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Commercial Vegetable Crop Nutrient Requirements in Florida[1]

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The purpose of this circular is to present **crop nutrient requirements** for commercial vegetables in Florida. It is intended to be a supplement to Extension Circular 225-C (1988), *Commercial Vegetable Fertilization Guide* and supersedes the 1989 edition of Circular 806. Certain information included in Circular 225-C is repeated here to increase clarity of this presentation. Research documentation to support fertilization recommendations is provided where available. Fertilization recommendations are updated as new research indicates needed changes.

CROP NUTRIENT REQUIREMENTS

Plants require 16 elements (C, H, 0, P, K, N, S, Ca, Mg, Fe, B, Mn, Cu, Zn, Mo, Cl) for normal growth and reproduction. The crop nutrient requirement (CNR) for a particular element is defined as the total amount in lb/A of that element needed by the crop during the production season to produce optimum economic yield. This nutrient requirement can be satisfied from many sources including soil, water, air, organic matter, or fertilizer. For example, the CNR of potassium (K) can be supplied from K-containing minerals in the soil, from K retained by soil organic matter, or from K fertilizers.

The CNR for a crop is determined from field experiments that test the yield response to levels of added fertilizer (Plate 1). For example a K study of watermelon might be conducted on a soil that tests very low in extractable K. In this situation, the soil is expected to contribute negligible amounts of K to watermelon growth or yield and all of the CNR would be expected to be supplied from fertilizer. The researcher then plots the relationship of crop yield to K fertilizer rate. In this example the CNR is equivalent to the fertilizer rate above which no significant increases in yield resulted. The CNR values derived from such experiments take into account factors such as fertilizer efficiencies in various soils. If data are available from several experiments, then reliable estimates of CNR values can be made.

Vegetable fertilization recommendations must take into account both yield and quality. For example, enough fertilizer must be recommended for crisphead lettuce to achieve high biomass yields **and** large, firm, marketable heads.

In Florida, CNR values vary according to soil type and vegetable crop. CNR values have been determined for many vegetable crops on several soils in Florida. For other situations, CNR values have been estimated because no research data are available. Table 1, Table 2, and Table 3 present CNR values for vegetable crops in Florida. Recommendations for marl and rockland soils have been combined into one table, since few research results have been published for these soils, and crop nutrient requirements are probably similar for crops grown on both soils. Production guides containing information on nutrient management for specific crops are listed in Table 4. Using the CNR concept when

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developing a fertilizer program will ensure optimum, economic yields while minimizing both pollution from overfertilization and loss of potential yield due to inadequate fertilization.

SOIL TESTING

The CNR values listed in Table 1, Table 2, and Table 3 are those maximum amounts of nutrients shown by research to be needed to produce optimum economic yields. It is important to remember that these amounts of nutrients are supplied to the crop from both **the soil and the fertilizer**. The amounts listed in the tables are applied as fertilizers **only** when a properly calibrated soil test indicates very low extractable amounts of these nutrients to be present in the soil. Therefore, calibrated soil tests must be used to determine the contribution of native soil-derived nutrients to the overall CNR. Based on such tests, the amount of fertilizer needed to supplement the native-soil-nutrition component can be calculated. The current calibration for the Mehlich-1 (double-acid) soil test for mineral soils is presented by Hochmuth and Hanlon (l995). Research on soil test calibration for some vegetables has been summarized by Hochmuth et al. (1993).

It is important that soil samples represent the field or management unit to be fertilized. A competent soil testing laboratory that uses calibrated methodologies should analyze the samples. Not all laboratories can provide accurate fertilizer recommendations for Florida soils. Details on soil testing and how to make it work effectively can be found in Extension Circular 817, *Soil, Container Media, and Water Testing - Interpretations and IFAS Standardized Fertilization Recommendations* (Hanlon et al. 1990).

IRRIGATION

Fertilizer- and water-management programs are linked. Optimum management of one program requires proper management of the other as well.

Overhead irrigation generally causes the downward movement of nutrients such as nitrogen (N) and K. Small amounts of irrigation water applied on a regular basis will result in less leaching than will large amounts applied infrequently. Excessive irrigation can even remove fertilizer from plastic-mulched beds, especially from the soil near the plant hole or where the water table rises, leaching nutrients from the bed.

