Effect of Density of Mother Plants on Efficiency of Nursery Production in Dwarf Napiergrass (*Pennisetum purpureum* Schumach)

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Abstract

Recently, dwarf napiergrass (*Pennisetum purpureum* Schumach) of late-heading type (named as DL) was introduced widely for multi-purpose uses into Kyushu Island, Japan. Napiergrass needs to be propagated vegetatively, while nursery production was not efficiently established yet. We examined to obtain an optimal plant density of mother plants for the efficient nursery production (per both unit land area and labor time bases). Dwarf napiergrass was transplanted at three levels (1, 4 and 8 plants m^{-2}) from cell-tray plants by Latin square method in the University of Miyazaki (31°83´N, 131°41´E) on 2 July, 2010. Compound fertilizer containing 14% of N, P_2O_5 and K_2O was applied monthly at 5 g each m^{-2} $time^{-1}$ (annual total 20 g) and growth attributes of plant height and tiller density were monitored monthly. Dry matter yield (DMY) of mother plants and efficiency of nursery production using single-node stem cutting were determined per both land area and labor time on 8 December, 2010 and wintering ability was determined on 17 May, 2011 (Trial-1). Nursery plant was grown at cell-tray bed in glasshouse during wintering from December to April and trimming effect on tillering ability of nursery plants was checked on 13 April, 2011 (Trial-2). In Trial 1, plant height and tiller density increased with increasing plant density and tiller density saturated earlier at 4 and 8 plants m^{-2} than at 1 plant m^{-2}. Although DMY and number of nursery plants per mother plant was significantly higher ($P < 0.05$) at 1 plant m^{-2}, those per m^2 were significantly higher ($P < 0.05$) and labor time for nursery production per cutting, significantly lower ($P < 0.05$) at 4 and 8 plants m^{-2} than at 1 plant m^{-2}. Wintering ability was considerably high above 93% among 3 densities. In Trial-2, emerged percentage of nursery plants was consistent around 75% among 3 densities and trimming increased tiller number to promote quicker establishment of nursery plants in the field. Thus, 4 and 8 plants m^{-2} were concluded to be optimal for nursery production in the established year.

Keywords: dwarf napiergrass, nursery production, plant density, trimming, wintering ability.

Introduction

Napiergrass (*Pennisetum purpureum* Schumach) is a tropical C_4 grasses and its dry matter yield was higher than other crops. Napiergrass can be used for multi-purpose uses such as feeding to herbivores (Fukagawa *et al*., 2010; Utamy *et al*., 2011), rotational grazing use of dwarf variety (Ishii *et al*., 2009), feedstock for bioethanol production (Khairani *et al*., 2010) and phytoremediation activity (Hamano *et al*., 2011) in Kyushu, Japan. Napiergrass needs to be propagated vegetatively, while efficient nursery production is not so established that the extension of this grass species is hardly progressed. Therefore, in the present study, we examined the effect of mother plant density on the efficiency of nursery production per both land area and labor time bases (Trial-1). In Trial-2, we examined the effect of trimming on growth attributes of nursery plants, to obtain faster establishment of this grass species.

Materials and Methods

Dwarf variety of late-heading type (DL) napiergrass, which was overwintered on a cell-tray bed in a glasshouse from December 2009 to April 2010, was transplanted into the field at three densities (1, 4 and 8 plants m^{-2}) by Latin square method in University of Miyazaki (31°83´N, 131°41´E) on 2 July, 2010. Compound fertilizer containing 14% of N, P_2O_5 and K_2O was applied monthly at 5 g each m^{-2} $time^{-1}$ (annual total 20 g) and growth attributes of plant height and tiller density were monitored monthly. Dry matter yield (DMY) of mother plants and efficiency of nursery production using single-node stem cutting were determined per both land area and labor time on 8 December, 2010. Wintering ability, such as percentage of overwintered plants (POP) and regrown tiller number (RTN), was determined on 17 May, 2011 (Trial-1). Nursery plant was grown at cell-tray bed in a glasshouse during wintering from December to April and the effect of trimming at 5 cm above the ground on tillering ability of nursery plants was checked to determine plant height, tiller number and dry matter weight on 13 April, 2011. Additional fertilizer was supplied at 9.8 g N m^{-2} on 16 April, 2010 (Trial-2).

