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Ecology of Alfombrilla

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Highlight

Alfombrilla (*Drymaria arenarioides* H.B.K.) is a poisonous plant that has caused severe damage to the cattle industry in Chihuahua, Mex. This plant is a potential problem in the United States because it has been found growing near the New Mexico-Chihuahua and the Arizona-Sonora borders. A joint Mexico-United States research program has been initiated to generate information on control and to prevent livestock losses. Alfombrilla is well adapted to soils and climates within the *Bouteloua-Aristida* type. Germination of freshly harvested alfombrilla seed was less than 5%; however, over 75% of 20-month-old seed germinated. Optimum temperatures for germination were 18-21 C. Alfombrilla vegetative growth under alternating day/night temperatures of 26 and 15 C was greater than at 32 and 21 C. Alfombrilla under field conditions has been shown to be a great competitor in the habitat, especially before and after the growing seasons of other plants.

Alfombrilla is a poisonous plant that has caused severe damage to the cattle industry in Chihuahua, Mexico (Martinez 1960). This fact is of great importance to both sides of the Mexico-United States border because of the demonstrated problem in Mexico and the potential of spreading into the United States (Reed 1977; Morton et al. 1976). Alfombrilla has been found growing near the New Mexico-Chihuahua and the Arizona-Sonora borders, to within 11 km south of Antelope Wells, N. Mex. (El Berrendo, Chih.) and 150 km south of Nogales, Arizona.

A joint Mexico-United States research program has been initiated to generate information on alfombrilla control and the prevention of livestock losses. The participating institutions are: Agricultural Research Service, USDA, located at Tucson, Arizona and Logan, Utah; the University of Arizona, Tucson; Instituto Nacional de Investigaciones Pecuarias, SARH, located at La Campana Experimental Station in Chihuahua; and the Animal Research Center at Carbo, Sonora.

Alfombrilla is native of northern Mexico (Fig. 1). A specimen collected near the city of Chihuahua in September 1886 is deposited in the University of Arizona Herbarium. The plant is well adapted to soils and climates within the *Bouteloua-Aristida* type. It has been found at altitudes ranging from 200 m in Sonora to 1800 m in Chihuahua, being most abundant at about 1450 m. However, moving southward, it is adapted to higher altitudes such as Zacatecas at 2500 m and Hidalgo at 2435 m (Martinez 1960; Gonzalez 1960). It grows best in sandy soils of acid nature (pH 5.6 to 7.2), but has been found in soils with pH as high as 9. It is also found in understory strata in mesquite stands. It occasionally occurs on clay textured soils or in lowlands.

Methods

The research program has been conducted under laboratory conditions at the Agricultural Research Service installations at Tucson, Arizona, and under field conditions at the La Campana Experimental Station and a private ranch, Rancho San Francisco, located in northwestern Chihuahua, Mexico.

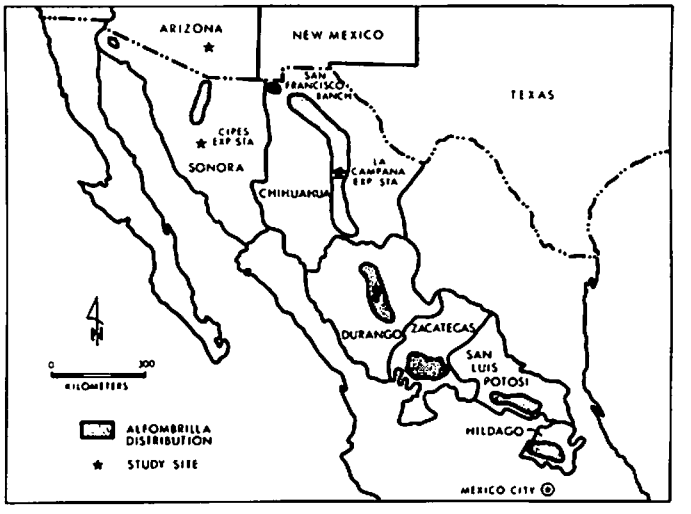

Fig. 1. Distribution of alfombrilla in Mexico and location of study sites.

