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Effects of cow dung manure and NPK fertilizer on the growth characteristics of Moringa (*Moringa oleifera* Lam.) in Gombe, Northeastern Nigeria

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Abstract

A pot experiment was conducted at the Demonstration farm of the Department of Agricultural Education, Federal College of Education (Technical), Gombe during the 2018/2019 dry season to investigate the effect of cow dung and NPK fertilizer on the seedling growth characters of Moringa. The treatment consisted of four levels of cow dung (0, 5, 10, and 15 t/ha) and three levels of 20:10:10 NPK fertilizer (0, 50, and 100 kg/ha) arranged in a randomized complete block design (RCBD) replicated three times. The data collected were subjected to analysis of variance (ANOVA) using STAR software. Significant means were separated at 5% probability level ($P<0.05$) using Least Significant Difference (LSD). The growth parameters measured include plant height, number of leaves per plant, number of branches per plant, plant girth, and leaf area. The result showed that application of cow dung at 15 t/ha and 50 kg/ha NPK fertilizer produced the greatest plant height, higher number of leaves, greater plant girth, and highest leaf area. Cow dung at 15 t/ha combined with 50 kg/ha NPK fertilizer which produced better growth parameters than other combinations is hereby recommended for farmers in the study area for optimum production of Moringa.

Keywords: Cow dung, growth, manure, Moringa, NPK fertilizer

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1.0 Introduction

Moringa oleifera is the most widely cultivated species in the genus Moringa. The Moringa tree is grown mainly in the semi-arid, tropical, and subtropical areas. The tree is native to northern India, but today it is a common tree throughout the tropical and sub-tropical regions of Asia, Africa, and Latin America. Moringa grows easily from seeds or through cuttings, they grow quickly even in the poor soil and bloom eight (8) months after planting (Rockwood *et al.*, 2013).

Moringa seed oil is beneficial for protecting hair against free radicals and keeps it clean and healthy. Moringa also contains proteins, which means it helps to protect skin cells from damage. It also contains hydrating and detoxifying elements which also boosts the skin and hair tone (Rockwood *et al*., 2013). *Moringa oleifera* extracts help treat some stomach disorders such as constipation, gastritis, and ulcerative colitis. The antibiotic and antibacterial properties of Moringa help inhibit the growth of various pathogens and its high vitamin B content help indigestion. Due to its antibacterial, antifungal, and antimicrobial properties, Moringa extracts can combat infections caused by Salmonella, *Rhizopus,* and *E. coli* (Kasolo *et al.,* 2010). Despite the high nutritional value, farmers that plant them around their farms do not apply any form of nutrients to enhance the plant growth and development (REF).

Application of organic manure such as cow dung to Moringa produces taller plants, higher number of leaves and branches (Agbogidi, 2012). The higher value of morphological and yield traits obtained with organic manure application is an indication that the tree responds positively to organic manure application (Agbogidi, 2012). Moringa grows best in organic manure mixed with loamy or sandy soil and can tolerate poor soil, but not waterlogged soil (Aregheore, 2012). Moringa is especially promising as a food source in the tropics and does better when inorganic fertilizer such as NPK is applied (Aiyelaagbe, 2011). Inorganic fertilizer helps in the fast growth of Moringa, enhancing its ability to produce a healthy plant (Mbikay, 2012). Application of phosphorus and nitrogen fertilizers to Moringa will encourage root development as well as leaf canopy growth. According to Ainikan & Amans (2011), the crop growth and vegetable yield parameter of Moringa have positive correlation to the amount of NPK fertilizer applied (). Furthermore, higher application of phosphorus may expose the plant nutrient to a larger surface area that enhances fixation of the nutrient (Ehigioto *et al.,* 2011). Moringa needs potassium for growth and the plant turns nitrogen into carbohydrates, amino acid, and protein needed for good growth (Mbikay, 2012). However, the use of excess fertilizer can result in several problems, such as nutrient loss, surface and groundwater contamination, soil acidification or basification, reduction in useful microbial communities, and increase sensitivity to harmful insects (Ndukwe *et al.,* 2011). Similarly, improvement in growth in response to inorganic fertilizer has been reported (Aiyeleagbe, 2011).

