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## PROCEEDINGS

# POT CHRYSANTHEMUM SCHOOL ··· 1971

**OHIO AGRICULTURAL RESEARCH AND DEVELOPMENT CENTER**
**Wooster, Ohio**

## CONTENTS



## PREFACE

Pot Chrysanthemums are popular year-round, mainly because of their tremendous keeping-quality and their diversity in flower shape and color. During 1970, 20 million pot mums were sold nationally, while 1.43 million were sold in Ohio for an estimated retail price of $6½ million. Production and sales have increased 120 percent in the last 10 years and the outlook is for a slightly higher rate of gain. Advances in production have occurred in the pot mum industry, especially during the past decade, so that many of the "tried-and-true" practices may well be outmoded. New to the industry recently are:

1. Over 50 new cultivars
2. 8-week pot mums
3. Direct-stick
4. Lighter-weight media
5. Automatic watering with fertilizer injection and slow-release
6. New growth regulators and pest controls
7. Tremendous, untapped mass-market outlets.

In order to bring the latest information on these advances together, the Pot Chrysanthemum School - 1971, and the Proceedings sponsored by the Department of Horticulture in cooperation with The Ohio State University and the Ohio Cooperative Extension Service were developed and held at the Ohio Agricultural Research and Development Center.

The expertise of many authorities who were familiar with specific aspects of Pot Mum culture was called upon. It is hoped that this written record will benefit Ohio's growers and consumers. Deep appreciation is extended to everyone who helped to make this conference a success.

# SPACE MANAGEMENT

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The term "space" has a number of connotations. The romantic one, of course, is travel to the moon, but the more practical meaning for us is how close do we put our pot mums. Is this important? Heck, yes, for depending on the spacing selected we control *quality, cost per pot,* and *labor costs.*

QUALITY - As a general rule, maximum spacing will give maximum quality. The most efficient utilization of space and sunlight is to space the pot mums so the leaf tips of each pot just touch one another. This will allow the plant to capture the maximum amount of sunlight and produce top quality without wasting bench space. The ideal is very difficult to achieve.

COST PER POT - Obviously, the maximum number of pots per square foot will reduce the space cost per pot. To find a good cost figure for greenhouse bench space is difficult. There are a number of sources, but the variation is quite large. People include different cost items in their figures for cost of greenhouse space. I have selected for our discussion a 5¢ per square foot per week as a working figure. Each grower will obviously vary from this and will have his own figures. It is also true that summer costs per week will be less than winter costs per week because of heating, etc., but again each grower's costs will be different and he will have to compute his own.

LABOR COSTS - For our discussion the labor costs are only for moving the pots. It will be assumed that other labor costs, potting, disbudding, watering, spraying, etc., will be the same no matter what the spacing. Again, figures for labor vary and we have selected $2.00 per hour.

Another difficult figure to find is the number of pots a man can move in an hour. This, of course, will depend on the man and how far he has to move the pots and the number of labor-saving devices to help. We have decided to select 1 pot per minute, or a cost of 3.3¢ per pot per move.

CULTIVAR AND SEASON - Another important variable we have ignored in these computations is the cultivar and season. Both of them must be considered by the grower to determine what is the best spacing for each cultivar at each season of the year to achieve the kind of quality and production he desires.

Now with all these variables it would seem like a perfect situation to feed this information into a computer and press the button to have the right decision printed out. We can't do this for the simple reason we don't have the basic information to give to the computer. (It is too bad, for as we hope to demonstrate with a few examples, there is money to be made by using the proper spacing.) We, for example, don't know the growth rates of a pot mum (for all cultivars and seasons), specifically the diameter. We know it's not a simple linear arithmatic curve, but rather a sigmoid or S-shape curve. It is important to know exactly what the growth rate is if we are to use our greenhouse bench space to its maximum efficiency and still produce a quality product. Right now most of us are either wasting greenhouse space or reducing quality by overcrowding. Sometimes we do both with a single crop and over-space when it's not important for growth and over-crowd when growth rates are critical. Good basic growth rate information of at least the popular cultivars would be valuable information to have.

We would like to propose some hypothetical examples to look at, and hopefully to show why it may be worthwhile looking at your own spacing program.

We have selected figures that are easy to follow. A 100 sq ft bench area is equal to 14,400 sq in. We will discuss just 6-in. pots (but note the difference between a 6-in and 5-1/2-in is 36 sq in of greenhouse space versus 30-1/4 sq in on a pot to pot basis, or on a 100 sq ft bench 400 6-in pots versus 476 5-1/2-in pots, respectively).

How many 6-in pots can be spaced on a 100 sq ft area at the various common spacings?

| | |
|---|---|
| 6 x 6 | 400 pots |
| 8 x 8 | 225 " |
| 10 x 10 | 144 " |
| 12 x 12 | 100 " |
| 14 x 14 | 73 " |
| 16 x 16 | 56 " |

Note that you can get almost 8 times the number of pots on a 100 sq ft bench area at a 6 x 6 spacing compared to a 16 x 16 in spacing.

If we assume greenhouse space at 5¢ per sq ft per week, what is the cost per pot at the various common spacings?

| | |
|---|---|
| 6 x 6 | 1.25 ¢ per pot per week |
| 8 x 8 | 2.22 ¢ " " " " |
| 10 x 10 | 3.46 ¢ " " " " |
| 12 x 12 | 5.00 ¢ " " " " |
| 14 x 14 | 6.90 ¢ " " " " |
| 16 x 16 | 8.90 ¢ " " " " |

Note the cost per pot varies from 1.25¢ at a 6 x 6 spacing to 8.9¢ per week at a 16 x 16 spacing.

If we multiply this for a full pot mum crop of approximately 12 weeks for the various common spacings the cost per pot would then be:

| | |
|---|---|
| 6 x 6 | 15.0 ¢ per pot per 12 weeks |
| 8 x 8 | 26.6 ¢ " " " " " |
| 10 x 10 | 41.5 ¢ " " " " " |
| 12 x 12 | 60.0 ¢ " " " " " |
| 14 X 14 | 87.8 ¢ " " " " " |
| 16 x 16 | 106.8 ¢ " " " " " |

Note, put on this basis we have a cost just for space of \$1.06 at a 16 x 16 spacing as compared to just 15¢ for a 6 x 6 spacing. Now there's no question that a 6 x 6 spacing would be too close to produce any kind of quality, but again obviously the 16 x 16 spacing for the total length of the crop would almost make the pot mum too expensive to grow.

Let's compare the space efficiency of moving pots 1, 2 and 5 times. For example we will use 400 pots.

