The Relationships of Soil Moisture and Temperature among Certain Grassland Associations of Southeastern Washington[1]

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THE PATTERN of vegetation as well as of soil in the *Festuca idahoensis* grasslands of southeastern Washington has been attributed, at least in part, to the microclimatic influences of the strongly undulating topography (Daubenmire, 1942, and Lotspeich and Smith, 1953). However, so far as is known, the only published measurements of soil moisture and temperature values in these grasslands have been presented by McMinn (1952).

The purpose of this investigation was to determine the magnitude of variation of temperature and soil moisture for a 30-day period in the spring season in three associations of native *Festuca* grassland.

Location and Vegetation of the Study Area

The study area is a 28-acre tract of relatively undisturbed native vegetation located 13 miles southwest of Pullman, Washington. For a detailed description and location of the area see Wing (1949). The area has been preserved from plowing by fortuitous circumstances and consists primarily of an east-west ridge estimated to be about 75 feet higher than the surrounding landscape.

The area lies at the ecotone between the *Festuca* grasslands and the *Agropyron* grasslands, which follow along the north bank of the Snake River. The south-facing slopes and exposed ridges are occupied by stands representing the *Agropyron/Poa* association while the north-facing slopes and protected sites are occupied by stands of two more mesophytic associations. The latter, the *Symphoricarpos/Festuca* association and the *Festuca/Symphoricarpos* association, are distinguished by physiognomy for they both have essentially the same species composition. Stands of the *Symphoricarpos/Festuca* association are dominated by the deciduous shrubs *Symphoricarpos rivularis, Rosa spaldingii, Rosa ultramontana,* and *Prunus virginiana* var. *melanocarpa* which form dense thickets usually 0.5 to 1 meter in height with occasional shrubs taller (Daubenmire, 1942). The herbaceous vegetation beneath the

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shrubs is a sparse representation of the perennial forbs also found in the surrounding *Festuca* grassland. The physiognomy of the *Festuca/Symphoricarpos* association appears as a more or less even herbaceous sward. The perennial grasses, *Festuca idahoensis* and *Agropyron spicatum,* along with a rich assortment of large perennial forbs, are the dominant plants. Subordinate to these grasses are the same shrubs found in the thickets, but they are reduced in numbers, strongly dwarfed, and seldom attain the height of the mature grasses. The *Agropyron/Poa* association has a markedly different species composition than the other two associations and is characterized by the caespitose habit and wide spacing of the *Agropyron spicatum* bunches.

Methods Employed

Three stands representing each of the three climax plant associations were selected to compare the moisture and temperature conditions of the soils occupied by each association. The per cent of moisture in the surface decimeter, taken in duplicate, was determined at each stand at the beginning and end of the study period, *i.e.,* April 22, and May 22, 1956. At the same locations, summation of temperatures was obtained by the method of Pallman, Eichenberger and Hasler (1940) in which a buffered sucrose solution is sealed in glass vials and analysed polarimetrically after exposure for varying periods of time under field conditions. The rate of inversion of sucrose to glucose and fructose is related to the temperature of the immediate environment of the glass vials. Paired vials were placed horizontally in the soil at a depth of one decimeter and left to incubate for 30 days.

Relative wetness was obtained by dividing the per cent of moisture in the soil by the moisture equivalent. This figure can be related to temperature to yield an index of the hydrothermal conditions of the habitat.

The amount of precipitation during the study period was assumed to be similar to that recorded by the Soil Conservation Service weather station two miles northwest of Pullman, Washington.

Results

Temperatures obtained during the 30-day study period differed rather consistently among the associations and stands sampled (see Table 1). The temperature values for the *Festuca/Symphoricarpos* association are more like the values of the *Symphoricarpos/Festuca* than they are to the values obtained for stands of the *Agropyron/Poa* association. There is some overlapping of temperature values between the *Symphoricarpos/Festuca* and *Festuca/Symphoricarpos* stands.

TABLE 1. Soil Temperature and Moisture Relations in Three Plant Associations

	Exposure	Site	Mean Temp. °C	% Moisture Apr. 22	% Moisture May 22	M. E.	% M. May 22 / M. E.
Agropyron/ Poa	South	Slope	17.7	8.7	17.6	23.1	76.2
	South	Slope	16.8	14.5	11.0	23.5	46.8
	Southeast	Slope	16.5	15.4	14.0	24.4	57.4
	Average		17.0	12.9	14.2	23.7	60.1
Festuca/ Symphoricarpos	South	Bottom	15.3	25.9	21.0	27.4	76.6
	Ridge	Ridge Top	12.7	36.8	32.2	33.1	97.3
	North	Bottom	12.5	42.8	35.9	58.7	61.2
	Average		13.5	35.1	29.7	39.7	78.4
Symphoricarpos/ Festuca	North	Slope	11.5	47.7	43.6	32.8	132.9
	Northeast	Slope	12.7	39.0	30.2	29.5	102.3
	North	Bottom	12.3	35.1	29.8	33.4	89.2
	Average		12.2	40.6	33.4	31.9	108.1

Soil moisture values showed the stand of the *Agropyron/Poa* association to be distinctly drier than the other two associations. Again the *Festuca/Symphoricarpos* association exhibits intermediate values between the *Agropyron/Poa*

