

# Crop Profile for Geranium (seed and cutting) in Ohio

## General Production Information

- Area of production in Ohio: 9,477,000 sq. ft - 60% of cutting and 90% of seed for wholesale market
- Percent of US Acreage/Rank: 9%/2<sup>nd</sup>
- Number of Growers: 287
- Wholesale Price Per Flat: \$6.15
- Value of Wholesale Production in Ohio: \$10,541,000

### Production Methods:

Geraniums are propagated by seed and cutting. Cuttings are usually taken from outdoor geranium plants during late summer or early fall. Shoot tips are cut off 4 to 6 inches in length, leaves removed and placed in a rooting medium. A rooting hormone can be applied to stimulate the rooting process. Cuttings are kept well watered and provide with bright indirect light. Cuttings are planted into small individual containers filled with coarse, well-drained soil mix when the new roots are ½ to 1 inch long. Seed are sown in moist sterile soil mix in seed flats or plugs. Seeds are kept uniformly moist to ensure maximum germination that usually occurs in 5 – 10 days. The correct temperature (70 - 75° F) and supplemental irradiation promotes quicker germination and stronger seedlings. Seedlings are transplanted from flats 14 –21 days after sowing, when the first true leaves form. Seedlings can remain in plugs 4-6 weeks depending upon the size of the cells. Fungicides to prevent damping off and fertilizer are applied. For best results the plants are grown in a peat-lite mix, fertilized regularly, kept at the proper temperature (62° F at night and 70° F during the day) and provided adequate water. Growth retardants can be used to hasten flowering as well as keep the plants compact. As with all ornamental plants, managing pests and diseases is a critical component of geranium production since any damage usually renders a plant unsaleable

## Insect Pests

### Thrips

Thrips are often the most serious insect pest in greenhouses. They are very difficult to control once a population becomes well established. Thrips feed on leaves and flowers of a wide variety of host plants. The feeding injury can render a plant unmarketable and the act of feeding by a thrips can transmit viruses to a susceptible host plant. The thrips lifecycle begins as an egg is deposited in plant tissue. After the larvae emerge they begin feeding on the plant. Thrips pass through 2 larval and transformation stages before becoming an adult. Feeding injury is done by the larvae and adults, but only the adults can transmit viruses. The lifecycle of thrips is temperature dependant with development occurring between 50 – 90° F. The egg to adult cycle lasts between 10-38 days at these temperatures. At temperatures below 50° F thrips can survive but no development occurs.

### Whiteflies

Whiteflies are a very common pest in greenhouse production. The most common species are the greenhouse whitefly (*Trialeurodes vaporariorum*) and the silverleaf white fly (*Bemisia argentifolii*). The adult silverleaf whiteflies are smaller, more yellow and active than the greenhouse whiteflies. In the pupal state the silverleaf whiteflies are flat without spines or fringes whereas the greenhouse whitefly pupae have vertical sides with spines. The adult whitefly lifecycle lasts from 21-36 days. Each female produces 60 to 100 eggs that hatch in 7-10 days. The newly emerged crawlers move for a short distance before settling down to feed. After molting 3 times the pupae emerge and in 6 days will grow into adults. During development whiteflies are usually found on the underside of leaves. The adult and immature stages of whiteflies use their piercing-sucking mouth parts to extract fluid from plant tissue. A few adult whiteflies on plants are a nuisance. However, feeding by a large number of adults and especially immatures can weaken or kill a plant. Whiteflies also produce a sticky honeydew that can be a growth medium for lack sooty fungus.

## **Spider Mites**

Spider mites are a persistent pest problem in the greenhouse. Many species of spider mites are found in the greenhouse, but the most common is the two-spotted spider mite (*Tetranychus urticae*). Spider mites are very small arthropods that develop mostly on the undersides of leaves. Their lifecycle lasts between 7-14 days but varies considerably depending on temperature. An adult female spider mite can produce 100-200 eggs in her lifetime. The eggs hatch into tiny larvae in a few days. The larvae pass quickly through several nymph stages before becoming adults. Spider mites cause injury to plants while feeding. Using their piercing-sucking mouth parts, they extract plant fluids. Feeding injury often give the upper leaf surface a characteristic mottled or speckled appearance. Large numbers of spider mites produce a webbing that can completely cover leaves and flowers.

