AN EVALUATION OF WINTER HARDINESS IN SASKATCHEWAN FORAGES GRASSES

A.E. Limin and D.B. Fowler
Crop Development Centre, University of Saskatchewan
Saskatoon, Saskatchewan

ABSTRACT

The cold hardiness of forage grasses recommended for production in Saskatchewan was evaluated at both the seedling growth stage (fall sown) and from established stands (spring sown). Plant crowns from the established stands were on average approximately 6°C more cold-hardy than crown tissue of the same varieties at the seedling growth stage. 'Norstar' winter wheat and 'Puma' winter rye were used as standards for cold hardiness comparison. None of the grass varieties which were tested at the seedling stage were more cold-hardy than Puma rye. The least cold hardy forage grasses, orchard grass and reed canary grass, were considerably less cold-hardy than Norstar winter wheat. Fall seeding of these species is not recommended because of the high risk of winter-kill. Many other varieties would need adequate snow-cover to ensure winter survival if fall sown. When spring sown, the least cold-hardy varieties were similar in cold hardiness to Norstar. Once established, many other varieties had cold hardiness levels similar to Puma rye.

INTRODUCTION

The severe winters experienced in Saskatchewan can subject forage crop stands to a considerable degree of cold stress. There is very little information available on the relative cold hardiness of the common forage grass varieties. To properly assess the potential for winter damage in established stands an objective cold hardiness rating is needed. Ouellet (1976) demonstrated differences in winter survival of a number of species and varieties both within regions and across Canada. However, the actual cold

tolerance of most forage grasses grown under Saskatchewan conditions is not known.

The stage of plant development has been shown to influence cold tolerance in winter wheat (Andrews et al., 1960; Fowler and Gusta, 1977) and in some forage grasses (White and Horner, 1943; White and Currie, 1980). The extent to which fall seeding might reduce cold tolerance in forage grasses would be an important factor in determining the advisability of this practice. This study was initiated to determine cold hardiness values (LT_{50}s) for both established and fall-sown grasses.

EXPERIMENTAL METHOD

The seed of a total of 35 forage grasses grown in Saskatchewan were collected for cold hardiness evaluation. The seed of most grasses was kindly provided by Dr. R.P. Knowles (Agriculture Canada, Saskatoon). Seed of Russian wild ryegrass and 'Clarke' intermediate wheatgrass was supplied by Dr. T. Lawrence (Agriculture Canada, Swift Current). The most cold-hardy varieties of winter wheat (Triticum aestivum L.) and winter rye (Secale cereale L.), 'Norstar' and 'Puma' respectively, were included in all freeze tests for the purpose of comparison. The varieties evaluated for cold hardiness are listed in table 1.

The experimental design used was a randomized complete block. Three replicates of material for the evaluation of cold hardiness in established stands were seeded with a hoe drill in the spring of 1983. Two replicates of the material for the determination of seedling cold hardiness were seeded on August 30, 1983. The fall-sown grasses were dug out of the field on October 18 and October 31 for cold hardiness evaluation. The single crowns produced by these seedlings were used in the freeze tests. Plants from three replicates of the spring-seeded material (established stands) were removed from the field on

October 19, 24, and November 2. In most instances single crowns were removed from the established plants for cold hardiness evaluation. The test temperatures were at 2°C intervals and five crowns of each variety were used at each test temperature. The freeze testing procedure was basically that described by Fowler and Carles (1979). The roots and upper leaves were removed from the plant crowns, the plants were covered in moist sand and placed in a freezer, then removed at the desired temperatures. The freezing rate was 2°C/h down to -17°C, then 8°C/h. The plants were then transplanted into soil for a period of 4 weeks, and the temperature at which 50% were killed (LT_{50}) was determined by their ability to grow shoots and roots.

RESULTS AND DISCUSSION

The mean and the minimum LT_{50} ratings from all replicates are listed in table 1. For some varieties, there are no mean values because plants were not available in one of the replicates or the selected test temperatures fell either above or below the actual LT_{50}. Over the approximately two week period between the first and the last replicates, there was little cold acclimation after the first sampling date in some varieties, while in others, a considerable increase in cold hardiness occurred. Therefore, minimum LT_{50} values were included because the mean value frequently underestimated the actual cold hardiness of a variety. Plants from the established stand increased in hardiness by an average of 3.3°C. The seedlings increased in hardiness by an average of 2.7°C over the test period (table 2).

Table 1 has been arranged with the least cold-hardy seedling species at the top and the most cold-hardy species at the bottom, based on the species varietal means. The crested wheatgrass varieties were the most cold-hardy seedlings tested, having LT_{50}s close to that of 'Puma' rye. These varieties could probably survive the cold stress of most winters even with minimal snow

Table 1. The LT_{50} rating (temperature at which 50% of the plants are killed) of 29 seedling forage grasses and 2 winter cereals sown in late August, and 34 established forage varieties sown in the spring and evaluated for cold hardiness in late fall. The mean and the minimum LT_{50} temperatures are given for both seedling and established stands.

