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THE EFFECTS OF PLANTING DENSITY ON THE DRY MATTER YIELD AND THE OVERWINTERING ABILITY OF THE DWARF AND NORMAL NAPIERGRASSES IN TWO YEARS AFTER PLANTING

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Abstract

The objective of this study is to determine the optimum planting density in napiergrass (*Pennisetum purpureum* Schumach) among two dwarf varieties introduced from Thailand and two normal ones under three levels of density. Dwarf varieties showed lower plant height and mean tiller weight, and higher leaf area index (LAI) and leaf blade percentage. Crop growth rate was positively correlated with LAI, and net assimilation rate and canopy extinction coefficient (K) were negatively correlated with LAI in the second year, including all dwarf and normal varieties, while K tended to be lower in the dwarf varieties. With the increase in the planting density, dry matter yield tended to increase, the difference between the normal varieties and early-heading dwarf variety was reduced, and the over wintering ability in all varieties was decreased. It was concluded that late-heading dwarf and normal varieties should be planted at the medium density by a desirable combination of productivity and considerable over wintering ability.

Keywords: Napiergrass, dwarf variety, normal variety, planting density, productivity, canopy structure, over wintering ability

Introduction

After breeding the dwarf napiergrass varieties in the United States (Hanna et al., 1993), the characteristic of the dwarf was compared with the normal in several areas of the world (Hanna et al., 1993; Wang and Lee, 1993; Ishii et al., 1998). Since Miyazaki, the Southern part of Japan is located at the border between the sub-tropical and temperate area, tropical grasses are suffered from frosts (Ishii et al., 1996a). Thus, the productivity of napiergrass in this region is closely correlated with the over wintering ability for its perennial use, and the dwarf varieties should be estimated for their productivity and perenniality, compared with the normal ones (Ishii et al., 1996b). It is stressed that the dwarf varieties has the superior forage quality to the normal as higher leaf percentage, crude protein content and digestibility (Hanna et al., 1993; Wang and Lee, 1993). By increasing the planting density, the fault of lower productivity in the dwarf might be compensated due to lower competition among neighboring tillers (Ito et al., 1989). This study was tried to estimate the optimum planting density in the dwarf and normal napiergrasses from the aspect of productivity and over wintering ability.

Material and Methods

Two dwarf varieties (early-heading variety, DE and late-heading, DL) introduced from Thailand and two normal varieties (Wruk wona, Wr and Merkeron, Me) were grown at the experimental field, Miyazaki University under three levels of planting density (High density, 16 plants/m^2; Medium, 8 plants/m^2; Low, 4 plants/m^2) in 1998-99. Plots were arranged in a blocked design of Latin square method, where the main plot was planting density and the subplot was variety with three replication. Plots were established by a over wintered tiller in May, 1998 and used again in 1999 from over wintered stubbles except DE, which should be replanted because of its low over wintering ability. Annual fertilization was 40 g/m^2 of N, P_2O_5 and K_2O in both years by four split applications. Cutting at 10 cm above the ground was conducted twice in 1998 and three times in 1999, and growth analysis was applied into the herbage and stubble parts. Canopy structures were measured every month in 1999 by the Plant Canopy Analyzer (Model LAI-2000, Licor Co. Ltd.). Over wintering ability was measured by the percentage of regrown plants to the whole plants in May, 1999.

Results and Discussion

Comparing the change in several plant characters, plant height and mean tiller weight were lower in the dwarf than in the normal varieties, while leaf area index (LAI) and leaf blade percentage to the aboveground parts tended to be higher. Including all varieties examined, crop growth rate was positively correlated with LAI and the regression coefficient was higher in the normal in the first year, while it was impossible to separate the equations between the dwarf and the normal in the second year (Fig. 1(a)). Net assimilation rate and canopy extinction coefficient (K) were negatively correlated with LAI as noted in Fig. 1 (b, c). The K tended to be lower in the dwarf varieties, which suggested the adaptability to the higher planting density (Ito et al., 1989). With the increase in the planting density, the dry matter yield tended to increase, the difference between the normal varieties and the dwarf DE was reduced, and the over wintering ability in all varieties was decreased (Fig. 2). It was concluded that DL and normal napiergrass varieties should be planted at the medium density by a desirable combination of productivity and considerable over wintering ability.

