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TESTING PROCEDURES FOR BEDDING PLANTS

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Growers should establish a routine monitoring program to avoid nutritional disorders and to insure the subsurface environment is properly created during bedding plant production. These tests fall into three categories: ① general operations, ② preplant, and ③ post-plant tests.

General operations testing includes examining irrigation water quality and conducting injector calibrations. Preplant tests are measuring substrate moisture content, pH, and soluble salts prior to flat filling and planting. Post-plant tests involve checking fertilizer delivery (rechecking injectors); and monitoring nutrients, pH, alkalinity, and soluble salts during the crop. All of these tests should be simple, and performed frequently to be useful to the grower.

General Operations Testing

Every greenhouse should be submitting water samples for complete chemical analysis at least annually as part of their general operations testing (Table 1). If your greenhouse has a history of alkalinity problems in the irrigation water, you should have an on-site test kit and should be

testing your water source at regular intervals (we will discuss alkalinity testing in more detail later). Chemical analysis of your irrigation water is critical information for formulation of a fertilization program. For example, some waters in North Carolina already contain ample calcium for plant production while others would supply very little calcium. These two locations should be using a different fertilization program to assure proper nutrition for their crops.

Fertilizer and acid injectors should be *calibrated monthly*; more often when you suspect a problem. Remember, these devices are only as accurate as their last calibration, so frequent calibration is essential.

Preplant Testing

Preplant testing of substrate moisture content, pH and soluble salts should be done prior to tray filling.

When water is added to dry components, such as peat, they hydrate and swell. This swelling helps to create more aeration by reducing the tendency of the particles to nest within one another. This effect is not so dramatic on larger

Table 1. Recommended upper limits of nutrient and chemical capacity factors for water used for greenhouse crop production.

Capacity factor	Upper limit for greenhouse use
Substrate pH Factors	
pH ^A	5.4 to 6.8 is acceptable
Alkalinity ^B	100 ppm CaCO ₃ (2 meq/L)
Total Carbonates (TC)	100 ppm CaCO ₃ (2 meq/L)
Bicarbonate (HCO ₃ ⁻)	122 ppm (2 meq/L)
Hardness ^C (Ca + Mg)	150 ppm CaCO ₃ (3 meq/L)
Salinity Factors	
Electrical conductivity (EC)	
for plug production	0.75 mmho/cm
for general production	2.0 mmho/cm
Total Dissolved Salts ^D (TDS)	
for plug production	480 ppm
for general production	1,280 ppm
Sodium absorption ratio (SAR)	4
Sodium (Na)	69 ppm (3 meq/L)
Chloride (Cl ⁻)	71 ppm (2 meq/L)
Macro Elements	
Nitrogen ^E (N)	10 ppm (0.72 meq/L)
Nitrate ^E (NO ₃ ⁻)	10 ppm (0.16 meq/L)
Ammonium ^E (NH ₄ ⁺)	10 ppm (0.56 meq/L)
Phosphorus ^F (P)	1 ppm (0.3 meq/L)
Phosphate ^F (H ₂ PO ₄ ⁻)	1 ppm (0.01 meq/L)
Potassium ^F (K)	10 ppm (0.26 meq/L)
Calcium ^G (Ca)	0 to 120 ppm (0 to 6 meq/L) is normal range
Magnesium ^G (Mg)	0 to 24 ppm (0 to 2 meq/L) is normal range
Sulfur ^H (S)	20 to 30 ppm (0.63 to 0.94 meq/L) is optimum for most plants
Sulfate ^H (SO ₄ ⁻²)	30 to 45 ppm (0.63 to 0.94 meq/L) is optimum for most plants

^AWater with high pH should be analyzed for alkalinity and can be safely used if alkalinity is neutralized.

^BWater with high levels of alkalinity can be used safely if it is treated with acid to neutralize the bicarbonates and other ions contributing to alkalinity. A limit of 1.5 meq/L alkalinity is suggested for plug production. Labs differ in how they report alkalinity. "Alkalinity", "TC", and "bicarbonates" are the three methods used.

^CHardness is a measure of Ca and Mg content, but it can be used as an indicator of alkalinity. Hard water should be checked for high alkalinity and can be safely used if alkalinity is neutralized.

^DA conversion factor of 1 mmho/cm EC = 640 ppm TDS is assumed for TDS readings.

^ENitrate and ammonium provide nitrogen to plants and should not cause damage at moderate levels. Nitrate and ammonium levels higher than listed indicate that the water source may be contaminated with fertilizer or some other contaminant.

^FPhosphorus and potassium normally occur in very low concentrations in irrigation water. If your water contains more than the listed levels, it may be contaminated with fertilizer, detergent, or some other contaminant.

^GThe numbers reported here indicate the range of both elements usually found in North Carolina waters. Calcium and magnesium content of water should be taken into account during fertilization programming.

^HSulfur is usually found at low concentrations. The numbers listed here indicate the suggested optimum range of sulfur for most greenhouse crops.

Table 1, continued.

Capacity factor	Upper limit for greenhouse use
Micro Elements	
Aluminum (Al)	5 ppm
Boron (B)	0.5 ppm
Copper (Cu)	0.2 ppm
Fluoride ¹ (F ⁻)	1 ppm
Iron ² (Fe)	0.2 to 4 ppm
Manganese (Mn)	1 ppm
Molybdenum (Mo)	---
Zinc (Zn)	0.3 ppm
Organisms to Test For	
Iron fixing bacteria	
Plant pathogens	

¹Safe for most crops but toxic for many members of the lily family.
²Although 4 ppm is maximum for plants, even as little as 0.3 ppm can lead to iron rust stains on foliage if water is used for overhead irrigation.

containers, but can be the difference between success and failure of a plug crop. Most plug mixes tend to be inadequately moistened prior to flat filling. Water should be added to the mix before it is placed into the cells. Ideally, the substrate should be moistened, mixed, and allowed to set overnight prior to use. However, even a 2 hour wait after adding the correct amount of water is beneficial for the hydration process.

How much water should be added to the mix? For peat-based substrates used in large containers and bedding plant cell pak production, use a 1 water : 1 oven dry substrate (w : w) ratio (50% moisture content). Plug mixes should have a 2 water : 1 dry substrate ratio (67% moisture content) prior to filling

the plug tray. The rule of thumb is, the smaller the cell, the more water to add prior to planting. This level of moisture will seem much wetter than “normal,” but will actually improve aeration (Table 2). Increasing initial moisture content from 60 to 70% more than tripled the air space of a 273 plug (Table 2).

Figure 1 outlines how to calculate the initial moisture content of a mix and lists how much water is present at different moisture levels. Once you have calculated the initial moisture percentage, add the difference between the target water volume and the initial water volume. For example, if your initial moisture percentage is 20%, there are 5 gallons of water per cubic yard of substrate. If you want a moisture content of 50%, you should add 15 gallons of water per cubic yard. If you want a moisture content of 67%, then 35 gallons should be added per cubic yard.

Note that the table in Figure 1 is based on substrates having a bulk density of 0.1 g/cm³ (168.55 lb/yd³ or 6.2426 lb/ft³). If the substrate

Best for cells

Percent Moisture Content:

$$([IW - DW] \div IW) \times 100$$

- IW = initial weight of substrate
- DW = dry weight of substrate
- weigh 3 known volumes (~1 cup each)
- dry in 225 °F oven for 24 hours
- take dry weights
- use averages in above formula
- add difference needed

Best for plugs



Water volumes present in one cubic yard of peat : vermiculite or peat : perlite plug mixes.*

Moisture** (% weight)	Water volume (gal/cubic yard)
0	0
10	2
20	5
33	10
50	20
60	30
67	40
72	50
75	60

*Calculations based on dry bulk density of 0.1 g/cc (6.25 lb/cu ft).

**Actual calculations based on mass wetness values of 0, 0.1, 0.25, 0.5, 1.0, 1.5, 2.0, 2.5, and 3.0 g/g, respectively.

Figure 1. How to calculate moisture content of a substrate and to reach a targeted moisture content.

Table 2. Effect of substrate moisture content on total porosity (TP), unavailable water (UW) and air space (AS) of a 1 peat moss : 1 vermiculite mix in a 273 plug tray. TP, UW, and AS are reported as % of plug volume.

Moisture (% wt)	TP	UW	AS
60%	87	21	2
70%	88	16	7

you are measuring has a different bulk density, then you must adjust the gallon numbers given in the table in Figure 1 for water additions. To measure the bulk density (BD) of your substrate, weigh 1 cubic foot of oven-dried substrate. Insert the measured BD into the equation below:

$$1 + [(BD - 6.2426) \div 6.2426] = \text{gallon multiplier}$$

Multiply the numbers in the water volume column of the table in Figure 1 to adjust for the bulk density of you substrate. For example, if your measured BD is 5 lb/ft³, then the resulting numbers in the water volume column would be: 0, 1.6, 4.0, 8.0, 16.0, 24.0, 32.0, 40.0, and 48.1 gal/cubic yard. If your measured BD is 8 lb/ft³, then the resulting numbers in the water volume column would be: 0, 2.6, 6.4, 12.8, 25.6, 38.4, 51.3, 64.1, and 76.9 gal/cubic yard.

