Effects of Environment on Germination and Occurrence of Sixweeks Fescue[1]

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The objectives of this study were to determine basic physiological and ecological attributes of sixweeks fescue (*Festuca octoflora* Walt.). At Central Plains Experimental Range[2] sixweeks fescue is unpalatable to cattle and they tend to avoid grazing in areas infested with this annual grass.

During the summer of 1958 the utilization of blue grama (*Bouteloua gracilis* (H.B.K.) Lag) was impaired by the abundance of sixweeks fescue. The fescue was dense on the upland sites and sparse on the bottomland sites. Heavy-use pastures instead of having a uniform slicked-off appearance were grubbed to the ground on bottomlands and very lightly grazed on uplands. Moderate-use pastures received heavy use on bottomlands while the uplands were essentially ungrazed. This unusual type of utilization appeared to be due primarily to the occurrence of sixweeks fescue. At the close of the 1958 summer grazing season, total beef gains were below those expected from current perennial grass production. The loss in gross return per heifer in 1958, as a result of poor utilization attributed to sixweeks fescue, amounted to about $25 per head.

Laboratory Seed Germination

Sixweeks fescue seeds harvested at Central Plains Experimental Range were used in a laboratory study of factors affecting germination. Seeds were collected on June 25, July 6, and July 22, 1959. They were stored at room temperatures of 10 to 30° C until germination tests were started in October 1959.

Cleaned seeds from each harvest date were planted on top of 2 thicknesses of moistened filter paper in 9-centimeter Petri dishes. Initial moistening of the substrata was with tap water or a 0.2-percent KNO_3 solution; thereafter, all substrata were kept moist with tap water. The seeds were subjected to the following light (fluorescent) and temperature conditions:

Temperature (C) Duration (hr)	Dark (hr)	Light (hr)
10° constantly	intermittently[3]	
15° constantly	15	9
20° constantly	15	9
10° for 15 hr; 30° for 9 hr	15	9
15° for 15 hr; 25° for 9 hr	15	9
15° for 15 hr; 30° for 9 hr	15	9
20° for 15 hr; 30° for 9 hr	15	9

Alternating temperatures were obtained by using electronically controlled germinators. Relative humidity in these germinators ranged from 95 to 100 percent. Constant temperatures were obtained with the germinators or temperature-controlled chambers.

Germination counts were started after the seeds had been in the germinators for 7 days and were continued at 7-day inter-

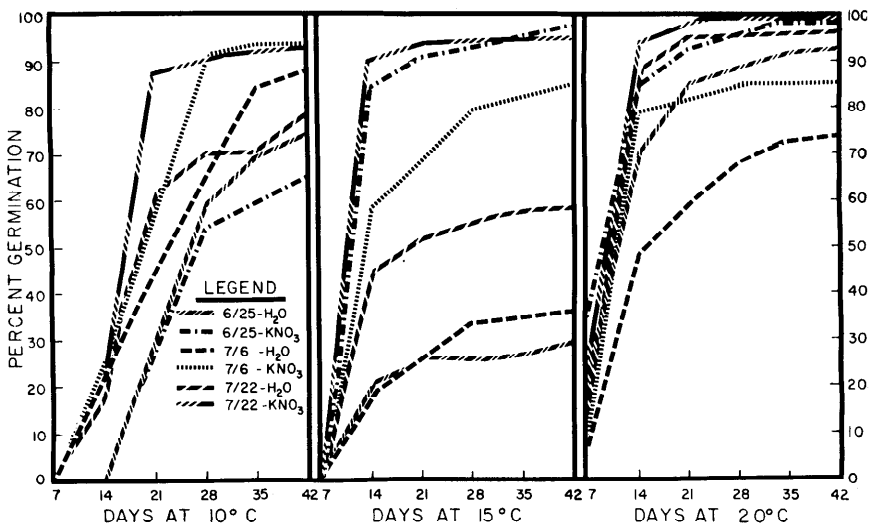

FIGURE 1. Percent germination of sixweeks fescue at seven-day intervals as affected by (1) the constant temperatures 10, 15, or 20° C; (2) the stage of seed ripeness determined by the harvest dates June 25, July 6, or July 22; and (3) the moistening agent, tap water or a 0.2-percent KNO_3 solution.

