Keith Johnson
Forage Crops Specialist
(765)494-4800 johnsonk@purdue.edu
Impact of Cutting Management and Soil Fertility on Winter Survival

I appreciate the contributions of Dr. Jeff Volenec.

Objective

- Improve winter survival of alfalfa with use of “Best Management Practices”
Critical Periods for Alfalfa Growth and Development

- Seedling establishment
- Herbage regrowth after harvest
- Fall growth and its impact on winter hardiness (and ultimate survival)
- Spring growth and first harvest yield
Calculating Risk of Alfalfa Winter Injury
from: NCR 547 Alfalfa Management Guide

Factors
- Stand age
- Alfalfa variety
- Soil pH
- Exchangeable K level
- Soil drainage
- Soil moisture during fall/winter
- Harvest Frequency
- High stubble with a late harvest
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People do have some control!
Varieties Differ in Persistence
Later Seedling Development Involves Contractile Growth That “Pulls” the Cotyledonary Node (CN) Below the Soil Surface Forming the Crown

Alfalfa Crown With 2 Inches of Contractile Growth
- Enables Alfalfa to Tolerate Mowing/Grazing and
Also Key to Winter Survival
Heaving Caused By Freeze-Thaw Cycles in Late Winter
Reverses Contractile Growth Exposing Crowns and Taproots
to Hazards of Mowing and the Extremes of Winter Weather

Don’t be surprised. Routinely scout the fields.
Taproots Anchor the Plant, Assist with Nutrient Uptake, and Store Organic Reserves Essential for Shoot Regrowth

Fall Dormancy = 1
Most dormant

Fall Dormancy = 4
Common to Midwest

Fall Dormancy = 9
Least dormant
Large Differences in Fall Dormancy Exist, and This Trait is Positively Associated with Winter Hardiness
Nondormant alfalfa is like diet soda, whereas dormant alfalfa is like normal soda when put in a freezer. Which freezes first?
Genetic Selection for Greater Fall Dormancy Reduced Winter Injury

Winter Injury
(1=uninjured, 2=injured, 3=dead)

Year 1
Y = 1.12 + 0.035x
R^2 = 0.88**

Year 2
Y = 0.4 + 0.046x
R^2 = 0.81**

Height in Autumn, cm

4 in. 16 in.
Past Research .......(Smith, 1964)

“The fact that plants have high carbohydrate reserves does not mean that they will necessarily develop a high degree of hardiness, but as carbohydrates are the main source of energy, plants low in these reserves cannot develop a high level of hardiness.”

Adapted from Castonguay et al., 1995
The Rankings of Winter Hardiness and Root Raffinose Family Oligosaccharide Concentrations Have a Near-Perfect Correlation – Sucrose Does Not
Impact of Harvest Management
Herbage Regrowth After Harvest in Summer Depends Upon Stored Reserves in Taproots

![Graph showing taproot starch levels over time with harvest dates marked by asterisks.]

* = Harvest Date
Frequent Harvesting in Summer Depletes Taproot Reserves and Reduces Yield and Persistence

![Graph showing taproot starch levels over time with annotations for 35-day and biweekly harvest intervals.](image)
Accumulation of Stored Reserves is Key to Herbage Regrowth and Plant Survival. Pushing hard if number of harvests >4 in a year.
Alfalfa Taproot Reserves Accumulate in Autumn and are Necessary for Winter Survival
Fall Cutting Management Influences Alfalfa Taproot Reserves and Winter Survival

![Graph showing the influence of fall cutting on alfalfa taproot reserves.](image-url)

- **Harvest**
- **Avg. Taproot Starch**
- **Killing Frost**
- **Low Taproot Starch**

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**X-axis:** Days from September 1

**Y-axis:** Taproot Starch, %

- **No Fall Harvest**
- **Fall Harvest prior to killing frost**
Fall Cutting Management Influences Alfalfa Taproot Reserves and Winter Survival

The graph shows the percentage of taproot starch over time from September 1. The x-axis represents the days from September 1, and the y-axis represents the taproot starch percentage. Two lines are plotted:

1. A line for harvest in early October, which shows a decrease in taproot starch after the harvest date.
2. A line for no fall harvest, which shows a decrease in taproot starch after a killing frost.

Key events:
- Harvest in Early Oct.
- Killing Frost
- Low Taproot Starch

The graph indicates that early fall harvest increases the taproot starch reserves and improves winter survival.
Plant Survival Over Winter and Shoot Growth in Spring Depends on Taproot Reserves

![Graph showing the decrease in taproot starch over time, indicating CHO used for respiration, shoot growth appears, and when ready for harvest 1.](image)
Plant Survival Over Winter and Shoot Growth in Spring Depends on Taproot Reserves

- Taproot Starch, %
- Days From January 1

- Jan.
- Feb.
- Mar.
- Apr.
- May

- Ready For Harvest 1
- CHO Used For Respiration
- Mismanaged Previous Fall
- Shoot Growth Appears
Spring Vigor is Reduced by Fall Cutting
As expected, fall cutting increased winter injury.

Fall cutting also reduced spring vigor (measured as shoot length)

From Haagenson et al., 2003
Impact of Cutting Management on Winter Survival

No harvest mid-Oct

Harvested mid-Oct

May 19
Impact of P and K Fertility

Low K and P  High K and P
Classic K deficiency
Regrowth - 1 Week Post-Harvest

Balance, Balance, Balance
May 19, 2003: First Hay Harvest

Severe Stand Losses Have Occurred Where P Has Been Applied Without K

Balance, Balance, Balance
Yield Component Analysis Permits Us to Understand How Alfalfa Responds to Improved P and K Nutrition

\[ \text{Yield} = \text{plants/area} \times \text{shoots/plant} \times \text{mass/shoot} \]
Yield was Increased by 0K/66P in 1998 to 2000, But Resulted in the Lowest Yields in 2002 to 2004
Mass per Shoot Mimicked
Trends in Forage Yield

![Graph showing trends in mass per shoot for different conditions over years. The x-axis represents years from 1998 to 2004, and the y-axis represents mass per shoot in grams. The graph includes lines for different conditions labeled as 0K 0P, 0K 66P, 360K 0P, and 360K 66P.]
Plant Density Declines For All Fertility Treatments, and is Not Closely Associated with Forage Yield.

Death occurs in summer not winter.
Plant Population versus Time

Plant Population, plants/m²

Dec 97 May 98 Dec 98 May 99 Dec 99 May 00 Mar 01 May 01 Dec 01 May 02 Dec 02 May 03

Summer Plant Disappearance

LSD.05 = 14
A Final Word on Alfalfa Stand.

Fewer shoots are needed for an economic stand when proper attention is given to the P and K fertilizer needs of the alfalfa.

Balance, Balance, Balance

Mass per shoot is most closely associated with yield.

Loss of stand mostly occurs during the summer. Does this result because of cumulative stress from mismanagement other times of the season?
Alfalfa possesses high tolerance to physical stress, including defoliation and cold. Our management, however, does make a difference.