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Preliminary Study on the Effects of Two Different Sources of Organic Manure on the Growth Performance of Moringa oleifera Seedlings

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Abstract

The study was designed to investigate the effects of application of two sources of organic manure, namely poultry droppings and cow dung manure on the vegetative growth and photosynthetic pigments of *Moringa oleifera* seedlings. The experimental design was completely randomized design, consisting of 540 seedlings in black polythene bags fertilized with 15 g of organic manure per plant by point application of poultry dropping and cow dung. Thus, each seedling in the treatments received 15 g of either partly decomposed poultry droppings or 15 g of partly decomposed cow dung or none of the manure (ie controls). Seedling height, stem girth, root length and root girth were measured with a metre rule and the aid of a thread. Seedling dry weight and leaf relative water contents were also determined. Photosynthetic pigments were determined by the spectrophotometer technique. The results indicated that both sources of organic manure significantly ($p < 0.01$) increased growth performance of *Moringa oleifera* seedlings but the photosynthetic pigments in the leaves were not significantly affected by the effects of both sources of organic manure. The results thus showed that both poultry manure and cow dung are valuable sources of fertilizer for *Moringa oleifera* seedlings but poultry manure out-performed cow dung in all growth attributes assessed because it produced higher values for all the attributes. However, the values for chlorophyll and carotenoid content did not show clear-cut differences between the two sources of organic manure. It is therefore, recommended that in the event of a choice between the two for crop production in general and *Moringa* in particular, poultry manure would be a better option.

Keywords: Cow dung, *Moringa oleifera,* Organic manure, Poultry manure, Seedling.

Introduction

In recent times, *Moringa oleifera* has gained a lot of popularity due to recent discoveries of its usefulness to mankind, resulting in rapid growth in interest for the plant. Therefore, considerable research has been conducted into the extraction of its seed oil, use in agroforestry systems, water purification property, medicinal and nutritional benefits (Fuglie, 2001). This makes *M. oleifera* one of the most useful tropical plants. The relative ease, with which it propagates through both sexual and asexual means and its low demand for soil nutrients and water, makes its production and management easy. Hence introduction of this plant into agricultural land use system can be beneficial to both the owner of the farm and the surrounding ecosystem (Foidl *et al*., 2001). It is a fast growing plant reaching 6-7 m in a year in areas receiving less than 400 mm annual rainfall (Odee, 1998). Interest in *Moringa* in recent times is skewed towards its medicinal properties and, hence, much research has gone into this aspect. Consequently, the demand for the plant products has been on ascendancy. However, not much work has been done on its cultivation especially in the different ecological zones of Ghana with respect to its growth and productivity using the different types of organic manure commonly used by local farmers. According to Agyenim-Boateng *et al*. (2006), there is generally little use of organic manure, especially poultry manure in Ghana even though this commodity abounds nationwide owing to the growing poultry enterprise and the paucity of knowledge on their effects on crops for efficient utilization.

Generally, most soils in Ghana have organic matter content falling below one percent, low phosphorus and high acidic medium (pH below 5) leading to low plant productivity. Furthermore, the rising cost of inorganic fertilizers coupled with their inability to condition the soil has directed attention to organic manures in recent times. (Agyenim-Baoteng *et al.*, 2006). The use of organic manure as fertilizer releases many important nutrients into the soil and also nourishes soil organisms, which in turn slowly and steadily make minerals available to plants (Erin, 2007). Organic materials serve not only as sources of plant nutrients but also as soil conditioners by improving soil physical properties, as evidenced by increased water infiltration, water holding capacity, aeration and permeability, soil aggregation and rooting depth, and by decreased soil crusting, bulk density and erosion (Allison, 1973; USDA, 1978) Usually, when organic wastes of acceptable quality are returned to agricultural soils on regular basis they contribute greatly to the overall maintenance of soil fertility and productivity, and reduce the need for mineral fertilizer (Parr and Colacicco, 1987). According to Cox and Atkins (1979), ecologically sound agricultural technologies that do not sacrifice productivity are feasible and one of such practices is to employ the use of organic materials to fertilize the land for both food crop and tree crop production. Amojoyegbe *et al,* (2007) have concluded that the use of organic manure and inorganic fertilizer resulted in improvement in crop yield, and this suggests that their use would aid both the vegetative and post-anthesis development of the plant.

