FARMING

Nutrient Management in High Tunnel Systems

► **Important considerations for nutrient management in high tunnel systems are soil pH, nitrogen, phosphorus, potassium, and micronutrients.**

Nutrients and water are essential for growing any vegetable or fruit crops in a high tunnel system. Since natural rainfall is absent in high tunnel systems, water must be supplied by an irrigation system. Nutrients can be supplied through commercial fertilizer or composted materials that have been cured to kill harmful pathogens. All nutrients should be supplied based on soil test results and should be crop specific. Fertilizer can be applied to soil preplant or injected through an irrigation system during key growth stages. Some important considerations for nutrient management in high tunnel systems are soil pH, nitrogen, phosphorus, potassium, and micronutrients.

Soil pH

Soil pH is important for maximizing nutrient availability to plants. For example, nitrogen, phosphorus, potassium, sulfur, calcium, and magnesium are most available at pH 6.0 and 7.0. Iron, manganese, boron, copper, and zinc tend to be most available between pH 5.0 and 6.0. If soils are naturally rich in aluminum and iron, the pH tends to be in the acidic range (pH less than 4) and can significantly decrease nutrient availability. Under low pH conditions, large amounts of aluminum in soil can cause aluminum toxicity and inhibit root growth.

Determining pH through annual soil testing is therefore extremely important for maintaining a favorable soil environment for profitable production. If soil is too acidic for a given crop, lime is applied based on soil testing laboratory recommendations, and the amount of lime required varies between soil types and crops to be grown. There are several kinds of liming materials that can be used to raise the pH; however, these materials vary in their relative neutralizing value or calcium carbonate equivalent. Liming materials that are most commonly used are calcitic limestone, dolomitic limestone, basic slag, hydrated lime, and burned lime. For more information on liming material, see ANR-2542, “Choosing Effective Liming Materials,” on the Alabama Extension website at www.aces.edu. Lime should be applied 2 to 3 months before planting because it takes time for lime to fully react with the soil to raise the pH.

Nitrogen

Nitrogen (N) is one of the most limiting plant nutrients and is needed in large quantities for profitable production. Its management in high tunnel systems is crucial for obtaining high yields, good quality crops, and a substantial economic return. Nitrogen added to soil is subjected to several transformations. In sandy soils, nitrogen is prone to leaching. In poorly drained clay soils, nitrogen can denitrify and get lost into the air as dinitrogen (N_2) or nitrous oxide gas. Another important nitrogen loss pathway is volatilization. When urea-based fertilizers or manure are used, volatilization losses can be significant especially when soil pH is greater than 7.5 and soil temperature and moisture are high. Hence, irrigation management in high tunnel systems is crucial for managing nitrogen.

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Soil testing is not recommended to determine nitrogen levels in the soil, but recommendations are based on crop species to be grown. Once the nitrogen rate is determined, the application timing of nitrogen should be selected to match the plant nitrogen demand. Split applications of nitrogen through fertigation are a recognized best management practice. Important considerations for injecting fertilizers into irrigation water are the amount needed per application, source of fertilizer, percentage analysis of the materials, and the number of acres to be irrigated. Nitrogen overfertilization can cause excessive growth and other mineral deficiencies. Nitrogen can also leach into groundwater in sandy soils. Look for more information on efficiently using nitrogen and preventing losses in Alabama Extension publication ANR-2594, "Using a Nitrogen Budget in Farm Management."

The most common liquid source of nitrogen is urea-ammonium nitrate (UAN). Dry, solid fertilizers such as urea, ammonium nitrate, ammonium sulfate, and calcium nitrate can also be used. Composted poultry litter can also be used as a slower-release source of nitrogen. It is nutritionally rich for high tunnel systems and can provide multiple benefits. Not all litter is created equally. Several factors can cause variations in nutrient content in litter or any manure. For more information about poultry litter nutrient content and factors causing variations in nutrient concentration, see Alabama Extension publication ANR-2522, "Nutrient Content and Composition of Poultry Litter."

One ton of poultry litter can potentially provide 30 pounds of nitrogen (50 percent available nitrogen coefficient in poultry litter). However, composted poultry litter contributes more to the organic matter content of the soil than nitrogen. Avoid side-dress application of fresh poultry litter in vegetable production systems because it contains various pathogens, such as Salmonella, that can sicken anyone who eats the fresh produce. If raw poultry litter or manure is used in high tunnel organic systems, the poultry litter must be applied at least 3 months before harvesting aboveground vegetable crops or 4 months before harvesting root or leafy vegetables that stay in contact with the soil. Composting kills most pathogens in poultry litter and makes it safe for application in high tunnel systems.

