RELATION BETWEEN GROWTH IN SUMMER AND THE OVERWINTERING ABILITY IN HYBRID *PENNISETUM* AND NAPIERGRASS GENOTYPES

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ABSTRACT

The growth in summer and the overwintering ability of interspecific hybrid (Hy) between pearl millet (*Pennisetum glaucum*) and napiergrass (*P. purpureum*) was compared with those of two napiergrass varieties, i.e. Wruk Wona (Wr) and Merkeron (Me) in the field. The Hy had smaller dry matter yield (DMY) and mean tiller weight with higher tiller number and *in vitro* dry matter digestibility (IVDMD) than Wr and Me at the end of July, but DMY and IVDMD were not significantly different among genotypes in November. Regrown percentage of plants, number and dry weight of regrown tillers after overwintering were the highest in Me, followed by Wr but nil in Hy, due to the differences in the survived percentage of emerged tiller buds on the underground stem (UG) and non-structural carbohydrate content of UG. Thus, Hy can be used for the annual fodder grass comparable to napiergrass under the frosting South-western Japan.

KEYWORDS

Pennisetum hybrid, *P. purpureum*, dry matter production, *in vitro* digestibility, overwintering, tiller bud, non-structural carbohydrate

INTRODUCTION

Interspecific hybrids between pearl millet (*Pennisetum glaucum*) and napiergrass (*P. purpureum*) have been bred for aiming at improving nutritive value with the high dry matter production by seed-propagation as described by Diz and Schank (1993). These characters were desirable to overcome the burden in the heavy labor cost of planting stem-cuttings of normal napiergrass and to spread the planting area of *Pennisetum*s widely into the South-western Japan. As napiergrass can overwinter in the coastal area of South-western Japan even where the frost falls frequently (Ishii *et al.*, 1995a), the overwintering ability in the hybrid should be examined for its perennial potentiality. There was also reported for the variation in dry matter production and overwintering ability among napiergrass varieties and *Pennisetum* hybrids (Sanada et al., 1994; Ishii *et al.*, 1995b). We wanted to evaluate the summer growth, overwintering ability and their relation in hybrid *Pennisetum* by comparing with napiergrass varieties.

MATERIALS AND METHODS

Seedlings of interspecific hexaploid hybrid, line SV-1 (designated as Hy) grown in the pot and rooted tillers of stem cuttings of two napiergrass varieties, i.e. high yielding variety, Wruk Wona (Wr) and popular variety, Merkeron (Me), were transplanted into the field at the density of 4 plants/m^2 on May 10, 1995. Growth characteristics, such as dry matter yield (DMY) of the aboveground part, *in vitro* dry matter digestibility (IVDMD) of leaf blade and stem with leaf sheath analyzed by pepsin-cellulase method, leaf area index (LAI) and net photosynthetic ability (P_0) measured with the hand-held chamber and portable infra-red gas analyzer (Model LCA4, Analytical Development Co.), were determined through July to November, 1995. Plants were harvested at 20 cm above the ground level on November 18, and measured for the overwintering ability such as the dry weight (DW) of underground stem (UG), viability of tiller buds attached on the UG as described by Ishii *et al*. (1995a), non-structural carbohydrate content of UG assayed by enzymatic method of the F-kit (Boehringer Mannheim Gmbh) through November, 1995 to April, 1996 and the regrowth rate of plants on April 20, 1996.

RESULTS AND DISCUSSION

Summer productivity. The Hy had the lower DMY with the smaller mean tiller weight than the other napiergrass varieties at the end of July, which may be due to the delayed early growth by the seed propagation of Hy. However, larger number of tillers, higher DW ratio of leaf blade to stem with leaf sheath and IVDMD of Hy, as the characteristics of early growth, resulted in the non-significant difference in the *in vitro* o digestible DMY. Both DMY and IVDMD turned to be similar among genotypes in November, which was brought about by the larger increase rate in DMY and the more rapid decline in IVDMD of Hy. The early earing habit of Hy appeared to promote the stem-elongation as well as the rapid decline in IVDMD, especially of the stem part as described by Schank and Chynoweth (1993). The greater productivity in Hy through July to November might be due to trends in the higher LAI with the similar P_0, as compared with the other napiergrass varieties.

Overwintering ability and regrowth characters before and after overwintering. The regrowth characters of plant and tiller buds were investigated on November 19 (before overwintering) and March 16 (after overwintering) as shown in Table 2. Emerged percentage of tiller buds (EPtbs) and survived percentage of emerged tiller buds (SPetbs) attached on UG, judged by their appearance, were consistently higher in Me than in Wr and Hy. Especially, there was found the distinct genotypic difference in SPetbs on March 16. The tiller buds on UG tended to position shallower, and starch and total sugar contents of UG were lower in Hy than in the other napiergrass varieties, especially on March 16. However, DWs of UG were not significantly different among genotypes and total number of tiller buds was not related to the overwintering ability. Regrown percentage of plants, number and DW of regrown tillers in April were the highest in Me, followed by Wr but nil in Hy. The overwintering ability among genotypes ranked in the similar order as Sanada et al. (1994). Higher overwintering ability was related with higher SPetbs, deeper position of tiller buds on UG which may be mediated by cold avoidance under deeper soil layers (Ishii et al., 1995a) and the smaller breakdown in starch and total sugar contents of UG during overwintering.