(Readers interested in more information on physical properties of substrates and further information on moisture content should refer to August 1995 NCCFGA Bulletin, 40(4):3-8.)

The next preplant substrate tests is pH. Limestone may take two days to two weeks to fully adjust the pH. If you make your mix just before you fill the trays, the pH will be different than if you mix the substrate a few days ahead and moisten the mix. You should know the rate of reaction time necessary for your mix to reach its final pH. The best way to do this is to establish a *liming curve* for your mix. The rate of reaction will change with changes in peat source and quality / type / particle size of the limestone used.

Soluble salts should be measured to assure that salt levels are below levels that could cause plant damage (Table 3). Note that acceptable salt levels depend on the sampling method used as well as the crop being grown (more on how to take a substrate sample for salts and pH later).

Post-Plant Testing

A complete post-plant testing program should include visual monitoring of the crop's appearance; routine substrate monitoring checking for pH, soluble salts, and substrate nutrient concentrations (Tables 1, 3, 4, & 5); fertilizer solution analysis including pH and soluble salts; irrigation water analysis including pH, soluble salts, and alkalinity; and plant tissue analysis.

During plug production, weekly substrate and tissue analysis should be conducted. For finishing flats, every two weeks may be sufficient. Separate substrate and tissue tests should be conducted for different bedding plant species, as individual species differ in pH and fertility requirements. Fertilizer delivery should be checked daily, or at least at every fertilization if done every second or third irrigation. This can be accomplished by simply capturing some of the fertilizer water in a glass, jar, or beaker and measuring the EC.

Frequency of water analysis depends on the alkalinity content and stability of the water quality. If your water quality (especially alkalinity) changes frequently, then weekly testing of these parameters may be needed, especially for plug production. The alkalinity of a water source can change drastically with weather conditions and pumping fluctuations. We have measured alkalinity ranging from 2.8 meq/L to 5.4 meq/L in well water drawn from the same well in North Carolina during the course of one year! Municipal water in many locations is derived from different sources. Although municipalities try to maintain consistent output from water plants, it is possible to encounter alkalinity fluctuations from a municipal water source also.

Table 3. Electrical conductivity guidelines from various laboratories using the saturated paste, 1 : 2, and pour through extraction techniques.*

Extraction method													
Saturated paste**				1 substrate : 2 water (v : v)**				Pour through exfiltrate**				Interpretation	
Soil-based		Soilless		Soil-based		Soilless		Soil-based		Soilless			
CU	NCSU	MSU	FAS	UC	NCSU	MSU	NCSU	CU	CU	CU	VTU***		
	≤0.75	≤0.74	≤0.75	<50	≤25	≤24	0 to ?						Insufficient nutrition
	0.75 to 2.0	0.75 to 2.0	0.75 to 2.0	50 to 70	26 to 50		? to 100				<0.5		Low fertility unless applied with every watering
2.5	2.0	3.5	1.99	100 to 120	100	75		0.6 to 1.0	1.5				Maximum for seedlings or newly rooted cuttings
<3.5	2 to 4	2.0 to 3.5	0.76 to 2.5 (no bark) OR 1.5 to 3.5 (with bark)	<150	51 to 125	75 to 125	100 to 175				0.75 to 1.5		Good for most crops
<3.5		<5.0		<200	126 to 175	125 to 175	176 to 225	1.0 to 2.0	≤2.0		2.0		Good for established crops
>3.5	4 to 8	5.0 to 6.0	>3.5	>200	176 to 200	175 to 225	225 to 350						Danger area
	>8.0	>6.0	>5.0		>200	>225	>350						Usually injurious
	0.75 to 1.0				25 to 100		50 to 150						Range for Stage 1 & 2 plugs
	1.0 to 1.5				25 to 125		50 to 175						Range for Stage 3 plugs
	1.5 to 2.0												Range for Stage 4 plugs
	1.5 to 4.0			50 to 175			100 to 225						Range for finish flats of bedding plants

*Laboratory abbreviations are CU = Cornell University, NCSU = North Carolina State University, MSU = Michigan State University, FAS = Fafard Analytical Services, UC = University of Connecticut, and VTU = Virginia Tech University.

**Saturated paste and pour through exfiltrate ECs are given in mmho/cm (mho × 10⁻³/cm). The 1 substrate : 2 water ECs are given in mho × 10⁻⁵/cm.

***The Virginia Tech University (VTEM) pour through standards are for outdoor nursery production, not indoor greenhouse production. They are included as a comparison of greenhouse to outdoor culture recommendations.

Table 4. Interpretive values for essential macronutrients in the substrate solution of a soilless substrate using the saturated paste extraction method.

Interpretation	Concentration in extract solution (ppm)				
	Nitrates	Phosphorus	Potassium	Calcium	Magnesium
Michigan State University					
Low	0 to 39	0 to 2	0 to 59	0 to 79	0 to 29
Acceptable	40 to 99	3 to 5	60 to 149	80 to 199	30 to 69
Optimum	100 to 199	6 to 10	150 to 249	200+	70+
High	200 to 299	11 to 18	250 to 349	—	—
Very high	300+	19+	350+	—	—
The Ohio State University					
Extremely low	0 to 29	0 to 3.9	0 to 74	0 to 99	0 to 29
Very low	30 to 39	4.0 to 4.9	75 to 99	100 to 149	30 to 49
Low	40 to 59	5.0 to 5.9	100 to 149	150 to 199	50 to 69
Slightly low	60 to 99	6.0 to 7.9	150 to 174	200 to 249	70 to 79
Optimum	100 to 174	8.0 to 13.9	175 to 224	250 to 324	80 to 124
Slightly high	175 to 199	14.0 to 15.9	225 to 249	325 to 349	—
High	200 to 249	16.0 to 19.9	250 to 299	350 to 399	125 to 134
Very high	250 to 274	20.0 to 40.0	300 to 349	400 to 499	135 to 174
Excessively high	275 to 299	40.0+	350+	500+	175+

Regular monitoring of alkalinity is essential if your water quality changes over time. For a plug producer, *weekly measurements* may be needed due to the rapid effects alkalinity can have on a plug substrate system, because of the small volume of substrate in each plug. Alkalinity effects on larger sized containers (larger substrate volumes) occur more slowly, and monthly testing may be sufficient to give growers enough knowledge to adjust for alkalinity fluctuations in the water source.

Testing Procedures

Every greenhouse range should have the capability to measure pH and electrical conductivity (EC). These parameters can change too rapidly to rely solely on lab test results, and the cost of the testing equipment is no longer prohibitory for growers.

When selecting a pH meter, look for an accuracy of ± 0.1 pH unit and a range of 1 to 14. To be useful for fertilizer injector calibration as well as substrate and solution testing, EC meters should have a range of 0 to 1,990 $\text{mho} \times 10^{-5}/\text{cm}$ and have an accuracy of $\pm 10 \text{ mho} \times 10^{-5}/\text{cm}$. Many EC meters report EC in units of $\mu\text{S}/\text{cm}$ (microSiemens per centimeter). The conversion between S/cm and mhos/cm is simple: 1 S/cm = 1 mhos/cm. Both pH and EC meters are available from many sources including the following: Cole-Parmer Instruments, 745 North Oak Park Ave., Chicago, IL 60648, (800)323-4340; Extech Instruments Corp., 150 Bear Hill Road, Waltham, MA 02154, (617) 890-7440; Myron L Co., 6231 C. Yarrow Drive, Carlsbad, CA 92009, (619) 438-2021.

Whether you are collecting a sample for in-house testing (of substrate pH and EC for example)

Table 5. Recommended ranges for essential nutrients in the substrate solution of a soilless substrate using the saturated paste extraction or the pour through exfiltrate method.

