COMPARISON OF YIELD, FORAGE QUALITY AND PERSISTENCE OF 11 GRASSES GROWN WITH IRRIGATION IN A SEMI-ARID CLIMATE.

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ABSTRACT

Nutritive quality of many grass species used for forage in the Northern Great Plains of Canada and the United States is not well documented, especially at different maturity stages. This study compared agronomic and forage quality characteristics of eleven grasses common to Saskatchewan. Botanical separation and quality analysis was undertaken at three growth stages. Meadow Brome (*Bromus riparius*), Russian Wildrye (*Psathyrostachys juceus*) and Altai Wildrye (*Elymus angustus*) were shown to have high leaf to stem ratios which corresponded with high protein levels. Separations showed persistence of Reed Canarygrass (*Phalaris arudinaceus*), Creeping Foxtail (*Alopecurus arundinaceus*), Russian Wildrye, Smooth Brome (*Bromus inermus*), Tall Wheatgrass (*Agropyron elongatum*) and Altai Wildrye (*Elymus angustus*) to be greater than 65% of the sward botanical composition after four years of establishment. Digestibility of the grasses was analyzed using total tract and in vitro techniques. Tall Wheatgrass (*Agropyron elongatum*),(58.4%) and Intermediate Wheatgrass (*Agropyron intermedium*),(59.7%) were shown to have the highest apparent digestibility. In vitro digestibility of clipped samples was similar to digestibility values determined by total tract digestibility.

KEYWORDS

Forage quality, grasses, digestibility, irrigation

INTRODUCTION

There are 0.75 million hectares of irrigated land in Canada (Statistics Canada 1986) and 19.8 million hectares in the United States (US Dept. of Comm. 1986) much of which is affected with salinity. Approximately two million hectares of cultivated land in Saskatchewan are classified as saline (Holm and Henry 1982). One method of preventing salinity problems is to maintain plant cover (Holm and Henry 1982). Alfalfa is widely grown under irrigation and has excellent forage quality. However, alfalfa is only moderately saline tolerant (Dodds and Vasey 1985). Many species of grass have been found to be more salt tolerant than alfalfa, but the forage quality of many of these grasses is not well known. To further confound forage quality information, many samples are taken on a calendar date rather than a specific maturity stage which makes it difficult to compare results from different reports. The purpose of this study was to compare the agronomic factors and forage quality of eleven grass species common to Saskatchewan at similar stages of maturity and at different times in the growing season.

MATERIALS AND METHODS

In 1991 plots of eleven grasses were established in a semi-arid climate (mean annual precipitation (30 cm ≈ yr^{-1}) at the Semiarid Prairie Agricultural Research Centre, Swift Current, Saskatchewan on a clay-loam soil. The grasses studied were: Smooth Brome (*Bromus inermus*), Meadow Brome (*Bromus riparius*), Tall Wheatgrass (*Agropyron elongatum*), Crested Wheatgrass (Agropyron desertorum), Intermediate Wheatgrass (*Agropyron intermedium*), Slender Wheatgrass (*Agropyron trachycaulum*), Altai Wildrye (*Elymus angustus*), Russian Wildrye (*Psathyrostachys junceu*s), Dahurian Wildrye (*Elymus dahuricus*), Reed Canarygrass (*Phalaris arudinacea*e), and Creeping Foxtail (*Alopecurus arundinaceus*) which have all been shown to be moderate to strongly saline tolerant (Dodds and Vasey, 1985; Henry and Johnson, 1980). All plots were approximately 0.9 hectares in area, replicated twice and flood irrigated. Stand density was visually estimated to be 100% of the desired species in 1992. The plots were cut for hay once per year (1992-1994) and irrigated (20 cm yr^{-1}) depending on environmental conditions and estimated plant water use. Approximately 10 cm was applied per irrigation.

Quadrat clippings (0.25 m^2) were taken in 1995. Clippings were collected at approximately the same growth stages: the three leaf stage (V3), head emergence (R1), and seed set (S5), (Moore et al., 1992). Samples were stored at -20° C immediately after clipping until separation. Separation included measurement of botanical composition, mean stage by count (MSC),(Moore et al., 1992) and leaf to stem ratios (LSR). Samples were dried at 50° C for 48 hrs and to approximately 90% DM. Yields, botanical composition, MSC and LSR were estimated from DM weights. Crude protein (CP), phosphorus (P), neutral detergent fibre (NDF) and acid detergent fibre (ADF) were determined using proximate analysis techniques (AOAC, 1984).