The water table in a subsurface (seep) irrigation system should be maintained at an appropriate level for a given soil situation, usually 18 to 24 inches below the top of the bed. The water table should not be allowed to fluctuate appreciably because nutrients can be lost from the bed during moisture fluctuations. Water tables during heavy rains should be controlled to avoid leaching of nutrients from flooded beds.

Drip irrigation provides an efficient method for applying water and nutrients, especially if used in conjunction with mulch. Savings of water of more than 50% compared to either seepage or overhead irrigation methods have been reported. However, nutrient leaching can be severe with an improperly managed drip system. The calculation of irrigation water quantities by pan evaporation, and the use of tensiometers and water table observation wells as irrigation scheduling aids can help growers improve water management (Clark et al., 1988; Clark et al., 1990).

SUPPLEMENTAL FERTILIZER

If the fertilizer component of the CNR is properly managed to minimize fertilizer losses, it is unlikely that supplemental fertilizer will be needed. Supplemental fertilizer might be needed after a leaching rainfall. As a general rule, about 50% of the N and 25% of the K is leached out of the root zone by a 2- to 3-inch rainfall under unmulched culture. The "leaching rain rule" should be used to aid in decisions concerning supplemental fertilizations. If rainfall exceeds 3 inches in 3 days or 4 inches in 7 days, apply 30 lb N/A and 20 lb K_2O/A. The number of supplemental applications will vary according to the number of leaching rainfalls and the length of the crop growing season.

Supplemental fertilizer should be applied in bands to each side of the row for unmulched crops. The fertilizer should be placed in the soil just ahead of the advancing root tips. For crops growing in close rows or in "broadcast" fashion, the supplemental fertilizer can be broadcast over the top by air, ground spreader, or overhead sprinkler-irrigation system. Where plastic mulch is used, supplemental applications can be made through the mulch by a liquid-injection wheel or by drip irrigation systems.

Equipment used to apply supplemental fertilizer should be carefully calibrated. Fertilizer should be correctly placed to avoid damage to either plants or roots from the application equipment and irrigation managers should be sure that excess water is not applied which might cause leaching.

MULCHED CROPS

Mulching is a standard practice for many vegetable crops in Florida (Plate 2). Polyethylene mulch improves fumigant effectiveness, provides weed control, increases soil temperature, and reduces fruit rot (Hochmuth, 1988). In addition, mulch can reduce fertilizer leaching. Even though crop growth and production are often greater with mulch, the increased fertilizer efficiency for the mulch system means that CNR requirements are similar to those of unmulched crops.

When using mulch, all fertilizer can be applied in the bed prior to mulching. Extra or "insurance" fertilizer is not recommended, because it can cause soluble-salt injury to plants and can also contribute to groundwater pollution if it is leached from under the mulch by flooding or by a high water table. If supplemental fertilizer is required, it can be applied by a liquid-fertilizer injection wheel or by drip irrigation systems.

SOIL pH

Current IFAS standardized recommendations call for maintaining soil pH in the range of 6.0 to 6.5. However, some vegetables, such as watermelon, will perform normally at lower pH values. A common problem in Florida has been overliming, resulting in high soil pH levels. Overliming and resulting high soil pH can cause the "tie-up" of micronutrients and restrict their availability to the crop. Overliming also can reduce the accuracy with which a soil test can predict fertilizer requirements.

It is important, however, not to allow soil pH to drop below approximately 5.5 for most vegetable production, especially where micronutrient levels in the soil may be high due to a history of micronutrient fertilizer and micronutrient-containing pesticide applications. When soil pH decreases in such soils, the solubility of certain micronutrients can increase to levels that may become toxic to plants.

Irrigation water from limestone aquifers is an additional source of liming material not usually considered in many liming programs. The combination of routine additions of lime and the use of alkaline irrigation water has resulted in soil pH values near 8.0 for some sandy soils. To estimate this liming effect, a water sample should be analyzed for total bicarbonates and carbonates. The results are then converted to pounds of calcium carbonate per acre annually depending on the quantity of water applied. This information should be used in decisions concerning lime requirement.