1 MOVE PROGRAM

| | | |
|---|---|---|
| 2 wks | 6x6 | 200 sq ft |
| 10 wks | 16x16 | 7110 sq ft |
| | | 7310 sq ft |

2 MOVE PROGRAM

| | | |
|---|---|---|
| 2 wks | 6x6 | 200 sq ft |
| 5 wks | 10x10 | 1385 sq ft |
| 5 wks | 16x16 | 3555 sq ft |
| | | 5140 sq ft |

5 MOVE PROGRAM

| | | |
|---|---|---|
| 2 wks | 6x6 | 200 sq ft |
| 2 wks | 8x8 | 355 sq ft |
| 2 wks | 10x10 | 562 sq ft |
| 2 wks | 12x12 | 800 sq ft |
| 2 wks | 14x14 | 1088 sq ft |
| 2 wks | 16x16 | 1411 sq ft |
| | | 4416 sq ft |

The cost per pot for the greenhouse space for the 3 programs including 3.3¢ per pot to move:

1 MOVE PROGRAM

Cost of space $\frac{7310 \times .05}{400} = .912$

labor $1 \times .033 = .033$

.945¢/pot

2 MOVE PROGRAM

Cost of space $\frac{5140 \times .05}{400} = .643$

labor $2 \times .033 = .066$

.709¢/pot

5 MOVE PROGRAM

Cost of space $\frac{4416 \times .05}{400} = .552$

labor $5 \times .033 = .163$

.715¢/pot

There is little question the 1 move program is the most costly. There is little difference in cost per pot between the 2 move and 5 move programs. Note our selected costs per sq ft and labor have biased these figures and only your own figures would make these examples really valid.

Another consideration is that more pots can be grown in a given area with more frequent moves. With a weekly pot mum program almost 3000 less total sq ft were needed for the 5 move program as compared to the 1 move program.

Yet another consideration is the bench width and maximum efficiency. Care should be given to select spacing that utilize maximum efficiency of the bench.

SUMMARY. Each grower should compute his cost for bench space, labor, etc. He should have some feeling for the growth rates of the various cultivars and seasons. He should know what quality level his market wants and will pay for. This information can then be integrated and the best spacing program determined. Maximum utilization of bench space for the production of quality plants is available if the proper spacing is used.

# SOILS

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The soil mixture supports the plant, provides a favorable air-water relationships for the root system, and serves as a partial supply of fertilizer for the plant.

## NATIVE INORGANIC CONSTITUENTS

Inorganic natural constituents are clay, silt, and sand. Clay will adsorb positively-charged fertilizer ions (ammonium, potassium, calcium, magnesium, and manganese) and also the negatively-charged phosphate ion. Presence of some clay in the soil mix adds to fertilizer-retentive capacity of soil. The less clay, the greater the attention that must be given to proper amount and frequency of fertilizers applied. Silt and sand retain fertilizer only in the soil solution around the particles themselves, and hence add "body" to the mix.

## DRAINAGE OF FIELD SOIL

Field soil with considerable clay or silt or very fine sand, in place, has long capillary columns that are affected by gravity so water is pulled down in the capillary (water-holding) pores and drains freely from the non-capillary pores (air spaces). When field soil is placed in a pot, capillary columns are drastically shortened, pull of gravity on water columns is less, so the field soil in the pot is much wetter than it was in the field, hence roots will not grow as satisfactorily.

## IMPROVING AIR-WATER RELATIONSHIP

To provide a mixture that has less water and more air for optimum root growth, diluents or additives are incorporated to literally replace some of the soil with materials holding less water or more air.

## INORGANIC MATERIALS

Sand, particularly the coarser grades, is a useful diluent in that it holds no water (solid particle), but replaces soil that does, and also loosens the soil by dilution. Sand is heavy, but this may be an advantage with plastic pots that tip easily. Fine sand added to clay or silt soils may cause compaction resembling concrete.

Perlite, a volcanic rock expanded by heating to 1800 F, is lightweight (6 to 9 lbs/cu ft), holds 3 to 4 times its own weight of water, and is generally neutral in reaction. The coarser or horticultural grade is suggested. Excessive handling fractures the particles. Ungraded perlite may have too many fine or dust-like particles.

Vermiculite, a mica material heated to 1400 F, has a platelike structure that is easily fractured when handled excessively. If compressed, air-holding capacity is reduced. Vermiculite is now finding favor when mixed with equal parts of fine peat moss which is used as a substitute for soil (very lightweight).

Calcined clay (Turface, Terra-Green, Arcillite, etc.) is baked montmorillonite clay that holds water which later serves as a reservoir when the soil mix becomes drier (fertilizer contained in this water). The material does not fracture when handled, but is heavy--this can be advantageous in plastic pots.

## ORGANIC MATERIALS

Manure is quite variable in its composition and its degree of decomposition, and furthermore is difficult to obtain, hence it is not recommended unless a proven source is available. To keep down odors, manure may be treated with materials that are phytotoxic. Packaged dried manure is too expensive.

Sphagnum moss peat, known as peat moss, is a uniform material, resists decomposition, is acid, and is fibrous unless ground or shredded too fine. It provides a lump of material that contains air and water, replacing soil holding primarily water. This material is universally used in soil mixes, and corrective measures are often necessary to raise the pH of the soil mix to 6.3 to 6.8. A bale will "fluff out" to approximately twice its stated cubic foot size (6 cu ft bale makes 12 cu ft of peat moss).

Peat from hypnum moss, cat-tails, reeds, sedges, and other water plants generally has little or no fibrous structure, is quite well-decomposed, and primarily adds bulk to the soil, though it may be substituted in part for sphagnum peat (usually no more than half). The pH varies depending upon the nature of the area where it occurs.

Muck is generally a non-sphagnum derived peat moss still further decomposed. If rubbed between thumb and forefinger when wet, it smears rather than rolls up into a ball, indicating lack of fibrous material. It can be used as a partial substitute for sphagnum peat moss (no more than half), and the pH varies depending upon its origin.

Sawdust is not generally used in the midwest or east because the material decomposes making it economically unfeasible to supply enough nitrogen to offset nitrogen starvation of the plant. Redwood sawdust, aged by weathering, can be substituted for peat moss up to half by volume. Ammoniated forms are available which prevent nitrogen starvation.

## PROPORTIONS OF INGREDIENTS

Most soil mixes are far too heavy and root development is therefore insufficent. If, 5 days after potting, new roots are not developing rapidly, either the soil mix is too heavy, the soil is overwatered, or the soil is too cold. It is easy to overwater a heavy soil, and by adding diluents in sufficient quantities, the mix can be made virtually idiot-proof with respect to watering.

Water stress or inability to absorb enough moisture to keep the foliage turgid is usually due to too heavy a soil. Air is the limiting factor because roots must have oxygen for respiration to actively absorb water (and fertilizer).

Suggested volume proportions are given below, and if in doubt, use a lighter mix with more diluent or less soil, providing capillarity will exist to enable use of "spaghetti" tubes for irrigation:

| | | |
|---|---|---|
| 1 clay soil | 2 silty soil | 3 sandy soil |
| 1 organic diluent | 1 organic diluent | 1 organic diluent |
| 1 inorganic diluent | 1 inorganic diluent | 1 inorganic diluent |

## SOIL PREPARATION

Field preparation is largely a thing of the past. Soil can be obtained from housing developments, shopping center areas, etc., and can be stockpiled. It is often scarce in supply--see General Comments at end.

All ingredients can be steamed then stored for future mixing, but contamination with weed seeds, disease organisms, nematodes, and insects can easily occur. Materials handling equipment should be "sanitized" if root rot problems are commonplace.

It is more satisfactory to store ingredients "raw", then mix, and steam as needed, but you can also mix the ingredients and steam when needed.

If shredders are used, remove at least half the tines to reduce pulverizing the soil, perlite, vermiculite, or peat to a state of undesirable fineness.

Add superphosphate, 2 1/2 lbs per cubic yard or about one 2-inch pot per wheelbarrow (2 1/2 bu) for phosphorus at time of mixing ingredients to eliminate need for addition of costly complete liquid fertilizers during growth.

