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Full Length Research Paper

Initial growth response of *Moringa oleifera* seedlings to different soil amendments

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***Moringa oleifera* is one of the important traditional multipurpose food plants that is produced and used in many African countries. However, the production capacity is low and therefore do not meet the ever growing demand for human and animal consumption. To solve the problem, this study was initiated to assess the effect of three different soil amendments on the initial growth performance of *M. oleifera* seedlings. Compost, poultry manure and rice husk were the soil amendment with top soil only used as a control. The experiment was conducted at the Farming for the Future Project site in Nyankpala, Northern region. The experimental design used was completely randomized design. Daily germination record of seedlings was kept for two weeks after sowing. Also, three destructive harvesting regimes at 4, 8 and 12 weeks after germination were used to measure parameters such as stem height, stem girth, number of leaves, fresh weight and dry weight of seedlings. Generally, germination was high for all treatment especially that of the poultry manure. Analysis of variance of the various parameters during each harvesting regime showed a significant difference ($p < 0.05$) among soil amendments at 8 and 12 weeks after germination. There was however no significant difference among soil amendments in growth performance at 4 weeks after germination. Generally, compost performed better than the other soil amendments, while control performed the least. Sustainable production of moringa seedlings may be achieved by adopting soil amendment practices, especially the use of compost.**

Key words: *Moringa oleifera*, multipurpose, amendments, treatment, poultry manure, compost, rice husk.

INTRODUCTION

Moringa oleifera is a plant which belongs to the moringaceae family. It is one of the important traditional multipurpose food plants that is produced and used in many African countries (Amaglo, 2007). Moringa has a great potential to become one of the most economically important crops for the tropics and subtropics considering its use in many fields as a medicine (Peixoto et al., 2011), food (Pontual et al., 2012) and fodder plant.

Studies have shown that the plant can be a source of high quality food for both humans and animals (Fugli, 2001). In the Indian sub-continent, moringa has long been cultivated for its edible fruits. These were exported, fresh and canned to consumers in Asia and Europe The edible leaves are very nutritious and are consumed throughout West Africa, in parts of Ethiopia and in some countries of Asia (Fugli, 2001). It is extensively used in alley cropping systems and its leaves are readily eaten by animals such as cattle, sheep goats, pigs and rabbits. Similarly, the leaves are also used for feeding fish in Aquaculture.

During the 19th century, *M. oleifera* grew from the domestic uses to industrial uses. Plantations in the West Indies were exporting the seed oil (known as Ben oil) to Europe for use as a lubricant for the machinery industries. Also, the seed cake is used as protein-rich plant fertilizers. The juice extracted from the leaves can be used to make foliar nutrient capable of increasing crop yield by up to 30%. The leaves also provide excellent materials for the production of biogas (Kivevele et al., (2011).

Crushed leaves are used in some parts of the world to scrub cooking utensil or to clean walls. The blue dye from

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Table 1. Major nutrient composition of the various growth media.

Media and nutrient element	Nitrogen (%)	Phosphorus (%)	Potassium (%)
Poultry dropping	1.3	0.400	0.55
Stop soil	0.04	0.002	0.05
Compost	1.8	0.040	0.15
Rice husk	0.25	0.006	0.09

the wood is used in Jamaica and Senegal. The powdered seed kernel acts as natural flocculants, able to clarify even the most turbid water (Jahn and Dirar, 1979; Lea, 2010; Poumaye et al., 2012).

Pharmaceutically, *M. oleifera* is rich in health promoting phytochemicals such as carotinades, phenolics (chlorogenic acids), flavonoids (quercetin and kaempherol glycosides), various vitamins and minerals (Foidl et al., 2001; Becker and Siddhuraju, 2003; Bennett et al., 2003).

Despite very interesting properties and many potential applications of the *M. oleifera* outlined previously, the plant is often grown in Ghana as a live fence or as a backyard tree (Amaglo, 2007). This has led to under production of the plant especially in the northern part of the country to meet the ever growing demand for human and animal consumption.

