For further information, I suggest that you read Dr. George McVey's article (2) published in the 1977 IPPS Proceedings (Volume 27) and the article (1), *Nutrition And Its Role In Plant Production*, by Dr. Ernest L. Bergman in the October 1, 1978, issue of "American Nurseryman." There are also numerous articles on the same subject that have been published in the Proceedings of the last few Southern Nurseryman's Association Research Conferences.

LITERATURE CITED

1. Bergman, Ernest L. 1978. Nutrition and its role in plant production. *American Nurseryman*. 148, No. 7 and 8.
2. McVey, George R. 1977. How soil chemistry can work for you. *Proc. Inter. Plant. Prop. Soc.* 27:277-284.

METHODS OF FERTILIZING CONTAINERS AT GREENLEAF NURSERY

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The nursery industry is continually faced with maintaining a balanced fertilization program for optimum plant growth and low production costs. The nurseryman must compare the maximum beneficial effects of fertilizers with the cost of application of the fertilizer. After making this comparison then one can consider which method of application is most suited for a particular operation. Let us consider the options for applying fertilizers to container-grown stock: 1) balanced fertilizer added to the soil medium prior to the canning of stock; 2) granular or slow-release bulk fertilizer applied as top-dressing; 3) liquid-feed (fertigation), generally provided to the plant material at continuous levels. All of these methods have their distinct advantages and disadvantages. However, the nurseryman must decide which mode of application or combination of applications is best suited for the individual operation.

Greenleaf Nursery has adopted a modified combination of top-dress application and a liquid-feed program. The programs are modified in the sense that neither one singly provides adequate nutrition for optimum plant growth, but in combination both provide a balanced and productive fertilizer program at minimal costs.

Top-dress application. As a rule of thumb, 2 to 3 weeks after canning, or once the liner has established itself after transplanting, we top-dress a new crop with fertilizer. With our

spring one gallon crop we top-dress with Osmocote 19-6-12 (3 to 4 month formulation) at ⅓ ounce per 1 gallon container. This provides the basis of our fertilization program. Overfertilization is extremely dangerous at this stage of growth because of the sensitive root system of young liners; therefore, a slow-release fertilizer seems to be best suited for this application. This task of hand application is accomplished with specially prepared spoons. We have fabricated several fertilizer spoons according to the amount of fertilizer to apply to a container. With our spring 1 gallon crop, spoons were designed that held exactly ⅓ ounce of Osmocote. A small diameter of the cylindrical shape eliminates any possibility of a heaping effect. There is now a commercially-produced fertilizer spoon (O.M. Scott Program spoon) on the market for container application.

Generally, two employees working an eight hour day can hand-feed 30,000 to 36,000 1 gallon containers using the spoon method. However, this past year, we introduced two commercially-produced drop-tube fertilizer applicators (O.M. Scott) into our top-dress program. Two employees now can top-dress approximately 55,000 to 60,000 1 gallon containers per day with suitable accuracy. The drop-tube applicator can be adjusted to dispense various amounts of fertilizer depending on the container size. Besides increasing the number of cans per day that we can now top-dress, we can get more uniform distribution of material from container to container by using either the spoons or the drop-tube applicator. We like to have the fertilizer spread evenly in the containers, but after the 20,000th can it may be placed in a pile. There is some question as to how significant this is, but we prefer to have it spread evenly.

Following our fall planting of 1, 2 and 5 gallon containers we top-dress with Osmocote 18-6-12 (8 to 9 month formulation). One gallons are fed with ⅓ ounce per can; 2 gallons with ⅓ ounce per can and 5 gallons with 1½ ounces per can. Our top-dress fertilizer program then is complimented by our liquid-feed program to produce optimum growth of plant materials.

Liquid feeding. The actual items of equipment involved for fertigation are two storage tanks, one or two nurse tanks, a Silas Jones injector tank or two Milton Roy diaphragm injector pumps for each block.

The process begins by filling the nurse tanks from the storage tank(s). In our liquid-feed operation we use a 32 percent Uran solution supplemented with a 10-34-0 blend. However, soil analysis determines the frequency of application of the two formulations. The 500 gallon nurse tank is transported to the block injectors and filled with the proper amount of solution. The rate is usually figured as 1.66 pounds actual nitrogen per

sprinkler head. Approximately 1.5 pounds actual phosphorus per sprinkler head is used.