Get the mix tested for pH and soluble salts so corrective action can be taken before problems arise! If the soil pH is less than 6.3, add 2 to 5 lbs of lime (calcium hydroxide), limestone (calcium carbonate), or dolomite (calcium-magnesium carbonate) per cubic yard. If soil pH becomes more acid during the growing period, add 1 lb of lime to 100 gal of water, stir, let settle, and apply supernatant solution to moist soil as a liquid fertilizer.

If pH is above 7.0, apply 2 lb of sulfur per cubic yard, but reaction time for sulfur is several months. Faster acting is 2 to 5 lb of iron sulfate per cubic yard. Should pH remain too high, apply iron sulfate at 1 oz per 3 gal as a liquid fertilizer. Syringe foliage after applying iron sulfate to avoid discoloration or burn. Do not apply through an injector.

If the soluble salts level is above 60 on a 1 to 5 soil-water ratio, trouble in rapid establishment of the new roots can occur unless soil is watered thoroughly after potting.

Concrete mixers are useful but often dry ingredients "float" in the drum and are not mixed properly. If too much water is added, soil mix will "ball up" in marbles and is difficult to work with.

## FERTILITY AND IRRIGATION

Don't add Osmocote to soil mix before steaming since the heat breaks down the coating, liberating all of the fertilizer at once, raising the soluble salts level. MagAmp can be steamed without detrimental effects.

Thorough wetting of the soil is imperative. Irrigate soil for newly potted cuttings at least twice manually or by suitably coarse sprays to "settle" the soil around the roots or stem and provide good contact as well as to keep soluble salts low. This can be followed by application of a liquid nitrogenous fertilizer or 1 teaspoon of a slow release fertilizer to provide initial fertility for subsequent fertilizer injection.

If soil is to be irrigated only with tap water, 10 lb of either Osmocote 18-9-9 or MagAmp 7-40-6 can be incorporated at time of preparation (don't steam Osmocote-treated soil) and this should last the life of the crop.

## GENERAL COMMENTS

Grower records indicate the cost of preparing one cubic yard of soil is approximately $25.00 (covers ingredients, labor, proportional cost and depreciation on materials handling equipment, storage space, etc.). This may result in formation of companies offering packaged or bulk potting soil ready for immediate use. Mixtures of Oasis dust, plasticized wood fiber, etc., with perlite or vermiculite may be as satisfactory as the traditional soil mix and cheaper.

# NUTRITION

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The field of plant nutrition has long been recognized as being a very complex, if not the most complex, area of plant growth and development. The reason for this complexity is a result of trying to understand the many interrelations and interreactions of the soil - plant - atmosphere complex. As a result of this complexity, only a small part of nutrition will be discussed in relation to pot mum culture. The following subject areas will be covered:

1. Classification and importance of Minerals.
2. Soil Structure, pH and Fertilizer Type in Relation to Mineral Uptake and Availability, and
3. Time of mineral availability in relation to the growth and development of pot mums.

There is little reason to doubt that all elements known to man are not in plants. However, at the present time, there have been approximately 60 elements positively identified and plants. Traditionally, these are classified as macro, Micro and nonessential elements. This classification is mainly based on total amounts found in plants as well as functions of these elements. Nitrogen, phosphorus, potassium, magnesium, iron, calcium, carbon, hydrogen, oxygen and sulfur are normally classified as macro elements while manganese, zinc, boron, chlorine, aluminum, molybdenum and copper are considered micro elements. The main point to be discussed is that all of these elements are necessary for proper growth and development. Just because an element like boron is classified as a micro element does not mean that it's presence is not essential.

Let's assume that a grower had a test made on his pot mum soil and the results revealed that all elements were present at optimum amounts. Does this mean the pot mums will grow properly, assuming no problems with pests, light, etc.? The obvious answer is not necessarily, because of a number of other factors related to plant nutrition, including, pH and soil structure. A pH range from 6.3 to 6.7 will result in quality pot mums whereas pH values below 6.0 and above 8.0 can result in nutrient deficiencies in the plant even though proper nutrient levels are in the soil. Soil pH can be influenced by native soil, water, fertilizer, diluents, and pesticides.

Different types of soils need to be handled differently to assure proper uptake of nutrients by plants. For example, a soil high in organic matter or of a very sandy nature will require a higher nutrient level to assure good growth and development as compared to a silt-clay-loam soil.

Finally, the time of fertilizer application can dramatically influence the nutrient level and thus, quality of the finished product. It has been shown many times that the first 4 weeks of chrysanthemum growth is the most critical time in which optimum levels of nutrients should be made available. If one should fail to supply sufficient nutrients during this early growth stage, regardless what is done subsequently, the resulting pot mum will never be of optimum quality.

# TEMPERATURE AND PHOTOPERIOD

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Two of the most important environmental factors that affect growth and flowering of the potted chrysanthemum are temperature and photoperiod. Some of the earlier work conducted with chrysanthemums by Cathey (1954) indicated that both temperature and photoperiod exhibited a significant effect on flower initiation and flower development. While space does not permit a review of all of the many experiments conducted on chrysanthemum flowering, emphasis will be placed on the effects that temperature and photoperiod exhibit on flower initiation and development of the potted chrysanthemum.

## TEMPERATURE

Most of the modern chrysanthemum cultivars are not as sensitive to temperature as were the older cultivars. This does not imply that flower initiation and development occurs uniformly over a wide range of temperatures, but rather with no apparent difficulty between $60^{\circ}$ and $80^{\circ}$ F.

HEAT DELAY. One of the most obvious influences that temperature has on flower initiation and development is "heat delay." When the night temperature exceeds $80^{\circ}$ - $85^{\circ}$ F, many cultivars do not respond in the allotted time. Heat delay may be minimized by improved night ventilation. New cultivars are introduced regularly that are less sensitive to the high summer night temperatures.

LOW TEMPERATURE. Flower initiation and development are both equally influenced in winter by low temperature. Most potted chrysanthemum cultivars initiate flower buds readily at a night temperature of $65^{\circ}$ F. However, flower initiation and development is delayed or prevented for some cultivars when grown at night temperatures below $65^{\circ}$ F. A low night temperature provided during the final two to three weeks results in pink shades for many white cultivars. A low temperature finish for cultivars other than white intensifies flower color.

TEMPERATURE CONTROL. The introduction of exhaust fans and evaporative cooling systems to the floricultural industry has been the single most significant factor that has enabled quality potted chrysanthemums to be grown during the summer. Exhaust fans are particularly useful in dissipating the accumulated heat associated with black cloth shading. Many potted chrysanthemum growers select bench construction that allows good air circulation around individual pots.

WINTER TEMPERATURE. Uniform budding is dependent upon maintenance of optimum day and night temperatures. An efficient heating system used in combination with convection tubes and/or unit fans results in fewer temperature fluctuations and eliminates the microclimates.

THREE CLIMATE CONTROL. A three climate control was suggested to potted chrysanthemum growers in 1968. Essentially this involved starting plants at a minimum $65^{\circ}$ F night temperature, $65^{\circ}$ cloudy days and $75^{\circ}$ bright days for the first seven to fourteen days. The growing on climate involved removal of the potted plants to a house that was maintained at a minimum night temperature of $62^{\circ}$ - $64^{\circ}$, $67^{\circ}$ - $69^{\circ}$ cloudy days and $72^{\circ}$ - $74^{\circ}$ bright days. The finishing climate involved reducing the minimum night temperature to $56^{\circ}$, $65^{\circ}$ cloudy days and $62^{\circ}$ to $65^{\circ}$ bright days.

