Available online at www.elixirpublishers.com (Elixir International Journal)

Applied Botany

Elixir Appl. Botany 58 (2013) 14691-14695

ISSN: 2229-712X

Effect of plant spacing on fodder yield and regrowth height of *moringa oleifera* in south western Nigeria

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ARTICLE INFO

Article history:

Received: 6 March 2013;

Received in revised form:

17 April 2013;

Accepted: 3 May 2013;

Keywords

Spacing,
Fodder yield,
Regrowth,
Recoppicing,
Season,
Moringa.

ABSTRACT

Seeds bags of *Moringa oleifera* were transplanted into a field on the Teaching and Research Farm of Ekiti State University, Ado- Ekiti, Nigeria at 30 x 40cm (81,833 plants ha^{-1}), 40 x 60cm (41,667 plant ha^{-1}), 60 x 80cm (20, 833 plant ha^{-1}) and 100 x 100cm (10,000 plants ha^{-1}). Cured poultry manure was applied at 3MT.ha^{-1} one week before transplanting and thereafter at two month interval. No fertilizer or irrigation was applied throughout the duration of the experiment. Fodder was harvested from the top to tender stems at 60 days after transplanting and fresh and dry weights were measured. Regrowths were harvested at 30-day intervals during the wet (60, 90, 120 and 150 days after transplanting) and dry (210, 240, 270 and 300 days after transplanting) season. Regrowth height was measured at each cutting day and harvesting involved the tender portion of stem. The 30 x 40cm spacing produced the highest fodder yield (14.89 ton ha^{-1}) which was significantly higher than other spacings. Fodder yield in the wet season (7.6MT.ha^{-1}) was significantly higher than that of dry season (2.79MT.ha^{-1}). Also, there was a positive correlation between the fodder yield and the amount of precipitation in all the months under study. However, plant spacing did not significantly affect regrowth height ($p > 0.05$) of *Moringa oleifera* in this area. It was therefore concluded that the agronomic potentials of *Moringa oleifera* is implicated for its use as an alternative feed resource for small ruminants in South Western Nigeria.

Introduction

Fodder trees are increasingly being recognized as the panacea for increased productivity of small ruminants through supplementary feeding (FAO, 1997; Kass *et al*., 2010}. Nutritional studies have revealed their potentials as feed resources to enhance the nutritive value of low quality fibrous feed consumed by the animals (Leng 1997; Kass *et al*., 2010). These tree species have been shown to contain at least 20g kg^{-1} crude protein in their leaves with a balance of other nutrients needed for maintenance, growth and reproduction (Makkar and Becker,1996; Aregheore, 2004).

In an attempt to help farmers in south western Nigeria meet their priority of food production and at the same time provide supplementary feeds for their animals, the Humid Zone Programme (HZP) of the International Livestock Centre for Africa (ILCA) and the Institute for Tropical Agriculture (IITA) since the 1980's have been conducting on- farm and on-station research aimed at integrating two tree fodder species – *Leucaena leucecophala* and *Gliricidia sepium* into the farming system through alley farming and feed garden systems (Onwuka *et al*., 1989, Attah-krah and Francis, 1997). Information available on the agronomic features such as established yield and management are therefore limited to these two species and a few others such as *Sesbania sesban* and *Cajanus cajan* [Smith and Van Houlert, 1997).Also, the cultivation of these species by farmers has become imperative to source for other tree species which will serve multiple purposes acceptable to farmers and with good agronomic potentials.

Moringa oleifera is an evergreen non-leguminous multi-purpose tree with great potentials but grossly under-exploited in Nigeria {Akinbamijo *et al*., 2006; Asaolu *et al*., 2010). The leaves are good sources of protein, vitamins and minerals (Fuglie, 2005; Oduro *et al*., 2008) while other parts of the tree are used as oil, medicine, water purification, fertilizer etc (Jahn *et al*., 1986). Its nutritional profile and variety of uses confer on it the potential for cultivation in any region of the world where environmental conditions are favourable. *Moringa oleifera* cultivation is restricted to the semi- arid zone of Nigeria where it is used as food and live fences (Gutteridge and Shelton, 1998; Anjorin *et al*., 2010). There is limited knowledge of its cultivation and benefits in Southern Nigeria where many of the farmers were ignorant of the plant and could not identify it either physically or by name (Odeyinka *et al*., 2007).

This also suggests dearth of agronomic research to address yield- limiting problems and from which appropriate improved recommendations would have been developed for farmers' adoption. One component of improved farming practices, instrumental to incremental crop output is plant population as determined by spacing ,plant geometry and density because it affects the crop environment which influences growth, yield and yield components (Lauer,1994). At optimum population, plants would exploit physical growth factors found in the natural environment to maximize yield, such that overstocking (too high density to endanger inter-plant competition and mutual shading) and under-stocking (too low density to cause resources under-utilization) are avoided (Zhang *et al*, 2006).

Research on manipulating spacing and the effects on yield and recopping potential of trees during the rainy and drought season are crucial to generating information and data base for use by farmers willing to adopt its cultivation. The aim of this

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study therefore was to determine the effect of spacing on fodder yield and re-growth potential of *Moringa oleifera* when cut at thirty (30) days interval during the wet and drought season in Ado-Ekiti South Western Nigeria.