## **Aphids**

There are many species of aphids that can attack greenhouse plants but the two most common species are the green peach aphid (*Myzus persicae*) and the melon/cotton aphid (*Aphis gossypii*). Both of these species are green in color but it can vary from light to dark green for the melon aphid and from light green to nearly pink for the green peach aphid. Aphids have small soft bodies with piercing-sucking mouth parts which they use to insert into the phloem tissue of plants and remove fluid. Aphids cause problems from injury by feeding, the transmission of viruses and by spreading sticky honeydew over the surface of leaves and flowers. In the greenhouse most aphids are female and they produce live young called nymphs. An average female produces between 50 to 200 nymphs during her lifetime. The nymphs, that are all female, begin reproducing in 7-10 days. Adult aphids appear in 2 forms, winged and wingless, depending on population density and /or host plant conditions. Winged aphids are troublesome because they are able to disperse throughout the greenhouse and are also able to fly into the greenhouse from outdoors.

## **Chemical Insect Controls:**

(all chemicals applied at an average rate of 200 gal/A unless otherwise noted)

### **Abamectin (Avid)**

**Percent of total area treated:** 47%

**Target pests:** Thrips and Mites

Average rate and frequency of application of most common formulations: (2)

Avid 0.15 EC – 5.5 oz/100 gal, 3 times

**Application method:** High Volume Spray or Fogger

**REI:** 12 hours

**Efficacy rating:** Good to Very Good

### Spinosad (Conserve)

**Percent of total area treated:** 39%

**Target pests:** Thrips

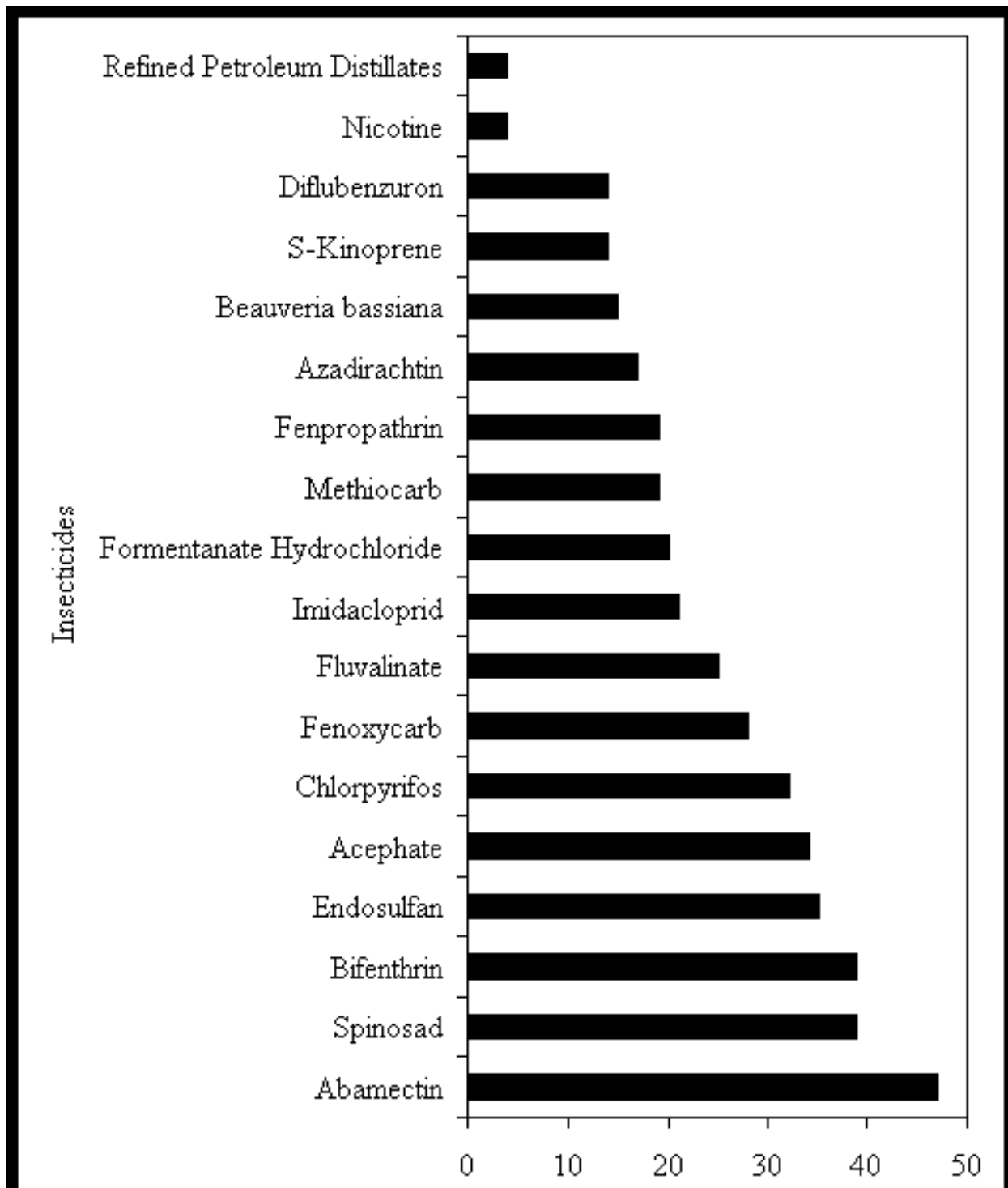
Average rate and frequency of application of most common formulations: (2)

