Proc. Fla. State Hort. Soc. 96: 274-278. 1983.

A COST ANALYSIS OF PEST CONTROL ON POMPON CHRYSANTHEMUM FARMS IN FLORIDA[1]

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Additional index words. investment costs, variable costs, fixed costs, pesticides, leafminers, *Liriomyza trifolii.*

Abstract. **An analysis was performed to estimate the total cost (application and chemical products) of controlling microbial, insect, mite, and nematode pests during the commercial production of pompon chrysanthemums** (Chrysanthemum x morifolium **Ramat.). Pest control systems were evaluated on 2 farms. During the time of the study, leafminer** (Liriomyza trifolii **(Burgess)) was of great concern to many growers. Therefore, total costs were partitioned for the circumstances where the leafminer was and was not perceived as an economic threat. Total cost per acre for pest control on the farms were $2,981 and $2,988 when the leafminer was a threat. The costs of chemical products applied for pest control accounted for 69 and 65% of the total cost of pest control on the 2 farms, respectively, when leafminers were a threat. The total cost per acre for pest control on the 2 farms were $1,406 and $969 less when leafminer was not a threat.**

The presence of pests in cut flower chrysanthemums often results in economic losses due to reduced crop yield and quality, and increased cost of pest control. The costs incurred for controlling pests in pompon chrysanthemums totaled $1,026 per acre (excluding fixed costs) in 1973 (5). The costs of controlling pests during this period typically accounted for about 7% of the total cost of chrysanthemum production. Today's growers observe more pest pressure and more expensive pesticides resulting in substantial increases in the costs of pest control.

Records from 4 commercial pompon crops during the 1979-80 production year indicate that an average of 70 (range: 56-102) doses of pesticides (including insecticides, miticides, fungicides and bactericides) were applied for control of pests during the 14-16 wk of crop development (4). Based on these records, the costs of applying pesticides (not including the costs of the pesticidal products) using 5 mechanized spray methods and 2 granular application methods were calculated (3).

The purpose of this study was to provide current estimates of the total costs of applying insecticides, miticides, fungicides and nematicides, including the chemical product costs used to commercially grow pompon chrysanthemums. In addition, this study estimated costs attributable to leafminers, the pest of greatest concern to many growers at the time the data were collected. The pest control costs developed will provide the basic cost information necessary to establish future economic injury thresholds for leafminers and other pests associated with pompon chrysanthemums and to aid the pesticide industry in estimating potential markets.

Materials and Methods

Total pest control costs were evaluated utilizing pest control systems on 2 similar farms managed by different chemical control strategies. The information used to develop the pest control strategies was obtained through interviews of flower growers. The strategies were reasonable representations of pest control programs on 2 pompon farms in Florida when 1) the leafminer was perceived as an economic threat and 2) the leafminer was not perceived as an economic threat. A detailed cost analysis was performed for both conditions concerning the leafminer on each farm. For each farm, costs incurred when the leafminer was not perceived as an economic threat were subtracted from costs incurred when the leafminer was perceived as an economic threat to determine costs attributable to the leafminer.

Farm setting. In this analysis, the total costs for pest control were evaluated for a 20-acre saranhouse site. The production program assumed that an average of 1.5 chrysanthemum crops could be grown annually per acre (20-acre site x 1.5 crops per year = 30 acres per year).

Equipment. Farm A. Equipment was a nozzle boom sprayer composed of a 30-horsepower, diesel, high clearance tricycle tractor with center-mounted 200-gal spray tank and a drop boom equipped with spray nozzles, and a multiple-row granular applicator composed of a spiral-flow applicator mounted on a 30-horsepower, diesel, high clearance tricycle tractor.

