TIGER-SUL UNIVERSITY

# INCORPORATING NUTRIENT MANAGEMENT IN POTATO PRODUCTION

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The potato is a nutritious, nutrient dense vegetable recommended as part of a healthy, balanced diet. Potatoes are a primary staple is North American diets and can be grown in most areas; although, there are specific areas more conducive to potato production due to climate and soil conditions. There is wide range of production from backyard gardens to commercial operations. Potatoes are produced for specific purposes including fresh market, processing such as fries, chips, frozen goods and seed stock. Each end market purpose requires unique set of production requirements to maximize yield and quality.

Potatoes produced in intensive management environments have high demand for plant nutrients. Producers must strive to enhance plant nutrient availability throughout the growing season. "To optimize fertilizer use efficiency potato growers need to understand: 1) nutrient uptake patterns and associated sufficiency levels for soil and plant tissue nutrient concentrations, 2) cultural and environmental factors that influence plant nutrient availability, and 3) fertilizer management practices that optimize nutrient use efficiency" (Stark et al. 2004). Familiarity with plant physiology will enhance an individual's correlation between growth stages and plant nutrient demands (Figure 1.0).

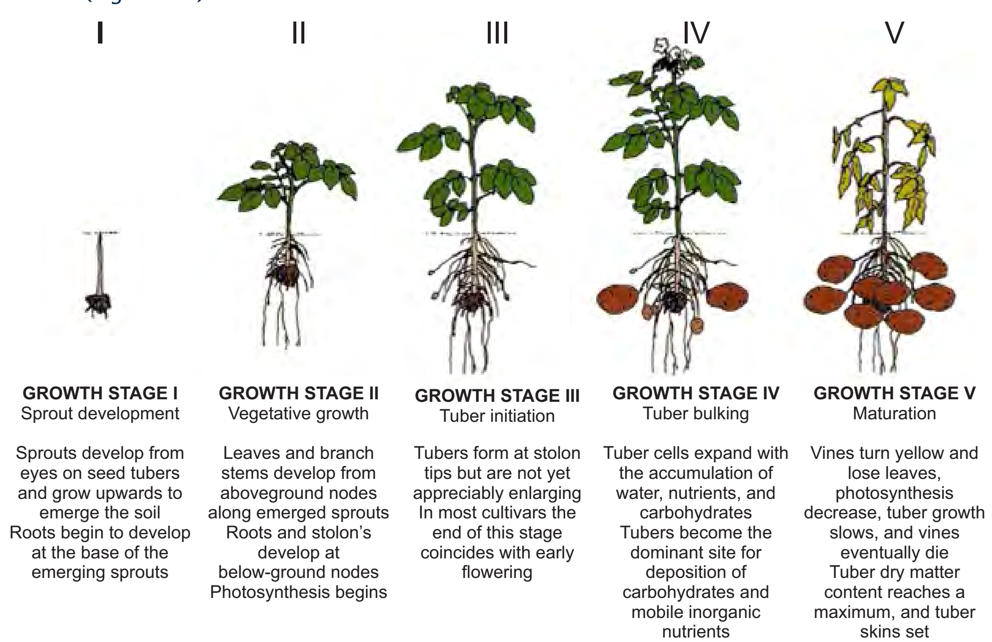
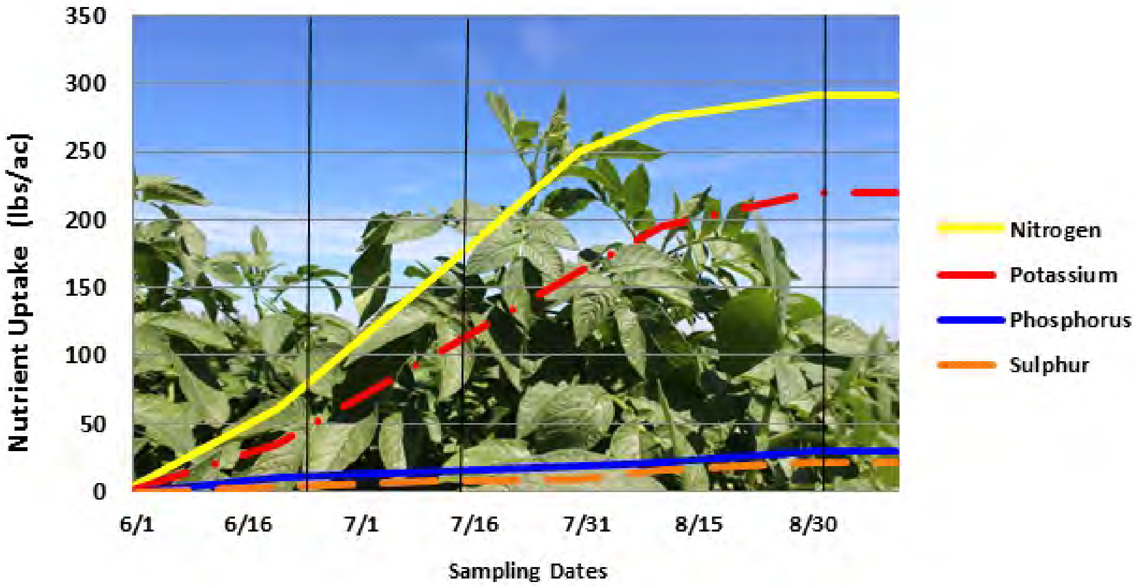



