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APPRAISAL OF TEMPORAL VARIATION IN SOIL AND FORAGE IRON AND ZINC IN A PASTURE UNDER SEMI-ARID ENVIRONMENTAL CONDITIONS

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Abstract

In the present investigation we determined the effect of sampling periods on iron and zinc contents of soil and forage of a pasture from Sargodha (Pakistan) consisting of plants mainly of *Brassicaceae*. Soil and plant samples were taken six times at a regular interval of 15 days. They were then wet digested and analyzed for Fe and Zn. The data showed that there was no significant influence of sampling periods on both soil and forage Fe and Zn contents. However, there was statistically non-significant variation in mineral contents of soil and forage showing an inconsistent pattern of fluctuation with sampling periods. The highest value of soil Fe was found at the 3rd period and the lowest at the 5th period of sampling. Mean values of soil Fe varied from 7.5-7.7 mg/kg at different periods of sample collection. The highest value of forage Fe was found at the 1st period and the lowest at the 6th period ranging from 57.85-64.67 mg/kg across all sampling times. Mean values of soil Zn varied from 0.36-0.15 mg/kg at different sampling periods. Forage shoot Zn concentration was the highest at the 1st period and the lowest at the 5th period during the whole investigation period. Forage Zn ranged from 13.22 to 23.92 mg/kg in leaves/shoots. There was an inconsistent variation in its concentration at different sampling periods. The concentration of Zn both in soil and forage were at severe deficient levels indicating the need of soil amendment with zinc containing fertilizers to enhance the Zn contents of the pasture soil and in turn availability of Zn to forage from soil. These Fe concentrations were within the marginal and severe deficient levels for the ruminant requirements. The naturally upset balance of Fe offers a potential hazard not only for both pastures, but also the Fe status of grazing ruminants therein.

Introduction

Impaired levels of minerals in soils and forage species is the major cause of low forage yield and livestock production throughout the world. Fluctuation in mineral content in soil and plants depends on a number of factors including soil pH, inherent soil mineral content, soil texture, variation in ambient temperature, season, etc., (McDowell & Arthington,2005).

Mineral deficiencies or excesses may affect growth and reproduction rate of ruminants in many areas of the world. These nutrients may be major elements such as Ca, P, Mg, Na, S or the trace elements Co, Cu, I, Mn, Se and Zn (Little, 1982; Judson *et al*., 1987; Judson & McFarlane, 1998; Evitayani *et al*., 2004; Khan *et al*., 2005; Goswami *et al*., 2005). High amount of minerals ingestion usually has harmful effects on livestock health (Judson & McFarlane, 1998). Symptoms of mineral ailments are often ill-defined and in cases of minor deficiencies may go ignored by the stock holders. The analysis of such signs is also complicated if more than one mineral is lacking (Suttle & Jones, 1989). The feed resources of grazing livestock have a complex relationship of soil, plant and animal-continuum. Seasonal inconsistency can drastically affect the feeding of minerals as a result of variation in structure, growth and accessibility of pasture as well as the moisture content of the soil (Hannam & Reuter, 1987; Smith & Longeran, 1997; Islam *et al*., 2003). Research in the area of the role of trace elements in ruminant nutrition, especially in many undeveloped countries of Asia like Pakistan been not been much. Hence, there is a need to examine the status of trace minerals in soil, and forages in areas rearing ruminants. Thus, the purpose of this research was to investigate and evaluate the effects of different seasons on trace minerals status of soil and forages of a ruminant producing region of Pakistan so as to formulate mineral supplements with high bioavailability of essential trace elements, if required.

Materials and Methods

The present investigation was carried out at a Rural livestock farm in Sargodha, located in northeast of Pakistan. Sargodha possesses a variety of industries and is renowned for its best citrus-production. Like the over all climatic conditions of the country Sargodha also enjoys four different seasons in a year, so these seasons have varying effects on both plants and animals.

Pasture description: The flora of the animal farm comprises grasses, legumes, trees and crops for ruminants. The samples of forage species commonly grazed by the livestock at the farm were collected for minerals analysis. The forage species sampled during the whole experimental period were mostly of family *Brassicaceae.* As mineral status of soil differed from place to place, therefore soil and corresponding forage samples were collected at three different places in five replicates from each place.

