http://www.pjbs.org

PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 10 (4): 632-636, 2007
ISSN 1028-8880

The Effect of Stocklength, Stock Diameter and Planting Angle on Early Establisment of *Gliricidia sepium*

[1]J.T. Amodu, [1,2]O.S. Onifade, [1]I.A. Adeyinka, [1]J.O. Jegede and [3]S.B. Afolayan
[1]National Animal Production Research Institute, Ahmadu Bello University, Shika-Zaria, Nigeria
[3]Division of Agricultural Colleges, Ahmadu Bello University, PMB 1082, Zaria, Nigeria
[2]University of Agriculture, Abeokuta, Nigeria

Abstract: Legume tree crops, which establish easily and do not require extensive agronomic inputs, constitute potentially valuable sources of supplementary feeds that subsistence and medium-scale livestock farmers in the tropics could use to improve livestock nutrition and productivity. A field trial was conducted with *Gliricidia sepium* cuttings to investigate the effect if three stock lengths (20, 30 and 40 cm), two stock diameters (1.5-2.5) and (3.0-3.5 cm) and three planting angles (30°, 60° and 90°) in a factorial experiment. There were high significant differences ($p<0.05$) in all the growth parameters of the stock diameters and stock lengths used. The highest dry matter yield of 3.83, 4.61 and 4.65 t ha^{-1} were produced by stock length 20, 30 and 40 cm, respectively. The highest planting angle of 90° produced the tallest shoot height and biggest basal diameter, while the least planting angle of 30° produced the least shoot height and basal diameter, respectively. The interactions between the smaller stock diameter and the least planting angle (30°) produced the least values of growth parameters. Gliricidia cuttings could be easily established with thicker stock diameter of not less than 3.0 and 40 cm stock length, planting in an angle between 60 and 90 degrees.

Key words: Establishment, gliricidia, planting angle, stock diameter, stock length, yield

INTRODUCTION

A tree or shrub is classified as fodder if it is browsed by animals. Fodder trees and shrubs constitute a vital component in livestock productivity in the arid and the semi-arid zones where about 52% of the cattle, 57% of the sheep, 65% of the goats and 100% of the camels in tropical Africa are found (Von-Kaufmann, 1986). They supply goats and camels with the bulk of their nutritive requirements and complement the diet of cattle and sheep with protein, vitamins and minerals in which bush straw is deficient during the dry season (Dicko and Sikena, 1992). Biomass production of browses vary from 2 to 20 tons of dry matter per hectare for *Leucaena*, 2-10 t ha^{-1} for *Gliricidia* and *Sesbania* and 4-10 tons for *Cajanus cajan* (NAS, 1984).

Browse plants are sources of feed to livestock, especially during the dry season in the tropics, these plants remain green longer into the season and fluctuate less in quality than most herbaceous legumes or grasses (Akinola *et al*., 1991).

Gliricidia sepium has been recognised as very important browse plant. Though introduced into Nigeria many years ago, it has naturalised and is receiving attention as a very promising browse species for livestock feeding, particularly during the most critical part of the long season when fresh and high quality livestock feeds are not available. The plant is drought resistant, deep rooted and has nodules for nitrogen fixation. *Gliricidia sepium* has been widely used for plantation shade, agroforestry systems, living fence, wood production, fence posts, fire wood, green manure and livestock fodder (Sumberg, 1986). It has been successfully intercropped with a variety of species in alley farming systems. A range of provenances is grown throughout the tropics. Most are adapted to wet, warm environments with temperature ranging from 22 to 30°C and average annual rainfall of at least 1500 mm (Wiersum and Dirdjosoemarto, 1987). Although, *Gliricidia sepium* does best in acid soils and humid conditions, it has been successfully introduced into the subhumid zone of Nigeria, a region that holds a large number of ruminant stock (Williams, 1987; Cobbina *et al*., 1990).