Figure 1.0 Potato growth stages (Graphics: University of Wisconsin)

## Plant Nutrient Uptake

An understanding of nutrient uptake requirements enhances nutrient management planning. Potatoes take up approximately 40-50% of their nitrogen (N) and potassium (K) needs and about 30-40% of the phosphorus (P) and sulphur (S) requirements prior to tuber bulking. During the bulking growth stage nutrient uptake increases dramatically and levels out as plant matures (Figure 2.0). Russet Burbank potatoes with tuber yields of 400 – 500 cubic 100 weight (cwt) per acre will take up significant amounts of nutrients: N 200-240 lbs/ac, K 280 – 320 lbs/ac, P 25-35 lbs/ac, S 18-24 lbs/ac. (Stark et al., 2004).

Figure 2.0 Potato nutrient uptake 3 years average. (Adapted from Stark et al., 2004)




Soil conditions can influence plant nutrient availability. Compaction, hardpans, shallow soils, and soil texture alter plant root growth resulting in less soil volume from which nutrients can be accessed. Sandy soils have a low cation exchange capacity (CEC) which results in low nutrient holding ability and potential for some nutrient leaching. Soil temperature influences the biological and chemical processes. Root growth is slow at low soil temperature and contributes to limited access to immobile nutrients. Microbial activity is reduced when soil temperature is below 60ºF followed by slower nutrient mineralization such as nitrogen and sulphur. Soil pH regulates nutrient availability with optimum levels at 6.5-7.0. Phosphorus and the micronutrients availability decreases as the soil pH increases above 7.0. When soil pH falls below 6.0, phosphorus availability decreases due to interactions with iron and aluminum oxides.

## Monitoring Potato Nutrient Demand

Sulphur is often overlooked as a nutrient addition in potato nutrient management programs. If soil sample analyses reveal S levels less than 10 ppm and previous crop history of a given field has had low sulphur levels, it would be wise to apply 30 – 40 pounds per acre (lbs/ac) of S to enhance the crop's yield potential. Those sulphur rates could be met with TIGER 90CR at 33 - 45 lbs/ac or TIGER XP at 35 – 47 lbs/ac. Potatoes tend to respond to Zn and Mn micronutrients with greater yield and/or quality. Table 1.0 provides the minimal soil test values for selected micronutrients. If your soil test analysis has values less than those shown, additional micronutrients should be included in the nutrient management plan such as 1) TIGER Micronutrients Potato Mix, 2) TIGER Micronutrients Root Crop Mix, 3) TruTerra $ZnSO_4$, or 4) TruTerra $MnSO_4$.

