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Survey of Insecticide and Miticide Usage by 158 Nurseries in Pennsylvania[1]

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Abstract

Of 254 nurserymen surveyed in 7 Pennsylvania counties in 1979, 158 responded. Respondents used 3719.5 kg (8184 lb) of insecticides/miticides with an estimated cost of $64,436. They applied an average of 2.5 kg (2.2 lb/a) ai/ha. Seven pesticides accounted for 88.7% of the 29 pesticides used. The nurserymen tended to use low to moderate toxicity chemicals (96%); 74% used power spray equipment and 47% used wetting agents. The most commonly reported pests are listed.

Index words: Nursery pests, insecticides, miticides, spray equipment, pesticide cost

Introduction

Pesticide usage by non-agronomic industries is difficult to assess but sorely needed to determine current and future decisions on research efforts, state and federal regulations, and industry voids (1). Estimates are available on the amount of pesticides manufactured in the United States (9, 10, 11), but minimal information exists on how these pesticides are distributed and used. Since knowledge of pesticide utilization by urbanites is minimal and reasonable estimates are difficult to make (3, 4, 12), we selected the nursery industry to survey for pesticide usage. This industry provides landscape plants for

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the urban environment, and if pest-free nursery and landscape crops were available, some urban pest problems may be retarded or at least minimized. Nursery pesticide usage information will also provide a basis for comparisons of pesticides used in other crops.

Pennsylvania produces wholesale nursery stock on approximately 5,191 ha (12,822 a) by 933 nurseries and produced a 1981 wholesale crop worth about $135,000,000 (5). This production is similar to the surrounding states (New York, New Jersey, and Ohio) which have a combined land usage of 9,762 ha (24,112 a). These states have 3,607 nurseries which produced a wholesale crop worth about $347,000,000. Nurseries in these states should have pesticide usage similar to those surveyed.

Methods and Materials

A survey was undertaken in 1979 to determine insecticide and miticide usage by 254 nurseries located in seven Southeastern Pennsylvania counties (Berks, Bucks, Chester, Delaware, Lancaster, Lehigh and Montgomery). These nurseries were selected from a list provided by the Pennsylvania Department of Agriculture, Bureau of Plant Industries.

Nurserymen were visited and asked the following questions:

1. Which insecticide and/or miticide formulations were applied and how much of each was used during the season?
2. Which formulations and rates caused damage to the host plants?
3. What type of equipment was used to apply the pesticides?
4. Was a wetting agent used?
5. Was the pesticide(s) used for prevention of a pest or when the pest was actively feeding on the host plant?
6. What pests were present and which formulations were directed against these pests?
7. What size was the nursery?

The surveyer filled out a tabular survey sheet during the interview. The nurserymen were assured anonymity by destroying their names after the forms were received.

Three nursery suppliers were contacted and wholesale prices for different insecticide/miticide formulations were obtained in order to estimate total costs.

Results and Discussion

Of the 254 nurserymen contacted, 158 (62%) agreed to respond. All products were totaled and converted from formulation amoung to kg (lb) of active ingredient (kg ai). The proprietary products, formulation, amount used, kg (lb) ai used, and costs for pesticides are presented in Table 1. The nurserymen used 29 different insecticides/miticides in 50 formulations in 1979. This amounted to a total of 3719.5 kg (8183.7 lb) ai costing an estimated value of $64,432.80.

The formulations were converted into their pesticide components and the number of nurseries using a pesticide, total kg (lb) ai used, average kg (lb) ai used per nursery, kg (lb) ai used for prevention (pest not present), and the LD_{50} (8) for each pesticide are presented in Table 2. Seven of the pesticides (carbaryl, diazinon, dicofol, dimethoate, Isotox, lindane, and malathion) accounted for 3322 kg (2956 lb) ai (88.7%) of the total used. Nurserymen used 23 pesticides for preventive control. This accounted for 1250.5 kg (2751.1 lb) ai (33.4%) (not including oil) of the total used. If these preventive sprays could be reduced or eliminated by proper monitoring, pesticide usage could be cut by one-third.

A 1981 survey by the American Association of Nurserymen (AAN) (2) produced a usage list of insecticides/miticides which agrees closely with this survey. In fact, in both surveys, the top seven pesticides used by nurserymen were the same except that orthene was higher in the AAN survey than Isotox. This would seem reasonable considering the marketing push for orthene subsequent to the 1979 survey.

