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Periodic Variation in Soil, Forage and Serum Minerals of Dry Cattle in Punjab, Pakistan

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Abstract: An investigation was conducted to evaluate the nutrient level of grazing livestock as influenced by the sampling periods in Punjab state district Sargodha, Pakistan. Twenty composite soil and pasture and twenty five blood samples were collected at two different sampling periods during December 2010 to March, 2011, respectively. Higher soil content of all elements except iron was observed during December than those found in March at the 2nd harvest during this period but all mean values were above the critical levels investigated for soil for the requirements of forage crops. Forage potassium, magnesium and copper levels did not differ between samplings. Calcium, sodium, zinc, manganese, cobalt and selenium were higher during December, while reverse was true for forage iron reflecting the soil iron contents. The sodium, manganese, iron and selenium in forage were found to be deficient than the requirements of livestock during both sampling times in this investigation. From the four minerals assessed in the serum calcium, magnesium and zinc levels were high after the December in March. The macro minerals which were found to be moderately deficient at this animal farm are sodium and magnesium. Specific mineral supplementation should be supplied containing copper and zinc, as both pasture and blood plasma samples exhibited their deficiency. The present investigation suggested the requirement of provision of an appropriate specificity tailored mineral mixture to ruminants in this specific studied area.

Key words: Soil · Forage · Serum · Ruminants Productivity · Punjab · Pakistan

INTRODUCTION

Elemental concentration of different forages is mostly affected by soil characteristics including pH, fertilization practices, drainage system, plant species forage stage of maturity and, various types of interactions among different mineral elements [1, 2]. When animals depend exclusively on forage plants to fulfill their fodder requirements it is necessary to identify various attributes that may change forage composition and to measure strategy program to improve livestock productivity and performance [2]. Variable environmental limitations in the subtropical and semiarid region including drought stress during dry season, elevated temperature and intensity of light radiations result in low level of soil elemental composition. These conditions impose many restrictions on the achievement of primarily goal for the maintenance of suitable forage plant production and their quality which has been considered to support required levels of ruminant's production. The composition of the elemental concentration varies with the change of season and sites and period of sample collection, which in turn may affect elemental profile of animal consuming these forages. This situation may limit the animal production due to imbalances of minerals in the forage diet [3, 4]. The prominent and devastating consequences of mineral

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deficiency are the delayed puberty of heifers and late and low productivity of cows which is often correlated with long calving duration [5].

Mineral composition assessment of grazing livestock in Punjab, Pakistan has received extremely small consideration and incredibly inadequate information is existing concerning mineral nutrients of accessible forage plants and mineral constituents in grazing livestock. A very little information has been available as widespread imbalances of both macro and micro minerals in soil, forage and animal continuums in different countries and Pakistan [6-10].

The aim of the present study was to appraise the mineral composition and status of a livestock farm and evaluate the elemental composition of ruminant's blood serum, forage and soil during two different sampling periods. This information would be useful for the livestock owners and scientists working for the improvement of livestock in different regions of Pakistan and other countries with similar ecological conditions.

MATERIALS AND METHODS

This investigation was conducted in the district Sargodha at a rural livestock farm in Sargodha Punjab, Pakistan. The study was done within the pasture of 25 acres located in almost subtropical/semiarid region. Samples were haphazardly chosen in the parts of the animal grazing land where animals were presently grazing. The soil texture was loamy to clay with pH ranging from 7.5 to 8.4. In the investigation region, livestock grazed round the season in the meadows consisted principally of *Trifolium spp*. and some plants of *Brassicaceae*. The main breed of cow was known as 'Desi' which was investigated in this study. Pasture and soil samples were gathered throughout the commencement of desiccated period with knife to accumulate 20 merged pasture and soil samples. Every soil sample composed of 3-sub samples obtained from the depth of 20 cm [11]. Soil and forage samples were obtained from 25 acres pastures.

Blood samples were obtained from 25 cows in dry physiological state for both sampling periods. The age of cows lied between 3-5 years. Samples of soil were analyzed for the determination of Mn, Na, Zn, Ca, Cu, Mg, K and pH [12] and soil extractable minerals were analyzed using flame photometer and atomic absorption spectrophotometer [13]. The soil pH was dogged by means of 1:2 (v/v) soil: water ratio. Forage and blood samples (after separation) were subjected to wet digestion with nitric acid and per chloric acid and minerals were analyzed by the method as for soil.

The data collected in this investigation were analyzed statistically following the SAS procedures [14]. Soil, forage and serum mineral components were analyzed to establish reference/decisive values to decide percentages of lacking samples.

