Corn Response to Potassium in Liaoning Province

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Corn is an important crop to the northern province of Liaoning. Approximately 1.4 million hectares (M ha), or 47 percent of the province's total cultivated area, is planted to corn. Recent production has been as high as 9.9 million tonnes (M t), or 58 percent of the total cereal crop produced. The introduction of improved crop varieties and increased availability and use of nitrogen (N) and phosphorus (P) fertilizers were key factors in improving yields and production, but these practices also depleted soil potassium (K). This study emphasizes the need for high levels of available soil K throughout the corn-growing season.

Liaoning province has made good progress in increasing availability of mineral fertilizer, but crop yields stagnated as a result of unbalanced fertilization with respect to K. In efforts to maximize crop yields during the period from 1978 to 1990, the province rapidly increased N and P use from 1.47 and 0.57 to 1.97 and 0.74 M t, respectively. However, at the same time, K use increased only from 14,000 to 25,000 t. Problems associated with soil K deficiency are becoming more widespread throughout the province.

Mr. Y. Lei (at left) is shown at maximum yield research trial in Liaoning province.

The Canpotex/PPIC Balanced Fertilization Demonstration Program was initiated by the Soil and Fertilizer Institute of the Liaoning Academy of Agricultural Sciences to resolve this problem. Results indicate that judicious use of K improves N and P fertilizer use efficiency while providing farmers better profit opportunities.

Effect of Fertilizer K on K Uptake and Corn Yield

The field experiment, conducted on a meadow soil, used three rates of K (0, 112.5 and 225 kg K_2O/ha) applied along with constant rates of 300 kg N/ha and 150 kg P_2O_5/ha. A control treatment with no fertilizer was also included.

Grain yields from K and zero-K treatments were significantly different. Comparing NPK treatments with the control and NP treatment, respectively, average increases in grain yield ranged between 17.3 and 23.2 percent with 112.5 kg K_2O/ha, and 20.1 to 26.2 percent with 225 kg K_2O/ha (**Table 1**).

Table 1. Corn yield response to fertilizer K, K concentration by corn, and soil K status, Liaoning.

Fertilizer treatment	Grain yield, t/ha	K concentration, % Grain	Stem	Leaf	Available soil K 0-20 cm	Available soil K 20-40 cm	Slowly available K 0-20 cm	Slowly available K 20-40 cm
					mg K/100 g soil			
Control (CK)	7.71b	0.2172	0.75	0.68	9.8	8.8	60.6	60.0
NP	8.10b	0.2169	0.81	0.86	9.4	8.3	61.5	60.8
NPK1	9.50a	0.2122	0.86	0.72	8.8	8.5	59.8	58.1
NPK2	9.73a	0.2154	1.41	1.02	12.4	9.2	61.2	59.1

*Yields followed by different letters are significantly different at the 5 percent level.

Potassium concentrations in the corn stem and leaves were related to the respective fertilizer treatments (**Table 1**). Potassium concentrations in plant stems and leaves increased with K application rates. The highest rate of K increased the K concentration in the stem to almost double the level found with the control. Despite this, grain K concentration did not appear to be related to K application rates. Data also indicated that stem K concentration was 3.5 to 6.5 times greater than levels found in grain.

The product of yield and K concentration in the harvested portion determines K removal. Therefore, adequate K fertilizer rates required for maintaining soil K levels are related to the amounts of K removed from the field. This experiment points to the importance of returning crop residue to the corn field in order to maintain soil K fertility.

Available and Slowly Available Soil K

Soil K status in the 0 to 20 cm and 20 to 40 cm depths shows available K to be highest in the treatment with the highest rate of K application, reflecting the amount of applied K (**Table 1**). Available K was lower in the NP treatment than in the control, which may be reflecting the effect of crop removal since corn yield was higher in the NP treatment than in the control. Similarly, the first addition of K (NPK1) further increased yields and K removal, thereby lowering available K. The higher K addition (NPK2) increased yields above the NPK1 level, but sustained good available K rates. Changes in slowly available K within the two soil depth positions and amongst treatments were not significant. This underscores how difficult it is to affect soil K levels at depth through short-term K fertilizer applications.

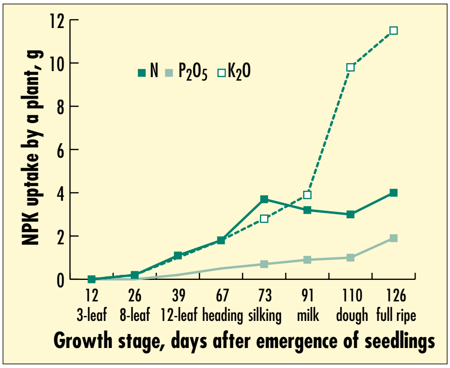

Figure 1. NPK uptake by corn during various physiological stages, Liaoning, China.

Nutrient Uptake by Corn

To characterize N, P and K uptake by corn in Liaoning province during various plant growth stages, plant samples were taken throughout the growing period and analyzed. The results are presented (**Figure 1**).

Plant uptake of N, P and K increased throughout the growth period. The three nutrients reached their highest accumulated level at the 'full

Mr. Y. Lei at corn field in Liaoning.

ripe' (mature) stage. At this stage, the aerial portion of each corn plant had accumulated 3.9 g N, 1.65 g P_2O_5, and 11.1 g K_2O. The ratio of NPK uptake was approximately 1:0.42:2.85, showing the high K requirement of corn.