Element	Extraction Method				
	Saturated paste			Pour through exfiltrate	
	Cornell University	Michigan State University	Fafard Analytical Services	Cornell University	Virginia Tech University*
NO ₃ -N	23 to 68	75 to 150	40 to 200	23	50 to 100
NH ₄ -N	<12	2 to 10	0 to 20	---	50
P	5 to 20	10 to 20	5 to 30	15	3 to 15
K	150 to 350	75 to 150	40 to 200	50	<100
Ca	200 to 400	125 to 175	40 to 200	15	40 to 200
Mg	70 to 200	40 to 60	28 to 80	15	10 to 50
S	---	75 to 125	---	---	75 to 125
Fe	---	1 to 2	0.3 to 3.0	---	0.3 to 3.0
Mn	---	1 to 2	0.1 to 3.0	---	0.02 to 3.0
Zn	---	1 to 2	0.1 to 0.3	---	0.3 to 3.0
Cu	---	0.1 to 0.5	0.01 to 0.3	---	0.01 to 0.5
B	---	0.1 to 0.5	0.05 to 0.5	---	0.5 to 3.0
Mo	---	0.1 to 0.5	0.01 to 0.1	---	0.0 to 1.0
Al	---	---	---	---	0.0 to 3.0
Fl	---	---	---	---	<1
Na	---	<25	---	---	<69
Cl	---	<25	---	---	<71

*The Virginia Tech University (VTEM) pour through standards are for outdoor nursery production, not indoor greenhouse production. They are included as a comparison of greenhouse to outdoor culture recommendations.

or for laboratory analysis (of substrate nutrient concentrations or nutrient analysis of plant tissue), take a "representative sample". In problem free, routine sampling situations, a sample should consist of material from several locations. This will provide a sample of the entire crop / greenhouse. When the cause of a problem is being investigated, such as why plants look chlorotic, then a representative sample should consist only of the material from problem areas, plants, or water sources. For best results, a comparative sample from non-affected areas

should be taken and submitted at the same time to serve as a comparison for problem samples.

To complete the many analyses of a single sample, laboratories require a prescribed amount of material, whether it is plant tissue for foliar analysis, a water sample, or a substrate sample. Submitting less than the amount required results in incomplete testing and / or a delay until additional material is sent. Always be aware of and send the requested sample size for laboratory analysis, and use sample containers provided by the laboratory you utilize, if provided.

Collecting a substrate sample for laboratory analysis. When collecting a substrate sample, always sample more than one container and collect the sample from all levels in the pot. Draw at least 10 cores of substrate, each from a different location within the crop such that many different benches and locations within a bench are included. When drawing a problem sample, make sure to only sample from affected areas. Exclude the top 1/2 inch of substrate (top 1/8 inch for plug samples), since it is not representative of where plant roots are located and could contain high salt levels, especially in a subirrigation delivery system. If the substrate contains a slow release fertilizer such as Osmocote®, it will be necessary to remove all the fertilizer particles prior to testing to avoid skewing nutrient readings. Samples should be refrigerated until sent to the lab or dried for 24 hours at 125 °F. Do not heat to greater than 125 °F as nutrient loss from the sample may occur. One cup (8 fl oz.) of substrate is usually sufficient for most laboratories; always send the volume requested by the laboratory.

Recently, affordable meters for NO₃-N and K (Cardy® meters) became available. These meters allow growers to conduct in-house measurements for both NO₃-N and K. However, for use with substrate solutions, this means that growers must conduct saturated paste extraction for meaningful interpretation of meter readings.

Preparing a substrate extract for in-house measurement of pH and EC. Routine on-site analysis of substrate pH and EC allows growers to catch fertilization errors early and to prevent major problems from developing. One of the major obstacles to successful testing is the lack of uniformity when many workers do substrate sampling and testing; from location to location within in greenhouse range and from different times. The best remedy is to assign the task of sampling and testing to one worker for consistency in testing.

Probably the easiest method for growers to measure pH and EC of a substrate is a 2 water : 1 substrate mixture (volume : volume). When

collecting a substrate sample for in-house testing, follow the collection procedures outlined previously taking care to collect a representative sample and removing any slow release fertilizer, if present. Collect an 8 fl oz. volume of substrate. To this volume of substrate, add twice the volume (16 fl oz.) of distilled or deionized water, readily available at most grocery stores. Stir the mixture, then allow it to stand for approximately 15 minutes prior to measuring pH and EC. During this time, calibrate both the pH and the EC meter against standard solutions to assure accuracy of sample measurements. Consult the instructions that came with your meters to know whether you must filter out particulate matter with a coffee filter or cheese cloth prior to reading the pH and EC. Use Tables 1 and 3 as guidelines for interpreting the EC and pH readings of your samples. Out-of-range readings warrant submission of a substrate sample for laboratory analysis. Adjust your fertilization and / or pH control program accordingly.

Alternative in-house substrate testing procedures include pour through exfiltrate (VTEM method) and the NCSU “squeeze” method. The pour through exfiltrate method offers the advantage of nondestructive sample collection and the potential for submitting the sample to a lab for nutrient analysis after measuring pH and EC or using in-house meters (Cardy meters) for measuring NO₃-N and K. However, guidelines for interpreting the pour through exfiltrate results are not as complete as for saturated paste and 2 : 1 (Tables 3, 4, & 5). The squeeze method also allows the grower the option of in-house NO₃-N and K analysis or submitting the solution for nutrient analysis, but it is a destructive sampling method and some crop must be harvested during sampling. Also, as with the VTEM method, interpretive tables are still in the formulation stage of development.

Collecting a plant tissue sample for foliar analysis. Analysis of leaves is the most precise method of measuring micronutrient and macronutrient status of a crop. Routine sampling

should be conducted in order to establish a "base line" of nutrition readings for reference in case of a future problem. For problem solving, remember to collect material only from problem areas, and to send a second sample representing a problem-free site concomitant with the problem sample for comparison. Table 6 lists nutritional guidelines for various bedding plants. For those not listed, use the last column, general, as a guide.

Leaf samples should be collected in the morning (before noon), when plants are not under water stress. Collect the appropriate number of leaves / volume of leaves indicated on the instruction sheet included in the tissue analysis kit from the laboratory you utilize. Leaves that best represent the crop nutrient status are those that have most recently matured; collect new, fully expanded leaves. If no instructions are given for your crop species, collect at least one cup (8 fl oz.) of leaves with the petioles attached. Collected leaves should be rinsed in distilled or deionized water. Do not use tap water, as the water nutrient content may contaminate the foliar sample. Allow leaves to dry prior to packing for shipment. Leaf samples often rot if enclosed in plastic bags; package in paper bags for best results. Keep samples refrigerated until shipping. Shipping via overnight or next day delivery is helpful in assuring that samples arrive at the lab in good shape.

The Cardy meters mentioned previous can be used for on site testing of plant $\text{NO}_3\text{-N}$ and K concentrations, usually petiole sap concentrations. This technique has been used for many years to test the nitrogen status of tomato, pepper, and other food crops. In the future, standards for floricultural crops may allow for meaningful in-house testing of crop $\text{NO}_3\text{-N}$ and K concentrations.

Collecting a water or fertilizer solution sample for laboratory analysis. When collecting a solution sample, allow the water to run long enough to flush all piping prior to collecting the sample. Sample containers should be clean and must not be metallic or have an exposed metal cap; plastic bottles are ideal. A 16 fl oz. sample should be

more than sufficient for solution analysis. Keep the sample refrigerated until it is submitted to the lab. Transfer samples to the laboratory as expediently as possible, and avoid prolonged exposure to air. Table 1 outlines irrigation water standards.

In-house analysis of water and fertilizer solution pH and EC. Both EC and pH can be measured in-house on a solution sample. However, accurate measurement of water pH is difficult and may require a longer measuring time than for a fertilizer solution or a substrate extract. This is due to the relatively low buffering capacity of tap water.

In-house analysis of water alkalinity. Water alkalinity is caused by the presence of carbonates, bicarbonates, hydroxides, and other dissolved salts. It is measured by titrating a water sample with an acid (usually dilute sulfuric acid) to an endpoint pH of about 4.6 (varies from 5.1 to 4.5 depending on the indicator dye used and the initial alkalinity). A pH indicator dye (usually bromocresol green plus methyl red) is added to a known volume of water (indicated in the test kit instructions; usually about 8 fl oz.), and acid is added until the solution changes color. With the bromocresol green plus methyl red dye system, the color will change from green to pink.

Most water sources acceptable for greenhouse use will have alkalinity of 0 to 8 meq/L (0 to 400 ppm alkalinity expressed as CaCO_3). When looking for a test kit, this is the range that is needed. The level of accuracy does vary from kit to kit; ± 0.4 meq/L (20 ppm alkalinity expressed as CaCO_3) is accurate enough for most situations, but more precise kits are available. We have used Hach alkalinity kits #24443-01 (about \$30 for 100 tests) and #20637-00 (about \$155 for 100 tests, but includes versatile digital titrator) and are satisfied by both (Hach Company, P.O. Box 389 Loveland, Co 80539; phone (800) 227-4224). Although the second model is more expensive, it does have twice the accuracy (± 0.2 meq/L) and also comes with a digital titrator that can be used to measure other solution parameters

Table 6. Suggested nutritional guidelines for foliar analysis results of various bedding plant species.

