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Nitrogen Management Practices for Vegetable Production in Florida[1]

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Introduction

Nitrogen (N) is an important element for economic vegetable production, and is especially required for successful production on all mineral-soil farms in Florida. Nitrogen is required on mineral soils because such soils are largely sandy in nature, having low organic matter content. Thus, these soils retain little N against leaching so that frequent, intense rainfall, or excessive irrigation water, can leach N from the root zone and potentially into groundwater. Nitrogen management strategies should be used on vegetable farms to maximize the chances that N fertilizer will benefit crop yields and fruit quality, while minimizing the chances that N will be lost to the environment. This publication outlines some of the major N management practices, determined from research and grower experience, that can be used on vegetable farms to ensure that N fertilization results in economic vegetable production without serious negative impact on the environment.

Water Management

Water management on the vegetable farm is a critical component of N management. Regardless of the form or source of N fertilizer applied to the soil (nitrate, ammoniacal, urea, or easily mineralized organic N), the end-product, in a few days to a few weeks, is the nitrate ion, which easily leaches in sandy soils. Growers can do nothing to avoid frequent, intense **rainfall** received during the growing season; however, vegetable growers can use cultural practices and fertilizer management strategies that minimize the chances of N leaching. These practices and strategies include:

1. Using polyethylene mulch where practical, and applying N in the root zone under the mulch.

2. Reducing the water table level in subsurface-irrigated fields prior to anticipated heavy rainfall events so there is a soil reservoir for the rain water. This reduces the chances that a sudden rise in the water table will saturate the root zone, solubilize N fertilizer, and leach it from the field.

3. Scheduling N applications to coincide with crop N need and avoiding large applications of N at any given time, part of which might be leached before being used by the crop.

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4. Avoiding the application of fertilizer or N-containing organic materials, such as sludge or manure, to noncropped areas such as drive roads, field alleys, or row middles. These areas are highly subject to leaching or erosional losses of nutrients, especially in polyethylene mulch culture, because large amounts of rain are shed from the mulched beds into these noncropped areas.

5. Minimizing the chances of large residues of N fertilizer being left in the field at season s end due to overfertilization of a crop. When the crop is finished or when the mulch is removed, this remaining N is subject to leaching.

A component of water management on the farm that is within grower control is **irrigation**. Although vegetable farms receive large amounts of water from rainfall, this water often comes at times when there are no crops in the field. Therefore, irrigation is required during most seasons for successful vegetable production. There are several important irrigation management practices that should be used to minimize N leaching. These include:

1. Where practical and economical, choosing the most efficient irrigation system. In terms of water use on the farm, efficiency is often greatest with drip irrigation, less with sprinkler irrigation, and least with subsurface irrigation.

2. Operating irrigation systems at peak efficiency with attention to proper design of the overall system, pump, and water delivery components. Repairing all leaks and checking periodically for uniformity of water application, replacing worn parts in the process.

3. With subsurface irrigation, monitoring of water tables with float indicator devices and minimizing the fluctuation of water tables that can “scrub” N from the root zone.

4. Adopting soil moisture indicator devices, such as tensiometers, or other moisture-status indicator tools. For most sand-soil farms in Florida, a soil moisture potential of -8 to -12 centibars in the root zone is optimum. Moisture potential values less negative than -8 centibars indicate soil water contents that generally exceed the water-holding capacity of the soil, thereby adding to the possibility of N leaching.

5. Scheduling water applications according to crop water needs. Water requirements for several crops have been well documented and these requirements should be used as targets when scheduling irrigation, then fined-tuned using soil-moisture sensors (see Chapter 8 in Hochmuth and Maynard, 1998).

