Soil Potassium in Uruguay: Current Situation and Future Prospects

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Recent field research in Uruguay has revealed K deficiencies in the main field crops of the country. A preliminary survey indicates that almost 5 M ha would be deficient in K. A critical soil test K (STK) level of 0.34 meq/100g (133 ppm) has been estimated based on 50 field trials conducted on the six primary field crops.

Efforts to understand K dynamics in soils of Uruguay have been scarce compared with those that have measured soil N and P dynamics. These latter studies have already been conducted for numerous cropping situations and systems. Historically, soil P experimentation has had a much higher priority over K (**Figure 1**).

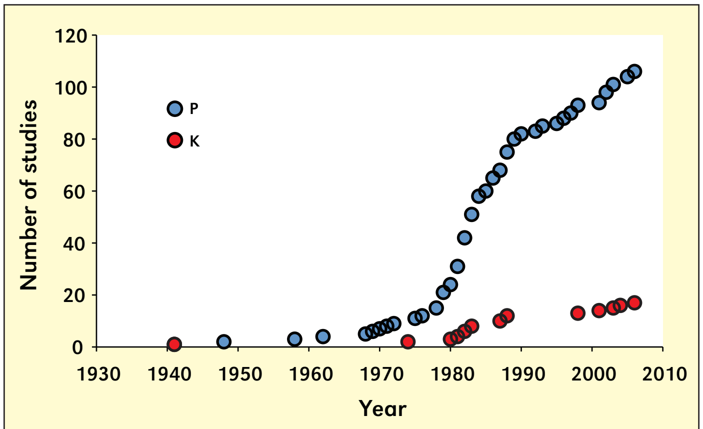

Figure 1. Number of P and K studies in Uruguay for grain crops and forages made between 1950 and 2010.

Earlier studies on crop response to K fertilization have been done for those with high K requirements such as sugarcane, sugar beet, potato, onion, and cotton. Some guidelines for fertilizer recommendations, based on soil type, have also been established (Oudri et al., 1976). In grain crops, the first K studies were made in the 1960s where K responses were observed in wheat grown in soils developed from cretaceous sandstones (Moir and Reynaert, 1962; Castro, 1965). Two decades later, a few studies in soybean showed little or no K response in Uruguay's northeastern soils (Docampo et al., 1981; Marella et al., 1981; Colombo and Collares, 1982; Pereira et al., 1983).

The lack of K studies has likely been due to the development of agriculture on high K soils under conventional tillage, and crop rotations that included pastures, which resulted in no K fertilizer recommendations. Potassium fertilization was recommended only below 0.30 meq/100g (117 ppm), following references from the U.S. Corn Belt, which reported low K response probability with STK levels over 0.23 to 0.33 meq/100g (90 to 130 ppm) in soybean and maize under conventional tillage (Voss, 1982).

More recently, Morón and Baethgen (1996) and Barbazán et al. (2007) reported some cases of K deficiency symptoms in soils with low STK in maize and *Lotus corniculatus* L. Moreover, the increasingly frequent occurrence of visual symptoms of K deficiency, confirmed by plant analysis, has led to more specific studies showing K responses in several crops (Almada, 2006; Cano et al., 2007, 2009; Bautes et al., 2009; García et al., 2009). Determining a critical STK level for a wide range of situations has been a key challenge. Barbazán et al. (2010, 2011) summarized 50 recent studies (which had the same tillage system, and similar experimental design, rate, and K source), and found a critical STK level of 0.34 meq/100g (133 ppm; 0 to 20 cm depth), representing a breakthrough in K research in Uruguay (**Figure 2**).

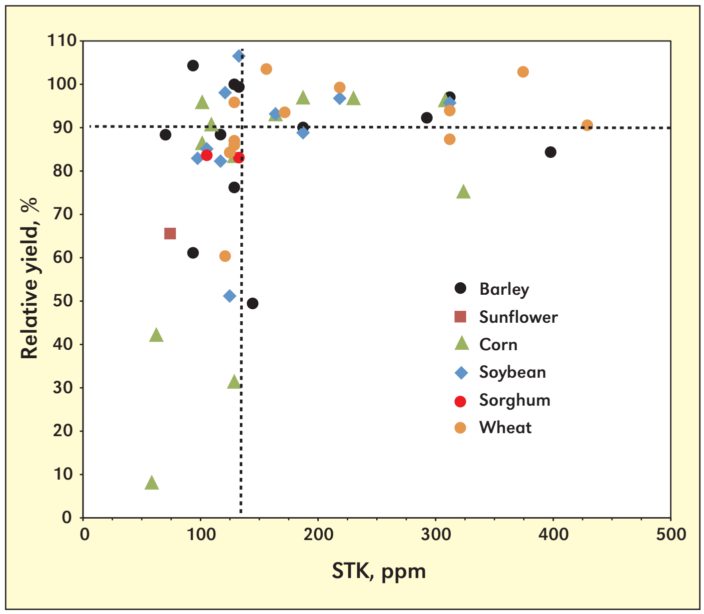

Figure 2. Relationship between relative crop yield (RY) and soil test K (STK; 0 to 20 cm) in Uruguay. Based on data of 50 field experiments. RY expressed as the percent ratio between averaged yields of check and fertilized plots (100 to 200 kg/ha of KCl). Source: Barbazán et al. (2010, 2011).