One hay cut was taken on July 10, 1995 at approximately the soft dough stage, for determination of total tract digestibility using sheep in individual metabolic stalls with two replicates, each with three ram lambs (mean 86 kg). Nine of the eleven grasses were used in the total tract digestibility trial. Two species with <50% botanical composition were excluded for the trial. Grasses were chopped to 5 cm length before feeding. Voluntary intake was determined by measuring intake over a 7 d period following 7 d of adaptation. The voluntary intake period was followed by 7 d of restricted intake (90% of voluntary intake). Total fecal collection occurred in the final 5 d of the 7 d restricted intake period. Apparent digestibility was calculated from dry weights of intake and fecal output.

In vitro digestibility was also determined (Tilley and Terry, 1963) using sheep rumen fluid. Statistical analysis used SAS (SAS, 1990) procedures. All data were analyzed by analysis of variance and Student Newman Kuels means for separation.

RESULTS AND DISCUSSION

Visual observation in 1991 and 1992 confirmed that grass species had been successfully established. Sampling for forage quality was carried out 4 yrs after establishment. Botanical separation performed on samples destined for forage quality analysis provided an approximation of plant persistence under flood irrigation in semi-arid conditions. Dahurian Wildrye (36%), Crested Wheatgrass (41%) and Meadow Brome (32%) had the lowest mean botanical composition and were therefore the least persistent of all the grasses studied. While Creeping Foxtail (99%) and Smooth Brome (86%) had the highest botanical composition. Yield was estimated using dry matter weights of the desired species in the botanical separations. Smooth Brome (4470 Kg ha^{-1}), Tall Wheatgrass (2950 Kg ha^{-1}) and Creeping Foxtail (2940 Kg ha^{-1}) showed the greatest yield at the head emergence (R1) stage. Meadow Brome (890 Kg ha^{-1}) and Dahurian Wildrye (640 Kg ha^{-1}) showed the lowest pure yield at the heading stage (R1). Kentucky Bluegrass (Poa pratensis L.) and Creeping Foxtail were the dominant weed species in the plots.

Crude protein decreased with maturity in all species, however, all did not appear to decline at the same rate (Table 1). Species with the highest crude protein at the three leaf stage were Reed Canarygrass (19.6%) and Crested Wheatgrass (19.4%) while Russian Wildrye (11.7%) and Meadow Brome (10.1%) had the highest crude protein at the seed set stage. The crude protein level of Russian Wildrye declined the least throughout the growing season. This is possibly due to its vegetative growth behavior which resulted in an increased proportion of leaf to stem, this vegetative growth behavior was reflected in Table 1.

Intermediate Wheatgrass (59.7%) and Tall Wheatgrass (58.3%) had the highest apparent digestibility while Creeping Foxtail (48.8%) and Reed Canarygrass (48.7%) had the lowest. The lower digestibilities of the latter may be due to earlier maturation. Apparent digestibility and apparently digestible NDF are shown in Table 2.

In vitro digestibility of clip 2 samples (post heading) closely reflected apparent digestibility of the grasses analyzed (Table 2). In vitro analysis of Creeping Foxtail and Reed Canarygrass used clip 3 samples (seed set) to compare with apparent digestibility because clip 3 samples were

taken closest to the time of harvest for those two species.

Dry matter intake of Dahurian Wildrye (4110 g/d) and Intermediate Wheatgrass (4000 g/d) were greater than the other grasses (P<0.05). Altai Wildrye had the lowest intake (2280 g/d) which may be attributed in part to the morphological coarseness of the hay. However, intake data may have been influenced by contamination with other plant species. Dahurian Wildrye and Intermediate Wheatgrass were less pure than the other species (Table 1).

Results discussed are from the first year of a two year study. Forage quality and digestibility analysis are being repeated for a second year, however, data is not presently available. Conclusions at this time indicate that Intermediate Wheatgrass, Russian Wildrye and Slender Wheatgrass may be preferable species for moderately saline areas. All three showed adequate yield, persistence of stand and digestibilities under moderately saline conditions.

REFERENCES

Association of Official Analytical Chemists. 1984. Official Methods of Analysis (14th Ed.). A.O.A.C., Washington, D.C.