While excellent results are obtained with such a regime, the practicality of fluctuation of night temperatures is somewhat difficult since most growers produce plants that are in all stages of growth and budding within the same house.

## LIGHT

While artificial light is routinely used by potted chrysanthemum growers to time quality plants, the knowledge of photoperiod is relatively new. Pioneer work by Garner, Allard, Laurie, Poesch and Post in the late 1920's and early 1930's made it possible for the chrysanthemum to become one of today's most important floricultural crops.

Lighting of chrysanthemums should be practiced year round in order to keep plants vegetative. Research has shown that the middle of the night (dark period) is the most effective time to light chrysanthemums. Two hours of light is required for June, July; three hours for August, September, April and May; and four hours for October, November, December, January, February and March.

At least seven foot candles light intensity is required to prevent premature budding. For a three and one-half to four foot bench, use 60-watt incandescent light spaced four feet apart and two to three feet above the plants or use 100-watt incandescent bulbs spaced six feet apart and two to three feet above the plants. When lighting, precaution must be taken to prevent light drift to those plants in a flowering program.

LIGHTING. Many growers use flash lighting to prevent premature flower initiation of the potted chrysanthemum. Using a minimum of seven foot candles light intensity, artificial light may be supplied for 20 percent of the normal lighting period or six minutes for each thirty minutes. Instead of lighting consecutively for four hours in December, a total of forty-eight minutes of light will give comparable results. Flash lighting is not recommended for chrysanthemum stock plants.

SHADING. In order to initiate flower buds on potted chrysanthemums, at least twelve hours of darkness is required for each twenty-four hour period. A good grade of black sateen cloth or black polypropylene is required to prevent penetration of more than two foot candles of light. Shading should be practiced daily until flower color develops. The failure to shade each day results in delayed flowering and taller plants.

CROWN BUDS. Crown buds are distinguishable from terminal buds by the vegetative shoots that surround the bud rather than reproductive buds. Crown bud formation results from failure to apply black cloth consistently; time clock failure; insufficient light intensity during the lighting period; or black cloth applied too late after the plant was pinched.

BRACT BUDS. During the warm summer months it is not unusual to find over-developed individual floret bracts on some cultivars. Bract buds may develop when day and/or night temperatures exceed 80° F; black cloth is removed too soon; black cloth is worn or leaks light; or incandescent lighting is not uniform over the plants.

AFTER LIGHTING. Some recent research indicates that many cultivars flower successfully when shaded for thirty-five days and then followed by long days. Since many cultivars do not respond to such treatment, growers are cautioned to try "after lighting" only on a trial basis.

REDUCED LIGHT INTENSITY DURING SUMMER. Light intensity may be reduced in a greenhouse by application of a shading compound to the roof or by placement of cheesecloth over the plants. A light shade is necessary during summer to reduce the ambient and tissue temperature. Excessive shading should be avoided since it results in taller plants and flower delay.

FLOWER INITIATION. The rate of change from a vegetative to reproductive state varies with each response group. Most floral components are initiated in two weeks for the eight, nine and ten-week response groups. A twelve-hour photoperiod has been found optimum for chrysanthemum flower bud initiation.

# AUTOMATED SHORT DAY CONTROL

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Black cloth shading is done for one reason--to control plant growth through extension of the no-light period in a 24 hour cycle. The no-light requirement means a light intensity of less than 2 foot candles at the leaf surface. The no-light or dark period should be 12 1/2 hours long for best results but this creates two problems in greenhouse operations. The first is a time problem for getting the covering and uncovering done by employees whose normal working hours are from 8:00 a.m. to 4:30 or 5:00 p.m. The second is a problem of heat buildup under the black cloth during sunlight hours. The first is essentially a management problem and either the dark period is extended to meet working time or hours are adjusted to provide help at the proper time for day length control activities

Heat buildup can be avoided by covering after the potential solar load has decreased a significant amount. This would mean delaying shading until after 6:00 p.m. standard time (7:00 p.m., daylight saving time). An alternative would be to provide positive air movement through the plant area under the shade material. This is not very easy to do and still maintain the desired level of darkness.

There are other shading problems that involve either house construction details or management schedules for less than complete house shading at one time. For example, a grower may want to shade one bench or a half bench at a time. The construction details may be posts in benches, no clearance at walls or equipment, or benches of different dimensions.

A distinction should be made between mechanization and automation. Mechanization replaces manpower with mechanical power but man must be available as the controller whenever the power is used. Automation replaces the man in the control position with such devices as time clocks, relays, reversing switches, and trouble indicators. Man's function is to set the controls to operate in a desired mode and made corrections in case of trouble. Mechanization may consist of as little as providing a hand operated winch for moving the cloth but this can be an improvement over dragging the cloth across a house by hand.

The easiest shading is to cover a complete house that is free of internal posts and has clear space around the perimeter of the crop area. There are several commercial units available to cover that situation although they are essentially custom made. The problem is one of sizing and selection of the shade cloth support system and the design of a mechanical unit to move the shade from the no shade position to full shade and return. Side and end covers are easily constructed and operated with the top or independently to give satisfactory light control.

The greenhouses with interior posts or part bench shading are more difficult to mechanize and automate and get the quality of light control necessary.

Black cloth is generally used for shading although black PE film can be used successfully. A shading system must be concerned with the selection of components to move the cloth or plastic. The size of wire, cable or bar for shade support and transfer depend on such things as area to be covered and time available to do the job.

An example will illustrate this. A grower wishes to cover an area 30' x 100' with black shade cloth. Cloth weighs about 0.05 lbs. per square foot so the top cloth for the 3000 square feet weighs 150 lbs. This weight must be supported and moved without damage to the plants. Whether the covering is done in one minute or 20 minutes is not important unless there is a labor charge proportional to the covering time. If the shade is moved mechanically, it will probably cost less to use a longer time period to move the cover.

If cables or wires are spaced 10 feet apart and are stretched across the 30 feet, each wire will carry 15 lbs. of cloth. A force on the wire of 240 lbs. will be necessary to keep the sag less than 3 inches at the center. Eleven gage steel wire or 5/64 inch diameter aircraft cable will carry this load. End anchors need to be strong enough to transfer this load to the building frame or to a separate framing system. Table 1 gives safe loads on wire and aircraft cable.

