Cold Resistance and Chemical Composition in Overwintering Alfalfa, Red Clover, and Sweetclover

R. J. Bula and Dale Smith

ALFALFA, medium red clover, and biennial sweetclover are among the most important legumes used for forage and soil improvement in the northern areas of the United States. Even in short rotations, killing or weakening of stands of these legumes during the winter period is a problem in most of the northern areas. Winter survival of these legumes is dependent not only upon the development of cold resistance but also on its maintenance during the winter months.

This paper deals with the trends of cold resistance from early fall to late spring in alfalfa, red clover, and sweetclover, and the relationship of these trends to prevailing weather conditions. These determinations were made during the winters of 1950-51 and 1951-52 using seedling plants sown each spring at Madison, Wis. The trends of certain carbohydrate fractions, total nitrogen, and total ash were also studied.

**REVIEW OF LITERATURE**

Dexter et al. (4) followed the trend of cold resistance in three alfalfa varieties by electrical conductance from late September to late November in 1929. They found no varietal differences in September but during October and November, the hardy Grimm became progressively more cold resistant while the tender Hairy Peruvian continued to have about the same cold resistance as in late September. Utah Common was intermediate in response. Peltier and Tysdal (13) report similar trends through the artificial freezing of several alfalfa varieties during two winters, 1928-30. They observed further that the hardy alfalfa varieties retained hardiness longer in the spring than the nonhardy varieties. Grandfield (7) has shown that the hardening period in alfalfa at Manhattan, Kans., extended from about Sept. 1 to Dec. 1, the most rapid change taking place between Oct. 1 and Dec. 1. Suneson and Peltier (17) reported seasonal and intra-seasonal variations in the development of cold resistance in winter wheat during a 6-year period, and these variations were related closely to prevailing climatic conditions. Meader and Blake (12) and Chaplin (2) found also that changes in cold resistance of peach fruit-buds were related to prevailing weather conditions. Meader and Blake concluded that the level of cold resistance changed inversely with the prevailing air temperatures.

**MATERIALS AND METHODS**

Ranger alfalfa, medium red clover (a Wisconsin stock) and biennial white sweetclover (a Canadian stock) were cold-hardened in the field. Plants from spring seedings made each year were used. During the winter when the soil was used which had been dug in late November of soil, and buried in the field. The crowns were about the same degree as if the plants had remained in the field.

The plants were washed in cold tap water after the field. The alfalfa and red clover top growth was cut 1½ inches above the initial crown branches and then to just above the rhizomes. All roots were cut to 1 inch.

The electrical conductance method described by Dexter et al. (3, 4, 5) to measure the degree of cold resistance was used in the present study. At each determination were made on quadruplicate 10-gram samples of each legume. Roots were trimmed to a length of 4 inches and included the intact crowns as trimmed previously. The tissue was frozen for 4 hours at −8°C, and then soaked for 3 hours at 3°C in 50 ml of distilled water. Specific conductivity readings were made on the liquid from around the plant. Each sample was brought to 25°C.

Plants not used in the cold tests, consisting of the intact crowns, were oven-dried and ground for analysis. Analyses for total available carbohydrates were carried out by extracting with the Weinmann method (19) used in conjunction of Lindahl et al. (11). Reducing and total carbohydrates were calculated as glucose. Total nitrogen was determined by a sem-micro Kjeldahl method outlined by Umbreit. Total ash was determined as outlined by A.O.A.C. (1). The results were calculated as glucose. Total nitrogen was determined by the A.O.A.C. (1). The results were calculated as glucose. Total nitrogen was determined by the A.O.A.C. (1). The results were calculated as glucose. Total nitrogen was determined by the A.O.A.C. (1). The results were calculated as glucose. Total nitrogen was determined by the A.O.A.C. (1). The results were calculated as glucose. Total nitrogen was determined by the A.O.A.C. (1). The results were calculated as glucose. Total nitrogen was determined by the A.O.A.C. (1). The results were calculated as glucose. Total nitrogen was determined by the A.O.A.C. (1). The results were calculated as glucose. Total nitrogen was determined by the A.O.A.C. (1). The results were calculated as glucose. Total nitrogen was determined by the A.O.A.C. (1). The results were calculated as glucose. Total nitrogen was determined by the A.O.A.C. (1). The results were calculated as glucose. Total nitrogen was determined by the A.O.A.C. (1). The results were calculated as glucose. Total nitrogen was determined by the A.O.A.C. (1). The results were calculated as glucose. Total nitrogen was determined by the A.O.A.C. (1). The results were calculated as glucose. Total nitrogen was determined by the A.O.A.C. (1). The results were calculated as glucose. Total nitrogen was determined by the A.O.A.C. (1). The results were calculated as glucose. Total nitrogen was determin