Soil K levels: Distribution and Nutrient Balances for Uruguay

Soils of Uruguay present a wide range of STK levels (Hernández et al., 1988) (**Figure 3**). According to the Soil Survey Guide of Uruguay (Altamirano et al., 1976), soil units covering approximately 5 M ha would have low K availability. In the typical agricultural area of western Uruguay, STK levels are medium to high.

However, agricultural scenarios of Uruguay have changed during the last two decades. Cropping systems have intensified to a current index of 1.5 crops per year (DIEA, 2010) result-

Common abbreviations and symbols: N = Nitrogen; P = phosphorus; K = potassium; KCl = potassium chloride; M = million; meq = milliequivalents; ppm = parts per million.

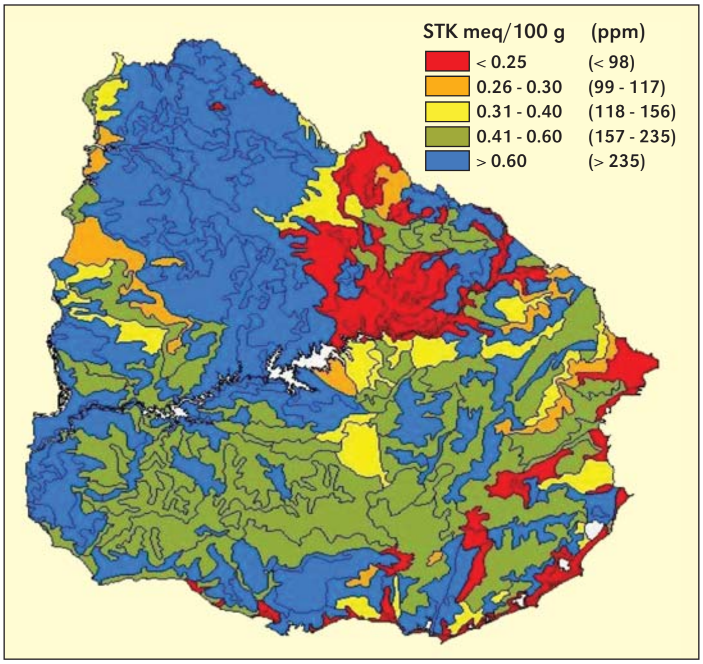

Figure 3. Soil test K (STK; 0 to 20 cm) according to the soil recognition guide of Uruguay. Scale: 1:1,000,000. From Califra and Barbazán (unpublished).

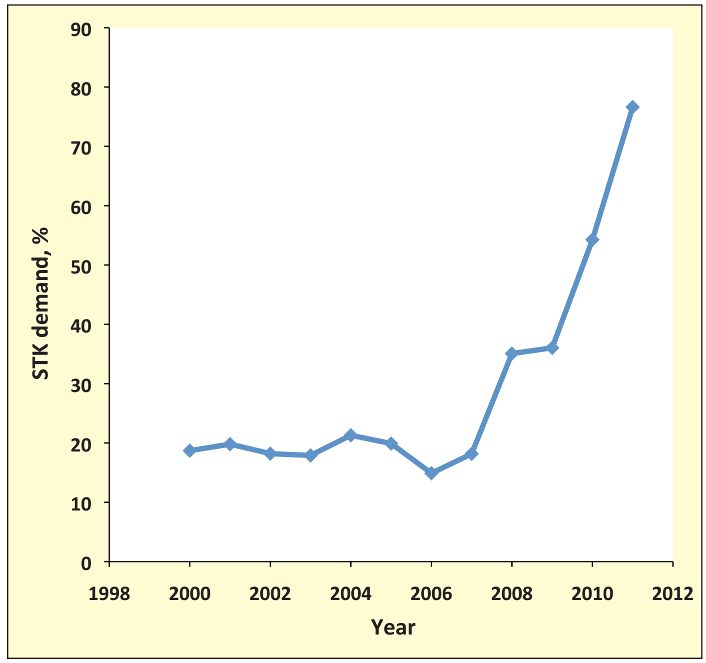

Figure 5. Evolution of soil test K (STK) demand in Uruguay. Values are expressed as a percent of total amount of samples analyzed.

ing in significant soil K depletion. To this effect, Morón and Quincke (2010) reported that STK levels in soils under agriculture within the Department of Soriano (western agricultural area) have decreased by 40% (0 to 7.5 cm depth) and 44% (7.5 to 15 cm depth) from levels observed in the same soils without agricultural history. In addition, agriculture has expanded to marginal regions where low STK soils are already common.