Table 1
Weights and Safe Loads for Galvanized Wire and Aircraft Cable

| Wire Gage | wt/ft (lbs) | Safe Load (lbs) | Aircraft Cable Dia. (in) | wt/ft (lbs) | Safe Load (lbs) |
|---|---|---|---|---|---|
| 8 | 0.070 | 485 | 5/32 | 0.047 | 1300 |
| 9 | 0.059 | 415 | 1/8 | 0.025 | 675 |
| 10 | 0.049 | 345 | 3/32 | 0.015 | 460 |
| 11 | 0.039 | 275 | 5/64 | 0.010 | 275 |
| 12 | 0.029 | 210 | 1/16 | 0.008 | 240 |
| 13 | 0.022 | 160 | | | |

The force necessary to slide the cover depends on whether the cover is in direct contact with the wire or supported by rings or rollers that are in contact with the wire. If steel rings are used on steel wire, the force necessary to slide the rings will be about 10 lbs. to overcome friction on each wire for the example above. If rollers are used, the force will be reduced to about one pound per wire. It will require a slightly greater force in each case to start the motion. A force of 100 lbs, will be required to pull the cloth over the 100 foot long house. This force will increase to get the cloth started. The speed of cloth travel will be in the 5 to 30 feet per minute range so acceleration forces will be negligible. The design and fabrication of the drive system can now be done. In most cases compromises will be made in order to use available components. For example, steel pipe can be used for shafting but it is difficult to get bearings and pulleys that will fit, therefore, a solid bar must be used. Another problem is getting the desired speed of cloth travel from the rpm of an electric motor. This can be done through pulley ratios or with a gear motor and pulleys. For example, a 1750 rpm motor may be used to power the drive for the 30' x 100' cover. If this is used the speed must be reduced to get cloth travel of about 15 fpm.

A 6" pulley on the final cloth drive turning at 10 rpm would give a cloth speed of 15.7 fpm. Therefore, the 1750 rpm of the motor must be reduced to 10 rpm at the cloth drive. This can be done through either gears or pulleys. Gear motors are expensive but they may be the best solution because several sets of pulleys and belts will require space and support that are difficult to get in an already crowded greenhouse. Horsepower requirements are low for these systems. A one-quarter horsepower motor would operate the system in the example. More power is required for faster cloth travel.

The movement of side covers can be related to top cover movement through proper selection of components. For example, the 30 foot long sides covers can be fixed to the end wires or cables so when the top is pulled the sides move. Clearance along the outside of the bench is necessary. The 100 foot long sides can also be tied to the top movement or they can be operated separately. If the benches run the length of the greenhouse the side covers can be pulled up from a shelf to close with the top cover. If the benches run across the greenhouse or a peninsular bench system is used, the long side cover could be dropped from a roll supported above head height although this could create some undesirable shade if left in place year round.

Individual benches can be covered by a tunnel shaped cloth with several benches covered simultaneously or singly. This system provides control of each bench according to the grower's production schedule. Individual bench covers may be more expensive to install than multiple bench systems. Each situation has to be studied to determine relative costs.

It is more difficult to cover a bench or a series of benches with roof support posts in the area to be covered. The solution depends on the position and number of the posts in benches. Wires or cables may be placed on each side of a post and the cover made with a slot and flap to allow it to pass the post and the flap closed after the cover is in place. If a single row of posts is near the center line of the area to be covered, the cover could be pulled from the center to the ends or from the sides to the center. These systems can be mechanized in the same way as for a clear area.

# GROWTH REGULATORS

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Chemical controls have a greater potential than just reducing the size of a chrysanthemum so as to make a satisfactory potted plant. The oldest use of chemicals is in increasing the ability of cuttings to form roots. Recent reports have shown that certain retarding chemicals as well as ethylene-producing chemicals can have beneficial effects.

## POTENTIAL CHEMICAL TREATMENTS

In propagation:

- Increase branching of stock plants
- Keep plants vegetative
- Pre-treated cuttings for better rooting and branching
- Faster rooting of slow rooting varieties and better root system on sparse rooting varieties
- Protectants to reduce mist requirements and leaching
- Reduce stretching of cuttings during misting

In pot-plant production:

- Increased branching and number of flowers per plant
- Reduce height for better quality in place of delayed pinch
- Chemical pinching
- Chemical disbudding
- Inhibition of side shoots in place of disbudding
- Chemical promotion of flowering
- Prevent stalling in low light or heat delay at high temperature
- Stimulation of flower size

In the home lasting ability:

- Controlled water loss
- Longer lasting flowers
- Prevention of leaf senescence

## CHEMICALS IN CURRENT USE

Rooting:

NAA or IBA. *Rootone, Hormodin, Jiffy Grow,* etc. Dusts and dips.

Dwarfing:

*Ammo-1618* soil treatment, still available.

*Phosfon L* soil treatment, considered uniformly effective, long lasting, flowering delay.
*Alar* (or *B-Nine*) foliar spray usually applied to point of run-off, but can be applied in concentrate sprayers on an area basis. Variable with variety and time of year. Usually only slight delay. Can be reapplied. Quel can be applied as foliar spray but necessitates accurate applications in terms of amount applied per plant or per square foot of area with no run-off to soil. Same variability as with Alar can be expected. Over-treatment, with serious delay in flowering is easily possible. Soil treatment is extremely effective so that no more actual material is used than would be applied as a foliar spray. A practical concentration for soil application is 2 ppm. A cup of this solution will contain just slightly less than 1/2 mg and would be expected to produce a desirable dwarfing response in many varieties of chrysanthemums growing in the usual way in 6" pots. The 0.0264% S formulation of Quel is diluted at 1:128 for this concentration and so a Commander proportion is ideal in applying Quel to the soil. For small trials use 1 liquid ounce of Quel to a gallon of water to treat 16 plants.

## EXPERIMENTAL CHEMICALS

Synthetic cytokinins supplied by Shell Development Company have a potential for increasing the branching of plants and also of producing a temporary stimulation of growth which could prove valuable. The same class of materials can potentially prevent leaf yellowing in the home and make the plant more efficient in the greenhouse by reducing respiration.

Gibberellins are capable of promoting growth and so reduce growing time to produce required stem length. They are also capable of stimulating the resumption of growth during adverse conditions. Chrysanthemums respond to sprays of 25-100 ppm gibberellic acid and weekly sprays at the lower concentration are suggested for trial to overcome heat delay.

Ethylene producing chemicals have increased the rooting, induced more branches, and dwarfed chrysanthemums but must not be applied immediately prior to or during flower initiation. So far, the most satisfactory results have been obtained by sprays made to stock plants 2 weeks prior to the removal of cuttings. Very light applications of these materials have also had the effect of stimulating growth much in the fashion of gibberellin.

Chemical pruning compounds are widely used in azalea production but should be considered experimental on chrysanthemums. The benefits of chemical treatments are not as great with chrysanthemums and also there is more varietal difference and more possibility of serious plant injury from improper treatment. Emgard 2077 and Offshoot-O are related to fatty acid esters used on mums experimentally at concentrations of from 1 1/2-3% active ingredient. Uniroyal-H414 is an experimental material effective at 1/2% active material.

# PROGRAMMING FOR INSECT-FREE POT MUMS

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Programming for insect-free pot mums has nothing to do with computers. It simply means making insect and mite control a normal part of growing a crop, just as watering and fertilization.

In order to have an effective control program, growers must obtain and understand some basic information.

1. What Pests to Expect and Approximately When to Expect Them.

   Some pests (aphids and spider mites) can be found during most of the year, even in colder parts of the country. Others (European corn borers, thrips) generally occur only at certain times of the year.

2. Life Cycles of Pests.

   Most insects and mites pass through several growth stages. Not all stages may damage plants, or be easily controlled.

3. Proper Chemicals and When to Apply.

   Both No. 1 and 2 contribute to this factor. A grower's choice of materials may depend on many things, not all related to the insect or mite he is attempting to control. Other factors, such as crop growth stage, variety, etc. also enter the picture.

   It is the responsibility of research workers and the Cooperative Extension Service to provide much of this information, and the grower's responsibility to utilize it.

