Manipulating Fertility of Potted Chrysanthemum Influences Cotton Aphid (*Aphis gossypii*) Populations

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Nature of Work: This study tested the hypothesis that increased nitrogen will enhance insect pest populations of cotton aphid (*Aphis gossypii* Glover). Slow-release, pre-incorporated fertilizer was supplied to rooted cuttings of chrysanthemum (*Dendranthema grandiflora* var. 'Charm') potted in 6-in (15.2 cm) containers. Plants were grown for eleven weeks in growth chambers under three fertility levels of Nutricote 18N-6P_2O_5-8K_2O — 0.5x rate: 3 lb yd^{-3} (1.8 kg m^{-3}), 1x rate: 6 lb yd^{-3} (3.6 kg m^{-3}), and 2x the recommended rate: 12 lb yd^{-3} (7.2 kg m^{-3}). After 5 weeks, plants were inoculated at five aphids per pot. Each pot contained four rooted cuttings, which is the industry standard.

Ornamental crops in Texas rank first economically among agricultural commodities. During the 1990's there was a 10.3% increase per annum in Texas ornamental crop production. However, horticultural and pest management inputs to ornamentals are 10-fold greater than with other commodity crops. Consequently, fertilizers, pesticides and growth regulators are carried off in effluents. Texas Surface Water Quality Standards (proposed in July 2000) protect, maintain, and restore Texas water resources to guarantee the health of Texas citizens. These Standards mandate monitoring by regulatory agents for pollutants and that nurseries submit environmental management plans. The challenge to the $1.3 billion (per anum) Texas ornamental industry —resulting from this policy — will be to optimize inputs, reduce effluents, and maintain quality yields. The utilization of best management practices (BMP) such as recycling irrigation water, increased slow release fertilizer usage, and biological pest control are some of the practices that the nursery industry has implemented (Yaeger et al. 1997).

To better maintain the economic health of this vital industry, while addressing environmental concerns, our research is focusing on how precision fertilization and irrigation systems impact entomological interactions and subsequent crop yield and quality. In this preliminary study, the effect of nitrogen fertilization on the abundance of cotton aphid, *Aphis gossypii* was studied on chrysanthemum, *Dendranthema grandiflora* var. “Charm”. We tested three fertilization treatments that consisted of 0.5x, 1x, and 2x (the recommended nitrogen level). Thirty-five days after four rooted cuttings per pot were established, plants pinched, treated with B-9 at 3500 ppm, and placed under short-day conditions — five apterous aphids were transferred to each pot. Aphids were counted weekly over a seven-

week period. The experiment was harvested after 78 days and all treatments evaluated for plant growth and leaf tissue elemental analysis.

Results and Discussion: Greatest plant height, leaf, shoot and flower bud dry mass, leaf area, shoot number and flower number occurred with the highest fertility level (Table 1). Conversely, least growth occurred at the lowest fertility level. Aphids had no effect on plant growth, except at highest fertility level where aphid inoculated plants had a greater leaf area and higher shoot number (Table 1). There were no aphid effects on reproductive growth (i.e., flower dry mass or flower number) (Table 1).

Highest leaf elemental nitrogen (N) and magnesium (Mg), and lowest phosphorus (P) and potassium (K) occurred at the highest fertility level (Table 2). There was no difference in leaf elemental calcium (Ca) among fertility treatments. Plants at the low fertility level had the lowest leaf elemental N and the highest P. Plants at the highest fertility level had highest iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), and boron (Bo) and lowest molybdenum (Mo) and sodium (Na) (Table 3). Both boron (B) and Na were lowest in aphid-colonized plants (Table 3).

From 2 to 7 weeks after inoculation of aphids, aphid populations were lower at the low fertility (0.5x) than 1x or 2x levels (Fig. 1). Aphid levels were comparable between the medium and high fertility rates.

Dietary nitrogen is one of the most important factors that influence the development and performance of insect pests such as aphids (Mattson 1980). Nitrogen fertilizers are used in nursery/greenhouse ornamental production and are an important source of nitrogen for both pests and host plants. Studies on nitrogen fertilization and aphid population development have led to mixed results. Reproduction of melon aphid (*A. gossypii*) was affected by cultivars of chrysanthemums, but not irrigation or fertilizer treatments (Bethke et al. 1998). Reduction of fertilizer usage and subsequent reduction in nitrogen run-off has caused changes in nitrogen usage for a number of ornamental crops (Cabrera et al. 1993; Yeager et al. 1997). Knowing the influence of nitrogen fertilizer on the host plant and pest insects will minimize insect damage and help improve crop quality.