Nurserymen used mostly products in toxicity categories II and III ($LD_{50} > 500$ mg/kg), 2209.5 kg (4860.9 lb) ai (59.4%) and $LD_{50} < 500$, > 50 mg/kg), 1265.6 kg (278.4 lb) ai (34%). The most toxic products $LD_{50} \leq 50$ mg/kg) accounted for only 149.8 kg (329.6 lb) ai (4.0%) of the total used. Of the products used, four (chlordane, DDT, endrin, parathion) are not currently labelled for the areas applied. This only accounts for 168.4 kg (370.5 lb) ai (4.5%) of the total used.

In order to assess the effect of nursery size on amount of pesticides used, nurseries were divided into three size categories related to the number of hectares (acres) under cultivation. The nursery categories, number of nurseries in each category, ha (a) used, kg (lb) used, and average kg/ha (lb/a) are presented in Table 3. The small and large nurseries had similar pesticide usage characteristics, 2.1 (1.9 lb) and 2.0 kg (1.8 lb) ai/ha (a) respectively. The medium sized nurseries used considerably more pesticides per ha (a), 5.5 kg (4.9 lb) ai/ha (a). This may mean that small nurseries are either labor intensive operations or too marginal to afford pesticides. Larger nurseries may be able to afford the expertise to provide decisions as to when control actions are needed.

An average of 2.5 kg (2.2 lb) ai/ha (a) of insecticides/miticides were used by the nurserymen at a cost of $43.33/ha ($17.54/a). This is approximately half the cost incurred by Pennsylvania's apple growers, $97.49/ha ($39.46/a) (7).

Most nurserymen use some kind of power spraying equipment as 97 (26%) applications were made by hand while 282 (74%) were with power equipment. About half of the applications [177 (47%)] included a wetting agent.

The identity and frequency of insects and mites reported by the nurserymen are listed in Table 4. Because certain pests were not specifically identified, the following groups are listed according to feeding types: lepidopterous foliage feeders = 85 reports; mites = 81 reports; coleopterous (beetle) foliage feeders = 58 reports; borers = 31 reports. By including the identified pests, it appears that the 10 most commonly controlled pests of nurseries in southeastern Pennsylvania are: lepidopterous foliage feeders, mites, leafminers, coleopterous foliage feeders, spruce gall adelgids, aphids, scales, lacebugs, borers, and whiteflies. These account for 87.9% of all pests reported.

The ranking of pests controlled by nurserymen is much like the most common arthropod pests found on nursery crops in Maryland communities (6). In an inte-

grated pest management program (IPM) on landscape plantings, the most frequently encountered pests were: (in order of decreasing occurrence) lacebugs, mites, aphids, bagworms, scale insects, Japanese beetle, borers, leafminers, spittlebug and weevils. The only major differences were the nurserymen's spraying for spruce gall adelgids and whiteflies while the Maryland IPM program gave more attention to spittlebugs and weevils. This indicates that more research should be directed towards management of these few important pests, both for the nursery industry and urban pest managers.

Significance to the Nursery Industry

The nursery industry is periodically accused of over usage and improper application of insecticides. A survey of insecticide and miticide usage on small,

Table 1. Insecticide and miticide formulations used by 158 nurserymen in Pennsylvania and estimated costs.[z]