   For the majority of growers, a preventive control program is probably better than one that depends only upon visual inspection of plants. It is difficult to get insurance after you're dead.

SOME MAJOR PESTS:

1. Aphids

   Aphids or plant lice commonly appear on chrysanthemums. They are soft-bodied sucking insects, and adults may be winged or wingless. In greenhouses, all adults are females and give birth to living young. Each female is capable of producing about 50 daughters. The young can mature and begin reproducing within 7 days.

   Control programs for aphids should begin in spring and continue until late fall. Chemicals recommended for aphid contro include: diazinon, endosulfan (Thiodan), Meta-Systox-R, Vapona (DDVP), sulfotepp (Dithio), and Systox. Note: See table 1 for application rates of materials listed.

2. Two-Spotted Spider Mites (Red Spider)

Mites are not insects, but are closely-related. These eight-legged creatures are among the most troublesome pests to control because by the time any visible damage symptoms appear, it may be too late.

Mite populations can build up very rapidly in warm weather. Each female may deposit up to 200 eggs, and the young can mature and begin reproducing in less than a week.

A preventive aphid control program with most recommended materials will help keep mites in check, but will not eliminate them. Generally, a material specific for mites is necessary, especially during warm weather months. These materials include: Kelthane and Pentac.

3. Caterpillars or "Worms"

Two common pests are the European corn borer and the cabbage looper.

If crops susceptible to corn borer attack, such as corn or peppers, are grown near a greenhouse area, a preventive control program is essential. Once you discover this insect, the damage has been done.

The adult stage of this pest is a light colored moth that is active at night and is attracted to lights. The damaging larvae begin boring into stems shortly after hatching. When egg-laying moths are active depends on area of the country and the weather. In Ohio, moth activity generally begins in late July and continues through early autumn.

Cabbage loopers are larvae of moths that feed on foliage and flowers. Larvae are green with a series of white stripes running the length of the body. Sometimes their presence can be detected only by the dark fecal pellets on the foliage.

Control of caterpillars can best be obtained when they are small. Materials such as Sevin or one of the Bacillus thuringiensis formulations applied at weekly intervals will usually give good control.

Table 1
Application Rates of Materials Listed

| Material and Formulation | Amount of formulation/ 100 gallons $H_2O$ | Application method |
|---|---|---|
| Thiodan 50% WP | 1 lb. | Spray |
| Diazinon 50% WP | 1 lb. | Spray |
| Meta-Systox-R 2 EC | 1 pt. | Spray |
| Systox 2 EC | 1 pt. | Spray |
| Sevin 80% SP | 1 lb. | Spray |
| Bacillus thuringiensis | * | Spray |
| Pentac 50% WP | 1/2 lb. | Spray |
| Kelthane 18.5% WP | 1-1 1/2 lb. | Spray |
| Sulfotepp (Dithio) aerosol | 1 lb. 5% aerosol/ 50,000 cubic ft. | - |
| Vapona 4 EC | 1 oz./10,000 cubic ft. | Steam Pipes |
| Vapona Aerosol | Follow manufacturer's directions | |

* Several formulations available (Biotrol BTB, Thuricide, Dipel); follow directions on label.

# PROGRAMMING FOR DISEASE-FREE POT MUMS

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| PRODUCTION PRACTICE | DISEASE CONTROLLED<br>Disease | Causal Organism |
|---|---|---|
| I. PREPARATION FOR PLANTING | | |
| A.<br>Hang hose so nozzle does not touch floor. | I. (A,B,& C)<br>Verticillium Wilt | Verticillium albo-atrum |
| B.<br>Prepare soil mix for planting. Allow for good aeration. | Bacterial Blight | Erwinia chrysanthemi |
| | Pythium Root and Basal Stem Rot | Pythium spp. |
| C.<br>Fill pots with soil; put pots in place on bench. Cover bench, filled pots, and tools and steam treat at 180$^{\circ}$F for ½ hour at coolest point | Rhizoctonia Basal Stem Rot | Rhizoctonia solani |
| | Sclerotinia Rot | Sclerotinia sclerotiorum |
| | Nematodes | |
| | Ascochyta Ray Blight | Ascochyta chrysanthemi |
| | Septoria Leaf Spot | Septoria obesa |
| II. PLANTING | | |
| A.<br>Purchase pathogen-free rooted cuttings from a specialist propagator. Plant directly from shipping container. Always wash hands thoroughly before planting or pinching young plants. | II. (A)<br>Virus diseases and other diseases as listed above. | |

| PRODUCTION PRACTICE | DISEASE CONTROLLED<br>Disease | Causal Organism |
|---|---|---|
| III. YOUNG PLANTS | | |
| A.<br>Drench, as required, with soil fungicides. DEXON 35% WP (8 oz.) plus TERRACLOR 75% WP (4 oz.)/ 100 gal. water. Apply ½ pint per 6-in. pot (one application only). If Pythium continues, make an additional drench of DEXON alone in 30 days. | III. (A)<br>Pythium Root and Basal Stem Rot<br>Rhizoctonia Basal Stem Rot<br>Sclerotinia Rot | <br>Pythium spp.<br>Rhizoctonia solani<br>Sclerotinia sclerotiorum |
| IV. GROWING PLANTS | | |
| A.<br>Spray growing plants on a 7-14 day schedule, covering both leaf surfaces with FERBAM 76% WP (1½ lb./100 gal. of water). Avoid overhead watering. | IV. (A)<br>Septoria Leaf Spot<br>Ascochyta Ray Blight<br>Stemphylium Ray Speck | <br>Septoria obesa<br>Ascochyta chrysanthemi<br>Stemphylium or Alternaria spp. |
| For powdery mildew use KARATHANE 22.5% WP (4 oz. /100 gal. of water). | Powdery Mildew | Erysiphe cichoracearum |
| V. FLOWERING | | |
| A.<br>When flower buds begin to show color: 1. Reduce relative humidity by venting and heating at sundown. 2. Mist spray on a 3-7 day schedule with ZINEB 75% WP or CAPTAN 50% WP (1½ lb./ 100 gal. of water). | V. (A)<br>Botrytis Petal Blight<br>Ascochyta Ray Blight<br>Stemphylium Ray Speck | <br>Botrytis cinerea<br>Ascochyta chrysanthemi<br>Stemphylium or Alternaria spp. |

| PRODUCTION PRACTICE | DISEASE CONTROLLED<br>Disease | Causal Organism |
|---|---|---|
| OR<br>Thermal dust weekly with Termil at manufacturer's recommendations (for Botrytis Petal Blight only). | | |
| VI. FLOWER STORAGE | | |
| A.<br>Control measures for flower rot in storage or shipment must be applied in the greenhouse. Mist spray before storage with ZINEB 75% WP or CAPTAN 50% WP (½ lb./100 gal. of water).<br>OR<br>Thermal dust weekly with Termil at manufacturer's recommendation (for Botrytis Petal Blight only). | VI. (A)<br>Botrytis Petal Blight<br>Ascochyta Ray Blight<br>Stemphylium Ray Speck | <br>Botrytis cinerea<br>Ascochyta chrysanthemi<br>Stemphylium or Alternaria spp. |

# WHERE YOU GO WRONG

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SOIL MIXTURE. The soil mixture is where the whole ball game begins. Many growers are still using soil mixtures that are too heavy. It is difficult to make a general recommendation, however, the following may be used as a guide.

