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# Assessment of Organic Amendments on Vegetative Development and Nutrient Uptake of *Moringa oleifera* Lam in the Nursery

A.G. Adebayo, H.A. Akintoye, A.O. Olufolaji, O.O. Aina, M.T. Olatunji and A.O. Shokalu
National Horticultural Research Institute, Ibadan, Nigeria

**Abstract:** This study carried out to investigate the effects of organic amendments on the early growth and nutrient uptake of *Moringa oleifera* in the nursery. The treatments consisted of cured poultry manure, cow dung and different combinations of composted organic waste on dry weight basis: cassava and poultry manure (Cp3pm) 3:1, cassava and poultry manure (Cp2pm) 2:1, elephant grass and poultry manure (Ep3pm), 3:1, and elephant grass and poultry manure (Ep3pm) 2:1 and top soil as control. Organic amendments at 5 tons $ha^{-1}$ (15.8 g) were mixed with topsoil in polythene pots containing 6 kg top soil (15.8 g $pot^{-1}$) except the control. The experiments were arranged in a Completely Random Design (CRD) and replicated three times. Data on vegetative development, number of leaves, stem girth and plant height were taken for five weeks beginning from two weeks after planting (2WAP). The seedlings were uprooted and separated into roots, stem and leaves for fresh and dry weights data. Shoot were analyzed to determine plant tissue uptake per treatment. Results indicated that treatments significantly affected ($p<0.05$) growth parameters, except stem girth. Cow dung application significantly had higher number of leaves at five and six (WAP) and also recorded higher plant height throughout the observation period. Dry matter accumulation was also influenced by organic amendment. Significantly higher stems, leaves and root dry weights were recorded under cow dung application.

**Key words:** *Moringa oleifera*, organic amendments, early growth, nutrient uptake, nursery

## INTRODUCTION

*Moringa oleifera* known as horseradish tree or drumstick is a medium-sized tree of about 10 m height. It belongs to the family Moringaceae. It is adapted to a wide range of soil types but grows best in well-drained loam to clay loam, neutral to slightly acidic soils, but cannot withstand prolonged water logging. It does best where temperature ranges from 26 to 40°C and annual rainfall totals at least 500 mm. According to Fuglier (1999), uses of Moringa includes: alley cropping (biomass production), animal forage (leaves and treated seed-cake), biogas (from leaves), domestic cleaning agent (crushed leaves), blue dye (wood), fencing (living trees), fertilizer (seed-cake), foliar nutrient (juice expressed from the l e aves), green manure (from leaves), gum (from tree trunks), honey- and sugar cane juice-clarifier (powdered seeds), honey (flower nectar), medicine (all plant parts), ornamental plantings, biopesticide (soil incorporation of leaves to prevent seedling damping off), pulp (wood), rope (bark), tannin for tanning hides (bark and gum), water purification (powdered seeds) and moringa seed oil (yield 30-40% by weight).

*Moringa oleifera* still remains unpopular in southwestern Nigeria despite its acclaimed economic values and importance (Odeyinka *et al*., 2007); hence very little research has been done on the species although it is widely used by the rural poor as a food resource.

One of the factors required for optimum yield of crops is adequate nutrient in the soil and its proper management. Organic amendments are sustainable relatively cheap materials of plant and animal origin that are incorporated into the soil before seeding to increase its productivity and crop yield. Green manure, compost and sewage sludge are some of the materials used as organic amendment. Compost as an organic amendment has been decomposed by the existing micro-organism. The main objective of composting is to re-cycle nutrients in the plants and animal left over back to the soil for plant growth. Stoffella *et al*. (1997) has shown that compost and other organic manures can serve as soil amendments to improve soil nutrient status. They provide a ready source of carbon and nitrogen for microorganisms in the soil, improve its structure, reduce erosion and lower the temperature at the soil surface and also aid in seed germination and increase its water holding capacity (Stoffella and Graetz, 1996; Roe *et al*., 1997), particularly in sandy soils, stabilize soil pH, increase soil organic matter and ultimately improve plant growth and yields (Roe *et al*., 1997). The advantage of readily available

**Corresponding Author:** A.G. Adebayo, National Horticultural Research Institute, Ibadan, Nigeria

materials for their preparation, gradual release of plant nutrients without being wasted through leaching or erosion, destruction of harmful weed and toxic materials during preparation and environmental friendliness have made organic amendments, particularly composted manure popular among farmers. The aforementioned advantages of organic amendments application in crop production have long been recognized. However to obtain maximum benefit, certain conditions (Marchesini *et al*., 1988) among which is suitably balanced ratio of nutrients must be considered Effectiveness of compost depends primarily on source and type of organic material, method of composting and compost maturity. Compared with raw organic wastes, mature compost provides a stabilized form of organic matter and has the potential to enhance nutrient release in the soil (Adediran *et al*., 2003). An adequate choice and treatment of composted materials may suffice the above points. However this varies with type of organic materials.

