A Comparison of Grass Growth on Different Horizons of Three Grassland Soils

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ASSOCIATION of plant production with soil quality has been generally recognized and tested on agricultural lands. Few studies of such relationships between soil conditions and plant growth have been made on range lands. Sinclair and Sampson (1931) have made an intensive study for a single soil series in California. The purpose of the present study was to evaluate the growth responses of two grasses grown on separate soil horizons of three grassland soils of western Montana.

Methods and Materials

Plants of beardless wheatgrass (*Agropyron inerme*) and cheatgrass (*Bromus tectorum*) were grown in samples of soil collected at depths of 0–6, 6–12 and 12–18 inches from dark, medium and light chestnut soils. Five replicate containers were seeded to each grass for the three depth horizons of each soil. Plants were grown under greenhouse conditions with supplementary illumination to provide a 15-hour day. Air temperatures were maintained at an average of 72° F. All containers were well watered as needed.

Responses of plants were evaluated in terms of vegetative height and weights of herbage and roots. Height measurements were taken at 30-, 60- and 90-day intervals after planting. Herbage was clipped

Table 1. Height of beardless wheatgrass and cheatgrass at 30-, 60- and 90-day intervals of plants grown in various soil layers of three grassland soils

Soil type and horizon	Beardless wheatgrass			Cheatgrass		
	30 days	60 days	90 days	30 days	60 days	90 days
	Inches					
Dark chestnut						
0–6 in.	5.1	9.2	10.8	2.4	8.7	9.4
6–12 in.	4.5	8.2	9.2	2.1	7.2	8.0
12–18 in.	3.8	7.4	7.0	2.0	6.9	6.8
Medium chestnut						
0–6 in.	4.0	7.7	8.7	2.2	7.3	8.2
6–12 in.	3.3	7.5	6.7	1.5	5.9	6.3
12–18 in.	2.8	6.9	6.2	1.3	5.7	4.9
Light chestnut						
0–6 in.	2.2	5.2	5.7	1.8	5.9	6.6
6–12 in.	2.7	5.4	5.9	1.0	3.3	3.2
12–18 in.	2.5	6.5	6.0	1.3	4.5	4.5

after 90 days to stimulate growth and possible seed-head production. At the end of 120 days, the total herbage and root production was oven-dried and weighed. Total herbage included production before and after clipping.

Mechanical, organic matter, potassium and phosphorus analyses were made of each soil horizon in the three grassland soils.

Results and Discussion

Significant differences in growth response were obtained in the seedlings of beardless wheatgrass and cheatgrass grown on the separate horizons of the three grassland soils. In both species, maximum height growth was obtained in plants grown in the surface six-inch horizon of all soils (Table 1). With one exception, height growth of plants grown in the 6–12 inch horizon exceeded that in the 12–18 inch horizon. In the light chestnut soil, height growth of plants on the 12–18 inch horizon exceeded that of plants from the 6–12 inch depth. This difference may be attributed in part to the relatively high clay content of the 6–12 inch horizon in comparison to that in the 12–18 inch depth.

Maximum height growth occurred in both species on the dark chestnut soil. Poorest growth took place on the light chestnut soil.

Data on average weights of herbage and roots presented in Table 2 show similar differences in growth response in relation to soil type and depth. Weights of both herbage and roots were greater on plants grown in the 0–6 inch soil horizon than in the other horizons. Herbage and root weights from the 6–12 inch horizon were generally superior to those obtained on the 12–18 inch horizon. Plants grown in the dark and medium chestnut soils were heavier than those from the light chestnut soil. Under the conditions of the experiment, herbage and root weights of cheatgrass exceeded somewhat those obtained with beardless wheatgrass on the three soil types.

FIGURE 1. Vegetative height of cheatgrass plants after 90 days growth. Left to right—dark, medium and light chestnut soils, respectively. Bottom row, 0–6 inches; center row, 6–12 inches; top row, 12–18 inches.

