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SOIL SUITABLE FOR THE GROWTH OF LEGUMINOUS CROPS

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The profile of the soil sample indicated that the surface horizon was dark brown, messive, silty clay loam, under lain by non-saline/sodic, distinctly mottled and weakly structured silty clay to 240 cm. depth. The soil was classified as Aquic ustochrepts. Chemical analysis of the soil showed that it contained adequate amounts of essential metal ions. Two forage legumes *Trifollium resupinatum and Trifolium alexandrium* (Persian and Egyptian clovers) grew well when irrigated. The yield of these fodder crops, without application of fertilizer was 86.5 and 94.1 tonne/ha/season, respectively. The protein content of the crops on a dry matter basis was calculated as 25 and 30% respectively. The soil classified as above is regarded as suitable for growing leguminous crops.

Key words: Soil, Clovers, Growth.

Introduction

The most important factor to be considered in developing an irrigated system of agriculture in an area is the land classification. According to Ashraf *et. al.* [1] there are four categories of soil in Pakistan. (a) Naturally productive soil which requires relatively little effort to produce large yields of a wide range of crops; (b) Soil having some limitations for agriculture use and which requires more effort to produce good crops yield and on which the crop choice may be nerrow; (c) Soil not fit for arable farming but suitable for forestry; (d) Unproductive soil. Jalal-ud-Din *et. al.* [2] have described the land forms and explained the properties of different categories of soils. The present study was carried out to assess the suitability of land in the Lahore area for agricultural practice, and to conduct long term experiments cultivating leguminous fodder crops for the production of leaf protein concentrate for human and animal consumption.

Experimental

Soil sa mpling and profile description. A pit was prepared in the experimental field of PCSIR Laboratories, Lahore and soil samples (2-3 kg) were collected from the profiles at depths of 0–12; 12–20; 20– 48; 48–80 and 80–240 cms. for mechanical and chemical analysis. The samples were described according to the Soil Survey Manual [3] and FAO Guidelines [4]. Nomenclature of the horizons was according to the Soil Survey Manual Supplement [5]. The soil colour was studied by comparison with Munsell Soil Colour Charts [6] and the soil was classified according to the USDA classification system [7].

Analyses. Mechanical analysis of the soil samples was done by the hydrometer method [8] using calgon solution (sodium hexametaphosphate 50 g/100 ml) as dispersing agent and electrical conductivity was measured by solu-bridge*. Chemical analysis of the soils were done by using standard AOAC methods [9]. Moisture content of all the samples was determined by oven drying at 100±2° for 24 hours. Sodium and potassium were determined photochemically using flame photometer and nitrogen by a micro-kjeldahl method. pH was determined by glass electrode.

Cultivation of leguminous fodder crops. The experimental field ploughed five times and levelled and weeded. Persian clover (*Trifolium resupinatum*) and Egyptian clover (*Trifolium elexandrinum*) seeds, at the rate of 1 kg/418 sq.m. were sown (separately) in mid-September by the conventional local method i.e. broadcasting the seed in standing water. The area allocated to each variety was 8360 sq.m. The field was flooded with canal water after every 10-15 days for irrigation, and no fertilizer was applied. Both crops were harvested at intervals of 30 days until the end of the season (mid-June). The crop from each harvest was weighed in order to determine the yield/hectare/season.

Results and Discussion

The profile description (Table 1) and mechanical analysis (Table 2) show the general characteristic and texture of the soil. The results showed that the surface horizons (A_{11} and A_{12}) were dark brown, silty clay; tending to silty clay loam. The underlying horizon B_{21} to B_{23} were dark brown, mottled, silty clay; very plastic and sticky, blocky subangular and contained fine concretions of manganese, iron and was moderately calcareous. The soils were wet, non-saline and had a pH of 8.2. The soil was classified as Aquic ustochrepts which has been reported suitable for growing common crops such as sugarcane, rice, wheat and clover if irrigated properly [2].

The samples were also analysed chemically for the determination of essential elements (Table 3) and the results

*Apparatus for measuring the conductivity of the soil. It is known as soil tester Reg. No. 9446, USA.

