Effect of Sources and Rates of Potassium Application on Potato Yield and Economic Returns

By Shahid Umar and Moinuddin

Leaf potassium (K) content increased significantly with applied K and showed positive correlation with tuber yield and negative correlation with frost score. Yields obtained with muriate of potash (MOP) were comparable to those produced with sulfate of potash (SOP) after balancing sulfur (S) using gypsum.

Potato is the most important food crop in the world after wheat, rice and maize. In India, potato occupies 1.28 million ha producing 22.5 million tonnes, but the average yield (17.6 t/ha) is very low. Apart from other factors, the main cause for poor yield is inadequate and unbalanced use of fertilizers.

Potato is a heavy feeder of K, but application rates in India are low. The crop commonly suffers from K deficiency leading to disease and pest problems, frost damage, poor yield, and reduced quality.

Cultivar sensitivity to K deficiency varies greatly, and the resulting yield loss is equally variable. This study was planned to evaluate the effect of varying rates and K sources on yield, economics, and frost damage in different potato cultivars.

Materials and Methods

The two-year experiment was conducted on a farm field near Masoori in Uttar Pradesh in 1999 and 2000. Soil at the experimental site was Gangetic alluvium with sandy loam texture, pH 7.8, electrical conductivity (EC) 0.40 dS/m, organic carbon (C) 0.40 percent, available phosphorus (P) 6 parts per million (ppm), available K 75 ppm, and available S 4 ppm [0.15 percent calcium chloride ($CaCl_2$) extractable]. The experiment comprised 16 treatments including all combinations of four potato cultivars (Kufri Chandramukhi, Kufri Jyoti, Kufri Bahar, and Kufri Sindhuri), four levels of K (0, 60, 120, and 180 kg K_2O/ha),

Potato crop without (left) and with (right) K application, Uttar Pradesh, India.

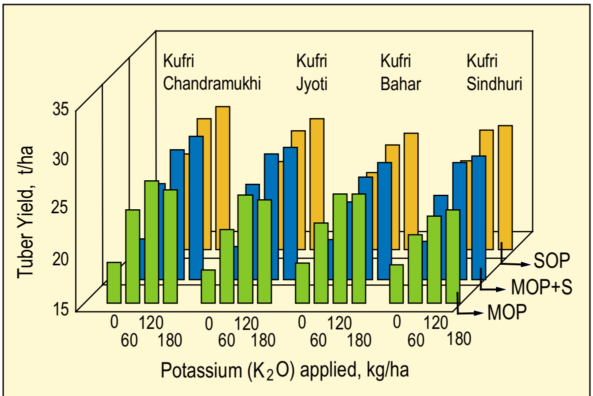

Figure 1. Yield response of potato cultivars to MOP, MOP+S and SOP, Uttar Pradesh, India.

and two K sources, MOP and SOP. Equivalent quantities of S added with SOP were balanced in MOP treatments with gypsum ($CaSO_4$) to avoid bias. Nitrogen (N) and P (as P_2O_5) were supplied at 200 and 100 kg/ha, respectively, using urea and diammonium phosphate (DAP) as sources. Tuber yields were recorded at maturity. As there was occurrence of frost 10 weeks after sowing, observations regarding intensity of frost were scored and, simultaneously, leaf samples were collected and analyzed for K content. Relationships of leaf K content with tuber yield and frost score were calculated. Frost score was also correlated with tuber yield.

Results and Discussion

Potato tuber yield increased significantly with applied K (MOP alone) up to 120 kg K_2O/ha (**Figure 1**). The magnitude of this response differed according to cultivar as the percent increase in tuber yield was highest in Kufri Chandramukhi (43 percent) followed by Kufri Bahar and Kufri Jyoti (41 percent) and Kufri Sindhuri (26 percent).

Application of S (as gypsum) along with MOP enhanced tuber yield significantly, regardless of cultivar. However, the magnitude of response to applied S also differed according to cultivar. Application of 66 kg S/ha produced the largest response with Kufri Sindhuri (3.05 t/ha), followed by Kufri Jyoti (3.0 t/ha) and Kufri Chandramukhi (2.97 t/ha). No S response was found with the Kufri Bahar cultivar. These observations give clear indication of differential susceptibility of cultivars to soil S deficiencies. A similar trend was recorded with SOP with respect to S supply. Sulfur deficiency is an important problem in many states and soils of India as nearly 130 districts are considered to be suffering from varying degrees of S deficiency. Indications are that S deficiencies will become even more important in coming years. In such areas, balanced fertilizer use will have to include S along with NPK application (Anonymous, 2000).

