UNIVERSITY OF FLORIDA

Cooperative Extension Service
Institute of Food and Agricultural Sciences

SP 215

Pepper Production Guide for Florida: Fertilization[1]

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Prior to each cropping season, soil tests should be conducted to determine fertilizer needs. Obtain an IFAS soil sample kit from the local Agricultural Extension Office for this purpose. Commercial soil- testing laboratories also are available. Soil testing labs chosen should only be those that employ procedures calibrated for Florida soils and can provide accurate recommendations. Routine soil-testing will help reduce overfertilization, which lowers farming efficiency and increases the risk of goundwater pollution.

The crop nutrient requirements of nitrogen (N), phosphorus (P), and potassium (K) (designated in fertilizers as N-P_2O_5-K_2O) in Table 1 represent the optimum amounts of these nutrients needed for maximum production. A portion of this required nutrition will be supplied by the native soil and by previous crop residue. The remainder of the nutrient requirements will be supplied by fertilizer, and this amount must be determined by soil testing. Therefore, nutrient amounts in these tables are applied as fertilizer **only** to soils testing very low in the specific plant nutrients. Automatic use of the amounts of nutrients in the tables without a soil test will possibly result in wasted fertilizer, crop damage, reduced yields and quality, and a risk to the environment.

Table 1. Fertility recommendations for mulched bell or specialty peppers grown on irrigated soils testing low in phosphorus and potassium.

	Nutrient requirements			Supplemental applic.			
	lb/acre			lb/acre			
Soil	N	P_2O_5	K_2O	N	P_2O_5	K_2O	Number
Organic	0	200	200	0	0	0	0
Marl and Rockland	150	150	150	30	0	20	0-2
Sand	175	160	160	30	0	20	0-2

1. This document is a chapter of SP 215, last printed in 1990 as Circular 102 E. SP 215, Pepper Production Guide for Florida, last printed in 1990 as Circular 102 E, is a publication of the Commercial Vegetable Guide Series, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Publication date: August 1997. For more information about how to order the complete print document, SP 215, call UF/IFAS Distribution at (352) 392-1764. Please visit the FAIRS Website at **http://hammock.ifas.ufl.edu**

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Growers should resist the urge to overfertilize because excessive fertilizer can have negative effects on fruit earliness, yield, or quality. For example, excessive N leads to vigorous plants that grow vegetatively at the expense of early fruit set and total yields. High nitrogen also increases the severity of blossom-end rot and reduces fruit firmness by reducing wall thickness.

Excessive K can increase the soil soluble salt level, damaging young transplants and reducing plant stands or early transplant vigor. High K also has been shown to increase shriveling of harvested pepper, thus reducing shelf life of fruits.

Growers often apply P even on soils that test high in P. If the soil test for P was high, then crops do not respond to added P because a high soil test means that enough P will be made available from residual soil P. Some growers think this residual P is not available, but in fact, a very large amount of P is available from soils that have a high soil test.

Liming

The optimum pH range for peppers is between 6.0 and 6.5. It is not advisable to raise the pH higher than 6.5 because of reduced micronutrient availability.

Calcium and magnesium levels should be corrected according to the soil test. If both elements are low, broadcast and incorporate dolomitic limestone. Where calcium alone is deficient, lime with "hi-cal" limestone. Adequate calcium is important for reducing the severity of blossom-end rot. A Mehlich-1 calcium index of 300 to 350 parts per million indicates adequate soil calcium. Growers should avoid routine gypsum or lime applications on soils already high in calcium. The extra calcium is not needed by the crop and excess gypsum could raise the soil soluble salt level and excess lime increases the pH to undesirable levels. On limestone soils (marl and rockland), add 30 to 50 pounds per acre of magnesium in the basic fertilizer mix. It is best to apply lime several months prior to planting; however, if time is short, it is best to apply it any time before planting than not to apply it at all. Where the pH level does not need modification but magnesium is low, apply magnesium sulfate or potassium-magnesium sulfate with the fertilizer.

Micronutrients

Peppers growing on sandy soils require the following amounts of micronutrients (in pounds per acre): manganese–3, copper–2, iron–5, zinc–2, boron–2, and molybdenum–.02. Use a soil test to determine which elements and what rates are needed. Micronutrients may be supplied from oxides or sulfates. Growers using micronutrient-containing fungicides need to consider these sources when calculating fertilizer micronutrient needs. Do not apply unneeded micronutrients, since certain elements can build up to toxic levels in the soil.

Properly diagnosed micronutrient deficiencies can often be corrected by foliar applications of the specific nutrient. For most micronutrients, a very fine line exists between sufficiency and toxicity. Foliar application of major nutrients (nitrogen, phosphorus, or potassium) has not been shown to be beneficial where proper soil fertility is present. For more information on foliar micronutrient fertilization of peppers, consult the “Commercial Vegetable Fertilization Guide”, Circular 225D.