Peak N uptake occurred between the heading and silking stages. The amount of N uptake during this period was 46.4 percent of the total N accumulated and averaged 0.3 g N/plant/day. Peak P uptake occurred between the milk and full ripe stages, was 65.4 percent of the total P accumulated, and averaged 0.03 g P_2O_5/plant/day. Peak K uptake occurred between the milk and dough stages, was 68.6 percent of the total K accumulated, and averaged 0.4 g K_2O/plant/day.

These data clearly demonstrate the need for adequate levels of N, P and K to be available to the crop throughout its growing period. This in turn requires adequate application of mineral fertilizers to ensure these needs are met.

Potassium Uptake by Corn as Influenced by K Application

The K absorption pattern in corn was influenced by fertilizer treatments (**Figure 2**). Fertilization with N and P stimulated K uptake by corn, but the addition of K to the NP treatment further enhanced K uptake and increased both dry matter and yield of the corn crop. Potash application made more K available for crop absorption.

Seasonal Variation of Available Soil K

Available soil K was influenced by fertilizer treatment, corn growth, and seasonal changes (**Figure 3**). In the control, change in available K was relatively small, varying between 12.4 and 15.6 mg K/100 g soil, with the highest value appearing on July 26. The NP treatment showed a similar trend as higher temperatures and abundant rains in July appeared to affect soil K release. However, the pattern of available soil K was different in the balanced NPK treatment. It ranged from 9.4 to 22.4 mg K/100 g soil, with the highest value occurring before July 20. Available soil K in the NPK treatment after July 20 was actually lower than either the control or NP treatments. This difference may be due to higher corn growth under balanced fertilization, creating greater nutrient uptake after July 20, thus reducing available soil K levels.

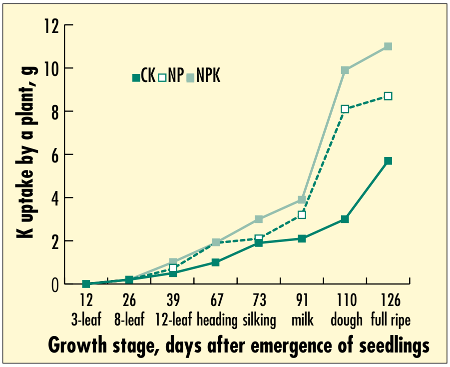

Figure 2. Effect of fertilizer application on K uptake by corn during various physiological stages, Liaoning, China.

Conclusions

Potash increased corn yield significantly, by 17 to 20 percent, when compared with the NP treatment. Corn has a large K requirement under high yield production practices. The NPK uptake ratio was about 1:0.42:2.85 at the full ripe stage. Although total K uptake increased throughout the growing period, peak K uptake appeared between the milk and dough stages. The amount of K uptake during this time was 68.6 percent of the total K accumulated. These data point to the need for high levels of available K throughout the growing season.

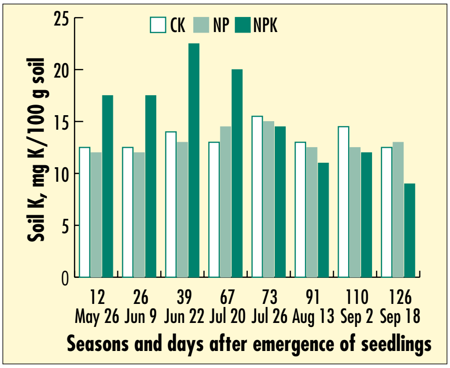

Figure 3. Seasonal fluctuations in available soil K, Liaoning, China.

The concentration of K in the stem and leaf was observed to be 3.2 to 6.5 times higher than levels found in grain. Therefore, the practices of recycling crop residue and adequate K fertilization should be combined to maintain high soil K levels, as well as to maximize crop yields.

Available soil K was influenced by fertilizer treatment, corn growth, and season. Potash application increased available soil K before July, which was subsequently reduced by greater plant uptake after July. Available soil K was higher in summer than in spring and autumn due to higher temperatures and abundant rainfall. **BCI**

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Dr. Kaushik Majumdar Joins PPIC Staff as Deputy Director, India Programme

Dr. Kaushik Majumdar has joined the staff of PPIC-India Programme as Deputy Director, Eastern India. He will work from the newly inaugurated office in Calcutta, West Bengal. Dr. Majumdar received his B.Sc. (Ag) Hons. degree at Visva-Bharati University in 1984. He continued with graduate study at Bidhan Chandra Krishi Viswavidyalaya (BCKV) and earned his M.Sc. (Ag) degree in Agricultural Chemistry and Soil Science in 1987. He joined Rutgers University, in the U.S., in 1988 as a Teaching/Research Assistant and completed his Ph.D. in Soil Mineralogy/Soil Chemistry in 1993.

In 1994, Dr. Majumdar rejoined BCKV as a Research Associate, and later moved on to the Potash Research Institute of India (PRII) in 1995 as a Soil Mineralogist. During his tenure as Soil Mineralogist at PRII, Dr. Majumdar did extensive work on potassium dynamics of Indian soils. Dr. Majumdar will direct programmes in agronomic research and education related to market development for potash and phosphate in West Bengal, Bihar, Orissa, and Assam of eastern India and the north eastern states of India. **BCI**