



Chapter 9

Plant Tissue Analysis for Strawberry and Fertilizer Recommendations

Plant tissue analysis is an excellent means of monitoring nutrient levels in strawberries. Soil tests are very useful to determine the quantity of certain nutrients in the soil, and tissue analysis measures the levels of nutrients taken up by the plant. It is important to test both the soil and plant tissue to avoid any potential problems in a planting. Nutrient levels can be corrected when analysis indicates that abnormal levels exist. Target ranges of soil test results for strawberry are shown in Table 9-1.

Soil Test

A soil test should be taken one year before planting. Other than nitrogen, fertilizer and lime should be applied and incorporated into the soil. This application should be sufficient for a four- to five-year period or the expected life of a matted-row system.

Take a soil sample from the top 8 inches and take 10 or more samples in the field, particularly if

there are more than 5 acres, and mix the samples. Send this to a soil testing laboratory that can provide recommendations for strawberries. The recommendations are estimates for each element but do not vary for different soil types and cation exchange capacity (CEC). Clays and soils high in organic matter tend to have a higher CEC where sands have low CEC. Also, limestone differs in purity and the time acquired for it to react in the soil.

Phosphorus can be limiting in strawberries. Keeping the pH near 6.5 will aid in maintaining the optimal uptake of phosphorus. After planting, monitor plant nutrient needs with a combination of tissue analysis, soil tests, and observation of leaf conditions. In the Midwest, clay soils with a pH of 7.0 or higher with high amounts of organic matter may show low zinc in the leaf. Applications of zinc sulfate at 15 to 20 pounds per acre prior to planting have shown good results when soil zinc levels are low. Compare your soil test results with those in Table 9-1.

Table 9-1. Desirable Range of pH, Organic Matter, and Elements from Soil Test for Strawberries.

	Strawberries ^b
pH	5.8 to 6.5
Organic Matter	2 to 3%
Phosphorus ^a	60 to 80
Potassium ^a	280 to 320
Magnesium ^a	250
Boron ^a	1.5 to 2.0
Zinc ^a	10 to 12

^a Given in actual pounds of available phosphorus, boron, and zinc and as exchangeable pounds of potassium and magnesium, per acre.

^b Desirable range will vary with soil type (sand, silt, or clay), organic matter already present in the soil, and pH. Soil levels may need to be changed to correct deficiencies or excesses as they are accessed.

Leaf Analysis

Leaf analysis is used to evaluate nutritional abnormalities in strawberries. Excessive levels of certain elements can be detected along with deficiencies. Tissue analysis allows a grower to detect macro and micronutrient deficiencies before a plant's health is impaired or yields are reduced.

Fresh whole leaves should be collected for analysis. Samples should be healthy and free of disease or damage. Plant material should be kept cool using

an ice chest or refrigeration. If samples are contaminated with dust or soil, wash gently and quickly in flowing water. Do not prolong the washing, as this will leach nutrients out of the leaves. Air dry wet tissue samples on a paper towel in a cool area at least one day before mailing.

A soil sample should also be collected from the area where the plant tissue sample was collected to help in interpreting the results.

Ship to a lab as soon after sampling as possible. Record all foliar nutrient sprays in case the results are influenced by foliar fertilizer or pesticide applications.

Contact your county Extension office for information on where to send your leaf and soil samples for analysis. Be sure to read and follow all instructions regarding the completion of the record sheet submitted with each sample.

Sampling

Date, Location, and Number of Leaves to Sample

Try to collect all samples in the morning before temperatures heat up by mid-day. This will assure that turgor pressure is at its highest, and leaf tissue will be freshest for handling and shipping.

A minimum of 60 leaves should be collected by cultivar for analysis. Do not mix plant tissue samples from different cultivars. Leaves should be sampled from growth that is not too old or young. Samples should be gathered from fully expanded leaves.

Be sure to collect leaves randomly throughout the planting. A single sample should be from the same cultivar but should be taken from a number of plants. There may be a situation (*i.e.*, poor growing plants) in which you desire to collect individual samples for analysis. If you suspect that there may be a localized nutrient deficiency, try to keep this plant material separate from the rest.

Detach leaves from plants. Place leaves in a dry paper bag and label immediately. Be sure to include the date, cultivar, and field location.

Interpretation of Results

When you receive results from leaf or petiole tissue, consult the tables presented here for interpretation. The final decision requires a soil test taken from the same area as the tissue. Therefore, compare your results with Table 9-3.

These values are a composite of the best nutrition information currently available in strawberries. This assumes that the plant root system is healthy and that the soil pH is within optimal ranges for strawberries (5.8 to 6.5). If either of these assumptions is not true, do not attempt to use this information.

Remember these are guidelines, and additional information from a horticulturist may be required. For example, high organic matter plus a high pH may reduce zinc uptake even when the soil shows adequate zinc. Foliar zinc sprays may be the best choice. Soil-test results listed in ppm can be converted to lbs/acre by multiplying each number by two.

Table 9-2. Plant Tissue Sampling Periods and Crop Specifications.

Crop	Sampling Date	Leaf Number	Part Sampled
STRAWBERRY New and second season plasticulture plantings. Renewed matted-row plantings.	June 15 – July 1 July 15 – Aug. 15	60 60	Youngest fully expanded mature leaves. First fully expanded leaves.

Table 9-3. Specific Element Recommendations for Strawberries from Leaves.