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[2] *Operated in northeastern Colorado by Agricultural Research Service, U. S. Department of Agriculture in cooperation with Forest Service, U. S. Department of Agriculture.*

[3] *Seeds in 10° constantly received light only when counted or when someone was in the chamber doing other work.*

[4] *Density is used as the percent of ground area covered by a species when viewed from directly above.*

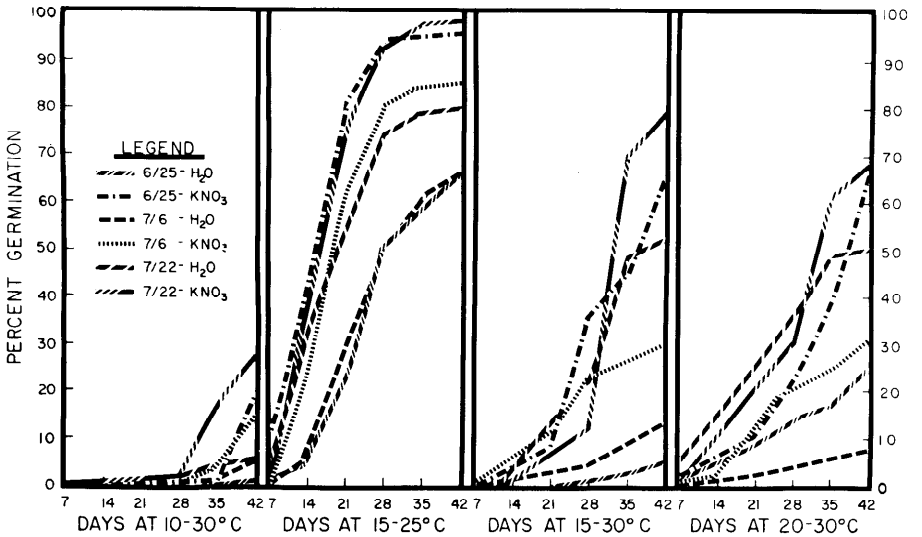

FIGURE 2. Percent germination of sixweeks fescue at seven-day intervals as affected by (1) the alternating temperatures 10-30°, 15-25°, 15-30°, or 20-30° C; (2) the stage of seed ripeness as determined by the harvest dates June 25, July 6, or July 22; and (3) the moistening agent, tap water or a 0.2-percent KNO_3 solution.

vals through 42 days. A seed was recorded as germinated if the shoot and the root had elongated at least one-eighth inch from the testa. During the count, the seedlings were removed, and if necessary the subtratum was moistened with tap water.

Figures 1 and 2 and Table 1 show the average percent of total germination was significantly different between all temperatures except 20-30° and 15-30°, and between 10° and 15-25° C. At the environmental conditions shown in Table 1, the total germination was significantly different between the July 6 and the July 22 harvest dates. Total germination was significantly higher on substrata moistened with a 0.2-percent KNO_3 solution than on substrata moistened with tap water.

Germination speed as well as total germination was influenced by temperature, stage of seed ripeness, and moistening agent. In general, germination began between 7 and 14 days after the seeds were placed in the germinator at most temperatures. Under 20°, however, germination began between 0 and 7 days. Generally, germination speed reached its peak between 14 and 21 days at constant temperatures and between 28 and 35 days at alternating temperatures. Germination speed and total germination were highest at the constant temperature of 20°. The alternating temperature of 15-25° was practically as good, however, and probably more nearly simulates natural conditions.

Germination speed was generally greater for seeds harvested July 22 than for seeds harvested July 6 or June 25. Seeds moistened with a 0.2- percent KNO_3 solution generally germinated more rapidly than seeds moistened with tap water.

Plant Development on Two Sites

Measurements of growth and development of sixweeks fescue were taken from 5 plants at each of 8 stations on March 19, April 4, April 25, May 9, and June 9, 1959. Four stations were selected in sites with a sandy loam surface soil and four in sandy clay sites.

The lengths of the plant shoot (portion above seed coat) and longest root were recorded in millimeters. The number of roots was recorded until the roots became too numerous and matted to count.

Data in Figure 3 show a relation between surface-soil texture and development of the roots and shoots of six weeks fescue. The roots and shoots developed more rapidly in sandy loam than in sandy clay. During seedling emergence and growth the roots were approximately three times as long as the shoots. This condition gradually became more pronounced until the transition from the vegetative to the bloom stage. At this time the roots were

Tabl 1. Average germination of sixweeks fescue at seven temperatures from three harvest dates with two moistening agents. (Each average based on two replications of 100 seeds each).

Date of harvest	10° C		15° C		20° C		10-30° C		15-25° C		15-30° C		20-30° C		Harvest date average	H_2O average	KNO_3 average
	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3			
	- - - - - - - - (Percent) - - - - - - - -																
June 25	75	64	29	97	93	98	1	19	66	96	5	65	25	67	57		
July 6	88	94	35	85	73	84	4	14	67	85	13	30	7	31	51		
July 22	79	93	57	95	96	99	5	27	79	97	52	79	50	67	70		
Temperature average	82		66		90		12		82		41		41				
Moistening agent average																48	71

Table 2. Average density of sixweeks fescue for 11 years, under various grazing treatments. (Each average based on four pastures for each degree of grazing and four exclosures for no grazing).

