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EVALUATION OF POTASSIUM STATUS OF RAMS: THE USE OF PASTURE AND BLOOD PLASMA AS INDICATORS UNDER SEMI-ARID ENVIRONMENTAL CONDITIONS IN PUNJAB, PAKISTAN

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Abstract

The present study was conducted to assess the potassium (K) status of soil, forage, and blood plasma of male sheep (rams) at Livestock Experimental Station, Khizerabad, Sargodha, Pakistan. Soil, forage, and blood samples were obtained on monthly basis and analyzed after wet digestion to determine the sampling period effect on K in these variables, in addition to the transfer of K in soil-, forage-animal system during this investigation period. The K levels of soil, forage and blood plasma were significantly influenced by the sampling periods and these were found to be above the critical value established for these markers. The forage was deficient in K particularly in the beginning of the growth stage. Plasma had adequate level of K for the normal requirement of rams being reared at this livestock farm, but deficiency of K may be expected during the early season because of deficient level of K in forages. Occasional supplementation of K with locally accessible feed sources and mineral mixture having high availability of this element may alleviate the deficiency if occurs at any time at this animal farm.

Introduction

Livestock contributes about 51.8% towards agricultural GDP and nearly 11.3 % to GDP of Pakistan (Anon., 2009). It also supplies milk, meat, and a variety of other by-products. It has also been reported that livestock plays a vital role in improving the fertility and productivity of soil (Ali, 2005). All types of livestock mainly depend on forages for their body requirement of minerals in addition to the other nutrients. However, forages only rarely satisfy their body requirements for minerals. As a result of this animals encounter various metabolic complications which greatly affect their productive and reproductive potential and adequate intake of forages by grazing animals is very essential to meet their requirements of minerals (McDowell and Arthington, 2005). Analogous to other minerals, potassium has a major role in the body of ruminants. Potassium utilization of ruminants and other livestock is normally higher than that of the animal requirement in dietary sources, which is close to 0.5 % of the dietary sources (Kayser *et al.,* 2005). Although sodium deficiency if occurs it can be replaced with K in saliva of the animals (Blair-West et al., 1970; McDowell, 2003), the high oral amounts of K in ruminants have been proved to be very harmful to animals and K toxicosis results in cardiac insufficiency, weakness of muscular system and death in severe cases, but K toxicosis is not a severe problem under normal conditions in ruminants (Anon., 1980; McDowell & Arthington, 2005). Diarrhoea and muscular tremors of legs and excitability are also attributed to the higher levels of K intake by the ruminants. It has also been reported that young forages contain higher concentrations of K and its higher level I an important risk factor in the development of tetany in the ruminants (McDowell and Arthington, 2005; Ward, 1966). Despite the role of K in animal metabolism, it plays a vital role in a variety of processes in plants (Johnston *et al.,* 2001; Mengel *et al.,* 1987; Frame, 1992). However, high K level and imbalance in ratio of nitrogen and potassium in forage plants are considered to have a negative effect on the ensiling quality of various grass species (Keady, 1998). It has been reported that mineral essentialities of different sexes of sheep vary due variation in their rate of growth; the rate of growth of rams is generally higher than that of ewes, and thus rams require considerably higher daily intake of different minerals. Furthermore, the mineral requirement of pregnant and lactating ewes is more than the non-pregnant females (Anon., 1980). However, K is needed in higher amounts by the animals. In Pakistan, there are 28 different breeds of sheep, in which Kajli breed is considered of high economic value. However, a number of factors like climate, agronomic practices, feed processing technologies and genetic variation may influence the nutritive value of feed for Kajli sheep like in other animals (Khan *et al.,* 1982).

Keeping in view the essentiality of K for ewes and rams and other livestock/ruminants, the present study was conducted to appraise the K status of soil, forage and rams. This information would be used by the farmers, animal nutritionists and scientists working in extension services for the improvement of their animals by adopting various strategies for supplementation to animals for enhancing the reproductive and productive potential of the ruminants.