The leaf relative water contents of the seedlings were determined because the experiment was conducted in the dry season, and since water deficit in plants has several adverse physiological consequences such as reduced tissue relative water content, reduced photosynthesis, reduced hormonal levels and general reduction in metabolism, it was relevant to assess this parameter against the stated objective. As pointed out by Chaves, (1987), most plant species experience a decline in their tissue relative water content due to water stress, leading finally to a decline in net photosynthesis and ultimate yield. Decreased photosynthetic capacity usually occurs at relative water content below 70% which in many plants correspond to severe wilting of leaves but these inhibitory effects are still reversible down to 30% - 40% of relative water content (Kaiser, 1987).

The efficiency of photosynthesis of the plant is crucial to agriculture, forestry and ecology, especially in analysing productivity for food, fuel and many other useful products for man (Hall and Rao, 1999). This together with the quality and quantity of incident light, temperature and availability and utilization of nutrients (manure) in the soil are among other factors that affect plant productivity. Green plants contain a variety of pigments that are responsible for trapping the sun's energy for primary productivity; the major ones among these include chlorophylls and carotenoids, without which growth and biomass accumulation in plants would be adversely affected or cease completely. Foidl *et al*., (2001) reported chlorophyll contents of *Moringa* leaves and stems to be 6890 $mgkg^{-1}$ and 271.1 $mgkg^{-1}$ dry weight respectively while carotenoids contents of the leaves and stems to be 1508 $mgkg^{-1}$and 34.4 $mgkg^{-1}$ dry weight respectively. This study, therefore, sought to compare the effects of poultry manure and cow dung manure on the growth, biomass accumulation and some photosynthetic pigment-contents of *Moringa oleifera* seedlings.

Materials and Methods

Study Area

The experiment was conducted on the Navrongo campus of the University for Development Studies, which is located at latitude 10º 54'N and longitude 01º 06'W. The daily minimum and maximum temperatures at the experimental site were 32ºC and 47ºC, respectively while relative humidity was between 36 and 58 percent. Navrongo experiences unimodal rainfall pattern with an annual rainfall of about 1100 mm, with a single peak in August but the total amount of rainfall received during the experimental period was 119.9mm (Meteorological Services, Unpublished).

Plant Culture and Treatment

Five hundred and forty (540) black polythene bags of size 18 cm x 12 cm were each perforated with two holes at the bottom to facilitate drainage and filled with thoroughly mixed loamy soil. Three *Moringa* seeds were sown in each polythene bag and when they germinated, the seedlings were thinned to one per polythene bag. The inter row and intra row spacing between the polythene bags at the experimental site were 90 cm x 40 cm, respectively, giving a density of six plants/m². Each seedling received 400 ml of water two times daily until they were 17 days old when the treatments began. All the seedlings continued to be subjected to the same watering regime throughout the experimental period.

Completely Randomized Design was used in three replications. One group received 15.0 g of partly decomposed poultry manure per each seedling, while the other group received 15.0 g of partly decomposed cow dung manure. No manure was applied in the third group, which served as the control.

Data were collected at seven days interval, beginning from when the seedlings were 24 days old and seven days after treatments were imposed.

Growth Measurements

Six seedlings were randomly selected from each treatment and the shoot height, stem girth, root length, root girth (bulb tap root) and plant dry weight determined. Seedling height was measured from the soil surface to the shoot apex with a thread and a metre rule. Stem girth was measured at a height of 10.3 cm from the base of each stem with the aid of vernier callipers, while root length was measured from the base of the bulb tap root to the tip after they had been removed from the polythene bags and the soil washed off. Root girth (bulb) was also determined at a length of 3 cm away from stem base of each seedling with the aid of thread and a metre rule. Plant dry weight was determined after carefully removing the seedlings from the growing medium and washed off any soil particles. The seedlings were divided into root and shoot components for each treatment and put in separate envelopes and dried in an oven set at 80ºC for 48 hrs. The dried plant materials were removed from the oven and allowed to cool under a desiccator and their dry weights determined with an electronic balance.