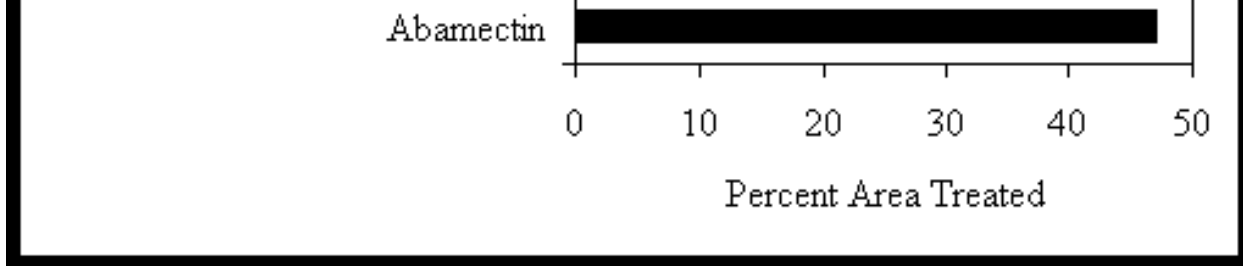
Conserve SC – 6 oz/100 gal, twice

**Application method:** High Volume Spray

**REI:** 4 hours

**Efficacy rating:** Very Good





### **Bifenthrin (Talstar)**

**Percent of total area treated:** 39%

**Target pests:** Thrips and Whiteflies

Average rate and frequency of application of most common formulations: (2)

Talstar F – 12 oz/100 gal, 3-4 times

**Application method:** High Volume Spray

**REI:** 12 hours

**Efficacy rating:** Good

### **Endosulfan (Thiodan)**

**Percent of total area treated:** 35%

**Target pests:** Thrips, Aphids and Whiteflies

Average rate and frequency of application of most common formulations: (2)

Thiodan 50 WP – 16 oz/100 gal, twice

Thiodan 3EC – 41 oz/A, twice

**Application method:** High Volume Spray

**REI:** 24 hours

**Efficacy rating:** Good to Very Good

### **Acephate (Orthene)**

**Percent of total area treated:** 34%

**Target pests:** Thrips and Aphids

Average rate and frequency of application of most common formulations: (2)