Materials and methods

The study was conducted in the Teaching and Research Farm, Ekiti State University, Ado-Ekiti South Western Nigeria between April 2010 and April 2011. Ado-Ekiti lies between latitude 07°37'15''N and longitude 05°13'17''E, average humidity of 72%. It experiences a tropical climate with a temperature range of 20°C-28°C and a bimodal rainfall distribution between April and October with peaks in June and September and a break in August. Dry season is between November and March. The average precipitation in this area is 1367mm.

The land was ploughed and harrowed; and surface soil samples (0-15cm) randomly were collected from the plot and bulked for a composite sample. The soil was air-dried, sieved (less than 2mm) and then analysed for some physical and chemical properties; using methods described in IITA (1979): particle size distribution by hydrometer method; in 1:2 soil – distilled water mixture using the electronic pH meter; organic carbon by the dichromate oxidation method and total nitrogen(N) by macro-kjeldahl digestion; phosphorus by bray's P-1 extraction and determination with molybdate blue method while cations were extracted with ammonium acetate, and determined with flame photometer.

Fields were lined and holes 15x25cm dug at specified spacings and poultry manure (3MT.ha-^{1}) applied into the holes one week before transplanting the seedlings. The bags were torn and one seedling transplanted into the hole with the ball of earth pressed firmly at soil level and watered. Weeding was done manually at two(2) months interval.

The treatments were four plant spacings: 30 x 40cm(81,833 plants/ha), 40 x 60cm (41,667plants per/ha), 60 x 80cm (20,833 plants/ha) and 100 x 100cm (10,000 plants/ha) in four replicates and arranged in a randomised complete block design

Green fodder was harvested from a at 2 x 2m area of the plot using portion that were 20cm from the top to tender stems at 30 days intervals during the wet season (60, 90, 120 and 150 days after transplanting) and at (210, 240, 270 and 300 days after transplanting) during the dry season and weighed. The fodder was rinsed separately to remove dirts, air dried to constant moisture content and weighed. At each cutting interval, the amount of regrowth was measured.

Data were analysed using the GLM (General Linear Model) procedure of MINITAB (2000). Significant differences among means were separated using the Duncan's Multiple Range Test (Steel and Torrie, 1980).

Characteristics of the soil used

Some physical and chemical characteristics of the soil in the study site are shown in Table 1. The soil was a strongly acid sandy loam with high organic matter content, moderate total N and low available P based on soil test criteria established for soil in Nigeria (Anon, 2006; FDALR,2004). The exchangeable cations are low. The soil contained K, Ca, Mg, Zn, Cu, Mn, and Fc at 92.4, 64.50, 84.80, 15.71, 2.83, 0.35 and 1.22 mg Kg^{-1} respectively.

Moringa oleifera has been implicated to tolerate a wide range of soil types which is not water logged and within a pH range of 4.5-9 (Ritu *et al*., 2011, Adebayo *et al.*, 2011).

Results and discussion

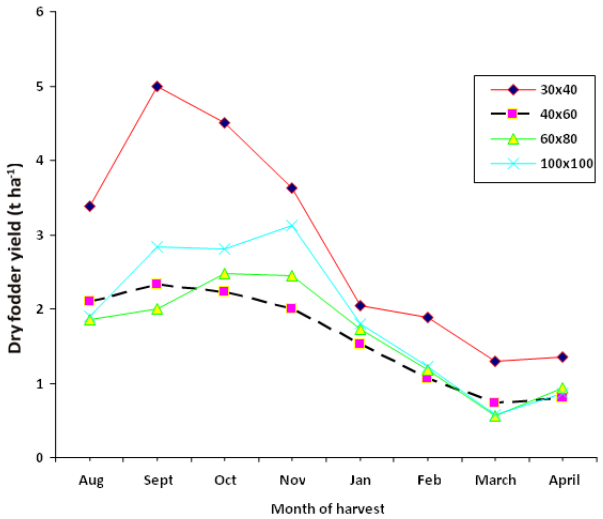

Fig. 1. Dry fodder yield under different spacings

The effects of plant spacing on fresh and dry matter yield of *Moringa oleifera* during the entire study period are shown in Table 2. The total fresh and dry produced fodder yield at 30x40cm spacing are 14.89tonnes ha-^{1} and 5.76 tonnes ha^{-1} respectively which were significantly higher than the values obtained for the other spacings.

Sanchez *et al.* (2006) had reported that dense stands are a key means of establishing sufficient leaf production for high biomass production in *Moringa oleifera*. Yield improvement associated with low spacing had been noted for other browses (Sartay *et al*., 1984; Biabani *et al*., 2008; El-Morsy, 2009). Significantly higher wet yield reported for 100 x 100cm than 40 x 60cm and 60 x 80cm may be due to availability of space for lateral development which in turn supported high vegetative production. Closer spacing between plants caused comparatively less availability of space around the plants for lateral development thereby forcing plants to grow vertically (Patel *et al*., 1980). However, the closer spacing in 30 x 40cm, caused yield per plant to decrease, but this was more compensated for by the highest number of plants thereby resulting in higher yield per area as plant population increased (Bali *et al*., 2000).

