Paper ID: 242
Theme 2. Grassland production and utilization
Sub-theme 2.1. Quality, production, conservation and utilisation

Effect of growth stage on the macro mineral concentrations of forbs and grasses in a semi-arid region of Sudan

Sahar Ezzat*, B. Fadlalla
Sudan University of Science and Technology, Khartoum, Sudan
*corresponding author e-mail : s_abdelhag@yahoo.com

Keywords: Flowering stage, Rangeland, Seed set

Introduction

Ruminants grazing forages in severely mineral-deficient areas may be more restricted by this condition than by inadequacy of energy or protein. Mineral imbalances in soils and forages are responsible for low production and reproduction in grazing livestock. As grazing livestock are not usually offered mineral supplements apart from common salt, they depend upon forages for their requirements. However forages rarely fully satisfy all mineral requirements. Mineral intakes of livestock are influenced by the factors that determine the mineral content of plants and their seeds. The concentrations of minerals in plants depend largely on plant genotype, soil environment, climate and stage of maturity. Leguminous species are generally much richer in macro-elements than grasses growing in similar conditions, whether temperate or tropical. The objective of this study is to assess the status of the macro-mineral elements Na, K, P, Ca, and Mg in the dominant native species during the flowering and seed set stages of plant growth at Sheikan Locality, North Kordofan State, Sudan.

Materials and Methods

Sampling periods corresponded to two different stages of growth namely flowering (rainy season) and seed set (early dry season) of 2010 and 2011. A total of 29 plant species (21 forbs and 8 grasses) were collected from the rangelands. Plants' shoots (leaves and stems) were picked randomly by hand according to diet selected by sheep. ICP was used to determine mineral content. T-test was used to compare differences between stages of growth. Missing data was accounted for by GLM.

Results and Discussion

Mineral concentrations in plants generally reflect the adequacy with which the soil can supply absorbable minerals to the roots. However, plants react to insufficient supplies of available minerals in the soil by limiting their growth, reducing the concentration of the deficient elements in their tissues or, more commonly, by reducing growth and concentration simultaneously. The extent of a particular response varies with type of minerals, plant species as well as with the soil and climatic conditions. The primary reason for mineral deficiencies in grazing animals is that the soils are inherently low in plant-available minerals.

Tables 1 and 2 illustrate the levels of the macro-minerals Na, K, P, Ca and Mg of some plant species of rangeland over the two stages of growth for forbs and grasses respectively. Flowering stage showed a higher concentration of macro-minerals compared with the seed set stage ($P<0.05$). A similar result was obtained by Coates *et al*., 1990 who reported that, phosphorus concentrations of forage plants decline markedly with advancing maturity, although the decline is less in legumes than in grasses. Changes in mineral concentration with maturity often reflect increases in the proportion of stem to leaf with stems showing lower mineral concentrations than young leaves. Our data also indicated a higher content of macro-minerals in forbs compared with grasses. These results suggest adequate macro-mineral levels for sheep as reported by Grusak (2001) for phosphorus, calcium, magnesium and potassium (0.2 %, 0.5%, 0.2% and 1.0 %) respectively. The present results are in variance with those of Cook and Fadlalla (1987) who reported a deficiency of phosphorus in the diets of grazing animals in South Kordofan, Sudan, which ranged from 0.18% in the rainy season (flowering stage) to 0.09% in the dry season (seed set stage). The difference may be explained by variance in soils and rainfall. Soils of South Kordofan are predominantly clay while those of North Kordofan are mainly sandy, locally known as Qoz soils. Rainfall is also higher in South Kordofan. Berman and de Wit (1983) reported that northern sandy soils rangelands are superior in protein and minerals compared with those of ecological areas with heavier soils and higher rainfall. Abundant rainfall seems to have an adverse, probably leaching effect, on phosphorus. During long periods of P deficiency this mineral may become deficient in the rumen, leading to reduced microbial growth efficiency and at times

digestibility and intake of forage (Leng, 1990). This author also reported that calcium deficiency is also most likely to occur in areas of high rainfall and humidity.

