Effects of Clipping Treatments and Clonal Differences on Water Requirement of Grasses[1]

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One factor of fundamental importance to grass improvement is the reaction of the individual grass tillers to clipping under various conditions including moisture levels. This would help explain the relation between the stage of growth and defoliation as well as the reaction of the plant to soil moisture levels.

Review of Literature

Ellett and Carrier (1915) studied the effect of defoliation on composition and total yield of some grasses. They found that frequent defoliation decreased the yield of dry matter. Also frequent defoliation increased total protein content enough to compensate for the decrease in yield of dry matter. In a similar investigation, Aldous (1930) verified the decrease in total dry matter produced. However, he stated that the increase in total protein was not enough to compensate for the decreased yield.

In a study in Wyoming by Lang and Barnes (1942), the grasses were divided into short and midgrasses. Short grasses cut frequently at ground level yielded more dry matter than those not clipped during the growing season. On the other hand, midgrasses cut often yielded less dry matter than those not clipped.

In addition to frequency of clipping, height of clipping is important. Under ordinary grazing conditions, grasses are not cut at uniform levels. The effect of clipping at different levels on crested wheatgrass (*Agropyron desertorum* (Fisch.) Schult) was studied by Cook and Stoddart (1953). In this investigation, the crested wheatgrass plants defoliated below the uppermost node made regrowth from the axillary buds at the base of the culm. On the other hand, if the culms were defoliated above the last node, the shoot continued to develop and elongate. If the culm was cut between the uppermost node

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and the seedhead, elongation continued but the culm remained headless. Plants clipped early in the season above the terminal bud produced normal culms, but they failed to produce leaves. Regrowth did not occur if the plants were closely cut and subjected to arid conditions.

The studies made by Cook and Stoddart suggest another thing to be considered, the stage of growth when defoliated. Experiments concerning stage of growth are usually concerned with hay production but could be of interest in grazing management. A study by Bird (1943) was primarily concerned with the effect of clipping on hay production at various stages of growth. The six stages of growth he compared were short grass, long grass, beginning of heading, beginning of bloom, end of bloom, and following seedset. Total yield of dry matter increased with each successive stage up to the beginning of bloom; thereafter, the increases in dry-matter yields were not significant.

Stoddart (1946) in Utah studied the effect of cutting *Agropyron spicatum* (Pursh) Scribn. Because the area was primarily a spring-fall grazing area, clippings were made in both seasons. Cutting the plants in early spring had a less harmful effect than cutting in late spring. The reason for this being that plants defoliated in early spring had a chance to recover and make regrowth before the dry summer. Clipping in the fall had little detrimental effect on the plants.

Keller (1953, 1954) made two studies of the water requirement of orchardgrass (*Dactylis glomerata* L.). Water requirement was defined as "the ratio of weight of water absorbed by a plant during its growth to the weight of dry matter produced." In the first study Keller (1953) found a significant difference in water requirement among genotypically different strains of orchardgrass. He reported that the higher yielding plants were more efficient in their use of water. The second study (1954) involved techniques of making greenhouse studies on water requirement of orchardgrass. This appears to be an effective method of selecting plants on the basis of their economy of water use, but, as Keller stated, the plants should be tested in the field as well as in the greenhouse before any final selections are made.

Materials and Methods

The clones of grasses used in the investigation were selected on the basis of their leaf width, growth habit, leaf color, and vigor. Three intermediate wheatgrass and two pubescent wheatgrass plants which differed rather widely in the above characteristics were selected (table 1).

Part of each clone to be used in this study was brought into the greenhouse in September, before the plant was subjected to cold. They were allowed to develop under short day length until the experiment was begun. The remainder of the plant was taken from the field in December, after being subjected to several periods of low temperatures. These plants were assumed to have become vernalized.

After greenhouse acclimation, the plants were separated into individual tillers. These were then rooted in sand.

The canisters, to which the tillers were eventually transferred, were prepared next. The canisters were seven inches high and six inches in diameter. The bottom of every container was evenly covered with 450 grams of pea gravel. A glass tube, one-half inch in diameter and approximately seven inches in length, was placed in each. The glass tube stood upright along the side with the base resting on the pea gravel. Next, 3,000 grams of air-dry soil, previously dried by spreading it out in a thin layer on a greenhouse bench, was added to each container. A standard greenhouse soil mixture, on which field water capacity was determined to be approximately 23.5 percent on a dry-weight basis, was used. Therefore, 705 ml. of water was added to every container to bring the moisture content up to field capacity. The canisters were then allowed to stand overnight. The following day, five well-rooted tillers from one clone were planted in each canister. An additional 100 ml. of water was then added to make up for evaporation and to wet the pea gravel. An additional 400 grams of pea gravel added to the top of each canister brought the total weight of each container to 4,955 grams. This top layer served as a mulch to reduce evaporation.

