
		2	phosphamidon EC	1.0 pt	Newt	23.5
		3	formetanate SP	1.0 lb	GD	14.3
		4	formetanate SP	1.0 lb	Newt	36.0
		5	control	-	Newt	24.6
		6	control	-	GD	31.6

* Numbers with asterisks are total fruit with thrips marks counted per five minute sample.

Table 3.--Insecticides used against thrips, full-bloom applications.

Year	Orchard	Block	Material	Rate/acre	Variety	% Injury
1975	A	1	formetanate SP	2.0 lb	GD	5.3
		2	control	-	GD	94.6
	B	1	formetanate SP	2.0 lb	GD	3.2
		2	control	-	GD	69.2
	F	1	formetanate SP	2.0 lb	GD	8.8
1976	A	1	methoxychlor WP	8.0 lb	GD	14.3
		2	methoxychlor WP	10.0 lb	GD	20.0
		3	formetanate SP	1.0 lb	GD	2.8
		4	formetanate SP	1.7 lb	GD	8.0
		5	formetanate SP	2.0 lb	GD	3.8
		6	control	-	GD	26.0
		7	control	-	GD	34.5
		8	methoxychlor WP	10.0 lb	Newt	21.8
		9	formetanate	1.7 lb	Newt	7.8
		10	control	-	Newt	48.0
	C	1	formetanate SP	1.3 lb	GD	0.5
		2	formetanate SP	1.25lb	GD	0.0
		3	formetanate SP	1.25lb	Newt	1.4
		4	formetanate SP	2.0 lb	Newt	0.6
		5	formetanate SP	2.0 lb	GD	0.8
		6	methoxychlor WP	8.0 lb	GD	2.8
		7	methoxychlor WP	8.0 lb	Newt	4.8
		8	control	-	Newt	12.2
		9	control	-	GD	17.5
	E	1	formetanate SP	1.0 lb	GD	4.0
		2	formetanate SP	2.0 lb	GD	6.0
		3	methoxychlor WP	8.0 lb	GD	30.0
		4	methoxychlor WP	8.0 lb	GD	30.8
		5	control	-	GD	52.5
	F	1	formetanate SP	1.0 lb	GD	3.0
		2	control	-	GD	20.5
	G	1	formetanate SP	1.0 lb	GD	2.0
		2	formetanate SP	2.0 lb	GD	0.3
		3	methoxychlor WP	8.0 lb	GD	10.0
		4	control	-	GD	10.8
1977	F	1	formetanate SP	1.0 lb	GD	11.3
		2	control	-	GD	37.0

Table 4.--Insecticides used against thrips, petal-fall applications.

Year	Orchard	Block	Material	Rate/acre	Variety	% Injury
1966	A	1	DDT WP	5.0 lb	Newt	33.3
1968	A	1	DDT WP	8.0 lb	Newt	27.7
1969	C	1	DDT WP ⌿	8.0 lb		
			parathion WP	4.0 lb	GD	* 1
		2	DDT WP ⌿	8.0 lb		
			toxaphene WP	8.0 lb	GD	* 1
		3	dimethoate WP	6.0 lb	GD	* 5
		4	endosulfan WP	4.0 lb	GD	* 1
		5	control	-	GD	*15
1970	A	1	parathion WP	4.8 lb	Newt	23.6
		2	phosmet WP	8.0 lb	Newt	35.0
		3	azinphosmethyl WP	4.0 lb	Newt	20.0
1972	C	1	formetanate SP	1.0 lb	GD	24.4
		2	azinphosmethyl WP	3.0 lb	GD	23.1
		3	control	-	GD	26.9
	E	1	ethion WP	8.0 lb	GD	92.6
1973	H	1	endosulfan D	50.0 lb	Newt	17.0
		2	diazinon D	50.0 lb	Newt	14.7
		3	control	-	Newt	12.8
1974	A	1	control	-	GD	19.0
		2	control	-	GD	22.1
		3	control	-	Newt	22.7
		4	control	-	Newt	25.1
	B	1	control	-	Newt	26.5
		2	control	-	Newt	26.4
		3	control	-	Newt	15.9
	C	1	endosulfan WP	5.0 lb	GD	7.6
		2	endosulfan WP	5.0 lb	GD	4.7
		3	endosulfan WP	5.0 lb	GD	3.6
		4	endosulfan WP	5.0 lb	Newt	2.0
	E	1	formetanate SP	3.0 lb	GD	13.0
1975	F	1	endosulfan WP	4.0 lb	GD	45.2

