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Chemical Controls for Michigan Commercial Greenhouse and Bedding Plant Production
Michigan State University Extension Service

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Issued April 1980

1 pages

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COOPERATIVE EXTENSION SERVICE • MICHIGAN STATE UNIVERSITY • EXTENSION BULLETIN E-1275, April 1980

Disease Control

DISEASE	CHEMICAL	RATE/100	RATE/GAL	RATE/AREA	COMMENT
Damping-off Rhizoctonia	PCNB ¹ (Terraclor 75%)	¼ lb	1¼ tsp	¼ lb/100 gal/ 100 sq ft	Preplant application
	BENOMYL	½ lb	1 Tbl	1-2 pt/sq/ft	10-14 di ³
	Banrot	¼-½ lb	½-1 tsp	1 pt/sq ft	4-8 wi ⁴
Damping-off Pythium	Lesan	½-1 lb	1½-3 tsp	1 pt/sq ft	2-4 wi
	Truban	4-6 oz	½ tsp	1 gal/8 sq ft	4-8 wi
	Captan ¹	2 lb	8 tsp	4-5 oz/1,000 sq ft	Preplant application
	Banrot	¼-½ lb	½-1 tsp	1 gal/8 sq ft	4-8 wi
Botrytis	Captan	2 lb	8 tsp	X ⁵	5-7 di
	BENOMYL	½ lb	1 Tbl	X	10-14 di
	Daconil 2787 (Chlorothalonil) ²	1½ lb or 1½ pt	1½ tsp	X	7-14 di
	Maneb ¹	1-3 lb	1½-5 tsp	X	7-10 di
	Mancozeb ¹	1½-3 lb	1-2 Tbl	X	7 di
	Ferbam ¹	¾-1½ qt or 1-1½ lb	1½-1½ tsp or 1-1½ Tbl	X	7-10 di
	Zineb ¹	1½-2 lb	1½-2 Tbl	X	7-10 di
	Copper oxychloride sulfate	3-4 lb	4-5 tsp	X	7-14 di
	Bordeaux mixture ¹	6 lb CuSO ⁴ + 6 lb Lime	6 Tbl	X	2 wi
	Botran ¹	½-1 lb	1-2 Tbl	X	5-7 di
Fusarium Rot	BENOMYL	1 lb	2 Tbl	1-2 pt of mixture/ sq ft	2-4 wi
	Banrot	¼-½ lb	½-1 tsp	1 pt/sq ft	4-8 wi
Sclerotinia Rot (White mold)	PCNB ¹ (Terraclor 75%)	¼ lb	1¼ tsp	¼ lb/100 gal/ 100 sq ft	Preplant application
	BENOMYL	1 lb	2 Tbl	1-2 pt/sq ft	2-4 wi
	Banrot	¼-½ lb	½-1 tsp	1 pt/sq ft	4-8 wi
	Captan ¹	2 lb	8 tsp	3-4 pt/100 sq ft	7-10 di
Powdery Mildew	BENOMYL	½ lb	1 Tbl	X	10-14 di
	Dinocap	4 oz	1 tsp/4 gal	X	7-10 di
	Actidione PM	5 Tbl	X	X	7 di
	Sulfur ¹	2 gal	1 pt/6 gal	X	7-10 di
	Folpet ¹	2 lb	2 Tbl	X	7-10 di
Alternaria	Daconil 2787 (Chlorothalonil) ²	1½ lb or 1½ pt	1½ tsp	X	7-14 di
	Mancozeb ¹	1½-3 lb	1-2 Tbl	X	7 di
	Ferbam ¹	1-1½ lb	1-1½ Tbl	X	7-10 di
	Zineb ¹	1½-2 lb	1½-2 Tbl	X	7-10 di
	Folpet ¹	2 lb	2 Tbl	X	3-7 di
	Ziram ¹	2-3 lb	2-2½ Tbl	X	7-10 di
	Bordeaux mixture ¹	8 lb CuSO ⁴ + 8 lb Lime	14 Tbl	X	7-14 di
	Tribasic Copper Sulfate ¹	3 lb	3½ tsp	X	10-14 di

¹ Some vegetable uses² CHLOROTHALONIL may damage blossoms³ = day intervals⁴ = week intervals⁵ Chemical rates given in lb/100 gal of water assume that this amount may also be applied per acre. Hence, 1 lb/100 gal = 1 lb/acre = 1 pt/54 sq ft = 2 pt/108 sq ft (Approximate equivalents.)

