Effect of Weed Control Management on Herbage Yield and Quality in the Established Dwarf Napiergrass (*Pennisetum purpureum* Schumach)

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Abstract

In our previous extension activity of dwarf variety of late-heading type (DL) napiergrass (*Pennisetum purpureum* Schumach) to southern Kyushu, weed control management is found to be a crucial factor for obtaining good establishment and considerable herbage dry matter (DM) yield in an established year. The objective of this study was to examine the effect of several weed control practices, *i.e.* mixed sowing of annual setaria (abbreviated as S), which has no regrowth ability in stem-elongated tillers, paper-mulching (as P) and hand-weeding (as W), compared with no-weeding (as –W) on DM yield and quality of this species for two years (Trial-1,2). Weed control practices had a significantly ($P < 0.05$) positive effect on plant height, tiller density, percentage of leaf blade and leaf area index in DL napiergrass, compared with no-weeding (S-W or –W), and paper-mulching (P or P+S-W) had the highest yields in both trials. Setaria-sowing had a partially mitigating effect of weed damage on growth of DL napiergrass, while additive DM gain from setaria could compensate the yield decrease in DL napiergrass and reduce herbicide cost. Neither IVDMD nor CP content was affected by any weed control in either trial. Thus, paper-mulching and annual setaria-sowing could be a good proposal in weed control of this species.

Key words: annual setaria, dwarf napiergrass, herbage yield, paper mulch, weed control

Introduction

Based on extension activity of dwarf variety of late-heading type (DL) napiergrass (*Pennisetum purpureum* Schumach) to southern Kyushu, weed control management is found to be a crucial factor to obtain good establishment of this grass and achieve considerable herbage yield in the established year (Utamy *et al*., 2011). Hand-weeding was a sole weed control practice, which caused physical and spiritual burden for farmers before the launch of herbicides. Therefore, invention of easy and environmentally effective weed control technology has been strongly desired.

Weed invasion into the established forage crop fields is a visible sign of management problems. Damages to forage crop production by weeds are mediated principally from loss in growth rate and yield, and secondarily from decline in forage quality. However, in forage crop production, use of herbicide should be avoidable because of the negative effect on livestocks and increase in production cost (Sakai & Kawanabe, 1981).

Weeds in the inter-row space of DL napiergrass are normally controlled by hand-mowing machine 2–3 times before the first defoliation of this grass. Repeated weed control is essential until the leaf canopy is well established at the establishment. Even though close spacing is desirable from the weed control point of view, weeds do invade even at 50 × 50 cm of plant spacing.

Mulching at the inter- and intra-row spaces reduces weed problems by preventing the seed germination and suppressing growth of emerged weed seedlings, resulting in facilitating soil fertility and plant productivity (Wilson *et al.*, 1987; Obiefuna, 1991; Salau *et al.*, 1992). Mulching is a well-known method for the establishment of horticulture crop such as lettuce (Moniruzzaman, 2006) and

tomato (Anzalone *et al*., 2010) and also in paddy rice field (Won *et al*., 2011). In the grass cultivation, mulching is often used as living mulch or cover crop such as white clover (Deguchi *et al*., 2005), legume (Hiltbrunner *et al*., 2007) and hairy vetch (Mohammadi, 2010). However, paper-mulching has not been applied to DL napiergrass as weed control management.

The other way for weed control management is the oversowing of annual grass species to compete weed at the early growth of perennial forage crops. DL napiergrass was oversown with temperate Italian ryegrass (*Lolium multiflorum* Lam.) to get herbage in the spring-early summer season (Ishii *et al*., 2005). In the present study, tropical annual setaria (*Setaria italica* cv. Natsukanso), released from Yukijirushi Seed Co. Ltd., is utilized as once-cutting herbage with no regrowth ability if it starts stem elongation at the harvest, gives early summer growth, and should be also ideal to suppress summer weeds at the early growth of perennial forage species (Wakamatsu, 2004).

Therefore, the objectives of this study was to examine the effect of weed control management on dry matter yield and herbage quality in the established DL napiergrass by paper-mulching, oversowing of annual setaria and several time of weeding practices, compared with no weeding control in two years.

