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IFAS Standardized Fertilization Recommendations for Vegetable Crops[1]

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Introduction

This publication presents in abbreviated form the fertilization recommendations for vegetable crops based on soil tests performed by the IFAS Extension Soil Testing Laboratory (ESTL). It contains the basic information from which ESTL soil-test reports and fertilization recommendations are generated. More information on vegetable fertilization is presented in SP 170, **Commercial Vegetable Production Guide for Florida.**

Water Management

Nutrients can leach in Florida's sandy soils due to heavy rainfall or excessive irrigation. The fertilization recommendations presented in this circular were developed from research and on-farm experience with optimum water management. A well-managed irrigation program will keep water and nutrients in the root zone, where both inputs will benefit yield and vegetable quality while minimizing chances for negative environmental impact.

Soil Testing

Soil testing is a tool in crop fertilization management. Successful use of soil-testing requires that: (1) you send to the lab soil samples that adequately represent your field or management unit, (2) the laboratory uses calibrated soil-test methods for predicting fertility requirements, and (3) the fertilizer recommendations you get are based on measured crop responses.

The ESTL extracts phosphorus (P), potassium (K), magnesium (Mg), calcium (Ca), copper (Cu), manganese (Mn), and zinc (Zn) from soil samples with the Mehlich-1 extractant and bases fertilization recommendations for those nutrients on the test results. Nitrogen (N) fertilization is not based on soil tests but on crop need documented in research literature. Liming recommendations are based on the Adams-Evans lime requirement test, a calibration equation developed for Florida soils, and the target pH for the crop for which the recommendation is being made.

1. This document is Circular 1152, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Date first printed: 1989 as SS-SOS-907. Revised as Circular 1152 in 1995. Last publication date: March 2000. Please visit the EDIS Web site at **http://edis.ifas.ufl.edu**

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Soil-test Rating Level

The current UF-IFAS interpretation of the Mehlich-1 extractant is presented in Table 1. This interpretation scale has been verified by field research on growers' fields throughout Florida for vegetable production.

Interpretations of results for Mehlich-1 extractable micronutrients have been developed from experience and field testing with vegetables (Table 2). Because responses to micronutrients are commodity specific, these interpretations should be used as guides only. Zinc, Cu, and Mn can build up with time since they are quite immobile in the soil. The decision to add micronutrients should include an accounting of all sources such as fungicides and micronutrient content in irrigation water.

Soil-test Recommendations

Soil test reports from the ESTL are computer-generated from soil-test data and crop information. Reports contain the results of the tests (soil pH, ppm extractable P, K, Mg, Ca, and Cu, Mn, and Zn, if requested), a rating of the P, K, and Mg (very high to very low), and a fertilization recommendation. The recommendation is composed of two parts: (1) the rates of N, P_2O_5, and K_2O fertilizer to apply and (2) footnotes that give important information about fertilization management, such as application timing, special crop requirements, etc.

Table 3 contains crop descriptions, target pH, and N, P_2O_5, and K_2O recommendations for each of the five soil-test rating levels, for which footnotes will be printed for each of the crop reports, and the references upon which the recommendations are based. Table 4 contains a listing of the footnotes.

Recommended fertilizer rates have been determined from research using typical standard bed spacing (Table 5). These fertilizer rates are expressed on a "per acre" basis, which can be converted to pounds per 100 linear bed feet. For planting patterns other than the typical bed spacing, refer to Table 6 for the equivalent fertilizer application rate given in pounds of nutrient per 100 linear bed feet. Using Table 5 and Table 6 will ensure correct fertilizer application rate using variable planting patterns.

References

Hochmuth, G., and K. Cordasco. 1998. A Summary of N, P, and K Research with Eggplant in Florida. Fla. Coop. Ext. Fact Sheet HS-751 (11 pp.)

Hochmuth, G., and K. Cordasco. 1998. A Summary of N, P, and K Research with Muskmelon in Florida. Fla. Coop. Ext. Fact Sheet HS-754 (11 pp.)

Hochmuth, G., and K. Cordasco. 1998. A Summary of N, P, and K Research with Pepper in Florida. Fla. Coop. Ext. Serv. Fact Sheet HS-753 (16 pp.)

Hochmuth, G., and K. Cordasco. 1998. A Summary of N, P, and K Research with Potato in Florida. Fla. Coop. Ext. Serv. Fact Sheet HS-756 (22 pp.)

Hochmuth, G., and K. Cordasco. 1998. A Summary of N, P, and K Research with Snapbean in Florida. Fla. Coop. Ext. Fact Sheet HS-757 (15 pp.)

Hochmuth, G., and K. Cordasco. 1998. A Summary of N, P, and K Research with Squash in Florida. Fla. Coop. Ext. Serv. Fact Sheet HS-750 (9 pp.)