Sample collection and preparation for analysis: Six samplings of soil and plants were done and each sampling with a fort nights interval during a sampling season. Five replicates of each soil samples and forage species were obtained from the pasture site allocated for experimentation. Each sample of forage or soil was a combination of three sub-samples. The allocated sites for sampling were dug up to 15 cm depth by a stainless steel auger to get samples of soil as it partially contained all the horizons in it. Forage samples were picked from the same site from which the sample of soil was obtained. All forage samples dried in ambient air, placed in labelled sealed paper bags and stored in an incubator for 7 days for 48 hrs and crushed, using a Wiley mill, with a 1-mm stainless steel sieve (forage) or a 2-mm sieve for soil. Ground soil samples were stored in plastic whirl pack bags. Soil Fe and Zn were determined following the Mehlich-1 method (0.05 M HCl+0.0125 M H_2SO_4) as described by Rhue & Kidder (1983), whereas the forage samples were digested with sulphuric acid and hydrogen peroxide following Wolf (1982) Zn and Fe concentrations were analyzed by an atomic absorption spectrophotometry (Perkin-Elmer AAS-5000).

Statistical analysis: The data obtained for soil and forage Zn and Fe were statistically analyzed through a soft ware Statistical Analysis System (Anon., 1987), and statistical significance tested at 0.05, 0.01 and 0.001 levels of probability using Duncan's New Multiple Range Test (Duncan, 1955).

Results and Discussion

Soil-Fe: Soil Fe showed a non-significant effect of sampling intervals on its concentration during the present study. The highest value of soil Fe was found at 3rd interval and the lowest being at the 5th interval of sampling. Mean values of soil Fe varied from 7.5-7.7 mg/kg at different sampling times. In fact, no consistent pattern of increase or decrease in soil Fe concentration was found in this study (Fig. 1) The Fe contents in soil were far greater than the critical values of 2.5 mg/kg established by Rhue & Kidder (1983). These soil Fe concentrations found during the present study were much greater and far sufficient for the requirements of forage crop being raised at the pasture for livestock.

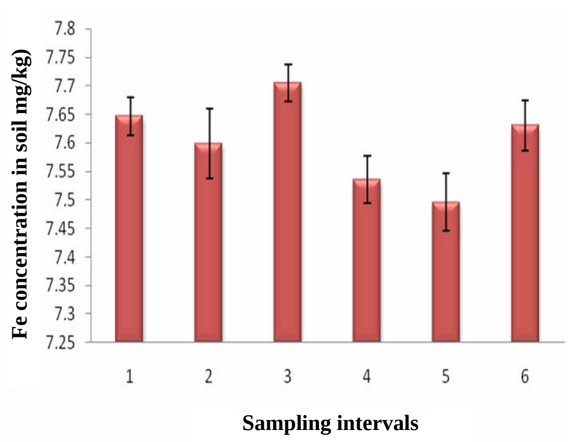

Fig. 1. Effect of different sampling intervals on soil Fe concentrations.

The soil Fe content found in the study was similar to those levels; found by various researchers from various regions of the world, e.g., (Espinoza *et al*., 1991 in central Florida, Khan *et al*., 2007 and Fardous *et al*., 2011) in Pakistan. Soil Fe values were lower than those previously reported by Aregheore et al. (2007). The findings of the present investigation for soil Fe showed great fluctuations which can be ascribed to the rainfall occurring erratically in this region during different season in a year. Several factors of the environment affects the soil Fe content like temperature, pH, nutrient concentration, aeration of the soil, etc. (Ahmad *et al*., 2011). These soil Fe reported in the present study are sufficient for forage growth on the pasture. These results support the assumption of various workers that deficiency of Fe is not common in different livestock forms due to higher concentration of this element in soil and forage (McDowell, 1984; Ahmad *et al*., 2010).

Forage-Fe: A non-significant effect of sampling intervals was found on forage Fe. The highest value of forage Fe was found at the 1st sampling interval and the lowest at the 6th interval during all sampling intervals. Mean values of forage Fe varied from 57.85-64.67 mg/kg at different sampling periods. There was no consistent pattern of increase or decrease in forage Fe concentration in this investigation (Fig. 2). These values were lower than those previously reported elsewhere (Ahmad *et al*., 2010; Khan *et al*., 2009), but are similar to those reported by Khan *et al*., (2011). Similar fluctuations in forage Fe contents have already been reported by Kuhn *et al*., (1999) and Khan *et al*., (2011) in their investigations. Forage Fe reported in the present study was slightly higher than the critical values of 30-50 mg/kg as suggested by McDowell *et al*., (1984).Thus there is no potential threat to the ruminants grazing in the pasture at the rural live stock farm.