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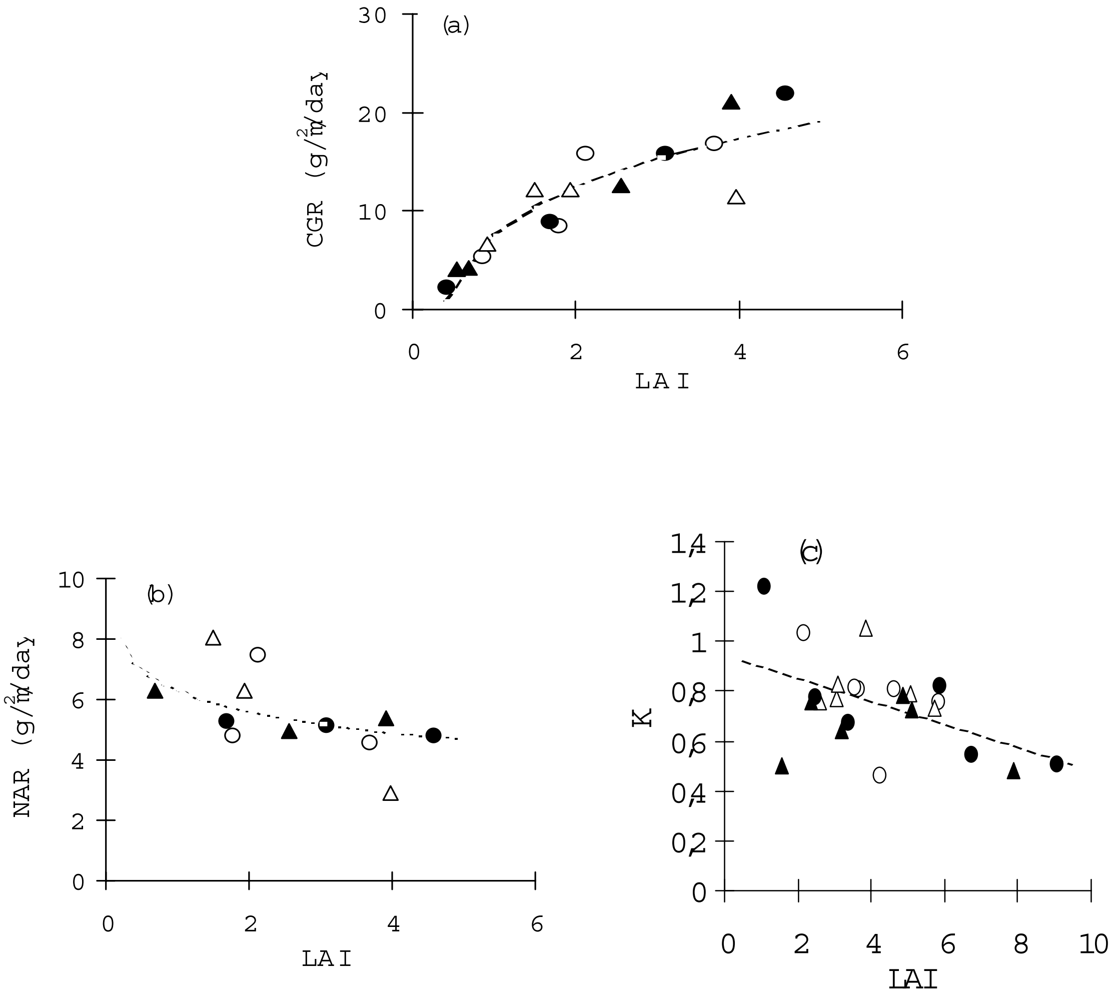

Figure 1 - Relationships between leaf area index (LAI) and (a) crop growth rate (CGR) of the aboveground parts, (b) net assimilation rate (NAR) and (c) canopy extinction coefficient (K) at the medium density plots in 1999. Normal variety: Wruk wona (Wr, ○), Merkeron (Me, △); Dwarf variety: Early heading (DE, ●), Late-heading (DL, ▲). (a) y=7.466+7.1975*ln(x), r=0.9085 (P<0.001), (b) y=6.313-1.007*ln(x), r=-0.559 (P<0.05), c) y=0.948-0.0466*x, r=-0.504 (P<0.05).

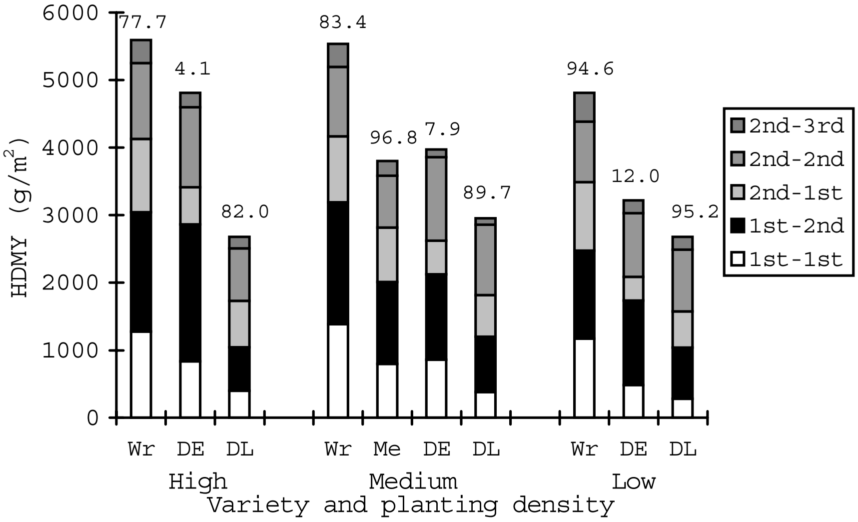

Figure 2 - Herbage dry matter yield (HDMY) at each cutting of the first and second year after establishment and the percentage of overwintered plants as affected by the planting density in 1998 and 1999.

HDMY: First year (1998); First-cut (1^{st}-1^{st}), Second-cut (1^{st}-2^{nd}).Second year (1999); First-cut (2^{nd}-1^{st}), Second-cut (2^{nd}-2^{nd}), Third-cut (2^{nd}-3^{rd}).

Figure above a bar shows the percentage of over wintered plants in May, 1999.