Trade Name	Formulation	Amount Used	Kg (lb) Used)	Cost/Unit	Total Cost
Blackleaf 40 (nicotine)	EC	1.9 l (0.5 gal)	0.5 (1.0)	11.10/l	$ 21.09
Chlordane	4 EC	103.1 l (27 gal)	109.0 (240)	9.24/l	953.01
	50 WP	45.4 kg (100 lb)	22.7 (50)	14.41/kg	654.36
Cygon (dimethoate)	2 EC	792.9 l (209 gal)	190.0 (418)	5.39/l	4,273.62
DDT	50 WP	6.8 kg (15 lb)	3.4 (7.5)	9.90/kg[x]	67.32
Diazinon	12.5 EC	1.0 l (.25 gal)	0.2 (0.5)	5.31/l	5.04
	4 EC	128.1 l (34 gal)	61.4 (136)	9.06/l	1,160.76
	25 E	1286.4 l (340 gal)	616.6 (1360)	9.06/l	11,654.51
	50 W	189.6 kg (417 lb)	94.8 (208.5)	9.77/kg	1,852.01
	14 G	45.4 kg (100 lb)	6.4 (14)	4.18/kg	189.60
Dieldrin	4 EC	18.9 l (5 gal)	9.1 (20)	7.96/l[x]	150.68
Dipel[y]	WP	5.8 kg (13 lb)	——	22.22/kg	129.54
Di-Syston (disulfoton)	15 G	11.3 kg (25 lb)	1.7 (3.8)	2.95/kg	33.48
Endrin	2 EC	11.4 l (3 gal)	2.7 (6)	5.28/l	59.98
Guthion	2 EC	7.6 l (2 gal)	1.8 (4)	7.76/l	58.74
(azinphos-methyl)	50 WP	4.8 kg (10.5 lb)	2.4 (5.3)	12.80 kg	60.94
Imidan (phosmet)	50 WP	26.1 kg (57.4 lb)	13.0 (28.7)	6.41/kg	167.54
Isotox[w]	EC	581.4 l (153.5 gal)	71.0 (156.3)	2.84/l	1,651.12
Kelthane (dicofol)	18.5 EC	121.3 l (32 gal)	23.3 (51)	4.78/l	579.86
	35 WP	351.5 kg (795.4 lb)	123.0 (270.7)	9.13/kg	3,209.56
Lindane	1.8 EC	591.2 l (156 gal)	127.5 (280.6)	7.68/l	4,540.73
	25 WP	13.6 kg (30 lb)	3.4 (7.5)	10.67/kg	145.22
	35 WP	2.3 kg (5 lb)	0.8 (1.8)	14.96/kg	33.96
	75 WP	4.5 kg (10 lb)	3.4 (7.5)	31.90/kg	144.83
Malathion	5 EC	21.2 l (5.5 gal)	12.7 (27.5)	5.73/l	121.48
	9.7 EC	1.9 l (0.5 gal)	2.2 (4.8)	6.47/l	12.23
	57 EC	1178.1 l (311 gal)	564.7 (1242)	5.73/l	6,750.40
	25 WP	417.6 kg (918 lb)	104.4 (230)	2.55/kg	1,065.72
	50 WP	206.6 kg (454.5 lb)	103.3 (227.3)	4.84/kg	999.94
Metasystox-R (oxydemeton-methyl)	2 EC	10.6 l (2.95 gal)	2.5 (5.5)	8.78/l	93.07
Methoxychlor	2 EC	4.2 l (1.1 gal)	1.0 (2.2)	3.80/l	15.81
	50 WP	9.1 kg (20 lb)	4.5 (10)	8.69/kg	78.82
Oil		1193.2 l (315 gal)	——	1.06/l	1,264.81
Oil + Ethion		49.6 l (13 gal)	0.9 (2)	1.72/l	85.28
Orthene (acephate)	spray	31.2 l (3.25 gal)	5.6 (12.3)	2.30/l	71.83
	75 SP	29.6 kg (65 lb)	22.2 (48.8)	18.70/kg	553.52
Parathion	8 EC	3.8 l (1.0 gal)	3.6 (8)	6.50/l	24.64
Pentac (dienochlor)	50 WP	0.5 kg (1 lb)	0.2 (95)	53.90/kg	24.25
Pirimor (pirimicarb)	50 WP	22.7 kg (50 lb)	11.3 (25)	49.92/kg	1,132.14
Plictran (cyhexatin)	50 WP	3.6 kg (8 lb)	1.8 (4)	43.96/kg	159.56
Sevin (carbaryl)	4 F	760.0 l (200.5 gal)	364.3 (802)	7.03/l	5,343.01
	50 W	1022.4 kg (2249.4 lb)	511.2 (1124.7)	4.73/kg	4,836.14
	80 S	381.4 kg (340 lb)	305.1 (672)	7.00/kg	2,667.99
Sevimol 4 (carbaryl)	——	60.6 l (16 gal)	29.0 (64)	6.22/l	376.68
Spectricide (diazinon)		22.7 l (6 gal)	3.2 (7)	1.76/kg	39.92
Systox (demeton)	6 EC	3.8 l (1.0 gal)	2.7 (6)	10.96/l	41.54
Temik (aldicarb)	10 G	2.5 kg (5.5 lb)	0.3 (0.6)	4.18/kg	10.41
Thiodan (dneosulfan)	50 WP	204.1 kg (449 lb)	102.1 (224.5)	11.11/kg	2,267.77
Vendex (fenbutatin oxide)	50 WP	90.8 kg (200 lb)	45.4 (100)	44.00/kg	3,996.52
Zectran (mexacarbate)	2 EC	113.6 l (30 gal)	27.2 (60)	5.30/l[x]	601.82
Totals			3719.5 (8183.7)		$64,432.80

[z]Average cost taken from three quotations.