RESULTS AND DISCUSSION

Soil Analysis: Mineral concentrations of soil as related to the sample collection were given in table 1. Average soil pH was exaggerated by the sampling occasion of meadow soil. Soil pH standards are attributed to soil from a variety of derivation. Gough [15] did not come across momentous differences in soil pH with variation in time. Sampling of time reported herein was assessed after two to four month

Table 1: Mineral concentrations of pasture soil as related to site of sample collection

		1st sampling			2nd sampling		
Element	C.L.	Mean	S.E.	% Def.	Mean	S.E.	% Def.
pH	5.5	7.4	1		7.8	-	-
Ca	<71	450.4	15	4	278.6	5.4	0
Mg	<30	87.8	3.7	2	48.5	2.3	0
K	<62	80.2	5.5	3	45.4	1.8	3
Na	-	14.35	1.4	-	9.5	0.8	-
Zn	<1	5.78	0.23	0	2.63	0.14	4
Cu	<0.3	0.72	0.03	2	0.45	0.02	5
Mn	<5.0	80	4.3	2	55	2.3	0
Fe	<2.5	5.9	0.7	2	9.65	1.2	0

C.L.: Critical level.

%Def.: percentage of samples below the critical level.

Least square means (mg/kg, dry basis) are based on 20 composite samples by sites.

Table 2: Forage mineral concentrations in relation to sampling time

	1st sampling				2nd sampling		
Element	C.L.[a]	Mean[b]	S.E. [c]	%Def.[d]	Mean	S.E.	% Def.
Ca	0.3	0.76	0.02	10	0.18	0.01	55
Mg	0.2	0.16	0.01	40	0.17	0.01	60
K	0.8	1.19	0.07	5	1.29	0.06	3
Na	0.08	0.14	0.02	60	0.05	0.02	100
Zn	<30	57	1.3	10	40	1.2	50
Mn	<44	55	2.2	20	29	2.5	30
Fe	<50	19.45	2.0	100	51	3.5	100
Cu	<8	14.77	1.4	30	11.55	1.6	50
Co	<0.1	0.31	0.02	65	0.26	0.02	70
Se	<0.2	0.14	0.01	72	0.09	0.002	100

a: Critical level.

b: Least square means (Unit??) based on 20 forage samples.

c: Standard error of the least square means.

d: Percentage of samples below the critical level.

interval. The sampling period affected various levels of soil minerals that they are found to be higher during 1st sampling (December), While reverse was found for soil Fe, according to critical level [12]. Soil Ca during sampling II was low which indicates probable small contents of Ca phosphates with small water solubility. Elevated percentages of calcium and copper scarce samples of soil were co-related with other findings [16].

Mean soil minerals varied between sampling periods and all elements except Fe were higher in concentrations at sampling period I compared to sampling period II, while reverse was true for soil Fe. A number of factors may perhaps have probably contributed to this tendency or climatic / edaphic [17]. As soil organic matter OM has a small attraction for alkali cations, therefore, alkali invariable of the soil OM tends to the adequately short and it is probable that with the OM in lower amount in the soil, the concentration of Ca possibly will be elevated. Some additional factors that influence Na and Ca, to a great extent may be climatic which might have affected the amount of Ca and Na levels of pasture land [17]. No Mg scarce samples were found according to the decisive stage of <15 mg/L [12].

Forage Analysis: Concentrations of minerals in forage; Ca, Na, Zn, Mn, Fe, Co and Se were exceedingly exaggerated by the harvesting stages (Table 2). The percentage of Ca lacking harvests was elevated for the second sampling period (55%) compared to that at first collection period (10%) according to the decisive value of < 0.3% [16, 18]. The percentages of Mg lacking harvests were 40 and 60% for I and II harvesting stages, respectively. Small amounts of forage Mg can cause deficiencies in livestock, particularly, if forage contains elevated K values. Vogel and Fennessey [19] recommended that in cases of hypomagnesaemia that the interface of Mg, Ca and K is extremely significant. They recommended that a ratio of K/ (Ca + Mg) be used to approximate the grass tetany prospective of forage. The relative amount is supposed to be fewer than 2.2 for forage to be secure in stipulations of its impending for inducing grass tetany in lactating cows. In this investigation, the K/ (Ca + Mg) relative amount wasn't different between sampling stages, but all individual forage samples were higher than the 2.2 value recommended by Vogel *et al*. [19]. This suggests that a possible difficulty may be at hand in this cattle farm if livestock depend on forage with no supplementation. Although soil Mg tended to decrease at II sampling period, this propensity was not established in forage samples. Average forage contents of Mg and K were not exaggerated ($P > 0.05$) by the sampling periods. Although soil Mg concentration indicated a decrease at sampling period II, this tendency was not found in forage K and Mg contents at it was higher for sampling period II.

