Crop: Hydrangea
Scientific Name: Hydrangea macrophylla (Saxifragaceae)

I. Introduction

A. *Hydrangea macrophylla* appears to be a cross between two Hydrangea species of Japan (35° N latitude). One of the species is a woodland species and the other a maritime species.

B. Plants of certain cultivars will have blue flowers if grown on an acid soil and pink flowers if grown on analkaline soil.

C. The demand for hydrangeas has decreased in recent years. Probable causes for the decrease are the high cost of production, large plant size, and poor keeping quality when inadequately watered in the home.

D. Many growers start with pre-cooled plants that have been produced by specialists from the Midwest, California or New Jersey.

II. Species, Cultivars, Breeding, Development

A. Most of the breeding work has been done in Northern Europe and England.

B. Cultivars are grouped by flower color. The number in parenthesis refers to the response group or weeks to flower when grown at 15°C (59°F) night plus the last 2 weeks at 12°C (54°F).

1. Pink - many cultivars including 'Merveille' (13 weeks), 'Bondense', 'Rose Supreme' (14 weeks), 'Todi', 'Stafford' (14 weeks), and 'Merritts Supreme' (13 weeks).

2. Blue - best cultivars include 'Kuhnert' (13 weeks), 'Bondense', 'Merkur', 'Rose Supreme' (14 weeks) and'Red Star'.

3. White - 'Regula' (12 weeks) and 'Sister Therese' (12 weeks)

III. Flower Induction Requirements

A. Hydrangea can be classified as a facultative short day plant with accelerated flower development under short photoperiods.

B. Flower bud development will occur in 6 weeks at temperatures between 13 and 18°C (55 and 65°F). Nine weeks are required for full flower development irrespective of photoperiod.

C. At temperatures of 20-22°C (68-72°F), the critical photoperiod is 14-16 hours with short days promoting flower initiation. Above 22°C (72°F), no flower initiation occurs.

D. High light intensities are required during floral initiation.

E. Long photoperiods or high temperature (greater than 18°C, 65°F) delays initiation.

F. Short days induce dormancy which is broken by cold treatment.

IV. Environmental Requirements

A. Light

1. Light intensity is usually reduced during early vegetative development but full light intensity is desired during floral initiation and development.

2. Flower initiation occurs fastest under short day conditions at temperatures below 18°C (65°F).

3. When forcing to flower, full light intensity should be used.

B. Temperature

1. Temperatures of 18°C (65°F) or less are required for rapid floral initiation.

2. After the floral bud is developed, an additional 6 weeks at 2-9°C (35-48°F) is required for subsequent development of the flower.

3. Plants are often forced at 16-17°C (60-62°F) night temperature. Time to flower is highly dependent on temperature.

Growth phase	Night temperature 12°C (54°F)	16°C (60°F)	19°C (66°F)
	Weeks (days)		
Planting to bloom	16 (112)	12 (84)	10 (70)
Planting to visible bud	6 (42)	4 (28)	3 (21)
Inflorescence diameter to bloom			
0.5 cm (size of a pea)	10 (70)	8 (56)	7 (49)
2.0 cm (size of a nickel)	7.5 (54)	6 (42)	5 (35)
4.0 cm (size of a silver dollar)	5 (35)	4 (28)	3 (21)

4. A combination of long and short days has been used successfully to flower hydrangea without a cold treatment.

C. Water

1. Hydrangea plants require large amounts of water. Wilted leaves are easily damaged and burned.

2. During the spring as flowers begin to show color, it may be necessary to water twice a day.

3. Consumers should be reminded of the plant's high water requirement.

D. Nutrition

1. During vegetative summer growth and bud initiation, 60-100 ppm nitrogen from a 25-10-10 should be adequate.

2. For plants to develop blue flower color, no super-phosphate or phosphorus should be added to the soil.

3. During forcing, 100 ppm nitrogen should be used. For pink varieties, a 25-10-10 fertilizer is ideal while a 25-5-20 or 25-0-20 fertilizer should be used for blue flowers.

4. For blue cultivars, aluminum sulfate at 10-15 lbs per 100 gallons of water should be applied during the summer. In addition, 3 or more applications may be necessary during forcing to insure a low pH (5.5) and adequate aluminum in the plant and flowers. High potassium should be maintained with a low ammonium to nitrate ratio.

5. For pink varieties, a higher pH (6.5-7.0) and phosphorus level should be maintained. Ammonium phosphate at 3 lb per 100 gallon water should be applied weekly. Low potassium is desired as well as a high ammonium to nitrate ratio.

6. Summary for flower color

Factor	Flower Color	
	Blue	**Pink**
P	Little or None	High
K	High	Low
NH_4 to NO_3 ratio	Low	High
$Al(SO_4)_3$	+	-
pH	Low (5.5)	High

E. Gases

1. Supplemental CO_2 at 1,500 ppm will promote growth at warm temperatures and high light.

V. Cultivation

A. Propagation

1. Plants are propagated by cuttings.

2. Terminal stem cuttings, 2-eye (butterfly), or single-eye (leaf-bud) cuttings can be used.

3. Single-eye cuttings are useful to produce pinched plants but must be taken by mid-April to allow sufficient growth for pinching.