Element	Begonia, wax leaf ^{Z,Y}			Geraniums, seed ^{Z,Y}			Geraniums, zonal ^X			Impatiens ^Y
	Low	Normal	Excess	Low	Normal	Excess	Low	Normal	Excess	
N (%)	3.5 to 3.9	4.0 to 6.0	>6.0	3.0 to 3.49	3.5 to 4.8	>4.8	2.4 to 3.2	3.3 to 4.8	---	4.3 to 5.3
P (%)	0.2 to 0.29	0.3 to 0.75	>0.75	0.3 to 0.39	0.4 to 0.7	>0.7	0.25 to 0.39	0.4 to 0.7	>1.0	0.6 to 0.8
K (%)	2.0 to 2.4	2.5 to 6.0	>6.0	1.0 to 2.49	2.5 to 4.3	>4.3	0.6 to 2.4	2.5 to 4.5	---	2.8 to ?
Ca (%)	0.6 to 0.9	1.0 to 2.5	>2.5	0.6 to 0.79	0.8 to 1.2	>1.2	0.7 to 0.9	1.0 to 2.0	---	2.9 to 3.3
Mg (%)	0.25 to 0.29	0.5 to 0.8	>1.0	0.15 to 0.19	0.2 to 0.5	>0.6	0.14 to 0.19	0.2 to 0.7	---	0.6 to 0.8
S (%)	0.25 to 0.29	0.3 to 0.7	>0.8	0.2 to 0.24	0.25 to 0.7	>0.8	0.12 to 0.24	0.25 to 0.6	---	---
Na (%)	---	---	---	---	---	---	---	0.1 to 0.5	>1.0	---
B (ppm)	15 to 19	20 to 75	>75	18 to 29	30 to 200	>200	18 to 29	30 to 100	>200	45 to 95
Cu (ppm)	4 to 6	7 to 30	>30	5 to 6	7 to 25	>25	5 to 6	7 to 16	---	10 to 15
Fe (ppm)	40 to 49	50 to 200	>200	60 to 99	100 to 290	>300	50 to 99	100 to 300	---	400 to 600
Mn (ppm)	30 to 49	50 to 200	>200	25 to 39	40 to 200	>200	9 to 39	40 to 150	>400	200 to 450
Mo (ppm)	---	---	---	---	---	---	0.5 to 0.9	1.0 to 5.0	---	---
Zn (ppm)	20 to 24	25 to 80	>200	12 to 17	18 to 80	>200	6 to 9	10 to 50	---	65 to 70

Element	Pansy ^{X,W}			Salvia ^Z			Marigold ^X			Snapdragon ^X			Vinca ^{Y,X}			General
	Low	Normal	Excess	Low	Normal	Excess	Low	Normal	Excess	Low	Normal	Excess	Low	Normal	Excess	
N (%)	1.5 to 2.4	2.5 to 4.5	>4.6	2.5 to 2.99	3.0 to 4.5	>4.5	3.5 to 5.0	4.0 to 5.5	>4.5	4.0 to 5.5	3.0 to 5.0	>4.5	4.0 to 5.5	3.0 to 5.0	>4.5	variable
P (%)	0.11 to 0.24	0.25 to 0.7	>0.7	0.22 to 0.29	0.3 to 0.7	>0.7	0.3 to 0.45	0.2 to 0.4	>0.7	0.2 to 0.4	0.3 to 0.45	>0.7	0.2 to 0.4	0.3 to 0.6	>0.7	0.25 to 1.0
K (%)	1.0 to 2.4	2.5 to 5.0	>8.0	3.0 to 3.49	3.5 to 5.0	>5.0	3.5 to 5.5	2.5 to 4.0	>5.0	2.5 to 4.0	3.5 to 5.5	>5.0	2.5 to 4.0	1.3 to 3.0	>5.0	variable
Ca (%)	0.3 to 0.59	0.6 to 2.6	>3.0	1.0 to 1.49	1.5 to 2.5	>2.5	2.0 to 3.0	0.8 to 1.5	>2.5	0.8 to 1.5	2.0 to 3.0	>2.5	0.8 to 1.5	1.0 to 2.0	>2.5	1.0 to 2.0
Mg (%)	0.11 to 0.4	0.4 to 0.75	>1.5	0.2 to 0.24	0.25 to 0.6	>0.6	0.3 to 0.5	0.5 to 0.8	>0.6	0.5 to 0.8	0.3 to 0.5	>0.6	0.5 to 0.8	0.4 to 0.6	>0.6	0.25 to 1.0
S (%)	<0.2	0.2 to 0.7	---	---	---	---	0.25 to 0.35	---	---	---	0.25 to 0.35	---	---	---	---	0.2 to ?
Na (%)	---	0 to 0.5	>1.2	---	---	---	<0.5	<0.2	---	<0.2	<0.5	---	<0.2	<0.2	---	---
B (ppm)	14 to 19	20 to 80	>175	20 to 24	25 to 75	>75	30 to 100	25 to 40	>75	25 to 40	30 to 100	>75	25 to 40	25 to 100	>75	25 to ?
Cu (ppm)	<5	5 to 40	>40	5 to 6	7 to 50	>50	10 to 20	10 to 30	>50	10 to 30	10 to 20	>50	10 to 30	5 to 12	>50	5 to ?
Fe (ppm)	30 to 90	100 to 250	>250	50 to 59	60 to 300	>300	100 to 300	100 to 200	>300	100 to 200	100 to 300	>300	100 to 200	100 to 300	>300	50 to ?
Mn (ppm)	<25	25 to 250	>300	25 to 29	30 to 200	>200	80 to 300	60 to 160	>200	60 to 160	80 to 300	>200	60 to 160	100 to 250	>200	30 to ?
Mo (ppm)	<0.2	0.2 to 5.0	>5.0	<2	2 to 4	>4	---	---	>4	---	---	>4	---	---	>4	0.2 to ?
Zn (ppm)	<20	20 to 100	>100	20 to 24	25 to 200	>200	35 to 60	30 to 60	>200	30 to 60	35 to 60	>200	30 to 60	20 to 60	>200	20 to ?

^ZAdapted from: Jones, J.B. Jr., W. Wolf, and H.A. Mills. 1991. Plant analysis handbook. Micro-Macro Pub., Inc. 185 Paradise Blvd., Suite 108, Athens, GA 30607.

^YAdapted from: Dole, J.M. and H.F. Wilkins. 1988. Tissue testing of selected floricultural pot crops. Minn. State Florists Bul. 37(5):13-15.

^XAdapted from: Anonymous, Soil and Plant Lab, P.O. Box 6566, Orange, CA 92613-6566.

^WAdapted from: Anonymous, Masterblend Fertilizer Company, 4425 S. Western Blvd., Chicago, IL 60609.

(using different titrants and indicators) such as water hardness, chlorine, iron, nitrite, and sulfite concentrations.

Interpretation of test results. Most commercial laboratories will send an interpretation along with sample results. However, since laboratories differ in procedures (say saturated paste extraction compared to a 1 : 2 extraction), it may not be possible to use interpretative guidelines from one lab for analyses conducted in another, especially with substrate samples. When interpreting results of substrate analyses, use the interpretations that correspond with the extraction method employed by the lab (Tables 3, 4, & 5).

The biggest confusion for growers usually arises when trying to interpret soluble salts (EC). Interpretation of EC requires knowledge of the testing procedure employed. The two major extraction methods, saturated paste and the 1 : 2 (substrate : water) method are both reported in mho/cm, but at differing decimal places. Saturated paste EC is usually reported as mmho/cm, which is $\text{mho} \times 10^{-3}/\text{cm}$, while 1 : 2 EC is usually reported as $\text{mho} \times 10^{-5}/\text{cm}$ (Table 3). As previously mentioned, some EC meters read in $\mu\text{S}/\text{cm}$; remember that $1 \mu\text{S}/\text{cm} = 1 \mu\text{mho}/\text{cm}$ ($1 \text{ mho} \times 10^{-6}/\text{cm}$). Make sure to use the correct

decimal placement when using interpretative tables. For example:

$$1.7 \text{ mmho} (1.7 \text{ mho} \times 10^{-3}) = 170 \text{ mho} \times 10^{-5}$$

and

$$170 \text{ mho} \times 10^{-5} = 1,700 \mu\text{mho} (1,700 \text{ mho} \times 10^{-6})$$

Make sure to use the numbers and interpretations that correspond to the extraction method employed.

Foliar analysis interpretation (Table 6) varies from lab to lab and from crop to crop, especially for macronutrients. Consult the interpretation accompanying the sample analysis report for recommendations, or use Table 6 as a general guideline for interpreting test results.

Use Table 1 as a guide for interpreting water sample results along with laboratory interpretations. If micronutrient and / or sodium and chloride levels are out of range, then these ions could potentially lead to toxicity problems if the water source is used for irrigation. If alkalinity is too high, then you may need to acidify to neutralize the excess bicarbonates in the water for pH control.