The forage Fe concentration showed this trend in forage samples. Percentages of samples deficient in Fe were 100% at both sampling and Na 60 and 100% (I and II sampling, respectively) were found, whilst Se lacking samples were 72 % for I and 100 % at II sampling. Mean forage concentrations of Na, Ca, Zn, Cu, Se, Mn and Co decreased, while percentages of K deficient samples was

Table 3: Mineral concentrations of serum as related to sampling period

	1st sampling				2nd sampling			
Element	C.L[a]	Mean[b]	S.E[c]	%Def[d]	Mean	S.E	% Def	Significance
Ca mg/100ml	<8.0	7.2	0.06	11	8.4	0.05	2	*
Mg mg/100ml	<2.0	1.5	0.04	50	2.8	0.05	28	**
Cu g/100ml	<50	52	2.83	35	38	2.45	55	***
Zn g/100ml	<60	88	2.9	8	97	3.5	6	**
Se g/100ml	4.0	4.3	0.5	20	4.5	0.6	15	ns

*(P > 0.05),** (P > 0.01),*** (P > 0.001), ns=non-significant

5 and 3%, Na 60 and 100, Zn 10 and 50, Mn 20 and 30, Cu 30 and 50, Co 65 and 70 and Se 72 and 100% for I and II sampling periods, respectively while Fe, Mg and K concentration increased significantly during sampling II in March (P < 0.01).

The increase in mineral concentrations in forages agrees with the augment of these minerals in soil at the first harvest. Deposition of heavy metals in the soil can encompass and has an influence on plant incorporation of Fe and/or Mn. Mn contents in plants depend on plant stage of development and fraction of the plant. Mn content in some plants has been reported to be extremely small throughout swift increase and to mount up in grown-up leaves and leaf sheaths [20]. Kabata-Pendias and Pendias [21] recommended that Mn stage in forages reflects a constructive affiliation with soil organic matter and an unenthusiastic association with mounting soil pH. The organic substance deposited in the soil of this farm might have high Mn, though there was a decrease in soil organic substance that might have decrease Mn accessibility to the plant. Co uptake by plants is correlated to soil concentration of Mn. Elevated level of soil Mn may be the reason of underprivileged plant uptake of Co [22]. Other circumstance that may have exaggerated Co concentrations in forages is the soil humidity at the time when samples were collected. Mn, Fe and Co lacking forage harvests for animals found in this investigation were 20, 100 and 65%, correspondingly, during 1st sampling and 30, 100 and 70% during sampling period II in this investigation.

Serum Analysis: Mean serum minerals have been shown in table 3, there was overstatement variation (P > 0.001) in average serum Cu at I and II harvesting period, though there were not variation (P > 0.05) in average serum Se at those ones and II harvesting period, the percentage of samples under the decisive level (<4.0 mg/100 ml) vary from 20 to 15%, respectively. Serum Se concentration was lesser (P < 0.05) at 1st than that at 2nd sampling time (4.3 and 4.5 ug/100 mL, respectively). Mean serum Ca and Mg were elevated (P < 0.05) at sampling I than that at sampling period II. Nevertheless, forage Ca and Mg differed amid collection periods. This indicated a probable association between deposition of these minerals in the soil and animals consuming impure forages and/or soil which may have augmented Mg and Ca. Ca in serum is exaggerated only by severe shortage and is intimately synchronized hormonally. Consequently, Ca in feeds would be an additional dependable criterion to asses Ca composition in cattle, higher serum Mg was advanced (P <0.05) in dry cows [23].

Mean serum Zn varied between animals and sampling periods. The higher concentrations of serum Zn was at sampling period II sampling. Mean serum Zn concentration of animals (88 vs. 97μg/100) with 8 and 6 % of the samples respectively below the critical limit suggested by McDowell *et al.* [24]. Mean serum copper contents showed fluctuations (P < 0.05) between sampling intervals. Analysis of this interface recommended that serum Cu was elevated in lactating cows at sampling period I and lowered at sampling period II (38 μg/100 ml vs. 52 μg/100 ml). Copper was lesser than the required level and ranged from 35 and 55 percent for 1st and 2nd sampling periods. Hypocuprosis might be aggravated by admittance molybdenum (Mo), S, Fe, Zn and Ca and influence every one stages of increase and production [25]. In this investigation, Fe in forages was elevated with respect to the climatic and seasonal variation. This interface and others through Mo, S, Zn and Ca might encompass exaggerated levels of Cu found in this investigation.

It can be concluded that the variation in season enhances the amount of calcium, sodium, zinc and manganese along with decline the organic matter of soil. The copper, cobalt and zinc were below the required limit for ruminant grazing therein thus anticipating the requirement of supplementation with specifically tailored mixture for animals to enhance the productivity of livestock at the farm.

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