For soils predominate in clay, 1 soil
1 coarse sphagnum peat moss
1 coarse perlite

For soils predominate in silt, 2 soil
1 coarse sphagnum peat moss
1 coarse perlite

For soils predominate in sand, 3 soil
1 coarse sphagnum peat moss
1 coarse perlite

It should be noted that the recommendations are on a volume basis.

SOIL PREPARATION. Utilization of the soil mixtures recommended above does not insure a so-called ideal or proper medium for pot mums. Providing the right ingredients for the mixture is only part of the job. Preparation of the mixture or mixing the ingredients is equally important. Growers often times begin with a good thing and end up ruining it with a monster called a soil shredder. Using a shredder to mix a medium does just what the name of the machine implies - it shreds the coarse peat moss into powder form; it pulvorizes coarse perlite into powder form; and it shreds and pulverizes field soil with good structure into powder form. What is the end result, a very fine soil mixture void of good aeration. A cement mixer is a much better tool for mixing soil than a shredder.

SOIL pH. The optimum soil pH for pot mums is between 6.4 and 6.7. The time to adjust the soil pH to the optimum level is prior to mixing. A soil test is, of course, necessary to determine adjustment requirements.

PLANT IN DRY SOIL. Planting pot mums cuttings in dry soil not only is more difficult, but it usually means that the soil ball really never gets completely moistened when the cuttings are watered-in. This may result in the cuttings wilting, thus becoming hardened. The soil should not be sopping wet, but it should be reasonably moist.

GRADING CUTTINGS. Although the reliable sources of cuttings do an excellent job of maintaining quality control, it is still advisible to grade cuttings before planting. Planting tall and short cuttings in the same pot will present a problem to the grower at the time of pinching - an uneven pot. In order to correct this problem, the grower pinches the short cutting soft and the tall cutting hard. This often results in an unbalanced plant, since more flowers will develop from the soft pinched cutting than the hard. Prior to planting the cuttings should be graded into three categories - tall, medium, and short.

PLANTING TOO DEEP. Planting cuttings too deep may result in them becoming infected with Rhizoctonia Stem Rot. The cuttings should be planted so that the roots are barely covered by soil. Exposing stem tissue to the soil enhances the possibility of Rhizoctonia.

INITIAL FERTILIZATION. Research has clearly shown that most critical period concerning pot mum fertilization is during the first half of the growing time. Most soil mixtures contain little nutrients except for possibly lime and superphosphate. Therefore, it is extremely important that the plants be fertilized immediately after they are planted. In other words, they should be fertilized when the cuttings are watered-in. A rate of 1 ounce to 3 gallons of a 20 per cent nitrogenous fertilizer is recommended. This gets the fertility level up to the optimum range immediately. Since the cuttings are usually watered twice during the watering-in operation, the fertilizer should be applied during the second watering.

FERTILIZATION. Constant or injection fertilization is the name of the game. The rate should be 200 parts per million of nitrogen and 150 parts per million potassium at every irrigation. Improved growth has been observed where Osmocote has been used in addition to the constant fertilization. The Osmocote is applied immediately after planting and prior to watering-in at the rate of 1 level teaspoon per 6-inch pot.

ALLOWING CUTTINGS TO WILT. Wilting results in the cuttings becoming hardened, and fewer breaks develop from hardened cuttings. Therefore, the cuttings must be prevented from wilting after they are planted. The easiest method is to place the cuttings under intermittent mist. The misting cycle should be such that the cuttings are maintained in a turgid condition, but not over-misted. Six seconds every 15 minutes during the warm weather months and 6 seconds every 30 minutes during the cold weather months should suffice. The mist should be turned on 1 hour after sunrise and terminated 1 hour before sunset. Misting for a maximum of 4 days after planting is all that should be necessary.

APPLYING ENOUGH IRRIGATION WATERING. Applying an insufficient amount of irrigation water may lead to 2 problems - (1) excess soluble salts and (2) water stress. Both problems, of course, result in poorer crop quality. Sixteen fluid ounces should be applied per 6-inch pot at every irrigation.

HARD PINCHING. Extremely hard pinching-allowing less than 6 leaves to remain on the stem severely limits the number of breaks that may develop. Even moderate pinching-allowing less than 9 leaves to remain may limit the number of breaks that may develop. Cuttings should be pinched so that at least 9 leaves are allowed to remain after the pinch. Pinching probably will not be possible before 10 days. It should be done no later than 2 weeks following planting. It should be noted that pinch date does not affect flowering date.

DELAYED PINCHING. With present cultivars, under no condition should a delayed pinch be extended over 4 days. The longer the pinch is delayed past 4 days, the poorer the crop quality. This poorer quality is due to the development of small, sparse foliage between the point of the pinch and the flower.

TIME OF GROWTH REGULATOR APPLICATION. Research has shown conclusively that the maximum efficiency of B-Nine is obtained when it is applied 2 weeks after pinching. If a second application is required, the maximum efficiency of B-Nine occurs when it is applied 2 weeks after the first application. When B-Nine is applied too close to disbudding, pinks have a tendency to fade and become washed-out.

LIGHT INTERFERENCE. The problem of crown buds due to light interference occurs only because of the forgetfulness of growers. This problem occurs most frequently during the Easter season. Growers light lilies in order to get them in and forget they are also lighting the pot mums. When short days are initiated, they must be continued for a minimum of 7 continuous weeks. Any interruption may result in crown buds or malformed flowers.

STARTING AND STOPPING OF SHADING. To be certain, begin shading on March 15 and continue to September 15.

LOW TEMPERATURE IN WINTER. A minimum of 62$^{o}$ F night temperature should be maintained to insure proper flower development. Lower temperatures will result in uneven flowering. The temperature may be lowered to 56$^{o}$ to 58$^{o}$ F during the final two weeks.

HEAT DELAY. There are at least 3 possible ways to combat heat delay. The first is to grow cultivars that have less tendency to heat delay. The second is cover the plants later in the evening and uncover later in the morning. During the hottest months, it would be well to cover at 9 p.m. and uncover at 9 a.m. In addition it would be advisable to use cloth instead of plastic, since cloth will allow for some air exchange. The final one is to air condition the greenhouse.

SPACING. The amount of space given a pot mum, to a degree, is directly proportional to the quality. The more space, the better the quality. Space management must go hand in hand, however, with what price a pot mum will bring. Too close a spacing during the early stages of growth must, however, be avoided to insure the maximum development of breaks.

LATE DISBUDDING. Late disbudding results in smaller flowers and delayed flowering.

INSECT CONTROL. Insects should not be controlled, they should be prevented. To do this, a program must be followed and followed and followed. This is the secret to insect free pot mums. Meta-Systox-R and Diazinon AG 500 are the most effective for aphids, Meta-Systox-R, or Diazinon AG 500 should be used at the rate of 16 ounces per 100 gallons. Either should be applied weekly until color shows. Pentac 50% WP and Kelthane 35% WP are the most effective spider controllers. Either one is used at 8 ounces per 100 gallons of water. Kelthane is preferred over Pentac when a quick kill is needed and when the greenhouse temperature rises above 90$^{o}$ f. It has been observed that Pentac loses effectiveness at relatively high temperatures. Thrips are controlled quite well by either Dieldrin 50% WP at 1 pound per 100 gallons of water or by Diazinon AG 500 at 16 ounces per 100 gallons. Worms are best controlled by Lannate 50% WP at the rate of 4 ounces per 100 gallons of water. IT SHOULD BE NOTED THAT MOST OF THE INSECTICIDES MENTIONED ABOVE ARE NOT REGISTERED FOR USE IN FLORIST GREENHOUSES!

