# Response of Rabi Crops to Potassium

By Jag Pal Singh and Vinay Singh

**Results from this comparative study revealed significant responses to K application in mustard, oat, and wheat. Crop yields responded significantly up to 90 kg $K_2O$/ha.**

Intensive cropping with high yielding varieties over the last 50 years has resulted in a marked depletion of inherent K reserves in Indian soils. Potassium requirements of crops are often equal to N requirements and are three to five times higher than P. However, the current consumption per unit of gross cropped area of N (75 kg/ha) and $P_2O_5$ (29 kg/ha) are five and two times that of K (14 kg $K_2O$/ha), respectively (FAI, 2008). The scenario has been similar over the last 30 years as average K use has been about one-seventh of N and about one-third of P. Consequently, besides N and P, the deficiency of K is frequently reported from different parts of the country. Crop species, however, markedly vary in their response to K. Tiwari and Nigam (1985) reported mustard to be more responsive to K than wheat. The present investigation was undertaken to study the comparative response of different rabi crops to K application.

A field experiment was conducted at R.B.S. College Research Farm Bichpuri, Agra, during the rabi season of 2005 to 2007. The test soil had a pH of 8.0, EC (1:2.5) was 0.19 dS/m (non saline), and organic C content was 3.4 g/kg. The available N, P, and K contents were low (80, 5.8, and 112 mg/kg, respectively). Three rabi crops i.e. wheat (var. H.D. 2329), oat (var. Kent), and mustard (var. Rohini), were grown with treatments consisting of five K levels (0, 30, 60, 90, and 120 kg $K_2O$/ha) applied in the form of potassium chloride (KCl). All the treatments received recommended doses of N, P, S, and Zn at the time of sowing (wheat: 150, 60, 20, and 20 kg/ha; oat: 80, 60, 20, and 20 kg/ha; and mustard: 100, 40, 40, and 20 kg/ha). Sources included urea, diammonium phosphate, zinc sulphate, and elemental S. Grain and stover yields were recorded and K concentration was determined by flame photometer after plant samples were digested in a di-acid mixture ($HNO_3$: $HClO_4$: 4:1).

Results revealed an increase in grain and stover yields of mustard and both the cereals crops **(Table 1)**. The highest seed (2.24 t/ha) and stover yield (5.23 t/ha) of mustard was recorded with the application of 120 kg $K_2O$/ha. Differences in mustard yields obtained with 90 and 120 kg $K_2O$/ha were not significant. Potassium application at 90 kg $K_2O$/ha produced the highest grain (4.49 t of wheat and 2.34 t of oat) and straw (6.54 t of wheat and 3.44 t of oat) yields. Similar findings were reported by Meel et al. (1994) in oat, Singh and Singh (2002) in wheat, and Mishra (2003) in mustard. Returns over fertilizer cost steadily improved with K application rate through high single-year returns from investment in K across all rates studied **(Table 1a)**.

Among the crops, the highest K concentration was observed in mustard seed and stover and the lowest occurred in oat **(Table 2)**. Potassium application up to 120 kg $K_2O$/ha significantly increased K contents of all crops except oat grain, which did not respond beyond 90 kg $K_2O$/ha.

Uptake of K was highest in wheat grain and straw, followed by mustard. A progressive increase in K levels gradually increased the uptake of K by all the crops. Highest uptake of K corresponded to high-yielding treatments. In all crops, the uptake of K was significantly more than the control treatment with application of at least 60 kg $K_2O$/ha. No difference in K uptake was noted between the two highest doses, with the exception of mustard seed. Similar results were obtained by Singh and Pathak (2002), and Singh and Singh (2002).

The response in kg grain or seed per kg $K_2O$ showed an increase up to the level of 90 kg $K_2O$ in wheat and mustard while oat responded up to 60 kg $K_2O$/ha **(Table 3)**. Further increase in the level of K (120 kg $K_2O$/ha) tended to decrease the K use efficiency over 90 kg $K_2O$/ha. The comparative magnitude of the response to K varied among the crops as wheat had a 9.7 kg grain response/kg $K_2O$ applied compared to 7.5 kg mustard seed, and 6.0 kg oat grain. A similar increase in KUE with increasing levels of K application was reported by

**Table 1**. Effect of K on yield (t/ha) of selected rabi crops.

| Crop | Portion | $K_2O$ applied, kg/ha | | | | | CD |
|---|---|---|---|---|---|---|---|
| | | 0 | 30 | 60 | 90 | 120 | (p = 0.05) |
| Wheat | Grain | 3.62 | 3.76 | 4.10 | 4.49 | 4.52 | 0.30 |
| | Straw | 5.44 | 5.59 | 6.06 | 6.54 | 6.57 | 0.48 |
| Oat | Grain | 1.83 | 1.99 | 2.19 | 2.34 | 2.42 | 0.20 |
| | Straw | 2.76 | 2.98 | 3.25 | 3.44 | 3.55 | 0.27 |
| Mustard | Seed | 1.49 | 1.64 | 1.87 | 2.17 | 2.24 | 0.18 |
| | Stover | 3.66 | 4.03 | 4.47 | 5.04 | 5.23 | 0.59 |

**Table 1a**. Effect of K application on economic return over fertiliser cost (Rs./ha) and return on K investment (in parentheses) in selected rabi crops.

| Crop | Portion | $K_2O$ applied, kg/ha | | | | |
|---|---|---|---|---|---|---|
| | | 0 | 30 | 60 | 90 | 120 |
| Wheat | Grain | 34,201 (-) | 33,978 (6.5) | 35,211 (11.2) | 38,524 (13.5) | 42,669 (10.5) |
| Oat | Grain | 14,182 (-) | 15,422 (5.6) | 16,972 (6.3) | 18,135 (5.9) | 18,755 (5.1) |
| Mustard | Seed | 24,916 (-) | 27,483 (12.5) | 31,538 (15.9) | 36,895 (18.9) | 37,974 (15.9) |

Price per tonne of wheat grain = Rs.10,400; oat = Rs. 7,750; mustard = Rs. 18,600.
Cost per kg of fertilizer N, $P_2O_5$, $K_2O$, S, Zn = Rs. 10.5. 16.2, 7.4, 10.0, and 35.0, respectively.

