

Potassium Requirements of Pulse Crops

By Ch. Srinivasarao, Masood Ali, A.N. Ganeshamurthy, and K.K. Singh

In India, pulses are grown mostly on marginal and sub-marginal lands without proper inputs. Potassium (K) is rarely applied to these crops despite larger K requirements of pulses and continued mining of soil K. Many field experiments on various pulse crops show yield benefits from K application. Improved K supply also enhances biological nitrogen (N) fixation and protein content of pulse grains.



Chickpea, pigeonpea, urdbean, mungbean, mothbean, horsegram, lentil, pea, rajmash, and lathyrus are important pulse crops grown in India, occupying about 23 million hectares (M ha). The productivity of pulse crops is low for two reasons: cultivation on agriculturally marginal soils, and little if any crop inputs. Among production inputs, fertilizer plays a key role in enhancing productivity levels. Pulse crops fix atmospheric N, the predominant mechanism to meet their N requirement. However, this capability is jeopardized through insufficient supply of plant nutrients. General recommendations for phosphorus (P) fertilization are made in most states. However, K application is generally neglected, resulting in imbalanced nutrient supply and lower crop yields. Under intensive cropping systems, large amounts of K are removed, leading to serious depletion of soil K reserves. Pulses such as chickpea and pigeonpea remove about 60 and 52 kg K_2O /t grain, respectively.

The major pulse crop growing states in India are noted in the accompanying map. Soil types differ among these agro-ecological regions and include alluvial soils, medium and deep black soils, and red and lateritic soils (Subba Rao and Srinivasarao, 1996). Potassium status of these soils varies considerably depending on parent material, texture, and management practices. In general, black soils with smectite as a dominant clay mineral have higher clay percentage, cation exchange capacity (CEC), and exchangeable K, and medium to high levels of non-exchangeable K. Lighter-textured alluvial soils with higher contents of K-rich mica have moderate levels of exchangeable K and high levels of non-exchangeable K. Lighter-textured red and lateritic soils with kaolinite as the dominant clay mineral are low in both exchangeable and non-exchangeable K (Ali and

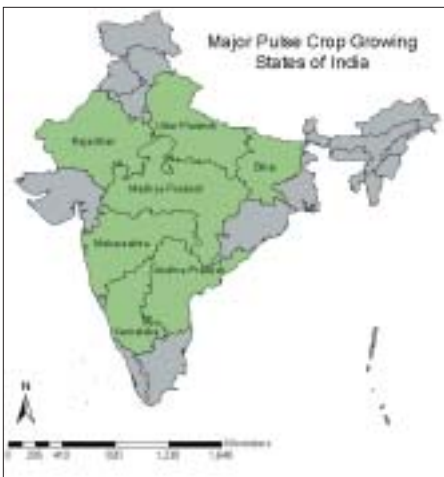
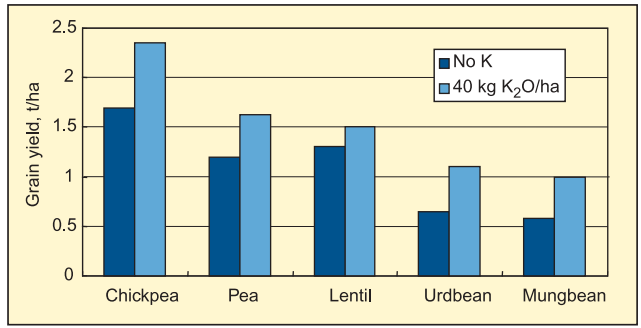


Figure 1. Effect of K application on grain yield of different pulse crops (Tiwari and Tiwari, 1999).



Srinivasarao, 2001).

The pattern and extent of pulse crop response to K fertilizer depends on yield potential, soil K status, genotype, and supply of critical inputs such as irrigation and other nutrients.

Compared to a zero K treatment, application of 30 kg K₂O/ha enhanced chickpea, pea, and lentil grain yields by 21, 25, and 24%, respectively, on a Typic Ustochrept soil in Kanpur (Tiwari and Nigam, 1985). Application of 60 kg K₂O/ha, produced respective yield increases of 23, 37, and 32%. The study reported higher K responses in pulses compared to cereal or oilseed crops and postulated that well branched root systems of cereal and oilseed crops might exploit soil K more efficiently than pulse crop root systems. Studies conducted under the All India Coordinated Research Project (AICAR) also found a significant grain yield response to K in lentil at Ludhiana, Pantnagar, and Ranchi (PRII, 1999). A study on effect of K application (40 kg K₂O/ha) along with rhizobium culture on different pulse crops resulted in substantial yield gains due to K (Figure 1) (Tiwari and Tiwari, 1999).