It should be evident that lime, fertilization, and irrigation programs are closely related to one another. An adjustment in one program will often influence another. To maximize overall production efficiency, calibrated soil testing and water analysis must be made a part of these programs.

NUTRIENT FORMS

Nitrogen can be supplied in both the nitrate and ammoniacal forms. Nitrate-N is generally the preferred form for plant uptake in most situations, but ammoniacal N can be used by some plants directly or after conversion to nitrate-N by soil microbes. Conversion occurs rapidly (essentially complete within 2 to 4 weeks) in warm soils. The rate of conversion is reduced in cold, fumigated, or strongly acidic soils, where it is recommended that 25 to 50% of the N be supplied from nitrate sources. This percentage is not as critical for unfumigated or warm soils where the bulk of the N can be supplied from ammoniacal sources. For more information on nutrient sources, consult Extension Circular 225-C.

Phosphorus (P) can be supplied from several sources including normal (ordinary) and triple superphosphates, diammonium phosphate, monoammonium phosphate, polyphosphates, and phosphoric acid. All sources can be effective for plant nutrition on sandy soil. However, diammonium phosphate has been shown to reduce yields of certain crops when banded in large amounts in mixtures containing micronutrients, on soils that tested very low in native micronutrients level. In addition, P availability from diammonium phosphate can be reduced where diammonium phosphate is applied to unlimed soils which are acidic and contain large amounts of aluminum or iron. Potential negative effects of diammonium phosphate can be minimized by correcting pH with lime before applying diammonium phosphate or by supplying part of the P from another P source (Rhoads et al., 1993).

Potassium can also be supplied from several sources including potassium chloride, potassium sulfate, potassium nitrate, and potassium-magnesium sulfate. If soil-test-predicted amounts of K fertilizer are adhered to, there should be no concern about the K source, its chloride content, or its relative salt index. Several recent vegetable studies on K sources have shown that comparable yields resulted from fertilization with various K sources.

CALCIUM, MAGNESIUM, SULFUR

Calcium (Ca), magnesium (Mg), and sulfur (S) deficiencies are seldom a problem in Florida. Calcium usually occurs in adequate supply from the soil for most vegetables, especially in irrigated or recently limed soils. Ca will be in abundant supply from soils with a Mehlich-1 Ca index of 300 ppm or above. Calcium is not mobile in the plant; therefore, foliar sprays of Ca are not likely to correct serious Ca deficiencies, especially in fruit. Ca does not mobilize in large enough quantities from the leaf to the fruit. Ca deficiencies such as leaf tip burn and blossom-end rots can be increased by inadequate irrigation management and by excessive fertilization from N or K. Highest quality pepper fruits (Plate 3) result from attention to both fertilization and irrigation.

Sulfur (S) deficiency is rarely a problem for Florida vegetables. Sulfur deficiency would most likely occur on deep, sandy soils low in organic matter, after leaching rains or where S-containing fertilizers have not been applied for several seasons. If S deficiency has been diagnosed, it can be corrected by using S-containing fertilizers, such as magnesium sulfate, ammonium sulfate, potassium sulfate, normal (ordinary) superphosphate, or potassium-magnesium sulfate. Using one of these materials in the fertilizer blend at levels sufficient to supply 30 to 40 lb S/A should minimize the potential for S deficiencies. In many areas of Florida, ample S will be supplied through the irrigation water from wells.

Magnesium deficiency may be a problem for vegetable production on deep, sandy soils. When the Mehlich-1 soil-test index for Mg is below 30 ppm, research has shown that 30 lb Mg/A will satisfy the Mg CNR. If lime is needed, Mg can be added by using dolomite as the liming material. If no lime is needed, then the Mg requirement can be satisfied through use of magnesium sulfate or potassium-magnesium sulfate. Inclusion of the Mg source in the fertilizer(s) to be applied to the soil or using a homogenized fertilizer that contains the correct amount of Mg are excellent ways of insuring uniform application of Mg.

MICRONUTRIENTS

It has been a common practice in Florida vegetable production to apply a micronutrient "package" in a blended fertilizer. This practice was justified in the past on the basis that these nutrients were inexpensive and their application was viewed as insurance for high yields even when uniform blending and application were difficult to achieve. In addition, there has been little research data and lack of soil-test calibrations to guide judicious application of micronutrient fertilizers. Prophylactic micronutrient fertilizer additions and use of micronutrient-containing pesticides, such as maneb, zineb, mancozeb, and assorted copper compounds for disease control have led to accumulation of some micronutrients in the soil of some farms.