Farm A; with leafminer threat. Methyl parathion and permethrin were applied in a tank-mix for leafminer control twice weekly during weeks 2-14. One fungicide was tank-mixed with the above preparation at each application. Chlorothalonil was applied as often as maneb was applied. Benomyl was applied as often as was captan, but half as many times as chlorothalonil or maneb. The fungicide schedule resulted in an application twice a week; without the leafminer, fungicides were applied on a 5-day schedule. The shorter interval, when the leafminer was present, resulted in 3 chlorothalonil, 3 maneb, 1 benomyl, and 1 captan additional applications, which increased costs under those conditions. This procedure was not mandated by the presence of the leafminer. A tank-mix of methomyl and *Bacillus thuringiensis* was applied for lepidopterous larvae, aphids, and plant bugs weekly during weeks 2-14.

Farm B; without leafminer threat. Chlorothalonil and maneb fungicides were alternated on a 5-day schedule during weeks 2-14. Hexakis was applied for mite control on a 10-day schedule during weeks 2-14 in a tank-mix with the fungicidal preparation. Methyl parathion was applied on a 10-day schedule during weeks 2-12 for plant bug control in a tank-mix with the fungicidal preparation. Every 2 weeks during weeks 2-14, permethrin, *B. thuringiensis* or a combination of the 2 were applied (in an equivalent number of applications) for lepidopterous larvas, aphids, and thrips.

Farm B. Equipment was an air blast sprayer composed of a trailer mounted 500-gal spray tank with PTO driven pump and hydraulically rotating spray head having a spray distance of 75 ft and pulled by an 80-horsepower diesel tractor.

Control programs. The following pest control programs were assumed to have been conducted on the 2 farms. Custom broadcast fumigation with methyl bromide (for weeds, nematodes and soil-borne diseases and insects) was performed and a fungicide drench of pentachloronitrobenzene with etridiazole was applied through the sprinkler irrigation system regardless of the farm or presence of leafminers. Common brand names, formulations, rates, dosages, and costs for each pesticide mentioned appear in Table 1.

[1]Florida Agricultural Experiment Stations Journal Series No. 5112.

Table 1. Costs of chemicals on 2 pompon chrysanthemum farms in Florida with and without the threat of leafminers, 1981[z].

Pesticide	Cost/unit ($)	Unit/acre/dose	Cost/acre/dose ($)	Leafminer present[y] Doses/crop	Leafminer present[y] Cost/acre/crop ($)	Leafminer not present[x] Doses/crop	Leafminer not present[x] Cost/acre/crop ($)
Farm A[w]							
Bacillus thuringiensis WP (Dipel)	8.70/lb.	1.0 lb.	8.70	13	113.10	13	113.10
benomyl 50WP (Benlate)	10.85/lb.	0.5 lb.	5.43	4	32.72	3	16.29
captan 50WP (Captan)	1.47/lb.	1.5 lb.	2.21	4	8.84	3	6.63
chlorothalonil 75WP (Daconil 2787)	5.75/lb.	1.5 lb.	8.63	9	77.67	6	51.78
dienochlor 50WP (Pentac)	21.90/lb.	0.5 lb.	10.95	0	0.00	3	32.85
disulfoton 15G (Disyston)	1.10/lb.	80.0 lb.	88.00	4	352.00	0	0.00
maneb 80WP (Manzate)	1.65/lb.	1.5 lb.	2.48	9	22.32	6	14.88
mehomyl 90SP (Lannate)	12.35/lb.	0.5 lb.	6.18	13	80.34	13	80.34
methyl bromide	288.00/acre	1.0 acre	288.00	1	288.00	1	288.00
methyl parathion 2F[v] (Penncap-M)	3.88/qt	1.5 qt	5.81	26	151.06	0	0.00
oxythioquinox 25WP (Morestan)	8.13/lb.	1.5 lb.	12.20	0	0.00	3	36.60
pentachloronitrobenzene + etridiazole (Terrachlor Super-X)	90.00/acre	1.0 acre	90.00	1	90.00	1	90.00
permethrin 2E (Ambush)	32.50/qt	1.0 qt	32.50	26	845.00	0	0.00
Total					2061.05		730.47
Farm B[u]							
Bacillus thuringiensis WP	8.70/lb.	2.0 lb.	17.40	4	69.60	4	69.60
chlorothalonil 75WP	5.75/lb.	3.0 lb.	17.25	14	241.50	9	155.25
hexakis 50WP (Vendex)	16.90/lb.	1.0 lb.	16.90	10	169.00	10	169.00
maneb 80WP	1.65/lb.	3.0 lb.	4.95	14	69.30	9	44.55
methyl bromide	288.00/acre	1.0 acre	288.00	1	288.00	1	288.00
methyl parathion 2F[v]	3.88/qt	4.0 qt	15.52	6	93.12	8	124.16
oxamyl 2L (Vydate)	9.30/qt	4.0 qt	37.20	22	818.40	0	0.00
Pentachloronitrobenzene + etridiazole	90.00/acre	1.0 acre	90.00	1	90.00	1	90.00
permethrin 2EC	32.50/qt	0.6 qt	19.50	5	97.50	5	97.50
Total					1936.42		1038.06