[y]Biological control agent, *Bacillus thuringiensis.*

[w]Mixture ot 5% carbaryl, 5% oxdemeton-methyl, 2% dicofol by weight.

[x]Estimated from old catalogue prices.

Table 2. Summary of insecticide and miticide usage by 158 nurseries in seven southeastern Pennsylvania counties.

Pesticide	# Nurseries Using and (% of total)	Total Kg (lb) Used	X kg (lb) used/nursery[z]	Kg (lb) used to prevent	LD_{50}[u] (mg/kg)
Acephate (Orthene)	9 (5.7)	27.8 (61.1)	[3.1] (6.8)	4.76 (10.5)	866.0
Aldicarb (Temik)	2 (1.3)	0.3 (0.6)	[0.1] (0.3)	0.00 (0.0)	0.8
Azinphos-methyl (Guthion)	4 (2.5)	4.2 (9.3)	[1.1] (2.3)	2.38 (5.2)	11.0
Bacillus thuringinesis[y] (Dipel)	1 (0.6)	——	[——]	1.18 (2.6)	——
Carbaryl (Sevin)	80 (50.6)	1209.7 (2795.7)	15.1 (34.9)	199.47 (439)	500.0
Chlordane	8 (5.1)	131.7 (290)	[19.9] (36.3)	22.68 (50)	250.0
Cyhexatin (Plictran)	3 (1.9)	1.8 (4)	[0.6] (1.3)	0.68 (1.5)	540.0
DDT	1 (0.6)	3.4 (7.5)	[3.4] (7.5)	0.00 (0.0)	113.0
Demeton (Systox)	1 (0.6)	2.7 (6)	[2.7] (6)	2.72 (6)	65.0
Diazinon	33 (20.9)	782.6 (1721.8)	23.7 (52.2)	167.66 (369)	300.0
Dicofol (Kelthane)	30 (19.0)	146.3 (321.7)	4.9 (10.7)	14.74 (32.4)	684.0
Dieldren (HEOD)	2 (1.3)	9.1 (20)	[4.5] (10)	4.54 (10)	46.0
Dienochlor (Pentac)	1 (0.6)	0.2 (0.5)	[0.2] (0.5)	0.00 (40)	3160.0
Dimethoate (Cygon)	34 (21.5)	190.0 (418)	5.6 (12.3)	169.08 (372)	225.0
Disulfoton (Di-Syston)	2 (1.3)	1.7 (3.8)	[0.9] (1.9)	0.00 (40)	2.6
Endosulfan (Thiodan)	1 (0.6)	102.1 (224.5)	[102.1] (224.5)	102.06 (224.5)	42.0
Endrin	1 (0.6)	2.7 (6)	[2.7] (6)	2.72 (6)	7.0
Fenbutatin-oxide (Vendex)	2 (1.3)	45.4 (100)	[22.7] (50)	45.36 (100)	2630.0
Isotox[x]	19 (12.0)	71.0 (156.3)	3.7 (8.2)	26.81 (59)	——
Lindane	28 (17.7)	135.1 (297.3)	4.8 (10.6)	57.68 (127)	88.0
Malathion	80 (50.6)	787.4 (1732.2)	9.8 (21.7)	395.35 (870)	1375.0
Methoxychlor	4 (2.5)	5.5 (12.2)	[1.4] (3.1)	0.45 (1.0)	6000.0
Mexacarbate (Zetran)	1 (0.6)	27.2 (60)	[27.2] (60)	27.22 (60)	35.0
Nicotine	1 (0.6)	0.5 (1.0)	[0.5] (1.0)	0.00	100.0
Oil	15 (9.5)	——	[——]	1080.05 l	——
Oil + Ethion	2 (1.3)	0.9 (2)	[——]	45.42 l	——
Oxydemeton-methyl (Metasystox-R)	8 (5.1)	2.5 (5.5)	[0.3] (0.7)	1.59 (3.5)	65.0
Parathion	1 (0.6)	3.6 (8)	[3.6] (8)	0.00 (0.0)	3.0
Phosmet (Imidan)	3 (1.9)	13.0 (28.7)	[4.4] (9.6)	0.99 (2.2)	216.0
Pirimicarb (Pirimor)	1 (0.6)	11.3 (25)	[11.3] (25)	0.00 (0.0)	147.0
Totals		3719.7 (8183.7)[w]		1250.5 (2751.1)[v]	