4. Butterfly cuttings develop more uniformly if the terminal shoot is removed 10-14 days prior to the harvest.

5. Stick cuttings in a medium such as a peat:perlite (1:1) mixture.

6. Recommended soil temperature is 21°C (70°F) and the air temperature should be kept at 13-16°C (55-60°F). During rooting, shade to reduce light 50%.

7. Rooting occurs in 3-4 weeks. Rooting hormones speed rooting.

8. Pot the plants when the roots are 1 cm (0.5 inch) in length.

B. Medium and Planting

1. A medium consisting of peat, perlite and vermiculite (2:1:1) is preferred.

2. The pH should be adjusted based on desired final flower color.

   a. 5.0 - 5.5 for blue (no superphosphate).

   b. 6.0 - 6.5 for pink and white.

3. Rooted cuttings can be planted directly into 13 or 15 cm (5 or 6 inch) pots. If desired for shipping, plant into 8 or 10 cm (3 or 4 inch) pots.

4. Plants should be repotted from the 8 cm (3 inch) pots within 3 weeks from potting.

C. Spacing

1. Rooted cuttings in 8 cm (3 inch) pots can be grown pot-to-pot until repotting after 3 weeks.

2. Plants in 13-15 cm (5-6 inch) pots should be spaced on 30 cm (12 inch) centers.

3. Plants brought from the cold treatment can initially be grown pot to pot, but should be spaced to the final spacing before the leaves overlap.

   a. Final spacing of single bloom plants at 25 cm (10 inch) centers is suitable.

   b. Final spacing of two bloom plants at 30 X 36 cm (12 X 14 inch) is suitable.

   c. Final spacing of three bloom plants at 36 cm (14 inch) centers is suitable.

D. Support

1. Due to the large, heavy flower head, support is often needed.

2. Place a stake in the center of the pot and tie to each stem.

3. The staking and tying is done about half the way through the forcing period.

E. Pinching

1. Pinching limits height and induces branching.

2. At pinching, leave 2 nodes on the plant which generally give 3 shoots. Two pinches will give 5 shoots.

3. Pinch before July 15 for most cultivars. Preferable date of pinching is June 20 to July 5.

4. Late pinching can result in insufficient flower bud development.

5. When double pinching, the top leaves should not point inward (toward the canopy) since low light will prevent the inner shoot from developing a flower bud.

F. Disbudding

1. None

G. Growth Regulators

1. Height control during the summer.

a. B-Nine at 5,000-7,500 ppm can be applied about 4 weeks after pinching or when the shoots are 1-2 inches in length. No B-Nine application should be applied after August 5.

b. A second application may be necessary 2-3 weeks later.

c. Any height reduction during the summer phase will result in shorter plants the following forcing season.

2. Height control during forcing

a. B-Nine at 2,500 should be applied twice for height control.

b. Apply the first spray between the 2nd and 3rd week of forcing (4-5 leaf stage) and the 2nd spray 1 week later.

c. Exact requirements vary with cultivars and date. Forcing 'Merveille' for Easter may only require 2 sprays of 2,500 ppm while 'Rose Supreme' for Mother's Day may require 3-4 sprays at 3,500 - 5,000 ppm. Requirements will be less if plants are grown with zero or negative DIF.

d. Applications can be made after buds are visible, if necessary but no later than 6 weeks before flower.

e. Stem elongation tends to be greater under low night temperatures (12-17°C, 54-63°F) (positive DIF) and long days of late spring.

3. Plants must be defoliated during the cold treatment to perceive the

cold and also to prevent *Botrytis* during storage.

a. Butyne-diol (2-butyn-1.4-diol) sprayed at 1% (1 lb in 12 gallons) 7-10 days before storage defoliates mature plants. Warm temperatures are required for proper defoliation.

b. Vapam at 1 teaspoon per 100 ft^3 of storage space defoliates mature plants. Dissolve in water and sprinkle on floor when flats are first brought into storage. More than one application may be necessary.

c. Ethephon at 1,000 - 3,000 ppm is effective. It also causes height reduction (8-31% with a 1,000 ppm spray) during forcing.

d. Remove dropped leaves to prevent *Botrytis.*

4. Substitution for cold treatment

a. Gibberellic acid (GA) can be applied weekly at a concentration of 5 ppm (up to 4 weekly sprays). Apply approximately 1 ml/plant.

b. GA should be used with caution as plants may become leggy, especially on tall and white flowering cultivars.

VI. Problems

A. Insects

1. Aphids and mites are common insect pests. Control with standard chemicals.

B. Diseases

1. *Botrytis* blight or bud rot can occur in storage at low temperatures. Early removal of dead leaves following defoliation is a preventative measure. Fungicide sprays every 2-3 weeks during storage will give control.

