CIR1168

UNIVERSITY OF FLORIDA

IFAS EXTENSION

Fertilization of Pepper in Florida[1]

George Hochmuth[2]

Pepper is the second most valuable vegetable crop in Florida. Bell peppers were produced on 22,000 acres in the 1993-94 season and had a value of $235 million (Freie and Pugh, 1995). In addition to the bell peppers, there might be 2000 to 3000 acres of various hot peppers and other specialty peppers such as cubanelle. Counties with the largest pepper acreage are in southern Florida and include Collier, eastern Palm Beach, Hendry, Hillsborough, Lee, and Manatee.

Production costs for pepper average $9,500 per acre with about $6,700 due to preharvest variables of which fertilizer accounts for about 5% (Smith and Taylor, 1995). Although fertilizer accounts for a relatively small portion of the total production costs, proper, judicious use of fertilizer is required for maximizing yield and quality of pepper fruits and for minimizing potential negative impacts to the environment caused by nutrient leaching or runoff. Fertilization requirements and practices for pepper have been exhaustively researched in Florida during the last 50 years. This publication presents the current pepper (bell and specialty) fertilization recommendations and pertinent research documentation behind the recommendations.

FERTILIZATION RECOMMENDATIONS

Soil pH.Peppers grow well under a wide range of soil pH from 5.5 to 7.5. Acidic soils should be limed to a pH of 6.0 to 6.5 using the recommendations of a calibrated lime requirement test, such as the Adams -Evans test used by the University of Florida. High-cal lime can be used to raise the pH, although dolomite might be preferred where Mg is also needed. Overliming can lead to reduced micronutrient availability.

N, P, K.Pepper P and K fertilization recommendations are based on the calibrated Mehlich-1 soil test results and vary according to the soil-test level of P and K (Table 1). N requirements are 175 lb per acre for the season (Hochmuth and Hanlon, 1995). Research documenting the N, P, and K recommendations is cited in the literature list at the end of this publication, especially in Circ. S-357 by Hochmuth and Hanlon (1989).

1. This document is CIR1168, one of a series of the Horticultural Sciences Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Original publication date May 1996. Reviewed May 2003. Visit the EDIS Web Site at http://edis.ifas.ufl.edu.
2. George Hochmuth, Professor, Horticultural Sciences Department, Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville FL 32611.

Magnesium, sulfur, and calcium.Magnesium (Mg) and sulfur (S) are mobile in Floridas sandy soil so do not build up to appreciable levels. The Mehlich-1 extractant is used by the University of Florida to test soils for Mg. The soil is **low** in Mg if the Mehlich-1 index is below 15 ppm, **medium** if between 15 and 30 ppm, and **high** if above 30 ppm. For soils low in Mg, growers should apply 40 lb Mg per acre from potassium-magnesium sulfate or magnesium sulfate.

The Mg requirement will be satisfied if dolomite was used as the liming source to correct soil pH.

Calibrated soil tests for sulfur do not exist for Floridas sandy soils. Usually 40 lb S per acre will satisfy the S requirement of any vegetable. The S can be supplied from several sources (Hochmuth, 1988) and is usually included in the blended fertilizer placed in the bed or could be supplied via fertigation through the season.

Calcium (Ca) is needed by all vegetables for normal growth and fruit development. Pepper is particularly sensitive to Ca shortages which lead to blossom-end rot. If the soil contains 300 ppm of Mehlich-1 Ca, then there is ample soil Ca for normal pepper production. The challenge then becomes one of ensuring that enough of that Ca is present in the plant when fruits are developing. Ca moves preferentially with the water stream in the plant so fruits usually do not receive their fair share of Ca when plants are under water stress. Factors that reduce Ca movement to the fruits and thus encourage blossom-end rot are:

- ***Water stress (drought).*** Since Ca moves with the water stream in the plant, any water stress, even temporary (one day) stress can lead to blossom-end rot. Dry soils, high soil soluble salts, windy conditions, etc., can reduce Ca movement to the fruits. Under these conditions, Ca moves mostly to the leaves and young vegetative growing areas.

- ***Excessive N and K fertilizer.*** High N encourages excessive vegetative growth and most Ca then moves to the leaves and actively growing shoot tips. High K leads to high soluble salt concentrations in the soil restricting water movement, and thus Ca movement, into the root.

- ***Damage to root system.*** Ca is absorbed by roots near the root tips. Anything (flooding, root disease, nematodes, mechanical damage, etc.) that damages the roots can inhibit Ca uptake.

Micronutrients.Micronutrients, boron (B), copper (Cu), manganese (Mn), and zinc (Zn) are needed by pepper in very small quantities and excessive amounts available to the crop can lead to toxicities. The interpretation of the Mehlich-1 micronutrient soil test is presented in Table 2. Micronutrients should be applied to the soil with the preplant fertilizer since there is the possibility of precipitation in drip irrigation tubing. Fungicides commonly used for control of pepper diseases can supply sizable quantities of some micronutrients such as Cu, Mn, and Zn. Boron can leach and, since there is no calibrated soil test for B in Florida, up to 2 lb B per acre could be applied with the preplant fertilizer where plant tissue test results have indicated potential B deficiencies. Foliar sprays of B will not be effective since B does not move out of the leaf on which it is sprayed to help cure a deficiency in the younger part of the plant.

FERTILIZER APPLICATION

Nearly all pepper in Florida is now produced on polyethylene - mulched beds. Peppers are grown with two major types of irrigation systems, drip irrigation and subsurface irrigation, although there is a small acreage irrigated with sprinklers. Although fertilizer amounts are the same with the various irrigation methods, the management of the fertilizer, including placement and timing will be different.

Subsurface irrigation.All P and micronutrients should be applied to the soil in the preplant fertilizer. About 15 to 20% of the total N and K amount also should be applied preplant. The preplant fertilizer can be incorporated in the bed soil. Remaining N and K should be banded in a 2- to 3-inch deep groove in the center of the bed. Depending on the sources used for the N and K, the S requirement also would be present in the band.

Bed placement of fertilizer risks all of the fertilizer before the crop is planted when high water tables from overirrigation or heavy rainfall could leach soluble N or K. An alternative practice would be to use a liquid fertilizer injection wheel to split-apply a portion of the N and K in the early part of the crop growth cycle.

Drip irrigation.With drip irrigation, all P and micronutrients should be applied to the soil preplant along with 20% of the N and K. Mg and S can be applied with the preplant fertilizer although the S also could be applied through the drip system.

Remaining N and K should be injected through the drip system (fertigated) as the crop develops. The fertilizer can be injected every day or less frequently such as every 3 or 4 days, or once per week. The choice depends on water management and the potential for leaching. For situations where potential for leaching is low, then weekly injection is acceptable.

Scheduling injections with the crop growth rate would result in the most efficient use of N and K. However, injections can consist of equal portions of the total seasonal N and K needs. The schedule for injection of N and K in Table 3 follows the growth and development of the crop.

IRRIGATION

Irrigation management.Fertilizer efficiency is closely related to water management. N and K are highly soluble in sandy soils and can be leached with the water when the water-holding capacity of the soil is exceeded by excessive irrigation. For subsurface-irrigated crops, water tables should be closely monitored and maintained at 18 to 24 inches below the surface of the bed. Soil water tension measured by tensiometers 6 to 8 inches deep should be about -8 to -12 centibars.

Tensiometers also should be used with drip-irrigated crops, keeping the tensiometer gauge at -8 to -12 centibars for the soil at the 6 to 8-inch depth. Water does not move laterally more than about 8 to 10 inches from the drip tube emitter. When water requirements are high, then irrigation should be operated in several cycles per day. Each cycle should not exceed 1.5 hours for a system with tubes applying 0.5 gal. per minute per 100 ft.

