Potassium Requirements of Pulse Crops

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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

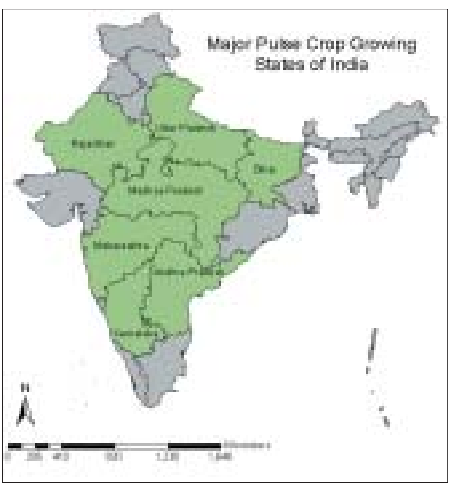
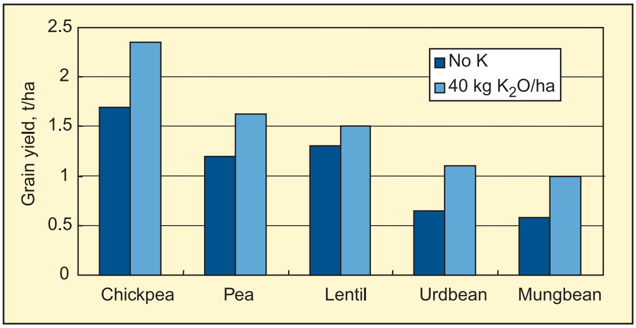


Figure 1. Effect of K application on grain yield of different pulse crops (Tiwari and Tiwari, 1999).



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 K_2O/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 K_2O/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 K_2O/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 K_2O/ha increased grain yield by 95 kg/ha over check K plots receiving only 20-40 kg N-P_2O_5/ha (**Table 1**) (Yadav et al., 1993). At the lowest K rate, 20 kg K_2O/ha, the average chickpea grain yield response was 4 kg grain per kg K_2O. The range of lentil responses to K was between 3 to 16 kg grain per kg K_2O. Average pigeonpea and pea responses to 20 kg K_2O/ha were 14 and 7 kg grain per kg K_2O, respectively. In a separate study, an average increase of 5 kg grain per kg K_2O was recorded for chickpea in northern states of India. It should be noted that economic response to 40 kg P_2O_5 was apparent in lentil, pigeonpea, and pea, while in chickpea and urdbean, economic responses were recorded at 30 and 20 kg P_2O_5/ha.

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

		Grain yield response to K, kg/ha		
Crops	No. of trials	20-40-20 kg N-P_2O_5-K_2O/ha vs. 20-40-0 kg N-P_2O_5-K_2O/ha	30-60-30 kg N-P_2O_5-K_2O/ha vs. 30-60-0 kg N-P_2O_5-K_2O/ha	40-80-40 kg N-P_2O_5-K_2O/ha vs. 40-80-0 kg N-P_2O_5-K_2O/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	-

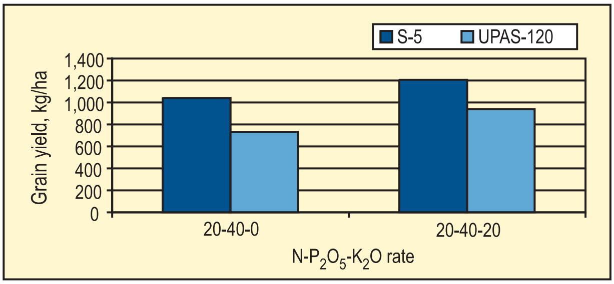


Figure 2. Differential response of pigeonpea genotypes to K application (PRII, 1999).

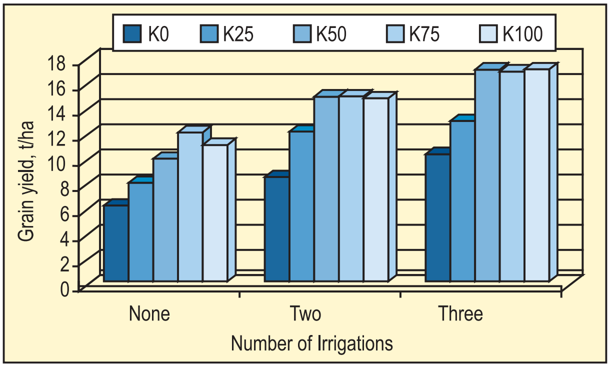


Figure 3. Response of pigeonpea to K application at different levels of irrigation (PRII, 1989).

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-P_2O_5-K_2O/ha over 20-40 kg N-P_2O_5/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 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).

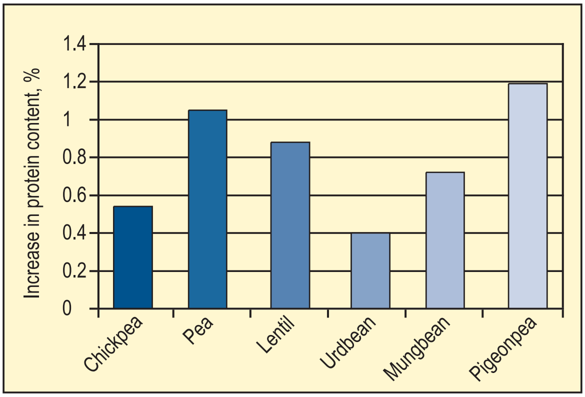


Figure 4. Effect of K application (60 kg K_2O/ha) on protein content of different pulse crops (Tiwari, 1986).

Added profit is achieved as a result of applying increasing K rates to various pulses (**Table 2**). At 20 kg K_2O/ha, the highest additional return was obtained in pigeonpea, followed by pea, chickpea, lentil, and urdbean (Yadav et al., 1993). Consistently large returns per rupee (Rs) invested in K were obtained at 20 kg K_2O/ha. Added profits obtained from application of either 30 or 40 kg K_2O/ha showed no immediately apparent crop-specific trends. At 30 kg K_2O/ha, pea, chickpea and lentil provided the highest rate of return, and at 40 kg K_2O/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 K_2O/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 K_2O/ha along with 40-80 kg N-P_2O_5/ha provided an additional net return of Rs 3,600/ha (US$75).

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

	kg K_2O/ha		
Crops	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)

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

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 NH_4OAC, 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**

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