Materials and Methods

The present investigation was conducted from October 2008 through January 2009 at the Livestock Station, Khizerabad, Central Punjab, Sargodha (32° 8′0″ N; 73° 7′ 0″ E; altitude 187 m). This livestock station comprised 2000 sheep of Kajli breed and nearly 1400 Sahiwal breed of cattle. These pastures were the representatives of the area and had sown a variety of forages of various species. During the present survey dominant forage species, mostly consumed by the ruminants were collected for analytical purpose. They were fertilized with 25 kg urea per ha and major sources of irrigation were canal and tube well waters.

Animals description: In the present investigation, 20 healthy male sheep called rams which were uncastrated adult male sheep of Kajli breed of 3-4 years of age, were used in sampling 10 ml of heparinized blood through the jugular vein. Average body weights were 38-44 kg of rams and these rams were kept at farms in herds of Kajli sheep breed for mating the female animals, i.e., 4 or 5 per herd of 60 female sheep each. All the experimental animals were of the same class of rams during the investigation. The class of rams adopted in this study basically grazed on the pastures in all seasons, but occasionally these rams were fed by tethering and small amount of concentrates. They were housed for most of the time but taken out for grazing each day. At the investigated livestock, farm sheep (rams) were also accompanied by herdsmen, but remained in the pasture of the same area during one season and the animals were moved also to other pastures of another area within the same station in other season depending upon the accessibility of forages therein.