TABLE 1. SOIL PROFILE DESCRIPTIONS

A 11P	0-12 cm	Brown/dark brown (10 YR 4/3 moist and pale brown (10YR 6/3) dry *silty clay* tending to silty clay loam; very sticky, very plastic, firm moist, very hard dry; common fine and very fine tubular and interstitial pores; moderately calcareous; few fine and very fine roots; clear smooth boundary; pH 8.2
A 12	12-20 cm	Brown/dark brown (10 YR 4/3) moist and pale brown (10 YR 6/3) dry *silty loam;* very weak coarse subangular blocky; slightly sticky, slightly plastic, friable moist, hard dry; common fine and very fine tubular pores; moderately calcareous; few pottery pieces; few fine and common very fine roots; clear smooth boundary; pH 8.2
B 21	20-48 cm	Borwn/dark brown (10 YR 4/3) moist and pale brown (10 YR 6/3) dry; common fine and medium distinct olive grey mottles; *silty clay;* weak coarse subangular blocky; very sticky, very plastic, firm moist, very hard dry; common fine and very fine tubular pores; moderately calcareous (but less than the above horizon); few fine and very fine roots; clear smooth boundary; pH 8.2.
B 22	48-80cm	Brown/dark brown (10 YR 4/3) moist and pale brown (10 YR 6/3) dry, common fine and medium distinct olive grey mottles; *silty clay* tending to slity clay loam; weak coarse subangular blocky; very sticky, very plastic, firm moist, very hard dry; common fine and very fine tubular pores; slightly calcareous; very coarse pockets of brown/ dark brown (7.5 YR 4/4) and moderately calcareous silt loam, containing few lime fine concretions; fine iron-manganese concretions; few fine and very fine roots clear wavy boundary; pH 8.2.
B 23	80-240cm	Dark greyish brown (10 YR 4/2 and 2.5 Y 4/2) moist; common fine and medium distinct yellowish brown mottles (mottles increase to many after 140 cm); *silty clay;* weak coarse subangular blocky breaking into medium and fine subangular blocky; very sticky, very plastic, very firm moist, very hard dry; common fine and very fine tubular pores; noncalcareous; common to many fine and medium iron-manganese concretions; few fine roots; pH 8.2.

Note: The soil was classified as Aquic Ustochrepts.

TABLE 2. MECHANICAL ANALYSIS OF THE SOIL SAMPLES

Soil harizon	Hydrometer readings Uncorrected/corrected 40 sec	4 min	2hr.	*USDA sand %	**Int. sand %	Clay %	*USDA silt 100-(Sand+ clay) %	**Int silt 100- (Sand+ clay) %	Soil texture
A11	41.0	26.0	16.0/17.0	100-82=18.0	100-52=48.0	34.0	100-(18+34) 48.0	100-(48+34) 18.0	Silty clay loam(heavy)
A12	39.0	26.0	12.0/13.0	100-78=22.0	100-52=48.0	26.0	100-(22+26) 52.0	100-(48-26) 26.0	Silt loam
B21	43.0	33.5	19.0/20.0	100-86=14.0	100-67=33.0	40.0	100-(14+40) 46.0	100-(33+40) 27.0	Silty clay
B22	42.5	33.0	19.0/20.0	100-85=15.0	100-66=34.0	40.0	100-(15+40) 45.0	100-(34+40) 26.0	Silty clay
B23	42.0	32.0	19.0/20.0	100-84=16.0	100-64=36.0	40.0	100-(16+40) 44.0	100-(36+40) 24.0	Silty clay

*United States Department of Agriculture; ** International

TABLE 3. CHEMICAL ANALYSIS OF THE SOIL SAMPLES

Soil horizon	*WSP	(Ca+Mg)	Na	Milliequivelents/litre CO_3	HCO_3	Cl	SO_4	Total cations anions	** Millimhose Exx10^3 at 25°C	*** S.A.R.
A 11	41.0	7.0	9.0	Nil	11.5	3.0	1.5	16.0	1.60	4.81
A 12	36.0	3.0	8.0	Nil	6.5	3.0	1.5	11.0	1.10	6.56
A 21	37.0	2.5	6.5	Nil	5.5	2.5	1.0	9.0	0.90	5.80
B 22	36.5	3.0	4.5	Nil	4.5	2.5	Traces	7.5	0.75	3.69
B B 23	38.0	4.0	4.0	Nil	4.0	3.0	1.0	8.0	0.80	2.84

Water saturation point. **Electrical Conductivity

*** Sodium Absorption Ratio = $\frac{Na^+}{\sqrt{Ca^{++} + Mg^{++}/2}}$

indicated that they contained adequate quantities of essential nutrients. The concentration of calcium and magnesium ions (which control the activity of nitrogen -fixing bacteria, photosynthesis and the transformation of carbohydrate) ranged from 2.5–7.0 milli-equivalents/litre over the different horizons. The concentration of sodium ranged from 4.0–9.0 milli-equivalent/litre. Sodium ions are reported[10] as being essential in promoting resistance to diseases, wilting of crops in hot weather and is especially helpful when the potassium supply is insufficient in the soil. The concentration of chloride ions which are more readily absorbed than sulphates ions were found from 2.5–3.0 milli-equivalents/litre. The conductivity and S.A.R. data did not show any problem of salinity. There is not any limiting factor in the land and it is very good for irrigated agriculture.

Growing of Persian and Egyptian clovers in this type of soil, without the addition of fertilizer gave green fodder yields 86.6 and 94.1 tonne/ha/season respectively. The protein content of the crops on a dry matter basis was calculated as 25 and 30% respectively. The maximum yield/hectare/season obtained by Musahib-ud-Din [11] by cultivating these clovers on "Bahri Mehra" land with super phosphate and ammonium sulphate fertilizer treatment was less than that found in the present studies. The results here confirmed the finding that the land examined was productive, suitable for long term experiments in agriculture and for producing crops which can be used for the large scale extraction of protein [12 a,b].

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* Bahri Mehra land comprises moderately fine textured soil, clay loams or silty clay loams.

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