Laboratory Studies

All experimental plants were obtained by establishment of seedlings from seeds collected at several dates and locations in Chihuahua. Germination-temperature relationship studies were conducted using the thermogradient plate described by Larsen (1971). Six 9 cm petri dishes were placed on each of the six gradient-temperature rows available on the plate. Each petri dish contained 50 seeds placed at random on moist filter paper. Seeds were germinated in the dark, and the number of seeds on which the radicle had emerged 5 mm was recorded at 4, 6, and 10 days. Germination values at a given temperature were transferred to coefficient of germination (CRG) (Maguire 1962). The CRG was calculated from the sum of accumulated germination on a given day (g_n) minus the germination percentage on the previous day [$g_{(n-1)}$] divided by the number of incubation days (n). The larger the CRG, the greater the aggregate rate of germination. The formula may be written:

$$CRG = \sum_{i}^{n} [g_n - g_{(n-1)}/n]$$

Germination was tested first at constant temperatures ranging from 5 to 38 C and second at alternating temperatures for 8/16 hour periods ranging from 15 to 30 C. Germination of freshly harvested seed at 30 C was tested every 15 days, using four petri dishes containing 50 seeds each. Alfombrilla vegetative growth was studied in two growth chambers. In one, the conditions were an alternating temperature of 26/15 C, and in the other, an alternating temperature of 32/21 C. Both temperature regimes had a 16/8 photoperiod, a light intensity of 10.8/0 klux, and a relative humidity of 50 to 60%. Two alfombrilla seed sources were tested under each condition: one was 18 months old collected at La Campana Experimental Station, and the other was 4 months old

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collected at Rancho San Francisco. Ten 20 × 39 × 10 cm trays, each containing 100 seeds planted on vermiculite medium, were established for each temperature regime and from each seed source. Trays were watered as necessary with 60% Hoagland's (1950) nutrient solution. After germination and emergence, 10 plants were left in each tray, and the number and length of stems, and number of leaves, buds and flowers were recorded every four or five days.

Field Studies

Alfombrilla was studied in its natural habitat at La Campana Experimental Station in Chihuahua. Five quadrats of one square meter and five belt transects of 30 cm wide by 30 m long were permanently established in two vegetative types.

Type 1: *Bouteloua-Aristida*. This site lies at an altitude of 1600 m and is characterized by dominance by species of the genera *Bouteloua, Aristida, Digitaria,* and *Setaria*. The topography is slightly undulating, with slopes less than 2%. The soil exhibits A, B & C horizons. Horizon A represents a sandy loam texture with good drainage, a pH between 5.3 and 6.6.

Type 2: *Bouteloua-Quercus*. This site is characterized by dominance by species of the genera *Bouteloua, Aristida, Andropogon, Leptochloa, Muhlenbergia, Setaria,* and *Elyonurus* associated with *Quercus* at higher elevations. Physiography is typical of the base of a granitic rocky mountain range, with slopes more than 3%. A and C soil horizons are present, with the A horizon consisting of a sandy loam with a pH between 5.2 and 6.5. Alfombrilla development was monitored in both vegetative types in square meter quadrats. The number of live plants exhibiting green tissues and flower production were recorded every week from April 1976 to July 1977.

Results

Germination

Constant temperatures

Alfombrilla seeds germinated best at constant temperatures ranging from 14 to 25 C. This resulted in 69, 73, 70, and 73% germination for 14, 17, 21, and 25 C, respectively, decreasing at lower or higher temperatures. The coefficient of germination rate for the best temperature range (14 to 25 C) shows the greatest differences at 4 days, attaining the highest value of 17.5 for 25 C and the lowest of 1.25 for 14 C. The coefficient of germination rate after 10 days was 17.9, 15.2, 14.4, and 11.6 for 25, 21, 17 and 14 C, respectively.