Fertilizer Application

Nonmulched Crops. Apply all phosphorus and micronutrients and up to one-half of the nitrogen and potassium prior to planting and incorporate by disking or rototilling. Increased fertilizer efficiency can be realized by a “modified broadcast” method where the needed fertilizer is broadvast in the bed area only, rather than over the entire field. It may be possible to reduce the total amount of fertilizer applied if using the modified approach. Incorporation will place some fertilizer near the transplant root or germinating seed. The remaining N and K fertilizer can be banded in the center of the bed between the two rows of pepper while the plants are young. Afterwards, the fertilizer can be banded on the bed shoulders and covered over. A typical approach would be to broadcast about 20% of the N and K per plant and then apply the remaining N and K in two or three applications through the early part of the season.

Several supplemental sidedress band applications of N and K may be needed after leaching rainfall. These are applied on the bed shoulders until two to four weeks before the end of the harvest period. A shallow sweep will cover the fertilizer and help correct bed erosion. Liquid fertilizer can be used for sidedressing by knifing it into the soil, using caution to avoid root damage.

Full-Bed Mulch With Subsurface (Seep) Irrigation. Under this system, the crop may be supplied with all of its soil requirements before the mulch is applied. It is difficult to correct a deficiency after the mulch application, although the liquid fertilizer injection wheel should facilitate sidedressing through the mulch. The injection wheel also will be useful for replacing fertilizer under the used mulch for double-cropping systems.

A general sequence of operations for the full-bed, seep-irrigated system is:

1) Land preparation, including development of irrigation and drainage systems and liming of the soil.

2) Application of "starter" fertilizer or "in-bed" mix, which should comprise only 10 to 15 percent of the total N and K and all of the P and micronutrients. Starter fertilizer can be broadcast over the entire bed area prior to bedding and incorporated. During bedding, the fertilizer will be gathered into the bed area.

3) Formation of beds, incorporation of herbicide, and application of mole cricket bait.

4) Application of remaining fertilizer: The remaining 85 to 90 percent of the N and K is placed in a band in grooves 2 to 3 inches deep in the center of twin-row beds or in narrow bands on the bed shoulders 9 to 10 inches away from the pepper rows. An alternative for twin-row beds is to place the fertilizer in three bands. Placing the fertilizer in the grooves allows it to be in contact with moist soil. Bed presses are modified to provide the groove. Only water-soluble nutrients sources should be used for the banded fertilizer. For example, nutrient sources such as potassium nitrate, potassium sulfate, potassium chloride, ammonium nitrate, ammonium sulfate, and calcium nitrate, among others, can be used.

5) Fumigation, pressing of beds, and mulching. This should be done in one operation, if possible. Be sure that the mulching machine seals the edges of the mulch adequately with soil to prevent fumigant escape.

There is equipment that will do most of the operations in steps four and five above in one pass over the field.

Water management with the seep irrigation system is critical to successful crops. Maintain the water level at 18 to 24 inches below bed surface. Do not fluctuate the water table since this leads to increased leaching losses of plant nutrients.

Mulched Culture with Overhead Irrigation. For sandy mineral soils, maximum production has been attained by broadcasting 100 percent of the fertilizer in a swath three to four feet wide and incorporating prior to bedding and mulching. For high fertilizer rates, a combination of broadcasting and banding should be used to prevent fertilizer burn. Incorporate 30 to 40 percent of the N and K and 100 percent of the P and micronutrients into the bed by rototilling. The remaining N and K is applied in bands six to eight inches to the sides of the seed or transplant and two to four inches deep to place it in contact with moist soil. Sometimes, on very sandy soils, not enough irrigation water enters the mulched beds through the plant holes so that perforation of the plastic might be required. Perforation of the mulch might be needed on extremely coarse sandy soils or the Rockdale soils of Dade County.

Little information is available on fertilizer placement for rockland-grown peppers. However, with other vegetables, yields have been maximized by broadcast-incorporation of fertilizers. Soluble starter fertilizers with N and P will help establish young transplants.

Mulched Production with Drip Irrigation. When drip irrigation is used, the drip tape or tubes should be laid ½ to 1 inch below the bed soil surface prior to mulching. This placement helps protect tubes from mice and insect damage, and minimizes movement of the tape on the bed surface during the season. The drip system is an excellent tool with which to fertilize the crop. Where drip irrigation is used, before planting apply all P and micronutrients, and 20 to 40 percent of the total N and K. Use the lower percentage (20 percent) on seep-irrigated crops where seepage irrigation will be used early in the season to establish the plants before irrigation is taken over by the drip system. Apply the remainder of total N and K through the drip system in increments daily or weekly as the crop develops (Table 2). Additional nutrients can be supplied through drip irrigation if deficiencies occur during the growing season.

Table 2. Injection schedules for N and K for drip-irrigated pepper.

Crop development		Injection rate (lb/acre/day)[z]	
Stage	Weeks[y]	N	K_2O
1	2	1.0	1.0
2	2	1.5	1.0
3	7	2.5	2.5
4	1	1.5	1.0
5	1	1.0	1.0

[z]Total seasonal amounts of nutrients are 175N and 160 K_2O (lb/acre), including any in-bed starter fertilizer. Extended-season applications can proceed at 1.0 to 1.5 lb N or K_2O per acre per day.

[y]Number of weeks length of a particular crop stage.

