Evaluation of yield and quality of *Moringa oleifera* plantation in southwest China

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Abstract

The aim of this study was to evaluate the effect of different planting densities (0.2 m×0.2 m, 0.4 m×0.4 m and 0.8 m×0.8 m) and cutting heights (15, 30 and 60 cm) on the biomass yield and quality of *Moringa oleifera* in valley areas of southwest. The results indicated that the highest planting density in combination with the intermediate cutting height produced the highest fresh matter (FM) and dry matter (DM) yield. The 0.2 m×0.2 m planting density not only produced the highest FM (8.43-76.41 Mg ha^{-1}) and DM (1.66-12.85 Mg ha^{-1}) yield, but also the highest fine and coarse fractions of the plant. The 30 cm cutting height resulted in the highest FM (25.18-41.53 Mg ha^{-1}) and DM (5.28-8.27 Mg ha^{-1}) yield in the rainy season, whereas the 15 cm cutting height resulted in the greatest yield in the dry season. Additionally, the crude protein content was higher in the rainy season (235.3-257.6 g kg^{-1} DM） than in the dry season (224.1-232.8 g kg^{-1} DM) , significantly affected by planting density. However, the crude fibre (192.7 g kg^{-1} DM), neutral detergent fibre (293.1 g kg^{-1} DM), acid detergent fibre (208.4 g kg^{-1} DM and ash (94.5 g kg-1 DM) contents were higher in the dry than in the rainy season. The crude lipid content (22.9-26.1 g kg^{-1} DM） did not differ significantly between the different planting densities, whereas in vitro DM digestibility (766.3-853.6 g kg^{-1} DM) was significantly affected by planting density in the rainy season. These data suggest that as a forage crop, moringa is not only a good source of protein but has a balanced fibre component with a high digestion rate for livestock, especially ruminants.

Introduction

Many fodder trees contain higher levels of crude protein, minerals and digestible nutrients. Furthermore, these trees are easily propagated and long-lived, and may enhance the sustainability of the farming system. *Moringa oleifera* is one interesting fodder tree species, which has expanded from northwest India into the tropics and subtropical regions. Moringa was introduced into Yunnan province of China in 1990s.

Experimental design

The experiment was designed as a split-plot with three randomized complete blocks. The blocks were divided into three main plots and three planting densities (D1:0.2 m×0.2 m, D2:0.4 m×0.4 m and D3:0.8 m×0.8 m) were randomized in each main plot. Cutting heights of 15 cm (H1), 30 cm (H2) and 60 cm (H3) were randomly split over the main plot. The experiment was set up in a field that covered an area of 1400 m^2, with 1080 m^2 for planting and 320 m^2 for border. The regrowth of moringa was harvested throughout the two subsequent years. Twelve cuts were performed starting with the first regrowth harvest, with Cuts 1–6 taking place in the rainy season (May–October) and Cuts 7–12 in the dry season (November–April).

Data collection

Yield parameters: the fresh and dry matter, including two fractions, i.e. fine fraction (with diameters ≤ 5 mm) and coarse fraction (with diameters>5 mm).

Quality parameters: crude protein (CP), crude fat (EE), crude fibre (CF), ash and DM contents, neutral detergent fibre (NDF),acid detergent fibre (ADF) concentrations and In vitro DM digestibility (IVDMD).

Results

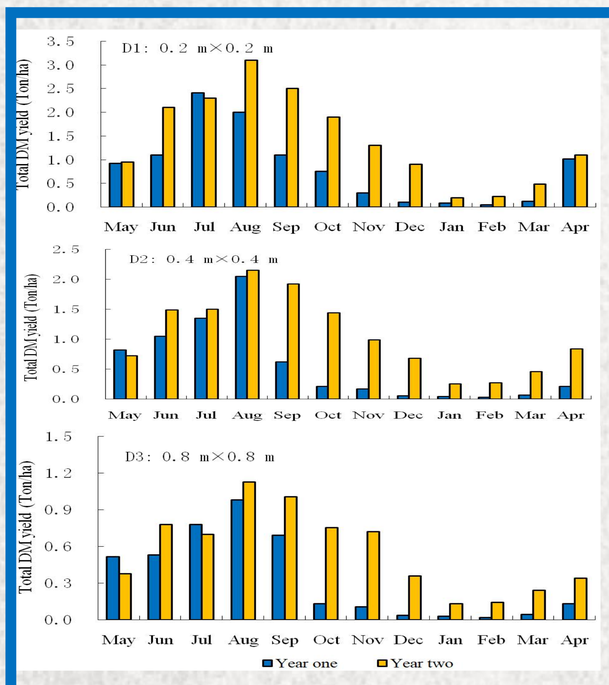

Figure 1. Total dry matter yield at different planting densities.