Besides poultry litter, several other soil amendments of organic origin can be used in high tunnel systems. For more information on the nutrient content of common organic amendments and important considerations when choosing an organic nutrient source, see Alabama Extension publication ANR-2634, "Applying Soil Amendments of Organic Origin to Agricultural Land."

Phosphorus

Phosphorus is another important nutrient for plant growth. Too little phosphorus can cause lower yields without plants showing any deficiency symptoms. This is most commonly referred as hidden hunger. Refer to Extension publication ANR-2588, "Phosphorus Basics: Deficiency Symptoms, Sufficiency Ranges, and Common Sources," to understand functions of phosphorus in plants.

Many Alabama soils are rich in iron and aluminum oxides and have great affinity to fix phosphorus and make phosphorus unavailable for plant use. Similarly, soils that are rich in calcium (Black Belt soils, for example) can make phosphorus temporarily unavailable to plants. Refer to Extension publication ANR 2535, "Understanding Phosphorus Forms and Their Cycling in the Soil," to learn about various forms of phosphorus in soil and factors affecting their availability for plant uptake.

Soil-testing laboratories rely on extractants to determine the concentration of plant-available phosphorus in soils. The two extractants used for Alabama soils are Mehlich-1 and Mississippi. Mehlich-1 extraction is used for acidic soils of the Coastal Plain, Piedmont Plateau, Limestone Valley, and Appalachian Plateau; Mississippi extraction is used for clay soils of the Black Belt region. These extractants are used to classify a soil as having very low, low, medium, high, very high, and extremely high fertility ratings. Phosphorus is recommended for soils that have fertility ratings of very low, low, and medium. Phosphorus application in soils testing high, very high, and extremely high do not provide any yield benefits but can cause certain micronutrient deficiencies. For example, certain soils with extremely high phosphorus levels or very high rates of phosphate fertilizer (more than 200 pounds P_2O_5 per acre) can potentially cause zinc deficiency.

The most common sources of phosphorus are mono-ammonium phosphates (MAP) and di-ammonium phosphates (DAP). Phosphorus can also be supplied through composted manure or poultry litter. One ton of composted poultry litter can supply roughly 40 pounds of phosphorus (65 percent available phosphorus coefficient in poultry litter). Decomposition of manure or poultry litter is much faster in a high tunnel system due to higher soil temperature and moisture.

Potassium

Potassium (K) is associated with numerous plant functions including the movement of water, nutrients, and carbohydrates in plant tissue, regulation of stomatal opening and closing, and increased root growth. If potassium is deficient or not supplied in adequate amounts, plant growth will be stunted and yield reduced. High tunnel systems established with sandy soils require greater amounts of potassium than clays and clay loams do. Better soil moisture conditions in high tunnel systems also aid in potassium availability for uptake by plant roots. Excessive moisture or saturated conditions can reduce oxygen in the soil and reduce the root activity, however, thereby decreasing potassium uptake. Potassium deficiency occurs in lower or older leaves first.

Soil testing is the most reliable predictor of a soil's ability to supply potassium. However, the type of clay and soil parent material can also determine the soil potassium supply. The most common sources of potassium are potassium chloride (KCl), potassium sulfate (K_2SO_4), K-Mag (K_2SO_4 $2MgSO_4$), and potassium nitrate (KNO_3). Composted poultry litter is also a good source of potassium. One ton of poultry litter can supply roughly 35 pounds of potassium (86 percent available potassium coefficient in poultry litter).

Micronutrients

The seven micronutrients that plants need for optimum production are boron, zinc, manganese, copper, iron, nickel, and molybdenum. These are needed in much smaller quantities than other nutrients, however. Alabama soils are rich in most micronutrients, but recently boron and zinc deficiencies have been observed in a few Alabama soils, especially sandy and acidic soils where nutrient leaching is an issue. Tissue testing can help identify these deficiencies if symptoms are observed regularly. Applying boron or zinc based on specific crop removal rates is more practical than performing routine soil analysis. Vegetable crops such as cauliflower, broccoli, or root crops have benefitted from boron application in soils with low boron supply. Similarly, crops such as edible beans, onions, snap beans, and sweet corn show a yield response to zinc application if the soil is deficient in zinc. The most common sources of boron are borax, Solubor, and N-Boron. The most common sources of zinc are zinc sulfate, zinc oxide, and zinc chelate. Poultry litter is also a good source of boron and zinc. It should be noted that overapplication of micronutrients can cause toxicity problems.

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