[z]Averages in brackets were used by less than 10% of the total nurseries.

[y]Biological control agent.

[x]Mixture of 5% carbaryl, 5% oxydemeton-methyl, 2% dicofol by weight.

[w]Excluding oil and *Bacillus thuringiensis*.

[v]Excluding oil and oil + ethion.

[u]According to Thomson, 1981.

Table 3. Summary of land usage and insecticide/miticide usage by different size categories of 158 nurseries in southeastern Pennsylvania

Nursery Category	Number and (% total)	Total ha (a) used and (% of total)	Total Kg (lb) used	% of total a.i. used	X Kg (lb) per ha
I (0.1 to 2.0 ha) (0.1 to 5.0 a)	80 (50.6%)	77.2 (190.5) (5.2%)	163.7 (360.0)	4.4	2.2 (1.9)
II (2.1 to 8.1 ha) (5.0 to 20 a)	45 (28.5%)	195.8 (483.7) (13.2%)	1067.5 (2348.5)	28.7	5.5 (4.9)
III (8.1 ha)	33 (20.9%)	1214.1 (2999) (81.6%)	2488.3 (5474.2)	66.9	2.1 (1.8)
Totals	158	1487.1 (3673.2)	3719.5 (8182.7)		2.5 (2.2)

medium and large nurseries in Pennsylvania is considered to be exemplary of the Northeast (New York, New Jersey and Ohio).

Nurserymen used 29 different insecticides/miticides in 50 formulations in 1979. However, 7 pesticides (carbaryl, diazinon, dicofol, dimethoate, Isotox, lindane and malathion) accounted for 88.7% of the total used. Only 4% of the pesticides used were in the highly toxic category, and only 4.5% of the pesticides used were not currently registered for application to landscape or nursery crops.

Nurserymen used an average of 2.2 lbs of active ingredients per acre; this is less than half the usage of the fruit and turfgrass industry. However, 33.4% of this

Table 4. Identification and frequency of insect and mite pests reported by 158 southeastern Pennsylvania nurseries.

Pest	#reports	Pest	# reports
1. Leaf miners	62	22. White pine weevil	4
2. Japanese beetle	48	23. Codling moth	3
3. Mites (general)	46	24. Nantucket pine tip moth	3
4. Spruce gall adelgids	46	25. Ants	3
5. Aphids (general)	44	26. Leafhoppers	3
6. Scales	39	27. Inchworms	3
7. Lacebugs	39	28. Cankerworms	3
8. Caterpillars (general)	37	29. Flies[y]	2
9. Red spider mites	35	30. Pales weevil	2
10. Borers	22	31. Zimmerman pine moth	2
11. Whiteflies	16	32. Mealybugs	2
12. Bagworms	14	33. Cottonwood leaf beetle	2
13. Sawflies	11	34. Bark beetles	2
14. Tent caterpillars	11	35. Spittlebugs	1
15. Gypsy moth	11	36. Slugs[z]	1
16. Leafrollers	9	37. Yellow jackets	1
17. Weevils (general)	8	38. Azalea gall midge	1
18. Black vine weevil	8	39. Beetles	1
19. Woolly aphids	8	40. Budworm	1
20. Webworms	7	41. Chinch bug[y]	1
21. Midges	7	42. Armyworm[y]	1

[y]unspecified crop, possibly not nursery crop pest

[z]Mollusca: Stylommatophora.

usage was applied as preventive sprays and may be significantly reduced through proper sampling and monitoring of pests.

The most common pests controlled by nurserymen (87.9%) were found to be the same as those deemed in need of control by a 1982 Maryland IPM program. This indicates that more information on the biology and management of these few common pests is needed to better serve the industry and consumer.

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