Quantitative Determination of Photosynthetic Pigments

An amount of 0.50 g fresh basal leaf excluding the midrib of each seedling was weighed and ground with 10 ml 80% acetone with the use of a mortar and a pestle. The green solution obtained was then filtered and the final volume of the pigment extract was adjusted to 50 ml by adding more 80% acetone. The absorbance of the extract was determined using a Jenway 6305 spectrophotometer set at 480 nm, 645 nm and 663 nm wavelengths.

The amount of total chlorophyll (in milligrams) present in the extracts was obtained using the formula described by Witham *et al* (1986) Viz:

$$\text{mg total chlorophyll g/tissue} = 20.2\,(A645) + 8.02\,(A663) \times \frac{V}{10^3 W}$$

Where: A is the absorbance reading of pigment extract at specific wavelength indicated.

V is the final volume of the acetone pigment extract and

W is the fresh (gram) weight of tissue extracted.

The carotenoid contents were also determined using the method described by Kirk and Allen (1965) as:

$$\frac{Car}{480} = A\,480 + 0.114\,(A663) - 0.638\,(A645)$$

Where $\frac{car}{480}$ is the change in carotenoid at 480 nm and

A is the absorbance at specific wavelength.

Determination of Leaf Relative Water Content

The basal leaf of each seedling was randomly selected and used for the determination of relative water content (RWC). Twenty leaf discs were cut out using a 0.7 cm cork borer and the fresh weights (FW) of the discs determined with the aid of an electronic balance. The discs were then floated in distilled water inside petri dishes. The petri dishes containing the leaf discs were allowed to stand for 3 hours under normal laboratory conditions. The discs were removed and blotted with filter paper and the saturated weights (SW) were quickly determined. The leaf discs were then put in labelled envelopes and placed in an oven set at 80ºC for 24 hours. The envelopes were removed after this period and allowed to cool in a desiccator and the dry weights (DW) of the leaf discs determined. The percent relative water content of the leaf discs was then calculated using the relation: $\frac{SW-DW}{FW-DW} \times 100$

Data Analysis

Data on plant shoot height, stem girth, root length, root girth and seedling dry weight as well as photosynthetic pigment contents were analyzed using a one-way analysis of variance (ANOVA) and where significant differences occurred between the treatments means, the least significant differences (LSDs) method was used to separate the means.

Results and Discussion

Effect of Organic Manure on Shoot Height and Stem Girth of *Moringa* Seedlings

The shoot height of seedlings treated with poultry manure produced the highest length compared to those treated with cow dung manure and controls respectively (Table 1). Those seedlings treated with cow dung manure also out-performed the controls in terms of plant height. The mean shoot height in the poultry manure- treated seedlings (0.49 m) and cow dung manure- treated seedlings (0.42 m) were significantly higher ($p > 0.01$) than seedling shoot height (0.35 m) of the control set-up. Shoot heights of poultry manure and cow dung manure- treated seedlings were however, not significantly ($p < 0.01$) different from each other. There were significant ($p > 0.01$) differences in the shoot height between those treated with organic manure and the controls respectively. There were however, no significant ($p < 0.01$) differences between those seedlings treated with poultry manure and cow dung manure, in spite of the fact that the values for seedlings heights in those treated with poultry manure were slightly higher than those treated with cow dung manure. Also, between the seedlings treated with cow dung manure and the controls, there were no significant ($p < 0.01$) differences, although, those treated with cow dung manure produced higher values for plant height than those of the controls. The poultry manure- treated seedlings however, showed a significant ($p > 0.001$) difference between them and those of the controls. This may probably be due to the fact that poultry manure contains concentrated nutrients and hence led to enhanced plant growth in those seedlings treated with poultry manure. The nutrient quality in poultry manure might surpass the ones in cow dung manure leading to more enhanced plant growth in those treated with poultry manure. The bulk of cow dung manure might probably be materials that do not significantly enhance plant growth as compared to those found in poultry manure. Other authors found significant improved height in maize using poultry manure (Obi and Ebo, 1995; Agyenim-Boateng *et al*, 2006).