Grazing Intensity	1941	1942	1944	1946	1947	1952	1955	1957	1958	1959	1960	Intensity average
						(Percent)						
Heavy	.183	.017	.002	.002	.064	.021	.001	.007	.170	.027	.001	.045
Moderate	.253	.050	.008	.001	.020	.017	.013	.012	.290	.050	.029	.060
Light	.256	.044	.017	.001	.022	.019	.001	.001	.088	.001	.001	.041
No grazing	.025	.065	[1]	.001	.004	.004	.001	.001	.012	.009	.004	.013
Year average	.179	.044	.007	.001	.027	.015	.004	.005	.120	.022	.009	
Percent of 1941		24.6	3.9	0.6	15.1	8.4	2.2	2.8	67.0	12.3	5.0	

[1] Data were not available.

about three and one-half times as long as the shoots. After this period, the shoots elongated rapidly and the roots began to dry and decompose. The lengths of the roots and shoots were about the same during the transition from the bloom to the dough stage. By the end of the dough stage the shoots were approximately one and one-half times as long as the roots. The number of roots increased until about the dough stage. More roots were produced on plants in sandy loam than in sandy clay.

Relation of Experimental Findings to Observed Field Conditions

Data collected at the Central Plains Experimental Range for a 20-year period, 1941-1960, were scrutinized for information on the occurrence of sixweeks fescue. The density[4] of this grass was tabulated by grazing intensity and year. Percentage composition, as it varied by degree of grazing intensity, was found for the years 1940-42, 1946-48, and 1952-53 (Klipple and Costello, 1960). Temperature and rainfall records for August, September, and October of several years were examined.

Density of sixweeks fescue varied sharply from year to year (Table 2). The occurrence of this fescue was slightly influenced by grazing, generally being favored by heavy and moderate grazing over light grazing. Grazing of all intensities, however, favored sixweeks-fescue density over no grazing.

Field temperature and rainfall records for the fall months of 1940 and 1957 indicated favorable germination conditions for sixweeks fescue when compared with germination conditions used in the laboratory. Sixweeks fescue was most abundant in 1941 and 1958. Field records for the fall months of 1956 showed less favorable germination conditions than existed in 1940 or 1957. Sixweeks fescue density in 1957 was lower than in 1941 or 1958.

During September 1940, the mean daily field temperature was 17° C. The average minimum and maximum temperatures for the month were 11 and 23° respectively. These temperatures approximated the 15-25° alternating temperature that allowed good germination in the laboratory. Total precipitation during September 1940 was 4.54 inches. This precipitation was well distributed over the month. The following year, 1941, sixweeks-fescue density was the highest on record. In the course of 13 days, August 15 through August 27, 1957, the average minimum and maximum field temperatures were 12 and 27° respectively. The mean daily temperature was 19°. The best temperature conditions in the laboratory studies were 15-25° alternating and 20° constantly. The total rainfall received in the

