Fertilizer Guidelines for Potatoes

Domesticated potatoes descend from wild potatoes native to the Andean mountains at an elevation of 4,000 to 12,000 feet where days are short, the climate is cool, and moisture is abundant. They produce 75 percent more calories per acre and 54 percent more protein per unit than wheat or rice. Although this crop produces more calories per acre than any other crop, it needs a surprisingly minimal amount of water and nutrients. For instance, a single 5.3-ounce potato can provide six grams of protein, 45 percent of the daily dose of Vitamin C, and 10 percent of the daily dose of B_6 but only requires approximately 160-240 pound per acre of nitrogen from all sources and 18-30 inches of water for a 20 ton per acre crop. In addition, a wide variety of soils suit potato growth with a well-drained and friable soil being ideal. Soil type is less critical when irrigation is used and planted when soil temperatures are between 45°F-70°F. These genetics and forgiving requirements, in most potato cultivates, dictate the nutrient requirements for the 22.7 million metric tons of potatoes grown annually in the US today.

Potato yield, quality, and its ability to resist biotic and abiotic stress is directly affected by proper nutrition. There are 17 nutrients essential for plant growth. Carbon, oxygen, and hydrogen are non-mineral elements and are supplied primarily through air and water. Added fertilizers and residual mineral nutrients residing in the soil, supply the remaining mineral nutrients.

Split N applications normally benefit potatoes with the optimum N rate and timing differing greatly among varieties and soil type. About 50% of the total rate should be applied at planting for long season varieties and 60%-100% of the total rate is applied pre-plant for short-season potatoes. During the tuber initiation and tuber bulking stages the remainder should be applied since late season cultivars will take up 25 to 30 pounds of nitrogen per week during bulking. Less of the N rate should be applied at or before planting on very sandy soils. As part of the total N rate, residual nitrogen from all sources should be included. A pre-plant application may be unnecessary and may even produce lower yields in soils with high available N. But approximately 160-240 pounds per acre will likely be needed for optimal projected yields of 20 tons per acre depending on potato variety, soil type, and moisture.

Pre-plant N is broadcasted while starter N is normally banded with varying methods and in varying forms depending on the conditions and costs. Pre-plant N is often broadcast along with other pre-plant fertilizers, and should be incorporated into the top 6-12 inches of soil, either mechanically or with irrigation water with equal benefit. Ammonium may be preferred over nitrate and urea because it is less at risk of leaching for pre-plant applications in sandy soils but may convert quickly, undergo nitrification, and leach out as nitrate. Since potato tubers are modified stems and used as "seeds," most germination is upwards and roots do not go much deeper than the seed piece which is planted at 2-12 inches. As a result of this unique growth characteristic, starter fertilizer bands should be located at least two inches away from the seed, on one or both sides. When soil condition are not ideal, foliar sprays of N may be useful in treating in-season deficiencies. In general, fertigation and side-dressing are less expensive and are preferred when

possible. Controlled release fertilizers such as polymer-coated urea may reduce early-season leaching losses and increase N use efficiency as well.

Anticipated yields and soil P tests determine appropriate P; rates, timing, and methods of applications. P fertilization is contingent upon uptake losses with the harvested tubers when soil test P is sufficient. Approximately 5 to 7 lbs P (11.5 to 16 lbs P_2O_5) are removed with every five metric tons of tubers. Soil test P values and petiole analyses should be the primary tool because actual potato P uptake depends on the variety and soil type. Phosphorus fertilizers are incorporated into the top 6-12 inches of soil and applied prior to planting via broadcasting along with other pre-plant fertilizers. Broadcasting of P is done because it encourages an adequate supply of P throughout the raised bed rooting area into the furrow. It may be broadcast and incorporated any time prior to planting because P is not mobile in the soil. It is more effective to apply sufficient P as a pre-plant or starter fertilizer but some additional P may be fertigated or side-dressed to correct deficiencies that may arise in-season. While foliar P may be applied as a rescue measure for deficient plants in difficult soils, it is less effective than an adequate soil application. Since P is important to early season root growth, canopy development and tuber set and is not likely to leach, it is best to apply the entire requirement at pre-plant or at planting.