Common name	Variety	Seedling LT_{50}		Established LT_{50}	
		Mean	Minimum	Mean	Minimum
Orchard Grass	Kay	-17.0	(-17)	-21.7	(-23)
Reed Canary Grass	Frontier	-17.5	(-19)	-22.0	(-23)
	Castor	-15.5	(-17)	-21.0	(-21)
	Vantage			-22.7	(-24)
Altai Wild Ryegrass	Prairieland	-19.0	(-21)	-26.7	(-28)
Meadow Bromegrass	Regar	-18.0	(-20)	-22.0	(-23)
	S-7414	-20.5	(-23)	-21.0	(-22)
Northern Wheatgrass	S-8895	-20.0	(-21)	-28.0	(-31)
Smooth Bromegrass	Carlton	-20.5	(-21)		(-30)
	Magna	-21.5	(-23)	-25.4	(-28)
	Baylor	-20.5	(-22)		(-28)
	Beacon	-20.5	(-22)	-26.0	(-29)
Russian Wild Ryegrass	Swift	-21.5	(-23)	-29.0	(-33)
	Cabree	-20.5	(-23)	-28.3	(-30)
	Sawki	-20.0	(-22)	-25.7	(-28)
	Mayak	-21.5	(-24)		(-28)
Tall Wheatgrass	Orbit	-22.0	(-22)	-26.0	(-28)
Intermediate Wheatgrass	Chief	-23.0	(-24)	-23.0	(-25)
	Clarke	-22.5	(-23)	-25.0	(-27)
	Greenleaf	-22.0	(-22)		
Timothy	Climax	-23.5	(-25)	-26.7	(-28)
	Champ	-24.5	(-26)	-25.7	(-27)
	Basho	-23.5	(-25)	-26.7	(-28)
Slender Wheatgrass	Revenue		(-25)	-27.0	(-30)
Creeping Red Fescue			(-22)	-28.0	(-30)
Western Wheatgrass	S-8580			-28.7	(-31)
Streambank Wheatgrass					(-32)
Crested Wheatgrass	Nordan		(-27)	-27.0	(-31)
	Summit		(-30)	-27.3	(-29)
	Parkway		(-28)	-27.7	(-30)
	Fairway		(-28)	-29.0	(-32)
	S-7317		(-28)	-31.3	(-38)
Hard Fescue	S-1792				(-35)
Kentucky Bluegrass	Dormie				(-37)
Creeping Bentgrass	S-4979				(-39)
Winter Wheat	Norstar	-23.0	(-24)		
Winter Rye	Puma	-30.0	(-31)		

cover. It is probable that hard fescue, Kentucky bluegrass, and creeping bentgrass would be at least as hardy as the crested wheatgrasses based on their excellent cold hardiness in established stands. All other species tested were either approximately equal to, or less cold hardy than Norstar winter wheat. These species, if fall sown, would require adequate snowcover to ensure winter survival. Among fall-sown seedlings, 'Kay' orchard grass, the reed canary grass varieties, and 'Regar' meadow bromegrass were the least cold-hardy. Fall-sown material of these varieties would be at considerable risk of winter damage in most areas of Saskatchewan even when sown into standing stubble.

Plant crowns from established stands were generally more cold hardy on similar sampling dates than crowns of the same variety which had been fall sown (tables 1 and 2). The varieties which were least hardy in the seedling stage, approached the cold hardiness of Norstar when sampled from established stands (table 1). When compared on the basis of the maximum cold hardiness level reached, usually the last sampling date, most other varieties were similar to Puma rye in cold hardiness. The most cold-hardy forage grasses taken from established stands were 'S-7317' crested wheatgrass, 'S-1792' hard fescue, 'Dormie' Kentucky bluegrass, and 'S-4979' creeping bentgrass. Winter damage due to cold stress is unlikely in established stands of most of these grasses.

Table 2. The mean LT_{50}s of spring and fall-sown grasses on the first and last sampling dates.

	Mean LT_{50}		
	A	B	
	Spring sown	Fall sown	A-B
First sampling date	-24.8	-19.3	5.5
Last sampling date	-28.1	-22.0	6.1
Mean acclimation over sampling dates	3.3	2.7	

The degree of cold tolerance in the established forage grasses indicates that winter survival has been an important factor in their selection for Saskatchewan conditions. Most forage grasses recommended for production in Saskatchewan are able to achieve very high levels of cold tolerance when spring-sown. Once established, only the least hardy grasses are in danger of winter-kill due to cold temperature stress. The risk of winter-kill due to cold temperature stress is quite high in many fall-sown grass varieties unless adequate snow cover is assured. Therefore, if fall seeding is considered, most grasses should be sown into standing stubble. The least cold-hardy forage varieties tested in the seedling stage do not have the cold tolerance necessary to survive undamaged under most Saskatchewan winter conditions if sown in the fall.

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