The average plant growth in those seedlings treated with poultry manure was 0.49 m per week while average seedling growth in those treated with cow dung manure was 0.42 m per week and that of controls was 0.35 m per week. These values showed appreciable growth rates even in the controls. This generally implies that the plant is a fast growing species and this conforms to the earlier findings by Odee (1998), that *Moringa* is a fast growing plant and grows between 6 to 7 m per annum even in areas receiving less than 400 mm of rainfall.

Stem girth of the seedlings also followed a similar pattern with the highest values recorded by those treated with poultry manure, followed by those treated with cow dung manure and the controls recorded the least (Table 1), indicating the superiority of poultry mature over cow dung in seedling height and girth. There were no significant ($p < 0.1$) differences between seedlings treated with poultry manure and the ones treated with cow dung manure, although those treated with poultry manure showed progressively higher stem girth values than their counterparts treated with cow dung manure. Also, the seedlings treated with cow dung manure showed no significant differences between them and the controls but those seedlings treated with poultry manure showed a significant ($p > 0.001$) difference between them and those of the controls with respect to their stem girths. The stem girth values of the seedlings were in the order: poultry manure- treated seedlings > cow dung manure- treated seedlings > controls.

Table 1: Mean shoot height and stem girth increment of *Moringa* seedlings treated with organic manure.

No. of Weeks after Treatment	**Shoot Height (cm)**			**Stem Girth (cm)**		
	Poultry Manure	Cow Dung	Controls	Poultry Manure	Cow Dung	Controls
1	24.5	23.0	22.8	1.6	1.6	1.5
2	36.8	29.3	23.9	2.1	1.8	1.7
3	43.4	31.3	28.3	2.5	2.0	1.8
4	45.1	33.9	31.8	2.6	2.1	1.9
5	45.9	38.8	33.8	2.6	2.4	2.0
6	47.6	42.0	38.1	2.7	2.4	2.1
7	54.3	48.1	38.4	2.7	2.4	2.1
8	55.1	48.6	38.7	2.9	2.5	2.2
9	55.6	50.9	40.3	2.9	2.6	2.3
10	56.9	52.1	41.6	3.1	2.8	2.4
11	58.4	53.2	42.2	3.2	2.9	2.4
12	59.7	54.4	43.1	3.5	3.1	2.5
SD ±	9.9	10.3	6.8	0.5	0.4	0.3

Effect of Organic Manure on Root Length and Root Girth of Moringa Seedlings

Organic manure generally increased root length and root girth of *Moringa oleifera* seedlings as compared to the controls (Table 2). Organic manure in the form of poultry manure had significantly ($p > 0.01$) increased the root growth estimates of *Moringa* seedlings. Thus, values for both the root length and root girth of seedlings treated with poultry manure increased significantly over the controls, indicating that poultry droppings are valuable sources of nutrients for *Moringa* growth. Also, seedlings treated with poultry manure significantly ($p > 0.01$) increased in root length as compared to those treated with cow dung manure but the root girth of seedlings treated with both sources of organic manure showed no significant differences between the two sources. The seedlings treated with cow dung manure showed no any significant differences between their root lengths and girths and those of the controls but the values for those treated with cow dung manure generally recorded higher values than those of the controls. Cow dung manure may be inferior in terms of plant nutrients as compared to the poultry manure and this may probably be due to the differences in feed between local cattle and fowls, in addition to the different nature of their metabolic characteristics.

Table 2: Mean root length and girth increment of *Moringa* seedlings treated with organic manure.

No. of Weeks after Treatment	**Root Length (cm)**			**Root Girth (cm)**		
	Poultry Manure	Cow Dung	Controls	Poultry Manure	Cow Dung	Controls
1	8.5	5.9	6.4	4.7	3.9	3.9
2	9.2	7.2	6.9	4.8	4.4	4.4
3	9.6	7.3	7.5	4.9	4.7	4.6
4	9.9	7.9	7.8	5.0	4.8	4.6
5	10.2	8.0	7.9	5.0	4.9	4.7
6	10.7	8.9	8.6	5.1	5.1	4.7
7	11.7	9.1	8.8	5.4	5.2	4.8
8	11.9	10.1	10.0	5.6	5.3	4.8
9	12.1	10.6	10.3	5.6	5.5	5.0
10	12.4	10.8	10.4	5.8	5.6	5.2
11	12.7	11.0	10.6	6.1	5.7	5.3
12	13.0	11.3	10.9	6.2	5.9	5.5
SD ±	1.4	1.7	1.5	0.5	0.6	0.4