Fertilizing

Most growers soil test their original mix and then add the fertilizers recommended. Superphosphate is often added to the mix and the grower then fertilizes with nitrogen and potassium, as needed, through the water system.

A common recommendation is 200 ppm of N and K at every watering (13 ounces of 20-20-20 per 100 gallons). However, since most growers are interested in short plants, they may reduce the frequency of fertilization.

Another method is to use a slow release fertilizer like 14-14-14 at 2 to 4 pounds per cubic yard of soil. This provides enough nutrition for about the first 4-6 weeks. Then the grower finishes off the crop with applications of liquid fertilizer.

TABLE 1. Determining PPM.

Multiply percent of any element in any given fertilizer by 75. This gives ppm in one ounce of fertilizer in 100 gallons of H₂O.

Ex. = (NH₄)₂SO₄ = 20% N
20% (.20) X 75 =
15 ppm in 1 oz (NH₄)₂SO₄ in 100 gal H₂O

To determine the number of ounces required to make up a 200 ppm solution, divide 200/15 = 13⅓ ounces.
100 ppm = 100/15 = 6⅔ oz

TABLE 2. Instructions for Use of Solu-bridge.

- Use tall cylinder for solu-bridge sample (1 part soil: 2 parts distilled water) as mixture must be ½ inch above hole on conductivity cell.
- Use thermometer to check temperature of soil sample, and set temperature on solu-bridge compensator knob to equal it.
- Immerse conductivity cell at least ½ inch above air vents; there must be at least ¼ inch clearance on sides and bottom.
- Move conductivity cell up and down under liquid surface to remove all air bubbles.
- Turn solu-bridge on. Move the big circular dial until both the red and green lights are on.
- Read scale around outer rim of dial. This reading (K value) is in mmhos.
- Turn solu-bridge off.
- Rinse conductivity cell off with distilled water — never scrub.
- Store cell either in clean distilled water or in dry condition.

K VALUE SCALE IN MMHOS

Below .25 — soil deficient
.25 - .50 — low in soluble salts
.50 - 1.00 — adequate
Above 1.00 — high soluble salts — trouble

TABLE 6. Various Soluble Salt Testing Procedures and Interpretations.

SATURATED EXTRACT ¹	1 PART SOIL TO 2 PARTS WATER MMHOS	1 PART SOIL TO 5 PARTS WATER	
<i>all soils</i>	<i>mineral soils</i>	<i>organic soils</i>	
0 - .74	0 - .25	0 - .12	Very low salt levels. Indicates very low nutrient status.
.75 - 1.99	.25 - .50	.12 - .35	Suitable range for seedlings and salt-sensitive plants.
2.00 - 3.49	.50 - 1.00	.35 - .65	Desirable range for most established plants. Upper range may reduce growth of some sensitive plants.
3.50 - 5.00	1.00 - 1.50	.65 - .90	Slightly higher than desirable. Loss of vigor in upper range. Okay for high nutrient-requiring plants.
5.00 - 6.00	1.50 - 2.00	.90 - 1.10	Reduced growth and vigor. Wilting and marginal leaf burn.
6.00+	2.00+	1.10+	Severe salt symptoms — wilting. Crop failure.

To convert mmhos to ppm, multiply by 700.

¹ Used by the soil testing lab at Michigan State University.

TABLE 7. Michigan State University Soil Testing Interpretations.