One of the major limitations to the full exploitation of Gliricidia appears to be with regards to its establishment. Francis and Atta-Krah (1989) reported establishment of an uneven stands of Gliricidia by localfarmers. The problem may be due to poor seed quality. This problem could be circumvented through planting of Gliricidia stocks. Atta-Krah and Kang (1992) found the use of stem cuttings to

Corresponding Author: Dr. Isaac Adetunji Adeyinka, NAPRI/ABU, Shika, Zaria, Nigeria Tel: +234 806 816 329

be feasible for some species such as *Gliricidia sepium* and *Erythrina* sp., but is generally less preferred when direct seeding is possible. Similarly, in the establishment of an alley farming system, a large number of cuttings is required. This study is therefore aimed to evaluate establishment procedures and early growth for the browse species in the sub-humid zone of Nigeria.

MATERIALS AND METHODS

Site characteristics: A field trial was conducted in 2001 and 2002 at the National Animal Production Research Institute, Shika (11° 12'N, 7° 33'E) in the sub-humid zone of Nigeria. Rainfall data during the experimental period are presented in Table 1. Shika soils have been classified as ferruginous tropical soils developed over schists, gnesis and quartzites (Klinkinberg and Higgins, 1968). The trial commenced in July 2001, when the rain was established and terminated in October, 2002.

Experimental design and treatment: Prior to planting, the area was ploughed and harrowed. Stocks of *Gliricidia sepium* fresh cuttings were used in a factorial experiment replicated four times. The factorial experiment involved 3 stock lengths (20, 30 and 40 cm); 2 stock diameters (1.5-2.5 and 3.0-3.5 cm) and 3 planting angles (30, 60 and 90°). The treatment combinations were constituted in 72 plots each measuring 2×2 m with a space of 50 cm between and within rows. The stocks of *Gliricidia sepium* used for the experiment were collected from Gliricidia trees grown for living fences at the University Quarters of Ahmadu Bello University, Samaru, Zaria.

Planting procedures: On the day Gliricidia stocks were collected, the top ends were immediately cut on a slant to allow water to run off and to prevent being attacked by diseases. In order to get the actual diameters needed, calipers were used to measure the required diameters of 1.5-2.5 and 3.0-3.5 cm. The stocks were later cut to 20, 30 and 40 cm, respectively. The cuttings were planted within two days to prevent from drying out. The plots were weeded thrice and protected from straying animals using available fencing materials such as chain-links and angle irons.

Measurement of growth parameters and biomass: At 12 months old various phenological parameters were measured. Percentage stock survival, shoot height, basal diameter, number of branches and plant spread were determined according to the procedure of NFTA (1989).

Table 1: Rainfall distribution (mm) in (2001-2002) and medium-term (1989-1999) means for Shika, Nigeria

Month	Medium-term mean	2001	2002
April	36(6)*	58(8)	79(3)
May	120(9)	76(14)	315(16)
June	175(14)	177(12)	163(13)
July	250(12)	250(16)	243(12)
August	279(24)	274(29)	81(8)
September	172(13)	203(17)	81(8)
October	42(5)	58(7)	43(4)
Total	1074(83)	1096(94)	1307(71)

*Values in parentheses are number of rainy days

Biomass production was determined when plants were 12 months old. Plants were cut at the middle of the row to 0.5 m above the ground. The fresh weight of the material was weighed on the field, sub sampled and oven dried at 60°C for 48 h for determination of dry matter. This was later analysed according to the procedure of AOAC (1975).

Statistical analysis: The mean values for all data collected were subjected to analysis of variance and significant mean differences were further separated using the Duncan's Multiple Range Test (Steel and Torrie, 1980).

RESULTS

There were high significant differences ($p<0.05$) in all the growth parameters of the two stock diameters. The percentage of stock survival was highly significant ($p<0.05$) compared with other growth parameters understudied (Table 2).