This study is therefore aimed at comparing the effectiveness of locally available organic soil amendments in vegetative development and nutrient uptake of *Moringa oleifera* in the nursery.

## MATERIALS AND METHODS

Experiments were conducted at the screen house of Floriculture Programme, National Horticultural Research Institute (NIHORT), Ibadan between October 2008 and April 2009 cropping season with the aim of investigating the effects of organic amendments on vegetative development and nutrient uptake of moringa oleifera in the nursery. The treatments consisted of cured poultry manure (Pm), cow dung (Cd) and composted organic waste of different combination on dry weight basis: cassava peel and poultry manure (Cp3 Pm) 3:1. Cassava peel and poultry manure (Cp2 Pm) 2:1 elephant grass and poultry manure (Eg3 Pm), 3:1 elephant grass and poultry manure (Eg2 Pm) 2:1 and top soil as control (Cts). Organic amendments at 15.8 g pot$^{-1}$ (5 t ha$^{-1}$) were added to pots containing 6 kg top soil. The experiments were arranged in a Completely Randomized Design (CRD) with three replicates. Data on vegetative growth parameters: plant height, stem girth and number of leaves were collected at weekly interval from 3 weeks after planting (WAP). Three seedlings per replicate were uprooted at 7 WAP and separated into stems, leaves and roots after which fresh weight were recorded; plants were later oven dried at 75°C for 48 h before dry weight were recorded. The dried stem and leaves were bulked together and grinded for laboratory analysis to determine the nutrient uptake. Data collected were subjected to analysis of variance using the GLM procedure of the 2000 version of the SAS software. Means were compared using Duncan's multiple range test at 5% confidence level.

## RESULTS

**Soil analysis:** The soil was mostly sandy loam in texture with pH of 7.7. Total nitrogen was 1.3 mg g$^{-1}$ while available P was 1.95 mg kg$^{-1}$, indicating that the quantities of these nutrients were inadequate for optimum plant vegetative development (Table 1). Similarly, the exchangeable acidity (H$^{+}$) of 0.06 c mol kg$^{-1}$ and organic carbon of 11.1 mg g$^{-1}$ are also poor (Aduayi *et al*., 2002).

**Organic amendments analysis:** The results indicated the differences in nutrients composition of the compost mixes. Cassava/Poultry manure mixed in ratio (Cp3 pm) 3:1 on dry weight basis contains the highest concentration of Nitrogen (1.20%), followed by cow dung (1.12%). Poultry manure, Cp2 pm 2:1 and Eg3 pm 3:1 had almost same P content, while Ep2 pm 2:1 and Cp3 pm 3:1 contains 0.28% P content, respectively (Table 2) and cow dung had the lowest P content. The materials also differ in K content, with Poultry m anure and Ep2pm 2:1 having the lowest content, while Ep3pm 3:1 and Cp3pmP 3:1 contain 3.91 and 3.77%, respectively. Depending on nutrients situation of soils, each of the amendments is suitable for ameliorating nutrient deficiency in soils.

**Vegetative development:** Table 3 indicated that application of organic amendments promoted vegetative development of moringa oleifera significantly ($p<0.05$), except stem girth. It also affected fresh weight of roots, stem and leaves (Table 4). Results of the two plantings followed the same trend for growth parameters; seedlings grown with cow dung were significantly at $p<0.05$ taller and had

Table 1: Pre-cropping physical and chemical properties of soils used

| Soil property | Vaues |
|---|---|
| pH | 7.70 |
| Sand (mg g$^{-1}$) | 770.00 |
| Clay (mg g$^{-1}$) | 56.00 |
| Silt (mg g$^{-1}$) | 174.00 |
| Ca (c mol kg$^{-1}$) | 1.80 |
| Mg (c mol kg$^{-1}$) | 0.74 |
| Na (c mol kg$^{-1}$) | 0.35 |
| K (c mol kg$^{-1}$) | 0.21 |
| Exch. Acidity | 0.06 |
| ECEC me (100 g$^{-1}$) | 3.16 |
| C (mg g$^{-1}$) | 11.10 |
| N (mg g$^{-1}$) | 1.30 |
| Av. P (mg g$^{-1}$) | 1.95 |
| Cu (mg g$^{-1}$) | 0.34 |
| Zn (mg g$^{-1}$) | 1.18 |
| Fe (mg g$^{-1}$) | 6.15 |
| Mn (mg g$^{-1}$) | 45.45 |