Hochmuth, G., and K. Cordasco. 1998. A Summary of N, P, and K Research with Strawberry in Florida. Fla. Coop. Ext. Fact Sheet HS-752 (18 pp.)

Hochmuth, G., and K. Cordasco. 1998. A Summary of N, P, and K Research with Sweet Corn in Florida. Fla. Coop. Ext. Serv. Fact Sheet HS-758 (14 pp.)

Hochmuth, G., and K. Cordasco. 1998. A Summary of N, P, and K Research with a Tomato in Florida. Fla. Coop. Ext. Fact Sheet HS-759 (21 pp.)

Table 1. Mehlich-1 soil-test interpretations used for vegetable crops on mineral soils.

Element	Parts Per Million				
	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
Mg	--	< 15	15 - 30	> 30	--
Ca	< 50	50-100	101-300	301-500	> 500

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
	parts per million		
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

[1] From "Notes in Soil Science" No. 9, 1983

Table 3. Target pH, and recommended N, P_2O_5, and K_2O fertilizer rates for commercial vegetable production. Phosphorus and potassium rates are based on an interpretation of a Mehlich-1 soil test on a mineral soil.

		Pounds/Acre/Cropping season												
			P_2O_5					K_2O						
Crop Description	Target pH	N (lb/A)	VL	L	MED	HI	VHI	VL	L	MED	HI	VHI	Footnotes[1]	References
BEAN Snap, Lima, Pole	6.5	100	120	100	80	0	0	120	100	80	0	0	250 251 350	Cir 100, 225, 478, SP170
BEET	6.5	120	120	100	80	0	0	120	100	80	0	0	250 251 350	Cir 225, SP170
BROCCOLI Cauliflower, Brussels sprouts	6.5	175	150	120	100	0	0	150	120	100	0	0	250 251 350 351 352 354	Cir 555, 225, SP170
CABBAGE Collard, Chinese Cabbage	6.5	175	150	120	100	0	0	150	120	100	0	0	250 251 350 351 352 354	Cir 117E, 225, SP100, SP170
CARROT	6.5	175	150	120	100	0	0	150	120	100	0	0	250 251 350	Cir 225, SP170
CELERY	6.5	200	200	150	100	0	0	250	150	100	0	0	250 251 350 354	Cir 757, 225, SP170
CUCUMBER	6.5	150	120	100	80	0	0	120	100	80	0	0	250 251 350 351 354	Cir 101E, 225, SP170
EGGPLANT	6.5	200	150	120	100	0	0	150	120	100	0	0	250 251 350 351 352 353 354	Cir 225, SP170
LETTUCE Crisphead, Romaine, Endive, Escarole	6.5	200	150	120	100	0	0	150	120	100	0	0	250 251 350 351 352 354	Cir 123, 225, SP170
MUSKMELON	6.5	150	150	120	100	0	0	150	120	100	0	0	250 251 350 351 354	Cir 122C, 225, SP170
MUSTARD Kale, Turnip	6.5	120	150	120	100	0	0	150	120	100	0	0	250 251 350	Cir 225, SP 170
OKRA	6.5	120	150	120	100	0	0	150	120	100	0	0	250 251 350 351	Cir 225, SP170
ONION Bulb	6.0	150	150	120	100	0	0	150	120	100	0	0	250 251 350 351 354	Cir 225, Bul 238, SP170
ONION Bunching, Leek	6.5	120	120	100	80	0	0	120	100	80	0	0	250 251 350	Cir 225, SP170
PARSLEY	6.5	120	150	120	100	0	0	150	120	100	0	0	250 251 350	Cir 225, SP170

Table 3. Target pH, and recommended N, P_2O_5, and K_2O fertilizer rates for commercial vegetable production. Phosphorus and potassium rates are based on an interpretation of a Mehlich-1 soil test on a mineral soil.

		Pounds/Acre/Cropping season												
			P_2O_5					K_2O						
Crop Description	Target pH	N (lb/A)	VL	L	MED	HI	VHI	VL	L	MED	HI	VHI	Footnotes[1]	References
PEA Southern, Snow, English	6.5	60	80	80	60	0	0	80	80	60	0	0	250 251 350	Cir 100, 225, SP170
PEPPER Bell, Specialty	6.5	200	150	120	100	0	0	200	150	100	0	0	250 251 350 351 352 353 354	Cir 102E, 225, SP170, Cir S357
POTATO	6.0	200	120	120	60	0	0	150[3]	150	150	150	150	250 253 350	Cir 118,225, SP170
RADISH	6.5	90	120	100	80	0	0	120	100	80	0	0	250 251 252 350	Cir 225, SP170
SPINACH	6.5	90	120	100	80	0	0	120	100	80	0	0	250 251 350	Cir 225, SP170
SQUASH Summer, Winter, Pumpkin	6.5	150	120	100	80	0	0	120	100	80	0	0	250 251 350 351 354	Cir 103D, 225, SP170
STRAWBERRY	6.5	150	150	120	100	0	0	150	120	100	0	0	250 350 352 353 354 355	Cir 142, 225, 1141, SP170
SWEET CORN	6.0	200	150	120	100	0	0	150	120	100	0	0	250 251 350	Cir 99,122, 225, SP170
SWEET POTATO	6.5	60	120	100	80	0	0	120	100	80	0	0	250 251 350	Cir 440-II, 551, 225, SP170
TOMATO Slicing, Cherry, Plum	6.5	200	150	120	100	0	0	225	150	100	0	0	250 251 350 351 352 353 354	Cir 98C, 225, SP170
WATERMELON	6.0	150	150	120	100	0	0	150	120	100	0	0	250 251 350 351 352 353 354	Cir 225, SP113, SP170

[1] Footnote numbers are the computer codes used in generating footnote printout.
[2] Cir = Circular
Bul = Bulletin
[3] K fertilization recommendations for potato not based on soil test results since yield response was not correlated with soil K.

Table 4. Footnotes used with vegetable crops.

250 Indicated fertilizer amounts, and the nutrients already in the soil, will satisfy the crop nutrient requirement for this cropping season. Fertilizer and water management are linked. Maximum fertilizer efficiency is achieved only with close attention to water management. Supply only enough irrigation water to satisfy crop requirements. Excess irrigation may result in leaching of N and K, creating possible plant deficiencies. Overfertilization has been shown to reduce vegetable quality.

For subsurface irrigation, maintain a constant water table between 18 (at planting) and 24 inches (near harvest) below the top of the bed. Monitor water table depth and do not fluctuate, else N can be "scrubbed" from the root zone.

On soils that have not been in vegetable production within the past 2 years, or where micronutrients are known to be deficient, apply 5 lb Mn, 3 lb Zn, 4 lb Fe, 3 lb Cu, and 1.5 lb B/A. Use soil testing to monitor micronutrient status every 2 years. When deciding about micronutrient applications, consider micronutrients added to the crop via fungicides. Some micronutrients can build up in the soil avoid micronutrient toxicity.

Up to 40 lb/acre Mg might be needed when soil test is medium or lower in Mg. Mg can be supplied in fertilizer or from dolomitic limestone, when liming is recommended.

Calcium concentrations are typically adequate in most soils used continuously for vegetable production or where the Mehlich-1 Ca index is >300 ppm. Calcium is added during liming activities and from calcium carbonate present in irrigation water drawn from aquifers in Florida. These sources should be considered in the determination of Ca fertilizer needs.

251 For unmulched crops, fertilizer should be applied in split applications to reduce leaching losses and lessen danger of fertilizer burn. Broadcast all P_2O_5 and micronutrients, if any, and 25 to 30% of the N and K_2O in the bed at planting. Apply remaining N and K_2O in sidedress bands during the early part of the growing season.

Additional, supplemental sidedress applications of 30 lb N/A and 20 lb K_2O/A should be applied only if rainfall/irrigation amounts exceed 3 inches within a 3-day period or exceed 4 inches within a 7-day period. Avoid mechanical damage to plants when applying fertilizers.

252 The amounts suggested are generally sufficient for 2 or 3 crops in succession.

253 Where scab-resistant cultivars are grown, a pH between 6.0 and 6.5 is optimum. Where scab-susceptible cultivars are grown, the pH should be below 5.2 or above 7.2. Band all phosphorus. Apply 50 to 70% of N and 50% of K_2O at planting or at emergence and the remaining N and K at 35 to 40 days after planting. Potatoes planted in cool soils might respond to up to 25 lb P_2O_5 applied as a starter fertilizer in the furrow with the seed pieces.

350 Supply 25 to 50% of the N in the nitrate form if soils were treated with multi-purpose fumigants or if the soil temperature will stay below 60^{o}F for up to one week following transplanting or germination.

351 For mulched crops and subsurface irrigation, incorporate 10 to 20% of the N and K_2O, plus all of the P_2O_5 and micronutrients, if any, into the bed. Apply the remainder of the N and K_2O 2 to 3 inches deep in one or more bands about 6 to 10 inches from the plants.

For drip irrigation, incorporate 20% to 40% of the N and K_2O and all of the P_2O_5 and micronutrients, if any, into the bed. Apply the remainder of the N and K_2O periodically through drip tubes according to the rate of crop growth. Consult Circular 1181, "*Fertilizer management for micro (drip) irrigated vegetable crops in Florida*" for information on injection schedules.

For management systems where both subsurface and drip irrigation are being used, apply no more than 20% of the N and K_2O, plus all of the P_2O_5 and micronutrients, if any, into the bed. Apply the remainder of the N and K_2O periodically through drip tubes according to the rate of crop growth.