The 40 gallon injector tanks are installed in such a fashion that the fertilizer solution will siphon directly into the 4 inch aluminum irrigation line. This action is accomplished through a ¾ inch inlet line directly to the tank from the 8 inch main irrigation line immediately *preceeding* the 4 inch brass gate valve to the block irrigation. A ¾ inch outlet line is attached on the tank to the 4 inch aluminum irrigation line *after* the valve. Once the tank is completely filled, primed, and pressurized with the water system pressure, the fertilizer will siphon into the irrigation line with the raw water. This expulsion process requires about 30 to 40 minutes of watering. Initially we have a concentration of 1500 ppm, but after the required time lapse our fertilizer concentration is only 5-10 ppm. At this point, the injector tank valves are closed so no fertilizer will be siphoned and the block is watered an additional 15-20 minutes with raw water to rinse off any high concentration of fertilizer.

This system has performed extremely well in years of usage. Fortunately, there appears to be an even distribution of fertilizer throughout the 615 feet of irrigation line because no irregular growth has occurred with the plants. Likewise, there have been no ill-effects observed with the high initial concentration of fertilizer *provided* the precautionary rinse procedure is maintained.

Also, at the Texas Division of Greenleaf Nursery, we have installed two Milton Roy diaphragm injector pumps at the irrigation well. Each pump has a 2 inch *suction* line directly from the 4250 gallon storage tank. The pumps inject the concentrated fertilizer directly into our 8 inch main irrigation line. One pump provides 32-0-0 and the other injects 10-34-0. The injector routes a constant and pre-determined amount of fertilizer into the entire irrigation system. The process obviously eliminates filling and refilling the block injectors. This system can provide a constant fertilization program; however, we choose not to use it as such, yet. The sole disadvantage to this system is that all of the blocks watered during a particular time period (in this case 5 blocks) must be fertilized. With the Silas Jonas block injectors, as few as 1 block or as many as 5 blocks can be fertilized during the watering time period. We believe this problem can be solved by a minor adjustment in our standard operating procedure. The major advantage again is the elimination of added labor to fertilize with the block injectors. With the Milton Roy injectors a precautionary rinse is not necessary immediately after liquid feeding. Also, with this fertilizer system we have a more accurate control of nutrient levels for optimum plant growth.

The obvious advantage of our liquid-feed system is that we can inject any water soluble nutrient into the irrigation system. Any minor elements in the chelate form are easily dispensed through irrigation, thus creating a considerable cost savings when compared to hand-feeding or spraying. However, water must be applied to release the fertilizer. In the spring and fall months, the climatic rainfall does not necessarily facilitate this process. In South Texas a nurseryman using fertigation solely is faced with the problem of underfertilizing or overwatering the crop. Obviously this fertilizer system is best suited in areas where rainfall is minimal, such as the U.S. West Coast. There it is a common practice to constant-feed nursery stock. With our combination of fertilization methods, the top-dress method forms the basis for maintaining nutrient levels during rainy seasons while our liquid-feed "tops out" the total fertilizer program for optimum plant growth. With any fertilizer program a constant check must be maintained for proper nutrient levels. This is especially true with the liquid fertilization method.

Soil analysis is an equally important part of our fertilization program. Through weekly analysis of soil samples using the Simplex Soil Testing procedure, we can obtain the accurate data required for maintaining nutrient levels. Our analysis of soil samples not only determines the frequency of fertilizer application but also the proper blend of fertilizer to use. Generally with one initial top-dress application of fertilizer we need only to maintain optimum nutrient levels with liquid blends applied through the irrigation system.

Without periodic soil analysis, any fertilizer program can end in one of three adverse results: (1) Insufficient fertilizer application for optimum growth; (2) more fertilizer than required for optimum growth; (3) overfertilization resulting in death of a particular crop.

With these three possibilities in mind one can easily see that soil analysis is important. It is the essential element for making any fertilizer program effective and productive, regardless of the method of application.