Table 2: Chemical properties of the compost mixes used for the experiment

| Treatment | Ca | Mg(%) | Mn | Cu (ppm) | Zn | Fe | Na | K | P(%) | C | N | C:N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cd | 1.57 | 0.510 | 112.00 | 19.30 | 115.40 | 0.09 | 0.41 | 1.49 | 0.12 | 36.10 | 1.12 | 32:1 |
| Pm | 2.87 | 0.300 | 501.00 | 27.10 | 374.20 | 0.78 | 0.69 | 0.26 | 0.99 | 15.67 | 0.62 | 25:1 |
| Cp2Pm2:1 | 2.15 | 0.270 | 284.00 | 19.00 | 326.00 | 0.50 | 0.44 | 1.40 | 0.77 | 19.46 | 1.03 | 15:1 |
| Cp3Pm3:1 | 2.86 | 0.280 | 136.00 | 10.20 | 65.80 | 0.08 | 1.58 | 3.77 | 0.28 | 34.94 | 1.20 | 29:1 |
| Eg2Pm2:1 | 0.51 | 0.005 | 318.00 | 71.70 | 471.30 | 1.23 | 0.20 | 0.09 | 0.28 | 37.00 | 0.96 | 38:1 |
| Eg3Pm3:1 | 5.26 | 0.300 | 314.00 | 20.80 | 396.50 | 0.51 | 0.45 | 3.91 | 0.97 | 14.64 | 0.99 | 15:1 |

Cd: Cow dung; Pm: Poultry manure; Cp3Pm: Cassava peel+poultry manure (3:1); Cp2Pm: Cassava peel+poultry manure (2:1); Eg3Pm: Elephant grass+poultry manure (3:1); Eg2Pm: Elephant grass+poultry manure (2:1)

Table 3: Effect of organic amendments on vegetative growth of Moringa oleifera in the nursery

| Treatments | Plant height (cm) | Stem girth (cm) | No. of leaves/plant |
|---|---|---|---|
| **First Planting November 2008-January 2009** | | | |
| Cts | 43.2b | 0.41a | 9.1b |
| Cd | 50.3a | 0.44a | 10.1a |
| Pm | 38.6c | 0.37a | 8.7c |
| Cp3Pm | 38.6c | 0.41a | 9.2b |
| Cp2Pm | 40.3bc | 0.37a | 8.6b |
| Eg3Pm | 42.6b | 0.54a | 9.7a |
| Eg2Pm | 31.8d | 0.41a | 8.9b |
| **Second planting February – April 2009** | | | |
| Cts | 24.7d | 0.40a | 11.0c |
| Cd | 28.3b | 0.52a | 13.7a |
| Pm | 26.4c | 0.48a | 11.8b |
| Cp3Pm | 31.2a | 0.48a | 12.3b |
| Cp2Pm | 26.5c | 0.50a | 11.1c |
| Eg3Pm | 28.7b | 0.50a | 14.2a |
| Eg2Pm | 20.7e | 0.41a | 9.6d |

Means with the same letters along columns are not significantly different at $p<0.05$. CTs: control; Cd : Cow dung; Pm: Poultry manure; Cp3Pm: Cassava peel+poultry manure (3:1); Cp2Pm: Cassava peel+poultry manure (2:1); Eg3Pm: Elephant grass+poultry manure (3:1); Eg2Pm: Elephant grass + poultry manure (2:1)

Table 4: Effect of organic amendments on fresh and dry weight of *Moringa oleifera*

| TRT | Shoot fresh weight | Root fresh weight | Leaves dry weight | Stem dry weight | Root dry weight |
|---|---|---|---|---|---|
| | (g plant$^{-1}$) | | | | |
| **First Planting November, 2008 - January 2009)** | | | | | |
| Cts | 9.43d | 4.94d | 1.30c | 1.10c1 | 1.61e |
| Cd | 12.28b | 8.43a | 1.83a | 1.70a | 3.94a |
| Pm | 10.56c | 6.03b | 0.98d | 1.10c | 2.24d |
| Cp3Pm | 13.29a | 8.06a | 1.37b | 1.86a | 3.29bc |
| Cp2Pm | 9.17d | 7.08c | 1.42b | 1.43b | 2.83c |
| Eg3Pm | 11.02c | 3.41c | 1.35bc | 1.45b | 3.61ab |
| Eg2Pm | 8.40e | 3.58d | 0.91d | 1.15c | 2.19d |
| **Second Planting February - April 2009)** | | | | | |
| Cts | 10.95d | 7.4b | 1.64bc | 1.99a | 2.90b |
| Cd | 25.30a | 9.8a | 1.94a | 1.50c | 3.90a |
| Pm | 16.75c | 5.6c | 1.30d | 1.50c | 2.70c |
| Cp3Pm | 16.71c | 8.4b | 1.46c | 1.30d | 2.4d |
| Cp2Pm | 17.69c | 6.1c | 1.31d | 1.64b | 2.2d |
| Eg3Pm | 19.52b | 4.4d | 1.75ab | 1.54c | 3.0b |
| Eg2Pm | 16.89c | 7.7b | 1.54c | 0.15e | 2.2d |