The need to intensify production of *Moringa oleifera* among farmers and to sustain the fertility of the soil while engaging in large-scale production cannot be overemphasized because the tree is an extremely valuable food source. Therefore, this study evaluates the effect of Cow dung and NPK fertilization on the growth characteristics of Moringa.

2.0 Materials and methods

A pot experiment was carried out at the Demonstration Farm of the School of Vocational Education, Federal College of Technical Education, Gombe (Latitude 930 N and Longitude 8^0 45 E) in Northern Guinea Savannah during the 2018/2019 dry season to assess the growth characteristics of Moringa, to which was applied different levels of cow dung and NPK fertilizer.

The experimental design used was Randomized Complete Block Design (RCBD), with treatments consisting0, 5, 10, and 15 t/ha of cow dung (CD) and 0, 50, and 100 kg/ha NPK fertilizer replicated three times. Moringa seeds were sown at two to three per hole into the experimental pots 14 days after curing. Shade was provided to minimize water loss through evaporation and transpiration from the seedlings. Parameters monitored were plant height, number of branches per plant, number of leaves per plant, and leaf area (cm^2). All the data collected were subjected to analysis of variance (ANOVA) using STAR statistical software. Treatment means were separated using the Least Significant Difference (LSD) at 5% probability level ($P<0.05$).

3.0 Results

3.1 Physical and Chemical Properties of the Experimental Site and Organic Manure Used

The physicochemical analysis of the soil (Table 1) showed that the soil was sandy loam in texture with 81.61%, 6.92%, and 11.47% of sand, silt, and clay respectively. It was slightly acidic with a pH of 5.22, low in available phosphorus (8.98 mg/kg), total nitrogen (0.06), and organic carbon (2.53 %). The soil is also low in most of the exchangeable bases, calcium (7.46 cmol/kg), magnesium (2.09 cmol/kg), sodium (0.07 cmol/kg) and potassium (0.13 cmol/kg). These values imply that the soil used for the trial was low in most of the nutrients which were beyond the critical levels (Enwezor *et al.,* 1989) and at such will lead to low fertility.

The composition of cow dung is indicated in Table 2. The results showed that the pH value was alkaline (8.68), organic carbon of 27.09 %, total nitrogen (1.61 %), available phosphorus was 8 %, exchangeable bases (Ca 1.07; Mg 0.58; K 0.23), and heavy metals (Fe 0.14; Mn 158; Cu 4.00 and Zn 45 %).

3.2 Effect of cow dung and NPK Fertilizer on plant height

The main effect of cow dung and NPK fertilizer on plant height is shown in Table 3. The result indicated that plants that received 15 t/ha cow dung, 15 t/ha cow dung + 50 kg/ha NPK, and 10 t/ha cow dung produced taller plants than other treatments with values of 15.10 cm, 13.60 cm, and 11.30 cm respectively at 2 weeks after planting. Similarly at 4, 6, 8, and 10 weeks after planting (WAP) revealed similar trends where plant height for 15t/ha CD (23.53cm), 15 t/ha CD + 50kg/ha NPK (24.50cm), 10t/ha CD + 100kg/ha NPK (16cm). The trend is the same for 6, 8, and10WAP the short plants were obtained from plants with zero treatment (9.97cm), 13.80cm, 19.23cm, 24.17cm and 30.80cm at 2, 4, 6, 8 and 10 WAP respectively.