2. Powdery mildew (*Erysiphe polygoni)* can be a problem in the fall. Higher temperatures (lower humidity) and increased air circulation is effective. Sulphur and other powdery mildew control compounds can

be used successful.

3. Hydrangea ringspot virus can be a problem. Tolerance varies with cultivar. The most tolerant cultivars include 'Strafford', 'Engel's White', 'Todi' and 'Monte Forte'. Discard badly infected plants.

C. Physiological

1. Blindness can be caused by several factors. Most of them occur during the fall and include poor light, too early storage, too early defoliation and too early onset of cool temperatures. Also at low temperatures, bud kill can occur.

2. Chlorosis of the foliage may be caused by low iron levels in the soil or poor root growth. Iron sulfate at 3 pounds per 100 gallon water is helpful for iron deficiency.

3. Chlorosis is common when forcing begins of 4-inch pots transplanted to 6-inch pots and is generally due to poor root growth. Dipping the 4-inch pot in an iron chelate and magnesium sulfate solution prior to planting will reduce this chlorosis problem.

VII. Harvesting, Handling and Marketing

A. Plants are sold in full bloom.

B. Plants should receive ample water throughout sales and in the home as plant require large amounts of moisture.

C. Cool temperature before sale intensifies color.

D. Decorative life of plants in the consumer environment is only slightly influenced by light intensity.

E. Shipment of plants for 4 or more days at 21°C (70°F) greatly reduces subsequent decorative life.

F. Plants can be shipped for up to 4 days at 2°C (35°F) without decreasing subsequent postharvest life.

VII. **Scheduling**

A. Traditional production (forcing for April 1)

Date	Growing Time for Cultural Segment	Cultural Procedure	Temperature
March-April		Cutting Propagation	16-18°C (60-65°F)
	3-4 weeks	| V	
No later than July 15		Transplant to 6 inch pot	18°C (65°F)
	10-14 weeks	| V	
		Pinch 4-6 weeks	
		| V	
No later than Aug. 5		B-Nine	
	3-5 weeks	| V	
Sept. 1		Flower induction	Below 18°C (65°F)
	6 weeks	| V	
Mid Oct.		Defoliate and start cold treatment	4-7°C (40-45°F)
	6 weeks	| V	
Dec. 25		Start forcing	16-17°C (60-62°F)
	2-3 weeks	| V	
Jan. 7		B-Nine	16-17°C (60-62°F)
	1 week	| V	
Jan. 15		B-Nine	16-17°C (60-62°F)
	1-2 weeks	| V	
Feb. 1		Buds visible	16-17°C (60-62°F)
	8 weeks	| V	
April 1		Flower	

B. Alternative schedule using reproductive stock plants.

Date	Growing Time for Cultural Segment	Cultural Procedure	Temperature
Oct. 15		Propagate cuttings[1] in 3 inch pots	18°C (65°F)
	4 weeks	↓	
Nov. 15		Move to greenhouse	16°C (60°F)
	2 weeks	↓	
Dec. 1		Lower temperature	10°C (50°F)
	2.5 weeks	↓	
Dec. 17		Spray with Bromodine	10°C (50°F)
	4 days	↓	
		Spray with Bromodine	10°C (50°F)
	1 week	↓	
Dec. 28		Move to storage	4°C (40°F)
	6 weeks	↓	
Feb. 15		Force	13-16°C (55-60°F)
	2 weeks	↓	
March 1		Repot 3 inch pots to finish pots	13-16°C (55-60°F)
	12 weeks	↓	
Memorial Day		Flower	

[1]Cuttings are taken from stock plants which have already initiated flower buds.
Growing: Time from propagation to storage is 73 days. Normal season (pinched) is 260 days.
Forcing: Plants are salable 100 days from start of forcing.

C. Schedule from Weiler and Lopes, Purdue University

Growing Time for Cultural Segment	Cultural Procedure	Temperature	Photoperiod
	Propagate terminal shoot cutting	18°C (65°F)	24 hours light
3 weeks	↓		
	Pot	18°C (65°F)	24 hours light
4 weeks	↓		
	Start short days	18°C (65°F)	8 hours light
6 weeks	↓		
	Return to long photoperiod	18°C (65°F)	24 hours light
7 weeks	↓		
	Flower		

Total production time is 140-145 days.

D. Modified schedule presented in Weiler, T.C. 1980. Hydrangeas. In R. A. Larson (ed.) Introduction to Floriculture p. 353-372. Academic Press, New York.

Growing Time for Cultural Segment	Cultural Procedure	Temperature	Photoperiod
	Propagate terminal shoot cuttings	23°C (73°F)	Long days
3 weeks	↓		
	Pot	23°C (73°F)	Long days
3 weeks	↓		
	Start short days	17°C (63°F)	Short days
6 weeks	↓		
	Return to long photoperiod	23°C (73°F)	Long days
6 weeks	↓		
	Lower temperature	13°C (55°F)	Long days
4 weeks	↓		
	Flower		

Both Schedule C and D are still experimental. Continuous high temperature forcing can result in severe plant distortion due to virus.