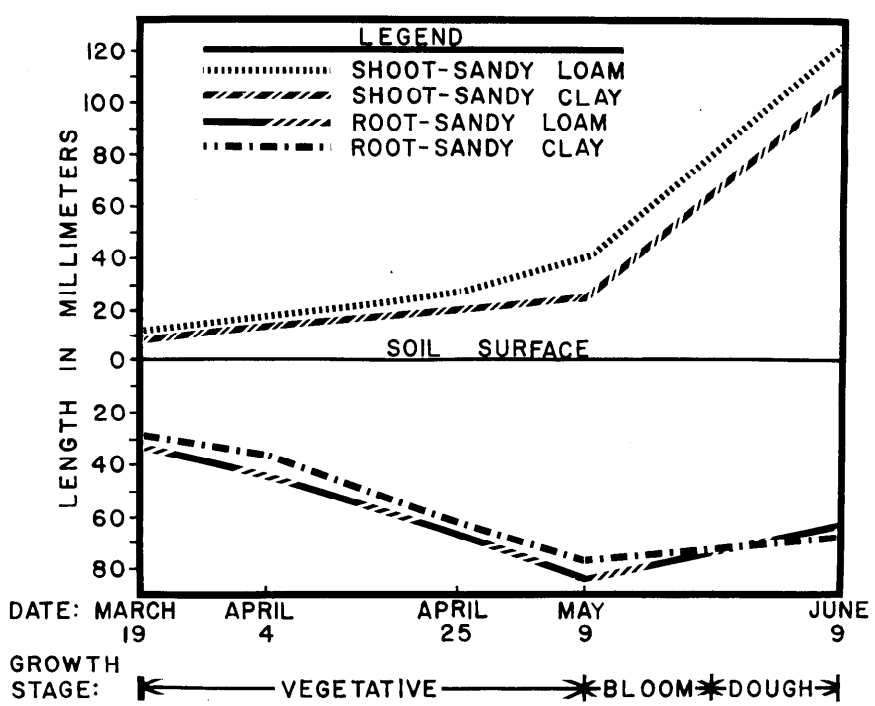

FIGURE 3. Average length in millimeters of the roots and shoots of sixweeks fescue in relation to surface-soil texture and growth stage on five observation dates.

period was 1.38 inches. Sixweeks-fescue density in 1958 was the second highest on record.

Early August 1956 moisture was available but temperature conditions were not favorable for optimum germination of sixweeks fescue. Rainfall from July 30 to August 19 amounted to 2.32 inches. Average field temperatures during this period were 12° minimum and 29° maximum. These temperatures approximated the 10-30° alternating temperature which allowed extremely poor germination in the laboratory. Sixweeks-fescue density in 1957 was low compared with its density in 1941 and 1958.

Discussion

Went (1948) reported that final population of annuals was solely a reflection of their germination response. Germination control, and not subsequent survival of the fittest, determined the floristic composition of annuals in the area he studied. We believe, as a result of this and other studies, that once the seeds of annuals have germinated, their chance for survival is good. Even when moisture after germination is low, an annual produces at least one flower stalk and gives rise to one or more seeds.

Determinations in this study, with respect to temperature requirements for laboratory germination, agree closely with those of other workers who studied seedling emergence under field conditions (Tevis, 1958; Went, 1948 and 1949). Indications are that the optimum temperature for germination and emergence of sixweeks fescue is generally 15 to 25° C. When temperatures are outside of this range, a significant decrease in germination results. From these determinations it is conceivable that large annual differences in sixweeks-fescue density may be related directly to the prevailing temperature during moisture availability. Therefore, we believe that extremely high or low sixweeks-fescue density may be predicted in the Central Great Plains by careful examination of the temperature and moisture conditions during August, September, and October preceeding the summer growing season.

Field observations of the growth and development of sixweeks fescue disclosed some physiological and morphological attributes which enable it to survive and perpetuate under extreme climatic conditions. We found that the seeds germinated and the seedlings emerged in the fall. The seedlings then remained dormant until late winter or early spring, when they resumed growth. Measurements of the roots and shoots showed that the roots developed much earlier than the leaves and culms. After the roots were well established, the upper appendages responded and developed rapidly. As the seed-ripe stage approached, the roots became completely dry and partially decomposed. At this time the leaves and culms began to dry and turn brown. We believe that most of the seeds were mature enough to germinate any time after the beginning of the seed-ripe growth stage.

Field data indicated that the occurrence of sixweeks fescue was slightly influenced by different grazing intensities. The major difference in the occurrence of sixweeks fescue, however, was between no grazing and grazing, regardless of the intensity. Fescue occurrence was favored by grazing.

Summary

Germination data from laboratory experiments were obtained by subjecting seeds harvested at three different stages of ripeness to various temperatures and using tap water or a 0.2-percent KNO_3 solution as the moistening agent. Germination counts were taken at 7-day intervals through 42 days.

Phenological data were collected from 2 types of surface soils at various growth stages from March 19 through June 9, 1959. Density of sixweeks fescue was compiled from records at the Central Plains Experimental Range for each year from 1941 through 1960. Fall temperature and rainfall records for this period were investigated.

Results of this study are summarized as follows:

1. The constant temperature of 20° C allowed the best germination under laboratory conditions. Also, 15-25° was the best alternating temperature.

2. Average percent germination was significantly increased when a 0.2-percent KNO_3 solution was used as the moistening agent rather than tap water.

3. Phenological data indicated that during seedling growth the roots were much longer than the shoots. As the plant approached maturity, this relation gradually reversed. The rate of structural development of the plant appeared to be related to surface-soil texture.

4. Records of plant densities at the Central Plains Experimental Range from 1941 through 1960 revealed that sixweeks-fescue density was the highest in 1941 and the second highest in 1958. Records of climatic data for the same period showed that the temperature and moisture conditions in late August and early September of 1940 and 1957 closely paralleled those found to be most favorable for the germination of sixweeks fescue in the laboratory.

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