General Guidelines for Greenhouse Soil Test Nutrient Levels and Their Interpretation					
SOIL TEST	LOW	ACCEPTABLE	OPTIMUM	HIGH	VERY HIGH
pH	< 5.5	5.5 - 7.0	6.0 - 6.4	7.0	> 7.5
Soluble Salts mmhos	0 - .74	.75 - 1.99	2.00 - 3.49	3.5 - 5.00	5.00+
Nitrate-N ppm	0 - 39	40 - 99	100 - 179	180 - 250	250+
Phosphorus ppm	0 - 3	4 - 7	8 - 13	14 - 19	20+
Potassium ppm	0 - 59	60 - 149	150 - 249	250 - 350	350+
Calcium	0 - 79	80 - 199	200 - 349	350 - 500	500+
Magnesium	0 - 29	30 - 59	60 - 99	100 - 149	150+

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1P-1R-4:80-2M-JP, 55 cents, for sale only

Growth Regulators

TABLE 1. Methods of Use of Various Growth Retardants on Seed Geraniums and Bedding Plants.

CROP	MATERIAL	PURPOSE	CONCENTRATION	APPLICATION ¹	TIME TO APPLY	REMARKS
Seed Geraniums	A-Rest	Height control and early flowering.	200 ppm	Spray 1 gal/200 sq ft	2-3 weeks after transplant (35-42 days after seeding).	Promotes branching and early flowering.
	Cycocel	Height control and early flowering.	1,500 ppm	Spray to runoff 1 gal/200 sq ft	2-3 weeks after transplanting (35-42 days after seeding).	Promotes branching and early flowering. May cause chlorosis in leaf margins.
Bedding Plants	A-Rest	Height control	100-200 ppm	1 gal/200 sq ft	2-4 weeks after transplanting.	Wide variation in sensitivity of species.
	B-Nine SP	Height control	2,500-5,000 ppm	1 gal/200 sq ft	2-4 weeks after transplanting.	Petunias should be 1½-2 inches in diameter. Tomatoes should have 2-4 times leaves. Alar is registered only for tomatoes among bedding plants.

¹ Apply material to the drip point — in some instances this quantity of material may cover a slightly larger area than indicated in the table.

TABLE 2. Effect of Growth Retardants on Specific Annuals.

	B-Nine SP ALAR	A-REST
Ageratum	Effective	Effective
Anthirrhinum (Snapdragon)	Effective	Effective
Browallia	Effective	Effective
Celosia	Effective	Effective
Centaura (Cornflower)	Effective	Effective
Chrysanthemum	Effective	Effective
Cleome	Not Effective	Effective
Coleus	Effective	Effective
Convolvulus (Morning Glory)	Not Effective	Effective
Cucumis (Cucumber)	Effective	Effective
Dahlia	Effective	Effective
Dianthus (Carnation)	Not Effective	Effective
Gomphrena	Not Effective	Not Effective
Hedera (English Ivy)	Effective	Effective
Impatiens	Effective	Effective
Lactuca (Lettuce)	Effective	Effective
Pelargonium (Geranium)	Not Effective	Effective
Petunia	Effective	Effective
Salvia	Effective	Effective
Tagetes (Marigold)	Effective	Effective
Verbena	Effective	Effective
Viola (Pansy)	Not Effective	Not Effective
Zinnia	Effective	Effective

On most crops, spray 2-4 weeks after transplanting. Remember, the retardant will only retard future growth; it will not make plants that are already tall shorter.

TABLE 4. Amount of Growth Regulator Solution to Prepare to Spray or Drench.

POT SIZE (inches)	SPRAY		DRENCH	
	pots/sq ft	ml/pot	oz/pot	pots/gal
2¼	20	1	3780	1 128
3	6	3	1260	3 42
5	3	6	630	4 32
6	2	10	375	6 21
6	1	20	189	10 13
Standard Bedding Flat	0.5	.36	100	— —

TABLE 5. Dilution and Dosage Rates for Concentrations of A-Rest (0.0264 Percent Active Ingredients) Used for FOLIAR SPRAYS.

