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RISK OF ALFALFA WINTERKILL

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Alfalfa, because of its high yield, its excellent quality, and its good seasonal yield distribution, is generally regarded as basic to a strong forage program on most Ontario farms. Alfalfa is a perennial plant, and has been known to live for 5 years or more. However, all too often alfalfa has thinned out badly by the third production year. An understanding of the factors that cause alfalfa to die out can lead to use of management practices geared to keeping this plant in the stand.

STAND AGE

The risk of winterkill increases with increasing age of the alfalfa stand. Three and four-year old stands of alfalfa suffer greater winter injury than one-and two-year old stands when subjected to the same cutting schedule. Younger plants are more stress tolerant compared to older plants as they have lower disease infestations and have been exposed to less physical damage. Producers have less risk of stand loss when the alfalfa stand is young (1 or 2 years) compared to older stands (greater than 2 years).

VARIETIES

Alfalfa varieties differ in winterhardiness and tolerance to disease. Varieties with resistance to several diseases (bacterial wilt, *Verticillium* wilt, *Fusarium* wilt and *Phytophthora* root rot) and high winterhardiness have reduced chance of winterkill. Planting winterhardy varieties of alfalfa with resistance to these major disease pests will lessen the risk of stand loss.

SOIL POTASSIUM LEVEL

Forage stands should be soil sampled regularly and recommended fertilizer levels applied each year before the September rest period. A low potassium level in the soil is one of the major factors leading to loss of alfalfa from stands. Low potassium level hinders the storage of carbohydrates in the root and the development of a winterhardy state. This is particularly true on loam and sandy loam soils. Unless the potassium levels in these soils have been built up through fertilizer or manure use, these soils usually need added potassium. Clay soils have very good potassium supplying power and can often meet alfalfa needs .

SOIL DRAINAGE

Alfalfa dies out under poor drainage. In wet soils, alfalfa is much more subject to frost heaving during the late winter-early spring. Heaving sometimes breaks the taproot, but more often it forces the crown out of the ground, and exposes it to drying winds, and to mechanical injury during harvest. Diseases will often invade the weakened root and the plant dies during the summer.

Excess surface and soil moisture can lead to the formation of ice sheets. Ice sheeting frequently occurs in low areas in conjunction with mid-winter thawing. Ice sheets contribute to winter injury by smothering plants and by promoting rapid cooling of the soil. Since ice is a better conductor of heat than air, ice sheets can lead to rapid soil cooling and low soil temperatures. High levels of soil moisture in the fall may also reduce hardening and predispose alfalfa to winter injury. A fall soil moisture level below 50% of field capacity has been found to be favourable for alfalfa survival.

Good drainage is essential to alfalfa persistence. Tile drainage will usually correct a drainage problem, and many hectares of alfalfa are now grown successfully on land formerly too wet for alfalfa. In very level areas, surface drainage ditches may be required to remove surface water in winter when soil is frozen. Otherwise, ice formation can smother alfalfa even on tiled land.

HARVEST MANAGEMENT OF ALFALFA

The timing of harvest (whether by cutting or grazing) is very important to persistence of alfalfa. Alfalfa stands can be quickly thinned by incorrect harvest timing. Several factors are involved: stage of maturity at cutting, the number of cuts per year, timing of fall cutting, and top growth going into winter. An understanding of how these factors affect persistence requires some basic knowledge on the role of stored food reserves in the alfalfa plant.

Alfalfa roots must contain sufficient stored food (sugars and starches) to survive low winter temperatures and provide energy for spring growth. This stored food is used in the spring and after each cutting to allow the rapid growth or regrowth of alfalfa. The stored food levels drop during the first 3 weeks of growth, or until new growth is about 25 cm high. By this time, sufficient leaf surface has developed to allow production of more food than is needed for growth. Surplus food produced by the leaves begins to move to the roots and crown and is stored there. In two to three weeks of such food storage, root reserves will be back up to maximum. This point is usually reached at about full bloom. Thus, the maturity of alfalfa can be used as an indicator of the food reserve situation in the roots, except in the fall when the crop usually does not come into bloom.

