Summary
And
Conclusions
In the modern agricultural systems where plants rely on fertilizers to meet their demand of nitrogen, inadequate practices still cause environmental problems mainly related to nitrate loss in the environment.

The present study was conducted to work out the interactive effects of nitrogen and potassium on nitrate leaching in soils belonging to the Lukhi soil series of Gurgaon and on nitrogen-use-efficiency of wheat and sorghum grown on these soils.

A field experiment was conducted during the years 2007 and 2008 at Potash Research Institute of India, Gurgaon (Haryana) on a Udic Ustochrept soil with wheat (PBW - 343) in rabi season and sorghum (fodder, Pusa Chari) in kharif. This experiment is a continuation of a long-term fertilizer field experiment which was laid out during 1985-86 with a fixed crop rotation of sorghum-wheat to study the impact of fertilizers, not only on the crop yield and quality but also on the soil and environment.

A factorial randomized block design experiment of nine treatments for nitrogen, potassium and FYM with three replications was conducted in a field having 27 experimental plots of 15 m$^2$ in size. Nitrogen was applied as a ½ basal + ½ top dressing in all the treatments. P as P$_2$O$_5$ was applied as a basal only. K as K$_2$O was applied as a basal in T$_2$ to T$_7$ and as two splits in T$_8$ and T$_9$. Top dressing of N and K was applied at 30 DAS in sorghum and at 45 DAS in wheat. Zinc Sulfate (ZnSO$_4$.7H$_2$O) @ 25 kg ha$^{-1}$ was applied as a basal in T$_2$ to T$_9$. 

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The experimental plots were irrigated at periodical intervals as per the requirement. Prophylactic means against pests and diseases were also taken, as and when necessary. Fodder sorghum was harvested after 65 DAS.

On the basis of results obtained from the long-term field experiment, experiment 2 was conducted in 60 liters, 25-cm-diameter and 120 cm height PVC-drums during the year 2007 and 2008 on sorghum and wheat in the Herbal Garden of Hamdard University, New Delhi, India under natural day/night conditions. The experimental period varied from July to October 2007 for sorghum and from November to April 2008 for wheat. Sixteen treatments were randomized in three blocks. The experiment had four rates of urea nitrogen (0, 90, 120 and 240 kg N ha\(^{-1}\)) and four rates of KCl potassium (0, 30, 60 and 120 kg K ha\(^{-1}\)). Phosphorus and zinc were applied uniformly to all treatments @ 60 kg P ha\(^{-1}\) as Single Super Phosphate and 25 kg ZnSO\(_4\).7H\(_2\)O ha\(^{-1}\).

Surface soil was collected from the Herbal Garden of Jamia Hamdard, New Delhi for filling of PVC-drums. The soils collected were mixed well, air dried and sieved with 4 mm sieve. The PVC-drum had a drain at 3 different places (30, 60 and 100-cm height of the soil column). The lower opening of the drum was filled with glass wool, followed by filling of 10 cm height with washed fine gravels. Plastic funnels (approximately 10 cm in diameter) with PVC tubes (5 mm diameter) were fitted with each drain to collect the leachate. These funnels were filled with washed fine sands after putting a piece of glass wool in the lower opening of the funnel. Soil was filled in PVC-drums above the 10 cm gravel layer to reach the height of 100 cm after the saturation process for the filled soil.

Results of the study revealed that the growth characteristics such as the fresh and dry weights, plant height, leaf area, and chlorophyll index, the in
vitro and in vivo nitrate reductase activity, in vivo nitrite reductase activity and the in vitro and in vivo protein contents (%), and N content (%) increased with increase in K or N levels. The effect of K as well as of its interaction (K × N) on these parameters was significant. Compared to the control (K₀ or N₀), the percent increase in these characteristics was the maximum at K₆₀ × N₁₂₀ and at par with K₁₂₀ × N₂₄₀.

In addition, the nitrate content in leachate increased with increase in N levels, while it significantly decreased due to K application. Interaction of the two nutrients (K × N) depicted minimal nitrate content with K₆₀ × N₁₂₀. Potassium content in leachate increased with increase in N levels, while significant reduction in K content in leachate was noticed due to K application. The interaction (K × N) depicted minimal K content with K₆₀ × N₁₂₀. In general, pH and EC of leachate decreased with increase in N and K levels, while this decrease was not significant with K × N interaction. However, pH and EC of leachate were higher at the second collection than at the first. The interaction (K × N) depicted minimal pH and EC with K₆₀ × N₁₂₀. Further, the combination of N, P, K and farm yard manure @ 10 t ha⁻¹ significantly improved the fresh weight per plot, dry weight per plot, plant height per plant, fresh weight per plant, dry weight per plant and K (%) in fodder.

Based on the conclusions mentioned above, we make the following recommendations:

- Substantial variation for K or N acquisition and utilization depending on the rate of these two important nutrients can be exploited in plant breeding programmes to improve crop yields in low-fertility-regimes area.
- K₆₀ × N₁₂₀ (K₆₀ kg ha⁻¹ with N₁₂₀ kg ha⁻¹) are the optimum levels of K and N fertilizers for the growth and yield response of wheat and
sorghum grown in alluvial inceptisols of the Indo-Gangetic plains, which were hitherto considered to be unresponsive to applied K. Thus, it can be considered as an optimum dose for cultivation of these two crops cultivated for grain and forage, respectively, on a large scale.

- Long-term integrated use of NPK fertilizers at $N_{120}P_{60}K_{60}$ with FYM at 10 t ha$^{-1}$ helps in sustaining the sorghum and wheat yield and also soil fertility of the alluvial soils.

- Optimum rate of K helps in maintaining good soil health in terms of pH, EC, and organic C.

- $K_{60} \times N_{120}$ ($K_{60}$ kg ha$^{-1}$ with $N_{120}$ kg ha$^{-1}$) are the optimum levels of K and N fertilizers for increased uptake and use efficiency of N, and for decreased K or N loss, and consequently give the best result in terms of better growth and yield response of wheat and sorghum.

- The application of K @ 60 kg ha$^{-1}$ can be recommended as a tool for reducing N leaching losses and thus improving the N fertilizer use efficiency of the applied urea fertilizer. The combination of K and N ($K_{60} \times N_{120}$) could help in sustaining the crop growth and productivity of sorghum and wheat at one hand and in reducing nitrate load of ground water, on the other. This, in turn, will help in checking the eutrofication of precious underground water resources and thus save the humanity from ill effects of nitrate pollution.