In summary, Greenleaf Nursery has not relied on any single method of fertilization, but instead, we have utilized the combination of two fertilizer application methods, top-dressing and liquid-feeding. In our operation neither method is solely effective; but when both are combined and accurate and frequent soil analyses are made, optimum plant growth can and will be obtained.

QUESTION PERIOD FOLLOWING FERTILIZING FORUM

BOB LOGNER. Can any of you suggest a method of fertilizing that would be suitable for a small nursery? How is it possible to avoid the cost of a large injector system?

ED BROWN: A good method would be to use 25 pounds of Nutri-leaf and a fungicide applied with a 500 gallon spray tank.

BRYSON JAMES: Some of the greenhouse equipment, such as a Gewa injector, is suitable for a small nursery. I would like to point out that at the rate Ed suggested, we are applying the equivalent of 7500 pounds total fertilizer per acre. This is a very high level of nitrogen for the amount of water. If we are losing much in run-off, we may face problems with EPA.

SIDNEY MEADOWS: Question for Curtis Wilkins: Did I understand you to say that you used N and P but not K_2O

CURTIS WILKINS: Yes, we have found K_2O to be most economical at $135 per ton. It is water soluble and easy to dispense; therefore, we buy it separately.

ROBERT WRIGHT: Question for Curtis Wilkins: Could you give the specifics on when to fertilize?

CURTIS WILKINS: We use the solubridge but rely more on soil testing by the Simplex method, texture, and various other factors. We try to maintain plant material levels in the 35 to 50 ppm range for N, 5 to 7 ppm for P and 10 to 15 ppm for K.

RICHARD VAN LANDINGHAM: Question for Curtis Wilkins: Did I understand you to say that you did not use any fertilizer in your soil mix?

CURTIS WILKINS: At one time we were adding fertilizer to our soil mix prior to canning. Then the question of leaching came up. We are now canning directly out in the field. We are not using a potting machine or anything like that. In order to use bare root liners, the mix in the can has to be wet. This takes about 3 to 4 days of watering, and again the question of leaching arose. Therefore, we now have really eliminated any fertilizer in the soil.

RICHARD VAN LANDINGHAM: What about pH control?

CURTIS WILKINS: We have really had no problem with pH. We try and let the plants tell us when adjustment is needed. Pine bark seems to take care of it.

RICHARD VAN LANDINGHAM: What is the pH of your water?

CURTIS WILKINS: Raw water is about 7.2, but we have had problems with bicarbonate. Usually bicarbonate runs about 300

ppm, so we have to inject sulfuric acid. Once we do, the pH drops to about 6.2.

DICK AMMON: Question for Curtis Wilkins: Do you have any problem getting your phosphates through your mix?

CURTIS WILKINS: No.

BOB KNECHT: Question for Tom Dodd. How do you avoid leaching minor elements from the pot?

CURTIS WILKINS: With the injector system, everytime they are fed, which is daily during the summer, they are getting minor elements. Out in the fields we use the fritted trace element mix. In addition we may use foliar trace element mix.

COMMERCIAL TISSUE CULTURING AT OGLESBY NURSERY

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Ornamental plant tissue culture successes in California have stimulated Florida growers' interest. Because of refinements in laboratory technique and the availability of commercially produced and packaged tissue culture media, tissue culturing commercially has become practical and profitable. This report will describe steps in rapid propagation of certain ornamental plants, including *Ficus elastica* 'Decora Burgandy.' Methods, technique, conditions and duration are described in detail from the initial shoot tip explant to outdoor planting and growing in 6-inch containers.

The tissue culture lab at Oglesby Nursery is just into its fourth year. Our present facility occupies 2,000 square feet and has a capacity of over 60,000 culture tubes, or a production level of over four million plants per year. We employ 13 people. High school students are used to wash the glassware. The development of the lab has been a tremendous expense; its operation is also expensive. Its function is to utilize *in vitro* culture procedures to these ends: (1) mass produce several desired cultivars for Oglesby Nursery, (2) provide tissue culture service for other nurseries, (3) produce retail consumer products *in vitro* and, (4) establish plant stocks that can be certified for freedom from certain pathogens and pests.

The starting tissue (explant): A shoot tip is cut with a pen knife from the parent plant. The outermost tissue, including all leaves, is removed. After a 10 mm by 20 mm piece of tissue is