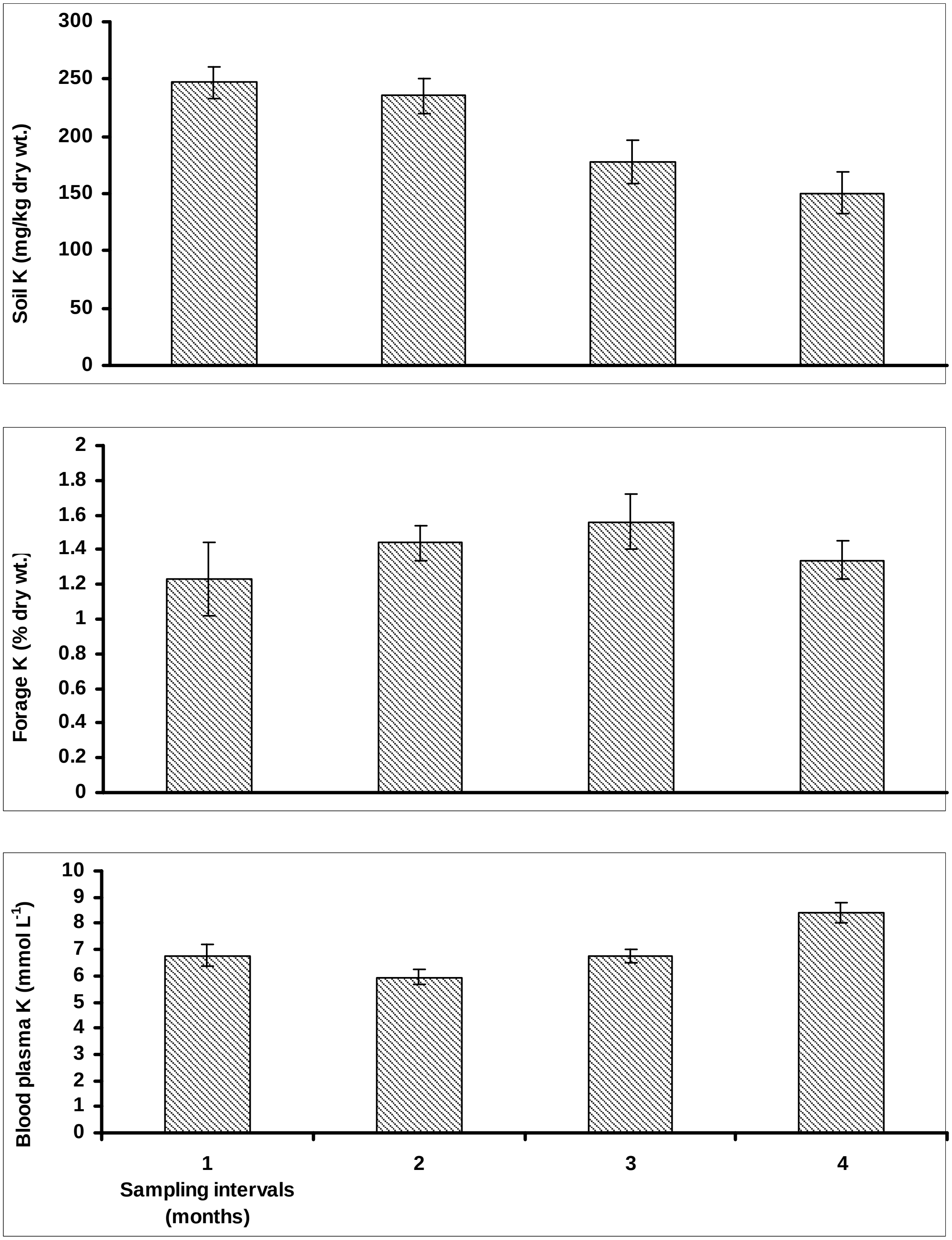

Fig. 1. Soil, forage and blood plasma K concentrations at different sampling intervals.

Table1. Analysis of variance of data for K concentrations in soil, forage and blood plasma at different sampling intervals

Source of variation	Degrees of freedom (df)	Mean squares		
		Soil	Forage	Blood plasma
Sampling periods	3	10663.517***	0.385***	5.330*
Error	16	701.125	0.002	1.578

***= Significant at 0.001 level; * = Significant at 0.05 level

Methods, location management procedures, climatic conditions, and floristic composition of the investigated Livestock farm, methods of soil, forage, and blood plasma collection and preparation for analytical work, methods of determination of metals, and statistical evaluations are presented elsewhere (Khan *et al.,* 2010a; b; c).

Results and Discussion

Soil: Statistical analysis (ANOVA) of soil K concentrations determined at different sampling periods showed highly significant effects (P<0.001) on K levels of soil (Table 1). Mean K concentration in soil ranged from 150.2 to 247 mg/kg during the whole investigation period. The highest level of K in soil was observed at the 1st sampling and the lowest at the 4th sampling interval (Fig. 1).The values of K at the first two sampling periods were similar, thereafter they decreased consistently at the 3rd and 4th intervals. Soil K concentrations were higher than the critical level (80 mg/kg) as suggested by Warncke & Robertson (1976). The values of K in soil in the present study were higher than those reported by Mooso (1982) in Florida and Merkel *et al*., (1990) in north central Florida, Espinoza *et al*., (1991) in central Florida, and in a similar ranch of Punjab, Pakistan by Khan *et al*., (2010b).

Forage: Sampling period effects on K concentrations in forage were highly significant (P<0.001) as is evident from the data in Table 1. Mean K concentration in forage ranged from 0.34 to 0.98 %. The highest value of forage K was found at sampling interval 1 and the lowest interval 4. K concentration suddenly dropped at the 2nd interval and then consistently decreased up to the 4th sampling interval (Fig. 1). Mean forage K values of the 1st interval was higher while those of the last three sampling periods were lower than the critical level of 0.6% as recommended by Anon., (1996) and 0.8% as suggested by McDowell *et al*., (1984). Higher concentrations of forage K have already been described by Khan *et al*., (2010b) in a semi-arid region of Pakistan and almost similar values by Aregheore *et al*., (2007). As the forage K concentrations were lower than the appropriate value to meet the requirement of grazing livestock, so fertilizer containing K is recommended for this particular region to enhance the K level of forage absorbed from the soil. In addition, soil amendment for appropriate fertilizers is also warranted to prevent the antagonistic behaviour of various minerals in the soil and promote the K absorption from the forages at that specific animal farm.