**Abbreviations: N = nitrogen; P = phosphorus; K = potassium; S = sulphur; Zn = zinc; C = carbon; CD = Critical Difference, equivalent to Least Significant Difference.**

# 2009 IPNI Science Award to Dr. J.K. Ladha

The International Plant Nutrition Institute (IPNI) named Dr. J.K. Ladha of the International Rice Research Institute (IRRI) as the winner of the 2009 IPNI Science Award. Dr. Ladha is a senior soil scientist, the coordinator of the Rice-Wheat Consortium in Asia, and representative of IRRI-India. He receives a special plaque plus a monetary award of US$5,000.00 (five thousand dollars).

"Dr. Ladha is a truly outstanding scientist and most deserving of this recognition due to the scope and breadth of his research, training, and extension activities," said Dr. Terry L. Roberts, President of IPNI. "He has made immense contributions to international agriculture through his activities in several Asia countries, on problems across national and regional boundaries."

Born in Gwalior, India, Dr. Ladha earned his Ph.D. in Botany from Banaras Hindu University in 1976. Earlier, he earned his B.Sc. in Biological Sciences in 1971 and his M.Sc. in Botany in 1975 at Jiwaji University in India. He has devoted nearly 30 years of his career to working in the area of integrated resources management with strong emphasis on soil fertility and nutrient management for achieving increased crop yields.

Dr. Ladha's work, in collaboration with many national partners, takes a holistic, systems approach covering various components of agronomic, soil, and water management. He emphasizes farmer-participatory approaches for developing innovative resource-use-efficient alternatives of tillage/crop establishment and fertilizer management strategies.


Dr. J.K Ladha

Dr. Ladha has published extensively in leading peer-reviewed journals and edited several books. He has authored or co-authored 183 research articles in international research journals, 60 articles in proceedings and other books, and has edited or co-edited 11 books.

The IPNI Science Award is intended to recognize outstanding achievements in research, extension, or education, with focus on efficient and effective management of plant nutrients and their positive interaction in fully integrated crop production that enhances yield potential and crop quality. Private or public sector agronomists, soil scientists, and crop scientists from all countries are eligible for nomination. The previous recipients of the IPNI Science Award were Dr. John Ryan of ICARDA in 2008 and Dr. M.S. Aulakh of India in 2007.

More information and nomination forms for the 2010 IPNI Science Award are available from the headquarters or regional offices of the organization, or from the website: www.ipni.net/awards. BC INDIA

**Table 2**. Effect of K application on uptake (kg/ha) in selected rabi crops.

| Crop | Portion | $K_2O$ applied, kg/ha 0 | 30 | 60 | 90 | 120 | CD (p=0.05) |
|---|---|---|---|---|---|---|---|
| Wheat | Grain | 20.2 (0.56) | 22.3 (0.59) | 27.0 (0.66) | 33.9 (0.75) | 35.2 (0.78) | 2.91 (0.021) |
| | Straw | 94.7 (1.74) | 100.1 (1.79) | 113.7 (1.87) | 130.1 (1.99) | 134.0 (2.04) | 10.27 (0.026) |
| Oat | Grain | 9.3 (0.51) | 11.4 (0.57) | 13.9 (0.64) | 16.1 (0.69) | 17.3 (0.71) | 1.57 (0.038) |
| | Straw | 46.3 (1.68) | 51.6 (1.73) | 58.2 (1.79) | 64.2 (1.86) | 67.1 (1.89) | 4.81 (0.021) |
| Mustard | Seed | 10.1 (0.67) | 11.9 (0.73) | 14.8 (0.79) | 18.8 (0.87) | 20.6 (0.92) | 1.70 (0.019) |
| | Stover | 71.8 (1.96) | 82.6 (2.05) | 95.9 (2.14) | 112.8 (2.24) | 119.5 (2.28) | 13.36 (0.030) |

Data in parentheses indicate mean content (%) of K.

Chaudhary and Roy (1992) and Surekha et al. (2003).

Apparent recovery (%) of K was influenced by K levels with the maximum recovery occurring at 90 kg $K_2O$/ha, with the exception of oat where a maximum apparent recovery of 7.7% was noted at 60 kg $K_2O$/ha **(Table 3)**. The ranges of apparent K recovery for these crops results in a ranking which is identical to that for K uptake, wherein wheat > mustard > oat. BC INDIA

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**Table 3**. Effect of K application on K use efficiency and apparent recovery in selected rabi crops.

| Crop | $K_2O$ applied, kg/ha 30 | 60 | 90 | 120 |
|---|---|---|---|---|
| | K use efficiency (kg produce /kg $K_2O$) | | | |
| Wheat | 4.6 | 7.9 | 9.7 | 7.4 |
| Oat | 5.5 | 6.0 | 5.6 | 4.9 |
| Mustard | 5.2 | 6.3 | 7.5 | 6.3 |
| | Percent apparent recovery, % | | | |
| Wheat | 6.8 | 11.2 | 15.1 | 12.5 |
| Oat | 7.1 | 7.7 | 7.5 | 6.6 |
| Mustard | 6.5 | 8.0 | 9.8 | 8.8 |

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