CUT FLOWER NUTRITION

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I. PRE-PLANT FERTILIZATION

A. Phosphorus and Sulfur

Greenhouse fertilization can be complicated by the large number of nutrient elements involved. Fortunately this situation can be simplified by providing 10 of the 12 fertilizer derived nutrients prior to planting the crop. Then, only nitrogen (N) and potassium (K) remain to be applied in a continuous program.

A relatively inexpensive source of phosphorus (P) is regular superphosphate (0-20-0), also known as single or 20% superphosphate. When applied at the rate of 5 lbs per 100 sq ft of plant bed (244 g/m^2) it can provide sufficient P to meet crop needs for one year or longer. Single superphosphate is a desirable source of P because it contains about half gypsum (calcium sulfate) by weight. This will generally meet crop requirements for sulfur (S) for a year or more. Thus, an annual application of 5 lbs of 20% superphosphate per 100 sq ft should meet cut flower requirements for P and S without any interim sources. Prior to each annual application a soil test should be taken to confirm the need for P and a leaf analysis should be conducted to confirm the need for S as well as P.

Triple superphosphate, also known as treble superphosphate, contains about 44 to 46% P_2O_5. It is a good source of P and also will provide sufficient P for one year if applied once at the rate of 35 oz per 100 sq ft of plant bed (106 g/m^2). Triple superphosphate is not a source of S since it does not contain gypsum. If 45 oz of gypsum, also known as land plaster, is applied along with 35 oz of 46% superphosphate (138 g/m^2) then the equivalent to 5 lbs of 20% superphosphate will be applied.

B. Calcium and Magnesium

Many greenhouse soils are acid. These should be limed with dolomitic limestone to a pH level of 6.2 to 6.8. Dolomitic limestone is preferred over calcitic limestone because the former contains both calcium (Ca) carbonate and magnesium (Mg) carbonate whereas the latter contains mainly Ca carbonate. Generally, as long as the soil pH level is maintained at or above 6.2 with dolomitic limestone, crop requirements for Ca and Mg will be met. Prior to the removal of each crop a soil test should be conducted to determine the need for dolomitic limestone. It is best applied by rototilling into the soil.

C. Micronutrients

Micronutrients, or trace elements, are also easily applied in a single application near the time of planting. Commercial mixtures are

available of 6 essential micronutrients including: iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), boron (B), and molybdenum (Mo). Fritted trace element mixtures available as FTE 555, FTE 503, and FTE 503PS are slowly soluble powders which should be rototilled into the soil prior to planting. These are products in which micronutrient salts have been dissolved in melted glass. The mixture is solidified on cooling and is then dried and ground. The glass is soft and dissolves over a period of about 10 months in the soil. During dissolution micronutrients are released for plant uptake. The more recent fritted product for greenhouse use is FTE 555. It is used at the rate of 3 oz per 100 sq ft of plant bed (9.2 g/m^2).

An alternative to the solid pre-plant mixture of micronutrients is a Robert B. Peters Div. of W. R. Grace & Co. product known as STEM (Soluble Trace Element Mix). It comes in a water soluble powder form. STEM is dissolved in water and applied to the plant bed in a volume equivalent to that used in a normal watering. It should be applied at the rate of 2 oz STEM per 100 sq ft of plant bed (6.1 g/m^2). STEM is applied after the crop is planted, generally, immediately after. The longevity of this product is difficult to predict, however, four months and longer is not uncommon. Leaf analysis should be used to determine subsequent applications.

If the three preceeding fertilizer materials (single superphosphate, dolomitic limestone, and a micronutrient mixture) are used prior to or at planting time, then 10 of the 12 essential nutrients which must be applied through a fertilization program will be taken care of. Only N and K will remain to be applied in a continuous maintenance program.

II. MAINTENANCE FERTILIZATION

A. Macronutrients

Roses are generally fertilized with a 1:1 ratio of N to K_2O. P is generally not necessary for the first year or so if it has been incorporated into the soil as superphosphate prior to planting. Soil or leaf analysis tests will indicate when it is necessary to begin applying P in the regular liquid fertilizer program.