[z]Information is based on interviews with flower growers. The use of trade names and pest control programs are solely for the purpose of providing specific information. They do not represent a guarantee or warranty of the products named or programs described and do not signify that they are approved to the exclusion of others of suitable composition.
[y]Tank mixing of some pesticide materials resulted in 39 and 4 applications for spray and granular materials respectively for Farm A, while Farm B received 28 applications of spray materials.
[x]Tank mixing of some pesticidal materials resulted in 28 applications of spray materials for Farm A and 18 applications of spray materials for Farm B.
[w]Farm A utilized a nozzle boom sprayer and multiple row, spiral flow spreader to administer pesticides.
[v]Micro-encapsulated formulation.
[u]Farm B utilized an air blast sprayer to administer pesticides.

Farm A; without leafminer threat. A tank-mix of methomyl and *Bacillus thuringiensis* was used for lepidopterous larvae, thrips, aphids and plant bugs weekly during weeks 2-14. A tank-mix of dienochlor and oxythioquinox was applied 3 times during the crop season to control 1 outbreak of the twospotted spider mites. A fungicide was applied alone on a 5-day schedule during weeks 2-14. Chlorothalonil was applied as often as maneb was applied; Benomyl was applied as often as captan but half as many times as chlorothalonil or maneb. No pesticides were applied when flowers were showing color after week 14.

These chemicals were tank-mixed with other chemicals to be applied at that time.

Farm B; with leafminer threat. Oxamyl was applied twice each week during weeks 1-14 for leafminer control. Once every 2 wk methyl parathion was substituted for oxamyl to control plant bugs in addition to the leafminer. Every 2 wk during weeks 2-14 permethrin, *B. thuringiensis* or a combination of the 2 were applied (in an equivalent number of applications) for lepidopterous larvae, thrips, nd aphids. These chemicals were tank-mixed with the above insecticides. Hexakis was applied during weeks 2-14 in a tank-mix with the above on a 10-day schedule for mite control. Each time that one of the above mixes was applied (i.e.twice each week), either chlorothalonil or maneb fungicides (in an equal number of dosages) were added to the tank-mix.

A summary of all spray and granular pesticide applications is presented by week of production in Table 2.

Variable and fixed costs. Costs were separated into 2 categories, variable and fixed costs. Variable costs describe those costs that vary with output during the production

Table 2. Pesticides sprayed or applied as granules to control arthropod and fungal pests on 2 pompon chrysanthemum farms in Florida when damaging levels of leafminers were present and when no threat of leafminer damage existed[z].