Results of the mechanical, organic matter, potassium and phosphorus analyses are presented in Table 3. The dark chestnut and medium chestnut soils were classified as sandy loams in each horizon; the light chestnut soil showed a high proportion of silt and clay and was classed as clay in the 0–6 and 6–12 inch horizons and silt loam in the 12–18 inch horizon.

Organic matter content was highest throughout the three soil horizons of the dark chestnut soil. Within the surface six-inch depth, organic matter varied from 5.5 percent in the dark chestnut to 1.5 percent in the medium chestnut type Potassium and phosphorus contents were greater in the medium chestnut soil than in dark or light chestnut soils. The light chestnut soil was very low in phosphorus.

The differences in weight of herbage and roots of plants grown on the separate soil horizons appeared to

Table 2. Herbage and root weights at 120 days of beardless wheatgrass and cheatgrass plants grown on three grassland soils

Soil type and horizon	Herbage		Roots	
	Beardless wheatgrass	Cheatgrass	Beardless wheatgrass	Cheatgrass
	Grams			
Dark chestnut				
0–6 in.	0.61	1.35	0.87	1.79
6–12 in.	0.22	0.78	0.30	0.51
12–18 in.	0.19	0.51	0.22	0.61
Medium chestnut				
0–6 in.	0.58	1.22	0.64	0.93
6–12 in.	0.25	0.63	0.08	0.44
12–18 in.	0.20	0.47	0.17	0.33
Light chestnut				
0–6 in.	0.16	0.86	0.16	1.05
6–12 in.	0.09	0.09	0.11	0.14
12–18 in.	0.15	0.29	0.22	0.19

Table 3. Soil analyses of dark, medium and light chestnut soils at depths of 0–6, 6–12 and 12–18 inches

Soil type and horizon	Mechanical Analysis			Organic Matter	Potassium	Phosphorus
	Sand	Silt	Clay			
	%	%	%	%	*ppm*	*ppm*
Dark chestnut						
0–6 in.	58.9	35.5	5.6	5.5	22	4.4
6–12 in.	57.4	37.0	5.6	4.5	14	2.0
12–18 in.	66.5	26.1	7.4	2.0	12	2.0
Medium chestnut						
0–6 in.	50.9	36.6	12.5	1.5	54	9.0
6–12 in.	57.4	33.8	8.8	1.0	48	5.6
12–18 in.	58.3	29.5	12.2	0.5	40	3.2
Light chestnut						
0–6 in.	17.4	41.0	41.6	4.5	34	1.6
6–12 in.	9.4	41.0	49.6	1.0	12	T
12–18 in.	11.9	83.5	4.6	0.5	15	T

be more closely related to differences in organic matter and nutrient content than to the textural characteristics of the soils studied. The maximum herbage and root weights were obtained on the dark chestnut soil with intermediate levels of phosphorus and potassium; less herbage and root growth was obtained on the medium chestnut soil with its high levels of potassium and phosphorus.

Summary

Vegetative responses of beardless wheatgrass and cheatgrass seedlings grown on separate soil horizons were evaluated in a greenhouse study on dark, medium and light chestnut soils of western Montana.

Height measurements made at 30-, 60- and 90-day intervals showed that maximum growth of both species took place in the surface six-inch horizon of all soils. Height growth was greatest in the dark chestnut soil and least on the light chestnut soil.

Herbage and root weights showed trends similar to those of height growth. Maximum weights were obtained from plants grown in surface horizons. Herbage and root weights were greatest on the dark chestnut soil.

The soils studied varied in textural classification from sandy loam for the dark and medium chestnut soils to silt and clay loam for the light chestnut soil. Potassium and phosphorus contents were greatest in the medium chestnut soil.

Differences in herbage and root weights obtained on the separate soil horizons appeared to be more closely related to differences in organic matter and nutrient content than to textural characteristics of the soils.

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LITERATURE CITED

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Fence-line contrast in the annual grass type of California. Photograph by Dr. Vernon A. Young, A. and M. College of Texas, College Station. First prize, Fence-contrasts, Photography Contest at Omaha, Nebraska annual meeting.