Potato Response to Potassium Application in Volcanic Soils

By Juan Córdova and Franklin Valverde

Volcanic soils are commonly mistaken as high potassium (K) soils that provide little opportunity for crop response to K fertilizer. This research, conducted in the highlands of Ecuador, shows K application is capable of increasing total potato yield, improving quality, and reducing the effects of water stress on successive crops.

Volcanic soils, classified as Andisols in the U.S. classification system, cover an extensive area of the highlands of Ecuador, Colombia, Panama, and Costa Rica. These areas support a high population density with growing food needs and which traditionally depend on potato as a staple. Research into potato breeding and crop management has improved the crop's yield potential and increased its K demand. Further research is needed to examine the effect of K on improved varieties grown on volcanic soils in order to challenge the general belief that economic K responses are not common in these areas.

Materials and Methods

Field experiments were established at two different sites in the heart of potato country in the highlands of Ecuador. Tests were conducted for three consecutive cycles of production in site 1 and two production cycles in site 2. Site 1 was classified as Vitrand, a volcanic soil characterized as having coarse volcanic glass and sandy loam texture. Site 2 was classified as Udand, a loamy textured volcanic soil dominated by allophane and imogolite in its clay fraction. Both sites were cultivated with potato, cv. Esperanza, a high yielding cultivar resistant to Phytophthora. Two K rates, 60 and 120 kg K_2O/ha, applied as potassium chloride (KCl), were compared to a check at both sites.

Results and Discussion

Yield response to K application was consistent during the three crop cycles at site 1. The response at site 2 was lower compared to site 1 (**Table 1**). After the final crop, soil K content was 0.19 $cmol_c$/kg in the check plot at site 1 and was 0.36 $cmol_c$/kg at site 2. Soil K status accounted for the difference in response to K application between the two sites.

Critical levels will change with variations in soil type. The coarse texture of the Vitrand soil is a key indicator of low cation exchange

capacity (CEC) and a poor ability to retain K for plant uptake, reflected in the low critical level of 0.25 $cmol_c$/kg at site 1. The finer textured Udand soil had an inherently higher CEC, thus a higher critical K level of 0.59 $cmol_c$/kg.

The generalized critical K level for potato grown on Andisols in Ecuador is 0.38 $cmol_c$/kg. Therefore, fertilizer recommendations based on this general value tend to ignore potential responses in soils with higher critical levels such as Udand soils.

The effect of K on alleviating water stress was clearly demonstrated by this research. Rainfall data indicate both sites had less than normal rainfall in years 1 and 2 (**Table 1**). The effect of drought was reflected in lower yields at both sites when compared with year 3, which had normal amounts of rainfall. The effect of K application on tuber yield was evident at both sites in dry years, but the effect was particularly interesting at site 1 in year 1. Investment in K fertilizer was well rewarded with improved yield during the drought. Of course, drought is difficult to forecast, but these data do show good K nutrition helps protect farmers from drought stress.

The effect of K on tuber quality, measured as tuber size, is presented in **Table 2**. Data indicate higher K rates consistently increased the yield of tubers weighing over 120 g while tubers weighing less than 120 g decreased accordingly. Tuber size is a significant factor at market and translates into price premiums for the farmer.

Table 1. Potato yield response to K application in volcanic soils of Ecuador.

K rates, kg K_2O/ha	Potato yield t/ha Year 1	Year 2	Year 3	Soil K, $cmol_c$ /kg[1] Year 3
Vitrand				
0	18.6	34.2	43.8	0.19
60	27.9	49.3	47.9	0.25
120	39.3	49.7	51.0	0.26
Udand				
0		20.6	49.3	0.36
60		21.7	43.1	0.59
120		25.0	51.3	0.60
Rainfall, mm	779	1,063	1,240	

[1] K extracted with modified Olsen solution

Table 2. Effect of K application on tuber size in potato grown in volcanic soils of Ecuador.

K rates, kg K_2O/ha	Potato yield t/ha >120 g	<120 g	Total
Vitrand			
0	22.0	21.8	43.8
60	32.5	15.4	47.9
120	33.0	18.0	51.0
Udand			
0	34.0	15.3	49.3
60	38.8	4.3	43.1
120	40.0	11.3	51.3

Conclusion

The preconceived notion that crops grown on volcanic soil do not respond to K application is false, particularly with high K-demanding crops like potato. These data show a generalized critical K level for volcanic soil of Ecuador is not a good reference for K recommendations, and site-specific characteristics need to be considered. Potassium's effect on helping potato cope with water stress was clearly demonstrated in the highlands of Ecuador. **BCI**

Ing. Juan Córdova and Ing. Franklin Valverde are with National Institute of Agronomic Research (INIAP), Santa Catalina Experiment Station, Quito, Ecuador.