The tillers were allowed to grow and develop for three weeks. Moisture was maintained at about field capacity in all the containers, and the day length was maintained at ten hours. At

Table 1. Clones of intermediate and pubescent wheatgrass selected for studies of effect of defoliation and morphological development on water requirements.

Kind of grass	Clone No.	Variety	Leaf width	Growth habit	Color	Vigor 1-3*
Intermediate wheatgrass:						
	1	S 4904	Medium	Erect	Light green	2
	2	A 12496	Medium	Erect	Light green	2
	3	Mandan 1274	Narrow	Erect	Green	1
Pubescent wheatgrass:						
	4	Loga II	Narrow	Erect	Light green	2
	5	Bismark	Narrow	Erect	Light green	2

*1=most vigorous; 3=least vigorous.

Table 2. Average number of tillers per plant.

Vernalization and water level treatments	Clipping height (inches)	Intermediate Clone 1	Intermediate Clone 2	Intermediate Clone 3	Pubescent Clone 4	Pubescent Clone 5
Vernalized:						
High	2	4.96	6.38	4.33	5.91	8.72
High	4	5.82	10.92	7.75	8.22	7.75
Low	2	2.99	4.42	2.31	3.40	4.31
Low	4	3.50	3.89	3.86	4.80	4.13
Non-vernalized:						
High	2	6.66	8.55	6.92	7.75	6.48
High	4	5.65	10.55	7.97	7.35	9.55
Low	2	3.70	4.43	3.71	4.20	3.35
Low	4	3.81	4.47	3.81	4.29	5.46
Clone means		4.63	6.70	5.08	5.74	6.22

L.S.D. 0.05 level for clone means 0.80

the end of three weeks, all the plants were cut back to two or four inches. The day length was increased to sixteen hours. All the canisters were brought back to a standard weight of 4,955 grams, or field capacity, by the addition of water.

The plants were permitted to grow for another two weeks, after which they were again clipped at two or four inches. The following treatments were then begun:

A. Moisture levels were maintained as follows:
   1. At field capacity
   2. At just above the wilting point

B. Clipping heights at each two-week intervals were as follows:
   1. At a height of two inches
   2. At a height of four inches

The experiment was designed as a randomized block with four replications. Evaluation of the clones was made on the basis of tillering, dry-matter yield, water requirements, and regrowth.

The plants were clipped at two-week intervals. The canisters were weighed and brought back to their corresponding moisture level each week. One-half of the canisters were kept at field capacity, or 4,955 grams, and the other half were kept at just above the wilting point, or 4,555 grams. To determine the weight to be used at the low water level, a canister containing plants was allowed to dry out until the plants started to wilt. Just enough water was then added to prevent the plants from wilting. The canister was then weighed and this weight, or 4,555 grams used for the low water level.

Several checks without plants were maintained at both water levels. They were weighed each week and brought back to field capacity. These checks helped in determination of the amount of water lost by evaporation. The amount of water that had transpired and had been used for photosynthesis and other physiological processes was then calculated for each canister containing plants.

At the end of the study, the numbers of tillers and reproducing culms were counted. The total clippings from the plants in each canister were dried in an oven at 150° F. for twenty-four hours and weighed.

Results and Discussion

Tillering

At the start, five individual tillers were planted in each canister. When the study closed, the tillers in every container were counted (table 2). The number of tillers produced by the vernalized and non-vernalized plants did not differ significantly.

The plants clipped at four inches yielded significantly more tillers than those clipped at two inches. This finding would be expected, as the plants cut at two inches were required to use more of their food reserves for regrowth. The numbers of tillers produced by the different clones differed significantly (table 2).

Dry-Matter Yield

Every two weeks, half of the plants were defoliated at two inches above the surface and half at four inches. All the clippings from the plants in each canister were dried in an oven at 150° F. for twenty-four hours and weighed. The mean weights, expressed in grams, are presented in table 3. The plants which had become vernalized

Table 3. Mean yield of dry matter per pot.