TISSUE TESTING

Whole-leaf testing.Fertilization programs can be monitored with plant tissue testing. Most testing procedures use the most-recently-matured leaves with petiole attached for mobile nutrients such as N, P, K, and Mg. Younger leaves should be used for nonmobile elements such as micronutrients. Sufficiency ranges for whole-leaf analyses for various crop growth stages are presented in Table 4 .

Petiole sap testing.Sometimes turn-around time may be too long and cost too high for whole-leaf analyses. A leaf petiole sap analytical procedure has been developed for Florida pepper. Petiole sap can be tested for nitrate-N and K and the results used in making decisions regarding adjustments in N and K fertilization programs. These analyses are particularly useful for fertigation programs. Sufficiency ranges for petiole sap analyses for nitrate-N and K are presented in Table 5.

RELATED LITERATURE

Everett, P.H., and R. Subramanya. 1983. Pepper production as influenced by plant spacing and nitrogen-potassium rates. Proc. Fla. State Hort. Soc. 96:79-82.

Freie, R.L., and N.L. Pugh. 1995. Florida Agricultural Statistics, Vegetable Summary. Fla. Agric. Statistics Serv., Orlando, FL.

Hanlon, E.A., J.G. Gonzalez, and J.M. Bartos. 1994. IFAS Extension soil testing laboratory chemical procedures and training manual. Fla. Coop Ext. Serv. Circ. 812.

Hanlon, E.A., and G.J. Hochmuth. 1989. Calculating fertilizer rates for vegetable crops grown in raised-bed cultural systems in Florida. Fla. Coop. Ext. Serv. Special Series SS-SOS-901.

Hochmuth, G. (ed.). 1988. Pepper production guide for Florida. Fla. Coop. Ext. Circ. 102.

Hochmuth, G. 1994. Plant petiole sap-testing guide for vegetable crops. Fla. Coop. Ext. Circ. 1144.

Hochmuth, G.J., and E.A. Hanlon. 1989. Fertilizer management for bell pepper production in Florida. Fla. Agr. Exp. Sta. Circ. S-357.

Hochmuth, G. J. and E. A. Hanlon. 1995. IFAS standardized fertilization recommendations for vegetable crops. Fla. Coop. Ext. Circ. 1152.

Hochmuth, G., and E. Hanlon. 1995. Commercial vegetable crop nutrient requirements for Florida. Fla. Coop. Ext. Circ. SP-177.

Hochmuth, G.J., E.A. Hanlon, and R.C. Hochmuth. 1994. Responses of pepper, muskmelon, watermelon, and sweet corn to P and K fertilization at Live Oak, FL. Suwannee Valley Agr. Res. Educ. Center Res. Report 92-28.

Hochmuth, G., and R. Hochmuth. 1994. Jalapeno pepper response to N and K fertilization. Suwannee Valley Agric. Res. Educ. Center Res. Report. 94-05.

Hochmuth, G., D. Maynard, C. Vavrina, and E. Hanlon. 1991. Plant tissue analysis and interpretation for vegetable crops in Florida. Fla. Coop. Ext. Special Series SS-VEC-42.

Hochmuth, G.J., K.D. Shuler, and P.R. Gilreath. 1990. Fertility management for peppers grown with drip and seepage irrigation. Proc. Fla. Pepper Inst. Fla. Coop. Ext. Serv. Special Series SSVEC-002.

Hochmuth, G.J., K.D. Shuler, P.R. Gilreath, and R.L. Mitchell. 1988. Field-testing of revised Mehlich-1-predicted potassium fertilizer recommendations for mulched pepper. Soil and Crop Sci. Soc. Fla. Proc. 47:30-35.

Hochmuth, G., K. Shuler, E. Hanlon, and N. Roe. 1994. Pepper response to fertilization with soluble and controlled-release potassium fertilizers. Proc. Fla. State Hort. Soc. 107:132-139.