3.3 Effect of cow dung and NPK fertilizer on number of leaves per plant

The main effect of cow dung manure and NPK fertilizer on the number of leaves per plant is shown in Table 4. The results indicated that plants that received 15t/ha CD + 50kg/ha NPK and 10t/ha cow dung manure, produced more leaves per plant than other treatments with the value of 25.00cm, 23.33cm, and 22.67cm respectively at 2 weeks after planting. Similarly at 4, 6, 8 and 10 weeks after planting revealed similar trends. The number of leaves per plant for plants applied 15t/ha CD was 66.67cm, those applied 15t/ha CD + 50t/ha NPK fertilizer (53.67cm) and those that received 10t/ha CD + 100kg/ha NPK (73.33cm). The trend is the same for 6, 8 and 10 WAP. The least number of leaves per plant were obtained from the control (no cow dung and NPK fertilizer) with values of 22.00 cm, 51.33 cm, 102.67 cm, 135.67 cm and 269.00 cm at 2, 4, 6, 8 and 10 WAP respectively.

3.4 Effect of cow dung and NPK fertilizer on number of branches per plant

The main effect of cow dung on the number of branches per plant is shown in Table 5. The results indicated that plants that received 15 t/ha cow dung recorded the highest number of branches per plant with values of 3, 5.33, 8, 10.44 and 12.89 at 2, 4, 6, 8 and 10 WAP respectively (Table 5).

3.5 Effect of cow dung and NPK fertilizer on plant leaf area

The main effect of cow dung and NPK fertilizer for leaf area is shown in Table 6. The result indicated that plants that received 15 t/ha recorded the greatest leaf area with the value of 4.84 cm^2, followed by those applied 10 t/ha + 50 kg/ha (3.52 cm^2), while the control (0 t/ha CD & 0 kg/ha NPK) had the least value of leaf area (1.61 cm^2). Similarly, plants applied 15 t/ha produced the greatest leaf area at 4, 6 and 8 WAP with values of 8, 10.41 and 14.41 cm^2 respectively, but 10 WAP, plants applied 10 t/ha recorded the greatest leaf area of 17.44 cm^2 (Table 6). The least values leaf area was obtained from the control (no cow dung and no NPK) with 1.61, 2.41, 3.54, 4.79 and 6.11 cm^2 for 2, 4, 6, 8 and 10

WAP.

3.6 Effect of cow dung and NPK fertilizer on plant girth

The result from the Analysis of Variance for plant girth is presented in Table 7. Results revealed that the effect of cow dung on plant girth was significant (P<0.05) at 2 WAP but highly significant (p<0.01) at 4, 6, 8 and 10 WAP, while that of NPK fertilization was significant (p<0.05) at 6 and 10 WAP, cow dung at 2 WAP and showed highly significant (p<0.01) effect at 4, 6, 8 and 10 WAP.

The main effects of cow dung and NPK fertilizer is shown in Table 7. Plants applied 15 t/ha recorded the greatest values of plant girth with 2.07, 2.77, 3.31, 3.82 and 4.44 cm at 2, 4, 6, 8 and 10 WAP respectively. The least plant girth values of 1.32, 1.58, 2.08, 2.59 and 3.13 cm were obtained from control (0 t/ha) at 2, 4, 6, 8 and 10 WAP respectively. Similarly, plants that received 100 kg/ha NPK fertilizer produced the greatest values of plant girth with 2.88 cm and 4.03 cm at 6 and 10 WAP respectively, while the control (0 kg/ha) had the least girths of 2.57 cm and 3.67 cm at 6 and 10 WAP respectively (Table 7).

