SMALL GRAINS IN CROPPING SYSTEMS TO THE BRAZILIAN SOUTHERN REGIONS

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ABSTRACT
Winter cereals genotypes (oats, wheat, rye, barley, and triticale) were evaluated for forage and grain yield at the experimental area of the Wheat National Research Center (EMBRAPA/CNPT) and Agronomy College of the Universidade de Passo Fundo (UPF/FA), in Passo Fundo, RS state, southern Brazil, during the years 1992-94. Three cutting frequencies were applied: no cutting, one and two cuttings. A completely random block design with split-plots and three replicates was used. The crops were established under conventional tillage. The fertilization was 200-300 kg/ha 5-25-25 , plus 22.5-30.0 kg/ha of N (urea) during tiller period (before 45 days after planting date). The cereals were planted on May 3-17, by hand, using 60-100 seeds/m in rows spaced 0.2m apart. The forage was cut by hand when the plants had approximately 30 cm of height at 7 cm of the soil level. Dry matter yield, grain yield, crude protein yield, and crude protein content were determined. The rye BR 1 showed the best performance for forage, and crude protein yield. Hectoliter weight, density, and emergence-flowering period were determined. The rye BR 1 showed the best performance for forage and crude protein yield, whereas oats UPF 15 was outstanding for grain yield. In addition, triticale BR 4, wheat IPF 55204, and PF 87451, and oats UPF 13, UPF 14, CTC 2, and UFRGS 12 were promising for double purpose, early grazing and harvest.

KEYWORDS
Cutting frequencies, grain yield of regrowth, oats, wheat, rye, barley, and triticale

INTRODUCTION

In the South Brazil winter cereals grow mainly in the region that comprises Rio Grande do Sul (RS), Santa Catarina (SC), and Southern-center of Paraná (PR) states. Serious damages from soil degradation, soil fertility losses and environment contamination negatively interfere with the economy and ecological balance. This circumstance occurs particularly in periods when the soil remains uncovered, between the summer harvest (March/April) and winter crops planting (from June onwards in most areas). Depending on the harvesting and planting dates specified, due to stubble decomposition and soil exposure, there are higher risks of water runoff and nutrient leaching content (Denardin *et al*., 1991). On the other hand, in this region the native pastures (range) are comprised of warm season grasses that have lower nutritive value in the late summer and early autumn, aggravating circumstances for frost. Cool season grasses like oats, wheat, rye, ryegrass, barley, and triticale are alternatives because of high quality of forage, early production, and coverage for soil conservation (Floss, 1988 and Fontaneli *et al*., 1996). The small grains when planted in March/May are grazed one or two times for ruminants. Typically cattle are removed from small grain pastures in late July-early August, and a harvest of winter cereals is then done. Although the usual grazing period is from May to late July/early August the grazing can continue until late October if the decision is made not to harvest during this time when the farmer needs soil coverage from no till summer crops. The injury to the plants by cuts changes with the development stages of the plants (Sofield *et al*., 1977; Mundstock, 1980; and Horie, 1994). The cutting removes the growing points (Gardner & Wiggans, 1960), especially during intermediate vegetative and reproductive phases. However, the damages are minimal when cut in the juvenile vegetative phase (Winter & Thompson, 1990 and Fontaneli & Piovezan, 1991). Postiglioni (1982) recommends the mixture of oats, rye, and ryegrass to South Brazil to extend the grazing period. Daily gains on cool season grasses are usually 0.6-1.0 kg per animal. Stocking rates vary 1.0-3.0 U.A./ha depending on the grazing system and the amount of top growth available. Cattle are removed from pasture during periods of heavy rainfall to prevent trampling damage and a significant reduction to the cereal crop. Alvin (1989) emphasizes that these mixtures are economic in Central and South regions of the Brazil. As a consequence of the winter pastures utilization, beef cattle finishing and milk production increased in the RS plateau (Del Ducca *et al*., 1994). The need for crop rotation and cattle production has led to activities integrating crop and cattle production and may result in a better use of the farm potential. In addition the diversification of activities normally reduce the risk. Similar technologies on the use of wheat for double purpose represent well-established handling practices, with important economic consequences in countries like United States of America (Taylor, 1994), especially in Texas, Oklahoma, and Kansas states, and Uruguay (DÌaz-Rosello, 1993). The purpose of this study was to test several genetic materials of winter cereals to be recommended for double cropping purpose and to select new material having in view the improvement of the predominant production system that is made up mainly by soybean/corn during the warm season and wheat/oats during the cold season.