Elevated micronutrient levels have forced some vegetable producers to overlime in an effort to avoid micronutrient toxicities. Data have now been accumulated which permit a more accurate assessment of micronutrient requirements. Growers are encouraged to have a calibrated micronutrient soil test (Mehlich-1) conducted and to refrain from prophylactic ("shot-gun") micronutrient fertilizer applications. It is unlikely that some micronutrients will be needed on "old" vegetable land, especially where micronutrients are being applied regularly via recommended pesticides. A micronutrient soil test every 2 to 3 seasons should help determine adequate micronutrient fertilization levels for crop production.

PLACEMENT AND TIMING

Because P is immobile in the soil, it should be placed in the bed (root zone) and not on the surface of the bed. Efficiency in P-fertilizer use may be enhanced by reducing the amount of soil with which the fertilizer is mixed. This statement is especially true for the carbonaceous marl and Rockdale soils of southern Florida and for the muck soils. Banding, or incorporating P in the bed area (as opposed to uniform broadcasting), are excellent methods of increasing P efficiency. Research has shown that banding P for lettuce on muck soils reduces P needs by at least one-half (Guzman et al., 1987; Sanchez et al., 1990a).

In most situations, all P should be applied before or at planting. Side-dressing of P in bands might be needed on the marl or Rockdale soils during winter to increase P availability to the slow-growing roots, but sidedressing P for a fast-growing crop such as lettuce was not proven beneficial on muck soil.

Nitrogen and K can leach in sandy soils. Therefore, these nutrients should be applied to unmulched crops in split-applications to reduce leaching losses and to reduce soluble-salt injury. For muck soils and clayey soils, potassium can be broadcast at planting time.

Most micronutrients are essentially immobile in soil and should be managed like P. Foliar applications of manganese (Mn), iron (Fe), copper (Cu), and zinc (Zn) can be used to correct specific deficiencies which might occur on high-pH (basic) soils during cool periods.

LIQUID VS. DRY FERTILIZER SOURCES

Research in Florida has shown that there is no difference in crop response to similar amounts of nutrients when applied in either liquid or dry form. Sidedress applications of fertilizer can be effectively made with dry or liquid forms of nutrients. Certain situations (use of drip irrigation or some injection wheels) require clear solutions.

The decision to use liquid or dry fertilizer sources should depend largely on economics and on the type of application equipment available. The cost per unit of nutrient (e.g., dollars per ton of actual N) should be used in any decision-making process.

FOLIAR FERTILIZATION

Foliar fertilization should be thought of as a "last resort" method for supplying micronutrients. The plant leaf resists easy infiltration by fertilizer salts. Foliar fertilization most appropriately applies to micronutrients and not to macronutrients such as N, P, and K. Research has shown that foliar applications of N, P, and/or K are not needed where proper soil-directed fertilizer programs are being followed. Leaves cannot absorb enough of these nutrients (and leaf burn might result) to correct any significant nutrient deficiency. Any benefit from macronutrient foliar sprays probably results when nutrients are washed by rain or irrigation water off of the leaf surface into the soil. The nutrient then enters the plant via the plant roots. Amounts recommended on the product label of most commercial macronutrient foliar spray materials are minuscule compared to nutrition derived from the soil so that benefit to the plant is highly unlikely. Fertilizer should only be added if additional yield results, and research with "shot-gun" foliar-nutrient applications has not clearly documented a yield increase for vegetables.

In certain situations, temporary deficiencies of Mn, Fe, Cu, or Zn can be corrected by foliar application. Examples include vegetable production in winter months when soils are cool and roots cannot extract adequate amounts of micronutrients and in cases where high soil pH "fixes" broadcast micronutrients in unavailable forms. Micronutrients are so termed because small, or "micro", amounts are required to satisfy the CNR. Such micro-amounts may be supplied adequately through foliar applications.