Week	Farm A[y,x,w]		Farm B	
	Leafminer	No leafminer	Leafminer	No leafminer
1			(13+4) (13+7)	
2	(9+11+4) (8+1) (9+11+2)	(4) (8+1)	(13+12+11+4) (13+7)	(9+11+4) (12+7)
3	(9+11+7) (6) (9+11+3) (8+1)	(2) (8+1)	(9+4) (13+12+7)	(9+4)
4	(9+11+4) (8+1) (9+11+7) (14)	(7) (8+1) (3) (14)	(13+1+4) (13+7) (14)	(1+12+7) (14)
5	(9+11+4) (8+1) (9+11+7)	(4) (8+1)	(9+4) (13+12+7)	(12+4) (9+7)
6	(9+11+4) (6) (9+11+7) (8+1)	(7) (8+1) (4)	(13+11+1+4) (13+12+7)	(9+11+1+4)
7	(9+11+2) (8+1) (9+11+3)	(7) (8+1) (4)	(9+4) (13+7)	(12+7)
8	(9+11+4) (8+1) (9+11+7)	(7) (8+1)	(13+12+11+4) (13+7)	(9+11+4) (12+7)
9	(9+11+4) (6) (9+11+7) (8+1)	(2) (8+1)	(9+4) (13+12+7)	(9+4)
10	(9+11+2) (8+1) (9+11+7)	(3) (8+1)	(13+1+4) (13+12+7)	(12+7) (9+1+4)
11	(9+11+4) (8+1) (9+11+3)	(4) (8+1) (7)	(9+4) (13+7)	(12+7)
12	(9+11+4) (6) (9+11+7) (8+1)	(3) (8+1) (5+10) (5+10)	(13+12+4) (13+11+1+7)	(9+11+1+4) (12+7)
13	(9+11+2) (8+1) (9+11+3)	(8+1) (5+10)	(9+4) (13+12+7)	(12+4)
14	(9+11+4) (8+1) (9+11+7)	(8+1)	(13+11+4) (13+12+7)	(11+12+7)

[z]Custom fumigation (methyl bromide) was considered to be performed on both Farms A and B regardless of leafminer situation prior to plant production.
[y]Pesticides grouped within parentheses were applied together in a tank mix.
[x]Numerals within the table represent pesticides as follows:

1 = *Bacillus thuringiensis* WP
2 = benomyl 50WP
3 = captan 50WP
4 = chlorothalonil 75WP
5 = dienochlor 50 WP
6 = disulfoton 15G
7 = maneb 80WP
8 = methomyl 90SP
9 = methyl parathion 2F
10 = oxythioquinox 25WP
11 = permethrin 2E
12 = hexakis 50WP
13 = oxamyl 2L
14 = pentachloronitrobenzene + etridiazole

[w]Pesticides were applied at the rates indicated in Table 1.

process and were calculated from the price and quantities used of items such as fuel, oil, lubricants, labor and pesticides.

Costs of fuel, oil and lubricant in this study were estimated from published engineering data (1) and labor costs were calculated from time for application information furnished by flower producers and equipment industry representatives. Chemical costs were obtained from interviews with pesticide industry representatives.

The fixed costs, unrelated to output and remaining constant during the production process (depreciation, insurance, repairs, taxes, and interest) were estimated for each item of machinery and equipment (2). Depreciation, a noncash cost, was based on a procedure for allocating the usefulness of an asset over its life. Straight-line depreciation, investment cost minus salvage value divided by the number of years of useful life, was used to calculate annual depreciation. All machinery and equipment were assumed to have a useful life of 10 yr except the granular applicator which was assumed to have a useful life of 5 yr. Annual insurance costs were estimated at 0.5% of the average of investment costs and remaining depreciable value. Annual repair costs were estimated at 10% of investment costs. Taxes were calculated at 70% of investment cost times the millage rate of $17/1000. Interest costs were calculated at 14% of the average of investment cost and salvage value.

Results and Discussion

Fixed costs. The investment costs of the pesticidal application systems are shown in Table 3. Investment costs represent the amount of capital necessary to purchase the machinery or equipment item. The air blast sprayer (used by Farm B) had a particularly high investment cost (due in part to the necessity of a large horsepower tractor to pull and operate the sprayer), while the nozzle boom sprayer (used by Farm A) required approximately one-half the amount of capital investment of the air blast sprayer. The investments of the 80-horsepower tractor included in the air blast system and the high clearance tractor used to apply granular materials were allocated according to the percentage of time used for pesticide application operations (Table 4).

The estimated annual fixed costs of the machinery and equipment for pesticidal applications on cut chrysanthemums are recorded in Table 4. The major portion of fixed costs was composed of depreciation, repairs, and interest. The fixed costs of the nozzle boom spray system prorated on a per acre basis were approximately one-half the fixed costs of the air blast spray system. The granular application system was estimated to have annual fixed costs and fixed costs per acre of $867 and $29, respectively.