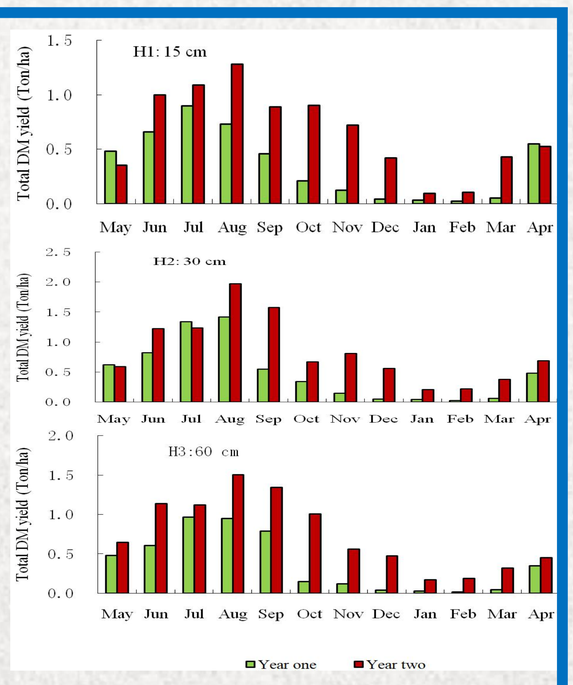

Figure 2. Total dry matter yield at different cutting heights.

●All planting densities and cutting heights produced higher total DM yields in Year two because of higher rainfall.

●The total DM yields in Year one and two consistently increased from D3 to D1.

●The highest total DM yield was measured in the rainy season for H2, but in the dry season for H1.