Significance to the Industry: There are excellent opportunities to develop best management practices (BMP) for the nursery and greenhouse industries to reduce fertility and pesticide usage, maintain crop productivity, and enhance integrated pest management systems. The long-term goal of this research is to develop management systems for maximizing crop quality and quantity while minimizing inputs, energy costs, and environmental and worker safety risks. Benchmarks need to be determined for optimal inputs in greenhouse and nursery crop production. The incorporation of new production systems to reduce fertilizer and pesticide usage without reducing plant quality is one of the most important challenges facing the nursery/greenhouse industries. Lower fertility reduced populations of cotton aphid on chrysanthemum. However, the nutritionally stressed, low fertility level plants were not commercially acceptable. Future experiments are focusing on fine-tuning fertility levels to minimize populations of cotton aphid, while maintaining marketable quality of chrysanthemum.

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Table 1. Influence of mineral nutrition and insect pest infestation on selected plant growth parameters of *Dendranthema grandiflora* L. 'Charm' grown under controlled environment for 78 days.

Fertilizer Rate[z]	Plant height (m)	Leaf DM (g)	Shoot[‡] DM (g)	Flower Bud DM (g)	Leaf Area (m^2)	Shoot number	Flower number
			Non-infested[‡]				
0.5X	0.14±0.005[y]	7.64±0.32	13.12±0.59	5.10±0.34	0.30±0.01	20.2±0.97	86.2±5.85
1X	0.16±0.005	9.04±0.56	16.66±0.68	7.66±0.32	0.35±0.01	22.0±1.38	118.2±6.70
2X	0.20±0.009	12.42±1.03	24.78±1.97	11.64±0.77	0.42±0.02	21.4±1.63	181.2±9.95
			Aphid infested				
0.5X	0.14±0.005	6.18±0.22	11.02±0.28	4.08±0.29	0.28±0.01	18.0±0.84	68.8± 2.42
1X	0.17±0.003	9.26±0.14	17.32±0.45	6.96±0.40	0.34±0.01	22.6±0.98	108.6± 4.95
2X	0.22±0.005	13.14±0.66	26.68±1.06	12.28±0.70	0.52±0.01	25.4±0.93	191.2±10.42
Source:				**Prob > F**			
Insect pest	NS[x]	NS	NS	NS	0.0233	NS	NS
Fertilizer	0.0001	0.0001	0.0001	0.0001	0.0001	0.0030	0.0001
Insect* Fertilizer	NS	NS	NS	NS	0.0002	0.0427	NS

[z]Fertilizer level supplied as Nutricote® 18N–6P_2O_5–8K_2O at rates of 0.5x, 1x, 2x [1.8, 3.6 and 7.2 kg m^{-3}(3, 6 and 12 lbs yd^{-3})]

[y]Mean values within columns ± SE (n = 5 plants at each fertilizer level).

[x]ANOVA: NS = Non-significant (P ≥ 0.05).

[‡]Shoot DM = stem + leaf DM; DM = dry mass.

[†]Insect pest: = infested or not infested with aphid.

Table 2. Influence of mineral nutrition and insect pest infestation on leaf macronutrient‡ content of *Dendranthema grandiflora* 'Charm' grown under controlled environment for 78 days.

Fertilizer Rate†	N (g kg^{-1})	P (g kg^{-1})	K (g kg^{-1})	Ca (g kg^{-1})	Mg (g kg^{-1})
			Non-infested†		
0.5X	11.74±0.61y	1.52±0.08	6.90±0.63	12.04±0.41	5.16±0.27
1X	17.82±0.67	1.26±0.08	6.20±0.54	12.86±0.24	5.68±0.14
2X	18.98±0.49	1.00±0.05	4.08±0.16	13.20±0.34	6.26±0.12
			Aphid infested		
0.5X	15.12±0.65	1.50±0.06	5.78±0.51	12.76±0.23	5.56±0.20
1X	18.06±0.23	1.32±0.02	5.60±0.24	12.66±0.30	5.68±0.15
2X	20.88±0.20	1.06±0.04	5.04±0.45	12.70±0.18	5.98±0.07
Source:			**Prob > F**		
Insect pest†	0.0002x	NS	NS	NS	NS
Fertilizer	< 0.001	< 0.001	0.0018	NS	0.0007
Insect* Fertilizer	0.0191	NS	NS	NS	NS
Sufficiency Rangev uChrysanthemum	35–-50	2.0–12	35–50	12–25	2.5–10

zFertilizer level supplied as Nutricote® 18N–6P_2O_5–8K_2O at rates of 0.5x, 1x, 2x [1.8, 3.6 and 7.2 kg m^{-3}(3, 6 and 12 lbs yd^{-3})]

yMean values within columns ± SE (n = 5 plants at each fertilizer level).

xANOVA: NS = Non-significant (P ≥ 0.05).

vSufficiency range of mineral elements determined from mature leaf tissue of *Chrysanthemum* (Jones et al., 1991).

‡Macronutrient concentration = per gram leaf dry mass.