For high root reserves and thus maximum persistence, alfalfa should reach full bloom before each harvest. However, the quality of alfalfa, as measured by protein level, digestibility and animal intake has declined by the full bloom stage. Thus in the interests of higher quality feed, alfalfa is often harvested in the bud or early bloom stage. This tends to reduce stored food levels, and careful management becomes necessary to reduce the chance of winterkill.

NUMBER OF CUTS PER SEASON

In Southern Ontario, two cuts rather than three prior to September will result in higher root reserves and greater alfalfa persistence. In Northern Ontario, the same can be said of one cut versus two prior to the fall rest period. With fewer cuts, each can be allowed to come into bloom before harvest, and there is plenty of time for adequate fall growth before heavy frosts halt further growth.

Unfortunately, a two-cut program (or one cut in the north) does not provide maximum protein and digestible dry matter yields. Four cuts in Southwestern Ontario, three cuts in Western, Central and Eastern Ontario and two cuts in Northern Ontario are needed to meet this objective. To squeeze these number of cuts in before the fall rest period, at least one cut will need to be harvested at a bud stage. To minimize risk to persistence harvest the first cut at the bud stage, and allow subsequent cuts to reach at least 25% bloom before harvesting.

FALL REST PERIOD

Harvesting alfalfa in the last 4 to 6 weeks of the growing period has been associated with reduced yield and persistence of stands. This association has led to the recommendation that alfalfa not be harvested during this period, commonly referred to as the critical fall harvest period. The start of the fall critical harvest period is the date when 450 growing degree days remain in the autumn growth period. This interval starts from mid August through September in Ontario (Figure 1).