Effect of Organic Manure on the Seedlings Dry Weight of *Moringa oleifera*

Results of the effects of organic manure on seedling dry weight are summarized in Table 3. Dry weight of shoots treated with organic manure was significantly higher ($p > 0.005$) than that of the control set-up, suggesting that organic manure has positive influence on primary production. Seedling dry weights of the above-ground components (shoot dry weight) of the Moringa plants showed significant difference between those treated with organic manure as compared to the controls. Also, dry weight of shoots treated with poultry manure was significantly higher ($p > 0.005$) than that of shoots treated with cow dung manure. The seedlings treated with poultry manure recorded the highest values followed by those treated with cow dung and the controls recorded the least values (Table 3). There was a general increase in biomass as the weeks progressed in all the treatments. Poultry manure- treated seedlings yielded significantly higher weights than the controls. Similarly, the cow dung manure- treated seedlings also showed significant differences between them and the controls in the dry weight of the above-ground components of the seedlings.

The below-ground component dry weight (root dry weight) also showed a trend quite similar to the above-ground pattern but does not completely agree with the one shown by the above-ground component's trend. Even though, the organic manure generally had significant ($p > 0.005$) effect between the treated seedlings and the controls in the root dry weight but between the seedlings treated with poultry manure and cow dung manure, there were no significant differences between them. However, there were significant differences between the poultry manure- treated seedlings and the controls and also significant differences between the cow dung manure- treated plants and the controls in their root dry weights.

Table 3: Mean plant dry weight increment of *Moringa* seedlings treated with organic manure.

No. of Weeks after Treatment	**Shoot Dry Weight (g)**			**Root Dry Weight (g)**		
	Poultry Manure	Cow Dung	Controls	Poultry Manure	Cow Dung	Controls
1	1.75	1.23	1.16	1.51	1.13	0.73
2	2.15	1.64	1.17	1.74	1.47	0.85
3	2.66	1.73	1.42	1.91	1.48	1.14
4	2.81	1.82	1.46	1.99	1.63	1.51
5	2.89	1.83	1.51	2.02	1.69	1.67
6	3.03	2.14	1.53	2.12	1.80	1.69
7	3.12	2.20	1.60	2.12	2.11	1.71
8	3.19	3.38	1.73	2.16	2.15	1.78
9	3.33	2.56	1.76	2.34	2.31	1.79
10	3.52	2.81	1.87	2.51	2.38	1.84
11	3.72	3.12	1.95	2.69	2.66	1.87
12	3.84	3.44	2.06	2.75	2.70	1.91
SD ±	0.8	0.6	0.2	0.5	0.6	0.4

Effect of Organic Manure on Leaf Relative Water Content of *Moringa* Seedlings

In general, the organic manure has no significant influence on the leaf relative water content. The seedlings treated with poultry manure and those with cow dung manure also showed no significant differences. Also, between the seedlings treated with poultry manure and the controls, there were no significant differences between them. In addition, there were no significant differences between seedlings treated with cow dung manure and the controls. The controls recorded the highest relative water content in the second week after treatment while the poultry manure-treated seedlings also recorded the highest in the fourth week and the cow dung manure- treated seedlings also recorded the highest in the eighth week after treatment (Fig.1). Although the experiment was conducted in the dry season, the trend observed in this study could probably be due to the fact that the seedlings were adequately watered throughout the experiment and hence did not experience any water deficit in the period and as such the organic manure itself probably did not influence the water content in any way appreciable in the treated plants. Agyenim-Boateng et al (2006) however, reported that organic matter released from poultry manure has the ability to retain appreciable amounts of soil moisture and this soil moisture retention could have probably led to high levels of relative water contents in organic manure- treated seedlings, but this was not observed. Yagodin (1984) also reported a positive change in soil moisture content after addition of poultry manure to the soil. Thus, one would have expected a corresponding increase in relative water content in treated plants as compared to the controls but this was not the case. Hence, this may be due to certain reasons which cannot be explained at this point by this study. Chaves, (1987) however, pointed out that most plant species experience a decline in their tissue relative water content due to water stress leading finally to a decline in net photosynthesis and ultimate yield.