Fertilizer Management

Optimum fertilization can be accomplished by using the correct amount of N, and applying the N according to a proper schedule and method of placement. The goal is to ensure that the applied N benefits crop yield and vegetable quality, while not negatively impacting the environment. Some growers might be tempted to apply N in excess of what is needed for best yields, because the extra N is thought to reduce overall risk associated with crop production. However, this extra N also represents reduced profits when it does not contribute to greater yields or improved fruit quality. Furthermore, recent research with several vegetable crops and strawberries has documented reduced yields and reduced fruit quality with excess N. In addition, excess N can lead to more disease, and for tomato, to more damage from insects such as thrips. The following N management practices and philosophies can be used on vegetable farms to ensure the greatest benefit from N fertilization while minimizing negative impacts on the environment:

1. Knowing the crop nutrient requirement (CNR) for N and targeting this amount for total crop N fertilization. Current N recommendations for vegetables in Florida are presented in Table 1, Table 2, and Table 3 and, in several cases, are supported by more than 40 years of research and on-farm trials. Supplemental N (30 to 40 lb per acre) should be applied when an impending N deficiency is predicted by leaf or petiole sap testing, or when leaching rainfall occurs (3 inches in 3 days or 4 inches in 7 days).

2. Setting realistic yield goals. Some growers continue to think that N fertilization is the key to greater yields and, therefore, set yield goals at unrealistic and rarely achieved levels. Once

optimum N-fertilization programs, determined by research, have been set, then weather and market conditions usually determine the fluctuations in marketable yield from year to year.

3. Using polyethylene mulch, where practical, to protect N from leaching.

4. Selecting controlled-release N fertilizers when practical and economical.

5. Calibrating fertilizer applicators accurately and making adjustments to equipment so that the correct amount of N is applied in the correct position of the root zone or production bed, near the root system.

6. Applying N at periods during the growing season when crop N uptake is most active. Avoiding late-season applications of N when crop uptake rate from the soil is diminishing. Using mid-season broadcasting on unmulched crops only after roots have expanded into the row middles where they can intercept applied N.

7. Using fertigation where possible to "spoon-feed" N to crops during the season. N-application schedules have been published for vegetables grown with drip irrigation (see Hochmuth and Maynard, 1998 and Hochmuth and Smajstrla, 1997).

8. Managing irrigation water properly to avoid leaching and to keep water and N in the root zone. Following guidelines under the subtopic **"Water Management"** above. Production of crops without irrigation is risky in Florida, not only economically but environmentally as well. Well-fertilized but drought-stricken crops will leave large amounts of unused N in the soil, subject to leaching when rain returns. Water tables also must be carefully managed for mulched, subsurface-irrigated crops. If the water table drops too far, any banded N in the bed may be left in overly dry soil, not used by the crop, but susceptible to leaching by rain when the mulch is removed. Optimally managed irrigation will reduce the risk of N leaching and increase the probability of successful crops with the N fertilization programs outlined herein.

9. Using tissue-testing or petiole sap testing (Table 4) to monitor crop-N status and to determine adjustments needed in the N-fertilization program. Guidelines for plant tissue testing have been published for Florida vegetables (Hochmuth et al., 1991).

Soil Management

Sandy soils in Florida are low in organic matter content, because the organic matter is oxidized (decayed) rapidly in Florida s warm, humid environment. Florida s environment makes it difficult to maintain increased organic matter content in these sandy soils. When N-containing organic matter materials, such as animal manures or composts, are used to raise the soil s organic matter content, then consideration also must be given to the potential loss of N upon organic matter decay, which continues during the summer rainy season, for example. Therefore, N-containing organic materials should be land-applied with attention to their N concentration, rate of application, likely N mineralization (decay) rate after application, and growth pattern and N needs of the particular crops to be grown.

Cover crops between growing seasons should be used whenever feasible in vegetable production, planted immediately after the vegetable crop is terminated and the soil tilled. Cover crops will capture some of the N left behind by the vegetable crop, and return that N (and organic matter) to the soil for use by subsequent crops.

Literature

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Table 1. Nitrogen recommendations for vegetable crop production on sandy mineral soils in Florida.