APRIL PROCLAIMED FLORICULTURE MONTH

For the third consecutive year, the governor has proclaimed April as "Floriculture Month" in North Carolina. The proclamation signed by governor Hunt noted that greenhouse and nursery crops account for 13% of all agricultural income in N.C. and rank second in crop value behind tobacco.

Earlier this month, NCCFGA president Jerry Whitley, Joe Stoffregen, Susan Rollins, and Bonnie Holloman visited the governor's mansion and presented Ms. Hunt with flowers, flowering potted plants, and flats of impatiens to help

promote floriculture month. Next, they visited the governor's office and presented his assistant with flowering plants; they also visited with NCDA Commissioner Jim Graham. Please make an effort to thank these NCCFGA members for taking time out of their schedule during this busy season to promote our industry.

To further promote floriculture month Jerry, Joe, and Bonnie conducted a television promotion at Homewood Nursery in Raleigh in early April. Your Association is working for all flower growers in North Carolina, and we all benefit from these generous efforts. Thanks again!

INTERIORESCAPE INSECT AND MITE MANAGEMENT

James R. Baker, Extension Entomologist North Carolina State University

Management of insect and mite pests of ornamental plants in public areas is difficult because of the many kinds of ornamental plants and their pests, the limited number of pesticides labeled for such use, the resistance of pests to pesticides and the public fear of pesticides. Public access to interiorscape plants makes the potential for human exposure to pesticides high. Control measures must be safe for humans. Even the odor of some pesticides might offend the public. Some interiorscapes have fish pools or may have adjacent pet stores. Pyrethroid insecticides are especially toxic to fish so great care must be taken to protect nontarget animals from exposure. Because pesticides are regulated by federal and state agencies, the selection of pesticides for use on indoor plants and the methods of application are likewise critical. Ornamental plants are primarily aesthetic so pesticides must be safe for the plants as well as effective for pest management. Failure to prevent accidental pesticide exposure problems may result in loss of clients and legal liabilities. In view of all the potential problems, correct identification of pests is very important so that proper management can be selected for optimal control and minimal effort.

Kinds of Pests

Mealybugs are very difficult to control and strong efforts should be made to exclude the insect from the interiorscape. Mealybugs distort growth and cause premature leaf drop. The wax covered bodies of the mealybugs and the honeydew which they excrete also degrade plants. Eggs are produced by the adult females in a large egg sac (ovisac) that may contain up to 600 eggs. The eggs hatch and the crawlers move about the plant seeking favorable sites for feeding in cracks and crevices. Development takes about 2 months

and infestations can rapidly become severe. Several other species of mealybugs infest interior plants. The longtailed mealybug is found on a wide variety of plants, particularly *Ficus* and *Dracaena*. The citrus mealybug can be quite damaging.

Aphids are small, soft insects which feed on the new growth and flowers of ornamental plants in the landscape. Aphids disfigure plants by excreting honeydew, a sweet liquid, and by the presence of the aphids themselves as well as their cast skins. Aphid populations often increase rapidly because they reproduce parthenogenetically and because they migrate into new areas from time to time. Melon aphids and green peach aphids may be introduced on plant material brought in from greenhouses or on the clothing of people passing by plants. Because flowers are more sensitive to pesticides than leaves, be sure to water the plants thoroughly before spraying them and (if possible) treat them early in the morning or late in the evening so that the pesticide residue is dry before the plants are exposed to direct sunlight.

Spider Mites are important pests of many crops. Two-spotted spider mites overwinter as adults in the soil or on weed hosts such as violets and hollyhocks. In mild winter weather, two-spotted spider mites continue to feed and lay eggs, although development in the winter is much slower than in the summer. Control of spider mites depends upon understanding the mites are usually found on the underside of leaves. Thorough application of pesticides to the underside of the plant foliage is essential for good control. Another application may be needed 7 to 10 days later to kill mites which were in the egg and resting stages during the first application. In hot weather when mites are dispersing by air, an eye should be kept on the plants to check for new

infestations by mites, as mites can be carried into interiorscapes on clothing.

Whiteflies infest a wide variety of ornamental and vegetable crops in greenhouses. Infested plants become chlorotic and unthrifty. Honeydew and sooty mold further detract from the appearance of the crop. Whiteflies are not easy to control because immature whiteflies feed as scalelike insects on the lower leaf surface and because these insects are resistant to many insecticides. Whiteflies are most likely to be carried into interiorscapes on infested plants.

Brown Soft Scale is a common scale insect pest in interiorscapes, and is often associated with *Ficus* and other woody plants. Large populations reduce plant vigor and produce abundant honeydew. This honeydew drips onto surfaces underneath and supports sooty mold fungi. Branches that are heavily infested with scale should be pruned and discarded, if possible. Aside from *Ficus*, common hosts for the brown soft scale include *Agave*, *Begonia*, *Brassaia*, *Citrus*, *Codiaeum*, *Dizygotheca*, *Euphorbia*, *Gardenia*, *Hedera*, *Laurus*, *Nerium*, *Peperomia*, *Pilea*, *Polystichum*, *Schefflera*, *Syngonium*, *Vinca*, and *Yucca*.

Hemispherical Scale is also widespread on interior plants. Ferns, *Chlorophytum*, and *Dizygotheca* are favored hosts. It is closely related and similar to the black scale which also attacks woody plant hosts such as weeping fig and *Citrus*. The hemispherical scale is larger than the brown soft scale, dark brown colored, and rounded (helmet-shaped). Young adults have H-shaped ridges on the back. The scales remove plant sap and can cause wilting and dieback of tender plant parts. Hemispherical scales produce less honeydew than brown soft scales but still enough to be obnoxious.

Fungus Gnats are small, dark, gnat-like flies. The immature stages breed in peatmoss, bark, potting soil, and other areas where decomposing debris allows development of the fungi on which they feed. Adult fungus gnats can be a serious nuisance in offices and cafeterias. The maggots

feed on fungi and rarely damage woody plants unless a root rot is involved. Controls should first give attention to correcting conditions which favor fungus development. Larval controls with insecticides (oxamyl, diazinon) have generally been marginal. Merit works well.

Thrips are small, slender plant pests. Orchid thrips and banded greenhouse thrips are occasionally pests of foliage plants. Thrips feed by piercing the leaf or petal surface and drawing sap from injured cells, causing the plants to "age" prematurely. The western flower thrips is found in many commercial greenhouses because it is resistant to many insecticides. Western flower thrips is an interior scape pest primarily when they come in on flowering plants. There are no pesticides labeled for interior scape control that are effective for the western flower thrips. With this pest, the only control is to depend upon the greenhouse operator to reduce the western flower thrips to a level that the flowers will last for a reasonable length of time in the interior scape.

Other Nuisance Pests. Millipedes, sowbugs, and pillbugs survive on organic matter and plant debris in interiorscapes. Although these cause little injury to plants, they can become nuisance problems around the interior scape. These arthropods require conditions of high humidity to thrive and die rapidly when exposed to typically low moisture conditions found in malls during the winter months. Removing mulches or other hiding sites can slow reproduction. Several insecticides (bendiocarb, cyfluthrin, diazinon) also are useful for control, when applications are directed to the harborage areas around the base of plants.

Control of Interior Scape Insects and Mites

The best method of pest management is the installation of pest-free plants. If you are fortunate enough to be able to select plants for an indoor landscape, much time and money can be saved by using plants free of insects, mites, and diseases. Plants may later become infested accidentally, but many pests probably come with the original

Table 1. Pesticides labeled for interiorscape control of insects and related pests.