Means with the same letters along columns are not significantly different at $p<0.05$. Cts: control; Cd: Cow dung; Pm: Poultry manure; Cp3Pm: Cassava+poultry manure (3:1); Cp2Pm: Cassava+poultry manure (2:1); Eg3Pm: Elephant grass+poultry manure (3:1); Eg2Pm: Elephant grass+poultry manure (2:1)

more leaves. The order of performance of moringa seedlings in the treatments was cow dung>elephant grass and poultry manure (3:1)>cassava peel mixed with poultry manure (3:1) (Table 3). Application of organic amendments also significantly ($p<0.05$) affected fresh weight of moringa seedlings harvested at six weeks after planting (6WAP), cow dung and cassava peel plus poultry manure (3:1) treated plots had higher fresh shoot and root weight in the first planting (Table 4), but in the second planting, moringa seedlings grown with cow dung significantly had higher shoot and root fresh weight (Table 4).

**Dry matter partitioning:** Dry matter partitioning to roots, stem and roots was influenced by organic amendment with cow dung amended plots significantly ($p<0.05$)producing higher root, stem and leaf dry weights (Table 4). This was closely followed by the performance of seedlings raised with cassava peel plus poultry manure (3:1) in the first planting and Elephant

Table 5: Effect of organic amendments on shoot nutrient uptake of *Moringa oleifera* 7 Weeks after planting (WAP)

| TRT | N | P | K | C | Ca | Mg | Mn | Fe | Cu | Zn |
|---|---|---|---|---|---|---|---|---|---|---|
| | (%) | | | | | | (ppm) | | | |
| Cts | 3.09e | 0.43d | 2.71e | 87.2a | 1.08e | 0.32de | 25.77e | 86.39c | 2.39e | 78.43a |
| Cd | 2.89f | 0.30e | 2.95c | 85.4bc | 1.17d | 0.41b | 24.08f | 87.16b | 2.25f | 27.41c |
| Pm | 3.34c | 0.59a | 3.31b | 86.6ab | 1.26bc | 0.36c | 22.88g | 85.27d | 3.25a | 20.57f |
| Cp3Pm | 3.54b | 0.43d | 2.19g | 86.2ab | 0.60f | 0.35cd | 27.87c | 87.54a | 2.59d | 22.98e |
| Cp2Pm | 3.61a | 0.47c | 2.62f | 87.61a | 1.41a | 0.32de | 28.13b | 82.34f | 2.41e | 30.57b |
| Eg3Pm | 3.55b | 0.45cd | 2.81d | 87.64a | 1.28b | 0.59a | 25.88d | 83.47e | 2.97b | 27.15d |
| Eg2pm | 3.21d | 0.30b | 3.96a | 84.13c | 1.24c | 0.31e | 29.32a | 67.69g | 2.86c | 19.84g |

Means with the same letters along columns are not significantly different at $p<0.05$. Cts: Control; Cd: Cow dung; Pm: Poultry manure; Cp3Pm: Cassava+poultry manure (3:1); Cp2Pm: Cassava+poultry manure (2:1); Eg3Pm: Elephant grass+poultry manure (3:1); Eg2Pm: Elephant grass+poultry manure (2:1)

grass plus poultry manure (3:1) in the second planting (Table 4).

**Shoot nutrient uptake:** Uptake of nutrients into the shoot of *Moringa oleifera* was significantly ($p<0.05$) affected by organic amendments. Cassava peel plus poultry manure (3:1) gave the highest value for Nitrogen (N) uptake, Poultry manure had the highest value for Phosphorus, Elephant grass plus Poultry manure (3:1) had the highest value for Potassium (K). For micronutrients uptake, Elephant grass plus Poultry manure (3:1) gave the highest value for Manganese (Mn) and Iron (Fe) and Poultry manure alone had the highest value for Cupper (Cu) uptake (Table 5).

