IDAHO

Potassium Diagnostic Criteria for Potato Plants

By D.T. Westermann and T.A. Tindall

Potassium is required for the functionality of many plant enzyme systems, transport of starch and sugars, and osmotic regulation. It is highly mobile in both the xylem and phloem conductive tissues of plants. When plants are K deficient, they may be stunted, the younger leaves may develop a crinkly surface, and their margins roll downward. Leaves have slightly black pigmentation. Marginal scorching with necrotic spots may occur on older leaves (see photo).

Potassium (K) deficiency in Russet Burbank potatoes will not occur as long as petiole K concentrations remain above about 7 percent as determined by 'K balance' (total plant uptake/ tuber uptake). Highest tuber yield and quality will be obtained when the K concentration of the petiole is kept above a 'K balance' concentration of 1.0 until about 20 days before scheduled vine kill or harvest.

Some plant disease symptoms can also mask K deficiency symptoms and will nearly always be present when potato plant K concentrations are marginal or low.

High yields are being achieved by many North American potato growers today. Production of 500 cwt/A can remove over 240 lb K_2O/A (200 lb K) in the tubers. Tubers become the dominant sink for carbohydrates and mobile inorganic nutrients during linear tuber bulking, often at the expense of the other vegetative portions of the plant. Most nutrient uptake occurs during this growth stage. As the plant matures, nutrients and dry matter in the tops and roots are also solubilized and translocated into the tubers. For highly mobile nutrients, such as K, the harvested tubers may contain over 90 percent of the total uptake, while only 10 to 20 percent of immobile nutrients are contained in the tubers.

Many potato growers apply a portion of the nutritional requirement as liquid fertilizers with the irrigation system. This practice provides an opportunity for a higher intensity of nutritional management during growth than possible with only preplant fertilization. This approach requires knowing the relationship between the nutrient concentration in a plant part and the nutrient status in the plant. For potatoes, this status can be defined as the ratio between the rate required by tuber growth divided by total plant uptake rate. When this ratio or balance is greater than 1.0, there is more nutrient uptake than required by tuber growth, so nutrients accumulate in the other vegetative portions of the plant or are available for additional growth. When the ratio is less than 1.0, uptake is less than that required for tuber growth, and mobile nutrients will be translocated out of the vegetative portions of the plant to the developing

Potassium deficiency symptoms during tuber growth of Russet Burbank potatoes.

tubers. This approach is currently being used for the nitrogen (N) and phosphorus (P) management of Russet Burbank potatoes using petiole nutrient concentrations.

When K availabilities and concentrations are relatively high, excessive K is translocated to the tubers, causing tuber dry matter to decrease because of increasing water content. Low K concentrations decrease tuber dry matter via a metabolic reduction in starch formation as well as reducing photosynthate needed for growth. The optimum tuber K concentration for highest dry matter is 1.8 percent on a dry matter basis. At this concentration, 0.4 lb K/A (0.48 lb K_2O/A) is required to grow 100 lb of fresh weight tubers. The goal of a K fertilization program for potatoes is to provide sufficient available K to achieve this concentration for all of tuber growth.

We undertook a study to develop a 'K balance' relationship for Russet Burbank potatoes from several field experiments established on grower fields in southern Idaho and northern Utah. There was a significant tuber yield and quality response to K fertilization in most experiments. Plant sampling started at early tuber growth (late June) and continued on about a 21 day interval until vines died or were killed prior to harvest. Plant samples consisted of petioles from the fourth leaf and the tops, tubers, and easily recoverable roots from a section of row.

Petiole K Response

Petiole K concentrations generally decrease with time after tuber initiation (**Figure 1**). The rate of decrease depends on plant/tuber growth rate and the amount of available K. The available K can come from soil, water, and recent fertilizer applications. Petiole concentrations can be very high initially when soil K availabilities are high or where large amounts of preplant K were applied. Fertilizer materials of greater solubility give higher petiole concentrations. Petiole K concentrations also respond to fertigation applications containing K.

We found that the petiole K concentration was linearly related to the K concentration in the photosynthetically active leaves. It was also significantly linearly related to the K concentrations in the above-ground plant parts and tubers. This indicates that K concentration in the fourth petiole is a good indication of the K status of the plant.

The relationship between the petiole K concentration and 'K balance' showed that the average K concentration was 6.4 percent when the 'K balance' was '1' (**Figure 2**). The 'K balance' and petiole concentration relationship was much better for individual experiments as it was dependent on the average tuber growth rate. The 'K balance' concentration varied between 5.4 and 7.3 percent K and was lower at the smaller tuber growth rates.

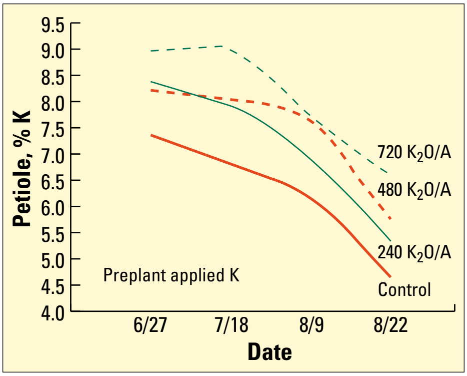

Figure 1. Typical changes in petiole K concentrations with time during Russet Burbank tuber growth.

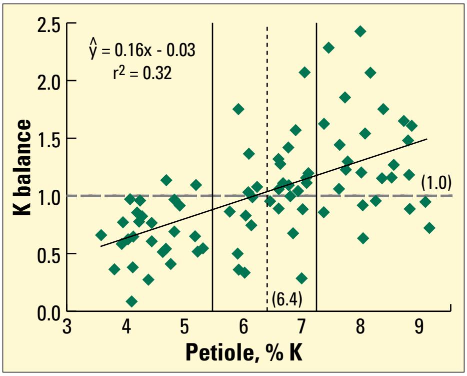

Figure 2. Relationship between petiole K concentrations and 'K balance' during Russet Burbank tuber growth. The lines on both sides of 6.4 show the range of K balances in seven individual experiments.

These data indicate that a K deficiency in Russet Burbank potatoes will not occur as long as petiole K concentrations remain above about 7 percent. Growers monitoring the K status of potato plants can use this concentration to schedule additional K materials via fertigation. Applications should be made 15 to 20 days before petioles reach this concentration for best results as there is a lag period for uptake to occur. Future petiole K concentrations may be estimated by plotting known concentrations against time and projecting the concentration trend line. This should be done for each field as the pattern of petiole K concentration with time is highly variable. For highest tuber yields and quality, K concentration of the petiole should be kept above the 'K balance' concentration until about 20 days before scheduled vine kill or harvest for best utilization of K sources. This will also allow tuber K concentration to decrease towards the optimum concentration.

Dr. Westermann is Soil Scientist, USDA-ARS, Kimberly, ID. Dr. Tindall is Agronomist, J.R. Simplot, Pocatello, ID. E-mail: ttindall@simplot.com

Research conducted with partial financial support from PPI, IMC Global (Great Salt Lake Minerals & Chemical Corporation), Agrium Inc. (Cominco Fertilizer Inc.), Idaho Potato Growers Association, and Idaho Fertilizer and Chemical Association.

Research Notes

Alberta: Canadian Spring Canola Yields Keep Climbing

The report of a 71 bu/A spring canola yield featured in the recent article "High Yielding Canola Production" (*Better Crops with Plant Food* 84: 26-27) was out only for a short time when reports of even higher canola yields were received. Mr. Lenz Haderlein, a research agronomist with Agrium, reported a spring canola yield of 96 bu/A in 1996. These record yields were obtained from a potassium (K) response trial conducted at the University of Alberta Ellerslie Research Farm near Edmonton, Alberta. The trial site had been a long-term alfalfa-brome hay field, broken in fall 1994 and left fallow during 1995. The site had high background nitrogen (N) fertility (146 lb/A), marginal K (201 lb/A) and sulfur (S) levels (41 lb/A), and deficient phosphorus (P) levels (15 lb/A).

The spring canola cultivar Quantum (*Brassica napus*) was seeded on May 8 at 14 plants/sq. ft., with a side banded fertilizer application of 93 lb N/A, 31 lb P_2O_5/A, and 18 lb SO_4-S/A. The K was applied at rates of 0, 13, 27, or 40 lb K_2O/A as potassium chloride (KCl). Even though K levels were considered marginal by soil test at this site, there was no response to K additions. The 1996 growing season was characterized by abundant rainfall through June, July and August, with air temperatures cooler than the long-term normal and an open fall, free of any early frost. Across the six replicate, four treatment trial (24 plots total), canola yields ranged from a low of 82 bu/A to a high of 105 bu/A at a grain moisture content of 4.5 percent. These high yield results illustrate that when optimum environmental conditions are matched with superior cultivars and balanced nutrient management, high yields of spring canola are achievable in the sub-humid climate of western Canada.

Source: Mr. Lenz Haderlein, Research Agronomist, Agrium, Redwater, Alberta. E-mail: lhaderle@agrium.com and Dr. Adrian Johnston, Western Canada Director, PPI/PPIC, Saskatoon, Saskatchewan. E-mail: ajohnston@ppi-ppic.org