To solve the problem of unreliable and insufficient production of Moringa, this study was initiated to determine suitable soil amendments for growing large quantities Moringa seedlings.

MATERIALS AND METHODS

Study area

The study was conducted at the Farming for the Future Project site of the Faculty of Agriculture of the University for Development Studies, Nyankpala Campus between 22nd November, 2008 and 21st February, 2009. It is located in the Tolon-Kumbungu District of the Northern Region, 16 km west of Tamale. The study site lies within the interior guinea savannah of Ghana between latitude 9º 25'N to 10º 40'N and longitude 0º 58'W to 1º 25'W at an altitude of 183 m above sea level. It is an area with vast land which can be used for commercial production of *M. oleifera* to meet ever increasing demand.

Experimental design and treatments

The experiment consisted of four treatment combinations of 1220.08 g of topsoil, 507.31 g compost, 301.72 g poultry manure 153.49 g rice husk in a ratio of 1:2 (thus one part of compost, poultry manure or rice husk is to two parts of the top soil) and a polybag of 1830.12 g of only topsoil as control in a completely randomised design (CRD).

The compost was made up of plant materials, ash and animal droppings (goats and sheep). This was watered and turned every two (2) weeks for three months to enhance decomposition. The three major nutrient components (Nitrogen, Phosphorus and potassium) of the growth media were determined before the start of the experiment (Table 1). Kjeldahl digestion method (Jackson, 1962) was use to determine total nitrogen (N) in the various media. Potassium was determined using flame photometer while phosphorus (P) was determined calorimetrically using spectronic 70 spectrophotometer. The various organic manures were then thoroughly mixed with the top soil and filled into a 21 cm by 15 cm polybags. The polybags were then watered daily for three weeks to enhance further decomposition.

To facilitate germination, the seeds were treated by soaking them in cold water for 24 h before sowing them directly into the polybags. One seed was sown per polybag. It took the seeds between 6 to 14 days to germinate. The seedlings were watered daily for the first month, every two days for the second month and every three days for the third month.

Data on germination percentages of seedlings on each soil amendment were recorded after the end of germination (two weeks after sowing). Three destructive harvesting regimes were employed at 4, 8 and 12 weeks after germination to collect data on seedling stem height, stem girth, fresh and dry weight and number of leaves. The stem height was measured using a measuring tape (from the base of each seedling to the terminal leaf). The number of leaves on each seedling was recorded by manual counting. The fresh and dry weights of the seedlings were taken using an electronic scale. The dry weights were taken after 48 h of oven drying at a temperature of 60°C as recommended by Auchmoody and Grewelling (1979).

Data collected were subjected to analysis of variance (ANOVA) using GENSTAT and the least significant differences (LSD 0.05) were used to separate the means between the treatments.

RESULTS AND DISCUSSION

Effects of soil amendments on germination percentage

Germination percentage recorded at the end of the study of the various soil treatments is shown in Figure 1. Poultry manure with topsoil (Pd) shows the highest germination while the lowest percentage is obtained with the topsoil only (control – Cl) the least.

Generally, the germination percentage record of all the soil amendments was high. This could be attributed to the pre-seeding treatment of the seeds before sowing. According to Fuglie (2000), subjecting Moringa seeds to pre-seeding treatment such as soaking in water, cracking shells of seeds, or removing shells of seeds and planting the kernel only would enhance germination greatly. The germination percentage results indicated that, treatment Pd recorded the highest percentage value. According to Balasubramaniyan and Palaniapan (2004), poultry manure contains higher percentage of phosphorus (1.2%

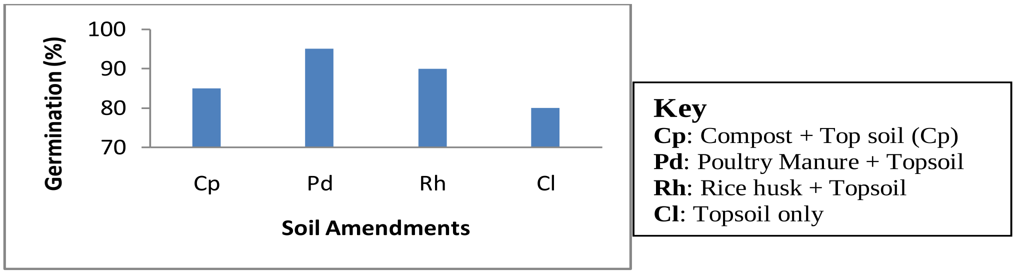

Figure 1. Effects of soil amendments on seed germination.

Table 2. Effects of soil amendments on stem height.

Soil amendments	Stem height (cm)		
	4 WAG	8 WAG	12 WAG
Cp	50.6	88.5	103.1[a]
Pd	49.4	79.9	98.8[a]
Rh	46.4	94.4	100.8[a]
Cl	36.3	73.6	73.9[b]
F. Pr	0.237	0.079	< 0.001
LSD (0.05)	15.54	16.75	12.91

Values with different superscripts along the same column have significant difference ($p < 0.05$); whiles those with the same superscripts have no significant difference ($p < 0.05$).

P_2O_5) than compost (0.5% P_2O_5) and rice husk (0.2 to 0.3% P_2O_5). This might have accounted for poultry manure recording the highest germination percentage.

Effects of soil amendments on the initial growth performance of seedlings

Stem height

Soil amendments showed a significant difference ($p<0.05$) at 12 weeks after germination in stem height. There was no significant difference ($p>0.05$) in stem height at 4 and 8 weeks after germination. At 12 weeks after germination, Cp recorded the highest stem height value followed by Rh, Pd, and Cl as shown in Table 2.

Higher stem height values recoded by compost could partly be due to the fact that it contains an appreciable percentage of nitrogen which is responsible for promoting vegetative growth as reported by Swiader et al. (1992) and Panda (2005).

It may also be due to the fact that, compost has high organic matter content than the other soil amendments and thus enhanced good drainage in compost. Balasubramaniyan and Palaniapan (2004), reported that compost has a higher percentage of potassium (0.8 to 0.9%) than poultry manure (0.5%) and rice husk (0.3 to 0.5%). This could also account for high mean stem height as potassium encourages strong stiff straw as indicated by Panda (2005).

Stem girth

Soil amendments showed significant difference ($p<0.05$) in stem girth at 8 and 12 weeks after germination. At 8 weeks after germination, Rh recorded the highest stem girth value and the control (Cl) recorded the least. At 12 weeks after germination, the highest stem girth value was recorded by soil amendment Cp and the least value recorded by Cl (Table 3).

The higher values recorded by treatment Rh could be attributed to the fact that it was fairly-drained and nutrient was more available to the seedlings than the rest. Due to this, the nutrient was readily used and depleted within a short period. On the other hand, compost which is well-drained sparingly releases its nutrient which is available for plant for longer period without depleting it.

It is important to note that, at 12 weeks after germination, Cp recorded the highest stem height and also the highest stem girth. This indicates that, stem height growth goes with the growth in stem girth.

Number of leaves

Table 4 indicated that soil amendments showed significant difference ($p<0.05$) at 8 and 12 weeks after

Table 3. Effects of soil amendment on stem girth.

Soil amendments	Stem girth (cm)		
	4 WAG	8 WAG	12 WAG
Cp	1.08	1.76^{a}	2.38^{a}
Pd	1.06	1.60^{ab}	2.12^{b}
Rh	0.86	1.84^{ac}	2.32^{c}
Cl	0.82	1.36^{d}	1.92^{d}
F. Pr	0.342	< 0.001	0.021
LSD (0.05)	0.3672	0.1628	0.3020

Values with different superscripts along the same column have significant difference (p <0.05); whiles those with the same superscripts have no significant difference (p<0.05).

Table 4. Effects of soil amendment on number of leaves.

Soil amendments	Number of leaves		
	4 WAG	8 WAG	12 WAG
Cp	113.4	307^{a}	408^{a}
Pd	91.8	179^{b}	153^{b}
Rh	95.6	270^{ab}	330^{a}
Cl	71.0	193^{c}	231^{cb}
F. Pr	0.318	0.049	< 0.001
LSD (0.05)	46.28	102.3	87.5

Values with different superscripts along the same column have significant difference (p <0.05); whiles those with the same superscripts have no significant difference (p <0.05).

Table 5. Effects of soil amendment on fresh weight.

Soil amendments	Fresh weight (g)		
	4 WAG	8 WAG	12 WAG
Cp	5.11	14.30^{a}	23.6^{a}
Pd	3.92	10.52^{ab}	19.2^{ab}
Rh	2.94	18.00^{ac}	22.5^{ab}
Cl	1.64	8.46^{ab}	10.8^{d}
F. Pr	0.147	0.016	0.003
LSD (0.05)	3.071	5.841	6.40

Values with different superscripts along the same column have significant difference (p <0.05); whiles those with the same superscripts have no significant difference (p <0.05).

germination in number of leaves. However, there was no significant difference at 4 weeks after germination. Amendment Cp recorded the highest number of leaves in all the three harvesting regimes (that is 4, 8 and 12 WAG). Control (Cl) recorded the least number of leaves at 4 weeks after germination, whilst Pd recorded the least values at 8 and 12 weeks after germination. This result confirms the findings by Swiader et al. (1992) that the best soil for growing vegetables is one that is well-drained, fairly deep and has a relatively high amount of organic matter (3 to 5%). Compost fits much into this description than the other soil amendments.

Fresh weight

Soil amendments differed significantly ($p<0.05$) in fresh weight of seedlings at 8 WAG and 12 WAG but did not differ significantly at 4 weeks after germination. Soil amendment Rh recorded the highest fresh weight value at 8 weeks after germination whilst Cp recorded the highest value at 12 weeks after germination. In both cases, Cl recorded the least values (Table 5).

The highest mean fresh weight recorded at 12 WAG by treatment Cp may be due to the fact that Cp has relatively higher amount of organic matter (3 to 5%) than

Table 6. Effects of soil amendment on dry weight.

Soil amendments	Dry weight (g)		
	4 WAG	**8 WAG**	**12 WAG**
Cp	0.970	2.76[a]	4.10[a]
Pd	0.712	2.08[ab]	3.30[ab]
Rh	0.550	3.64[ac]	3.90[ab]
Cl	0.356	1.58[ad]	1.92[d]
F. Pr	0.200	0.030	0.004
LSD (0.05)	0.5917	1.360	1.149

Values with different superscripts along the same column have significant difference (p <0.05); whiles those with the same superscripts have no significant difference (p <0.05).

the other media. Also, Cp is said to be a good substitute for farm yard manure and thus its effect on vegetable is similar to that of pure manure (Sinnadurai, 1992). It is capable of improving soil structure and soil tilth in addition to the supply of plant nutrients.

Dry weight

Dry weight of seedlings differed significantly (p<0.05) at 8 and 12 weeks after germination but not at 4 weeks after germination. Treatment Rh did best at 8 weeks after germination whilst, Cp did best at 12 weeks after germination as indicated in Table 6.

Muthusamy (1954) indicated that, the growing of Moringa plants may not require watering except during the hot weather when they may be irrigated once in about 8 days. Rh (rice husk) had a very high drainage property during the experiment. So, this could account for it performing best at 8 WAG in dry weight of seedlings than the other soil amendments.

For the performance of Cp at 12 weeks after germination, it might have been due to its high organic matter content than the rest of the treatments as indicated earlier on by Swiader et al. (1992).

CONCLUSIONS AND RECOMMENDATION

The general germination rate is high. However, the poultry manure (Pd) gives the highest germination percentage. The results on effects of soil amendments on growth performance indicate that treatment Cp (compost) is the best for all the parameters measured especially at the 12 weeks after germination. For successful high Moringa seedling production, it is recommended that compost should be used as a soil amendment for nursing Moringa seedlings.

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