Orthene TT&O – 12 oz/100 gal, 3 times

**Application method:** Fogger or High Volume Spray

**REI:** 24 hours

**Efficacy rating:** Good to Very Good

### **Chlorpyrifos (DuraGuard)**

**Percent of total area treated:** 32%

**Target pests:** Thrips, Aphids and Whiteflies

Average rate and frequency of application of most common formulations: (2)

DuraGuard ME – 46 oz/100 gal, 2-3 times

**Application method:** High Volume Spray

**REI:** 12 hours

**Efficacy rating:** Good

## **Fenoxycarb (Precision, Preclude)**

**Percent of total area treated:** 28%

**Target pests:** Thrips

Average rate and frequency of application of most common formulations: (2)

Precision – 4 oz/100 gal, twice

PT 2100 Preclude -

**Application method:** High Volume Spray or Aerosol (Preclude)

**REI:** 12 hours

**Efficacy rating:** Good to Very Good

## **Fluvalinate (Mavrik Aquaflo)**

**Percent of total area treated:** 25%

**Target pests:** Thrips, Spider Mites and Whiteflies

Average rate and frequency of application of most common formulations:

Mavrik Aquaflo – 9 oz/100 gal, 2-3 times

**Application method:** High Volume Spray or Fogger

**REI:** 12 hours

**Efficacy rating:** Good

## **Imidacloprid (Marathon)**

**Percent of total area treated:** 21%

**Target pests:** Aphids and White Flies

Average rate and frequency of application of most common formulations: (2)

Marathon 1% - ½ tsp (2 grams)/10 inch pot, once

Marathon 60 WSP – ¼ tsp/10 inch pot, once

**Application method:** top dress for 1% and drench for 60 WSP

**REI:** 12 hours

**Efficacy rating:** Very Good

## **Formentanate Hydrochloride (Carzol)**

**Percent of total area treated:** 20%

**Target pests:** Thrips

Average rate and frequency of application of most common formulations: (2)

Carzol – 16 oz/A, once

**Application method:** High Volume Spray or Fogger

**REI:**

**Efficacy rating:** Good

## **Methiocarb (Mesurol)**

**Percent of total area treated:** 19%

**Target pests:** Thrips

Average rate and frequency of application of most common formulations: (2)

Mesurool 75W – 32 oz/100 gal, 2-3 times

**Application method:** High Volume Spray or Fogger

**REI:** 24 hours

**Efficacy rating:** Good to Very Good

### **Fenpropathrin (Tame)**

**Percent of total area treated:** 19%

**Target pests:** Thrips and Whiteflies

Average rate and frequency of application of most common formulations: (2)

Tame 2.4 EC – 6.5 oz/100 gal, 4 times

**Application method:** High Volume Spray or Fogger

**REI:** 24 hrs.

**Efficacy rating:** Good

Used with Orthene TT&O for best results.

### **Azadirachtin (Azatin)**

**Percent of total area treated:** 17%

**Target pests:** Thrips, Whiteflies and Spider Mites

Average rate and frequency of application of most common formulations: (2)

Azatin XL – 12.5 oz/100 gal, 2-3 times

**Application method:** High Volume Spray or Fogger

**REI:** 12 hours

**Efficacy rating:** Good

### **Beauveria bassiana (Naturalis-O, BotaniGuard)**

**Percent of total area treated:** 15%

**Target pests:** Thrips, Aphids and Whiteflies

Average rate and frequency of application of most common formulations: (2)

Naturalis-O – 30 oz/100 gal, 3 times

BotaniGuard 22WP – 64 oz/100 gal, once

**Application method:** High Volume Spray or Fogger

**REI:** 4 hours

**Efficacy rating:** Good

### **S-Kinoprene (Enstar)**

**Percent of total area treated:** 14%

**Target pests:** Thrips and Whiteflies

Average rate and frequency of application of most common formulations: (2)