Table 1.0 Minimal micronutrient soil test values for potato production (Adapted from Stark et al. 2004)

| Zn | Mn | Fe | Cu | B |
|---|---|---|---|---|
| | | ppm | | |
| > 1.5 | > 6.0 | > 4.0 | > 0.2 | > 0.5 |

**A guide line for plant nutrient applications should be the soil test analyses and expected yield potential. That yield potential should be an average of last 3-5 crops from each field plus additional 10 – 15%.**

**Efficient potato production requires consistent crop monitoring throughout the growing season. One method of evaluating potato growth is plant tissue collections and analyses. Plant nutrient status can be evaluated throughout the growing season and immediate corrective actions can be implemented, especially where irrigation is available. Collections should begin approximately 4 weeks following plant emergence and continue every 10 days till about 4 weeks prior to vine defoliation. The plant part to collect is the petiole at fourth node (Lang et al., 1999, Figure 3.0). The leaflets should be removed and only submit the petiole from approximately from 30 – 40 plants.**

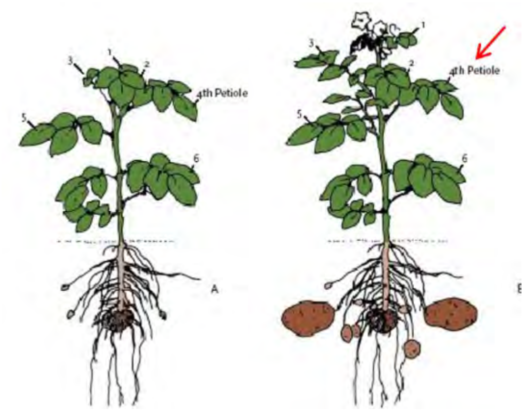



Figure 3.0 Petiole selections for plant tissue collection from potatoes. (Hopkins et al., 2004 & Potato Health Mgt, 1993)

Table 2.0 Potato petiole nutrient content levels.

| Nutrient | Low | Marginal | Sufficient |
|---|---|---|---|
| Nitrate nitrogen, ppm | < 10,000 | 10,000 - 15,000 | 15,000 - 20,000 |
| Phosphorus % | < 0.17 | 0.17 - 0.22 | < 0.22 |
| Potassium % | < 7 | 7.0 - 8.0 | < 8.0 |
| Calcium % | < 0.4 | < 0.4 - 6.0 | < 0.6 |
| Magnesium % | < 0.15 | 0.15 - 0.3 | < 0.3 |
| Sulphur % | < 0.15 | 0.15 - 0.20 | < 0.2 |
| Zinc ppm | < 15 | 15 - 25 | < 25 |
| Manganese ppm | < 20 | 20 - 40 | < 40 |
| Iron ppm | < 20 | 20 - 50 | < 50 |
| Copper ppm | < 2 | 2.0 - 4.0 | < 4 |
| Boron ppm | < 10 | 10.0 - 20.0 | < 20 |

Adapted from Stark et al., 2004

Table 2.0 reflects desired nutrient levels in potato petiole analyses. Due to lack of time and space all plant nutrients will not be discussed. Potatoes with less than 0.15% of sulphur in the petioles should receive 30 – 40 lbs/ac of sulphur. If sulphur levels are below 0.15% foliar deficiency symptoms may be displayed. Sulphur is not mobile within the plant and the symptoms are evident in the younger leaves. There will be general yellowing of young leaves in top of plant and lower leaves have normal appearance with dark green color (photo 1.0). Other test values that are at or below those listed in the "low" column should receive immediate attention.

Photo: 1.0 Sulphur deficiency symptoms in potatoes. Young leaves at growing point turn yellowish-green. (Photo: University of Idaho)

## Nutrient Application

Potatoes have a relatively high nutrient requirement and a small root system (Stark and Love, 2003). As a result, producers commonly apply significantly more fertilizer materials to their potato crops as compared to grain and other rotational crops that tend to be more nutrient efficient (Hopkins & Stephens, 2007).