Blood plasma of rams: Sampling intervals had a significant effect (P<0.05) on K levels in blood plasma of rams (Table 1). Mean K levels in blood plasma varied from 5.95 to 8.41 mmol/L. The higher value of plasma K among the sampling periods was found at the 4th and the lowest at the 2nd sampling interval (Fig. 1). Blood plasma K concentrations in the present study were higher than the critical level of 1.1 to 1.62 mmol/L as suggested by Underwood (1981), Boyd (1984), and Renner (2001). Almost similar values of K concentration in plasma were reported by Aregheore *et al*., (2007). In animals, almost 90% of ingested K has been reported to be absorbed in the digestive tract, irrespective of the K amount ingested by the ruminants (Grimm *et al.,* 1990). Potassium distribution and transport between the cells and in the extracellular body fluid is mediated by a well controlled mechanism and only 1.5- 2.5% of total K of the animal body is present in the extracellular fluid. A major proportion of K of the animal body is also present in the skeletal muscles as well as other organs containing blood (McMahon *et al*., 1982). In the present investigation, although the plasma K was higher than the critical level, it was at marginally deficient line. This may have been due to the loss of larger amount though excretion (McMahon *et al*., 1984). However, ruminants depending on K rich dietary sources were reported to have lower concentrations of 1-25-dihydroxy vitamin D and hydroxyproline in the blood plasma (Goff *et al.,* 2000).

Correlation among soil, forage and blood plasma K concentrations: The correlations between soil and forage and forage and plasma K concentrations were worked out from the samples collected across all sampling intervals. Correlation between soil and forage K was strongly positive with a value of 0.67543. Soil and blood plasma K correlated negatively (r = -0.46901). Very weak correlation (r = -0.22291) was found between forage and blood plasma K.

The above discussion reveals that strong relationship existed between soil and forage K, while a weak relation between forage and blood plasma K. In a nutshell, soil K levels were sufficient for the growth requirements of forage crops, but forage had low concentrations of K, particularly at the initial phase of the investigation than the requirement of grazing livestock. This indicates K supplementation for livestock animals at that farm. High correlation between soil and forage K, whereas a weak relation between forage and plasma K were observed in the present study.

References

Ali, M.Y. 2005. Livestock production under agro-grazing system as compared to open range/forest grazing and stall feeding system. M.Sc. Thesis. Department of Forestry, University of Agriculture, Faisalabad.

Anonymous. 1980. The Nutrients Requirements of Ruminants Livestock. 4th Edition. ARC *CAB International*, Wallingford, pp.73-310.

Anonymous. 1996. Nutrient requirements of beef cattle (Seventh Edition*). National Academy Press*, Washington, D.C.

Anonymous. 2009. Economic Survey of Pakistan (2008-09) *Published by Accountancy. Com. Pk*, pp. 67- 68.

Aregheore, E.M., D. Hunter, D. Perera and M.T. Matutoatasi. 2007. The plant-soil-animal phenomenon: Serum mineral status of Fiji Fantastic sheep grazing Batiki grass and Pangla grass in Samoa. *Journal of Animal and Veterinary Advances*, 6: 349-357.

Blair-West, J.R., J.P. Coghlan, D.A. Denton and R.D. Wright. 1970. In: *Physiology of Digestion and Metabolism in the Ruminant*. (Ed.): A.T. Phillipson. Oriel Press, Newcastle, England.

Boyd, J.W. 1984. The interpretation of serum biochemistry test results in domestic animals. Veterinary Clinical Pathology, *Veterinary Practice Publishing Company*, pp. 13.

Frame, J. 1992. Improved Grassland Management. Ipswich, UK: Farming Press Books.

Goff, J. and R. Horst. 2000. Cutting potassium in dairy feed decreases milk fever in cows. NRI Research Highlights. Ames, IA, USA: The United States Department of Agriculture - Agriculture Research Service.

Grimm, R.H., J.D. Neaton, P.J. Elmer, K.H. Svendsen, J. Levin, M. Segal, L. Holland, L.J. Witte, D.R. Clearman, P. Kofron, R.K. LaBounty, R. Crow, R.J. Prineas. 1990. The influence of oral potassium chloride on blood pressure in hypertensive men on a low-sodium diets. *New England Journal of Medicine*, 322: 569-574.

Johnston, A.E., P.R. Poulton and J.K. Syers. 2001. Phosphorus, potassium and sulphur cycles in agricultural soils. Proceedings No. 465, International Fertiliser Society, York, UK, London, UK: International Fertiliser Society, pp. 1-44.