Enstar II – 5 oz/100 gal, 4-5 times

**Application method:** High Volume spray

**REI:** 4 hours

**Efficacy rating:** Good to Very Good

## **Diflubenzuron (Adept)**

**Percent of total area treated:** 14%

**Target pests:** Fungus Gnats (larvae)

Average rate and frequency of application of most common formulations: (2)

Adept 25 WP – 1.5 oz /100 gal, once

**Application method:** Drench

**REI:** 12 hours

**Efficacy rating:** Very Good

## **Nicotine (Fulex)**

**Percent of total area treated:** 4%

**Target pests:** Thrips and Whiteflies

Average rate and frequency of application of most common formulations: (2)

Fulex Nicotine – 1 can/20,000 cu. ft, 1-2 times

**Application method:** Smoke

**REI:** 4 hours

**Efficacy rating:** Good

## **Refined Petroleum Distillate (Sunspray Ultra-Fine)**

**Percent of total area treated:** 4%

**Target pests:** Thrips

Average rate and frequency of application of most common formulations: (2)

Sunspray Ultra-Fine – 6 oz/A, 1-2 times

**Application method:** Cold Fogger

**REI:** 4 hours

**Efficacy rating:** Very Good

## **Cultural Controls:(2,3,5)**

Quarantine new plant material for at least one week. Use screens on ventilation system and doors to exclude pests. Practice proper sanitation and weed control in and around the greenhouse. Avoid excessive fertilization since some pests thrive on plant tissue high in nitrogen.

## **Biological Controls:**

Some new and effective biological control products are available for the greenhouse grower. Most growers are taking a cautious approach to these new products and only applying them to small portions of their operations.

## **Diseases**

### **Botrytis Gray Mold**

The most common disease of greenhouse floral crops is gray mold. Gray mold is caused by the fungus *Botrytis cinerea*. It is a common fungus, with a very wide host range and can persist in the greenhouse year-round. The fungus produces a large amount of spores that move throughout the greenhouse via air currents. Under environmental conditions of relative humidity at or above 85%, little or no air circulation and free water on the leaf surface, the fungal spores land on plant surfaces, germinate and penetrate the host. The symptoms of gray mold vary depending on the host and the environmental conditions associated with the host. In most cases the disease is characterized by the production of leaf spots, flower blight, bud rot, stem canker, stem and crown rot, cutting rot, damping off and in extreme cases, plant death. The fungal growth is characterized by the presence of fluffy gray/brown mycelium that produce a cloud of spores if disturbed. Affected tissue is soft and brown, and sometimes has a water soaked appearance. This disease can be anything from a common nuisance to an economic disaster depending on the host and the conditions under which the crop is grown.

## **Geranium Rust**

Geranium rust is caused by the fungus *Puccinia pelargonii-zonalis*. The fungus is spread via spores in the air or in splashing water. Once the spores land on the leaf surface and germinate in the presence of free water they enter the plant through the stomate. The first symptoms of the disease can be seen about seven days after infection. Small yellow spots will appear on the upper and lower leaf surface. In about a week brownish spore masses appear in the center of the yellow spots, mostly on the underside of the leaf. The "rust-like" spot expands in a concentric ring like growth. The leaf spots will continue to expand and coalesce if not treated, eventually causing leaves to turn yellow and drop. All of the plant can be covered with rust making the plant unmarketable.

## **Rhizoctonia**

Rhizoctonia is a soil-borne fungal disease that can infect many species of ornamental plants. It causes a seed rot and a pre- or post-emergent damping off. The symptoms include a "poor germination" because the seeds have rotted. If infection occurs after emergence, the seedlings exhibit poor growth and wilting. The fungus causes a lesion or sunken area on the stem at the soil line. The lesion will girdle the stem causing a sudden wilting of the plant. If left untreated the fungus will move down into the roots and cause root rot.

## **Pythium**

Pythium is a fungal disease of cuttings and young greenhouse plants. It is spread by contaminated cutting benches and tools and by infected potting soil mixes. The disease appears as brown water-soaked discolorations on roots near the base of a cutting and girdling black lesions near the soil line in seedlings. Plants are stunted as a result of a reduced root system from the root rot. Pythium is a soil-borne fungus whose spores are spread in water or in the soil. Infection is favored by excess soil moisture and poor drainage.