## DISCUSSION

The application of organic manures to soil provides potential benefits including improving the fertility, structure, water holding capacity of soil, increasing soil organic matter and reducing the amount of synthetic fertilizer needed for crop production (Akanbi, 2002; Phan *et al*., 2002; Blay *et al*., 2002). The effect of compost and other organic amendment on crop growth and development may be the result of the interaction between the nutrients present and plant growth hormones, as compost and co-compost has been found to contain auxins, gibberellins and cytokinins (Miezah *et al*., 2008). They are the main sources of nitrogen (N) and other nutrients supply in organic crop production. In this study, low levels of nitrogen, phosphorus and organic contents were observed in the soil used for the study, thus corroborating the reports of Aduayi *et al*. (2002) that most Nigerian soil are deficient in Nitrogen, Phosphorus and Potassium. A sustainable method of improving the nutritional status of these soils is the use of organic amendments, which include poultry droppings, cow dung, plant materials and other municipal waste.

The higher stem height and number of leaves observed in both experiments with cow dung application, followed by cassava peel mixed with poultry manure on 3:1, showed that cow dung and other compost mixes application aided vegetative development of *Moringa oleifera* in the nursery, but the superior performance of cow dung may be due to its higher nitrogen content. Cow dung is a mixture of dung and urine, generally in the ratio of 3:1 (Onwudike, 2010; Benckiser and Simarmata, 1994; Sommerfelt and Chung, 1985). It contains crude fibre, crude protein and materials that can be obtained in nitrogen-free extracts and ether extracts. It also contains micronutrients. The urine portion of cow dung consists of nitrogen, potash, sulphur and traces of phosphorus. When seed is treated with cow dung in various ways, it gets coated with cow dung residue that contains cellulose, hemi cellulose, micronutrients, metabolic nitrogen, and epithelial cells from the animals, bile salt and pigment, potash, sulphur, traces of phosphorus and a large number of bacteria. This thin dry layer of residue on seed absorbs moisture from the surrounding soil to the advantage of the seed. The presence of bacteria in cow dung plays a significant role in the development of the seed. As these cow dung bacteria have the capacity to utilize cellulose, hemi cellulose and pectin, so these can quickly colonize the area around sown seed and compete with the pathogenic fungi and bacteria and prevent them from attacking the seed thus resulting in higher seedling establishment. Earlier reports by Hageman (1986), Gungula (1999) and Akanbi *et al*. (2000) confirmed that nutrient availability especially nitrogen (N) determined plant vegetative development. The consistent poor performance of non-fertilized plants and those planted with low nitrogen amendment revealed that when nutrients are available at adequate amounts, plants tends to grow at their optimum potential. Bittenbender *et al.* (1998) reported significant reduction in plant growth parameters when soil is deficient in nutrient most especially nitrogen as they are often required for chlorophyll and protoplasm formation (Hay and Walker, 1989). The dry matter accumulation significantly increased with increased Nitrogen (N) content of the amendments and the highest values were recorded with cow dung and cassava peel mixed with poultry manure on 3:1 dry basis. The low dry matter at low nitrogen content shows that nutrient availability especially nitrogen greatly affects the photosynthetic activities of the plants and storage of dry matter assimilated. Nitrogen availability from applied manure includes the inorganic N ($NO^{3-}$-N and $NH^{4}$-N) in manure plus the amount of organic N mineralized following application. Nitrogen mineralization differs for different manure types since the inorganic/organic fraction and quality of organic N varies (Eghball *et al*., 2002; Jae-Hoon *et al*., 2006).

Accumulation of N, P and K in moringa seedlings was shown to have been significantly ($p<0.05$) influenced by application of different organic amendments, this agreed with the result of Chukwuka and Omotayo (2009) that application of organic amendment significantly improved chemical properties of soil and nutrients uptakes in plants. Cassava compost (CP 3:1) had the highest value for Nitrogen (N) uptake, Poultry manure had the highest value for Phosphorus, Elephant grass (3:1) had the highest value for Potassium (K). For micronutrients uptake, Elephant grass (3:1) had the highest value for Manganese (Mn) and Iron (Fe) and Poultry manure had the highest value for Cupper (Cu). Depending on the purpose of production, available organic material and the available resources, farmers can formulate any of these organic amendments for moringa in the nursery.

## CONCLUSION

The nutrient composition of the organic amendment used for the experiment varied with its mixing ratio. From the results, it appears that addition of organic amendment increased both vegetative and dry matter yield of moringa. Cow dung at 5 t $h^{-1}$ significantly increased the vegetative growth and dry matter uptake of moringa oleifera in the nursery.

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