Table 1: Physical and Chemical Properties of the Experimental Site during the Experiment

Soil Properties	Values
Physical Composition (%)	
Sand	81.61
Silt	6.92
Clay	11.47
Textural class	Sandy loam
Chemical composition	
pH in water	5.22
Organic carbon (g/kg)	2.53
Total nitrogen (g/kg)	0.06
Available phosphorus (mg/kg)	8.98
EC (dS/m)	0.45
Exchangeable bases (cmol/kg)	
Ca^{++}	7.46
Mg^{++}	2.09
K^{-}	0.13
Na	0.07
Base saturation (%)	74.33

Table 2: Chemical Composition of Cow Dung used during the Experiment

Chemical composition	Values
pH in water	8.68
Organic carbon (%)	27.09
Total nitrogen (%)	1.61
Available phosphorus (%)	8.00
Potassium (%)	0.23
Calcium (%)	1.07
Magnesium (%)	0.58
Iron (%)	0.14
Manganese (g/kg)	158.00
Copper (g/kg)	4.00
Zinc (g/kg)	45.00

Table 3: Effects of Cow dung and NPK fertilizer on Moringa Plant Height (cm)

Treatments	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP
0 (t/ha) CD	9.97d	13.8c	19.23c	24.17c	30.83c
5 (t/ha) CD	13.49c	19.33b	26.37b	39.03b	50.67b
10 (t/ha) CD	14.23b	20.00b	27.40b	40.8b	54.77ab
15 (t/ha) CD	15.10a	23.53a	32.47a	46.97a	60.03a
50 kg/ha NPK	9.31d	14.57d	19.95c	26.97c	36.67c
5 t/ha CD + 50 kg/ha NPK	11.17c	16.73c	23.83b	36.77b	48.50b
10 t/ha CD + 50 kg/ha NPK	12.57b	20.57b	33.43a	44.47a	54.33a
15 t/ha + 50 kg/ha NPK	13.60a	24.50a	36.13a	46.50a	57.17a
100 kg/ha NPK	9.11c	14.43c	19.30a	26.43c	35.80b
5 t/ha CD + 100 kg/ha NPK	10.43b	15.23b	19.90a	28.07bc	37.90b
10 t/ha CD + 100 kg/ha NPK	11.30a	16.00a	21.73a	31.97ab	41.13ab
15 t/ha + 100 kg/ha NPK	11.43a	16.63a	22.73a	33.93a	44.37a
LS	**	**	**	**	**
S.E.	0.2915	0.338	1.67	2.13	2.61
CV (%)	3.02	2.31	8.13	7.34	6.95

*and ** denote effects significant at 5 and 1% probability levels respectively

WAP=weeks after planting

Means with the same letter are not significantly different

Table 4: Effects Cow Dung and NPK Fertilizer on Number of Leaves per Plant

Treatment	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP
0 t/ha CD	22.00b	51.33b	102.67b	135.67b	269.00b
5 t/ha CD	22.67bc	61.67ab	113.67b	156.67b	293.67b
10 t/ha CD	23.00b	64.00a	116.67b	168.00b	278.33b
15 t/ha CD	25.00a	66.67a	313.33a	399.33a	526.67a
50 kg/ha CD	22.00b	60.33ab	99.67c	156.33c	254.67c
5 t/ha CD + 50 kg/ha NPK	22.00b	54.33b	189.67b	234.67bc	311.33bc
10 t/ha CD + 50 kg/ha NPK	21.67bc	68.00a	226.67ab	288.33ab	359.33ab
15 t/ha CD + 50 kg/ha NPK	23.33b	53.67b	258.33a	233.67a	409.33a
100 kg/ha NPK	21.67c	50.00b	121.33b	202.33b	298.00b
5 t/ha CD + 100 kg/ha NPK	22.00b	48.00b	189.00a	282.00ab	367.67ab
10 t/ha CD +100 kg/ha NPK	22.33b	65.33a	218.67a	348.67a	438.33a
15 t/ha CD +100 kg/ha NPK	22.67b	73.33a	242.33a	284.33ab	419.67a
LS	**	**	**	**	**
S.E.	0.40	5.15	25.89	40.36	35.97
CV (%)	2.18	10.57	17.36	19.84	12.51

* and ** denote effects significant at 5 and 1% probability levels respectively
WAP = weeks after planting
Means with the same letter are not significantly different