Sources of N - P_2O_5 - K_2O. Most sources of N can be used for pepper including ammonium nitrate, urea, ammonium sulfate, potassium nitrate, and calcium nitrate, among others. The use of ammoniacal-nitrogen to supply most of the N requirement should not increase the incidence of blossom-end rot over the nitrate from of nitrogen. The ammonium ion is rapidly converted to nitrate in warm soils. Blossom-end rot is more often related to excess total N or temporary water deficits than to specific N form. More information on blossom-end rot is presented in the Pest Management (Disease) Section of this guide.

Normal superphosphate and triple superphosphate are highly recommended for the P needs. Care should be exercised when using diammonium phosphate (DAP) as the phosphate source. Avoid banding large amounts of DAP-micronutrient mixtures on soils very low in native micronutrients. Research has shown that micronutrient precipitation is possible which might lead to deficiencies. In addition, P availability can be reduced when DAP is used on acidic soils before liming. To avoid any potential problems, use DAP to supply a portion of the P needs and incorporate it in the bed.

All sources of K can be used, including potassium sulfate, sodium-potassium nitrate, potassium nitrate, potassium-magnesium sulfate and potassium chloride. When soil-test predicted rates of K are used, there should be little concern about the K source or its associated salt index.

Plant Tissue Testing

Analysis of leaves for mineral element concentration can help growers guide the fertilization program. To be successful in tissue testing, growers need to know how to collect good samples, know a competent lab to do the analysis, and identify where to obtain accurate interpretation of the results.

The most detailed and accurate method of tissue analysis is to analyze dried whole leaves in a tissue testing laboratory, which can determine the concentrations of all mineral elements. Sufficiency ranges for vegetable whole-leaf analyses are presented in Table 3.

An alternative technique for testing for N and K on the farm is the use of plant sap-testing kits (Table 4). These procedures are particularly applicable to drip irrigated crops where N and K are injected through the irrigation system. Frequent petiole sap tests for N and K can help the grower make adjustments in the fertilizer injection program. More information on tissue testing can be found in Florida Cooperataive Extension Special Series SSVEC-42 “Plant Tissue Analysis and Interpretations for Vegetable Crops in Florida” and for sap testing from Florida Cooperative Extension Circular 1144, “Plant Petiole Sap-Testing Guide for Vegetable Crops”.

Table 3. Sufficiency ranges for whole-leaf tissue testing of pepper at various stages in the season.

Plant part	Time of sampling	Status	N	P	K	Ca	Mg	S	Fe	Mn	Zn	B	Cu	Mo
			Percent						parts per million					
MRM[z] leaf	Prior to blossoming	Deficient	<4.0	0.3	5.0	0.9	0.35	0.3	30	30	25	20	5	-
		Adequate range	4.0-5.0	0.3-0.5	5.0-6.0	0.9-1.5	0.35-0.6	0.3-0.6	30-150	30-100	25-80	20-50	5-10	- -
		High	>5.0	0.5	6.0	1.5	0.6	0.6	150	100	80	50	20	-
		Toxic (>)	-	-	-	-	-	-	-	-	-	350	-	-
MRM leaf	First blossoms open	Deficient	<3.0	0.30	2.5	0.9	0.30	0.3	30	30	25	20	5	-
		Adequate range	3.0-5.0	0.30-0.50	2.5-5.0	0.9-1.5	0.30-0.50	0.3-0.6	30-150	30-100	25-80	20-50	5-10	- -
		High	>5.0	0.50	5.0	1.5	0.50	0.6	150	100	80	50	10	-
		Toxic (>)	-	-	-	-	-	-	-	1000	-	350	-	-
MRM leaf	Early fruit set	Deficient	<2.9	0.25	2.5	1.0	0.3	0.3	30	30	25	20	5	-
		Adequate range	2.9-4.0	0.25-0.40	2.5-4.0	1.0-1.5	0.3-0.4	0.3-0.4	30-150	30-100	25-80	20-50	5-10	- -
		High	>4.0	0.40	4.0	1.5	0.4	0.4	150	100	80	50	10	-
		Toxic (>)	-	-	-	-	-	-	-	-	-	350	-	-
MRM leaf	Early harvest	Deficient	<2.5	0.20	2.0	1.0	0.3	0.3	30	30	25	20	5	0.1
		Adequate range	2.5-3.0	0.20-0.40	2.0-3.0	1.0-1.5	0.3-0.4	0.3-0.4	30-150	30-150	25-80	20-50	5-10	0.1-0.2
		High	>3.0	0.40	3.0	1.5	0.4	0.4	150	150	80	50	10	-
		Toxic (>)	-	-	-	-	-	-	-	-	-	350	-	-

[z] MRM= Most recently matured leaf.

Table 4. Guidelines for pepper plant leaf petiole fresh sap nitrate-N and potassium testing.

Crop development stage	Fresh petiole sap concentration (ppm)	
	NO_3-N	K
First flower buds	1400-1600	3200-3500
First open flowers	1400-1600	3000-3200
Fruits half-grown	1200-1400	3000-3200
First harvest	800-1000	2400-3000
Second harvest	500-800	2000-2400