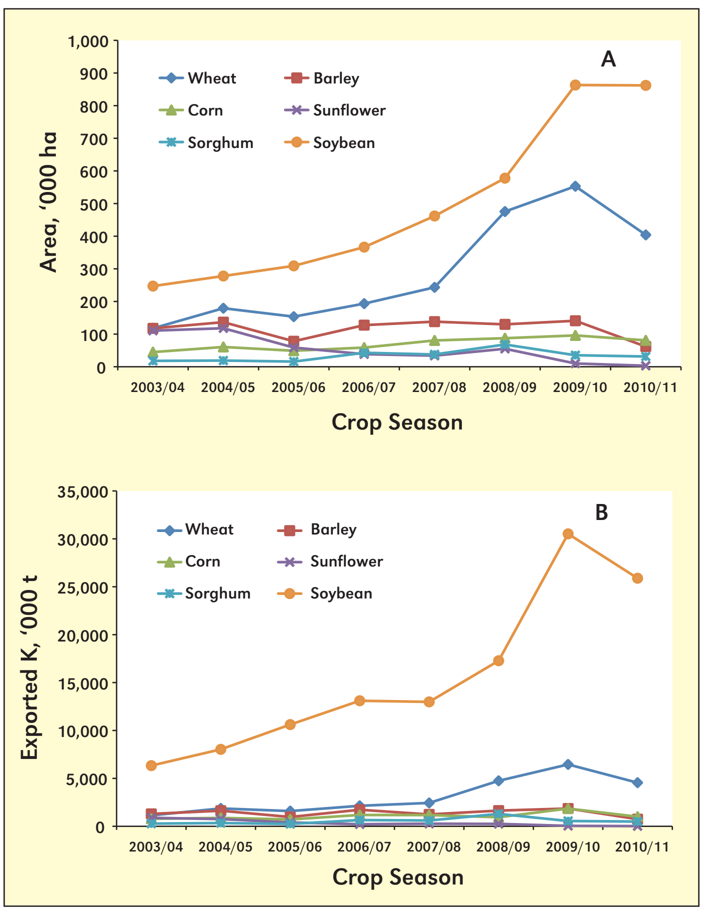

Figure 4. Cropped area (A) and exported K (B) by the six main crops in Uruguay during the 2003 to 2010 period. Based on DIEA (2010) and IPNI (2012).

The soil K balances for fields in Uruguay (application minus removal) have historically been negative due to the absence of K fertilization. Soil K removal has grown with soybean production, which currently covers about 1.0 M ha through a wide range of soils with different availability and stocks of K. As the area under soybean has increased (**Figure 4**), soil K balances have become more negative due to the crop's high K requirements [i.e. soybean exports for 2010 were 1.8 M t, implying a K removal of approximately 36,000 t of K_2O considering an average grain content of K (IPNI, 2012)].

Considering the large agricultural area and current fertilizer prices in Uruguay, priority must be maintained on improving our understanding of soil K dynamics in order to define research areas that are able to produce the most useful information on soil K management. Agronomists and farmers are already concerned about STK in their different regions, which is reflected by the increasing demand in soil K analysis (**Figure 5**).

Future research and experimentation will have to focus on the medium- and long-term relationships of K dynamics as impacted by soil mineralogy and physical properties, cropping system changes, and soil management history. The effect of crop residue quality and its management may affect K distribution with soil depth, and it should be considered by soil survey/sampling and fertilizer recommendations. These studies would be useful in developing K fertilization guidelines. Potassium use efficiency depends on the understanding of K dynamics in the soil-plant system, as well as crop and soil responses to soil fertility management. Long-term studies would greatly contribute to finding solutions to existing and anticipated problems. BC

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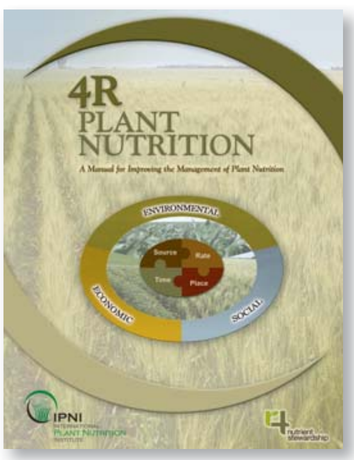

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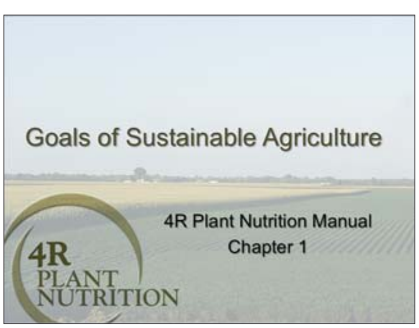

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