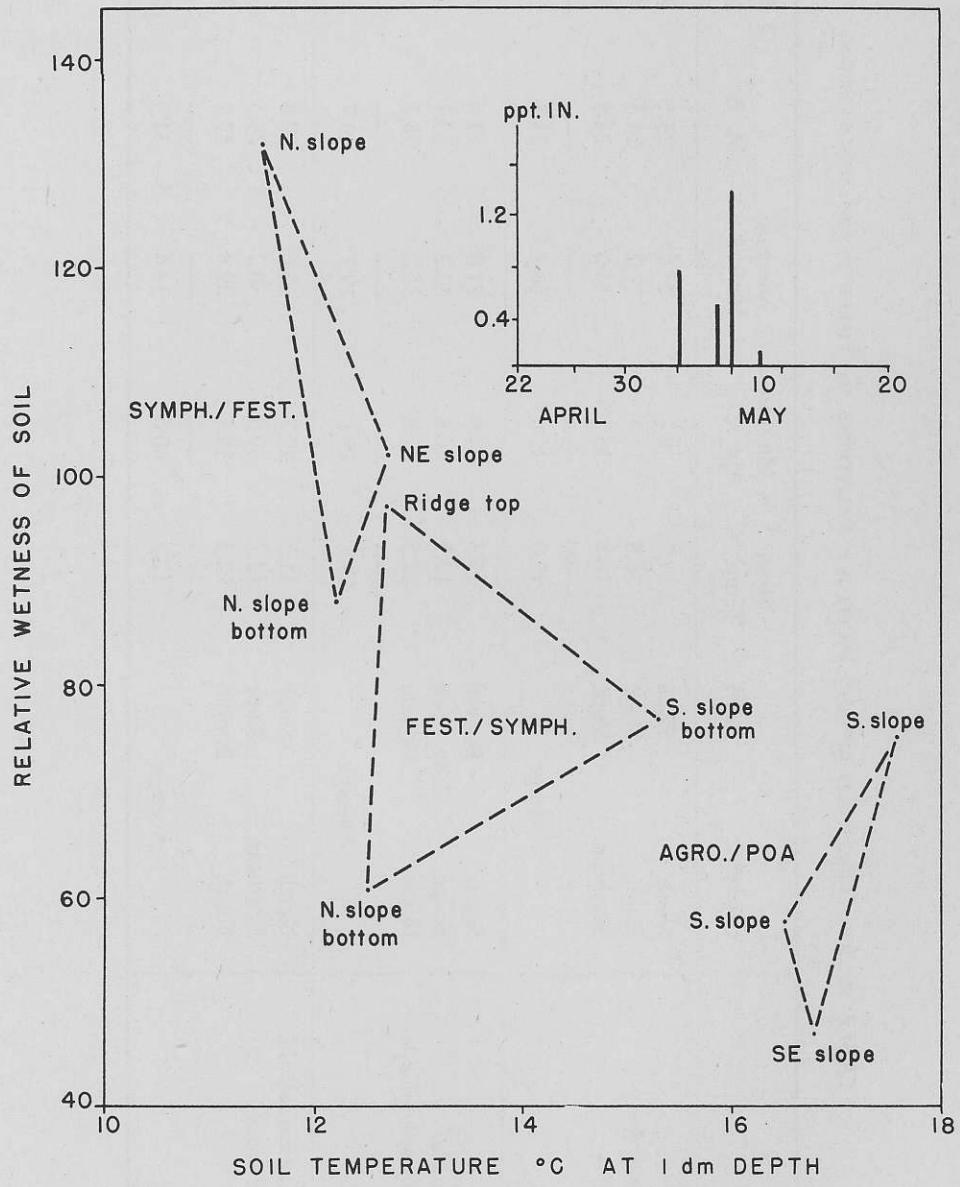

Figure 1. The relationship of soil temperature and relative wetness in nine stands representing three plant associations on May 22, 1956. The inset shows the precipitation recorded northwest of Pullman, Washington.

and *Symphoricarpos/Festuca* associations but are more like the latter, with somewhat more overlapping of soil moisture than of temperature values.

Although three inches of rain fell during the middle of the study period, all except one of the *Agropyron/Poa* stands showed a net decrease in soil moisture during the month.

When moisture is considered alone, there is no absolute environmental distinction among the associations, and when temperature is considered alone, the environments of the *Festuca/Symphoricarpos* and *Symphoricarpos/Festuca* associations cannot be differentiated. However, when moisture and temperature are considered jointly, as in Figure 1, the three habitat types appear to be distinctive, at least for the nine stands used to make the comparison. The *Agropyron/Poa* habitat type clearly differs more from the *Festuca/Symphoricarpos* than the latter differs from the *Symphoricarpos/Festuca.*

These findings indicate that complex interrelationships of moisture and temperature conditions may be responsible for the distribution of vegetation patterns of the study area. They support ecologic interpretations of the relative moisture balance that might be made in the field.

Conclusions

This study shows the *Agropyron/Poa* association as distinctly drier and hotter than the other plant associations. This association may be separated from the other two by either temperature or moisture when considered individually or concomitantly.

The distinctness is less pronounced between the *Symphoricarpos/Festuca* and the *Festuca/Symphoricarpos* associations. Considering temperature and moisture individually there is some overlap of values between these two associations, however, when the degree of wetness, *i.e.,* per cent moisture/moisture equivalent, of the soil is related to temperature, a hiatus is evident.

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