Alternating temperatures

Maximum alfombrilla germination under alternating temperatures was 72% at temperatures of 18 and 21 C for 16 hours in combinations with 15 and 30 C for 8 hours. However, highest germination was obtained at constant temperatures of 18 and 21 C with 77 and 76%, respectively. Higher temperatures of 27 and 30 C for a period of 16 hours, produced markedly lower germination.

Freshly harvested alfombrilla seed had shown a relatively high degree of dormancy. Seed 12, 18, and 26 months old reached a germination of 16, 40, and 81%, respectively.

Emergence and Seedling Establishment

Seeds from La Campana reached a maximum emergence of 40% in 6 days under 26/15 C for 16/8 hour period (Fig. 2), compared with only 32% at 32/21 C. San Francisco seeds showed a maximum emergence of only 32% after 8 days under 26/15 C. Regardless of site of origin, alfombrilla seedlings showed 82% survival under 26/15 C, but only 51% under the 32/21 C regime.

Vegetative Growth

Growth rates of alfombrilla were calculated as the number of leaves and stems produced per day (Fig. 3). Leaf production due to temperature and source was similar during early stages of growth. At 21 days of growth, San Francisco plants grown under 32/21 C showed the lowest leaf growth rate of 0.45 leaf/day compared to a range of 0.57 to 0.62 produced under other conditions. With time, this difference due to alternating temperature increased, resulting at the end of 39 days in

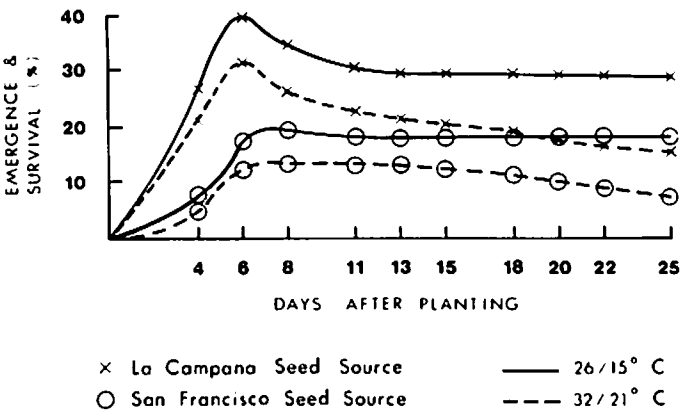

Fig. 2. Emergence and survival of alfombrilla seedlings from two seed sources and under two temperature regimes.

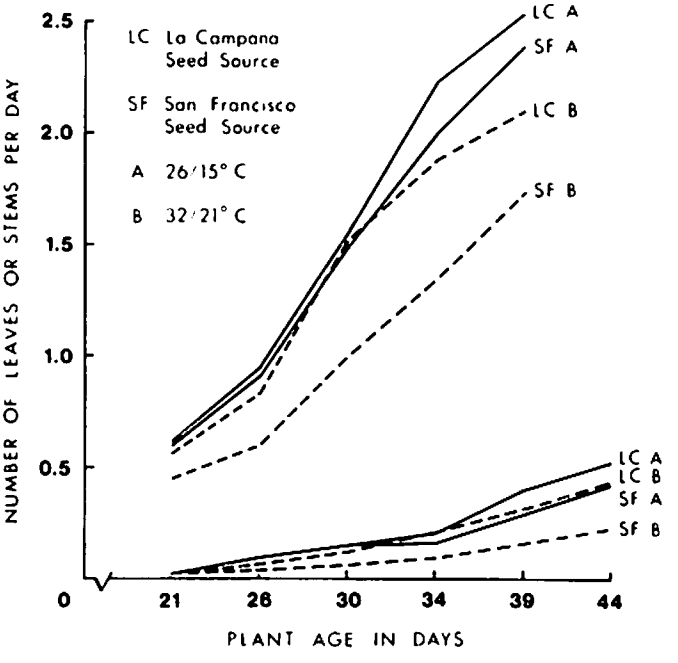

Fig. 3. Developmental rate of alfombrilla leaves and stems under two temperature regimes in growth chambers.

growth rates of 2.5 and 2.4 leaves/day under 26/15 C for La Campana and San Francisco plants, respectively. Warm temperatures of 32/21 C resulted in developmental rates of 2.1 and 1.7 leaves/day for the two seed sources, respectively.