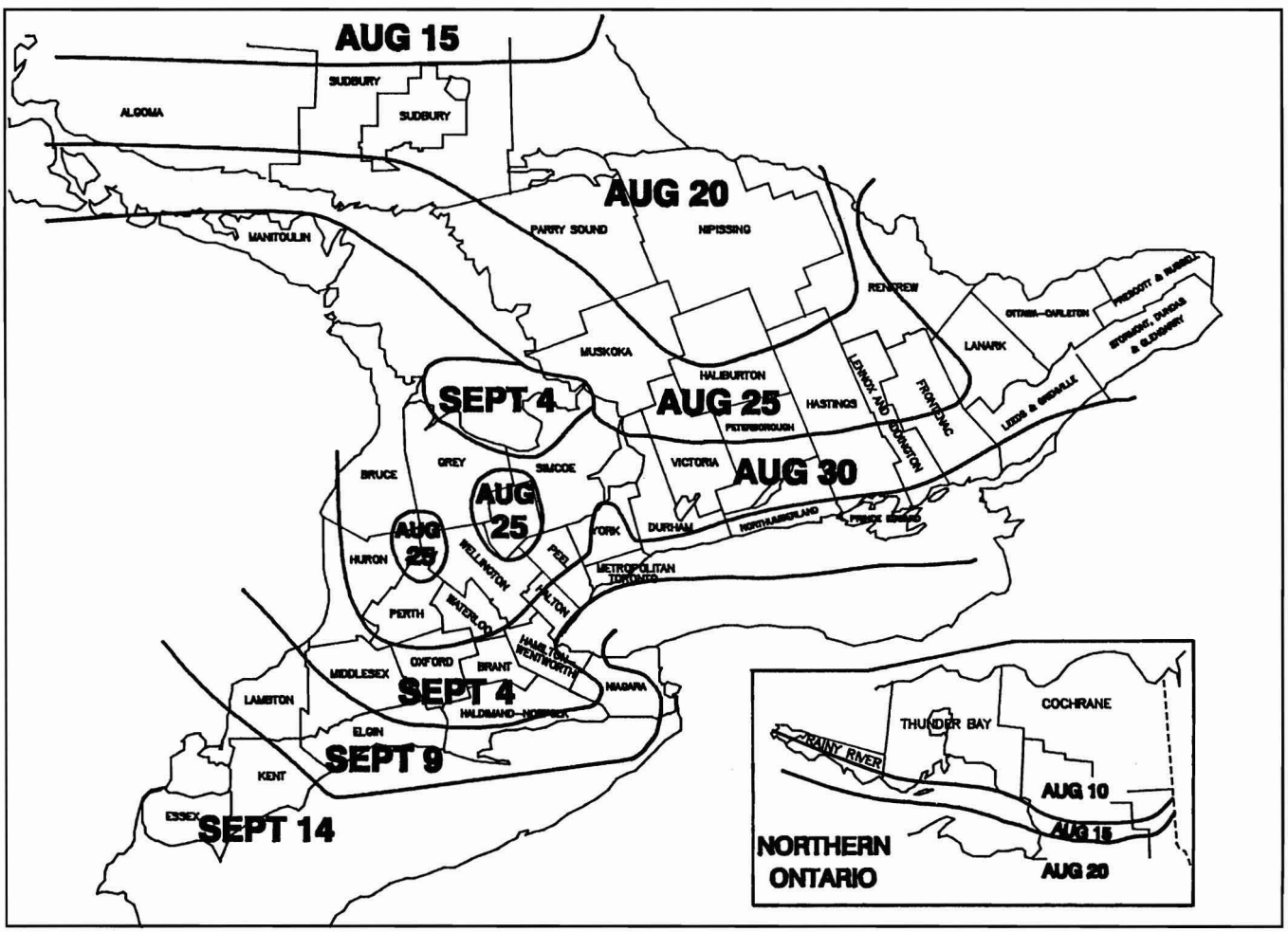

Figure 1. Start of the six-week alfalfa critical fall harvest period.

During the critical fall period, a number of developmental and physiological changes occur in response to decreasing daylengths and reduced air temperatures. The plants accumulate root reserves, initiate crown buds, and develop cold hardiness. These changes increase the plant's ability to tolerate low-temperature and other environmental stresses. The higher the degree of stress tolerance, the greater is the ability of alfalfa to tolerate adverse winter conditions.

The topgrowth produced during the critical fall period is also important for winter survival. Fall growth, in combination with snow, provides insulation to the crown which enables the plant to avoid low temperature stresses. Even though the air temperature may be several degrees below the lethal temperature for alfalfa, the insulation effect will keep the crown temperature higher and minimize the effects of low-temperature stress (Table 1). Plants which have not reached a high level of cold tolerance may be protected from winter injury by the fall growth-snow insulation.

Late-autumn harvests may also result in increased chance of frost heaving of alfalfa. Soil cover, which is provided by leaving the fall growth, reduces the extent of frost heave in alfalfa. If a particular soil or region is prone to frost heaving, leaving the fall growth to act as an insulator will reduce the chance of heaving and improve the long-term productivity of alfalfa stands.

Table 1. Snow cover effects on soil temperature 6 cm below surface, 3 year means, Elora, Ontario.

Average daily air temperature (C)	Soil temperature (C)			
		Snow		Uncompacted snow and stubble
	Bare soil	Compacted	Uncompacted	
- 2.2	-1.1	- 0.5	0.0	1.7
- 8.3	- 3.9	- 1.7	- 0.5	1.1
-10.5	- 5.6	- 4.4	- 1.1	0.6
-16.7	- 8.9	- 7.8	- 2.2	0.6

FALL CUTTING FLEXIBILITY

Modern varieties, with multiple-pest resistance, managed with high levels of soil fertility (particularly potassium), often have root reserves in excess of that required for persistence. Managed correctly, modern varieties may allow greater flexibility in terms of timing of the last harvests of the season. This flexibility includes the allowance of an extra cutting of the season or a delay of the last regular harvest of the season. However, alfalfa grown on soils subject to heaving should not be harvested in the fall.