†Insect pest = infested or not infested with aphid.

Table 3. Influence of mineral nutrition and insect pest infestation on leaf micronutrient‡ content of *Dendranthema grandiflora* 'Charm' grown under controlled environment for 78 days.

Fertilizer	Fe (μg g^{-1})	Mn (μg g^{-1})	Zn (μg g^{-1})	Cu (μg g^{-1})	Al (μg g^{-1})	B (μg g^{-1})	Mo (μg g^{-1})	Na (μg g^{-1})
				Non-infested†				
0.5X	36.16±6.77[y]	59.08±5.05	27.20±2.00	5.22±0.49	29.14±1.83	134.6±4.97	3.28±0.68	408.8±18.6
1X	46.80±2.37	69.58±4.35	30.50±1.62	7.14±0.56	27.52±0.83	168.4±5.94	3.26±0.48	430.4±44.1
2X	63.86±4.46	64.28±2.21	33.24±2.77	9.83±0.32	27.20±1.18	185.6±3.36	3.24±0.53	357.4±35.2
				Aphid infested				
0.5X	31.52±0.61	47.38±2.23	23.70±1.46	4.64±0.16	34.92±3.63	127.0±4.12	6.10±0.29	318.4±20.4
1X	44.34±3.12	58.26±2.87	27.66±2.30	6.27±0.35	27.52±1.26	154.0±5.63	4.90±0.65	224.6±10.8
2X	69.34±7.31	65.74±2.04	33.64±2.59	10.23±0.70	25.98±0.36	176.8±4.64	4.05±0.56	231.0± 7.5
Source:				**Prob > F**				
Insect pest†	NS[x]	0.0143	NS	NS	NS	0.0161	0.0006	< 0.0001
Fertilizer	< 0.0001	0.0027	0.0047	< 0.0001	0.0154	< 0.0001	NS	0.0458
Insect* Fertilizer	NS	NS	NS	NS	NS	NS	NS	NS
Sufficiency Range[v] [u]Chrysanthemum	50-250	50-250	20-250	6-30	—	25-75	—	—

[z]Fertilizer level supplied as Nutricote® 18N–6P_2O_5–8K_2O at rates of 0.5x, 1x, 2x [1.8, 3.6 and 7.2 kg m^{-3}(3, 6 and 12 lbs yd^{-3})]

[y]Mean values within columns ± SE (n = 5 plants at each fertilizer level).

[x]ANOVA: NS = Non-significant (P ≥ 0.05).

[v]Sufficiency range of mineral elements determined from mature leaf tissue of Chrysanthemum (Jones et al., 1991).

‡Micronutrient concentration = per gram leaf dry mass.

†Insect pest = infested or not infested with aphid.

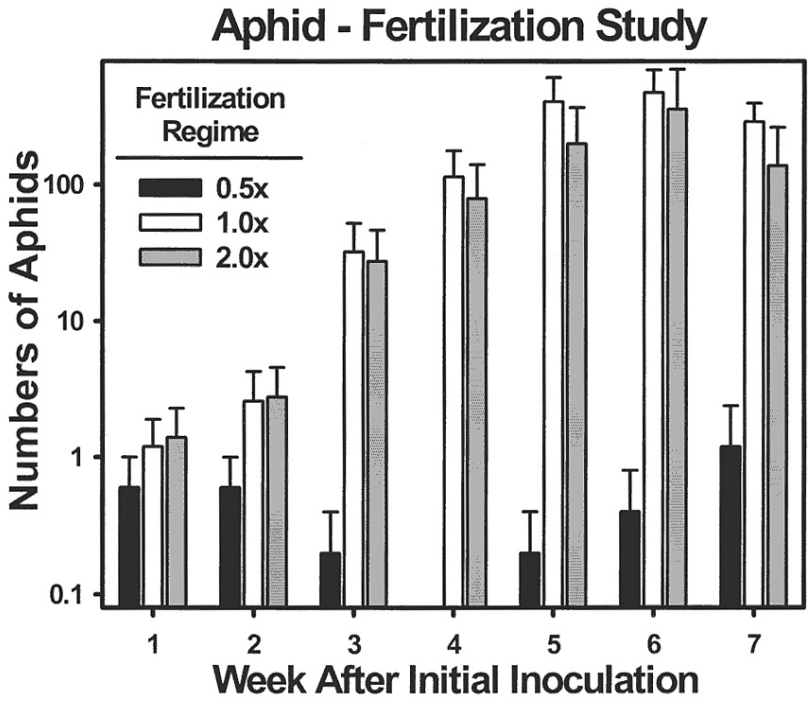

Figure 1. Effect of slow release fertilizer at 0.5x, 1x and 2x recommended rates on cotton aphid (*Aphis gossypii*) populations over a 7-week period in potted chrysanthemum (*Dendranthema grandiflora* 'Charm').