METHODS

Three experiments were carried out at fields of Wheat National Research Center (EMBRAPA/CNPT) and Agronomy College of the Universidade de Passo Fundo, in Passo Fundo, Rio Grande do Sul state, Brazil. The soil is the dark-red latosol (Passo Fundo unit) (Brasil, 1973). The experiments were conducted in completely random block design (RCDB) with split-plots, and three replicates. Each genotype of cool grass was subjected to cuts simulating cattle grazing (without cut, one cut, and two cuts) constituted the main plot and genotypes of annual cool season grass formed the subplot. The genotypes tested were: wheat (IPF 41004, IPF 55204, PF 86247, PF 87451); early check wheat (BR 23 and EMBRAPA 16); barley (MN 569 in 1993 and BR 2 in 1994); rye (BR 1); triticale (BR 4); and oats (UPFs 7, 12, 13, 14, 15, and 89S020; UFRGSs 7, 10, 11, and 12; CTCs 1 and 2); and *Avena strigosa* Comum (forage check). The subplots constituted 5 rows of 4 m or 5 m, with 0.2 m among rows. The evaluation were by 3 or 4 central rows. The crops were planted under conventional tillage. The fertilization was 200-300 kg/ha 5-25-25, plus 22.5-30.0 kg/ha the same quantities after each cut, and in the same date without cut treatment. The planting dates were, May 5, 1992; May 3, 1993; and May 17, 1994, by hand using 500 seeds/m in 1992, and 300 seeds/m in 1993-94 in rows spaced 0.2 m apart. The forage was always cut so that the plants had 30 cm of height at 7 cm of the soil level. The herbage was weighed and a sample was dried at approximately 60ºC until a constant weight (48-72 hours) occurred in driers. The dry forage was ground in Willey-mill with 1mm screen. The samples were storaged for future determination of CP. The CP was determined by Kjeldhal technique (Batman, 1970) to analysis total N. The harvest was done after maturation, cut by hand, and trashed in a stationary crusher. After the oats awn was removed and cleaned, the grains were weighed to determine yield. Hectoliter weight and the weight of 1000 seeds (Brasil, l976) were also determined. The data were submitted to analysis of variance and the means compared by Tukey test at 5% of significance (Montgomery, 1991).

RESULTS AND DISCUSSIONS

Considering the two-years average for DM production with one cut, the best cereal species, due to their early development and production were rye BR 1 and barley (MN 599, in 1993, and BR 2, in 1994), with 1,754 kg/ha and 1,714 kg/ha, respectively. Considering the sum of both cuts, the outstanding cereal were oats UPF 15 (2,790 kg/ha) and the wheat lines IPF 55204 and PF 87451 with 2,574 Kg/ha, and 2,475 kg/ha, respectively. In the two-years without cut, no other cereal surpassed the grain yield of the wheat cultivar EMBRAPA 16 (3,220 kg/ha). In the two years, very low grain yields were obtained with the two cuts, probably making it necessary to better anticipate the planting period (to April) so that grain yield is not greatly reduced, when greater amounts of DM- forage are contemplated. Under one cut, the wheats performed better than the other cereals, especially, the late-early types PF 87451, IPF 55204, and IPF 41004, with 2,629 kg/ha, 2,494 kg/ha, and 2,344 kg/ha of grain yield, respectively (EMBRAPA 16 with one cut yielded 2,120 kg/ha). However, in spite of the grain yield reduction with the clipping, the DM production of a wheat cultivar like EMBRAPA 16 with one cut (1,400 kg/ha) obtained over a 70 days period, makes possible an economic value equivalent to the steer weight gain of 140 kg/ha, approximately. These data are more significant when compared with the cattle weight gain of 40-50 kg/ha year, in South Brazil native pasture, with 0.7 cattle/ha. In addition the beef cattle lost 30-50% of the warm season gain (Moojen & Saibro, 1981).