* Numbers with asterisks are total fruit with thrips marks counted per five minute sample.

Table 5.--Insecticides used against thrips, multiple applications.

Year	Orchard	Block	Time	Material	Rate/acre	Variety	% Injury
1966	A	1	PNK	DDT WP	8.0 lb		
			PF	DDT WP	8.0 lb	Newt	13.3
	B	1	PNK	DDT WP	5.0 lb		
			PF	DDT WP	5.0 lb	Newt	10.8
		2	PNK	DDT WP	5.0 lb		
			PF	DDT WP	5.0 lb	Newt	13.4
1967	A	1	PNK	endosulfan WP	4.0 lb		
			PF	DDT WP	8.0 lb	Newt	0.6
		2	PNK	DDT WP	8.0 lb		
			PF	DDT WP	8.0 lb	Newt	1.2
1968	A	1	PNK	endosulfan WP	4.0 lb		
			PF	DDT WP	8.0 lb	Newt	23.1
1969	C	1	PNK	DDT WP +	8.0 lb		
				parathion WP	4.0 lb		
			PF	DDT WP +	8.0 lb		
				parathion WP	4.0 lb	GD	* 1
		2	PNK	DDT WP +	8.0 lb		
				toxaphene WP	8.0 lb		
			PF	DDT WP +	8.0 lb		
				toxaphene WP	8.0 lb	GD	* 1
		3	PNK	dimethoate WP	6.0 lb		
			PF	dimethoate WP	6.0 lb	GD	* 2
		4	PNK	endosulfan WP	4.0 lb		
			PF	endosulfan WP	4.0 lb	GD	* 2
		5	-	control	-	GD	*15
1971	A	1	PNK	endosulfan WP	5.0 lb		
			**PF	phosmet WP	4.0 lb	Newt	0.5
		2	PNK	endosulfan WP	5.0 lb		
			PF	phosalone WP	5.0 lb	Newt	1.7
		3	PNK	endosulfan WP	5.0 lb		
			PF	azinphosmethyl WP	2.0 lb	Newt	1.2

* Numbers with asterisks are total fruit with thrips marks counted per five minute sample.

** Rained off, reapplied two days later.

Table 5 (cont.)