## **Chemical Disease Controls:**

(all chemicals applied at an average rate of 200 gal/A unless otherwise noted)

## **Thiophanate-methyl (Cleary's 3336, Fungo)**

**Percent of total area treated:** 81%

**Target pests:** *Botrytis*, *Rhizoctonia*, Root Rots

Average rate and frequency of application of most common formulations:



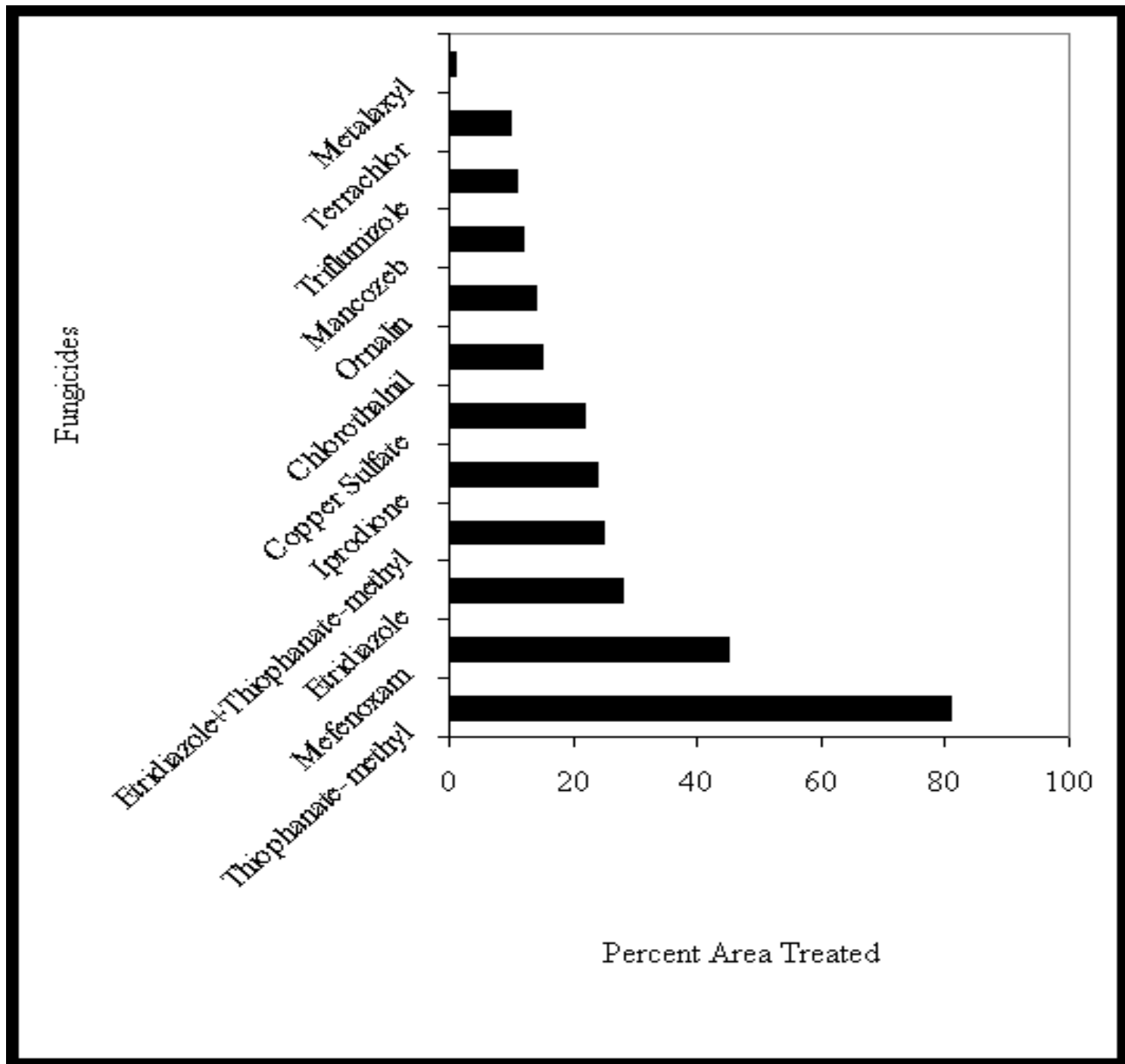
Cleary's 3336 4.5F - 14 oz/100 gal, 1-2 times