Vernalization and water level treatments	Clipping height inches	Intermediate Clone 1	Intermediate Clone 2	Intermediate Clone 3	Pubescent Clone 4	Pubescent Clone 5	Water level means
Vernalized:		— — — — — — (Grams) — — — — — —					
High	2	3.36	2.68	2.95	3.17	2.86	
High	4	3.04	3.90	3.19	2.78	2.39	3.03
Low	2	1.42	1.43	1.38	1.21	1.14	
Low	4	1.22	0.96	1.29	1.00	0.89	1.19
Non-vernalized:							
High	2	3.33	2.92	2.83	2.46	2.56	
High	4	2.83	2.36	2.14	2.51	2.70	2.66
Low	2	1.27	0.96	1.20	0.91	0.74	
Low	4	1.06	0.86	0.88	0.95	0.73	0.96
Clone means		2.19	2.00	1.98	1.87	1.75	

L.S.D 0.05 level for clone means	0.24
L.S.D. 0.05 level for source means	0.22
L.S.D. 0.05 level for clipping height means	0.11
L.S.D. 0.05 level for water level X source means	0.08

Table 4. Grams of water utilized per unit of herbage produced.

Vernalization and water level treatments	Clipping height (inches)	Intermediate Clone 1	Intermediate Clone 2	Intermediate Clone 3	Pubescent Clone 4	Pubescent Clone 5
Vernalized:						
High	2	97.08	172.42	116.50	159.67	252.60
High	4	221.65	355.77	188.53	220.18	228.76
Low	2	72.53	72.71	71.37	79.07	78.40
Low	4	116.73	84.04	107.96	116.77	153.62
Non-vernalized:						
High	2	151.65	196.47	197.55	120.37	239.50
High	4	241.74	238.95	212.17	249.34	280.23
Low	2	88.99	123.95	81.59	82.05	62.49
Low	4	112.94	129.19	89.87	134.83	144.84
Clone means		137.91	171.59	126.44	145.28	180.05

L S.D. 0.05 level for clone means 25.55

produced a greater amount of dry herbage than the non-vernalized plants. However, toward the end of the study, the non-vernalized plants were beginning to yield as much as the vernalized.

Plants clipped at two inches produced significantly more herbage than did the plants clipped at four inches. These results might have been reversed if the experiment could have been carried on for a longer period. As shown in table 2, the plants clipped at four inches were producing the largest number of new tillers.

Water Used Per Unit of Herbage Produced

The means by weight of water used to produce one gram of air-dry herbage are presented in table 4. These means were computed by dividing the total grams of water used by the total grams of herbage produced. The results obtained from this computation would be a partial measurement of a good dryland forage grass. Theoretically, a desirable dryland grass would be a grass that produces the greatest amount of forage with the water that is available. Although this is only one factor which should be considered, it could serve as one criterion in grass selection.

The plants clipped at two inches were more efficient in their use of water than those clipped at four inches. This difference is probably a result of the greater transpiring area of the plants clipped at four inches. There was no significant difference between the water requirements of the vernalized and the non-vernalized plants. Table 4 shows a significant difference in the water requirements of the different clones. To produce one gram of air-dry herbage, the most efficient clone, 3, had a water requirement of 126.44, while the least efficent clone, 5, had a water requirement of 180.05. Clone 3 was significantly more efficient in use of water than was 5. Pubescent wheatgrass clone 4 and intermediate wheatgrass clone 1 were more efficient in their use of water than clones 2 and 5. Clone 1, yielded the most, was one of the most efficient clones in the use of water, with a water requirement of 137.91 grams per gram of herbage produced.

Summary

The objective of this study was to determine the influence of clipping on the growth of individual grass tillers under drought stress. In the fall of 1958, three intermediate and two pubescent wheatgrass plants were selected from the source nursery located at the Wyoming Agricultural Experiment Station near Laramie. Half of each plant was brought into the greenhouse in September and the remainder in December. These plants were separated into individual tillers and planted in canisters after being rooted in sand. Half of the canisters were maintained at approximately field capacity and the other half were maintained just above the wilting point. The plants were clipped at two and four inches above the soil surface. Evaluation of the clones was made on the basis of tillering, dry-matter yield and water requirements.

Differences between the vernalized and non-vernalized plants in their reaction to total water use and dry-matter yield were observed. The results of the study indicate also that height of clipping affected the number of tillers produced, total herbage yield, and water used per gram of forage produced. There were significant clonal differences in the number of tillers produced and in the efficiency of water use.

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