Results and Discussion

Effect of mother plant density on growth rates of several plant attributes, dry matter production and nursery plant production

With the increase in mother plant density, the growth rate of plant height and especially number of tillers used for nursery production tended to increase and reached the stage of maximum tiller density earlier in early August than at the lowest density of 1 plant m^{-2} (Figure 1). Thereafter, it occurred self-thinning to diminish less vigorous tillers and to decrease the tiller density at 4 and 8 plants m^{-2}.

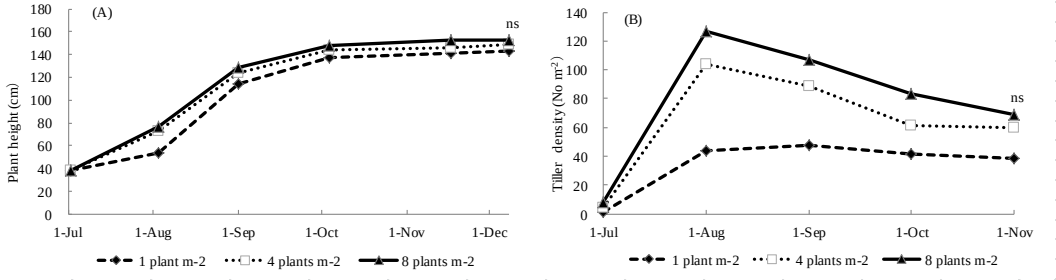

Figure 1. Changes in plant height (A) and tiller density (B) among three densities of mother plants.

Dry matter weight per plant was the highest at 1 plant m^{-2}, followed by 4 and 8 plants m^{-2}, while dry matter yield per unit land area (m^2) increased with the increase in mother plant density to reach the highest yield ($P < 0.05$) at 8 plants m^{-2} (Figure 2).

While number of nursery plants per mother plant was significantly higher ($P < 0.05$) at 1 plant m^{-2}, those per m^2 were significantly higher ($P < 0.05$) and labor time for nursery production per cutting, significantly lower ($P < 0.05$) at 4 and 8 plants m^{-2} than at 1 plant m^{-2} (Figure 3). Even though plant leaf area was not determined in the present study, it is estimated that optimum leaf area index (LAI) was attained at earlier stage to enhance dry matter yield in early December with the increase in plant density. It is suggested that the period to make internode and node with tiller buds matured would be proportional to periods from tiller emergence as the basis for matured tiller buds suitable for nursery production. It is suggested that even delayed tillers emerged in early September could be used for nursery production at 1 plant m^{-2}, which did not have enough time for tiller buds to matured (Figure 1 (B)).

These tiller productions also need more tillers to produce nursery plants, resulted in extending time for nursery production and increasing cost of labor power at lower densities.

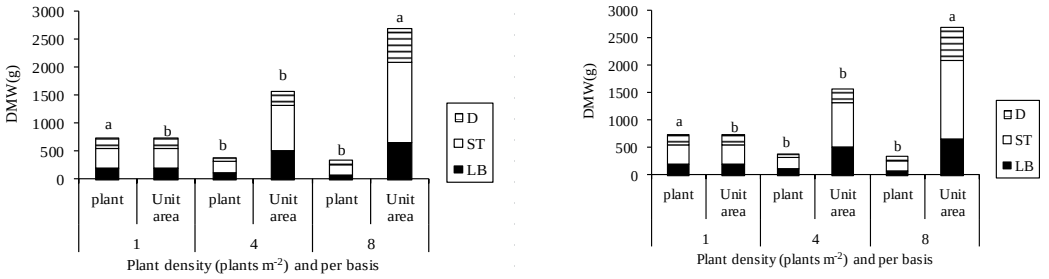

Figure 2. Dry matter weight (DMW) of plant organs per both plant and unit area bases among three densities of mother plants on 8 December 2010.