Variable costs. The estimated variable costs (excluding

Table 3. Estimated machinery and equipment investment cost (in dollars) for pesticidal applications on 2 pompon chrysanthemum farms, 1981[z].

Item	Investment costs
FARM A	
Granule applicator system:	
Spiral-flow spreader	1,000
High-clearance tractor	18,720
Total	19,720
Nozzle boom spray system:	
High-clearance tractor	18,720
FARM B	
Air blast spray system:	
Sprayer	19,000
Tractor	20,000
Total	39,000

[z]Investment cost is the amount of capital necessary to purchase the equipment item.

Table 4. Estimated annual fixed costs and fixed costs per acre (in dollars) of machinery and equipment for pesticidal applications on 2 pompon chrysanthemum farms, 1981.

Item	Annual fixed cost[z]	Fixed cost/acre[y]
FARM A		
Granule applicator system:		
Spiral-flow spreader	337	11
High-clearance tractor[x]	530	18
Total	867	29
Nozzle boom spray system:		
High-clearance tractor	5,310	177
FARM B		
Air blast spray system:		
Sprayer	5,390	180
Tractor[w]	4,823	160
Total	10,213	340

[z]Annual fixed costs include annual depreciation, insurance, repairs, taxes, and interest.
[y]Fixed cost/acre was calculated by dividing the annual fixed costs by the number of acres produced annually. It was assumed that the operation was 20 acres and that 1.5 crops per year were produced on each acre (i.e. 20 acres x 1.5 crops/yr = 30 acres/yr).
[x]It was assumed that 10% of the high-clearance tractor's use was for applying granular material through the spiral-flow distributor.
[w]It was assumed that 85% of the tractor's use was for pesticidal applications.

costs of the pesticidal products) per application of pesticidal materials are presented in Table 5. Variable costs per hour were calculated for each farm and leafminer condition according to the required use of fuel, oil, lubricants, and labor. The time (hours) required per acre for an application was multiplied by the variable costs (dollars) per hour which resulted in the variable costs for treating one acre one time.

Table 5. Estimated variable costs per application (in dollars) for pesticidal applications on pompon chrysanthemums, 1981[z].

System	Variable costs/hr	Hr/application	Variable costs/application
FARM A			
Granule applicator system	6.07	1.00	6.07
Nozzle boom spray system	6.07	0.75	4.55
FARM B			
Air blast spray system	9.52	0.75	7.14

[z]Variable costs include only the costs of fuel, oil, lubricants, and labor.

The estimated variable costs per acre during an entire season for pesticidal applications utilizing 2 pest control programs each on 2 farms are presented in Table 6. The variable costs (dollars) per application were multiplied by the number of applications for the 2 programs on each of the farms resulting in the variable costs per acre to apply pesticidal materials. Analysis of the variable costs (excluding costs of the pesticides) per acre for Farm A and Farm B revealed that the pest control program when leafminer was a threat cost an additional $46 and $71 per acre, respectively, for applying pesticidal materials.

The estimated chemical product costs per acre on the 2 farms when leafminer was present and when leafminer was not present are described in Table 1. The data indicate that the pesticides for Farm A when the leafminer was a threat cost approximately $2,061 per acre but only $730 per acre when leafminer was not a threat. Likewise, pesticide costs for Farm B when leafminer was a threat were $1,936 per acre and were $1,038 per acre when the leafminer was not a threat. Thus, increased pesticide costs due to the leafminer were $1331 and $898 for Farms A and B, respectively.

Total costs of pest control. All variable and fixed costs are summed in Table 7, representing the total costs per acre of applying pesticides on the 2 farms when the leafminer was present and when the leafminer was not present.

Table 6. Estimated variable cost per acre during 1 crop season for pesticidal applications (excluding cost of pesticidal products) on pompon chrysanthemums, 1981[z].