Boron (B) is highly immobile in the plant. To correct boron deficiencies, very small amounts of boron must be applied frequently to the young tissue or buds. Fruit deficiencies of B are unlikely to be corrected by foliar sprays for the same reasons discussed earlier for Ca. B deficiencies should be alleviated by B application to the soil or through a drip irrigation system.

Any micronutrient should be applied **only** when a specific deficiency has clearly been diagnosed. There is a fine line between **adequate** and **toxic** amounts of these nutrients. "Shotgun" application of micronutrients can actually reduce plant growth and yields because of toxicity (from unneeded nutrients in the mixture). Compounding this problem is the potential accumulation of some nutrients in the soil to levels which may threaten crop production on that soil. An important part of any micronutrient program involves careful calculations of amounts of all micronutrients being applied, from all sources.

DRIP IRRIGATION

Some nutrients can be efficiently applied through drip irrigation systems, achieving high fertilizer efficiency. Most often, N and K are injected. Although P and micronutrients can be injected if proper precautions are taken to prevent precipitation and emitter clogging, the general recommendation is not to inject these nutrients. Nutrients should be injected according to crop growth and demand with attention given to proper water management so that N and K are not leached. Drip irrigation systems to be used for nutrient injection must be properly designed for the purpose of injecting fertilizer. Details on system design, management, and specific injection schedules for various crops are presented in Special Series SSVEC-45, by Hochmuth and Clark (1991).

DOUBLE-CROPPING

Successive cropping of existing mulched beds is a good practice to make effective use of the polyethylene mulch and fumigant (Hochmuth, 1992). Double-cropping also can make use of residual fertilizer in the beds. If N applications and amounts were properly managed for the first crop, there should be negligible amounts of fertilizer N remaining in the beds. It is not a good practice to add extra fertilizer N to the soil when planting the first crop, thinking that this fertilizer will aid growth of the second crop. The extra fertilizer could contribute to soluble-salt damage to the first crop, and might be leached from the root zone before the second crop is established.

If double-cropping is planned, then a drip irrigation system could be used to supply adequate nutrition to each crop. Soil testing of a sample taken from the bed away from any fertilizer bands will help determine P or micronutrient needs, assuming that these nutrients were broadcast in the bed prior to planting the first crop. Phosphorus and micronutrient fertilization (if any) for the first crop will likely remain adequate for the second crop. If N for the first crop was not applied in excess of the CNR, then the second crop should receive an amount of N equal to its own CNR.

Potassium requirements of the second crop can be determined by soil testing where the K for the first crop was incorporated in the bed. Potassium requirements for the second crop are more difficult to determine where K for the first crop was banded. Soluble-salt measurements of the band area are difficult to interpret because the salt reading measures everything at the same time including nutrients and other salts. More accurately, K fertilization should be managed like N. If soil-test-predicted amounts of K were used for the first crop, there should be little residual K. At most, the second crop should receive an amount of K equal to that crop's CNR for K.

Once the crop fertilizer requirements have been determined, the needed nutrition may be applied through the drip system. Where drip irrigation is not being used, a liquid-injection wheel can be used to place fertilizer in the bed for the second crop.

PLANT TISSUE TESTING

Nutrient analysis of plant leaves or petiole sap can provide a means for diagnosing deficiencies or for refining fertilization programs. If deficiencies are detected early enough, then corrections can be made so that yield and quality are not sacrificed. For tissue testing, most laboratories use the most-recently matured leaves. For quick in-field testing, leaf petiole sap can be analyzed by the grower using hand-held testing kits. Growers should be careful that labs and testing kits also provide calibrated nutrient guidelines that were developed from field research (Plate 4). Nutrient sufficiency ranges for Florida vegetables have been published in "Special Series SSVEC-42, *Plant tissue analysis and interpretation for vegetable crops in Florida*, by Hochmuth et al. (1991).

Table 1. Crop nutrient requirements for N, P, and K for vegetables grown on irrigated mineral (sandy) soils.