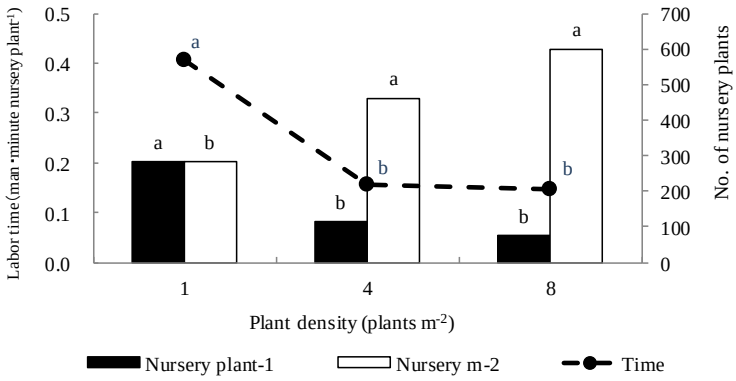

Figure 3. Nursery plant number and labor time for production per mother plant and per unit area.

Relationship between plant density of mother plants and sustainability of plants

In the present study, POP was hardly affected by plant density of mother plants and POP overpassed 93% in all densities to show sustainability of this grass species. However, RTN per unit land area (m^2) tended to decrease consistently with the increase in mother plant density (Figure 4). Since this phenomenon would affect negatively on maintaining tiller number for vegetative nursery production and sustainability of mother plants, it is essential to continue examining the potential of nursery production by these mother plants.

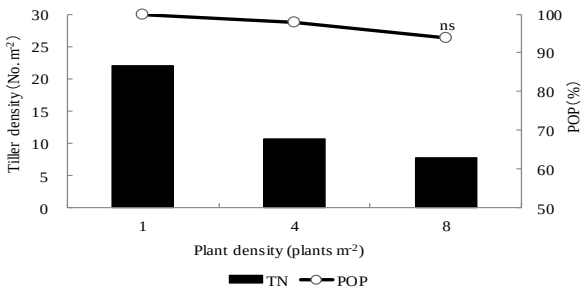

Figure 4. Percentage of overwintered plants (POP, ○) and regrown tiller density (■) on 17 May.

Effect of trimming on nursery plants

In Trial-2, emerged percentage of nursery plants was consistently 75% among 3 densities at 2 months after planting (Figure 5). Trimming on nursery plants affected to increase tiller number so as to promote quicker establishment of nursery plants in the field, even though plant height and dry matter weight of nursery plants decreased by the trimming practice (data not shown).

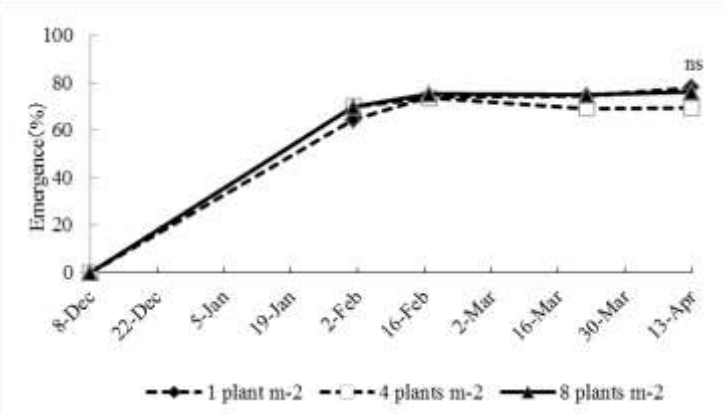

Figure 5. Changes in emerged percentage of nursery plants among three densities of mother plants during wintering period from early December 2010 to mid-May 2011.

In conclusion, 4 and 8 plants m^{-2} were suggested to be optimal for nursery production in the established year of DL napiergrass in southern Kyushu, Japan.

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