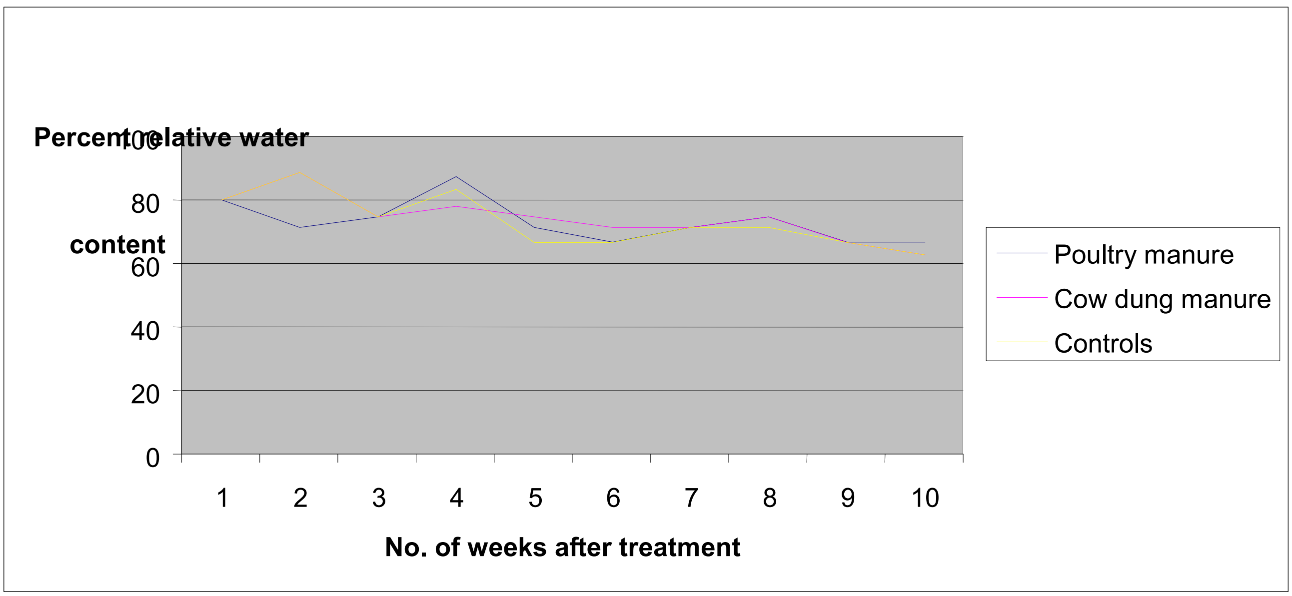

Fig 1: Relative Water Content of *Moringa* Seedlings

Effect of Organic Manure on Photosynthetic Pigment Contents of *Moringa* seedlings

The results of the effect of organic manure on photosynthetic pigment content of *Moringa* seedling leaves are presented in figures 2a and 2b. Generally, organic manure did not have significant effect on the amount of photosynthetic pigments, especially total chlorophyll content in the leaves of *Moringa* seedlings. There was an initial decrease in the total chlorophyll content, especially from the first to the third week after treatment but later steadily increased in both the poultry manure treated and cow dung manure treated seedlings as well as controls. Both treatments together with the controls then dropped after 5^{th} week to the 8^{th} week at different rates, and then increased again until they all reached their peaks in the 9^{th} week and then began to drop sharply again. The value for chlorophyll content for poultry manure- treated seedlings in the first week after treatment was the highest among the three but recorded the least value after the 10th week. On the other hand the value for cow dung manure- treated seedlings was low compared to that of the poultry manure- treated seedlings in the first week but this recorded the highest value after week ten (Fig. 2a). Perhaps, quantitative photosynthetic pigment content probably does not influence growth attributes of *Moringa* plants such as shoot height, root length and plant dry weight but may probably be due to the quality of photosynthetic pigments. There were no significant differences between those seedlings treated with poultry manure and cow dung manure in their total chlorophyll contents. Also, there were no significant differences between those seedlings treated with poultry manure and the controls. Similarly, there were no significant differences between those seedlings treated with cow dung manure and the controls. The total chlorophyll content fluctuated between the treated seedlings and the controls from the beginning to the end of the experimental period.

