5. Fertilization

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While fertilizer recommendations have been developed on an economic basis— which includes maximum yield, fertilizer cost, labor for application, and anticipated return—concerns for the environment also must be considered. This makes fertilizer use efficiency important. Based upon current fertilizer prices and tobacco yields, you can save 8 to 10 cents per pound of cured leaf through efficient fertilizer use. You can do this only through the use of soil tests to determine the available supply of nutrients in the soil.

Importance of Soil Testing

In the fall of 2004, many tobacco fields were flooded during tropical storms Frances and Ivan. Soil testing is very important for these fields. Floodwaters may have leached nutrients such as nitrogen, sulfur, boron, magnesium, and potassium from the soil below the root zone. In addition, floodwaters may have deposited sediment from upstream or may have caused severe erosion. In either of these situations, soil pH and nutrient levels may be very different than in previous years. The only way to know for sure is to soil test as soon as possible.

Soil testing also allows you to manage soil pH to ensure maximum yields and to minimize the possibility of manganese toxicity. Over time, soil pH declines in our soils in western North Carolina. Soil pH values as low as 4.0 have been identified in fields showing symptoms of manganese toxicity. Regular soil testing and following lime application recommendations will prevent this decline. Soil pH should be maintained in the range of 5.5 to 5.8 to maximize growth and minimize manganese toxicity. Proper liming may also aid in managing black shank disease.

For maximum economic returns, apply only the recommended rates of nutrients. Most burley tobacco producers have used complete fertilizers, such as 5-10-15, for many years and have built fertility levels in the soil. Soil test summaries over the past few years show that 70 to 80 percent of soils analyzed for burley tobacco contain high levels of phosphorus and potassium and require little or no addition of these nutrients for maximum yields. Soil testing will correctly identify the nutrients needed.

Seedling Boron Fertility

Boron deficiency may be a problem for both greenhouse and bed-grown transplants. In the case of float solutions, many growers have used soluble fertilizers containing 0.0068 percent boron, which may result in boron deficiency. The soluble tobacco-grade fertilizers contain 0.01 to 0.02 percent boron. When non-tobacco-grade fertilizers are used at the manufacturer's suggested rates, the boron concentration would be only 0.068 part per million (ppm) in the float water versus 0.360 to 0.720 ppm boron from tobacco grades. It is important to use the tobacco-grade fertilizers. Additional application of boron to the float water or routine foliar application should not be needed. In the case of ***confirmed*** boron deficiency, you may make foliar applications of 0.1 pound boron (0.5 pound Solubor) per 100 gallons to either greenhouse or seedbed plants. This treatment may be repeated in 10 days if needed. Be sure that any sprayer used has been thoroughly rinsed to prevent seedling damage due to herbicide or growth regulator residue. ***Caution:*** Remember that tobacco plants are very susceptible to boron toxicity. Do not assume that if a little is good, more is better. Severe plant damage can occur from over-application of boron.

Effect of Cold Temperatures on Seedling Boron Uptake

Boron deficiency symptoms are similar to those of cold injury. Boron deficiency is unlikely if you use a fertilizer with the proper boron content, make foliar applications, or both. If in doubt, have boron deficiency confirmed with tissue analysis.

Recent research has determined that cool temperatures may temporarily delay uptake of boron, even if there is sufficient boron in the float solution. The temperature conditions that inhibit boron uptake are similar to those that cause cold injury. Most likely, the two conditions are not related except that the same weather conditions may cause both. Cold injury symptoms should disappear on their own as soon as the temperature increases. Boron uptake also should improve when temperatures increase. This particular research did not address the use of foliar boron sprays. If you use a boron spray, it would be a good idea to leave a few trays untreated to see if indeed the spray was really needed. More information and photographs of cold injury, boron deficiency, and boron toxicity, are available in the on-line publication *Cold Injury and Boron Deficiency in Tobacco Seedlings*

(AGW-439-54), which is available on the Internet at **www.soil.ncsu.edu**.

A complete discussion of other aspects of seedling fertility and production can be found in Chapter 4. More information can be found in the publication *Tobacco Seedling Nutrition in the Greenhouse Float System* (AGW-439-48), which is also available on the Internet at **www.soil.ncsu.edu**.

Field Fertility

A well-planned fertilization program depends on the use of soil analysis and its proper interpretation. The following is a guideline for obtaining a representative soil sample and interpreting the results to develop a fertilizer program.

Soil Sampling Procedure

Because of soil variability, it is important to take samples from several locations in each field. Samples may be taken with a soil core sampler, shovel, or hand trowel and should be taken to a depth of at least 6 inches. Thoroughly mix the samples in a plastic bucket (never use a galvanized bucket because zinc contamination could occur). Fill each soil box, obtained from your county Cooperative Extension center, to the indicated level. Label the boxes carefully so that you will know which field the sample represents when the results are returned. Fill out the soil sample information sheet and submit the samples to the address shown on the box. If samples are to be sent to Raleigh by U.S. mail, write "Soil Sample" on the outside of the container in which they are shipped because there is a special postal rate for shipping soil samples. Be aware that late fall through early spring are extremely busy periods for the soil analysis laboratory, so you may find significant delays in getting results back from samples submitted then.