Various application methods may be employed to field apply plant nutrients. Most nutrients including sulphur (TIGER 90CR, TIGER XP, or TIGER Micronutrients) can be applied in fall or spring broadcast and incorporated into the rooting zone. Two exceptions are manganese sulphate ($MnSO_4$) and iron sulphate ($FeSO_4$) which tend to interact with oxides and converted to an unavailable form especially in calcareous soils. These sulphate forms should be spring applied as a band at planting. Other fertilizer application methods commonly used for potatoes include:

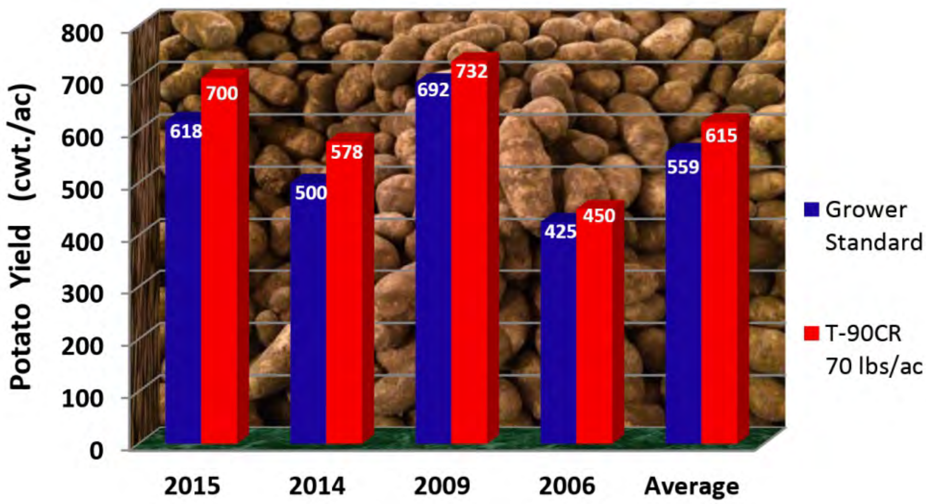
1) banding at mark-out or planting,
2) side-dressing after planting,
3) foliar nutrient sprays,
4) injecting liquid fertilizer through the irrigation system (Hopkins et al., 2004)

Banding at mark-out fertilizer is placed 2-3 inches to side and below the seed piece. Banding applications at planting are typically placed 1 to 2 inches to side and above the seed piece.

Side dressing after planting is a popular application method for nitrogen to enhance plant uptake by timing application with crop demand. Foliar nutrient sprays are utilized to apply low concentration nutrient formulations to treat nutrient deficiencies, especially some micronutrients. Injecting liquid fertilizer through the irrigation system is a method utilized to provide water soluble plant nutrients throughout the growing season. This system has proved very successful with nitrogen applications on sandy soils (Mikkelsen, 2006).

When a potato nutrient plan is implemented it results in greater yield potential. Granted, many factors influence crop yield. A producer's goal should be to minimize or eliminate those yield limiting factors he/she may have control of in a given field. One of those yield limiting factors producers can influence is plant nutrients. H.J. Baker & Bro. strives to assist in the plant nutrient area with research projects to evaluate potato yield response to sulphur products. As illustrated in Figure 4.0 the addition of sulphur with TIGER 90CR resulted in an average increase of 56 cwt. or 10% yield increase as compared to the grower standard which was the plant nutrient program implemented in remainder of field.

Figure 4.0 Potato yield response to TIGER 90CR sulphur. Average of 4 years over 3 locations.




Nutrient ions taken up by plants are the same irrespective of the source such as plant or animal residue, soil minerals, manure, or commercial fertilizer. Although, there are efficiencies and inefficiencies between the various nutrient sources and it is the responsibility of producers and professional advisers to recognize potential situations and incorporate appropriate management adjustments. Following the 4R best management practices will facilitate "fine-tuning" management decisions to optimize potato production. Successful potato production requires progressive integrated management to incorporate knowledge of the crop, influence of climate/weather, soil/water resources, cultural practices that promote optimum growth potential, and the interaction of all these factors that contribute to potato yield and quality.

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