Pesticide	Remarks
allethrin / resmethrin aerosols	Labeled for whiteflies and other interiorscape pests. Greenhouse whitefly may be resistant to combination.
bendiocarb (Dycarb, Ficam) 76 % wettable powder	Labeled for indoor plant pest control on ornamentals. Labeled for aphids, hemispherical scale, mealybugs, thrips, and greenhouse whitefly. Spray to glistening, not runoff.
Boric acid dust	Labeled for centipedes.
cyfluthrin (Decathlon)	Labeled for ants, aphids, cockroaches, mealybugs, pillbugs, scales, sowbugs, thrips, fungus gnats, and whiteflies. Used at very low rates.
diazinon (Knox-Out) flowable, aerosol	General contact insecticide. Good for fungus gnats. Whiteflies and some spider mites and green peach aphid are resistant to diazinon.
dicofol (Kelthane)	A good miticide, sometimes in short supply.
dienochlor (Pentac Aquaflow) 38 % flowable	Labeled for mites (spider mite, broad mite) on indoor plants. Two applications a week apart may be necessary for good control.
disulfoton (DiSyston) granular or spike	Jobe's spikes, House Plant Systemic Insecticide.
fluvalinate (Mavrik Aquaflow)	Labeled for aphid, mites, thrips, and whiteflies.
horticultural spray oil (Sunspray 6E, Ultra Fine Oil, etc.) 98 % emulsifiable concentrate	Petroleum oils can be used as a plant shine or as an insecticide for aphid, spider mite, mealybug, scale and whitefly control. On ferns use the plant shine rate only. For scales treat two or three times a week apart. Protect floor coverings and furnishings from overspray.
imidacloprid (Merit)	Labeled for use in and around buildings and residences for aphids, mealybugs, thrips (foliar), and whiteflies.
kinoprene (Enstar II) emulsifiable concentrate	Insect growth regulator. Labeled for fungus gnat, mealybug, scales, and whitefly control.
malathion 56% emulsifiable concentrate	Labeled for indoor pest control. Good control of mealybugs, scales and non-resistant aphids, whiteflies, and thrips. Ferns are sensitive to malathion.
oxamyl 10% granular	Labeled for interiorscape use of various pests including fungus gnats.
permethrin (Astro, code 1547)	Labeled for interiorscape use on ants, aphids, fungus gnat, leafminers, mealybugs, and whiteflies.
pyrethrin I / rotenone aerosol	Labeled for indoor pest control.
pyrethrum (X-Clude) aerosol	Labeled for aphids, mites(?), thrips, whiteflies, and scales.
resmethrin 23% emulsifiable concentrate	Labeled for indoor plants; centipedes, scales, thrips, whiteflies (some greenhouse whiteflies may be resistant to resmethrin).
soap (Insecticidal, M-Pede) 50.5% emulsifiable concentrate	Insecticidal soap is very effective for aphids, earwigs, mealybugs, scales, spider mites, and whitefly control. May be harsh on the plants so use carefully.
sumithrin aerosol	Labeled for whiteflies, crawler stages of scales, and mealybugs.

plants. A complicating factor for pest management in the interiorscape is that most of the plants used for indoor landscaping have at one time passed through a greenhouse in which intensive use of insecticides and miticides was the norm. Some are infested with pests that are resistance to pesticides. Thus, pest management in interiorscapes may be more labor intensive because the selection of pesticides is limited to those which are labeled for interiorscape use and which are effective for controlling resistant pests (Table 1). When an infestation occurs, there are two approaches to plant treatment: rotation to a greenhouse or on-site treatment.

Rotation to a Greenhouse: It is sometimes helpful to return plants to a greenhouse for treatment. There are greater options in types of insecticides available for use and applications are less constrained than in an interiorscape. If a substitute planting can be arranged, the client gets immediate relief from unsightly pest damage.

On-Site Treatment: Plant size usually dictates that infested plants be treated on location with the incumbent limitations on the types of pesticides that can be used and public concerns about them. Thoroughness of application of properly labeled pesticides along with proper timing of those application are other important aspects of an integrated pest control program. Treat commercial landscape areas at night, on weekends (in office building settings), or when a minimum number of people are present. The public should not be allowed in the vicinity of treated plants until the pesticide residue on the foliage has dried completely.

Precautions for pest control in restaurants and eating areas: Spraying for insect and mites pests of ornamentals in restaurants and food handling establishments must be done with extreme care in order to avoid contamination of food and utensils. If possible, plants should be carried out into a less critical area for treatment. If it is not possible to remove plants for treatment,

then all utensils and surfaces on which food is placed should be covered during treatment. Then any area which may have become contaminated during treatment should be covered with shelf paper before replacing food or utensils. Petroleum distillates used to dissolve pesticides may permanently stain fine wood paneling. To get good control, however, pesticides must be applied thoroughly. The use of polyethylene film to protect paneling and furniture during treatment should be considered.

Interest in biological control in indoor landscapes has expanded in recent years due to restrictions placed on interior plantscape pesticide application, cost of the pesticides, poor control with pesticide products, phytotoxicity, and potential human health hazards. To be successful at managing pest problems with biological control agents requires a knowledge of the biology of the pest species, the biological control agent(s), and a great deal of time and commitment. Biological control systems do not look after themselves. However, biological control is certainly a viable alternative to insecticide driven pest control. We intend to cover biological control in interiorscapes in a following article.

The physiological condition of indoor plants is different from plants in greenhouse production. Indoor plants endure suboptimal light, water and temperatures and may have excessive soluble salts. Such plants do not translocate systemic pesticides well. Woody plants in particular seem to translocate systemic pesticides poorly. Quick knockdown may depend on spraying.

General precautions for interiorscape pesticide use: ① Be sure plants are well irrigated before treatment to minimize plant injury from pesticide applications. ② Do not allow pesticides to pool in spider plants and other foliage plants or else injury could occur. ③ Ferns and ivies are exceptionally sensitive to pesticides; read labels carefully for known phytotoxicities. ④ Poinsettia bracts are extremely sensitive to pesticides.

1996 Southeast Greenhouse Conference and Trade Show Program

(Unless otherwise noted all activities are held at the Palmetto Expo Center, N. Pleasantburg Drive, just off I-385)

Thursday, June 13

- 8:00 - 12:00 **4th Annual Southeast Golf Tournament** - Verdae Greens Golf Club, 650 Verdae Boulevard, Greenville, S.C.
- 8:00 - 6:00 **Exhibitor Setup and Registration** - Exhibit Hall B
- 10:00 - 6:00 **Conference Registration** - 2nd Floor Lobby
- 12:00 - 4:30 **Hands On Plant Disease and Plant Pest Clinics** - Rooms 101,103,104A/B
- Plant Disease Identification - Jean Woodward, U. of Georgia
 - Insect and Plant Pest Identification - Ron Oetting, U. of Georgia
 - In-House Test Kits for Greenhouse Disease Identification - Mike Benson, North Carolina State U. & Steve Jeffers, Clemson U.
 - Update on Impatiens Necrotic Spot Virus and Tomato Spotted Wilt Virus - Jim Baker & Ron Jones, North Carolina State U.
- Each session is 52 minutes long and offered four times. Attenders should rotate among all four sessions. There will be a 20 minute break between each session to allow presenters to set up their demonstrations.*
- 4:50 - 6:00 **Conference Welcome and Opening Session** - SGCTS Executive Committee
"New and Different Stuff" - Allan Armitage, U. of Georgia
- 6:30 - 8:00 **Welcoming Reception and Get-Together** - Holiday Inn, I-385 and Roper Mountain Road
Sponsored by our exhibitors

Friday, June 14

- 7:30 - 5:00 **Registration** - 2nd Floor Lobby
- 9:00 - 5:00 **Trade Show Open** - Exhibit Hall B

Greenhouse Management Program

- 8:00 - 8:45 Southern Pansy Production - Doug Bailey, North Carolina State U.
- 8:45 - 9:45 Greenhouse Math - Plant Growth Regulator Calculations - Bill Miller, Clemson U.
- Parts per Million - Raymond Kessler, Auburn U.
- Square Foot Costing - Bill Miller, Clemson U.
- 9:45 - 10:30 Computer Software - Making it Work For You - Laura Davis, Texas Instruments
- 10:30 - 2:30 **Break -- Visit Our Trade Show**
- 2:30 - 3:30 WWWhat in the WWWorld is the WWWorldWWWideWWWeb? Dan Lineberger, Texas A&M U.
- 3:30 - 4:15 Propagation of Popular Perennials - Lula Norris, Ladyslipper Rare Plant Nursery
- 4:15 - 5:00 Forcing Perennials - Tom Weiler, Cornell U.

Greenhouse Production Program

- 8:00 - 10:30 Plug Production Update Part I:
- 8:00 - 9:10 Plug Substrates - Bill Fonteno, North Carolina State U.
 - 9:10 - 10:30 Plug Fertilization - Paul Nelson, North Carolina State U.
- 10:30 - 2:30 **Break -- Visit Our Trade Show**
- 2:30 - 5:00 Plug Production Update Part II:
- 2:30 - 3:15 Plug pH Regulation - Doug Bailey, North Carolina State U.
 - 3:15 - 4:15 Plug Height Control - Jim Barrett, U. of Florida
 - 4:15 - 5:00 Economics of Plug Finishing: Plug Size, Crop Time, and Greenhouse Area - David Edenfield, Greiling Farms.

Friday, June 14, Continued

- 7:30 - 5:00 **Registration** - 2nd Floor Lobby
- 9:00 - 5:00 **Trade Show Open** - Exhibit Hall B

Retail Marketing Program

- 8:00 - 9:00 At Your Service: Practical Advice for Honing Your Competitive Edge - Bridget Behe, Auburn U.
- 9:00 - 10:30 Garden Center Employee Training Clinic - Mary Beth Musgrove, Auburn U.
- 10:30 - 2:30 **Break -- Visit Our Trade Show**
- 2:30 - 3:30 Perfecting Labor Relations - Carol Petrone, Esquire
- 3:30 - 5:00 Extending Spring Sales - Moderator: Paul A. Thomas, U. of Georgia
Panel: Joe Stoffregen, Homewood Nursery
Sue Watkins, Bedding Manager - Tallahassee Nursery and Garden Center
Robbie Bellefontaine, Plants N' Whatnots
Louis Stacy; Stacy's Greenhouses

- 5:00 - 6:00 **Individual State Association Meetings** - Palmetto Expo Center

- 6:30 - 9:00 **Reception and Banquet** - Holiday Inn - Roper Mountain Road
Keynote: Debbie Hamrick - Ball Publishing Company
"International Floriculture, What It Means to You"
Tie and Scarf Contest to be held during the banquet: Prizes Awarded in both categories!