In 205 chickpea field trials conducted in various districts of Uttar Pradesh, application of 20 kg K₂O/ha increased grain yield by 95 kg/ha over check K plots receiving only 20-40 kg N-P₂O₅/ha (Table 1) (Yadav et al., 1993). At the lowest K rate, 20 kg K₂O/ha, the average chickpea grain yield response was 4 kg grain per kg K₂O. The range of lentil responses to K was between 3 to 16 kg grain per kg K₂O. Average pigeonpea and pea responses to 20 kg K₂O/ha were 14 and 7 kg grain per kg K₂O, respectively. In a separate study, an average increase of 5 kg grain per kg K₂O was recorded for chickpea in northern states of India. It should be noted that economic response to 40 kg P₂O₅ was apparent in lentil, pigeonpea, and pea, while in chickpea and urdbean, economic responses were recorded at 30 and 20 kg P₂O₅/ha.



Table 1. Response of pulses to K on cultivators' fields under rainfed condition (Yadav et al., 1993).

Crops	No. of trials	Grain yield response to K, kg/ha					
		20-40-20 kg N-P ₂ O ₅ -K ₂ O/ha vs. 20-40-0 kg N-P ₂ O ₅ -K ₂ O/ha		30-60-30 kg N-P ₂ O ₅ -K ₂ O/ha vs. 30-60-0 kg N-P ₂ O ₅ -K ₂ O/ha		40-80-40 kg N-P ₂ O ₅ -K ₂ O/ha vs. 40-80-0 kg N-P ₂ O ₅ -K ₂ O/ha	
Chickpea	205	95	72	24			
Urdbean	105	77	20	42			
Lentil	90	112	85	73			
Pigeonpea	69	163	29	59			
Pea	15	148	87	81			
Mungbean	14	30	29	-			

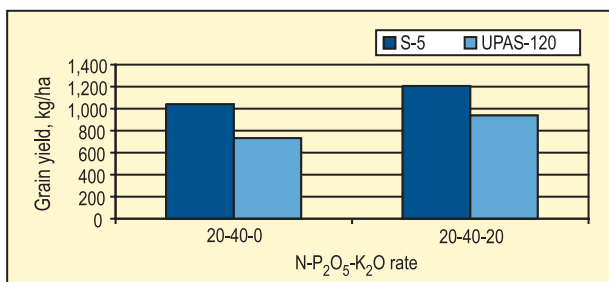


Figure 2. Differential response of pigeonpea genotypes to K application (PRII, 1999).

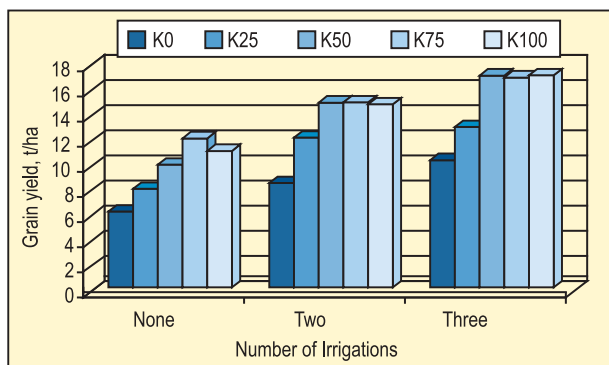


Figure 3. Response of pigeonpea to K application at different levels of irrigation (PRII, 1989).

cropping season.

Potassium nutrition is associated with grain quality, including protein content. Experiments conducted on farmer fields over several rainy and winter seasons under varying rates of K indicated that the protein content of grain improved considerably in all pulse crops studied, as shown in Figure 4 (Tiwari, 1986).

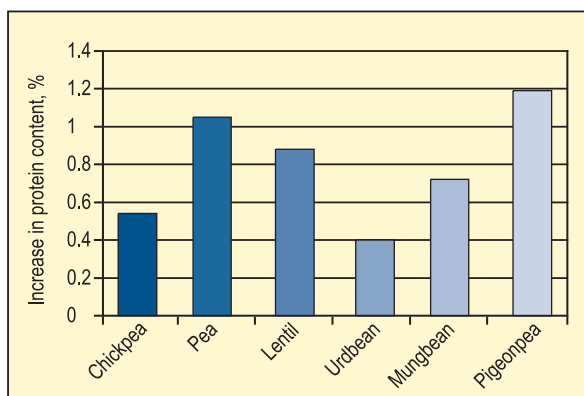


Figure 4. Effect of K application (60 kg K₂O/ha) on protein content of different pulse crops (Tiwari, 1986).

trends. At 30 kg K₂O/ha, pea, chickpea and lentil provided the highest rate of return, and at 40 kg K₂O/ha, pea, pigeonpea and lentil provided added rates of return greater than 2 Rs per Rs invested in K.