Kayser, M., J. Isselstein. 2005. Potassium cycling and losses in grassland systems: a review. *Grass and Forage Science*, 60: 213-224.

Keady, T.W.J. and P. O'Kiely. 1998. An evaluation of potassium and nitrogen fertilisation of grassland, and date of harvest, on fermentation, effluent production,dry-matter recovery and predicted feeding value of silage. *Grass and Forage Science*, 53: 326-337.

Khan, B. B., M. Younas and S. H. Hanjra. 1982. Breeds and types of livestock in Pakistan. University of Agriculture, Faisalabad.

Khan, Z.I., M. Ashraf, F. Al-Qurainy, K. Ahmad, S. Gondal and A. Fardous. 2010c. Studies on the transfer of copper from soil to pastures at different sampling periods: A case study of a semiarid region (Sargodha) in Pakistan. *Biological Trace Element Research*. doi: 10.1007/s12011-010-8731-0.

Khan, Z.I., M. Ashraf, K. Ahmad and E.E. Valeem. 2010b. Periodic evaluation of Potassium transfer from soil and forage to small ruminants on an experimental station in southern ,Punjab,Pakistan. *Pakistan Journal of Botany*, 42(2): 1353-1360.

Khan, Z.I., M. Ashraf, M.K. Mukhtar, N. Raza, K. Ahmad and N.A. Akram. 2010a. A Study on the Transfer of Iron in Soil–Plant–Animal Continuum Under Semi-arid Environmental Conditions in Sargodha, Pakistan. *Biological Trace Element Research*. doi: 10.1007/s12011-010-8799-6.

McDowell, L.R. 2003. Minerals in animals and human nutrition. 2nd ed. 144 p. Elsevier Science, BV Amsterdam, Netherlands.

McDowell, L.R. and J.D. Arthington. 2005. Minerals for grazing ruminants in tropical regions. University of Florida /IFAS, Gainesville, FL.

McDowell, L.R., J.H. Conrad and G.L. Ellis. 1984. Mineral deficiency imbalances and their diagnosis. In: Symposium on Herbivore Nutrition in Sub-Tropics and Tropics Problems and Prospects (Eds.):F.M.C. Gilchirst and R.I. Markel. *Craighall*, South Africa, pp. 67-88.

McMahon, F.G., J.R. Ryan, K. Akdamar and A. Ertan. 1982. Upper gastrointestinal lesions after potassium chloride supplements: a controlled clinical trial *Lancet*, 2: 1059-1061.

McMahon, F.G., J.R. Ryan, K. Akdamar and A. Ertan. 1984. Effect of potassium chloride supplements on upper gastrointestinal mucosa. *Clinical Pharmacology and Therapeutics* 35: 852-855.

Mengel, K. and E.A. Kirkby. 1987. Principles of Plant Nutrition. Berne, Switzerland: International Potash Institute.

Merkel, R.C., L.R. McDowell, H.L. Popenoe and N.S. Wilkinson. 1990. Mineral status comparisons between water buffalo and Charolais cattle in Florida. *Buffalo Journal*, 1: 33-41.

Mooso, G.D. 1982. Warm–season grass production and nutritive uptake with liquid and solid N-P-K fertilizers .M.S. Thesis, Brigham Yongh University.

Renner, D. 2001. Mineral supplementation: Indications of dietary deficiencies. Organic Farming technical summary. *http://143.234.192.24/mainrep/pdfs/dietary deficiencies.*

Underwood, E.J. 1981. The Mineral Nutrition of livestock. *Commonwealth Agricultural Bordeaux.* Royal, UK, pp. 107-109.

Ward, G.M.1966. Potassium metabolism of domestic ruminants. A review. *Journal Dairy Science*, *Champaign*, 49(3): 268-276.

Warncke, D.D. and L.S. Robertson. 1976. Understanding the MSU soil test report: results and recommendations. Extension bulletin 937, MSU AG Facts. *Cooperative Extension Service*, Michigan State University.

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