Year	Orchard	Block	Time	Material	Rate/acre	Variety	% Injury
1972	A	1	PNK	endosulfan WP	5.0 lb		
			PF	azinphosmethyl WP	2.0 lb	Newt	61.6
		2	PNK	endosulfan WP	5.0 lb		
			PF	azinphosmethyl WP	2.0 lb	Newt	33.0
		3	PNK	endosulfan WP	5.0 lb		
			PF	azinphosmethyl WP	2,0 lb		
			PF + 1 wk	ethion WP	8.0 lb	GD	42.1
		4	PNK	endosulfan WP	5.0 lb		
			PF	formetanate SP	2.0 lb	Newt	37.3
		5	PNK	endosulfan WP	5.0 lb		
			PF	azinphosmethyl WP	1.0 lb	Newt	39.5
		6	PNK	endosulfan WP	5.0 lb		
			PF	azinphosmethyl WP	2.0 lb	Newt	26.7
	B	1	PNK	endosulfan WP	4.0 lb		
			PF	azinphosmethyl WP	2.0 lb		
			PF + 1 wk	ethion WP	1.0 lb	Newt	50.0
1973	B	1	PNK	endosulfan WP	4.0 lb		
			PF	phosphamadon EC	2,0 qt	Newt	28.5
		2	PNK	endosulfan WP	4.0 lb		
			PF	formetanate SP	2.0 lb	Newt	6.2
		3	PNK	endosulfan WP	4.0 lb		
			PF	DDT WP	4.0 lb	Newt	27.1
	C	1	PNK	endosulfan WP	3.0 lb		
			BLM	formetanate SP	2.0 lb		
			PF	azinphosmethyl WP	2.0 lb	GD	2.0
		2	PNK	endosulfan WP	3.0 lb		