Crop	Crop nutrient requirements[1,2] N-P_2O_5-K_2O lb/A	Applicable footnotes	Crop	Crop nutrient requirement[1,2] N-P_2O_5-K_2O lb/A	Applicable footnotes
Bean, snap	90-120-120	3	Muskmelon	150-150-150	3,4,5,10
Bean, pole	90-120-120	3	Mustard greens, kale	120-150-150	3
Bean, lima	90-120-120	3	Okra	120-150-150	3
Beet	120-120-120	3	Onion, bulb	150-150-150	3
Broccoli	175-150-150	3,4,5,10	Onion, bunch, leeks	120-120-120	3
Brussels sprouts	175-150-150	3,4,5,10	Parsley	120-150-150	3
Cabbage	150-150-150	3,4,5,10	Pea, English — snow, snap, southern	60-80-80	3
Carrot	150-150-150	3	Pepper, bell, specialty	175-160-160	3,4,5,7,10,11
Cauliflower	175-150-150	3,4,5,10	Potato, Irish	175-120-140	3,12
Celery	200-200-250	3,10	Potato, sweet	60-120-120	3
Chinese cabbage	150-150-150	3,10	Pumpkin	120-120-120	3,4,5
Collards	150-150-150	3	Radish	90-120-120	3,6,9
Corn, sweet	150-120-120	3	Spinach	90-120-120	3
Cucumber	150-120-120	3,4,5	Squash, summer	120-120-120	3,4,5
Eggplant	160-160-160	3,4,5,10,11	Squash, winter	120-120-120	3,4,5
Endive, escarole	150-150-150	3,10	Strawberry	150-150-150	5,7,8
Lettuce, crisphead	150-150-150	3,10	Tomato, slicing, cherry	175-150-225	3,4,5,7,10,11
Lettuce, leaf	120-150-150	3,10	Turnip	120-150-150	3
Lettuce, romaine	150-150-150	3,10	Watermelon	150-150-150	3,4,5,10

[1]These fertilizer amounts should be applied only to soils testing "very low" in P and K. Use a calibrated soil test to determine precisely how much P and K fertilizer (if any) is needed.

[2]Additional supplemental sidedress applications of 30 lb N and 20 lb K_20 per acre should be applied only after rainfall/irrigation amounts that exceed 3 inches within a 3-day period or 4 inches within a 7-day period. Avoid mechanical damage to plants when applying sidedress fertilizers.

[3]Fertilizer should be applied in split applications to reduce leaching losses and to lessen danger of fertilizer burn. Broadcast in the bed or band all P_2O_5 and micronutrients, if any, and 25 to 50 percent of the N and K_2O at planting. Apply remaining N and K_2O in sidedress bands during the early part of the growing season.

[4]For mulched, subsurface-irrigated crops, incorporate 10 to 20 percent of the N and K_2O plus all of the P_2O_5 and micronutrients, if any, in the bed. Apply the remainder of the N and K_2O two to three inches deep in bands about 6 to 10 inches from the plant row. For mulched, overhead-irrigated crops, incorporate all of the N, P_2O_5, K_2O, and micronutrients, if any, in the bed prior to installation of the mulch.

[5]For drip irrigation, incorporate 20 to 40 percent of the N and K_2O and all of the P_2O_5 and micronutrients, if any, in the bed. For management systems where both subsurface and drip irrigation are used, apply no more than 20 percent of the N and K_2O in the bed before mulching. Apply the remainder of the N and K_2O periodically through drip tubes according to the rate of crop growth and development. For injection schedules, consult Special Series SSVEC-45, "Fertilizer application and management for micro (drip) irrigated vegetables in Florida."

[6]Apply all fertilizer prior to, or at, planting.

[7]From 25 to 30 percent of the N may be supplied from slow-release N sources, such as sulfur-coated urea or isobutylidene-diurea (IBDU). Due to higher N efficiency with slow-release N sources, it might be possible to reduce the overall N-fertilizer amount by about 15 to 20 percent.

[8]For overhead-irrigated strawberry, apply all P_2O_5 and micronutrients, if any, and 25 percent of the N and K_2O, in the bed. Place the remaining N and K_2O in a band 2 to 3 inches deep in the center of the bed.

[9]Usually adequate for 2 to 3 crops in succession.

[10]Transplants might benefit from application of starter-fertilizer solution containing N and P, especially under cool-soil temperature conditions.