Dodds, D.L. and Vassey, E. 1985. Forages for Salt-affected Soils. Cooperative Extension Service, North Dakota State University. Publ. R-584 Rev.

Henry, J.L. and Johnson, W.E. 1980. The Nature and Management of Salt-Affected Soils in Saskatchewan. Saskatchewan Dept. Ag. Publication.

Holm, H.M. and Henry, J.L. 1982. Understanding Salt-Affected Soils. Saskatchewan Agriculture. Publ.40M-3-82.

Moore, K.J., Moser, L.E., Vogel, K.P., Waller, S.S., Johnson, B.E., and Pederson, J.F. 1992. Describing and quantifying growth stages of perennial forage grasses. Agron. J. **83**:1073-1077.

SAS Institute Inc. 1990. SAS Procedures Guide, Version 6, Third Edition. Cary, NC, USA.

Statistics Canada. 1986. Census Canada - Agriculture. Ottawa. Cat. No. 96102.

Tilley, J.M.A. and Terry, R.A. 1963. A two-stage technique for the in vitro digestion of forage crops. J. British Grassland Congress. 18:104-111.

United States Department of Commerce. 1986. 1984 Farm and Ranch Irrigation Survey. AG84-SR-1 Special Report Series. Internet: www.usda.mannlib.cornell.edu:70/00/data-sets/land/87014/Readme.doc.

Table 1

Agronomic and forage quality data of eleven grasses grown with irrigation and clipped at the same phenological stages in 1995.

Grasses	Cut	AWR	CF	CWG	DWR	IWG	MB	RC	RWR	SB	SWG	TWG	SE
[1]Yield	1	780^{BYZ}	1980^{BX}	120^{BZ}	970^{BYZ}	880^{BYZ}	780^{YZ}	810^{CYZ}	1950^{BX}	1440^{BXY}	720^{BYZ}	700^{CYZ}	210
(Kg/ha)	2	1960^{BYZ}	2940^{BXY}	2100^{AYZ}	640^{BZ}	2190^{BYZ}	890^{YZ}	2321^{BYZ}	2410^{ABYZ}	4470^{AX}	2180^{AYZ}	2950^{BXY}	460
	3	4340^{AWXY}	4460^{AWX}	2000^{AYZ}	3360^{AXY}	4050^{AWXY}	720^{Z}	5350^{AWX}	3250^{AXY}	5820^{AW}	3070^{AXY}	3680^{AW}	560
SE		650	400	330	340	480	180	380	310	600	440	420	
Botanical	1	52.0^{XY}	100.0^{W}	7.8^{BZ}	23.3^{BYZ}	52.4^{XY}	39.8^{XYZ}	100.0^{AW}	74.0WY	100.0^{AW}	32.6^{YZ}	33.5^{BYZ}	8.9
Composition	2	49.4^{XYZ}	98.6^{X}	54.0^{AYZ}	22.8^{BZ}	55.3^{YZ}	27.5^{Z}	47.0^{CYZ}	62.1^{YZ}	74.8^{BXY}	37.9^{YZ}	67.1^{AY}	8.9
	3	74.1^{WXY}	97.4W	60.5^{AXY}	63.0^{AXY}	80.5^{WXY}	28.8^{Z}	84.5^{BWXY}	91.0^{WX}	84.2^{AWXY}	58.4^{Y}	81.4^{AWXY}	6.8
SE		10.0	0.7	7.7	7.3	11.6	8.9	5.2	9.6	6.3	7.6	5.0	
Leaf to	1	-	-	-	-	-	-	-	-	-	-	-	
Stem Ratio	2	1.95^{Y}	0.65^{BZ}	0.24^{Z}	0.86^{Z}	0.54^{Z}	2.07^{X}	0.46Z	4.02^{X}	0.48^{AZ}	0.47Z	0.76^{AZ}	0.29
	3	1.51^{Z}	0.67^{AZ}	0.21^{Z}	0.34^{Z}	0.46^{Z}	12.45^{Y}	0.42Z	3.62^{Z}	0.36^{BZ}	0.46Z	0.45^{BZ}	2.05
SE		0.25	0.05^{B}	0.06	0.20	0.05	4.70	0.20	0.90	0.03	0.05	0.04	
[2]Mean Stage	1	1.23^{BZ}	1.35^{CYZ}	1.46^{CXY}	1.52^{BXY}	1.58^{BX}	1.37^{BYZ}	1.32^{YZ}	1.37^{BYZ}	1.31^{CYZ}	1.47^{BXY}	1.37^{CYZ}	0.05
by count	2	1.90^{AYZ}	1.82^{BZ}	2.25^{BXY}	2.31^{AWXY}	2.40^{AWX}	1.96^{AYZ}	2.27Y	1.70^{AZ}	2.67^{BW}	2.23^{AWXY}	2.03^{BXYZ}	0.10
	3	1.94^{AXYZ}	2.23^{AWXY}	2.71^{AVW}	2.23^{AWXY}	2.37^{AWX}	1.56^{AZ}	2.46^{WX}	1.80^{AYZ}	2.93^{AV}	2.25^{AWXY}	2.27^{AWXY}	0.12
SE		0.04	0.06	0.15	0.07	0.08	0.07	0.17	0.13	0.06	0.11	0.04	
Crude	1	15.7^{AYZ}	14.7^{AZ}	19.4^{AW}	18.2^{AWX}	17.6^{AWXY}	15.9^{AXYZ}	19.6^{AW}	15.6^{AYZ}	18.7^{AW}	17.7^{AWXY}	16.3^{AXYZ}	0.6
Protein	2	10.5^{BYZ}	13.6^{BX}	10.2^{BYZ}	10.9^{BYZ}	12.3^{BXY}	9.4^{BZ}	11.2^{BYZ}	9.8^{CYZ}	11.2^{BYZ}	10.8^{BYZ}	10.2^{BYZ}	0.5
	3	9.0^{BVW}	8.8^{CVWX}	8.9^{BW}	7.4^{CWXY}	7.5^{CWXY}	10.1^{BUV}	7.0^{CXYZ}	11.1^{BU}	6.0^{CYZ}	8.1^{CWX}	5.5^{CZ}	0.5
SE		0.8	0.2	0.9	0.4	0.7	0.5	0.4	0.3	0.4	0.6	0.4	