(a) Extra cutting

Cutting schedules which include an extra cut after the killing frost (the end of the critical period) have sometimes been used. By taking the last cut following the critical fall harvest period, the alfalfa stands are allowed to develop normally through the critical fall period and attain a high degree of tolerance to cold stress. This minimizes the risk to long-term yield and persistence. The feed is high in quality, but the quantity produced (1T/ha) is minor relative to the entire production season. Most producers consider the fall growth not to be worth the harvesting effort particularly because of the difficulties in drying forage late in the fall.

(b) Delay of last harvest

In some situations, a cut during the fall rest period is not an extra cut during the season, but rather a delay of the last cut that would normally be taken prior to the critical fall period. This situation can arise if wet weather or equipment failure cause harvest delays. In these situations, producers have little option but to proceed with a harvest during the critical harvest period, knowing that the persistence and long-term productivity of the stand may be put at risk. The risk is lower if: (1) the stand is a young stand (younger plants are more tolerant of winter stresses); (2) the stand is a newer, multiple pest resistant variety, managed under a recommended fertility regime; and (3) the fall and winter conditions are such that there will be little risk of winter injury. Unfortunately, one cannot predict with sufficient accuracy the fall growing conditions, the winter temperatures, or the extent and duration of snowfall. Thus, the risks associated with a harvest during the critical fall harvest period cannot be assessed in advance. Furthermore, an early fall harvest may not allow alfalfa to provide sufficient competition for dandelions and other winter annual weeds, and infestations of weedy species will likely occur and reduce the potential productivity and quality of the forage.

(c) Cutting height

Stem and leaf stubble remaining in the fall catch snow, provides soil cover and reduces the fluctuation in soil temperature. Autumn regrowth is also important in reducing frost heaving. Leaving an 8 inch stubble or unmowed strips in the field are options to not cutting in the fall and can be effective in catching snow. This will help reduce the risk of winter injury.

(d) Practical aspects

Although there is more leeway with modern varieties managed under a recommended fertility regime, the practical aspects need to be considered if a cutting during the fall rest period is to be included as part of the production package. High soil moisture levels during fall harvest may result in serious rutting of the field during harvest operations. Poor drying conditions also increase the risk of forage exposure to rainy weather and the risk of field losses in yield and quality. Storage of a fall cutting as haylage is often the only option available for producers. These factors combined with the low yield production in the autumn period and conflicts with other fall activities (ie. corn silage/grain/oilseed harvest) leads one to question the merits of a fall harvest.

RISK OF ALFALFA WINTERKILL

The survival of alfalfa is conditional upon many controllable management factors and uncontrollable environmental factors. The uncontrollable factors include snow cover, temperature and temperature fluctuations. Controllable management factors include variety used, soil fertility (potassium level), soil and harvest timing. Management will greatly offset the risk of alfalfa winter injury. Table 2 outlines a method to estimate your risk of alfalfa winter injury. Enter the scores for answers which describe your management and field situation to assess your risk of winter injury to alfalfa.

Table 2. Risk of Alfalfa Winter Injury

Years Harvested for Forage	Points	Your Farm
1 year	1	
2 years	2	
3 years	3	
		_____
Disease resistance		
(R=resistant, HR=highly resistant)		
R or HR to all diseases	2	
R or HR to both verticillium and bacterial wilt	3	
R or HR only to bacterial wilt	4	
		_____
Potassium Soil Test		
High (above 150)	1	
Medium (80-150)	2	
Low (less than 80)	3	
		_____
Soil Drainage		
Excellent (eg. sandy loam)	1	
Good	2	
Moderate	4	
Fair (clay loam - no tile)	6	
		_____

Cutting Schedule

The following applies to Western, Central and Eastern Ontario. For Southwestern Ontario add 1 cut and for Northern Ontario subtract 1 cut.

2 cuts, last cut prior to critical fall harvest period	1	
2 cuts, last cut during this period	2	
3 cuts, last cut prior to this period	2	
3 cuts, last cut after this period	3	
3 cuts, last cut during this period	4	
4 cuts, last cut 5-6 weeks after this period	4	
4 cuts, last cut during this period	5	
		_____
Total		═══

Risk of Winter Injury

Total Score	7 or less	8-12	13-16	17 or more
Risk	low	medium	high	very high

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