Element	Deficient	Below Normal	Normal	Above Normal	Excessive
N (%)	1.50	1.80	2.00	2.80	>2.80
P (%)	0.20	0.25	0.30	0.40	>0.40
K (%)	1.00	1.50	1.60	2.50	>2.50
Ca (%)	0.60	0.69	0.70	1.70	>1.70
Mg (%)	0.25	0.29	0.30	0.50	>0.50
Mn (ppm)	40	49	50	150	>250
Fe (ppm)	30	59	60	150	>150
Cu (ppm)	5	6	7	20	>20
B (ppm)	19	24	25	35	>35
Zn (ppm)	15	20	35	50	>50

Source: Ohio State University Extension Bulletin 436 and University of Kentucky (personal communication) for leaves taken after renovation, July 15 to August 15.

Recommendations for Matted-Row Strawberries

Nitrogen (N)

Low N (if N is below 1.8). Increase rate of nitrogen application by 10% for each 0.1 that the sample is below the desired level. Apply nitrogen at renovation and again in mid-August.

N within desired range, but N/K ratio >1.5. To improve the balance between N and K in the plants, decrease the N application by 10%. Apply nitrogen at renovation and again in mid-August.

High N (if N is above 2.80). Reduce the rate of N application by 10% for each 0.1% that the sample exceeds the desired level. Apply nitrogen at renovation and again in August.

Phosphorus (P)

Low P (if P is below 0.25). Apply 200 lbs/acre 45% superphosphate at any time to the soil surface.

High P (if P is above 0.40). Omit phosphate from fertilizer program.

Potassium (K)

Low K (if K is below 1.5). Apply 45, 50, 70, 90, or 100 lbs/acre actual potassium for soil management

groups I (clay), II, III, IV, and V (sand), respectively. If Mg is also low, sulfate of potash-magnesia (sul-po-mag) can be used as a source of K at five times the above rates.

High K (if K is above 2.50). Discontinue use of K fertilizer for one year.

K within range, but N/K ratio > than 1.5 and K/Mg ratio <3.00. To improve the balance between N and K, increase K to a total of 80 lbs actual K.

K within range, but N/K ratio 4.00. To improve the balance between K and Mg, omit K from your fertilization program.

Calcium (Ca)

Low Ca (if Ca is below 0.70). Apply lime if pH is less than 6.0. See soil-test recommendations for adjustment of soil pH. If pH is greater than 6.0, then apply 1,000 lbs/acre calcium sulfate.

High Ca (if Ca is above 1.70). May indicate improper soil pH. See soil-test recommendations for adjustment.

Magnesium (Mg)

Low Mg (if Mg is below 0.30)

1. Apply magnesium sulfate (Epsom salts) to the soil surface in late fall or spring at 200 lbs/acre.

2. Use sulfate of potash-magnesia (sul-po-mag) if potassium is also low. Use at same rate as magnesium sulfate.
3. Apply dolomitic limestone according to soil-test recommendation if pH is below 5.5.
4. Make three foliar sprays of magnesium sulfate (MgSO_4) or magnesium oxide at two-week intervals beginning after renovation to temporarily correct deficiency (15 lbs MgSO_4 /100 gal/acre or 3 lbs MgO/100 gal/acre).

Mg is within range, but K/Mg ratio >5.00. To improve the balance between K and Mg, increase Mg application to a total of 80 lbs/acre actual Mg.

High Mg (if Mg is above 0.50). Omit addition of Mg.

Manganese (Mn)

Low Mn (if Mn is below 50.0). Apply a foliar spray of manganese sulfate (2 lbs/100 gal/acre) or manganese chelate (6 lbs/100 gal/acre) prior to September 15. Check for high soil pH.

High Mn (if Mn is above 200.0). May indicate a low soil pH or contamination by fungicide or irrigation water. Consult soil-test recommendations to determine need for lime. Contamination from sprays may give artificially high readings.

Iron (Fe)

Low Fe (if Fe is below 60). Apply 4 lbs/100 gal/acre ferrous sulfate or 8 lbs/100 gal/acre iron chelate as a foliar spray prior to September 15. If condition persists for several consecutive years and the soil pH is within the desired range, apply 25 lb/acre iron chelate or 15 lb/acre ferrous sulfate to soil in early spring.

High Fe. May be toxic if levels exceed 500 ppm. Contamination from sprays may give artificially high readings.

Copper (Cu)

Low Cu (if Cu is below 7). Apply copper chelate (4 lbs/100 gal/acre) in a foliar spray prior to May 15. If the condition persists for several consecutive years and the soil pH is within the desired range, apply 20 lb/acre copper sulfate to soil in late fall.

High Cu (if Cu is above 20.0). May indicate a low soil pH or contamination from sprays. Consult soil-test recommendations to determine the need for lime.

Boron (B)

Low B (if B is below 30). Apply Solubor to the soil at the rate of 4.0 lbs/acre in early spring or late fall, or apply a foliar spray of Solubor (20% actual boron) at the rate of 1.5 lb product/100 gal/acre in early spring and after renovation.

High B (if B is above 70). Discontinue use of boron. Toxicity can occur if levels exceed 100 ppm.

Zinc (Zn)

Low Zn (if Zn is below 20). Apply zinc chelate (2 lbs/100 gal/acre) once after renovation and again in early May of the following year. If the condition persists for several consecutive years and the soil pH is within the desired range, apply 10 lb/acre zinc sulfate to soil in the fall.

Zn in desired range, but P/Zn ratio >140. To improve the balance between phosphorus and zinc, apply 2 lbs of zinc chelate/100 gal/acre four times during the growing season. Follow label instructions.

High Zn (if Zn is above 50). May indicate fungicide contamination. Toxicity can occur if levels exceed 300 ppm.