The rose plant has a light to moderate nutrient requirement. Rates of application and four suggested fertilizer formulations are listed in Table 1. The first three formulations permit one to formulate their own fertilizer from such elementary carriers as potassium nitrate, ammonium nitrate, calcium nitrate, and phosphoric acid. There is a considerable savings in cost when this is done, particularly for a large greenhouse firm where the set up time is relatively small. The first two formulations provide N and K only while the latter two also include P. In the first formulation N is provided as nitrate only. This is a good winter formulation. The second formulation incorporates urea. Urea is a N source which promotes rapid, relatively soft growth in roses. It is a good source during heavy growth periods, particularly spring, or any time that growth is slow and hard.

Table 1. Recommended rates of application of N, K_2O, and P_2O_5 for constant (with each watering) and weekly application to roses and various formulations for achieving these rates.

	Constant		Weekly	
N (ppm)	170		400	
K_2O (ppm)	170		400	
P_2O_5 (ppm)	170		400	
	oz/100 gal	(g/l)	oz/100 gal	(g/l)
potassium nitrate	5.2	(.39)	12.2	(.92)
ammonium nitrate	1.2	(.09)	2.8	(.21)
calcium nitrate	7.5	(.56)	17.7	(1.32)
potassium nitrate	5.2	(.39)	12.2	(.92)
urea	3.6	(.27)	8.4	(.63)
potassium nitrate	5.2	(.39)	12.2	(.92)
ammonium nitrate	4.9	(.36)	11.4	(.85)
phosphoric acid	3.7	(.28)	8.7	(.66)
20-20-20	11.4	(.85)	26.7	(2.00)

Two programs of frequency are most common for cut flower producers. The constant program calls for the application of fertilizer in every watering. For this program 170 ppm (parts per million) each of N and K_2O is recommended. This figure can be as low as 140 ppm where the soil is well drained and watered frequently or as high as 200 ppm in other situations. The second program calls for fertilizer application at intervals of about one week. In the winter this is often lengthened to every other watering. A higher rate of 400 ppm N and K_2O is applied. The 1:1 ratio of N to K_2O provides a base line. With time soil or leaf tests will indicate the need to change this ratio temporarily.

The carnation plant has a moderate fertilizer requirement. K is favored over N for this crop. A good complete fertilizer formulation is 20-5-30. Rates of application and suggested formulations are presented in Table 2. The first two formulations include N and K only while the third includes P.

The chrysanthemum plant has a heavy fertilizer requirement. For the most part a 1N:1K_2O ratio is favored. Suggested rates of application are 250 ppm N and K_2O for constant application and 600 ppm for weekly application (Table 3). Four formulations are also presented in Table 3.

Table 2. Recommended rates of application of N, K_2O, and P_2O_5 for constant (with each watering) and weekly application to carnations and various formulations for achieving these rates.

	Constant		Weekly	
N (ppm)	175		420	
K_2O (ppm)	225		540	
P_2O_5 (ppm)	200		480	
	oz/100 gal	(g/l)	oz/100 gal	(g/l)
potassium nitrate	6.8	(.51)	16.4	(1.22)
calcium nitrate	9.0	(.68)	21.7	(1.63)
potassium nitrate	6.8	(.51)	16.4	(1.22)
ammonium nitrate	4.4	(.33)	10.6	(.79)
potassium nitrate	6.8	(.51)	16.4	(1.22)
ammonium nitrate	1.2	(.09)	2.9	(.21)
diammonium phosphate	5.0	(.38)	12.1	(.91)

Table 3. Recommended rates of application of N, K_2O, and P_2O_5 for constant (with each watering) and weekly application to chrysanthemums and various formulations for achieving these rates.

