Spinach

Management Highlights

- Target pH: **6.5**
- Split N into two applications to increase N use-efficiency in spinach.
- Use a B soil test or apply B annually at recommended rates to avoid deficiency in the crop.

Yield Goals

Yield of spinach is influenced by many factors beyond soil test results and fertilizer application. Cultivar selection, planting date, weather condition, soil type and water-holding capacity, weed, insect and disease pressure and crop management practices are just a few. ***For that reason, the University of Delaware does not use yield goals in determining nutrient recommendations for vegetable crops at the present time. Instead, recommended rates are designed to produce maximum economic yields of high market quality in a good to average year.***

Growers should use these nutrient recommendations along with field history data, their knowledge of specific crop requirements, their management plans, and conditions from the current growing season to develop an appropriate fertilizer program for the crop.

Soil pH and Liming

The target pH for spinach on most Delaware soils is **6.5**. Soils that are higher in organic matter ("black" soils) have a lower target pH (5.6) because organic matter moderates some of the effects of excessive soil acidity (e.g., aluminum toxicity). The lime recommendation for a specific field is calculated from the soil pH and buffer pH measurements using the steps outlined in ***Calculating the Lime Requirement – Chapter 3, Section 3.4.*** Avoid overliming in order to prevent deficiency of micronutrients such as manganese.

In most cases, the lime requirement can be met by either calcitic or dolomitic limestone. When soil test Mg is less than 38 FIVs, use dolomitic limestone to prevent Mg deficiency and increase soil Mg concentrations.

Nitrogen Management

The University of Delaware recommends a total nitrogen (N) application of **100-195 lbs N/ac** per growing season for spinach. Broadcast and incorporate **50-75 lbs N/ac** at or prior to planting. Sidedress or topdress an additional **25-40 lbs N/ac** later in the season after each cutting.

When the crop has been overwintered, apply an additional **80-120 lbs N/ac** in the spring in two applications. In **late February**, sidedress or topdress **50-80 lbs N/ac**. In **late March**, apply an additional **30-40 lbs N/ac**..

The total N rate applied should be reduced when planting into legume cover crops or when manure has been applied. To calculate the adjustment, see ***Nitrogen Rate Adjustments – Chapter 3, Section 3.5.1.2.***

Phosphorus Management

Yield-limiting phosphorus (P) deficiency is rarely a concern on Delaware soils. Long-term applications of fertilizers and manures have resulted in P accumulations on many soils that are capable of supplying crop needs for several years with no further additions.

To determine whether P fertilization is necessary for a specific field, conduct a routine soil test. University of Delaware P recommendations for spinach are dependent upon the soil test P value and the P requirement of the crop. A summary of those P recommendations is given in Table 1 below.

Table 1. Phosphorus recommendations for spinach.

Application Method and Timing	P Index Value			
	0-25	26-50	51-100	101 +
	---------- lbs P_2O_5 / ac ----------			
Broadcast and disk in prior to planting	200	150	100	0

Potassium Management

The need for potassium (K) fertilization of spinach is best determined by a routine soil test. Potassium recommendations are based on the soil test K value and the K requirement of the crop. A summary of University of Delaware K rates for spinach is given in Table 2.

Table 2. Potassium recommendations for spinach.

Application Method and Timing	K Index Value			
	0-25	26-50	51-100	101 +
	---------- lbs K_2O / ac ----------			
Broadcast and disk in at or prior to planting	200	150	100	0

Calcium and Magnesium Management

Calcium (Ca) and magnesium (Mg) needs of spinach are usually met through routine liming. If the soil test Mg value is low (e.g., less than 38 FIVs) and liming is indicated, use dolomitic limestone to raise soil pH and increase soil Mg. If, however, liming is not necessary but Mg fertilization is still indicated, apply soluble Mg as Mg sulfate or Mg chloride to increase soil Mg. Appropriate application rates are given below in Table 3.

Table 3. Application rates for soluble Mg as a function of Mg fertility index value.

Mg Index Value								
0	5	10	15	20	25	30	35	40
---------- lbs soluble Mg / ac ----------								
80	70	60	50	40	30	20	10	0

Manganese Management

Manganese (Mn) deficiency may occur in spinach grown on Delaware soils, most often as a result of overliming soils that are naturally low in Mn. The University of Delaware Soil Testing Program uses an availability index based on the soil test Mn value and soil pH to predict the likelihood of Mn deficiency. That availability index is calculated using the equation:

$$MnAI = 101.7 - (15.2 \times pH) + (2.11 \times ST\text{-}Mn)$$

where:

MNAI = Mn availability index
pH = water pH of the soil
ST-Mn = Mehlich 3 soil test Mn in lbs/ac.

Table 3-14 in ***Chapter 3, Section 3.5.5.2 (Manganese Management)*** gives a summary of MNAI values for various soil pH - soil test Mn combinations. Interpretations of the Mn availability index for spinach are given below in Table 4.

Table 4. Interpretation of the Mn availability index for spinach.

MnAI Value	Interpretation
Less than 12	Mn deficiency is likely at this soil pH and Mn concentration.
12 or greater	Mn deficiency is unlikely.

Suspected Mn deficiency can be confirmed by tissue analysis. Confirmed deficiency situations can be corrected in season by foliar applications of Mn of 1-2 lbs/ac of actual Mn as Mn sulfate, Mn oxide or Mn chelate. If deficiency is predicted by the availability index or was observed during the previous growing season, it can be prevented by an application of 8-10 lbs /ac of actual Mn in the fertilizer band. Band applications of acid-forming fertilizer, which lower the pH in the area of plant roots, may correct Mn deficiency without the addition of Mn fertilizer.

Other Nutrients

No other nutrients are known to be limiting to spinach production in Delaware.

Additional Information

See Soil Test Notes 1,4, 5 and 7 (Appendix 7) and **Extension Bulletin 137*: Commercial Vegetable Production Recommendations - Delaware - 2003*** (Kee et al., 2003) for additional information concerning nutrient management of spinach.