Interpreting the Soil Test Report

Note: The following information on soil analysis interpretation is based on the N.C. Department of Agriculture and Consumer Services publication *Crop Fertilization Based on North Carolina Soil Tests*. Soil testing is a service of the Agronomic Division of NCDA&CS.

The top line of each soil test report, which is shaded green and labeled "Test Results," gives the results of analyses performed on your

soil. These results are given in the following order and interpretation:

Soil Class. Soils are grouped into three classes in North Carolina: mineral (MIN), mineral-organic (MO), and organic (ORG). Classification is determined from soil analyses of the sample and its geographic location. Soils on which burley tobacco is grown are all classified as mineral and designated MIN.

HM%. Percent humic matter is a measure of the soluble organic constituents of the soil. The absolute value is not critical but, in general, the higher the value, the better. It generally runs 3 percent or lower and cannot be used as a guide for herbicide application based upon organic matter.

W/V. Weight/volume refers to the weight per unit volume of the soil and varies with the soil texture and organic matter content. A clay loam will have a value of approximately 1.0, whereas the value for a sandy loam may be 1.15 or higher. Also, as the organic matter content increases, the W/V declines.

CEC. This stands for ***c**ation **e**xchange **c**apacity*. It is a measure of the soil's capacity to hold cations such as calcium, magnesium, potassium, hydrogen, aluminum, iron, manganese, zinc, and copper. A high CEC is desirable because leaching of fertilizer nutrients is less likely, and higher reserves can be maintained, thus assuring an adequate supply throughout the growing season. Tobacco soils generally have a CEC between 3.5 and 15.0. You can raise this value through practices that increase the soil's organic matter, such as by planting cover crops, applying manure, and using conservation tillage systems.

BS%. The base saturation percent indicates the portion of the CEC that is occupied by nutrient cations, principally calcium, magnesium, and potassium. Generally, the higher the base saturation, the higher the plant nutrient supply and the less acidity present to interfere with plant growth. A well-limed and fertilized soil will have a BS% of 80 or higher.

Ac. Extractable acidity is the portion of the CEC occupied by the acidic cations aluminum and hydrogen. This is one of the values used to calculate the lime requirement of the soil. It will be relatively low when the soil is properly limed for tobacco production.

pH. This logarithmic expression represents the concentration of hydrogen ions in soil solutions. A pH of 7.0 is neutral, and at pH 6.0, the concentration of hydrogen is 10 times higher than at pH 7.0. This measurement is important because the availability of several plant nutrients is related to the soil pH. For burley tobacco, the value should be 6.0 or slightly higher.

P-I and K-I. These index values represent the plant nutrient availability of phosphorus and potassium. They are interpreted as low if the index is below 25, medium if it is 26 to 50, high if it is 51 to 100, and very high if it is above 100. For burley tobacco, these index values should be at least 100.

Ca% and Mg%. These values refer to the percentage of CEC occupied by calcium and magnesium. On a well-limed tobacco soil, Ca% should be 60 or higher and Mg% should be between 10 and 20.

Mn-I, Zn-I, Cu-I, and S-I. Manganese, zinc, copper, and sulfur are the remaining four elements that are routinely measured in soil samples. Manganese (Mn), zinc (Zn), and copper (Cu) are micronutrients, and sulfur is a secondary nutrient. All four are expressed as index values with 25 and above being adequate for normal plant growth. On many tobacco soils, the Mn-I may be over 100, a level that frequently results in manganese toxicity symptoms, especially if the pH is below 6.0.

Suggested Lime and Fertilizer Treatments

The second line of the soil test report for each sample lists the suggested lime and fertilizer treatments. These suggested treatments are based upon test results and were determined through many years of research and experience to result in maximum yield and quality. Under the suggested treatment, the following will appear:

Lime. Any lime application suggested on your report is designed to raise and maintain the soil pH between 5.8 and 6.2. In addition to supplying the essential calcium and magnesium, lime neutralizes aluminum, which becomes toxic to plant roots when the soil pH is too low. Increasing the soil pH also reduces the availability of manganese contained in most burley tobacco soils. The plants also take up and use phosphorus more efficiently when soils are properly limed.

There are two basic types of agricultural limestone applied to soil in North Carolina—dolomitic and calcitic. *Dolomitic limestone* is a mixture of calcium and magnesium carbonates containing at least 120 pounds Mg per ton. It is the preferred source if a $ appears in the Mg block of your report for suggested treatment. *Calcitic limestone*, which is calcium carbonate, does not contain magnesium, so it may be used for all applications where supplemental magnesium is not required.