			PF	formetanate SP	2.0 lb	GD	8.8
		3	PNK	endosulfan WP	3.0 lb		
			PF	azinphosmethyl WP	2.0 lb	GD	10.4
		4	PNK	endosulfan WP	3.0 lb		
			PF	azinphosmethyl WP	2.0 lb	Newt	25.4
		5	-	control	-	Newt	20.1
1975	C	1	PNK	phosphamidon EC	1.0 pt		
			BLM	formetanate SP	1.0 lb	GD	1.3
		2	-	control	-	GD	31.6

Table 6.--Most effective bloom applications and rates for thrips control on apple trees.

Effectiveness of insecticides

Material	Rate/A	Average % Injury	Average % Reduction
formetanate	1-2 lb	3.9	88.9
methoxychlor	8-10 lb	17.6	62.1
control	-	46.4	

Formetanate rate comparisons

Material	Rate/A	% Injury Treated	% Injury Control	Average % Reduction
formetanate	1.0 lb	4.6	30.2	84.8
	1.25 lb	0.7	14.8	95.3
	1.33 lb	0.5	14.8	96.9
	1.67 lb	7.9	36.6	78.2
	2.0	5.6	53.5	89.5

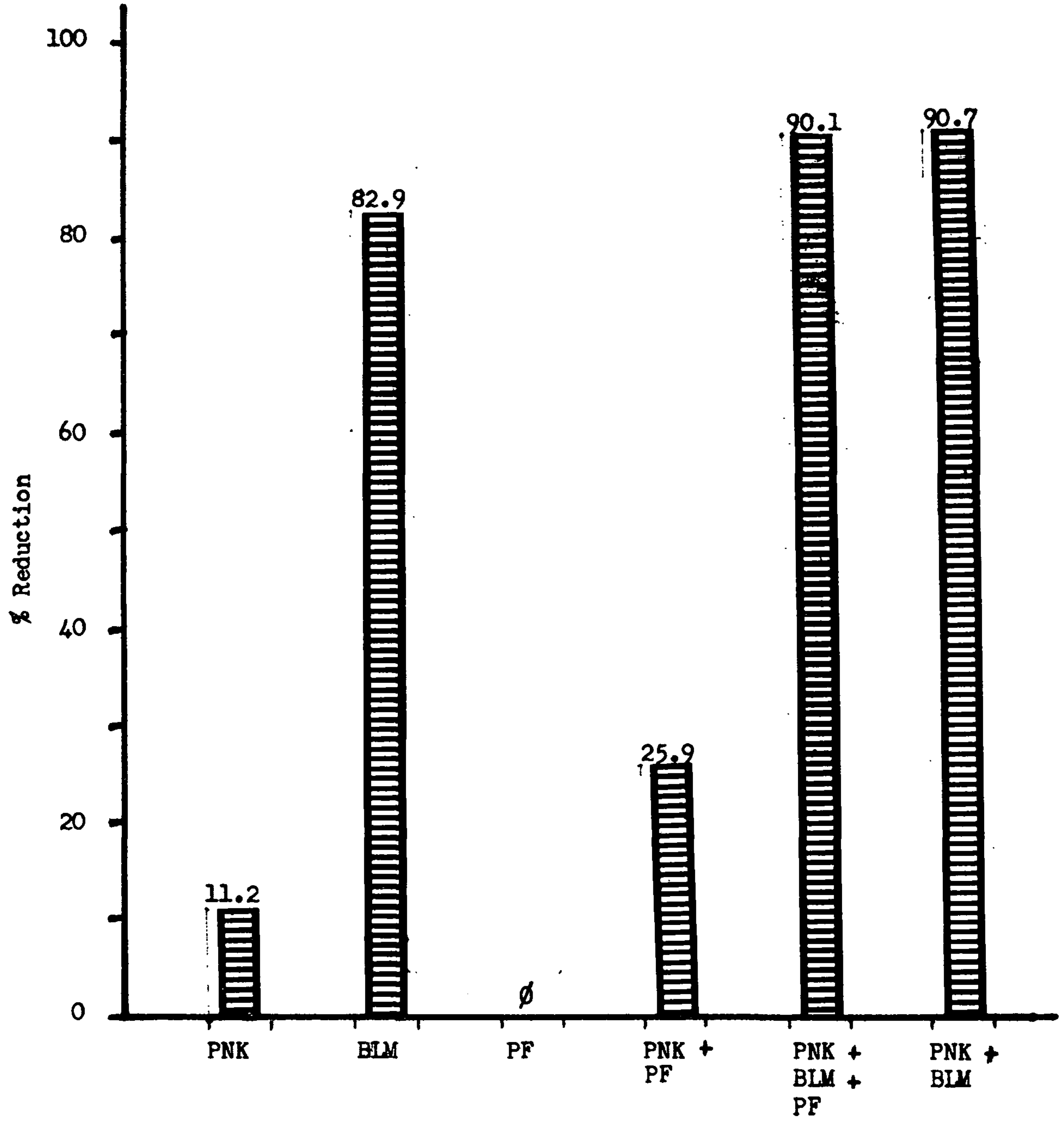
Table 7.--Economic analysis of thrips damage to seven acres of Newtown and three acres of Golden Delicious apples, orchard "A", 1975.