Yield of forage (DM): The mean of yield of forage in the first cut was 966 kg/ha (Table 1), the detach was the rye (BR 1), with 1,648 kg/ha of DM. However, in the first cut of the rye in the two-cuts system the rye was not different from the triticale (BR 4) and from the oats (UPF 13). The oats (Avena strigosa Comum) had less yield than rye in both systems, but was not different in the second cut. In the two-cuts total, the biggest production of DM were of rye and of triticale.

CP yield and CP content: The rye stood out in the one cut system, with a yield of 377 kg/ha and 22.87% of the CP-content. However in the two-cut system rye has the same CP-yield as the triticale, *Avena strigosa*, barley, and oats (UPF 13 and UFRGS 11). In the second cut triticale, rye, and oats UPF 12 stood out. In the two-cut totals rye, triticale, and *Avena strigosa* with yield of 536, 530, and 481 kg/ha, were superior. Fontaneli & Piovezan (1991) obtained similar results of 519 kg/ha of CP, and 24.79% of CP content with rye and triticale.

Grain yield: The oats (UPF 15) stood out in all cut systems (Table 2), with a mean of 3,675 kg/ha of grains. This was not different from UPF 14-oats (4,276 kg/ha) in the without cut system, and of the barley (2,667 kg/ha) in the two-cuts system. There was a decrease of grain yield with increase of number of cuts; this agrees with data of Pereira (1974) and disagrees with that of Costa & Markus (1977). These authors commented on problems of lodging in oats without cut, especially with an early planting date.

Hectoliter weight: The high hectoliter weight is attributed to nice conditions of weather during the cool period of 1992. UPF 14, UPF 15, CTC 1, and CTC 2 (oats) stood out. These results agree with Fontaneli & Piovezan (1991) who also noticed lowering hectoliter weight from the first to second cut.

Weight of 1,000 grains: The mean of 1,000-grains weight in the without cut system was 27.42 grams; that is not different from the one-cut system (25.67), and two-cuts system (25.57). However the triticale, barley, and CTC 2-oats stood out in the without cut system. In the one-cut system CTC 2-oats stood out, but did not surpass barley, and UPF 15-oats

Early density: The mean of early density was 355 plants/m^2). The oats Avena strigosa with (1,058 plants/m^2) stood out in the mean of the two systems of cut. However the bigger number of buds did not present an advantage to yield of grain. This result agrees with data of Fontaneli & Piovezan (1991).

Emergence-flowering period: The mean period of the emergence to flowering was 126.83 days in the without cut system, and increased significantly to 133.67 days in the one-cut system, and also increased significantly to 140.46 days in the two-cut system. The cereals rye (BR 1), barley (IAC 75741), and the triticale (BR 4) can be considered early, on the other hand the oats CTC 2 and UPF 89S020 can be considered late cereals.

The rye showed the best performance for forage yield and crude protein yield, whereas oats UPF 15 was outstanding for grain yield. In addition, triticale BR 4, wheat IPF 55204 and PF 87451, and oats UPF 13, UPF 14, CTC 2, and UFRGS 12 have potential for double purpose.

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Table 1

Dry matter yield (kg/ha) of winter cereals in each cut and total. Passo Fundo, RS, 1992.