Relation between productivity and overwintering ability. The regrowth characters before overwintering were estimated as the lower starch content and higher earing habit of HY in November, possibly influenced by the annual characteristic of parental pearl millet. Regrown plants were not obtained in Hy, which contained almost exhausted non-structural carbohydrate in March.

Thus, in conclusion, Hy should be judged as the annual and can be used for the annual fodder grass comparable to the yield and digestibility of first year's napiergrass under the frosting South-western Japan.

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Table 1

Dry matter (DM) yield (DMY), *in vitro* DM digestibility (IVDMD), *in vitro* digestible DMY (IVDDMY) and characters related to the summer growth in 1995

Date	Character	Genotype		
		Wruk Wona	Merkeron	Hybrid
July 29	DMY (g/m^2)	1622[a][5)]	1320[a]	833[b]
	Leaf blade / Stem[1)]	0.410[B][5)]	0.504[B]	1.073[A]
	IVDMD[2)] (%)	39.4[B]	41.9[B]	52.7[A]
	IVDDMY[2)] (g/m^2)	550[a]	501[a]	408[a]
	Tiller No. (No./m^2)	30[B]	44[B]	99[A]
	Mean tiller weight (g)	54.6[A]	30.3[B]	8.5[C]
	Leaf area index	5.24[a]	5.43[a]	8.38[a]
	Po 3)μ molCO_2/m^2/s)	24.2[a]	20.9[b]	25.9[a]
Nov. 7	DMY (g/m^2)	2875[a]	2631[a]	2730[a]
	Leaf blade / Stem1)	0.214[ab]	0.196[b]	0.278[a]
	IVDMD[2)] (%)	36.2[a]	35.1[a]	33.6[a]
	IVDDMY[2)] (g/m^2)	887[a]	743[a]	766[a]
	Tiller No. (No./m^2)	23[a]	30[a]	41[a]
	Mean tiller weight (g)	131.1[a]	86.7[b]	66.4[b]
	Leaf area index	7.18[a]	5.96[a]	7.48[a]
	Po [4)](μ molCO2/m^2/s)	11.8[B]	19.3[A]	19.1[A]
	Earing tiller percentage	0[B]	0[B]	48.6[A]

1) Dry weight ratio of leaf blade to stem with leaf sheath.
2) Measured for leaf blade plus stem with leaf sheath.
3) Net photosynthetic ability, measured on July 18.
4) Measured on October 18.
5) Figures with different large and small letters denote significant genotype differences at 1% and 5% levels, respectively.

Table 2

The regrowth characters of plant and tiller buds with non-structural carbohydrate content in the underground stem (UG) before and after overwintering

Date	Character	Genotype		
		Wruk Wona	Merkeron	Hybrid
Nov. 19	Total number of tiller buds (No./plant)	80.0[ab][1)]	68.5[b]	115.3[a]
	Emerged percentage of tiller buds	35.6[b]	47.3[a]	32.7[b]
	Survived percentage of emerged tiller buds	85.6[ab]	97.6[a]	85.0[b]
	Position of tiller buds below underground (cm)	-1.45[ab]	-1.89[b]	-1.22[a]
	Dry weight (DW) of UG (g/plant)	40.2[a]	34.3[a]	39.0[a]
	Starch content of UG (% DW)	12.85[A]	12.56[A]	5.00[B]
	Total sugar content of UG (% DW)	12.32[A]	6.80[B]	9.45[AB]
March 16	Total number of tiller buds (No./plant)	68.0[b]	72.8[b]	95.0[a]
	Emerged percentage of tiller buds	47.3[ab]	59.2[a]	40.4[b]
	Survived percentage of emerged tiller buds	22.1[b]	48.9[a]	1.2[c]
	Position of tiller buds below underground (cm)	-1.59[A]	-2.73[B]	-1.73[A]
	DW of UG (g/plant)	35.2[a]	46.2[a]	41.6[a]
	Starch content of UG (% DW)	5.61[A]	4.87[A]	1.19[B]
	Total sugar content of UG (% DW)	3.51A	4.24[A]	0.18[B]
April 20	Regrown percentage of plants	41.8[B]	84.2[A]	0.0[C]
	Regrown tiller number (No./plant)	2.12[B]	3.85[A]	0.0[C]
	DW of regrown plants (g/plant)	0.78[B]	3.39[A]	0.0[C]

1) Figures with different large and small letters denote significant genotypic differences at 1% and 5% levels, respectively.