Materials and Methods

In 2008, DL napiergrass transplanted at 2 plants m^{-2} was imposed by three treatments (P, S+W, S-W) with three replications by Latin square design in Sumiyoshi Livestock Science Station (31°98´N, 131°46´E), University of Miyazaki (Trial-1). In 2010, DL napiergrass transplanted at 2 plants m^{-2} was imposed by four treatments (P+S-W, S+W, S-W, -W) with three replications by a randomized block design in Kibana Agricultural Science Station (31°83´N, 131°41´E), University of Miyazaki (Trial-2). Growth attributes including yield, *in vitro* DM digestibility (IVDMD) and crude protein (CP) content as herbage quality were determined in both trials. Efficiency of weed control practices in plant parameters, such DM yield, IVDMD and CP content, was evaluated by the percentage of plant parameter value in each weed control practice to that in no weed control.

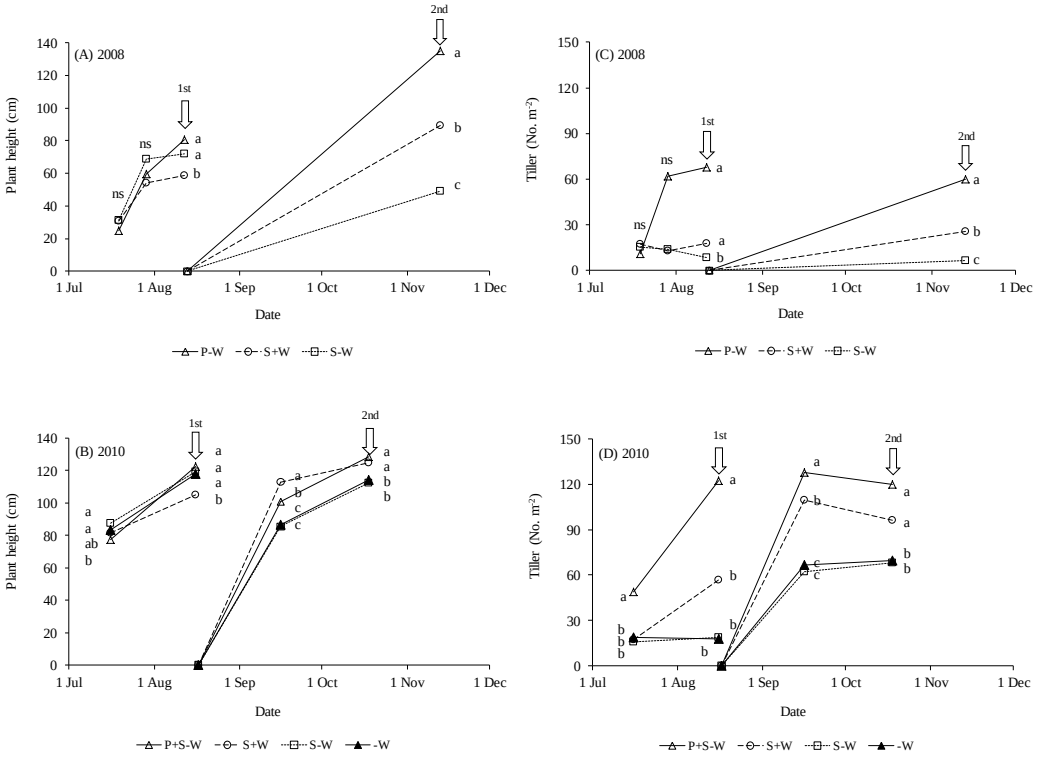
Results and Discussion

Weed control management had significantly ($P < 0.05$) positive effects on plant density, tiller density, percentage of leaf blade and leaf area index in DL napiergrass, compared with no-weeding (S-W or –W), and paper-mulching (P or P+S-W) had the highest yields in both trials (Figure 1).

