Influence of Cutting Management on Nonstructural Carbohydrate Accumulation and Crop Survival in *Medicago sativa* L.

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Introduction

Alfalfa has the potential of producing very high forage yields of excellent quality. Most dairymen prefer to grow alfalfa if soil conditions permit, due to its very beneficial effect on milk production. This is especially true when alfalfa is cut in the bud stage, which usually results in hay or silage with a crude protein concentration of 20% or more.

Cutting alfalfa in the bud stage generally results in a short-lived stand. The premature loss of stand is possibly due to insufficient TNC being stored in the roots (5). The following experiment was conducted to determine the effect of varying lengths of intervals between cutting on the TNC level in alfalfa roots at the beginning and end of winter.

Materials and Methods

Alfalfa cultivar Apollo was seeded at 11.2 kg/ha on 16 April 1976 using a Brillion seedin. The cutting frequencies were initiated in 1977 and terminated in 1980. The alfalfa was seeded on a Chalmers silt clay loam (Typic Haploguall, fine-silty, mixed, mesic) located on the Purdue University Agronomy farm.

The intervals between cuts were 4, 5, 6 or 7 weeks, giving 6, 5, 4 and 4 cuts per year, respectively. Initial cutting dates were 11 May and 1 June. Factorial combinations of interval lengths and initial cutting dates were arranged in eight randomized complete blocks. The individual plots were 1.83 m wide and 6.10 m long. The treatments of one replicate were arranged systematically because that replicate was frequently used for demonstrating to local farmers visible effects of cutting frequency. Fertilizer was applied in two split applications at rates of 112 kg/ha P_2O_5 and 336 kg/ha K_2O, giving an annual application of 224 kg/ha P_2O_5 and 672.60 kg/ha K_2O. The first fertilizer application was made immediately after the first cutting and the second immediately after the last cutting.

Ten alfalfa roots were dug from each plot on 4 December 1979 and 4 April 1980. After harvest, the roots were washed free of adhering soil particles, bagged, and stored at -29°C. This was necessary to halt or at least reduce respiration within the tissues. To eliminate any metabolic tissue breakdown during drying a second treatment was imposed on the roots when they were removed from storage. The frozen tissues were exposed to microwaves in a household microwave oven, after the method of Wolf and Carson (7). The tissues were treated for 30 seconds, after which they were transferred to a hot air oven and dried at 71°C for 5 days before being ground for laboratory analysis. Percent TNC was measured using a procedure outlined by Orwick (2). To determine crop survival or persistence, crowns were counted, using a quadrat with an area of $0.1M^2$ (20 x 50 cm); three such counts were made per plot.

Results and Discussion

Levels of TNC in alfalfa roots harvested on 4 December 1979 and on 4 April 1980 showed only significant difference ($P \leq 0.10$) between early and late cutting

dates in 1979 and no significant differences in the 1980 samples. December-harvested roots were much higher in TNC in all cases than April-harvested roots (Figure 1). In April, the TNC ranged from a low of 22.6% to a high of 25.3%, whereas in the December-harvested roots, the range was 34.5-43.0%. In both years, the alfalfa most frequently cut (every 4 weeks) was lowest in TNC. These results are consistent with the findings of Schmid *et al.* (4), Uhliar (6), and Rai *et al.* (3).

The high TNC levels observed in December 1979 were presumably the result of reduced above-ground physiological activity and increased storage of carbohydrates in the roots during the fall. By 4 April 1980, the levels of TNC had