Table 5: Effects Cow Dung and NPK Fertilizer on Plant Leaf area (cm²)

Treatment	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP
0 t/ha CD	1.92b	2.41b	3.54b	4.79c	6.11c
5 t/ha CD	2.25b	2.50b	4.96b	8.40b	11.49b
10 t/ha CD	4.03a	6.26a	7.94a	12.90a	17.44a
15 t/ha CD	4.84a	8.00a	10.41a	14.03a	17.33a
50 kg/ha CD	1.61b	4.31a	5.15c	7.75c	9.03b
5 t/ha CD + 50 kg/ha NPK	2.05b	2.26a	5.79c	7.83c	9.55b
10 t/ha CD + 50 kg/ha NPK	3.52a	3.66a	4.38c	6.49c	9.38b
15 t/ha CD + 50 kg/ha NPK	2.61ab	3.32a	3.99d	5.92c	8.45b
100 kg/ha NPK	1.77a	2.80a	3.42d	5.27c	7.02c
5 t/ha CD + 100 kg/ha NPK	2.12a	3.62a	5.17c	7.85b	9.68ab
10 t/ha CD +100 kg/ha NPK	2.09b	2.83a	4.29b	6.44c	8.49b
15 t/ha CD +100 kg/ha NPK	2.05b	4.1a	5.64b	8.13b	12.15a
LS	*	**	**	**	**
S.E.	0.649	1.06	1.26	1.43	1.88
CV (%)	30.91	33.69	28.67	21.94	21.92

* and ** denote effects significant at 5 and 1% probability levels respectively
WAP = weeks after planting
Means with the same letter are not significantly different

Table 6: Effects Cow Dung and NPK Fertilizer on Plant girth (cm)

Treatment	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP
0 t/ha CD	1.32b	1.58c	2.08c	2.59c	3.13d
5 t/ha CD	1.68ab	2.163b	2.56b	3.16b	3.74c
10 t/ha CD	1.96a	2.51a	3.03a	3.47b	4.12b
15 t/ha CD	2.07a	2.74a	3.31a	3.82a	4.44a
LS	*	**	**	**	**
S.E.	0.22	0.16	0.14	0.15	0.15
CV (%)	26.36	15.11	10.48	9.96	8.44
0 kg/ha NPK	0	0	2.78ab	0	3.89ab
50 kg/ha NPK	0	0	2.57b	0	3.67b
100 kg/ha NPK	0	0	2.88a	0	4.03a
LS	0	0	*	0	*
S.E.	0	0	0.12	0	0.13
CV (%)	0	0	10.48	0	8.44

* and ** denote effects significant at 5 and 1% probability levels respectively
WAP = weeks after planting
Means with the same letter are not significantly different

4.0 Discussion

The higher value of morphological and yield traits obtained with organic manure and application of NPK fertilizer was a good indication that the Moringa plant responds positively to organic manure and NPK fertilizer application. This finding is similar to that of Agbogidi (2012) who reported that application of cow dung and NPK fertilizer increased the plant growth and leaves of *Moringa oleifera.* Plant applied 10 t/ha of cow dung and 100 kg/ha NPK fertilizer produced the highest number of leaves, although not significantly different from those that received 15 t/ha cow dung. Control had the least number of leaves per plant. This is similar to the findings of Adebayo *et al.* (2011) who reported that the application of cow dung tends to improve the chemical properties of the soil and plant organs such as leaves. The present result is in contrast with those of Asante *et al.* (2014) who reported that high application of nitrogen did not influence the production of Moringa leaves. (Why so in this study?)

5.0 Conclusion and Recommendation

Based on the findings of this study, it can be concluded that soil amendment of both organic and inorganic origin improved vegetative growth of the Moringa plant and that the best combination for optimum Moringa production is cow dung applied at 15 t/ha and 50 kg/ha NPK 15:15:15.

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