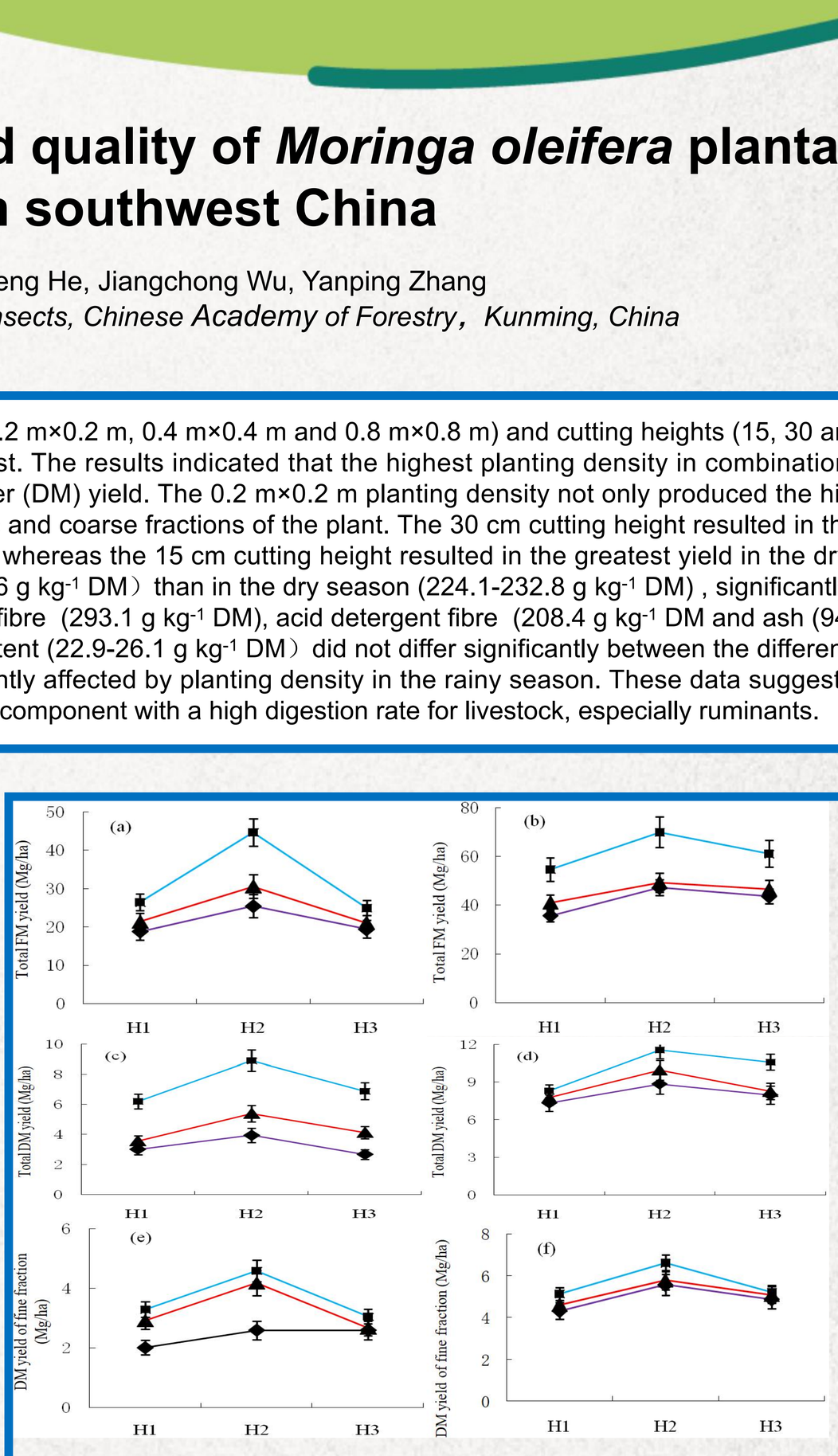

Figure 3. Effect of interaction between planting density and cutting height for Year 1 (a, c, e) and Year 2 (b, d, f).

●The highest planting density (0.2 m×0.2 m) in combination with cutting height of 30 cm produced the greatest total FM and DM yields and fine fraction of DM.

●The interactions between density and cutting height were significantly (p<0.05) different for the total FM and DM yield in both evaluation years.

Table 1. Quality parameters of *Moringa oleifera* at different planting densities.

Season	Density	Quality parameters							
		CP (g kg^{-1} DM)	EE (g kg^{-1} DM)	CF (g kg^{-1} DM)	Ash (g kg^{-1} DM)	DM (g kg^{-1})	NDF (g kg^{-1} DM)	ADF (g kg^{-1} DM)	IVDMD (g kg^{-1} DM)
Rainy season	D1	257.6 a	23.2 a	137.2 c	74.6 b	149.9 b	266.2 a	196.3 a	853.6 a
	D2	246.9 ab	26.1 a	155.4 b	85.8 a	158.4 ab	274.7 a	192.8 a	828.9 ab
	D3	235.3 b	25.4 a	189.8 a	89.2 a	167.2 a	277.2 a	198.4 a	809.4 b
	SE	3.34	0.57	1.46	1.02	2.28	4.36	2.11	9.97
Dry season	D1	230.7 a	24.8 a	149.3 b	88.3 a	173.7 a	286.0 a	206.3 a	766.3 a
	D2	224.1 a	22.9 a	157.5 b	92.6 a	165.8 a	290.6 a	202.2 a	768.2 a
	D3	232.8 a	25.3 a	192.7 a	94.5 a	170.2 a	293.1 a	208.4 a	772.7 a
	SE	3.13	0.61	1.71	1.23	2.52	4.69	2.35	9.35

DM: dry matter; CP: crude protein; EE: crude lipid; CF: crude fiber; NDF: neutral detergent fibre; ADF: acid detergent fibre; IVDMD: in vitro DM digestibility; D1: 0.2 m×0.2 m; D2: 0.4 m×0.4 m; D3: 0.8 m×0.8 m

●The CP and IVDMD contents were higher in the rainy than in the dry season for the same planting density.

●The CP and IVDMD contents consistently increased while the CF content significantly decreased (p <0.05) from D3 to D1 during the rainy season.

●The CF, NDF, ADF, DM and ash contents were higher in the dry than in the rainy season at the same density.

Conclusions

As a forage plant, *Moringa oleifera* with a good source of protein and a balanced fibre component can help farmers in the valley areas of southwest China overcome shortages of good quality feeds and therefore sustain and improve their livestock systems.

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