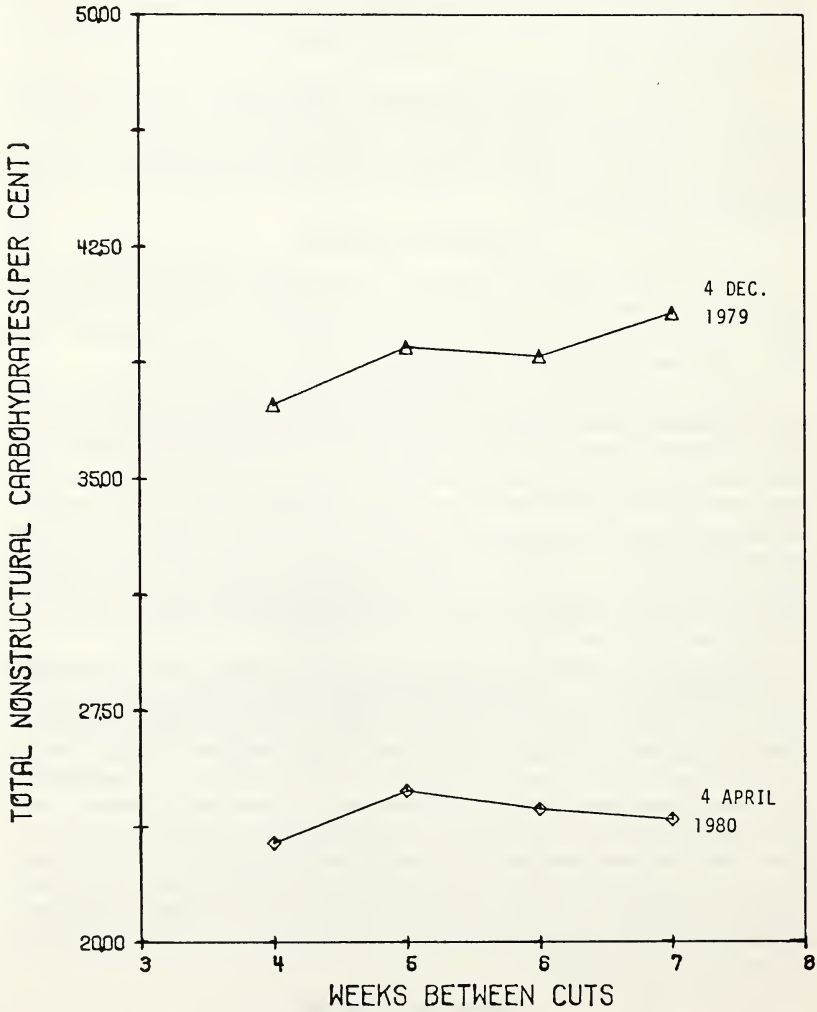

FIGURE 1. *Total non-structural carbohydrate concentrations in alfalfa roots in April and December as influenced by weeks between cuttings.*

TABLE 1. *Alfalfa stand counts at end of experiment, 3 June 1980.*

Treatment		Crowns/0.1m^2
Date 1st Cut	Weeks between cuts	
May 11	4	11.5*
May 11	5	10.7
May 11	6	11.0
May 11	7	11.7
June 1	4	10.3
June 1	5	11.2
June 1	6	10.2
June 1	7	10.8

* Ave. of 6 plots

declined significantly. At this time, due to the warming trend in the early spring, tillers had started forming on stems above, at, and below the surface of the soil. Thus, the plant was now mobilizing nutrients, particularly carbohydrates, from the root reserves and channeling these into the tillers from which new branches and leaves were beginning to develop.

Smith (5) stated that stored carbohydrates are a ready source of food material for winter survival and regrowth in the spring. Other functions of TNC in the plant include the development of cold and heat resistance, survival during dormacy, and the promotion of flower and seed production.

TNC levels increased slightly with decreased cutting frequency in 1979 but not in 1980.

The number of alfalfa plants/0.1m^2 surviving on 3 June 1980 did not vary greatly with the different cutting intervals as shown in Table 1. Number of stems/0.1m^2 might have been a better indicator of stand vigor than plants/0.1m^2.

It was noted that the problem of weeds was more severe in the frequently cut plots, presumably because of less vigorous competition from alfalfa. The major weeds encountered within the less dense plots were crabgrass (*Digitaria sanguinalis*), dandelion (*Taraxacum officianale*), barnyardgrass (*Echinochloa crusgalli*), downy bromegrass (*Bromus tectorum*) and pigweed (*Amaranthus species*).

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