CONCENTRATION percent	ppm	DILUTION			DOSAGE (mg/pot) ¹				
		oz/gal of solution	ml/liter of solution	Approx. Ratio A-Rest: Water	pot - 2¼ inches rate - 1 ml/pot space - 20 pots/sq ft	4 inches 3 ml/pot 6 pots/sq ft	5 inches 6 ml/pot 3 pots/sq ft	6 inches 10 ml/pot 2 pots/sq ft	8 inches 20 ml/pot 1 pot/sq ft
0.0010	10	4.9	38	1:25	0.010	0.030	0.06	0.10	0.2
0.0025	25	12.1	95	1:10	0.025	0.075	0.15	0.25	0.5
0.0050	50	24.2	190	1:5	0.050	0.150	0.30	0.50	1.0
0.0100	100	48.5	380	1:25	0.100	0.300	0.60	1.00	2.0
0.0200	200	97.0	760	1:1.25	0.20	0.600	1.20	2.00	4.0

¹ Dosage based on recommendations of 1 gal spray applied to 200 sq ft (1 liter/5 sq m) at close spacing but not necessarily final spacing.

TABLE 6. Dilution and Dosage Rates for Concentrations of A-Rest (0.0265 Percent Active Ingredients) Used for SOIL DRENCHES.

CONCENTRATION percent	ppm	DILUTION			DOSAGE (mg/pot) ¹				
		oz/gal of solution	ml/liter of solution	Approx. Ratio A-Rest: Water	pot - 2¼ inches rate - 1 oz or 30 ml	4 inches 3 oz or 90 ml	5 inches 4 oz or 120 ml	6 inches 6 oz or 180 ml	8 inches 10 oz or 300 ml
0.00005	0.5	0.3	1.9	1:500	0.015	0.045	0.06	0.09	0.15
0.00010	1.0	0.5	3.8	1:250	0.030	0.090	0.12	0.18	0.30
0.00025	2.5	1.3	9.5	1:100	0.075	0.225	0.30	0.45	0.75
0.00050	5.0	2.5	19.0	1:50	0.150	0.450	0.60	0.90	1.50

TABLE 7. B-Nine SP or Alar-85 (85 Percent Active Ingredient).

STOCK SOLUTION ¹ (CONCENTRATION)	B-Nine SP or ALAR-85/ GAL OF FINAL STOCK SOLUTION		B-Nine SP or ALAR-85/ LITER OF FINAL STOCK SOLUTION	
	5 percent	8 ounces	59 grams	
Spray Solution	fl oz of 5% solution/ gal of final solution		ml of 5% solution/ liter of final solution	
From Stock Solution	2,500 ppm	6.5	50	
	5,000 ppm	13.0	100	
	7,500 ppm	20.0	150	
	Spray Solution	tsp/gal of solution	oz of B-Nine SP or Alar-85/ 10 gal of final solution	gm of B-Nine SP or Alar-85/ liter of final solution
From Stock Powder	2,500 ppm	5.0 ²	4.0	3.0
	5,000 ppm	10.0	8.0	6.0
	7,500 ppm	15.00	11.0	9.0

¹ Unless you can accurately weigh small amounts of material, we suggest you use the stock solution method.² Approximate dosage only. Use weight measurement wherever possible.

Weed Control

CHEMICALS FOR NON-CROP AREAS

Paraquat:	One of the best herbicides on the market. It kills by contact and does not leave a residue. The weeds must be present to achieve control. Do not use near steam pipes or desirable plants.	Monuron (telvar): Diuron (karmex): Simazine (princep):	Any of these herbicides kills most weeds. Acting through the roots, they are most effective against young weeds and less effective against older weeds. Because they are long-lasting herbicides, they must not be applied on soil that will be used for crops in the next 2-3 years. Do not spray on heating pipes. Do not place pots or flats on soil treated with one of these herbicides.
Amitrol-T:	This herbicide should only be used in cold frames or plastic houses that have the plastic removed. It is effective against all weeds, but does have a 4-6 week residue. Under greenhouse conditions, it may not leach away and can cause problems. This material could also be used in a non-crop area outside the greenhouse.	Round-Up:	An effective herbicide for grasses in non-crop areas. This material would be effective in controlling quackgrass around the outside of the greenhouses.

None of these materials have a label for use in greenhouses. They can be legally used for weed control around the outside of greenhouses.