Genotypes	Cut System 1	Cut System 2		2-cuts totals	1-cut Means to the two Systems
		First	Second	1º + 2º cuts	
	July 14	July 14	August 13	(7/14 and 8/13)	July 14
Rye BR 1	B 1648 a	C 1296 a	958 bc	A 2254 a	1472 a
Triticale BR 4	B 1326 b	B 1246 ab	1170 a	A 2416 a	1286 b
Avena strigosa	B 1185 bc	B 1024 bc	871 cde	A 1895 b	1105 bc
Barley IAC-75741	B 820 efg	B 743 ef	637 g	A 1379 de	781 ef
Oats UPF 7	B 832 efg	B 692 efg	735 defg	A 1427 de	762 ef
UPF 12	B 922 cdef	B 856 cdef	1041 ab	A 1882 b	889 de
UPF 13	B 855 ef	B 1089 abc	722 efg	A 1811 bc	972 cd
UPF 14	B 946 cdef	B 904 cdef	717 efg	A 1621 bcd	925 cde
UPF 15	B 570 g	B 469 g	834 cdef	A 1303 e	519 g
UPF 89S020	B 980 cde	B 739 efg	636 g	A 1376 de	860 def
UFRGS 7	B 872 def	B 902 cdef	653 g	A 1555 cde	887 de
UFRGS 10	B 837 efg	B 49 def	669 g	A 1419 de	793 def
UFRGS 11	B 1139 bcd	B 1020 bcd	863 cdef	A 1883 b	1079 c
UFRGS 12	B 921 cdef	B 940 cde	881 cd	A 1821 bc	931 cde
CTC 1	B 689 fg	B 661 fg	620 g	A 1280 e	675 fg
CTC 2	B 917 cdef	B 860 cdef	709 fg	A 1569 cde	889 de
Means	B 966.2	B 886.9	774.8	A 1680.7	926.5
CV (%)	9.37	10.05	6.,44	5.81	(a)6.64/ (b)9.70

Means within a column followed by the same small letter and antedated in the row by the same capital letter are not different (P>0.0 5) by Tukey test.
(a) Systems.
(b) Genotypes and interaction.

Table 2

Yield of grains (kg/ha) of winter cereals in cutting systems. Passo Fundo, RS, 1992.

Genotype	Cutting Systems			Mean
	Without cut	1 cut	2 cuts	
Rye BR 1	A 3334 bcd	B 1850 fg	B 1641 cdef	2275 def
Triticale BR 4	A 3740 b	B 1646 g	B 1412 ef	2266 def
Avena strigosa	A 271 i	A 771 h	A 625 g	556 I
Barley IAC 75741	A 3571 bc	AB 3075 b	B 2667 a	3104 b
Oats UPF 7	A 2625 f	AB 2233 cdef	B 1792 bcde	2217 defg
UPF 12	A 1094 h	A 746 h	A 746 g	862 h
UPF 13	A 3276 bcd	B 2283 cdef	C 1666 cdef	2409 cde
UPF 14	A 4286 a	B 2571 c	B 2146 b	3001 b
UPF 15	A 4333 a	B 3688 a	C 3004 a	3675 a
UPF 89S020	A 2008 g	A 1963 defg	A 1938 bcd	1970 g
UFRGS 7	A 2729 f	B 2067 defg	B 1787 bcde	2194 defg
UFRGS 10	A 2938 def	B 2013 defg	C 1263 f	2071 fg
UFRGS 11	A 2771 ef	B 1892 efg	C 1275 f	1979 g
UFRGS 12	A 2925 def	B 2021 defg	B 1529 def	2158 efg
CTC 1	A 2922 def	AB 2384 cd	B 2029 bc	2445 cd
CTC 2	A 3229 cde	B 2341 cde	B 2100 bc	2557 c
Mean	A2878.15	B 2096.38	C 1726	2234
CV (%)	7.22	6.69	7.91	(a)9.56 (b)7.,38

Means within a column followed by the same small letter and antedated in the row by the same capital letter are not different (P> 0.05) by Tukey test
(a) systems
(b) genotypes and interaction