^{ABC} indicate significant difference (P<0.05) between cuts within a species, ^{UVWXYZ} indicate significant difference (P<0.05) between species within a cut

[1]Yield measured as amount of species separated from sample, weed species not included

[2]Moore et al. (1992)

Key: AWR= Altai Wildrye, CF= Creeping Foxtail, CWG= Crested Wheatgrass, DWR= Dahurian Wildrye, IWR= Intermediate Wheatgrass, MB= Meadow Bromegrass, RC= Reed Canarygrass, RWR= Russian Wildrye, SB= Smooth Brome, SWG= Slender Wheatgrass, TWG= Tall Wheatgrass, SE= standard error

Table 2

Dry matter digestibility estimates of 11 grasses grown under irrigation in Saskatchewan and fed to sheep.

		Total Tract		*In vitro
Grasses	Intake (g)	Apparent Digestibility (%)	Apparently Digestible NDF (%)	Digestibility (%)
Altai Wildrye	2280 ^{c}	53.9 ^{bcd}	59.5 ^{ab}	54.8 ^{a}
Creeping Foxtail	2660 ^{bc}	48.9 ^{d}	51.0 ^{c}	50.2 ^{bcd}
Crested Wheatgrass	-	-	-	51.9 ^{bc}
Dahurian Wildrye	4110 ^{a}	54.1 ^{bcd}	51.9 ^{c}	49.6 ^{cd}
Intermediate Wheatgrass	4000 ^{a}	59.7 ^{a}	59.4 ^{ab}	52.7 ^{bc}
Meadow Brome	-	-	-	51.3 ^{bcd}
Reed Canarygrass	2390 ^{c}	48.7 ^{d}	50.1 ^{c}	48.0 ^{d}
Russian Wildrye	3600 ^{ab}	54.8 ^{bc}	55.6 ^{bc}	53.4 ^{ab}
Smooth Brome	3300 ^{abc}	52.8 ^{cd}	52.0 ^{c}	52.9 ^{bc}
Slender Wheatgrass	3530 ^{ab}	51.4 ^{cd}	53.6 ^{c}	50.6 ^{bcd}
Tall Wheatgrass	2970 ^{bc}	58.4 ^{ab}	63.3 ^{a}	51.5 ^{bcd}
Standard error	255	1.3	1.4	-

abcd - values with different letters within columns differ significantly (P<0.05)

* samples are from clip two, taken at approximately the same time as total tract feed was harvested (except samples for Creeping Foxtail and Reed Canarygrass were from cut three)