Adoption of several weeding practices such as weeding, paper-mulching and setaria-sowing can be assessed by the percentage of gain or loss in attributes under the particular practice relative to those under no adoption of the practice (Table 1). Adoption of paper-mulching facilitated to obtain largest positive gain of DM yield in DL napiergrass at two defoliations in both Trials 1 and 2, respectively. Situation was similar for the positive gain by adoption of hand-weeding, while the degree of gain was reduced from paper-mulching (Table 1). The advantage of paper-mulching in DM yield was closely corresponded with positive gain in plant height, tiller density and leaf area index through improvement in light penetration (Peltzer & Köchy, 2001) and prevention of plant damage from weeds (TruGreen Tree and Shurub Field Guide, 2008). Positive effect of paper-mulching on DM yield matched with several crops such as paddy rice (Won *et al*., 2011), lettuce (Moniruzzaman, 2006), tomato (Anzalone *et al*., 2010) and turmeric (Sanyal & Dhar, 2006).

Weed control management by sowing setaria had no significant ($P > 0.05$) effect to suppress weed DM yield in Trial-2 (data not shown). However, 1 g m^{-2} DM production from setaria reduced 4 g m^{-2} of DM production from weeds ($y = 104.553 – 0.247x$, $r = 0.52$, $P > 0.05$). In several

stand establishments of perennial species, annual species are used to suppress weeds and mitigate the competition of crops from weeds. In the present study, annual setaria has characteristics to give good growth in early summer and suppress summer weeds (Wakamatsu, 2004).



Arrows indicate the time for the first (1st) and second (2nd) defoliation. P, interrow space was covered by paper mulch; S, oversown with setaria; W, weeding and –W, no weed control. Symbols with different letters are significantly different among weed control managements at each date by LSD method at 5% level. ns: $P > 0.05$.

Figure 1. Changes in plant height and tiller density of DL napiergrass under several weed control management in 2008 (Trial-1) and 2010 (Trial-2).

Neither IVDMD nor CP content was affected by any weed control in either trial. Consistently positive effect of any weed control practice on quality attributes was hardly obtained in either trial, while decline in CP content under weeding and paper-mulching practices was common at the second and first defoliation in Trial 1 and 2, respectively (Table 1). Living mulch with white clover improved plant nutrition by enhancing phosphorus uptake in maize (Deguchi *et al*., 2005). The present paper-mulching and hand-weeding could not contribute to herbage quality of DL napiergrass, possibly due to the negative correlation of DM yield with quality attributes under similar fertilization in this species. Dwarf napiergrass cv. Mott, which has almost equivalent plant attributes to DL napiergrass, had IVDMD and CP content at 67.5 and 13.2%, respectively (Sollenburger *et al*., 1988), almost corresponded with the present IVDMD at 74 and 60% at the first and second defoliation, respectively, in Trial 1.

Table 1. Effect of weed control practices on efficiency in several parameters of plant total in DL napiergrass at each defoliation in 2008 and 2010

Year	Defoliation	Parameter	Practice		
			Weeding	Paper-mulching	Setaria-sowing
2008	1st	DM Yield	248	2466	—
(Trial 1)		IVDMD	4	1	—
		CP content	2	-9	—
	2nd	DM Yield	7554	54091	—
		IVDMD	14	-6	—
		CP content	-16	-24	—
2010	1st	DM Yield	74	275	-4
(Trial 2)		IVDMD	6	7	1
		CP content	-19	-6	11
	2nd	DM Yield	73	73	36
		IVDMD	-1	-1	0
		CP content	-3	9	3

DM yield, dry matter yield; IVDMD, *in vitro* dry matter digestibility; CP content, crude protein content.

Conclusion

Paper mulch is not common to use in DL napiergrass cultivation, while it proved to be effective to avoid weed damage and facilitate good growth with high DM yield of this species. Cost of paper mulch is 50 yen/meter (Sanyo Seishi Co. Ltd., Tottori) and setting of paper mulch is a labor-extensive weed control practice. Thus, based on the amount of natural seed bank of weeds, paper mulch or other degradable mulching material can be applied to DL napiergrass, so as to reduce weed competition at the establishment. Annual setaria-sowing gave advantage to get herbage yield at the first defoliation of DL napiergrass, although prompt harvest time of annual setaria should be examined in the mixed cropping with DL napiergrass.

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