Fodder yield was significantly higher in the wet season means that stunted regrowth and lower DM yield characterized the fodder harvested during the dry months. Norton and Poppi (1995) noted that plants in the tropics grow rapidly during periods of heavy rainfall and high temperatures while significant reduction in yield during the drought season could be due to moisture stress but which may not be encountered by leguminous trees such as *Gliricidia sepium* and *Leucaena leucecophala* known for precocious growth and outstandingly high dry matter even during drought period (Barnes, 2002).

Figure 1 shows the effect of spacing on dry fodder yield of *Moringa oleifera* during wet the and dry months. Biomass production followed the rainfall pattern of Ekiti State. The biomass yield was highest during the month of September and reduced as rainfall decreased such that January, February and March gave low biomass yields but which picked up a little at the onset of rainfall in April. Minson and McLeod (1970) and Broadhead *et al*.(2003) revealed that crop yield reduction was strongly correlated with available soil moisture.

Table 3 shows the height of *Moringa oleifera* regrowths at different spacings and at 30days interval of harvesting.

Table 1: Physio-Chemical properties of soil used

Soil properties	Values
P^H	5.35
Organic matter,%	3.14
Total nitrogen	0.18
Sand($g.kg^{-1}$)	52.80
Silt ($g.kg^{-1}$)	31.20
Clay($g.kg^{-1}$)	16.0
Textural class	Sandy loam
Available P,($mg.kg^{-1}$)	4.36
CEC($cmol.kg^{-1}$)	12.04
EA ($cmol.kg^{-1}$)	2.80
Na ($cmol.kg^{-1}$)	0.24
K	0.24
Ca	0.16
Mg	0.35
Zn($mg.kg^{-1}$)	15.71
Cu($mg.kg^{-1}$)	2.83
Mn($mg.kg^{-1}$)	0.35
Fe ($mg.kg^{-1}$)	1.22

Table 2. Effect of plant spacing on fodder yield of *Moringa oleifera* during wet and dry season

	FRESH MATTER			DRY MATTER		
Spacing	**Rainy**	**Dry**	**Total**	**Rainy**	**Dry**	**Total**
30 x 40	11.33±2.31^a	3.54±0.86^a	4.89±2.64^a	4.12±0.96^a	1.64±0.52^a	5.76±0.50^a
40 x 60	5.83±0.91^c	2.26±0.23^b	8.09±1.26^c	2.17±0.36^b	1.05±0.10^b	3.22±0.32^b
60 x 80	5.96±1.10^c	2.43±0.31^b	8.39±1.32^c	2.19±0.32^b	1.10±0.20^b	3.29±0.48^b
100x100	7.26±0.56^b	2.53±0.16^b	9.79±1.26^c	2.66±0.41^b	1.10±0.18^b	3.76±0.50^b

Means with different superscript(s) in the same column are significantly different (P>0.05)

Table. 3: Re-growth Height of *Moringa oleifera* at different spacing and cutting days after transplanting

SPACING	60	90	120	150	210	240	270	300	MEAN
30 x 40	1.20±0.07^d	1.49±0.03^b	1.55±0.05^a	1.65±0.13^a	1.36±0.12^c	1.12±0.06^c	0.97±0.04^c	0.95±0.05^c	1.29
40 x 60	1.21±0.05^c	1.52±0.03^b	1.53±0.06^b	1.66±0.06^a	1.36±0.06^c	1.13±0.04^c	0.96±0.03^c	0.94±0.02^c	1.28
60 x 80	1.15±0.04^c	1.49±0.03^b	1.52±0.08^b	1.61±0.08^a	1.51±0.07^b	1.17±0.07^c	0.95±0.06^c	0.92±0.05^d	1.28
100 x 100	1.33±0.17^b	1.38±0.07^b	1.65±0.07^a	1.66±0.09^a	1.36±0.07^b	1.07±0.02^c	0.89±0.01^c	0.90±0.02^c	1.26

Means with different superscript(s) in the same row are significantly different (P>0.05)

There were no significant differences among the treatments ($p \geq 0.05$). Plant spacing did not affect the regrowth height of the plants under study. In *Sesbania aegyptiaca*, the plant height was significantly decreased with increased plant spacing (El Morsy, 2009). Also closer spacing between plants caused comparatively less availability of space round plants for lateral development in mustard as there were more plants at closer spacings (Patel *et al.*, 1980).

Conclusion

The development of *Moringa oleifera* as a new feed resource in the farming systems of the humid zone of South Western Nigeria could be the panacea to the much needed alternative feed material for increased small ruminant productivity. The fodder yield studies indicated that the closer spacing increased the fodder yield of *Moringa oleifera*. *Moringa oleifera* can still produce leaves during the dry season but fodder yield is influenced by the amount of rainfall. There is prospect for integrating *Moringa oleifera* into ruminants feeding systems in South Western Nigeria

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