Lime applications are most effective in the fall. However, finely ground limestone, as required by North Carolina law to be sold as agricultural limestone, may be broadcast and disked in just before transplanting.

Fertilizers. Burley tobacco producers have generally used a 5-10-15 fertilizer that has built high levels of soil phosphate and potash. Frequently, only a nitrogen application is necessary.

N rate. The column marked N (nitrogen) will have a rate of 160 to 200 pounds N per acre. Research results (Table 5-1) have shown no benefit from N application rates above 160 to 175 pounds per acre on fields producing yields less than 2,500 pounds per acre, whereas 200 pounds of nitrogen per acre are required in fields producing more than 2,500 pounds per acre. Nitrogen may come from any source shown in Table 5-2. On many soils, the recommended nitrogen may be broadcast and disked in before setting. However, on sandy textured, well-drained soils, you can achieve greater fertilizer efficiency by applying no more than 100 pounds of nitrogen per acre preplant and by topdressing the remainder 30 days after setting. Applying more than the recommended rates of nitrogen reduces use efficiency and increases the risk of groundwater contamination.

Table 5-1. Effect of nitrogen rate on the percentage of maximum yield (two yield levels)

	Yield Levels	
N rate (lb/a)	*Less than 2,500 lb/a*	*Greater than 2,500 lb/a*
	Percentage of Maximum Yield	
150	*91*	*75*
175	*99*	*84*
200	*100*	*94*
225	*99*	*97*
250	*98*	*100*

P_2O_5. This column indicates the suggested rate of phosphorus (P_2O_5) to be applied per acre. This rate is based upon the level present in the soil and reflects the amount required to raise the soil test P-I to approximately 100, which should give maximum yields. Although low levels of phosphorus may severely stunt tobacco growth, there is no advantage in exceeding the recommended rates. Any phosphorus source may be used and should be thoroughly incorporated. This is especially important if the soil test level is low.

K_2O. This column indicates the suggested rate of potash (K_2O) to be applied per acre. Potassium sulfate (0-0-50) or potassium nitrate (13-0-44) should be used. ***Do not*** *use muriate of potash (0-0-60)* as a potassium source because it contains chlorine, which causes poor curing and interferes with burning of the tobacco product. Many non-tobacco-grade complete fertilizers, such as 5-10-10 or 19-19-19, are blended with the chlorine-containing 0-0-60. For this reason, do not substitute a complete fertilizer for a tobacco-grade fertilizer.

Mg. An A, O, or $ will appear in this column depending upon the need for magnesium (Mg). An A, O, or a blank indicates no special need for Mg, and any lime source may be used. If a $ appears, any lime applied should be of the dolomitic type.

Cu, Zn, and Mn. These columns are normally blank because they represent micronutrients, and no general deficiencies of this type have been identified in burley tobacco grown in western North Carolina.

B. Boron is a highly soluble and leachable nutrient; field deficiencies have been experienced when wet winters are followed by heavy, late winter snowfall or heavy rains. Extremely low boron in tobacco tissue results in bud dieback and leaf distortion. In some cases where boron was below 10 ppm in tissue, the leaf midribs and stem have developed corky tissue. Foliar spray applications of 0.1 pound boron per 100 gallons may be used. ***Caution: Remember that tobacco plants are very susceptible to boron toxicity. Do not assume that if a little is good, more is better.***

Once N, P_2O5, and K_2O requirements have been established, consider how to supply these required nutrients at the most economical prices. Table 5-2 lists some of the recommended fertilizers

Table 5-2. Fertilizer materials and amounts to supply N, P_2O_5 and K_2O rates suggested on the soil test report

Material	Amount (lb/a)	lb/a		
		N	P_2O_5	K_2O
5-10-15	1,000	50	100	150
18-46-0	100	18	46	0
0-46-0	100	0	46	0
0-0-50	100	0	0	50
13-0-44	100	13	0	44
33-0-0	100	33	0	0
16-0-0	500	80	0	0
46-0-0	100	46	0	0

for tobacco. Assuming that the soil test results were medium (P-I=50, K-I=50), the recommendation would be to add 160 to 200 pounds N, 90 pounds P_2O_5, and 150 pounds K_2O per acre. Using Table 5-2, you could select 1,000 pounds of 5-10-15, which would supply the P_2O_5, K_2O, and 50 pounds of N. If your yield level is normally less than 2,500 pounds per acre, refer to Table 5-1 and select an N rate of 150 to 175 pounds. Since 5-10-15 supplied 50 pounds of N, you would need to add another 100 to 125 pounds of N, which could be supplied by 400 pounds of ammonium nitrate (33-0-0). Custom-blended fertilizer materials are available in most areas and can be used to meet fertility needs more effectively. By inquiring about the local price of these materials, you can also select a less costly fertilizer program.

Special Thanks

Special thanks to Dr. Jim Shelton, Dr. Jim Rideout, and Dwayne Tate, Soil Science, N.C. State University, for their input to this chapter.