Fungo Flo 50WP - 20 oz/100 gal, 1-2 times

**Application method:** High/Low Volume Spray or Drench

**REI:** 12 hours

**Efficacy rating:** Good to Very Good



**Mefenoxam (Subdue MAXX)**

**Percent of total area treated:** 45%

**Target pests:** Root Rots

Average rate and frequency of application of most common formulations:

Subdue MAXX - 0.75 oz/100 gal, once

**Application method:** Drench, Overhead Irrigation

**REI:** None

**Efficacy rating:** Good to Very Good

### **Etridiazole (Truban)**

**Percent of total area treated:** 28%

**Target pests:** Root Rots

Average rate and frequency of application of most common formulations:

Truban 30WP – 6 oz/100 gal, once

**Application method:** Drench

**REI:** 12 hours

**Efficacy rating:** Very Good

### **Etridiazole + Thiophanate-methyl (Banrot)**

**Percent area treated:** 25%

**Target pests:** Root Rots

Average rate and frequency of application of most common formulations:

Banrot 40WP– 8 oz/100 gal, once

**Application method:** Drench

**REI:** 12 hours

**Efficacy rating:** Very Good

### **Iprodione (Chipco)**

**Percent of total area treated:** 24%

**Target pests:** Botrytis

Average rate and frequency of application of most common formulations:

Chipco 26019 50WP – 24 oz/100 gal, twice

**Application method:** High Volume Spray

**REI:** 12 hours

**Efficacy rating:** Good to Very Good

### **Copper Sulfate (Phyton-27)**

**Percent of total area treated:** 22%

**Target pests:** Botrytis

Average rate and frequency of application of most common formulations:

Phyton-27 5.5EC – 24 oz/100 gal, twice

**Application method:** High Volume Spray

**REI:** 12 hours

**Efficacy rating:** Good to Very Good

### **Chlorothalnil (Daconil, Exotherm Termil)**

**Percent of total area treated:** 15%

**Target pests:** Botrytis

Average rate and frequency of application of most common formulations:

Daconil Ultrex 82.5 WDG – 16 oz/100 gal, twice

Daconil 2787 Flo 4F – 32 oz/100 gal, 1-2 times

Exotherm Termil – 3.5 oz/1000 sq.ft, once

**Application method:** High Volume Spray and fogger

**REI:** 12 hours

**Efficacy rating:** Good to Very Good

### **Vinclozolin (Ornalin)**

**Percent of total area treated:** 14%

**Target pests:** Botrytis

Average rate and frequency of application of most common formulations:

Ornalin – 20 oz/100 gal, once

**Application method:** High Volume Spray

**REI:** 12 hours

**Efficacy rating:** Very Good

### **Mancozeb (Protect T/O)**

**Percent area treated:** 12%

**Target pests:** Botrytis and Leaf Spots

Average rate and frequency of application of most common formulations:

Protect T/O 80 WP – 24 oz/100 gal, twice

**Application method:** High Volume Spray

**REI:** 24 hours

**Efficacy rating:** Good to Very Good

### **Triflumizole (Terraguard)**

**Percent of total area treated:** 11%

**Target pests:** Root Rots

Average rate and frequency of application of most common formulations:

Terraguard 50WP – 12 oz/100 gal, once

**Application method:** Drench

**REI:** 12 hours

**Efficacy rating:** Good

### **Quintozene (Terraclor)**

**Percent of total area treated:** 10%

**Target pests:** Root Rots

Average rate and frequency of application of most common formulations:

Terraclor 400 – 12 oz/100 gal, once

**Application method:** Drench

**REI:** 12 hours

**Efficacy rating:** Good to Very Good

## **Metalaxyl (Subdue II)**

**Percent of total area treated:** 1%

**Target pests:** Root Rots

Average rate and frequency of application of most common formulations:

Subdue II – 2 oz/100 gal, once

**Application method:** Drench

**REI:**

**Efficacy rating:** Good

## **Cultural Controls:**

Buy resistant varieties whenever possible. Quarantine new plant materials for at least a week. Screen the greenhouse doors and vents. Plant disease free cuttings and seeds. Keep growing area clean. Remove all diseased plants as soon as they have been detected. Periodically disinfect the hose end, especially after touching the growing mix or the contaminated water on the floor or benches. Benches should also be disinfected at the end of each crop cycle. Eliminate all weeds and algae. Fertilize plants judiciously. Adjust the pH of the growing medium appropriately. Control relative humidity of the greenhouse, especially during the evening hours. This can require simultaneously ventilating and heating the greenhouse during critical hours. Providing adequate air circulation will also help. The use of well draining growth mediums will help reduce the incidence of root diseases.

## **Weeds**

Weeds are a persistent problem in greenhouse production. Weeds are unsightly and can harbor insect pests and diseases. Therefore, weed management in and around the greenhouse is important to assist with pest and disease control and well as to improve aesthetics.

## **Chemical Controls:**

(all chemicals applied at a rate of 200 gal/A unless otherwise noted)

## **Glyphosate (Roundup)**

**Percent of total area treated:** 36%, primarily used as a spot spray in the work area.

**Target pests:** Annual and Perennial Weeds

Average rate and frequency of application of most common formulations:

Roundup Pro – 1.6 oz/gal, as needed

**Application method:** High Volume Spray

**REI:** 4 hours

**Efficacy rating:** Good to Very Good

## **Glufosinate-ammonium (Finale)**

**Percent of total area treated:** 14%

**Target pests:** Annual and Perennial Weeds

Average rate and frequency of application of most common formulations:

Finale – 1.5 gal/100 gal, once

**Application method:** High Volume Spray

**REI:** 12 hours

**Efficacy rating:** Very Good

## **Oryzalin (Surflan)**

**Percent of total area treated:** 1% (used on the exterior of the greenhouse)

**Target pests:** Annual Grasses and Broadleaf Weeds

Average rate and frequency of application of most common formulations:

Finale – 2 oz/3gal, once

**Application method:** High Volume Spray

**REI:** 12 hours

**Efficacy rating:** Very Good

## **Cultural Controls:(2,3,5)**

Use weed block fabric to cover the floor and remove any weeds that grow in along the edges of the fabric. Hand weeding and solarization can also be used to control weeds. Managing weeds outside the greenhouse is important to eliminate the major source of air borne weed seeds and to prevent perennial weeds from growing in under the foundation. Regular mowing can help prevent the most weed seed formation. However, maintaining a weed-free barrier around the greenhouse may be more effective. Adding lime to soil can help too.

## **Contacts**

**Dick Lindquist**, Entomology, OARDC, Wooster, OH 44691, (330) 263-3736.

**Claudio Pasian**, Horticulture & Crop Science, The Ohio State University, Columbus, OH 43210, (614) 292-9941.

**Steve Nameth**, Plant Pathology, The Ohio State University, Columbus, OH 43210, (614) 292-8038.

## **References**

1. Ohio Floriculture Report, [www.nass.usda.gov/oh](http://www.nass.usda.gov/oh)
2. Tips on Managing Floriculture Crop Problems, The Ohio Florists' Association, 1998.
3. Ohio Floriculture OnLine, [www.ag.ohio-state.edu/~flori/](http://www.ag.ohio-state.edu/~flori/)
4. 1999 Survey of Ohio Floriculture Growers, Ohio Pesticide Impact Assessment Program.
5. Commercial Potted Plant Production, Dr. Royal Heines (ed.), 1994, Michigan State University Department of Horticulture.