There were no differences in number of alfombrilla stems produced at 21 days; however, after 34 days, the San Francisco plants produced 0.124 stems/day under the 32/21 C temperature regime compared with a higher rate of 0.176 to 0.206 for other conditions. The effects of temperature and plant site were very marked. La Campana plants produced 0.522 and 0.443 stem/day under 26/15 and 32/21 regimes, respectively. San Francisco plants produced 0.440 and 0.229 stem/day under the cool and warm temperature levels, respectively.

Floral Production

Regardless of treatment, floral buds and flowers were detected 35 to 40 days after planting, and the flowers remained open for 3 days. Seed production was very scarce, probably due to lack of pollination. Rate of flower production was not significantly different for the two sources of seed, being 5.84 and 4.26 flowers/day, respectively, for San Francisco and La Campana plants under 26/15 C. Higher temperatures of 32/21 C reduced flowering to 2.85 and 2.75 flowers/day, respectively. La Campana plants demonstrated more vigorous vegetative growth but less flower production than San Francisco plants.

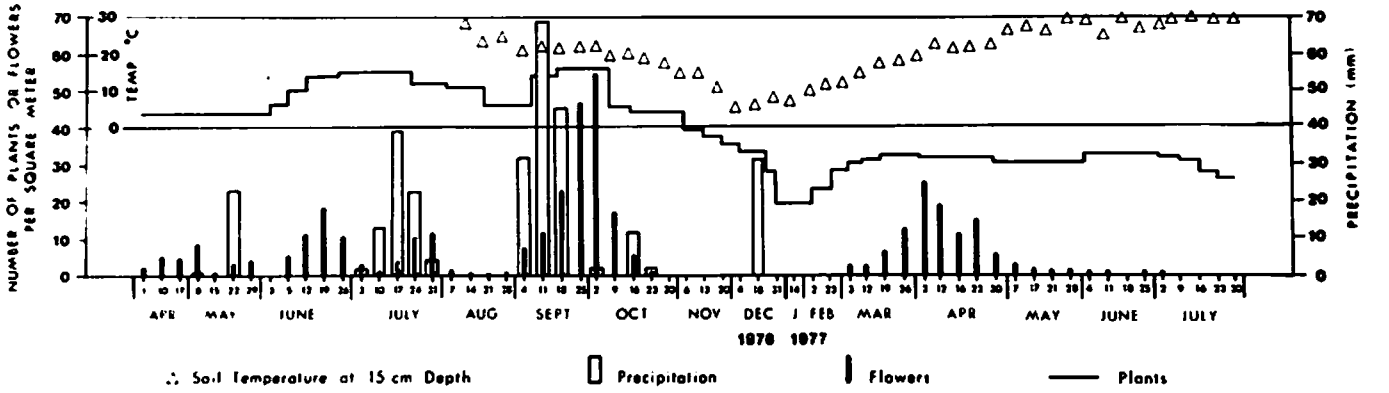

Fig. 4. Alfombrilla growth and development in the *Bouteloua-Aristida* type during the 1976-77 growing seasons.

Relatively high alternating temperatures of 32/21 C reduced the emergence, seedling survival, and growth of alfombrilla plants. Plant mortality under this higher temperature regime was 16 and 4% for San Francisco and La Campana plants, respectively.

Vegetative Growth Under Field Conditions

The number of green alfombrilla plants in the *Bouteloua-Aristida* type (Fig. 4) was abundant at the beginning of April 1976, with 44 plants per square meter, and reached the maximum number of 56 by July 1, 1976. The number decreased again to 44 in late August after air temperatures rose above 20 C and only 5 mm of precipitation fell during late July and August. Following 146 mm of fall precipitation, the number again increased to 56 plants. Declining temperatures in the fall and winter seasons, with temperatures below 0 C after October 9, reduced the number of green plants to 19 by January 1977. Because of increased temperatures during the spring of 1977 and abundant soil moisture from winter rains, the number of alfombrilla plants increased to 30 with minor changes through the following summer season.