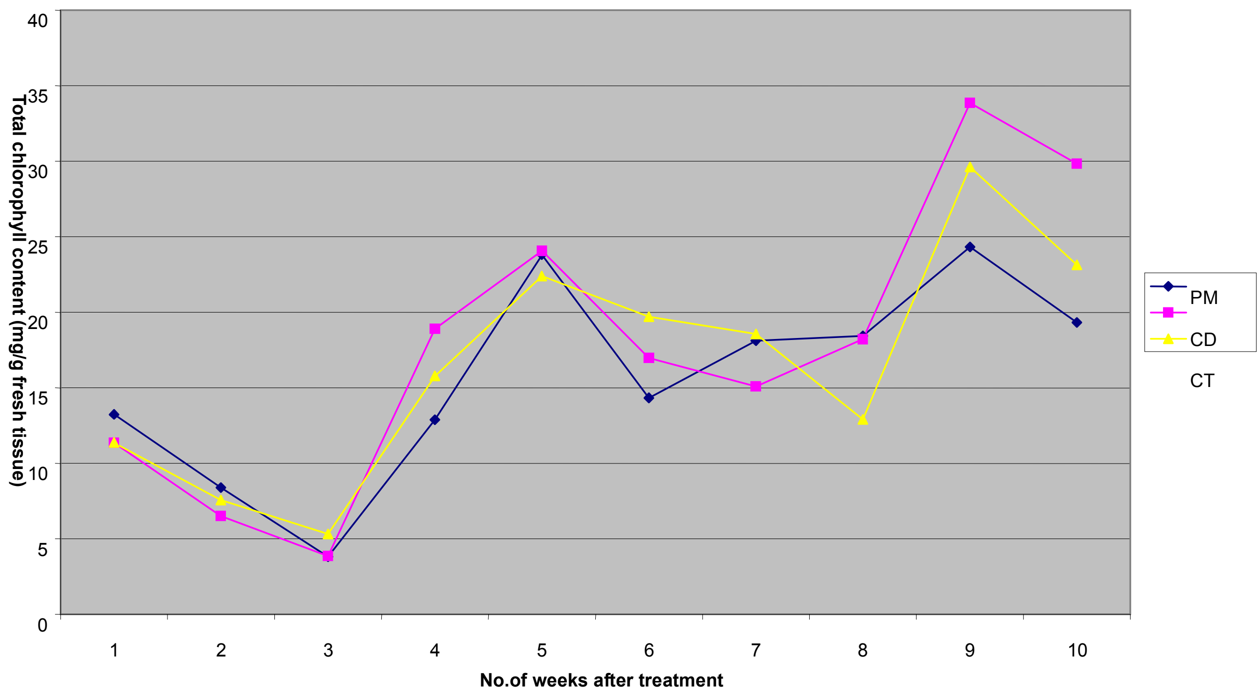

Fig.2a Effect of organic manure on chlorophyll content

The change in carotenoid content at 480 nm wavelength for the organic manure- treated seedlings and the controls showed no significant differences between the treated plants and the controls. Also, between the poultry manure and the cow dung manure- treated seedlings, there were no significant differences between the two sources. These observations may be due to the fact that organic manure may not exert direct influence on this photosynthetic pigment in the leaves of *Moringa* seedlings. The general trend presented by the changes in carotenoid content at 480nm wavelength is quiet interesting because it kept on changing almost every week. For instance, in the first week after treatment, the seedlings treated with poultry manure recorded the highest value, followed by the cow dung manure- treated seedlings and the controls recorded the least value. By the third week they all reached their lowest points with the poultry manure- treated seedlings recording the lowest value (Fig 2b). Cow dung manure- treated seedlings recorded the highest value in the fourth week while the controls recorded the highest value in the fifth week and maintained the highest value as the days progressed, even though dropping in value until after the seven week. In the eighth week however, the poultry manure- treated seedlings recorded the highest value and this was again overtaken by the controls in the ninth week but in the tenth week, the cow dung manure- treated seedlings recorded the highest value in all the treatments. This trend seems to be some form of sinusoidal in nature and it would be extremely difficult at this point to suggest a possible cause of this trend.