Granular and liquid P fertilizers are generally used. Uptake of both nutrients is increased when P and ammonium-N are delivered at the same time due to the acidifying effect of ammonium-N. To avoid damaging the seed do not utilize urea ammonium phosphate (UAP) or diammonium phosphate (DAP) as they emit free ammonia. In addition, they should not be banded at rates higher than 240 lbs P2O5 per acre or closer than 2 inches from the seed, mainly in course soils.

Expected yields and soil K tests govern proper K; rates, timing, and methods of applications. K is taken up by potatoes more than any other nutrient with the bulk of it being incorporated into the tubers. High K levels are common throughout California and yields may not increase with K fertilizer. However, the soil may become depleted over time because on average potato tubers remove about 40-70 lbs of K_2O for each 5 metric tons of yield. Approximately 160-280 pounds per acre of available K_2O would be required to replenish the K removed with a 20-metric ton per acre yield in a soil that is not deficient. Any time prior to final bed preparation is suitable for K fertilization because K does not leach much in the soil. The exception is in very course soils. However, broadcasting and incorporating half the K rate in the preceding fall and half in spring for spring-planted potatoes, will reduce the danger of damaging seeds if more than 300 lbs K_2O per acre is needed. Since, most of K is absorbed into the tuber and not the leaf, foliar applications will likely have little effect. Although little research has been done to make this a definitive estimation it is advised to apply K during the pre-plant phase unless soil conditions are difficult. More research is needed in California to determine the effectiveness of in-season K application to potatoes.

Suitability of application and price typically are the deciding factor in the choice of K fertilizer. However, potassium chloride (KCl) has a high salt index and potatoes are slightly

sensitive to salt so it would not be a great choice. Potassium sulfate (K_2SO_4) or a blend of K_2SO_4 and KCl is advised when applying greater than 300 pounds per acre because it increases specific gravity as well as yields of tubers. When soils or irrigation water is saline, potassium sulfate may be a good choice. Sulfate ions and chloride ions are also required nutrients for potato, albeit in ppm amounts. None the less, a blend of K_2SO_4 and KCl can also be beneficial under the correct conditions because they provide these vital ions. Also used, are potassium nitrate (KNO3) and potassium thiosulfate (KTS).

Many growers will lower the pH of the soil with various acidulants to prevent common scab in potatoes. However, this influences nutrient availability and microbial activity that decomposes organic matter. The availability of phosphorus, calcium, and potassium decline as soil pH drops below 6.0 while aluminum, iron, zinc, manganese, and copper increase. As the pH drops, aluminum toxicity can become a problem as it is detrimental to plant growth. Although potatoes are more tolerant to low pH, it is advised to keep the pH between 6.0 to 6.5 if not using a variety that is especially susceptible to common scab. If a susceptible cultivar is used, the pH should be between 5.0 to 5.4. If the more acidic soil is used, decomposition of organic matter will be reduced significantly due to decreased microbial activity so mineralization rates will be less predictable. Close monitoring of soil nutrients and nutrients within plant tissue must be monitored more closely in acidic soils and lime must be utilized if pH's fall below 5 in all soil types and cultivars. When raising or lowering pH it is best to experiment on a small unused plot that represents the soil or place the soil in some sort of large container like a 150-gallon horse trough before amending the soil with recommended amounts corresponding to the soil type.

There are many important and detailed potato yield and quality problems caused by nutrient deficiencies and surpluses. The specific gravity of potatoes can decrease if phosphorus deficiencies occur and if excess potassium and nitrogen occurs. Interruption of tuberization and delayed skin development at maturity occurs if excessive nitrogen is applied. Too much nitrogen can also harbor pathogens that increase the chances of infection. Various growth and development disorders can cause warped tubers, hollow heart, and brown center if nutrients are not provided in sufficient amounts at corresponding growth and developmental stages. Storage problems arise if potassium deficiencies are present and can cause black spot bruise at harvest, and darkened color. Internal brown spot is associated with calcium deficiency. Not only is it vital to provide adequate nutrients to the plant it must be provided at the right time, at the right rate, with the right fertilizer source, and at the right place to ensure optimal yield and quality are achieved.

Reference

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