For overhead irrigation, incorporate all of the N, P_2O_5, K_2O and micronutrients, if any, into the bed prior to installation of the plastic mulch.

Table 4. Footnotes used with vegetable crops.

352 Amounts suggested are for the first crop. Squash and cucumber following other crops on the same mulch may not need substantial additional fertilizer. If fertilizer is needed for the second crop, apply fertilizer using a liquid-injection wheel or via drip irrigation. Apply no more than 30 to 40 lb/acre N and/or K_2O in any single injection wheel application.
353 From 25 to 30% of the N may be supplied from slow-release N sources, such as sulfur-coated urea, polymer-coated fertilizers, or isobutylidene-diurea (IBDU).
354 Transplants may benefit from application of a dilute, soluble starter fertilizer, especially at cool soil temperatures. Starter solution rates of N and P_2O_5 need not exceed 10 to 15 lb/acre each.
355 For overhead irrigation, broadcast all the P_2O_5 and micronutrients, if any, and 25% of the N and K_2O into the bed. Band remaining N and K_2O in center of bed 3 inches deep. For subsurface irrigation, incorporate 10 to 20% of the N and K_2O, plus all of the P_2O_5 and micronutrients, if any, into the bed. Apply the remainder of the N and K_2O 2 to 3 inches deep in one or more bands about 6 to 10 inches from the plants. For drip irrigation, incorporate 20% of the N and K_2O and all of the P_2O_5 and micronutrients, if any, into the bed. Apply the remainder of the N and K_2O periodically through drip tubes according to the rate of crop growth; see Circular 1181, "*Fertilizer management for micro (drip) irrigated vegetable crops in Florida*" and Circular 1141, "*Fertilization of Strawberries in Florida*." For management systems where both subsurface and drip irrigation are being used, apply no more than 20% of the N and K_2O, plus all of the P_2O_5 and micronutrients, if any, into the bed. Apply the remainder of the N and K_2O periodically through drip tubes according to the rate of crop growth.

Table 5. Typical bed (row) spacings for vegetables.

Crop	Bed (row) spacing	Number of rows (per bed)
Bean, snap, lima	30 inches	1
Broccoli, cauliflower, Brussel sprout	6 ft (mulched)	2
Cabbage, collard, Chinese cabbage, Kale	6 ft (mulched)	2
Carrot	4 ft	2-3
Celery	4 ft	2
Cucumber	6 ft (mulched)	2
Eggplant	6 ft (mulched)	1
Lettuce, crisphead, romaine, endive, escarole	4 ft	2
Muskmelon	5 ft	1
Okra	6 ft (mulched)	2
Onion	6 ft	4
Pea, southern	30 inches	1
Pepper, bell, specialty	6 ft (mulched)	2
Potato	42 inches	1
Squash, summer	6 ft (mulched)	2
Strawberry	4 ft (mulched)	2
Sweet corn	36 inches	1
Sweet potato	42 inches	1
Tomato, slicing, cherry, plum	6 ft (mulched)	1

Table 5. Typical bed (row) spacings for vegetables.

Crop	Bed (row) spacing	Number of rows (per bed)
Watermelon	8 ft	1
For the following crops, see footnote[z]		
Mustard		
Turnip		
Parsley		
Pea, snow, English		
Radish		
Spinach		

[z] These crops are generally produced on wide (40 to 48-inch) beds on 6-ft centers with 4 to 6 multiple rows. Some of the crops are also sown in broadcast-fashion on the bed.

Table 6. Conversion of fertilizer rates in lb/A to lb/100 linear bed feet (LBF).

Bed Spacing	Recommended fertilizer (N, P_2O_5, or K_2O)												
	---------- lb/A ----------												
	20	25	40	50	60	75	80	100	120	140	160	180	200
(ft)[z]	Pounds of fertilizer (N, P_2O_5, or K_2O) to apply per 100 LBF												
3	0.14	0.17	0.28	0.35	0.41	0.52	0.55	0.69	0.83	0.96	1.10	1.24	1.38
4	0.18	0.23	0.37	0.46	0.55	0.69	0.73	0.92	1.10	1.29	1.47	1.65	1.84
5	0.23	0.29	0.46	0.57	0.69	0.86	0.92	1.15	1.38	1.61	1.84	2.07	2.30
6	0.28	0.34	0.55	0.69	0.83	1.03	1.10	1.38	1.65	1.93	2.20	2.48	2.77
8	0.37	0.46	0.73	0.92	1.10	1.38	1.47	1.84	2.20	2.57	2.94	3.31	3.67

[z] The number of linear bed feet (LBF) for any cropping pattern is equal to 43,560 sq ft divided by the row (bed) spacing (center-to-center).