Crop	N recommendations (lb/acre)[z]
Bean, snap, lima, pole	100
Beet	120
Broccoli, cauliflower, Brussels sprout	175
Cabbage, collard, Chinese cabbage	175
Carrot	175
Celery	200
Cucumber	150
Eggplant	200
Lettuce, crisphead, romaine, endive, escarole	200
Muskmelon	150
Mustard, kale, turnip	120
Okra	120
Onion, bulb	150
Onion, bunching, leek	120
Parsley	120
Pea, southern, snow, English	60
Pepper, bell, specialty	200
Potato	200
Radish	90
Spinach	90
Squash, summer, winter, pumpkin	150
Strawberry	150
Sweet corn	200
Sweet potato	60
Tomato, slicing, cherry, plum	200
Watermelon	150

[z] Rate of N application for crop growing in one acre (43,560 sq ft) using the typical row (bed) spacings summarized in Table 2. Amounts of fertilizer used “per acre” will vary with changes in amount of linear bed feet of crop in acre, as shown in Table 3.

Table 2. Typical bed (row) spacings for vegetables.

Crop	Bed (row) spacing	Number of rows (per bed)
Bean, snap, lima	30 inches	1
Broccoli, cauliflower, Brussels 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
Watermelon	8 ft	1
For the following crops, see footnote[y]		
Mustard		
Turnip		
Parsley		
Pea, snow, English		
Radish		
Spinach		

Table 2. Typical bed (row) spacings for vegetables.

Crop	Bed (row) spacing	Number of rows (per bed)
[y] 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 3. Conversion of fertilizer rates in lb/A to lb/100 linear bed feet (LBF).

Bed spacing (ft)[z]	Recommended N rate (lb/acre)												
	20	25	40	50	60	75	80	100	120	140	160	180	200
	Pounds (lb) of N 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).

Table 4. Guidelines for plant petiole fresh sap testing for vegetables grown in Florida.

Crop	Crop developmental stage	Sufficiency ranges for fresh petiole sap concentration (ppm)	
		NO_3-N	K
Broccoli and collard	Six-leaf stage	800-1000	NR[z]
	One week prior to first harvest	500-800	
	First harvest	300-500	
Cucumber	First blossom	800-1000	NR[z]
	Fruits three inches long	600-800	
	First harvest	400-600	
Eggplant	First fruit (two inches long)	1200-1600	4500-5000
	First harvest	1000-1200	4000-4500

Table 4. Guidelines for plant petiole fresh sap testing for vegetables grown in Florida.

		Sufficiency ranges for fresh petiole sap concentration (ppm)	
Crop	Crop developmental stage	NO_3-N	K
	Mid harvest	800-1000	3500-4000
Muskmelon	First blossom	1000-1200	NR[z]
	Fruits two inches long	800-1000	
	First harvest	700-800	
Pepper	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
Potato	Plants eight inches tall	1200-1400	4500-5000
	First open flowers	1000-1400	4500-5000
	50% flowers open	1000-1200	4000-4500
	100% flowers open	900-1200	3500-4000
	Tops falling over	600-900	2500-3000
Squash	First blossom	900-1000	NR[z]
	First harvest	800-900	
Strawberry	November	800-900	3000-3500
	December	600-800	3000-3500
	January	600-800	2500-3000
	February	300-500	2000-2500
	March	200-500	1800-2500

Table 4. Guidelines for plant petiole fresh sap testing for vegetables grown in Florida.

		Sufficiency ranges for fresh petiole sap concentration (ppm)	
Crop	Crop developmental stage	NO_3-N	K
	April	200-500	1500-2000
Tomato (field)	First buds	1000-1200	3500-4000
	First open flowers	600-800	3500-4000
	Fruits one inch in diameter	400-600	3000-3500
	Fruits two inches in diameter	400-600	3000-3500
	First harvest	300-400	2500-3000
	Second harvest	200-400	2000-2500
Tomato (greenhouse)	Transplant to second fruit cluster	1000-1200	4500-5000
	Second cluster to fifth fruit cluster	800-1000	4000-5000
	Harvest season (Dec.-June)	700-900	3500-4000
Watermelon	Vines 6 inches in length	1200-1500	4000-5000
	Fruits 2 inches in length	1000-1200	4000-5000
	Fruits one-half mature	800-1000	3500-4000
	At first harvest	600-800	3000-3500

[z]NR - No recommended ranges have been developed.