	Constant		Weekly	
N (ppm)	250		600	
K_2O (ppm)	250		600	
P_2O_5 (ppm)	250		600	
	oz/100 gal	(g/l)	oz/100 gal	(g/l)
potassium nitrate	7.6	(.57)	18.2	(1.37)
calcium nitrate	14.6	(1.10)	35.1	(2.64)
potassium nitrate	7.6	(.57)	18.2	(1.37)
ammonium nitrate	7.1	(.53)	17.1	(1.27)
potassium nitrate	7.6	(.57)	18.2	(1.37)
ammonium nitrate	3.1	(.23)	7.5	(.56)
diammonium phosphate	6.3	(.47)	15.1	(1.13)
20-20-20	16.7	(1.25)	40.1	(3.00)

B. Micronutrients

If micronutrients have not been applied prior to or at planting time then it will be necessary to apply them during crop culture. Even if they have been applied prior to a long term crop, after about one year it will be necessary to make an additional application.

Four commercial sources of micronutrients and their contents are listed in Table 4. FTE 555 is used as a pre-plant amendment. STEM may be applied as a single liquid amendment or may be applied with every fertilization at the rate of 8 oz per 100 lbs of macronutrient fertilizer used. Peters 20-20-20 fertilizer as well as their other complete fertilizers and the Plant-Prod line of complete fertilizers contain the six essential micronutrients listed earlier. Again, this is a system for metering out micronutrients with every fertilization. Peters Compound 111 when used at the rate of 2.5 lbs per 100 lbs of macronutrient fertilizer will provide a dye and micronutrients roughly equal to the quantities obtained from the aforementioned 20-20-20 fertilizer. It is applied with every fertilization. This product is used by some growers who formulate their own macronutrient fertilizer.

Table 4. The nutrient content (%) of various complete micronutrient products.

	FTE 555[a]	STEM[b]	Compound 111[b]	20-20-20[b]
Fe	18.0	7.50	1.50	0.05
Mn	7.5	8.15	0.12	0.003046
Zn	7.0	4.50	0.0754	0.002468
Cu	3.0	3.20	0.1136	0.003587
B	1.5	1.45	0.2324	0.006711
Mo	0.2	0.046	0.1076	0.004023

[a]Frit Industries, Inc.
[b]Robert B. Peters Div., W. R. Grace & Co.

Only one micronutrient program should be used. Where short term crops such as chrysanthemums are grown, the pre-plant FTE 555 product or a single application of STEM can be used. If not, a continuous application of micronutrients with each fertilization should be considered. The same alternatives exist for a long term crop such as roses. However, a pre-plant application will eventually run out necessitating subsequent applications. Leaf analyses should be run periodically to assess micronutrient status and to aid in application decisions.

All of the products listed in Table 4 work well. However, differences in their content render some more effective under specific problem situations. FTE 555 has a little more than twice as much Fe as Mn while STEM has close to equal amounts. If one is growing in soils containing clay high in Mn then it would be wiser to use FTE 555. On the other hand, soils low in Mn would dictate the use of STEM.

The quantity of micronutrients applied to 100 ft^2 of cut flower bed in one year from each of the products discussed is listed in Table 5. It is apparent that STEM is proportionately lower in Fe

Table 5. Total quantity (g) of each micronutrient applied to 100 ft^2 of cut flower bed in one year.

	Fe	Mn	Zn	Cu	B	Mo
FTE 555	15.3	6.4	6.0	2.6	1.30	0.17
STEM (once)	4.3	4.6	2.6	1.8	0.82	0.03
STEM (const)[a]	8.8	9.6	5.3	3.8	1.70	0.05
COMPOUND 111[a]	8.8	0.71	0.45	0.67	1.37	0.64
20-20-20[a]	11.8	0.72	0.58	0.85	1.58	0.95

[a]applied weekly with 2 lbs 20-20-20/100 gal.

and Mo than is FTE 555. STEM, on the other hand, is proportionately higher in Mn, Zn and Cu but lower in Mo than are Compound 111 and 20-20-20. These differences aid in handling specific nutritional problems. The poinsettia plant is very prone to Mo deficiency. STEM alone would not be the best choice for this crop.