The onion is a popular vegetable grown commercially and by the home gardener. Onions are in the allium family of plants, which includes garlic, leeks, shallots and chives. The popularity of these crops is driven from their unique flavor and odor. “These vegetables produce organosulfur compounds which react with the enzyme alliinase to create the compounds which give Alliums their distinctive flavors” (Brown & Conway, 2014). Primary onion production areas include Idaho, Oregon, Washington and California (Figure 1.0).

In 2016 U.S. farmers produced 3,412,850 tons of dry onions for an average of 26.25 tons per acre (USDA Ag Statistics).
Onion producers strive for optimum yield and quality to maximize economic return. Components of bulb quality include “bulb shape, scale color, scale thickness, scale retention, number of scales, bulb firmness, number of growing points, paper quality, and neck thickness” (Horneck, 2004). Managing plant nutrient application to optimize availability is a function of understanding onion physiology. “An onion bulb is different from a root (such as a sugar beet) or a stem (such as a potato). Each onion ‘ring’ is called a bulb scale in botanical terminology and is comprised of the base of a leaf. We describe onion growth and development during the following growth phases:

- Germination
- Leaf growth
- Bulb initiation
- Bulb growth
- Maturation” (Sullivan et al., 2001).

**Germination** – Onion seeds germinate uniformly when the soil temperature is greater than 50°F, although seeds will begin to germinate when the soil temperature rises above 35°F.

**Leaf Growth** – Early growth is slow compared to other cool season crops. It may require seven to nine weeks to develop three leaves. Leaf growth increases with ambient temperature and obtains maximum growth at approximately 80°F. Since each onion bulb layer is the leaf base, the number of leaves directly influences bulb size. Root development is consistent with leaf growth. New roots emerge from the base of the bulb into a sparsely branched root system. This type of root system has implications that influence management strategy for plant nutrient application (Sullivan et al., 2001, Horneck, 2004).

**Bulb Initiation** – “The bulbing growth stage is considered to begin when bulb diameter reaches twice that of the neck. Most onion varieties initiate bulbs after six to eight leaves have been produced. Bulbing begins in response to increasing day length” (Sullivan et al., 2001).

**Bulb Growth** – The greatest demand for water and plant-available nutrients occurs during this growth phase. During peak growth plant fresh weight accumulation can be 1,000-2,000 lb/ac/day (Sullivan et al., 2001).

**Maturation** – “As bulb growth slows, the onion neck becomes soft and the plant falls over. Maturation commonly is evaluated by the percentage of tops down and by the amount of dry leaves present” (Sullivan et al., 2001). After harvest the onions are graded based on size. Farmers receive a premium price for larger onion sizes. The size classes are:

- Super colossal (onion diameter > 4.25 inches – onion count must be 28-36 per 50 lb bag)
- Colossal (> 4 inches)
- Jumbo (3-4 inches)
- Medium (2.25-3 inches) (Sullivan et al., 2001)
NUTRIENT REQUIREMENTS

Onions are shallow-rooted with small branching roots in the top 6-8 inches of soil. The shallow rooting system limits access to plant nutrients, especially those immobile (P and K) in the soil environment. The mobile nutrients (NO₃ and SO₄) will move out of the rooting zone with excess rainfall or irrigation. To enhance availability and uptake of nitrogen (N) by onions, multiple (split) applications are conducted during the growing season. An onion crop in Washington that yielded 42 tons/ac (840 cwt/ac) took up 140 lb N/ac and at harvest about 80 percent of that N was removed in the bulbs (Horneck, 2004). “Since P is essential for rapid root development, a deficiency typically reduces bulb size and delays maturation. Total P uptake for a bulb yield of 840 cwt/A was 20-25 lb P/A (45-55 lb P₂O₅/A) at the time of harvest” (Horneck, 2004).

Phosphate application rates are a function of soil test analysis, calcium carbonate concentration and fumigation practices. Onions removed approximately 150 lb/ac of potassium (K) as K₂O. Application rates should be a function of soil sample analyses, especially when the soil test level is below 200 lb/ac or 100 ppm of K. “Substantial amounts of other essential nutrients … especially calcium (Ca), sulfur (S), and magnesium (Mg) … are also rapidly accumulated during the growing season. They must be available in adequate quantities to supply the rapidly growing crop. Due to the shallow nature of the root system, these nutrients must be present in relatively large amounts in the surface soil” (Horneck, 2004). Figure 2.0 illustrates the nutrient uptake demands of onions to produce 42 tons/ac.

Micronutrient research data on onions is limited. The limited data supports zinc (Zn) deficiency as a potential yield limiting factor. Zinc deficiency tends to be more prevalent in soils with high pH levels. “Soils are considered marginal at 0.8-1.0 ppm DTPA extractable Zn. Deficient Zn concentrations in leaf tissue probably are 10-20 ppm (dry wt. basis) based on data from other crops. There is insufficient data to support specific recommendations” (Sullivan et al., 2001). TIGER Micronutrients Zn 18% would be an excellent source that would provide S and Zn.

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SULPHUR’S ROLE IN ALLIUM PRODUCTION

Although S is not taken up in as large quantities as N or K it is a critical element as it is involved in protein synthesis and influences the flavor profile of the alliums. Sulphur is in several compounds that contribute to the unique flavors that onions, garlic and other alliums contain. Sulphur determines the pungency development in this group of plants, whereas sweet onions do not need the pungency and S is not a significant requirement (Boyhan, 2008). “Soils are the primary source of sulfur in plants, including onions and related Alliums. Because of the central role sulfur plays in flavor development in the Alliums, the soil nutrient status as it relates to sulfur can be very important. The amount of sulfur fertilizer that a soil requires is determined by several factors – soil texture, organic matter, leaching, sulfur content of irrigation water, previous fertilizer practices, and soil test results” (Boyhan, 2008).

A review of published literature on recommended sulphur application rates in the major onion and garlic production regions was conducted by George Boyhan. He found that the Columbia Basin area in Washington and Oregon recommended sulphur application rates at 40-60 lb/ac. In southwestern Idaho and eastern Oregon, sulphur was recommended at 40 lb/ac when the soil test and irrigation water tests were below 5 ppm. No specific rates were provided for alliums in California other than that sulphur was critical for the development of high quality onions. In Georgia the sulphur application rates varied from no sulphur for sweet onions up to 60 lb/ac for other onion varieties. TIGER 90CR or TIGER XP would be excellent choices to supply sulphur for the allium crops. Their gradual sulphur release characteristics can provide ample nutrients throughout the crop’s growing season to meet the high uptake demand.

Sulphur is an essential nutrient for all plants. The requirement for S varies by plant species. The allium family of plants has a unique demand for S. A greater understanding of the needs of these plants will contribute to maximizing a nutrient management program and optimizing crop productivity.

References: