Effect of Organic Manures on Survival and Growth of *Calliandra calothyrsus* Seedlings in Gatsibo District, Rwanda.

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Abstract: This study was undertaken with the aim of improving the survival and growth of *Calliandra Calothyrsus* seedlings in tree nurseries by use organic manures as potting material and evaluating growth characteristics of seedlings for 55 days after pricking out. An experiment was set up at Land Husbandry, Water Harvesting and Hillside Irrigation Project (LWH) nursery in Gatsibo District, Eastern Rwanda, using a Completely Randomized Block Design with four treatments, replicated four times. Top garden soil (100%), top garden soil (70%), + farmyard manure (30%), top garden soil (70%) + compost manure (30%) and top garden soil (70%) + farmyard manure (15%) + compost manure (15%) were used as potting substrates. The observed growth parameters were the survival, height (cm) and root collar diameter (cm) of seedlings at 25th; 40th and 55th days after pricking out. Data was subjected to analysis of variance using JMP IN 5.1 and the significant means were separated using LSD at $P \leq 0.05$. The overall survival of seedlings was 89.79%. The results further showed that the combination of farmyard manure and compost mixed with soil as potting material performed better compared to other treatments for all the parameters observed with a survival rate of 94.44 %, mean seedling height of 6.6 cm and mean root collar diameter of 0.06 cm after 55 days while the control was the worst performer with a survival rate of 73.89 %, mean seedling height of 5.6 cm and mean root collar diameter of 0.04 cm after 55 days. The use of organic manures can significantly improve survival and growth of *Calliandra calothyrsus* in the nursery. Tree nursery producers should use farmyard manure combined with compost manure at 1:1 ratio for better performance of seedlings.
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Key words: *Calliandra calothyrsus*, Organic manure, Survival, Growth rate, Height, Root Collar Diameter.

Introduction

Seed propagation is the principal mode of plant production all over the World. Thus, in managing nursery operations based on seed propagation, the main objective is to obtain good germination and provide optimum conditions for their survival and growth into strong healthy trees (Mukuralinda *et al.*, 1994).

Currently, the use of inorganic fertilizers to improve soil fertility is popular among farmers in some parts Rwanda, but the synthesized mineral fertilizer besides its deleterious effects (short and long term) on soil micro-organism and soil structure are expensive and this limits their utilization by small scale farmers (Mukuralinda *et al.*, 1994). Organic manures on the other hand are derived from decaying material of plant or animal origin and contribute to soil fertility and tilth (Wagner and George, 2004). Manures contribute to the fertility of the soil due to addition of organic matter and nutrients, such as nitrogen that is trapped by bacteria in the soil (Haynes, 2003). The main advantage of organic manures is that they provide more than one of the many substances needed by plants for their growth. Inorganic manures on the other hand usually provide only one of the many substances needed by plants for their growth (Boller and Hani, 2004). Organic manures which break down or decay quickly are available to the plant faster than those which decay slowly (Boller and Hani, 2004).

Calliandra calothyrsus is multipurpose species that has been highly promoted in Rwanda for forage since the implementation of "One cow per one family program". It is also used for the provision of green manure; shade for coffee and tea, land rehabilitation, erosion control and for the provision of stakes for climbing beans. Despite its popularity, there is no well defined type of organic manure and the rates of application that can be used in raising and improving the survival and performance of *Calliandra Calothyrsus* seedlings in the nursery. In this study, decomposed farmyard and compost manure were used as potting material for pricked out seedlings and their effects monitored for a period of 55 days.

Materials and methods

Study area

The research was conducted at LWH nursery site located in Gatsibo District, Eastern Province. This zone is characterized by an altitude of 1750 m with rainfall which varies in the range of 1200 - 1600 mm and average temperature of 19.5°C. The LWH tree nursery site is located at latitude 2° 48 and longitude 030° 17. The soils in the region are mainly sandy clay loamy red soil. Laboratory soil analysis is given by Table 1. The natural vegetation is characterized by small grasses covering the hilly areas, papyrus in the swampy areas and some natural trees. The main cultivated crops include legumes, potatoes, banana, cassava, groundnuts, beans, sorghum, and sugar cane integrated with agroforestry tree species.

Table 1: Soil physical and chemical properties.

Sand	Silt	Clay	pH	TOC	N	P avail	K	Na+	Mg+	Ca++	CEC
%	%	%		%	%	mg. kg-1	$cmolc.kg^{-1}$ of soil				
31.5	13.5	55	6.2	1.5	0.36	9.8	0.	1.3	2.1	5.2	8.7

Organic manures

Decomposed Farmyard manure used consisted of cow dung mixed with crop residues from maize. For preparation, crops residues from maize were used as mulch in the cowsheds for two weeks after which they were mixed then put in a pit for three month for complete decomposition. The Compost was prepared from bean straw, ash, maize straw, rabbit and chicken waste sprinkled with local soil and left for three months for complete decomposition. For decomposition, pits 1.50 m wide, 2 m long and 1m deep was used.

Experimental design and treatment application

A completely randomized block design was used with 4 different treatments: Top garden soil (100%), top garden soil (70%), + farmyard manure (30%), top garden soil (70%) + compost manure (30%) and top garden soil (70%) + farmyard manure (15%) + compost manure (15%) and were replicated 4 times. Five hundred grams (500 g) pots were used. Each plot had 15 pots equating to 15 seedlings per plot. Pricking out was done 10 days after direct seed sowing. Watering of seedlings was done two times a day and frequency was reduced with time.

Data collection

Parameters measured included survival rate (%), height (cm) and root collar diameter (cm). Data was collected on the 25th; 40th; and 55th days after pricking out.

All the surviving seedlings planted were counted on the 25th; 40th; and 55th days after pricking out. Considering survival is not always a clear-cut parameter; it was taken to refer to the presence of living trees, even if it is not completely healthy (Wood *et al.,* 1991).

The height (cm) was directly measured using a graduated ruler at 25th; 40th; and 55th days after pricking out. Height was measured at the highest point above ground attained by the main stem of the seedling (Wood *et al.,* 1991).

Root collar diameter (cm) was measured on the stem at the point close to the ground level on the 25th; 40th; and 55th days by use of a venier caliper.

Data analysis

The data was analyzed using JMP IN 5.0 and the means which were found to be significant were separated using LSD at $P \leq 0.05$.

Results

Survival of seedlings at 25th, 40th and 55th day after pricking out

The overall survival of the seedlings was 86.3 %. The treatment with mixture of farmyard manure and compost manure exhibited the highest survival rate of seedlings throughout the entire period with 96.7 % on 25th day, 93.3% on the 40th and 55th days, followed by the treatment with farmyard manure with 95% on the 25th day, 90% on the 40th day and 88.3% on the 55th day. The treatment in which compost was used depicted a lower survival in comparison to other treatments where organic manure was used and had a survival rate of 90% on 25th day, 83.3 % on both 40th and 55th days. The control showed the least survival rate with 76.7%, 73.3% and 71.7% on the 25th, 40th and 55th days respectively.

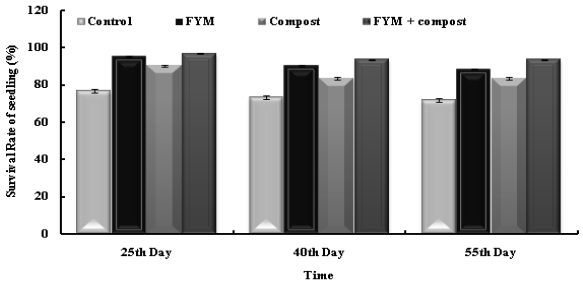

Figure 1: Effect of organic manure on survival rate.

Average survival of seedlings at the end of 55 days

Figure 3 shows the summary of the survival rate of seedlings after 55 days of the experiment and it reveals that soil mixed with both farmyard and compost manure had the highest survival rate of

seedlings with an average survival of 94.4%, followed by soil mixed with farmyard manure with 91.1%, then soil mixed with compost manure with 85.6 % while the control performed poorly as compared with the other treatment with an average survival rate of 73.9 %.

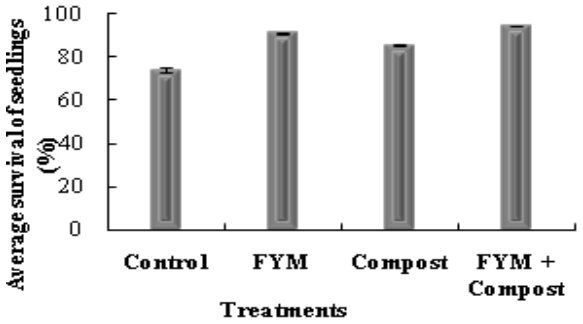

Figure 2: Effect of organic manure on survival rate of seedlings at 55 days after pricking out.

Effect of organic manure on height of *Calliandra calothyrsus* seedlings over time

The height of the seedlings was not significantly (p= 0.4085) different at the beginning of the experiment. However, differences in differences could be noted after 25 days with T4 (mixture of compost and farm yard manure) being with the highest mean. This trend was maintained during the entire period (Table 2). Use of compost manure alone performed poorly in comparison with the other treatments in which organic manure was used and its effect on growth in height was not significantly different from the control.

Table 2: Effect of organic manures on height (cm) of *Calliandra calothyrsus* over time.

Organic manures	1 day after pricking out	25 days after pricking out	40 days after pricking out	55 days after pricking out
Control	3.0a*	3.3c	4.6c	5.6c
FYM	2.9a	3.8ab	5.0ab	6.4ab
Compost	2.9a	3.6bc	4.8bc	6.0bc
FYM +Compost	2.9a	4.0a	5.3a	6.6a

*Means not connected by same letter within a column are significantly different according to LSD at P≤0.05

Effect of organic manure RCD of *Calliandra calothyrsus* seedlings over time

The RCD of *Calliandra calothyrsus* seedling was not significantly (p=0.5960) different at the beginning. Significant differences were noted after 25 days of pricking out and the same was maintained throughout the study period. The treatment with organic manure performed better as compared with the control. Significant differences were also noted among the treatments in which organic manure was applied with the one with a mixture of both farmyard manure and compost being the best performer attaining an average diameter of 0.055 cm after 55 days while compost performed poorest attaining a RCD of 0.042 cm at 55 days after pricking out (Table 3).

Table 3: Effect of organic manures on RCD (cm) of *Calliandra calothyrsus* over time

Organic manures	1 day after pricking out	25 days after pricking out	40 days after pricking out	55 days after pricking out
Control	0.022 a*	0.029 b	0.036 b	0.042 c
FYM	0.026 a	0.036 a	0.045 a	0.051 b
Compost	0.022 a	0.030 b	0.039 b	0.045 c
FYM +Compost	0.024 a	0.039 a	0.048 a	0.055 a

*Means not connected by same letter within a column are significantly different according to LSD at P≤0.05

Discussion

The survival rate of seedlings is an important indicator for pursuing observations and getting success at the experimental field. Thus, high survival rate depend on the quality of seeds, availability of nutrients, management practices and climatic conditions under which seedlings are grown (Habarugira, 2007). From the study, the survival rate of seedlings ranged from 73.93 % to 94.44 %. These results are quite lower as compared to those obtained by Galang (1988) where survival rate ranged from 89 % to 97 % during his research on effect of organic fertilizers on the growth of eight leguminous trees and shrubs. *Calliandra calothyrsus* grows well at altitudes from sea level to 1,860 m in areas where the annual precipitation ranges from 700 to 3,000 mm with less tolerance to drought (Lowry and Macklin 1989), although Gatsibo area is characterized by annual average rainfall ranging between 1500-2000 mm per year and an altitude of 1800 m, it has a hot climate and this could account for the lower survival.

The mean seedling height obtained after 55 days of experiment ranged from 5.6cm and 6.6cm. The treatment which contained farm yard manure mixed with compost performed better than the other treatments and attained the greatest height, this could imply a good synergetic interaction between the two types of organic manures which are very rich in nitrogen required by *Calliandra calothyrsus*. These results are lower compared to those obtained by Ndekezi (2008) who worked on *Grevillea robusta* with the same organic manures with seedlings attaining the height of between 7.13 cm to 11 cm after

60 days. This is because *Calliandra calothyrsus,* like many other tree legumes, often displays slow early growth (Evans 1984, Glover and Heuveldop 1985, Jama *et al*., 1989) due to poor and ineffective symbiotic associations of the species when they are still too young. However, once it is mycorrhizal, *Calliandra calothyrsus* grows quite vigorously and can achieve a height of 3.5 m in 6 months (Wiersum and Rika 1992).

The goal of root collar diameter measurement is to estimate the site quality and growth characteristics of seedlings. According to Bradshow (1977) and Williams (1987), the performance of a population on a habitat may be influenced by its response to climatic, edaphic, biological and cultural factors. *Calliandra calothyrsus* is a leguminous tree species which does not develop a very big diameter since it is mainly planted for fodder production due to its high protein content which indicate its potential as a valuable forage source and for soil conservation purposes (Glover and Heuveldop, 1985). The obtained results on the mean seedling diameter 55 days after pricking out ranged from 0.042 cm to 0.055 cm. These results are significantly higher than to those obtained by Baggio and Heuveldop (1984) which ranged from 0.03 cm to 0.042 cm after 60 days from direct sowing.

For any increment in any growth parameter, there is a need of nutrients availability and favourable site conditions. Organic manure improves soil quality and continuous addition of manures, such as farm yard manure and compost in soil increased soil organic carbon content and other constituents that affect soil humus content, biological activity, and soil physical structure (Wagner and George, 2004) and also play an important role in nitrogen and phosphorus transformations (Rayar, 2000; Haynes, 2003). Organic fertilizers are broad spectrum containing at least 20 nutrients (and often more) which include N_2, P_2O_5, K_2O, CaO, MgO, S, B, Ca and Mg (Jokela *et al*., 2004). These nutrients are required by *Calliandra calothyrsus* species for survival and high resistance to pests and diseases. Therefore, this could account for the poor performance of the treatment without supply of those nutrients in comparison to other treatments with a certain level of nutrient boost and this can be ascertained by the results obtained from the control experiment which performed poorly in height, RCD and survival in comparison with the other treatments.

Conclusion

The main use for organic manures is to improve survival and growth of plants without the soil degradation effects of inorganic manures. The main advantage of organic manures is that they provide more than one of the many substances needed by plants for their growth. Inorganic manures on the other hand usually provide only one of the many substances needed by plants for their growth (Boller and Hani, 2004). Based on the findings, it can be concluded that the use of organic manures can significantly improve the survival and growth of *Calliandra Calothyrsus* seedlings in the nursery. Different organic manure also yields different responses with farmyard manure being more superior as compared to compost manure. The most appropriate manure would be the mixture of both compost and farmyard manure at 1:1 ratio but also farmyard manure when used solely can give comparatively acceptable results.

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