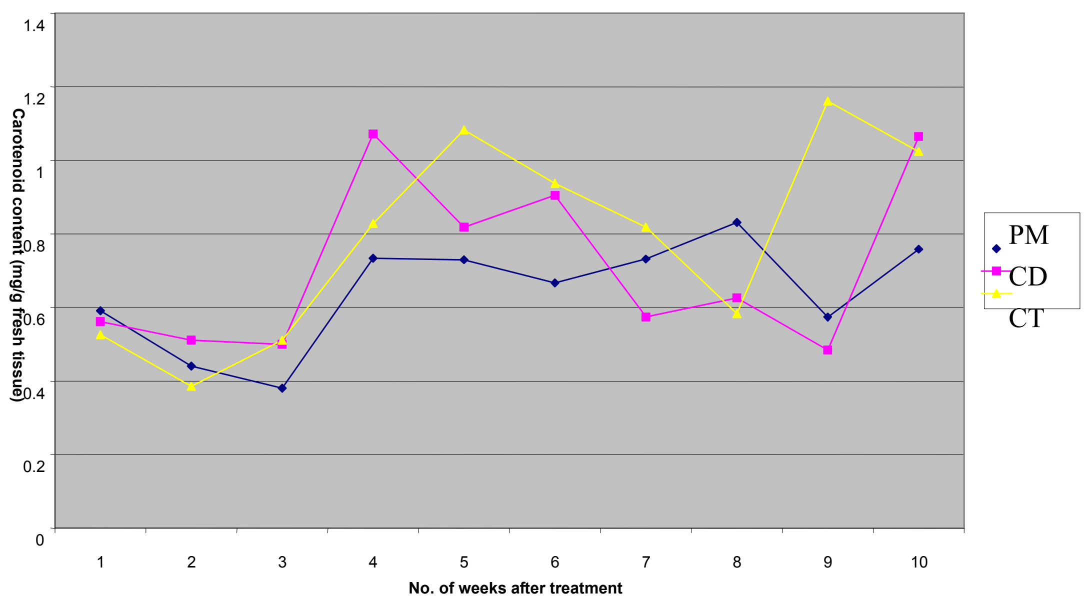

Fig 2b Effect of organic manure on carotenoid content of *Moringa* leaves

Conclusion

The study indicates that both poultry manure and cow dung manure are valuable sources of fertilizer for the growth of *Moringa oleifera* because they have greatly improved growth performance of treated plants over the controls. However, poultry manure proved more superior to cow dung manure because it produced better growth attributes such as shoot height, stem girth, root length, root girth and plant dry weight (biomass) than its counterparts produced. However, the photosynthetic pigment-contents especially total chlorophyll and carotenoid are not influenced significantly by the application of organic manure to *Moringa* seedlings. The results obtained in this study therefore suggest that application of poultry manure to *Moringa* seedlings grown in and around homesteads in Navrongo and its environs to provide leaves and other useful plant parts for medicinal and other purposes could be greatly enhanced in terms of quantity and possibility of shortened time for plant maturity, if the plants are not exposed to field stresses such as water stress and herbivory especially from domestic livestock. In spite of the fact that Navrongo lies in semi-arid Savannah zone of Ghana, *Moringa* growth was quite high in this study. The mean shoot heights recorded for the seedlings of poultry manure- treated plants, cow dung manure-treated and the controls were 0.49 m, 0.42 m and 0.35 m respectively. The study shows that both poultry manure and cow dung manure proved to be good fertilizer sources and their use must be encouraged especially among the resource-poor farmers in Northern savannah zone of Ghana in particular reference to the cultivation of *Moringa.* It is therefore recommended that in the small-holder production of *Moringa* especially in the backyard gardens, manure from chicken raised in the home could be used to fertilize the plants for better results. It is also recommended that further work should be done on the influence of organic manure on the quantitative and qualitative photosynthetic pigments of *Moringa* plants to ascertain its contribution to the plant production in general.

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