Generally there were variations in all the growth parameters and the dry matter yields and these were consistent relatively to the increase in the length of the stocks of cuttings. The highest dry matter yield of 4.65, 4.61 and 3.83 t ha^{-1} were produced by stock length of 40, 30 and 20 cm, respectively (Table 2).

There were significant differences ($p<0.05$) in both the growth parameters and the dry matter yields. The significant differences were consistent in shoot height, basal diameter and dry matter yield. The variations in number of branches and plant spread were not consistently relative to the increase in degrees of the planting angles. The highest number of branches (4.5) and plant spread (2.3 m) were produced by planting angle 60° and 30°, respectively (Table 2). Effect of stock diameter interactions on growth parameters was noticed thicker stock diameter of 3.0 to 3.5 (SD_2) was highly to be significant ($p<0.05$). The interaction between significant than thinner stock diameter (SD_1). The interactions between $SD_2 \times SL_1$ and $SD_2 \times SL_3$ were noticed to be highly significant than other interactions of stock diameters and stock lengths (Table 3).

Table 2: Effect of stock diameter, stock length and planting angle on shoot height, number of branches, basal diameter, percentage stock survival, plant spread and dry matter yield

	Growth parameters					
	NB	SS (%)	SH (m)	PS (m)	BD (cm)	DM (t ha^{-1})
Stock diameter (cm)						
1.5-2.5	3.78^{b}	43.70^{b}	1.69^{b}	2.23^{b}	3.67^{b}	3.81^{b}
3.0-3.5	4.56^{a}	76.10^{a}	1.86^{a}	2.35^{a}	4.25^{a}	4.51^{a}
SEM	±0.00	±0.51	±0.01	±0.33	±0.01	±0.01
Stock length (cm)						
20	3.67^{c}	37.32^{c}	1.79^{a}	2.16^{c}	3.84^{b}	3.83^{c}
30	4.00^{b}	50.21^{b}	1.80^{a}	2.32^{b}	4.02^{a}	4.61^{b}
40	4.83^{a}	75.10^{a}	1.71^{b}	2.38^{a}	4.02^{a}	4.65^{a}
SEM	±0.00	±0.51	±0.01	±0.01	±0.02	±0.01
Planting angle (degree)						
30	3.67^{c}	35.20^{c}	1.64^{c}	2.33^{a}	3.72^{c}	3.35^{c}
60	4.50^{a}	57.13^{b}	1.80^{b}	2.31^{a}	4.04^{b}	4.12^{b}
90	4.33^{b}	62.10^{a}	1.88^{a}	2.23°	4.12^{a}	4.16^{a}
SEM	±0.00	±0.52	±0.01	±0.01	±0.02	±0.01

Means in the same column with different superscripts differ significantly. ($p<0.05$), NB = Number of branches; SS = Percentage Stock survival; SH = Shoot Height; PS = Plant Spread; BD = Basal Diameter and DM = Dry Matter yield

Table 3: Effects of stock diameter, stock length and planting angle interactions on shoot height, number of branches, basal diameter, plant spread and dry matter yield