Saturday, June 15

- 7:30 - 5:00 **Registration** - 2nd Floor Lobby
- 9:00 - 3:00 **Trade Show Open** - Exhibit Hall B

Greenhouse Production Program A

- 8:00 - 8:30 Holiday Cactus Production - Jim Faust, U. of Tennessee
- 8:30 - 9:15 Affordable Recirculating Irrigation Systems - Tom Weiler, Cornell U.
- 9:15 - 9:45 Containerized Calla Lily Production - Jeff Kuehny, Louisiana State U.
- 9:45 - 10:30 Bract Edge Burn and Other Fun Poinsettia Problems - Allen Hammer, Purdue U.
- 10:30 - 2:30 **Break - Visit Our Trade Show**
- 2:30 - 3:15 Scheduling Poinsettias - Roy Larson, North Carolina State U.
- 3:15 - 4:00 Southern Poinsettia Height Control - Jim Barrett, U. of Florida
- 4:00 - 5:00 Poinsettias: Cultivars, Cultivars, Cultivars! Moderator: Jim Barrett, U. of Florida
Panel: Robert Milks, Van Wingerden International, Roy Larson, North Carolina State U.
David Wadsworth, Suncoast Greenhouses Allen Hammer, Purdue U.

Greenhouse Production Program B

- 8:00 - 8:45 Plant Patents and Patenting - Anne Whealy, Proprietary Rights, International
- 8:45 - 9:15 Flowering Cabbage and Kale Production - Brian Whipker, Iowa State U.
- 9:15 - 10:00 New Hanging Basket Crops - Terri Starman, U. of Tennessee
- 10:00 - 10:30 Garden Mum Economics - Brian Whipker, Iowa State U.
- 10:30 - 2:30 **Break - Visit Our Trade Show**
- 2:30 - 3:15 Product Liability: When Things Go Wrong - Paul A. Thomas, U. of Georgia
- 3:15 - 4:00 Water Quality Issues for Bedding Plants - Jeff Kuehny, Louisiana State U.
- 4:00 - 4:45 Problem Diagnosis Clinic - Jim Knauss, O.M. Scotts/Grace Sierra Company
- 4:45 - 5:15 Iron Toxicity and Other Bedding Plant Nutrient Disorders - Joe Albano, Clemson U.

Saturday, June 15, Continued

- 7:30 - 5:00 **Registration** - 2nd Floor Lobby
 9:00 - 3:00 **Trade Show Open** - Exhibit Hall B

Retail Garden Center Program

- 8:00 - 9:15 Native Plants You Should be Growing and Selling - Michael Dirr, U. of Georgia
 9:15 - 10:30 Tour of English Garden Centers: What We Can Learn From the Brits - Joe Stoffregen, Homewood Nursery
 10:30 - 2:30 **Break - Visit Our Trade Show**
 2:30 - 3:30 Marketing: Putting It All Together - Will Carlson - Michigan State U.
 3:30 - 5:00 Growing, Retailing, Landscaping: Partners for Profit - Branch Smith Publishing Company
 David Kuack, GMPRO
 Mitch Whitten, GCM&M
 Yale Youngblood, GCP&S

CONFERENCE HIGHLIGHTS

TRADE SHOW: At the 1996 Trade Show you'll find one of the largest, most exciting assemblies of suppliers exclusive to the greenhouse industry anywhere in the Southeast; all under one roof.

Featuring over 200 booths, the 1996 Trade Show provides you the opportunity to compare products, talk with industry representatives, observe equipment demonstrations, learn about the latest in greenhouse technology and network with other growers. With expanded lunch hours for the Trade Show, you won't have to skip any of the educational sessions to visit with exhibitors.

WELCOME RECEPTION: Sponsored by several of our exhibitors, this informal reception has become the official kickoff to the Southeast Greenhouse Conference. Growers find the reception an excellent opportunity to renew old acquaintances and meet growers from other areas around the Southeast. Join us at the poolside of the Holiday Inn Thursday evening for this enjoyable event.

FRIDAY NIGHT BANQUET: The SGCTS banquet held on Friday night is an opportunity to socialize with friends and enjoy an entertaining evening. Everyone is invited to participate in the tie and scarf contest held at the banquet. Prizes are to be awarded for the best and worst tie and scarf. Ms. Debbie Hamrick of Ball Publishing will be the keynote speaker, addressing International Floriculture. Tickets for this event are \$28.00.

GOLF TOURNAMENT: Held at the beautiful Verdae Greens Golf Club in Greenville, the Fourth Annual Greenhouse Conference Golf Tournament provides an opportunity for attenders and exhibitors to relax and have some fun. Beginning with a shotgun start at 8:00 AM on Thursday morning, four member teams play a Captain's choice format. Team and individual winners will be recognized and prizes awarded. Entry fee is \$50.00.

SAVE MONEY WITH EARLY REGISTRATION: The full conference registration fee includes all seminars on Thursday, Friday, and Saturday; admission to the Trade Show on Friday and Saturday; and the Welcome Reception on Thursday night.

Full conference registration is only \$89.00 if you register before 28 May 1996. After 28 May 1996, the full conference registration fee is \$109.00.

CAN'T COME BUT ONE DAY? A special one day registration is only \$69.00 for a full day of educational sessions and the Trade Show.

ONLY INTERESTED IN THE TRADE SHOW? A one day Trade Show only badge is \$15.00.

HEADQUARTERS HOTEL: The Haywood Area Holiday Inn (864-297-6300) located on Roper Mountain Road at I-385 is the Headquarters Hotel. Rooms have also been reserved at the Days Inn (864-288-6221) next door to the Holiday Inn. Special conference rates of \$64 per room at the Holiday Inn and \$55 per room at the Days Inn are offered to conference attendees. *When making your reservation, indicate that you are with the Southeast Greenhouse Conference.*

Questions??? Call the show office at 1-800-453-3070.

1996 SGCTS REGISTRATION FORM

(One per registrant-please make additional copies as needed; please complete both sides)

NAME: _____
(Last name) (First Name) (Middle Initial)

COMPANY NAME: _____

ADDRESS, P.O. Box: _____

CITY - STATE - ZIP: _____

TELEPHONE: _____ FAX: _____ E-MAIL: _____

Please indicate your business operations (check all that apply, estimating percent of total business for each operation, (i.e. Grower 70%, Retailer 30%):

- Grower ___%
- Retailer ___%
- Mass Marketer ___%
- Landscaper ___%
- Interior Plantscape ___%
- Florist ___%
- Distributor/Supplier ___%
- Manufacturer ___%
- Research/Education ___%

Please indicate your position in the business:

- Owner/CEO
- Senior Management (VP, Comptroller, etc.)
- Supervisor/Manager
- Employee
- Buyer/Purchasing Department
- Sales/Marketing
- Research/Extension
- Teacher

Please check appropriate statement:

- I have purchasing authority for my company.
- I have input and influence on purchasing decisions for my company.
- I am not involved in purchasing decisions.

Please indicate if you are a member of:

- Alabama Nurserymen's Association
- Florida Nurserymen and Growers Association
- Georgia Commercial Flower Growers Association
- N.C. Commercial Flower Growers' Association
- S.C. Greenhouse Growers' Association
- Virginia Greenhouse Growers Association

To prepare handouts indicate the sessions you plan attend. This is not binding and can be changed at the conference:

- Thursday** Disease/Insect/Virus Program Welcome Reception (evening)
- Friday AM** Greenhouse Production Program **or** Greenhouse Management Program
- Friday PM** Greenhouse Production Program **or** Greenhouse Management Program
- Saturday AM** Greenhouse Grower Program #1 **or** Greenhouse Grower Program #2 **or** Retail/Marketing Program
- Saturday PM** Greenhouse Grower Program #1 **or** Greenhouse Grower Program #2 **or** Retail/Marketing Program (p.m.)