In a separate study, addition of 20 kg K₂O/ha in lentil with recommended N and P rates provided Rs 672/ha (US\$14) more return. The study also noted that higher returns due to K application were obtained at higher levels of N and P. For example, application of 40 kg K₂O/ha along with 40-80 kg N-P₂O₅/ha provided an additional net return of Rs 3,600/ha (US\$75).

Generally, improved varieties can be expected to be more responsive to K application due to their larger yield potential and K requirement at critical growth stages. The K response of two genotypes of pigeonpea (*S 5* and *UPAS 120*) was evaluated in 37 AICAR on farm trials. *UPAS 120* showed a 28% yield increase, whereas *S 5* showed a 16% yield increase to 20-40-20 kg N-P₂O₅-K₂O/ha over 20-40 kg N-P₂O₅/ha (Figure 2). The magnitude of K responses can increase with irrigation intensity (Figure 3) (PRII, 1989), application of other limiting nutrients, method of application, and

Inclusion of K in nutrient management schedules of pulse crops is not common in many states. However, because of field-level K responses and awareness of soil K depletion under intensive cereal-pulse cropping systems, the importance of K fertilization has recently gained attention. Potassium recommendations based on a soil test and projected yield goal have been made for different pulse crops in several states. As an example, Subba Rao and Srivastava (1999) prescribed recommendations for chickpea (targeted yield of 2 t/ha) on two soil types. Black soils (vertisols) with high clay content and higher available K (1N NH₄OAC, pH 7.0) need K application. By comparison, alluvial soils required K application up to 150 kg extractable K.

Conclusions

Light textured alluvial soils, red and lateritic soils, and shallow black soils need immediate attention regarding K management for enhanced pulse crop productivity. Improved K supply is commonly associated with improved protein content in pulse grains, N fixation, and water use efficiency. Reduced pest and disease infestation as well as improved yield and quality characteristics result when K supply is optimal. **BCI**

The authors are with the Indian Institute of Pulses Research, Kanpur, 208024, Uttar Pradesh, India.

References

- Ali, M. and Ch. Srinivasarao. 2001. Proceeding of International Symposium on the Importance of Potassium in Nutrient Management for Sustainable Crop Production in India. Indian Institute of Pulses Research (PRII), Gurgaon. p. 261-278.
- PRII. 1999. Annual Report 1999-2000, All India Coordinated Research Project on MULLaRP (Rabi), Indian Institute of Pulses Research (PRII), Kanpur.
- PRII. 1989. Potash Research Institute of India Sponsored Project, Aligarh Muslim University, Aligarh, Progress Report.
- Subba Rao, A. and S. Srivastava. (Eds.) 1999. Soil Test Based Fertilizer Recommendations for Targeted Yields of Crops. Proceedings of the National Seminar on Soil Testing for Balanced and Integrated Use of Fertilizers and Manures, Indian Institute of Soil Science, Bhopal.
- Subba Rao, A. and Ch. Srinivasarao. 1996. IPI Research Topics No. 20, International Potash Institute, Basel, Switzerland. p. 1-57.
- Tiwari, K.N. 1986. 1985-86 Annual Report of the Indian Institute of Pulses Research (PRII) Sponsored Research Projects. CSAUAT, Kanpur.
- Tiwari, K.N. and V. Nigam. 1985. Crop responses to Potassium Fertilization in Soils of Uttar Pradesh. *Journal of Potassium Research* 1:62-71.
- Tiwari, V.N. and K.N. Tiwari. 1999. Proceedings PPIC-UPCAR Workshop on Use of Potassium in Uttar Pradesh Agriculture (Eds. Tiwari, K.N. and Modgal, S.C.). p. 79-87.
- Yadav, D.S., Alok Kumar, and V.K. Singh. 1993. Response of Different Crops to Potassium on Cultivators' Fields in Uttar Pradesh under Irrigated and Rainfed Conditions. *Journal of Potassium Research* 9: 253-261.

Table 2. Additional profit (Rs/ha) obtained by application of different rates of K (Yadav et al. 1993).

Crops	kg K ₂ O/ha		
	20	30	40
Chickpea	431 (9.47) ¹	294 (4.30)	39 (0.30)
Urdbean	341 (7.50)	320 (0.46)	119 (1.31)
Lentil	401 (8.82)	273 (4.00)	200 (2.20)
Pigeonpea	770 (17.0)	77 (1.13)	205 (2.25)
Pea	695 (15.3)	367 (5.28)	314 (3.46)

¹Figures in parentheses indicate the Rs gained per Rs invested in K.