	Growth parameters				
Interactions	NB	SH (m)	PS (m)	BD (cm)	DM (t ha^{-1})
$SD_1 \times SL_1$	3.33^{e}	1.69^{b}	2.12^{c}	3.61^{d}	3.08^{d}
$SD_1 \times SL_2$	3.67^{d}	1.68^{b}	2.22^{b}	3.65^{d}	3.08^{d}
$SD_1 \times SL_3$	4.00^{c}	1.70^{b}	2.35^{c}	3.75^{c}	4.01^{c}
$SD_2 \times SL_1$	4.33^{b}	1.91^{a}	2.20^{b}	4.07^{b}	4.02^{c}
$SD_2 \times SL_2$	4.33^{b}	1.94^{a}	2.43^{a}	4.38^{a}	4.05^{b}
$SD_2 \times SL_3$	5.33^{a}	1.93^{a}	2.43^{a}	4.39^{a}	4.09^{a}
SEM	±0.0	±0.01	±0.05	±0.03	±0.01
$SL_1 \times PA_1$	3.50^{c}	1.57^{h}	2.22^{c}	3.72^{f}	3.77^{g}
$SL_1 \times PA_2$	3.50^{a}	1.91^{b}	2.21^{c}	3.95^{d}	4.10^{f}
$SL_1 \times PA_3$	4.00^{d}	1.90^{c}	2.10^{d}	3.86^{c}	4.11^{a}
$SL_2 \times PA_1$	3.50^{e}	1.68^{g}	2.30^{b}	3.79^{f}	3.81^{d}
$SL_2 \times PA_2$	4.50^{c}	1.80^{d}	2.31^{b}	4.07^{c}	4.41^{c}
$SL_2 \times PA_3$	4.00^{d}	1.95^{g}	2.36^{a}	4.19^{b}	4.55^{b}
$SL_3 \times PA_1$	4.00^{d}	1.68^{g}	2.46^{a}	3.66^{h}	4.51^{b}
$SL_3 \times PA_2$	5.50^{c}	1.69^{f}	2.41^{a}	4.10^{c}	4.53^{b}
$SL_3 \times PA_3$.	5.00^{b}	1.77^{e}	2.29^{b}	4.30^{a}	4.62^{a}
SEM	±0.00	±0.00	±0.05	±0.03	±0.01
$SD_1 \times PA_1$	3.00^{d}	1.51^{f}	2.24^{e}	3.56^{f}	3.33^{f}
$SD_1 \times PA_2$	4.00^{c}	1.75^{c}	2.25^{e}	3.70^{a}	3.62^{e}
$SD_1 \times PA_3$	4.33^{b}	1.81^{c}	2.19^{d}	3.75^{d}	3.72^{d}
$SD_2 \times PA_1$	4.33^{b}	1.78^{d}	2.28^{c}	3.88^{c}	4.21^{c}
$SD_2 \times PA_2$	4.33^{b}	1.86^{b}	2.37^{b}	4.38^{b}	4.42^{b}
$SD_2 \times PA_3$.	5.00^{a}	1.94^{a}	2.41^{a}	4.48^{a}	4.72^{a}
SEM	±0.00	±0.00	±0.05	±0.03	±0.01

Means in the same column with different superscripts differ significantly $p = 0.05$). NB = Number of Branches; SH = Shoot Height; DM = Dry Matter; PS = Plant Spread; BD = Basal Diameter SD = Stock Diameter; PA = Planting Angle and SL = Stock Length

The effect of stock diameter and planting angle interactions is shown on (Table 3). Effect of stock diameter and planting angle interactions on growth parameters was noticed to be highly significant ($p<0.05$) with the thicker stock diameter (SD_2) and the highest planting angle of 90° (PA_3). The interactions between the smaller stock diameter (SD_2 and 30° planting angle (PA_1) produced the least values of growth parameters.

DISCUSSION

One of the major limitations to full exploration of Gliricidia appears to be with regards to its establishment. The major problem have been associated to poor seed quality, due to pods opening through explosive mechanism, which reduces seed recovery rate (Francis and Atta-Krah, 1989). This problem could be circumvented through the use of alternate method, even though the use of stakes may be expensive but has some advantages over the use of seed.

Gliricidia sepium is a browse plant that grows in the wet and warm weather conditions, flourishing from sea-level to heights of 1300 m (Chadhokar, 1982) or even 1600 m (Standley and Steyermark, 1946). Although the plant is easily established either from cuttings or seeds, choice of material depend on how the plants is to be used.

In a situation where establishment is to be carried out by cutting of stock, it, is very important to know the right size of the stock length and planting angle of the cutting.