(OVER)

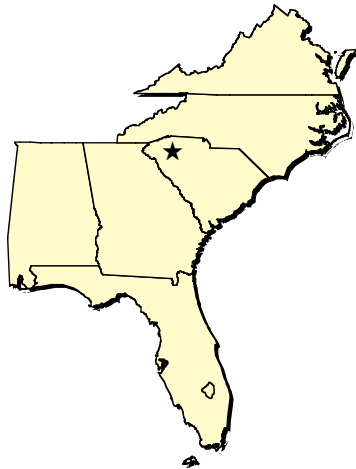
REGISTRATION FORM, Continued

- _____ Full Conference Registration @ \$ 89.00/person- before 5/28 _____
(Includes educational program on Thursday, Friday and Saturday,
Welcome Reception Thursday and Trade Show admission)
- _____ Full Conference Registration @ \$109.00/person - after 5/28 _____
- _____ One day registration for _____ @ \$ 69.00/person _____
(Includes educational sessions and Trade Show admission for that day)
- _____ One day Trade Show only pass _____
for _____ @ \$ 15.00/person _____
- _____ Banquet ticket - Friday evening @ \$ 28.00/person _____
- _____ Golf Tournament Entry @ \$50.00/player _____
Golf Handicap _____

TOTAL DUE _____

MAKE CHECKS PAYABLE TO : SGCTS

MAIL TO: Southeast Greenhouse Conference and Trade Show
P.O. Box 2945
LaGrange, GA 30241
1-800-453-3070



SOUTHEAST GREENHOUSE CONFERENCE AND TRADE SHOW

*Greenville, South Carolina
June 13-15, 1996*

*Six States Strong
and Growing!!!*

AMON BAUCOM

1927-1996

Amon Baucom, 69, founder of Baucom's Nursery Corporation, died in mid-March after a brief bout with cancer.

Amon was a very ambitious nurseryman-flower grower, and he was not at all hesitant to express the desire to be one of the very largest growers in the country. He succeeded in this goal, as by 1988 Baucom's Nursery ranked 56th in the list of Top 100 Growers listed by Greenhouse Grower magazine. He also had the strong desire to make plants available to people at all economic levels, and he succeeded in that goal as well. Plants from Baucom's could be purchased in mass market outlets throughout the Southeast, at very reasonable prices. In 1993 over 85% of their plants were sold to mass market outlets.

Amon started the operation in 1952. It originally was a grading and earth moving company, and then it expanded to landscaping and a retail nursery. By the early 1960s there were seven Baucom garden centers in the Charlotte area, primarily selling nursery stock. Then Amon got serious about the floral industry, built 100,000 square feet of greenhouse space, and began selling bedding plants and potted plants to the mass market outlets. Eventually Amon closed all his garden centers, with the last one closing down in 1986, and concentrated instead on selling to other merchandisers. His attitude on constantly moving ahead didn't change, however, and in 1988 he started another production facility in Mount Dora, Florida. Baucom's Nursery was one of the first to use huge quantities of pine bark in their container production (they were using 250 tractor-trailer loads annually) and they wanted to have a consistent medium from one crop to another, from one season to another, so they started up their own media formulating operation five miles

away from the operation in Charlotte. Now they not only provide for their own needs but they sell about 1,000 truckloads of their composted media annually.

While many nurserymen and flower growers continue to inconspicuously ship their products in tractor-trailers unadorned with any type of recognition the Baucom trucks act as moving billboards going up and down the interstates and other highways in the South. Motorists can read where the Baucom operations are located, what plants they grow and sell, and how many they grow and sell each year. Amon was way ahead of the American Floral Marketing Council and shippers of floral products with his advertising campaigns on wheels.

Amon, though the original "mover and shaker", has not been alone in the leadership of the company. His son, Gary, has been very active as a leader in the organization, as well as in the North Carolina Commercial Flower Growers' Association. Amon's official title was chairman of the board, Gary is president, and Amon, Jr. (Chip) is executive vice-president. The sales manager and vice president is Wes Livingston, a son-in-law of Amon, Sr. The company also employs over 300 people on a regular basis, and will have as many as 400 people at peak periods of production and handling.

Amon is survived by his wife, Imogene, his sons Gary and Chip, daughters Angela Livingston and Carol Holden, and 13 grandchildren. The membership of the North Carolina Commercial Flower Growers' Association extends its deepest sympathies to the family. Amon's positive belief in the future of the flower industry, and his ability to "think big", were a stimulant to all of us who knew him well.

(Some of the data used in this obituary were obtained from Greenhouse Grower articles written in 1988 and 1993).

NCCFGA NEWS

Jerry Whitley, President

Spring. Where are you? Cool, or cold raining dark days appear to have settled over our market areas and will not break it seems. The entire eastern half of the U.S. has been affected by very slow or no sales in most areas. However, the sun has appeared two days in a row and it is time for sunlight and warm days to cure the cabin fever and boost spirits that stimulate spring planting. Have a great spring season to all!

The Roy A. Larson appreciation and scholarship banquet was held as planned February 17. The event raised over \$2,300 that will go into the scholarship fund at N.C. State. Dr. Larson enjoyed the roasting and the tributes given. The past contributions on his part and his continuing participation with the poinsettia trials and other programs are greatly appreciated. He has been a great asset to our industry, and this Association cannot put it in better words than "Thank You Dr.

Larson." If you have not made a contribution to the Roy A. Larson Scholarship, please consider giving. We are still below our targeted goal of \$100,000 for the scholarship endowment. Call Bonnie Holloman at 919-779-4618 for information on how to make donations. NCCFGA is investing in the future of our industry with this project, and we desperately need your help and support.

The fourth annual Southeast Greenhouse Conference and Trade Show is set (see, read, fill out, and return the enclosed registration form!) for 13-15 June 1996. Advance booth (trade show) registration is tremendous. This show is growing in both booths and attendance. Make sure you register in advance to insure rooms and to take advantage of the reduced preregistration pricing.

The N.C. State Bedding Plant Field Day will be held on 31 July 1996. This year our

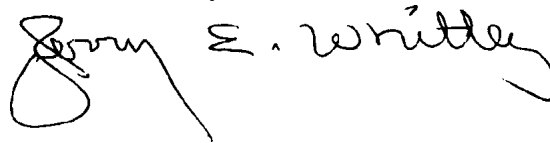
Association's annual business meeting will be held during the Field Day. This is a very important business meeting as we will be voting on new members for the Board of Directors. If you wish to nominate someone to the Board (or are willing to serve in that capacity yourself), call your nomination in to Bonnie at the association office; or you may present it from the floor at this meeting. Bedding Plant Field Day is the best attended event for our Association in North Carolina. Please come participate and see how the different varieties of annuals perform in the landscape.



Roy Larson receives a plaque of appreciation, honorary lifetime membership in NCCFGA, and a keepsake booklet from NCCFGA president Jerry Whitley.

On a sadder note, Amon Baucom, the founder of Baucom's Nursery recently passed away. Our regrets are extended to his family and friends. He was truly a leader in our industry and his presence will be greatly missed by all who knew him.

Sincerely,



CALENDAR OF EVENTS

Event	Date	Time	Location and contacts
NCSU Turf and Ornamental Field Day	Wednesday 15 May	9:00 am to 3:00 pm	Horticulture Field Laboratory, Raleigh, N.C. Contact Kim Powell at 919-515-1197 for more information
Southeast Greenhouse Conference and Trade Show	Thursday–Saturday 13–15 June		Palmetto Expo Center, Greenville, S.C. For more information, contact Charles Hall at 1-800-453-3070
NCCFGA Board Meeting	Friday 14 June	5:00 pm to 6:00 pm	Palmetto Expo Center, Greenville, S.C. For more information, contact Bonnie Holloman at 919-779-4618
Ohio International Floral Short Course	Saturday–Wednesday 13–17 July		Cincinnati Convention Center, Cincinnati, Ohio. Contact OFA at 614-487-1117 for more information
NCSU Bedding Plant Field Day	Wednesday 31 July	9:00 am to 4:30 pm	Horticulture Field Laboratory and McKimmon Center, Raleigh, N.C. For more information, contact Doug Bailey
NCCFGA General Membership Meeting	Wednesday 31 July	1:00 pm to 1:30 pm	McKimmon Center, Raleigh, N.C. Contact Bonnie Holloman for more information
NCCFGA Board Meeting	TBA mid-October		TBA. Contact Bonnie Holloman for more information
NCSU Poinsettia Open House	Thursday 5 December	9:00 am to 3:00 pm	Horticulture Field Laboratory, Raleigh, N.C. Contact Roy Larson at 919-515-3133 for more details
NCCFGA Board Meeting	TBA January, 1997		TBA. Contact Bonnie Holloman for more information



**NORTH CAROLINA
COMMERCIAL FLOWER GROWERS' ASSOC.**

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In This Issue:

Testing Procedures for Bedding Plants	1
April Proclaimed Floriculture Month	11
Interiorscape Insect and Mite Management	12
1996 Southeast Greenhouse Conference and Trade Show Program.	16
1996 SGCTS Registration Form	19
Amon Baucom 1927-1996.....	21
NCCFGA News	22
Calendar of Events.	23