Alfombrilla flower production in the *Bouteloua-Aristida* type was affected by climatic conditions, fluctuating between 5 and 18 flowers per square meter for the spring-summer season of 1976. Flower production declined in August, the plants becoming less vigorous, probably due to high temperatures and lack of precipitation. Early fall precipitation of 146 mm resulted in more flower production in September and reached a high value of 55 flowers on October 2. Flower production decreased during the next 3 weeks. Although no flowers bloomed in the quadrats during the winter, a few plants with one or two flowers were observed in the area. The spring of 1977 was characterized by relatively high soil moisture from winter rains and resulted in first flowering on March 3, which reached a maximum of 25 flowers on April 2, decreasing markedly in May and June. This response was probably due to the increase of air and soil temperatures and the lack of precipitation and resultant soil moisture.

Populations of alfombrilla in the *Bouteloua-Quercus* type were very sparse, with a low density of 6 plants per square meter (Fig. 5). This was reduced to 3 green plants during the winter when the soil temperature at 15 cm depth was 7 C, but recovered to 6 plants when the soil temperature reached 21 C on April 12, 1977. Maximum flower production during fall 1976 reached 28 flowers on October 2 after more than 150 mm of precipitation had occurred in previous weeks. Flowering did not occur during the winter, but resumed again on March 3 when soil temperature reached 13 C. There was flowering throughout the March-April period, with an average of 9 flowers. This was reduced to 2.2 flowers when soil temperatures were near 30 C during May and June. In July 1977, 13.4 flowers were observed in the *Bouteloua-Quercus* type compared to almost none in the *Bouteloua-Aristida* type.

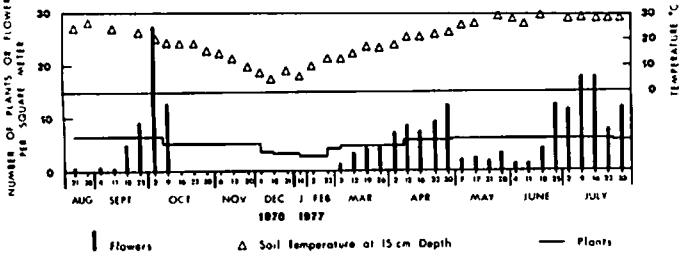

Fig. 5. Alfombrilla growth and development in the *Bouteloua-Quercus* type during the 1976-77 growing seasons.

Discussion

Alfombrilla grows in Mexico under a wide variety of physiographic, altitudinal, latitudinal, climatic, soil and pasture conditions. It is adversely affected by low and high temperatures. The best temperature range for germination is from 14 to 25 C. Although the greatest establishment potential occurs when favorable temperature and moisture conditions exist for 10 days, new seedlings can be established in as few as 4 days. A factor which reduces its rate of spread is that new seedlings are very weak and do not survive high temperatures or dry periods. Freshly harvested seed require at least 12 months to attain more than 20% germination. Temperatures of 32 C reduced the growth and flower production of well established plants. During periods of moisture and temperature stress, alfombrilla reduces its vegetative tissues and survives in a semidormant state. For example, in the winter time, there is a reduction in number of plants and more than 50% of the crowns remain green without stem elongation. As soon as soil temperatures increase to about 13 C and there is adequate soil moisture, alfombrilla grows luxuriously completing its reproductive cycle, while grasses and other desirable vegetation remain dormant. It can accomplish this cycle three or four times during a growing season if stress periods are interrupted with periods of favorable temperature and adequate soil moisture. Because alfombrilla grows profusely in early spring and late fall when warm season grasses are dormant, it is unlikely that a natural vegetative barrier will stop the spread of this toxic plant into areas where edaphic and climatic conditions favor its growth.

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