Hochmuth, G.J., K.D. Shuler, R.L. Mitchell, and P.R. Gilreath. 1987. Nitrogen crop nutrient requirement demonstrations for mulched pepper in Florida. Proc. Fla. State Hort. Soc. 100:205-209.

Locascio, S.J., and M.R. Alligood. 1992. Nitrogen and potassium source and N rate for drip-irrigated pepper. Proc. Fla. State Hort. Soc. 105:323-325.

Locascio, S.J., and J.G.A. Fiskell. 1977. Pepper production as influenced by mulch, fertilizer placement, and nitrogen rate. Soil and Crop Sci. Soc. Fla. Proc. 36:113-117.

Locascio, S. J., and J. G. A. Fiskell. 1979. Pepper response to sulfur-coated urea, mulch, and nitrogen rate. Proc. Fla. State Hort. Soc. 92:112-115.

Locascio, S. J., J. G. A. Fiskell, and F. G. Martin. 1981. Responses of bell pepper to nitrogen sources. J. Amer. Soc. Hort. Sci. 106:628-632.

Locascio, S.J., and W.M. Stall. 1994. Bell pepper yield as influenced by plant spacing and row arrangement. J. Amer. Soc. Hort. Sci. 119:899-902.

Smith, S.A., and T.G. Taylor. 1995. Production cost for selected vegetables in Florida, 1994-95. Fla. Agr. Exp. Sta. Economic Information Report EI 95-1.

Stanley, C.D., and G.A. Clark. 1993. Water use and nitrogen balance for subirrigated fresh-market bell pepper production. Proc. Fla. State Hort. Soc. 106:202-204.

Table 1.

Table 1. Interpretation of Mehlich-1 soil test and nutrient recommendations for pepper.

Element	Parts per million in soil				
	Very low	Low	Medium	High	Very high
P	<10	10-15	16-30	31-60	>60
K	<20	20-35	36-60	61-125	>125
Fertilizer	lb per acre (6-ft bed centers)				
P_2O_5	160	130	100	0	0
K_2O	160	130	100	0	0

Adapted from G. Hochmuth and E. Hanlon, IFAS standardized fertilization recommendations for vegetable crops, Fla. Coop. Ext. Circ. 1152, (1995).

Table 2.

Table 2. Interpretations of Mehlich-1 soil tests for micronutrients.

	Soil pH (mineral soils only)		
	5.5 - 5.9	6.0 - 6.4	6.5 - 7.0
	ppm		
Test level below which there may be a crop response to applied copper.	0.1 - 0.3	0.3 - 0.5	0.5
Test level above which copper toxicity may occur.	2.0 - 3.0	3.0 - 5.0	5.0
Test level below which there may be a crop response to applied manganese.	3.0 - 5.0	5.0 - 7.0	7.0 - 9.0
Test level below which there may be a crop response to applied zinc.	0.5	0.5 - 1.0	1.0 - 3.0

Adapted from G. Hochmuth and E. Hanlon, IFAS standardized fertilization recommendations for vegetable crops, Fla. Coop. Ext. Circ. 1152, (1995).

Table 3.

Table 3. Injection schedule 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 175 N 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 and K_2O per acre per day. First week or two of injection can be omitted where 20% N and K was applied preplant.

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

Table 4.

Table 4. 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
			%						ppm					
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	10	-
		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

Table 4.

Table 4. 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
		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	30-100	25-80	20-50	5-10	0.1-0.2
		High	>3.0	0.40	3.0	1.5	0.4	0.4	150	100	80	50	10	-
		Toxic (>)	-	-	-	-	-	-	-	-	-	350	-	-
^{z}MRM, most-recently-matured leaf.														

Table 5.

Table 5. Sufficiency ranges for leaf petiole sap N and K concentrations for pepper.		
Crop development stage	Fresh petiole sap concentration (ppm)	
	Nitrate - 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
Adapted from G. Hochmuth, Plant petiole sap-testing guide for vegetable crops. Fla. Coop. Ext. Serv. Circ. 1144, (1994).		