The dry matter yields of *Gliricidia sepium* in this study increased with thicker stock diameter, longer stock length and higher planting angles. The dry matter yields at 12 months after planting ranged between 3.81 and 4.65 t ha^{-1}. The dry matter yields obtained in this experiment is similar to the findings of Adu *et al*. (1996) and Smith and Houtert (1987). The higher dry matter associated with thicker and longer stocks or cuttings may be related to better root development and increased number of strike emergence from which growth can take place (Guevarra *et al*., 1978). Oakes and Skov (1962) obtained monthly dry matter yields of 0.99 t ha^{-1} during the dry season and 1.48 t ha^{-1} in the wet season. The yields reported by these workers was much lower the yield obtained from this study.

On the basis of experiments carried out on five year old Gliricidia plants, harvested for two years at varying intervals of 2, 3, 4, 5 and 6 months, Chadhokar (1982) suggested that Gliricidia be harvested once every 3 months to maximise foliage yield. In contrast ILCA (1988) reported a fall in Leucena yield from 30.4 t ha^{-1}, when cut at 12 weeks interval, to 10.3 t ha^{-1} when harvested at intervals of 6 weeks, with an accompanying higher plant mortality. In general, these workers concluded 1t, in humid climates where emphasis is on fodder production, short cutting intervals of 8-10 weeks appear suitable, while the longer interval of 12-14 weeks is recommended for the drier environment.

Although, *Gliricidia sepium* remain green all year round, particularly when pruned regularly, foliage growth and retention appear lower during the dry season demonstrating a seasonal effect. The seasonal effect on regrowth and total biomass yield, calls for some management strategy that will ensure adequate all-year round supply of fodder for livestock feeding in this region. Although, the dry matter yield of the Gliricidia plant in this study was impressive at 12 months of age, it may be quite difficult to get all-year round supply of fodder if the plants are not pruned during the wet season. Following the recommendations of Smith (1991), a pruning interval of 8 weeks during the wet and 12 weeks during the dry season may achieve this.

It was also observed from this study that the percentage stock survival rose as the stock diameter, stock length and planting angle were increased. The low percentage stock survival recorded for the thinner and shorter cuttings may be explained in terms of low carbohydrate reserves and immature stocks, Wills (1980) and Chadhokar (1982) prescribed using mature stocks of about six months old or more.

Although, there is no agreement as to the angle which the planted end of the stock should be cut Chadhokar (1982) recommends an oblique angle in order to increase the terminal bark area from which roots emerge, while Wills (1980) prefers a straight or right angle cut as this minimizes the area of white wood tissue exposed to rot.

CONCLUSION

From the present study, it is evident that *Gliricidia sepium* stakes can be established with ease. The study clearly shows that *Gliricidia sepium* could easily be established in the Northern Guinea Savanna of Nigeria, when thicker stock diameter of not less than 3.0 cm and stock length 40 cm are used. The plant, therefore promising candidate for programmes aim at increasing the contribution of browse to dry season forage resources.

REFERENCES

Adu, I.F., A.B.J. Aina and K.A. Okeleye, 1996. On-farm establishment and productivity of *Gmelina* and *Gliricidia* as browse for goats. Nig. J. Anim. Prod., 23: 47-52.

Akinola, J.O., R.A. Afolayan and S.A.S. Olorunju, 1991. Effects of storage, testa colour and scarification on seed germination of *Desmodium velutinum* (Wilid) D.S. Seed Sci., Technol., 19: 59-166.

AOAC, 1975. Association of Official Analytical Chemists. Official Methods of Analysis. 12th Edn., Washington DC.

Atta-Krah, A.N. and B.T. Kang, 1992. Establishment and Management of Alley Farming Systems. Alley Farming Network for Tropical Africa, Ibadan. The AFNETA alley farming. http://www.fao.org/Wairdocs/ILRI/x5545E/x5545e06.htm.

Chadhokar, F.A., 1982. *Gliricidia maculata*: A promising legume fodder plant. World Anim. Rev., 44: 36-43.