[11]This is adequate N and K_2O for three harvests. Where more than three harvests are anticipated, 30 to 40 lb N per acre and 20 to 40 lb K_2O can be applied (by liquid fertilizer wheel) two to three weeks prior to each anticipated additional harvest. Where drip irrigation is used, a crop maintenance application of 1.0 to 1.5 lb N and K_2O per acre per day can be used.

[12]For Irish potato, P is supplied according to soil test results. All potatoes receive 175 lb N and 140 lb K_2O per acre in split application of 50% to 66% of the N and 50% of the K_2O at planting or at emergence and the remaining N and K at about 35 to 40 days after the planting.

Table 2. Crop nutrient requirements for N, P, and K for vegetables grown on irrigated organic soils.

Crop	Crop nutrient requirements[1,2] N-P_2O_5-K_2O lb/A	Applicable footnotes	Crop	Crop nutrient requirements[1,2] N-P_2O_5-K_2O lb/A	Applicable footnotes
Bean, snap	0-120-120	3,5	Muskmelon	- -	4
Bean, pole	0-120-180	3,5	Mustard greens, kale	0-120-180	3,5
Bean, lima	0-120-180	3,5	Okra	0-200-200	3,5
Beet	0-120-180	3,5	Onion, bulb, bunch, leeks	0-200-180	3,5
Broccoli	0-200-200	3,5	Parsley	0-200-200	3,5
Brussels sprouts	0-200-200	3,5	Pea, English, snow, snap	0-120-180	3,5
Cabbage	0-200-200	3,5	Pea, southern	0-100-150	3,5
Carrot	0-260-200	3,5	Pepper, bell, specialty	0-200-200	3,5
Cauliflower	0-200-200	3,5	Potato, Irish	0-200-200	3,5
Celery	0-260-300	3,5	Potato, sweet	- -	4
Chinese cabbage	0-280-200	3,5	Radish	0-100-100	3,5,8
Collards	0-120-120	3,5	Spinach	0-100-120	3,5
Corn, sweet	0-160-120	3,5,7	Squash, summer	0-100-120	3,5
Cucumber	- -	4	Squash, winter	0-100-120	3,5
Eggplant	0-200-200	3,5	Strawberry	- -	4
Endive, escarole	0-200-200	3,5,6,7	Tomato	- -	4
Lettuce, crisphead leaf	0-200-200	3,5,7	Turnip	0-120-180	3,5
Lettuce, romaine	0-200-200	5,7	Watermelon	- -	4

[1]These fertilizer amounts should be applied only to soils testing "very low" in P and K. Use a calibrated soil test to determine how much fertilizer is needed.

[2]These CNR values are sufficient for normal conditions. Most crops will respond to supplemental applications of 30 to 40 lb of nitrate-nitrogen per acre during periods of cool weather or after a leaching rain.

[3]On new peat soils, make a broadcast application of 11 lb of copper, 7 lb of manganese, and 1 lb of boron per acre before the crop is planted. Use a calibrated soil test to determine needs for further micronutrient applications.

[4]These crops are not recommended for production on organic soils.

[5]Apply all K and micronutrient fertilizer broadcast, just prior to planting.

[6]Includes chicory

[7]Band P fertilizer.

[8]Usually sufficient for 2 or 3 consecutive crops.

Table 3. Crop nutrient requirements for N, P, and K for vegetables grown on irrigated marl and rockland soils.

Crop	Crop nutrient requirements[1,2] $N\text{-}P_2O_5\text{-}K_2O$ lb/A	Applicable footnotes	Crop	Crop nutrient requirements[1,2] $N\text{-}P_2O_5\text{-}K_2O$ lb/A	Applicable footnotes
Bean, snap	50-100-100	3	Mustard greens, kale	100-100-100	3
Bean, pole	70-100-100	3	Okra	120-120-120	3
Bean, lima	60-100-100	3	Onion	120-120-120	3
Beet	100-100-100	3,8	Parsley	100-100-100	3
Broccoli	100-100-100	3,10	Pea, English, snow, snap	50-100-100	3
Cabbage	100-100-100	3,10	Pea, southern	50-100-100	3
Carrot	100-100-100	3,8	Pepper, bell, specialty	150-150-150	3,4,5,9,10
Cauliflower	100-100-100	3,4,10	Potato, Irish	120-120-120	3,8
Celery	120-120-120	3,10	Potato, sweet	40-80-80	3
Chinese cabbage	100-100-100	3	Radish	80-80-80	6,8
Collards, Brussels -sprouts	100-100-100	3	Spinach	80-80-80	3
Corn, sweet	100-100-100	3	Squash, summer, -pumpkin	100-100-100	3
Cucumber	100-100-100	3,4	Squash, winter	100-100-100	3
Eggplant	120-120-120	3,4,5,10	Strawberry	120-120-120	4,5,9
Endive, escarole	100-100-100	3,7	Tomato, slicing, cherry	150-200-200	3,4,5,9,10
Lettuce, crisphead, -leaf, romaine	100-100-100	3	Turnip	100-100-100	3
Muskmelon	120-120-120	4,5,10	Watermelon	120-120-120	3,4,5,10