								Total Losses due to thrips	
Variety	Thrips injury (%)	Grade	Total boxes	F.O.B. price (box)	Value	% Crop	% Pack	Grade reduction (boxes)	Dollar loss
Newtown	82.1	XFNCY	1860	$7.50	$13,590.00	42.3	57.6	-0-	-0-
		FNCY	1369	6.50	8,898.00	31.1	42.4	268	268.00
		CULL	1168	1.89	2,205.00	26.6	-	375[1]	1,951.00
		Total	4397	-	$25,153.00	100.0	100.0	643	2,219.00
Golden Delicious	99.3	XFNCY	1474	$6.00	$ 8,844.00	72.7	82.2	-0-	-0-
		FNCY	319	5.00	1,595.00	15.8	17.8	-0-	-0-
		CULL	232	1.88	436.00	11.5	-	18[1]	96.00
		Total	2025	-	$10,875.00	100.0	100.0	18	96.00

[1] Based on % cullage due to thrips damage only.

Figure 1

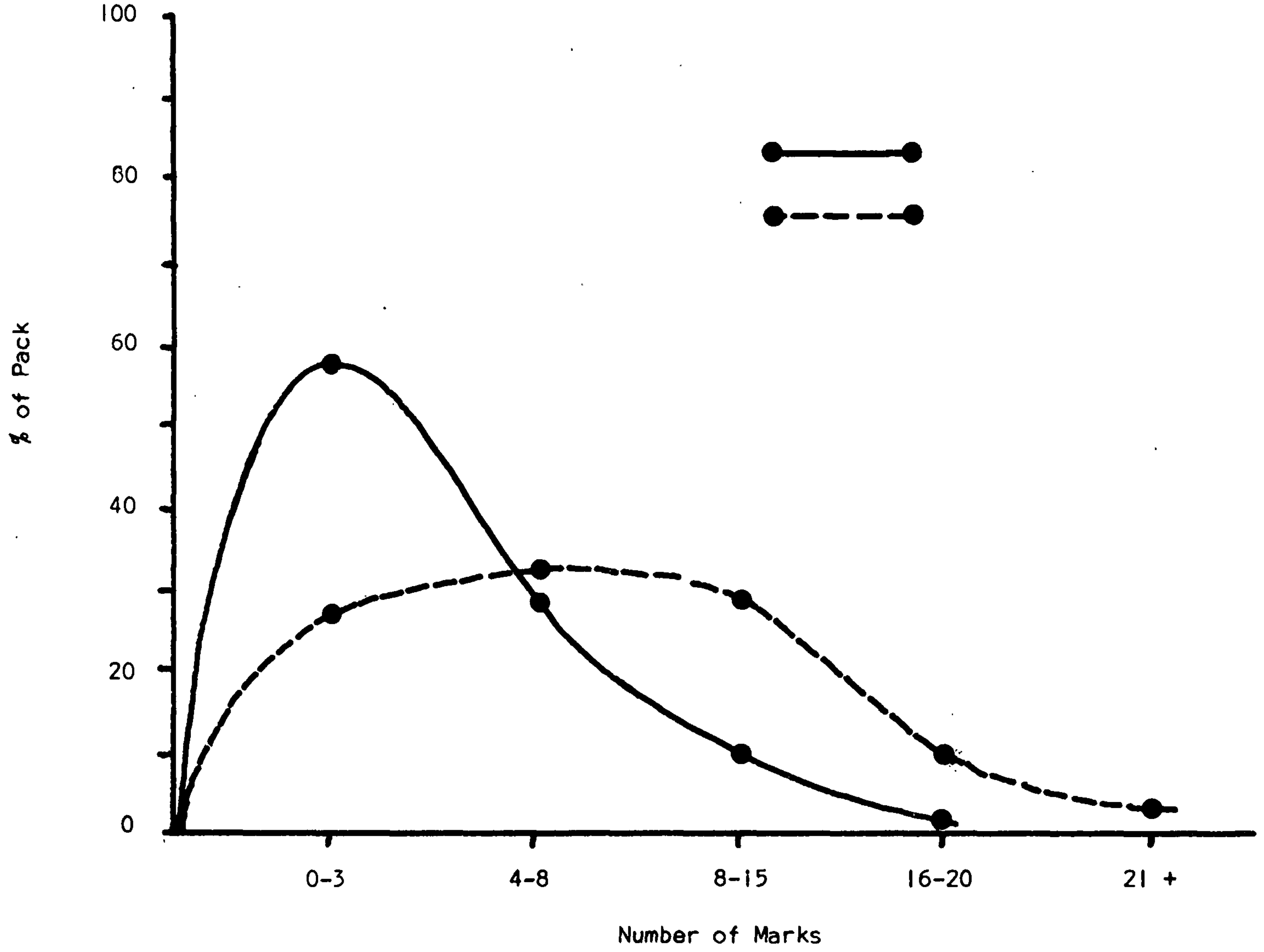
Percentage reduction in thrips damage related to insecticide application timing.



Spray Application Timing

Figure 2

Number of oviposition marks per Newtown apple in fresh pack grades.



List of Materials Tested

Common Name	Trade Name
azinphosmethyl 50% WP	Guthion®
chlorpyrifos 25% WP	Dursban®
DDT 50% WP	DDT
diazinon 50% WP	diazinon
dimethoate 25% WP	Cygon®; Defend®
endosulfan 50% WP; 3%D	Thiodan®
ethion 25% WP	ethion
formetanate 92% SP	Carzol®
methoxychlor 50% WP	Marlate®
methyl parathion 2 lb/Gal F	Penncap M®
parathion 25% WP; 8 lb/Gal EC	parathion
phosalone 25% WP	Zolone®
phosmet 50% WP	Imidan®
phosphamidon 8 lb/Gal EC	Dimecron®

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