NO AUTOMATIC WATER. It should be evident by now that the production of consistantly top quality pot mums is not possible with automatic watering.

# THE POT CHRYSANTHEMUM INDUSTRY

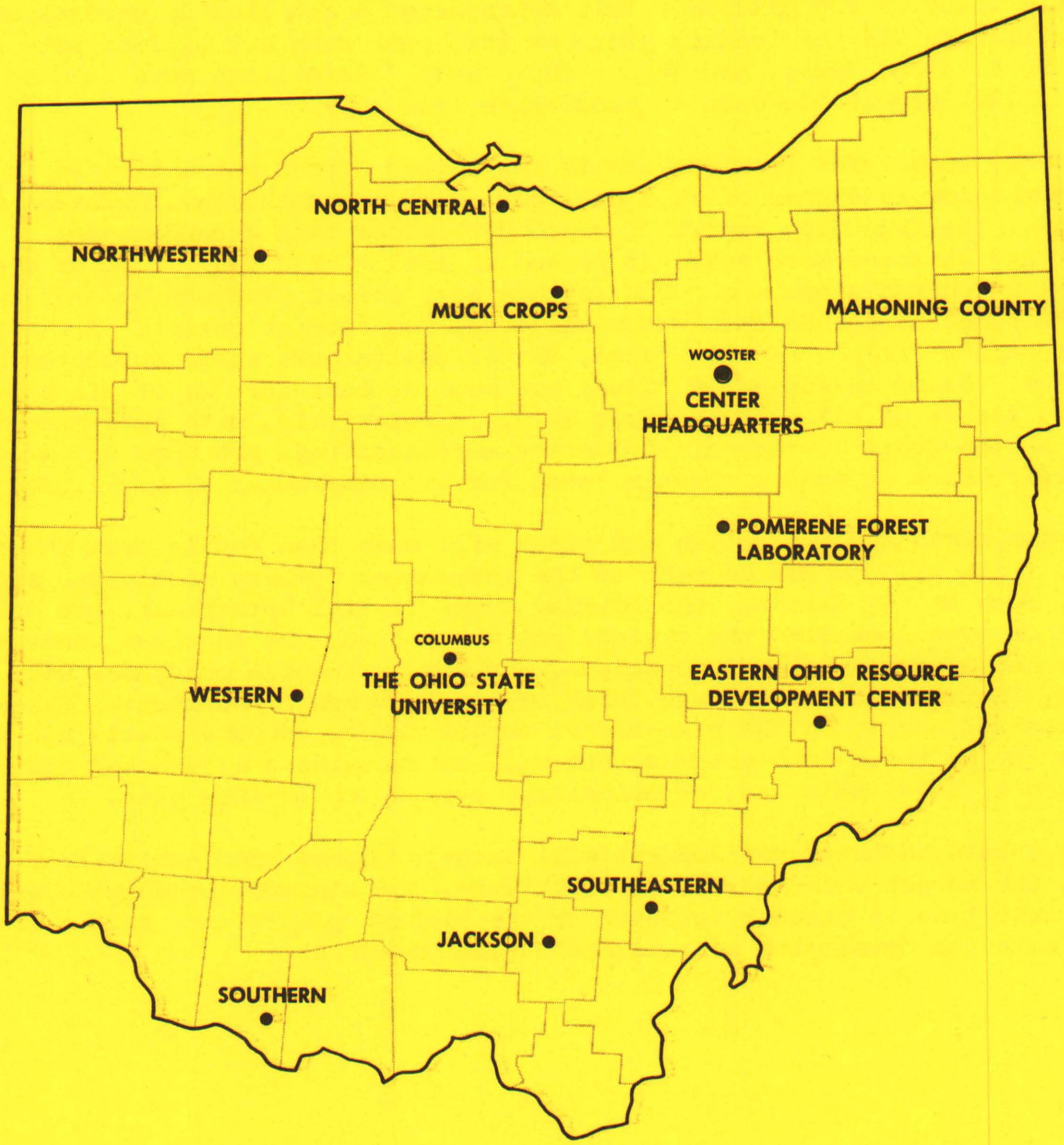
Nationally, it is estimated that 20 million pot mums were sold in 1970 for a wholesale value of $30 million. This represented a doubling in production from 1959. California was the leading producer last year with 3.1 million pots sold, followed by Florida, Texas, and Ohio. There were 1.43 million pots sold in Ohio which is a 120 percent increase in production from 1959.

In 1969, commercial floriculture in the United States was estimated to account for sales in excess of $1.9 billion. Pot chrysanthemums represent 6% of this total. The USDA Crop Reporting Board determined that 4 carnations, 2 gladioli, and 2½ roses were sold per person in 1969, while only 1 out of every 10 persons purchased a pot mum. Put another way, retail florists account for $6 per capita sales in the United States while the non-florist outlets participate in $3 per capita sales. Of this total, $9 per capita, the share accounted by pot mums is 50¢. Based on wholesale value, pot mums account for 12% of all potted plants and for 4% of all florist crops sold. Particularly, with mass-market outlets, a high quality product, and better merchandising, pot mums can account for a larger share or even a greater total for all commercial floricultural sales.

Pot chrysanthemum production and sales will more than double over the next 10 years. This will be due in part to the increasing numbers of diverse kinds of pot mums, such as the daisies, the novelty types (Illini Spinwheel), and others which do not even look like the typical pot mum. Also, the American consumer is gradually becoming more flower conscious, and his per capita purchases will eventually increase to approximate those of his European counterpart. Sales will increase predominantly in the mass-market outlet, where consumers will not necessarily be buying the 6-inch pot mum, but will be choosing 4's (pinched and non-pinched), 5's, 5½'s, 6½'s and, occasionally, even up to 12-inch pans.

This future industry development will largely depend upon utilization of research, the newest information, new cultivars, and improved production efficiencies resulting in greater turnover of the highest QUALITY per square foot, combined with the developing mass-market outlet potential.

# The State Is the Campus for Agricultural Research and Development




Ohio's major soil types and climatic conditions are represented at the Research Center's 12 locations. Thus, Center scientists can make field tests under conditions similar to those encountered by Ohio farmers.

Research is conducted by 13 departments on 6482 acres at Center headquarters in Wooster, nine branches, Pomerene Forest Laboratory, and The Ohio State University.

Center Headquarters, Wooster, Wayne County: 1953 acres

Eastern Ohio Resource Development Center, Caldwell, Noble County: 2053 acres

Jackson Branch, Jackson, Jackson County: 344 acres

Mahoning County Farm, Canfield: 275 acres

Muck Crops Branch, Willard, Huron County: 15 acres

North Central Branch, Vickery, Erie County: 335 acres

Northwestern Branch, Hoytville, Wood County: 247 acres

Pomerene Forest Laboratory, Keene Township, Coshocton County: 227 acres

Southeastern Branch, Carpenter, Meigs County: 330 acres

Southern Branch, Ripley, Brown County: 275 acres

Western Branch, South Charleston, Clark County: 428 acres