[1]These fertilizer amounts should be applied only to soils testing "very low" in P and K. Use a calibrated soil test to determine precisely how much fertilizer is needed.

[2]Make a supplemental sidedress application to unmulched crops of 30-0-20 lb $N\text{-}P_2O_5\text{-}K_2O$/A after any rainfall event that exceeds 3 inches of water in 3 days or 4 inches in a 7-day period. Use a liquid-injection wheel or drip irrigation to apply supplemental fertilizer to mulched crops. Supplemental applications will probably not be needed on mulched crops unless flooding occurs. Crops might respond to a sidedress-band application of 30 to 40 lb P_2O_5 per acre during cool periods.

[3]For unmulched crops, apply all P and micronutrients before, or at, planting. Increased efficiency of plant use of these nutrients might be realized by banding these nutrients in the soil to the side of the row. Apply 25 to 50% of the N and K at planting, or sidedress at crop emergence. Apply the remainder of the N and K in 2 to 3 split-applications during the growing season.

[4]For mulched crops, apply 25 to 50% of the fertilizer broadcast in the bed, and the remainder in bands prior to installing the mulch.

[5]For drip-irrigated crops, apply all P and micronutrients, and 20 to 40% of the N and K, in the bed. Apply the remaining N and K through the drip system.

[6]Apply all fertilizer prior to, or at, planting.

[7]Includes escarole and chicory.

[8]These crops are not recommended for commercial production on rockland soils.

[9]Controlled or slow-release N sources, such as sulfur-coated urea or isobutylidene diurea can be used to supply 25 to 50% of the N. Use of a slow-release N product might make it possible to reduce the overall N fertilizer requirement.

[10]Crops will probably benefit from a N and P starter solution used with the transplant.

Table 4. Selected University of Florida Extension publications pertaining to crop production and fertilization.

Topic	Publication number	Title of publication
Fertilization	Circ. 225-C	Commercial Vegetable Fertilization Guide
	Bull. 183-C	Fertilizers and Fertilization
	Circ. 817	Soil, Container Media and Water Testing
Beans	Circ. 100	Bean Production Guide
Broccoli	Circ. 555	Broccoli and Cauliflower Production in Florida
Cabbage	Circ. 117	Cabbage Production Guide for Florida
Cauliflower	Circ. 555	Broccoli and Cauliflower Production in Florida
Chinese leafy vegetables	Circ. SP100	Production Guide for Florida Chinese Leafy Vegetables
Corn, sweet	Circ. 99	Sweet Corn Production in Florida
Cucumber	Circ. 101	Cucumber Production Guide for Florida
Eggplant	Circ. 109	Eggplant Production Guide
Lettuce	Circ. 123	Lettuce and Endive Production Guide
Muskmelon	Circ. 122	Muskmelon Production Guide for Florida
Okra	Circ. 492	Okra in Florida
Onions	Circ. 176	Onion Production Guide
Peas, southern	Circ. 478	The Southern Pea in Florida
Pepper	Circ. 102	Pepper Production Guide for Florida
Potato, Irish	Circ. 118	Potato Production Guide
Potato, sweet	Circ. 551	Sweet Potatoes in Florida
Squash	Circ. 103	Squash Production in Florida
Strawberry	Circ. 142	Strawberry Production Guide for Florida
Tomato	Circ. 98	Tomato Production Guide for Florida
Watermelon	Circ. SP113	Watermelon Production Guide for Florida

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