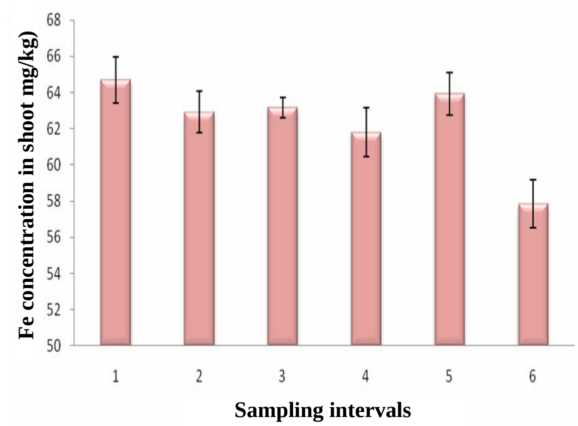

Fig. 2. Effect of different sampling intervals on shoot Fe concentrations.

Soil-Zn: Statistical analysis of the data for soil Zn showed a significant effect of sampling intervals on its concentration and varied at different sampling intervals during this investigation. The highest value of soil Zn was found at the 1st interval and the lowest concentration at the 6th interval. Mean values of soil Zn varied from 0.36-0.15 mg/kg at different sampling times. There was no consistent pattern of increase or decrease in soil Zn in this investigation (Fig. 3). In our findings the soil Zn levels were below the critical level for soil Zn (1-0.5 mg/kg) content for plants reported by Gune (2004).

Forage-Zn: A significant effect of sampling intervals on the Zn concentration was found on shoot Zn concentrations during the present study. Zn concentration was highest at the 1st sampling intervals and lowest at the 5th interval during this investigation (Fig. 4). Shoot Zn ranged from 13.22 to 23.92 mg/kg. There was an inconsistent variation in shoot Zn concentration at different sampling intervals. The forage concentration was lower than the values already reported and recommended by NRC (Anon., 1980) i.e., 20-30 mg/kg. The forage Zn was almost equal to the critical level but during some sampling intervals they decreased dramatically, which may pose a threat to the grazing ruminants therein. Forage Zn concentration during all the sampling periods were higher than those earlier observed by Espinoza *et al*., (1991) and Khan *et al*., (2009). The minimum Zn requirement of livestock varies with the chemical form or combination of diet (McDowell, 1985). In our study, forage Zn concentration seemed to be sufficient for all forms of life at different developmental stages of animals as 7 mg/kg dietary Zn is sufficient to maintain growth but 15 mg/kg is needed to maintain normal Zn blood levels (McDowell & Arthington, 2005). However, Zn intake of 17 mg/kg is apparently adequate for growth in ram lambs but not adequate for normal testicular development and function, which can be improved by a dietary intake of 32 mg/kg of Zn (Underwood & Suttle, 1999).Based on this investigation there is no warranted need of Zn supplementation to livestock grazing at the pasture. This information would be used for different ruminant producing regions during winter and summer seasons in Pakistan and other developing Asian countries with similar ecological conditions.

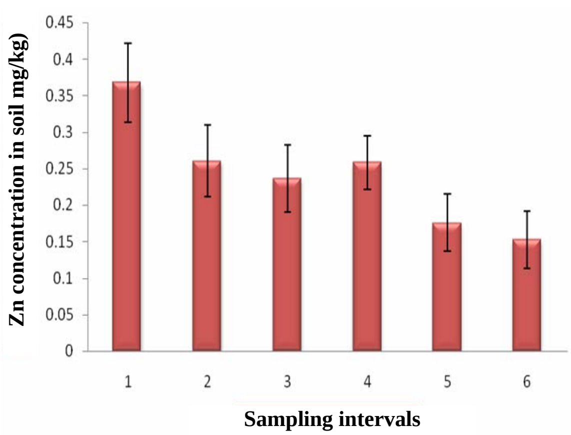

Fig. 3. Effect of different sampling intervals on soil Zn concentrations.

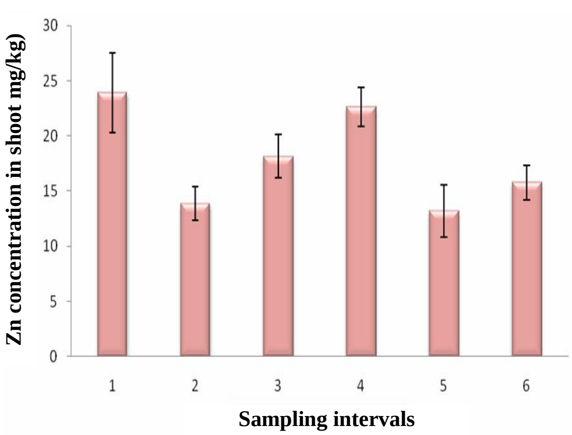

Fig. 4. Effect of different sampling intervals on shoot Zn concentrations.

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