System	Variable cost/application ($)	Leafminer present: No. times used	Leafminer present: Variable cost/acre/season[y] ($)	Leafminer not present: No. times used	Leafminer not present: Variable cost/acre/season[y] ($)
Farm A					
Granule application system	6.04	4	24	0	0
Nozzle boom spray system	4.55	39	177	35	155
Fumigation—custom	512.00	1	512	1	512
Total			713		667
Farm B					
Air blast spray system	7.14	28	200	18	129
Fumigation—custom	512.00	1	512	1	512
Total			712		641

[z]Variable cost inclues only the cost of fuel, oil, lubricants and labor.
[y]Values are rounded to the nearest dollar.

Table 7. Estimated total pest control costs per acre on pompon chrysanthemum farms in Florida with and without the threat of leafminers, 1981[z].

Item	Fixed cost/ acre	Variable costs/acre				Total costs/ acre
			Chemicals for			
		Application[y]	Bacteria and fungi	Arthropods	Fumigation	
Farm A						
Leafminer present	206	713	232	1,542	288	2,981
Leafminer not present	177	667	180	263	288	1,575
Difference due to leafminer						1,406
Farm B						
Leafminer present	340	712	401	1,247	288	2,988
Leafminer not present	340	641	290	460	288	2,019
Difference due to leafminer						969

[z]Total costs represent the sum of variable and fixed costs.
[y]Variable costs for application were derived in Table 6.
[x]Chemical costs were derived in Table 1.

Total costs per acre for pest control on Farm A when leafminer was a threat were $2,981, while total costs per acre when leafminer was not a threat was $1,575. Thus, when the leafminer was a threat on Farm A, an additional $1,406 per acre was required for pest control. The total costs per acre on Farm B when the leafminer was not a threat were $2,019 but costs were $969 greater on that farm when the leafminer was present. Costs of the pesticidal products represented the major cost component of applying pesticides (69% and 65%, respectively), for Farms A and B when the leafminer was a threat. The fixed costs and the variable costs incurred to apply pesticidal materials represented a small portion of the total pest control costs.

The results of this study indicate that the costs for pest control on pompon chrysanthemums in Florida have substantially increased since 1973. In addition, not only have pest control costs increased, but also the proportion of those costs with respect to the total production costs have increased. For instance, given that an acre of pompon chrysanthemums cost $17,000 to produce in 1981, the non-fixed costs of pest control on Farms A and B represented 16.3 and 15.6% of the total cost of production. Therefore, the results of this study reveal that during an 8-yr interval (1973-1981) pest control costs have nearly tripled, while the proportion of pest control costs to the total production costs have more than doubled.

The findings of this study should increase the grower's awareness of how pest control costs have increased and should emphasize the benefits of skilled pesticide management in chrysanthemum production. Those producers who recognize, properly plan, and effectively manage their pest control program will be in a better position to become more profitable.

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Proc. Fla. State Hort. Soc. 96: 278-280. 1983.

THE FEASIBILITY OF CONTROLLING ARECA PALM LEAF SPOT BY ALTERING HOST NUTRITION[1]

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Additional index words. *Exserohilum rostratum, Chrysalidocarpus lutescens, Phaeotrichoconis crotalariae.*

Abstract. **The influence of host nutrition on severity of Areca palm** (Chrysalidocarpus lutescens **Wendl.) leaf spot was tested under greenhouse and shadehouse conditions. Although nutritional level consistently affected the growth and quality of the palms, disease response to nutritional levels varied. Controlling this disease by altering the host plant nutrition is therefore not feasible at this time.**

Areca palm leaf spot is caused by several fungal pathogens including *Bipolaris setariae* (Saw.) Shoemaker, *Phaeotrichoconis crotalariae* (Salam & Rao) Subram. and *Exserohilum rostratum* (Drechs.) Leonard & Suggs (2). These diseases cause high losses in plant quality during production under shadehouse conditions where leaves are frequently wet and the conidia spread easily to infect new leaves. Control through application of chemicals has been only partially successful (3) under field conditions and the feasibility of altering the host's susceptibility to disease through manipulation of nutrition was investigated.

[1]Florida Agricultural Experiment Stations Journal Series No. 5050.