Cobbina, J., A.M. Atta-Krah, A.O. Meregini and B. Duguma, 1990. Productivity of some browse plants on acid soils of southern Nigeria. Tropical Grasslands, 24: 41-45.

Dicko, M.S. and L.K. Sikena, 1991. Fodder Trees and Shrubs in Range and Farming Systems in Dry Tropical Africa. In: Fodder Trees and Shrubs in Range and Farming Systems in Dry Tropical Africa. Andrew, S. and P. Pierre-Luc (Eds.), Proceedings of the FAO Expert Consultation Held Development Institute (MARDI) Kuala Lumpur, Malaysia, 14-18 October 1991, pp: 27-42.

Francis, P.A. and A.N. Atta-Krah, 1989. Sociological and ecological factors in technological adoption: Fodder tress in southeastern Nigeria. Exp. Agric., 25: 1-10.

Guevarra, A.B., A.S. Whiteney and J.R. Thompson, 1978. Influence of intra-row spacing and cutting regimes on the growth and yield of *Leucaena*. Agro. J., 70: 1033-1037.

ILCA., 1988. Annual report 1988. International Livestock Centre for Africa, Humid Zone Programme, Ibadan, Nigeria.

Klinkinberg, M. and G.W. Higgins, 1968. An outline of Northern Nigeria soils. Nig. J. Sci., 2: 91-115.

NAS., 1984. Leucena: Promising Forage and Tree Crop for the Tropics. National Academy of Sciences, Washington, DC., pp: 100.

NFTA., 1989. A Guide to Establishing Research and Demonstration Plantings with Nitrogen Fixing Tree Species. Nitrogen Fixing Tree Association, Waimanalo, Hawail, USA., pp: 36.

Oakes, A.J. and O. Skov, 1962. Some woody legumes as forage crops for the dry tropics. Tropical Agric. (Trinidad), 39: 281-287.

Smith, O.B. and M.F.J. van Houtert, 1987. The feeding value of *Gliricidia sepium*; A review. World Anim. Rev., 62: 57-68.

Smith, O.B., 1991. Fodder Trees and Shrubs in range and faming systems in tropical humid Africa In: Legume trees and other fodder trees as protein sources for livestock. Proceedings of the FAO Expert Consultation held Development Institute (MARDI) Kuala Lumpur, Malaysia, 14-18 October, 1991 pp: 43-59.

Standley, P.C. and G.A. Steyermark, 1946. Flora of Guatemala, Fieldiana Botany, 24 (Part 1). Chicago, Natural History Museum.

Steel, R.G.D. and J.H. Torrie, 1980. Principles and Procedures of Statistics. 2nd Edn., Mc-Graw-Hill: New York.

Sumberg, J.E., 1986. Note on estimating the foliage yield of two tropical browse species. Tropical Agric. (Trinidad), 62: 15-16.

Von-Kaufmann, R., 1986. An introduction to the sub-humid zone of West Africa and the ILCA sub-humid zone programme: Livestock system in Nigeria's sub-humid zone. Proceedings of the 2nd ILCA/NAPRI Symposium held in Kaduna, Nigeria, Oct. 29-Nov. 2, ILCA, Addis Ababa, Ethiopia.

Wiersum, F. and Dirdjosoemarto, 1987. Past and Current Research with Gliricidia in Asia In: *Gliricidia sepium* (Jocg) Walp: Management and Improvement. Proceedings of Workshop held at Catie, Turrialba, Costa Rica, June 1987. Nitrogen Fixing Tree Association Special Publ., pp: 81-101.

Williams, M.J., 1987. Establishment and winter survival of *Leucaena* spp. and *Gliricidia sepium* in the cold subtropics. *Leucaena* Research Reports, pp: 8: 78-81.

Wills, G.A., 1980. Establishment of *Gliricidia maculata* in Bungor series soil. Planter (Malaysia), 56: 128-136.