Optimum K rates were calculated by fitting quadratic response equations with tuber yield. The optimum K rate for Kufri Jyoti was higher (156 kg K_2O/ha) than other cultivars, in which the

Table 1. Quadratic equations predicting optimum K_2O requirements for different potato cultivars, Uttar Pradesh, India.

Potato cultivar	Quadratic equation	Optimum K_2O rate, kg/ha
	MOP	
Kufri Chandramukhi	$19.05+0.117x-0.0004x^2$	143
Kufri Jyoti	$18.17+0.097x-0.0003x^2$	156
Kufri Bahar	$18.94+0.095x-0.0003x^2$	144
Kufri Sindhuri	$18.84+0.065x-0.0002x^2$	143
	MOP + S	
Kufri Chandramukhi	$19.13+0.109x-0.0003x^2$	173
Kufri Jyoti	$18.38+0.124x-0.0004x^2$	149
Kufri Bahar	$19.04+0.072x-0.0002x^2$	167
Kufri Sindhuri	$18.79+0.097x-0.0003x^2$	153
	SOP	
Kufri Chandramukhi	$19.10+0.110x-0.0003x^2$	162
Kufri Jyoti	$18.36+0.108x-0.0003x^2$	159
Kufri Bahar	$19.00+0.074x-0.0002x^2$	154
Kufri Sindhuri	$18.82+0.105x-0.0003x^2$	155

optimum K rate varied within a narrow range of 143 to 144 kg K_2O/ha (**Table 1**).

Net returns from MOP+S and SOP exceeded US$300/ha (data not shown). Local markets, including MOP, SOP and S (gypsum) prices and product availability will determine which K sources fit individual grower needs.

Leaf K content was highly correlated (r=0.823) with tuber yield and frost score (r=0.981) on K- and S-deficient sites (**Figure 2**). The frost score also exhibited a highly significant correlation with tuber yield (r=0.852). Therefore, K application increased leaf K content, induced frost resistance, and ultimately produced larger tuber yields. It is of interest to mention that between the two K sources, the frost score in the case of MOP was lower (more resistant to frost) than SOP. The high concentration of both K and chloride (Cl) in leaves due to MOP application presumably would have lowered the freezing point of cell sap and thus helped mitigate frost incidence. Our results agree with those of Grewal and Singh (1980) who observed a significantly negative correlation between available soil K and frost damage to potato yield.

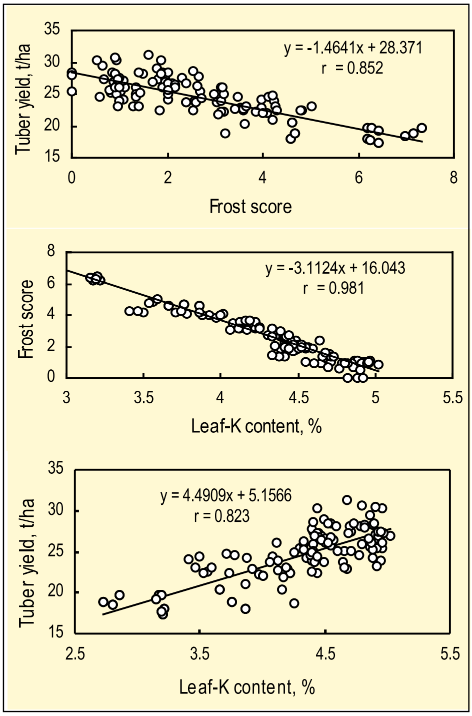

Figure 2. Relationships between leaf K content, tuber yield and frost score of potato, Uttar Pradesh, India.

Conclusion

Such a large increase in tuber yield (26 to 43 percent) with applied K clearly confirms that continuous cropping with insufficient K fertilization in India has impoverished soils of their native K fertility. Increasing susceptibility to frost incidence in the northern plains of India can be avoided by adequate K supply to soils. Thus, proper K applications would be essential and inevitable for obtaining maximum economic yield of potato. **BCI**

Dr. Shahid Umar is a lecturer in the Department of Botany at Jamia Hamdard, New Delhi, India. Dr. Moinuddin is a Scientist at the Potash Research Institute of India, Gurgaon, (Haryana), India.

References

Grewal, J. S. and S. N. Singh. 1980. Effect of K nutrition on frost damage and yield of potato plants on alluvial soils of the Punjab. Pl. Soil. 57, 105-110.

Anonymous. 2000. Nutrient deficiencies in Indian soils. In: Agri-Facts 2000:No.1. PPIC-India Programme, Gurgaon, (Haryana).