Table 1. Concentrations of Macro-elements Na, K, P, Ca and Mg (mg/kg) for some forbs at flowering and seed set Stages

Scientific name	Flowering stage					Seed set stage				
	Na	**K**	**P**	**Ca**	**Mg**	**Na**	**K**	**P**	Ca	Mg
Colocynthis citrullus	212	13863	1823	9948	2666	275	11854	1167	7907	1733
Seddera spp.	1433	11660	1328	21824	3593	4673	13485	1614	18997	4608
Polygala eriotera	473	22692	1654	18858	3247	625	12596	2049	6461	2486
Crotalaria spp.	280	21462	1854	12640	2426	178	14767	1043	8292	1501
Requeniaob cordata	235	16049	1517	9656	2631	389	17829	1606	9051	2658
Justicia kotschyi	203	27631	2011	31457	18277	230	28632	2063	18694	10340
Sesbania sesban	540	23236	2332	12260	1154	765	14164	1491	9986	1853
Belpharis linarifolia	127	21445	1581	18578	3978	102	15860	1295	17604	2650
Ipomoea sp.	10142	24012	2509	9194	4437	3084	26609	2581	9172	6197
Tephrosia spp.	669	18548	1504	10002	3173	172	14897	1319	11818	3524
Tribulus terrestris	1507	20173	2049	26132	5606	--	--	--	--	--
Corchorus oiltorius	808	22394	1703	13950	3669	388	15200	2301	20378	3459
Indigofera aspera	671	41579	2369	24604	11755	--	--	--	--	--
Acanthus spp.	665	15139	1696	11038	3813	613	20019	1838	12186	4746
Indigofera spp.	410	20191	1795	26752	5277	260	16176	1240	14524	2592
Solanum dobium	294	29652	2320	15361	6684	158	25396	1451	14516	4538
Dicomato mentosa	181	19597	2272	9748	4081	--	--	--	--	--
Farsetia longisclizua	594	15831	1870	18057	4673	--	--	--	--	--
Ipomoea belpharosepala	12156	19010	2536	7524	3382	8079	21194	1483	9199	3727
Acanthospermum hespidum	--	--	--	--	--	407	29131	1180	11733	4689
Abutilon glaucm	--	--	--	--	--	748	22719	1769	24015	6383

Table 2. Concentrations of macro-elements Na, K, P, Ca and Mg (mg/kg) for some grasses at flowering and seed set stages

Scientific name	Flowering stage					Seed set stage				
	Na	**K**	**P**	**Ca**	**Mg**	**Na**	**K**	**P**	**Ca**	**Mg**
Echinocloa colonum	2718	25962	1415	3863	4345	1319	21958	697	5531	3690
Eragrostis tremula	11606	11926	1689	3905	2244	11397	11894	1221	3552	2535
Schoenefoldia gracilis	3412	16114	1199	3994	2031	1091	15606	705	3658	1994
Cenchrus biflorus	280	23633	1101	6086	2417	1448	20262	706	4080	2608
Chloris virgate	299	22480	1209	3694	3553	--	--	--	--	--
Dactyloctenium aegyptium	3256	10673	1229	5121	2219	--	--	--	--	--
Cyprus spp.	632	17332	867	6175	3250	1282	20535	1017	6914	2708
Aristida mutablis	195	11324	1194	2972	1703	--	--	--	--	--

Conclusion

Our current investigations on minerals evaluation of rangelands revealed that these are good sources of macro-minerals that can meet the requirements of sheep in North Kordofan State, especially during the stage before plants set their seeds. Forbs are richer in macro-elements compared with grasses. They provide a better option compared with grasses in terms of mineral content as well as protein and as such can be used in reseeding of degraded areas to furnish animals with sufficient mineral nutrients.

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Acknowledgement
The authors wish to express their appreciation to Federal Research Centre for Cultivated Plants - Julius Kühn-Institut, in Braunschweig, Germany for technical support and for giving us the absolute access to their laboratory.