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Evaluation of Influence of Poultry Manure Levels on Growth and Yield of Courgettes in Rwanda

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Abstract: **This study was conducted to evaluate effects of poultry manure rates on growth and yield of *Cucurbita pepo* L. A complete randomized block design field trial with three blocks was conducted in Rwanda, Northern Province, Musanze district, Busogo sector. The treatments was five different poultry manure rates (0, 1.5, 3, 4.5 and 6 t/ha). The observed parameters were plant height, leaf area index, edible fresh yield and dry biomass of edible yield, above ground fresh biomass, and above ground dry biomass. The data was analyzed using JMP 5.1 and the means separated using Tukey HSD at 0.05 level of significance difference. The higher yield of 49.8 t/ha was obtained in the plants treated with 6 t/ha of poultry manure followed by the plants treated with 4.5 t/ha (47.9 t/ha) while the lowest yield of 5.6 t/ha was obtained in the control. The results of this study revealed that the highest poultry manure rate enhanced plant height by about, number of male, number of female, edible dry mass, above ground fresh biomass, above ground dry biomass and total yield compared to the control. However, poultry manure rate of 4.5 t/ha is recommended in courgette production.**

Keywords: **Poultry manure, courgette, edible yield, biomass.**

1. INTRODUCTION

Rwanda is a country of few natural resources, and the economy is based mostly on agriculture. Heavy demographic pressure resulted in many, very small and scattered farms. More than 80.0 percent of households hold less than 1.0 ha of land (World Bank, 2011). An estimated 80% of the working populations are engaged in subsistence agriculture which comprised an estimated 30% GDP in 2009 (RDB, 2010). The agriculture sector will play a key role in realizing Rwanda's vision of transforming the country's economy by 2020. Given its predominant role in the economy, agriculture is considered as a main catalyst for sustainable growth and poverty reduction. This is fundamentally linked to the fact that agriculture is the primary source of employment in Rwanda (World Bank, 2011).

Rwanda horticulture assets with a blessed climate, fertile soils and an abundant, hardworking labor force, the potential to develop a vibrant horticulture industry in Rwanda undoubtedly exists (RDB, 2010). Fruit and vegetables sector has become an important sector in Rwanda economy and contribute about 50% of non-traditional exports (RDB, 2010). Courgette is the new crops were introduced in Rwanda which has the market; the many farmers grow it in the garden. This crop is efficient in the production of Carbohydrates, proteins, vitamins and cash income per unit of land and time. Compared to other tropical food and cash crops, the courgette has a potential of small life cycle. Poultry manure has long been recognized the most desirable organic fertilizer. It improves soil fertility by adding both major and essential nutrients as well as soil organic matter which improve moisture and nutrient retention (Farhad *et al*., 2009). The nutrient contents of chicken manure are among the highest of all animal manures, and the use of it as soil amendment for agricultural crops will provide appreciable quantities of all the major plant nutrients. It also improves biological activities, soil tilth and soil chemical properties (Michael and George, 1998). Poultry manure application registered over 53% increases of N level in the soil, from 0.09% to 0.14 % and exchangeable cations increase with manure application (Boateng *et al*., 2006).The major constraints in Rwanda are low soil fertility due to intensive cultivation of soil without adequate replenishment of mined nutrients. Due to soil fertility problems, crops yields often decrease and they are more susceptible to pest and

disease. The farmers should maintain or restore soil productivity in using mineral fertilizers or organic fertilizers. Mineral fertilizers are expensive and the farmers are not able to afford them while organic manures are local available and cheap. Poultry manure is one of those available organic manures which is excellent organic fertilizer and can make an important contribution to better yields and lasting soil fertility. Poultry manure is a valuable fertilizer and can serve as a suitable alternate to inorganic fertilizer. Therefore, there is lack of skills on the rates to be used. While contributing to above problems, this research was evaluating effect of poultry manure rates on growth and yield of courgette in Musanze district.

2. MATERIALS AND METHODS

Experimental design was conducted at crop production research and demonstration field, University of Rwanda, College Of Agriculture and Veterinary medicine former Higher Institute of Agriculture and Animal Husbandry (ISAE Busogo), Northern Province, Rwanda. The altitude of this region is 2200m above sea level, annual rainfall of 1400 mm, with an average temperature of 13^{o}C and relative humidity of 86% and receives four seasons well established throughout the year. Such seasons are: Short rainy season: It covers the period between September and December; Short dry season: Starts around mid-December and lasts till February; long rainy season: It covers the period ranging from March to June; long dry season. The soil is of volcanic type and is classified into Andisol.

The plant material used was courgettes (*Cucurbita pepo var. diamant hybrid*) of cucurbitaceae family which is suitable for tropical climate. The seeds used were bought from AGROTECH Ltd at Kigali city.

The farm yard manure (FMY) used in this experiment is poultry manure collected at Gakenke district. To carry out cultural farming practices like tillage; planting; weeding; and the data collection, the material used were: hoe for cultivation, graduated ruler to measure the height of crops; leaves length and width, balance to measure the weight of fertilizers and yield, the decameter to measure the size of plots, the piquet to limit the plot, bags and baskets to transport the farmyard manures, oven to dry the harvested fruit and auger to take soil sample.

The experimental design was randomized complete block design (RCBD) with 5 treatments and each replicated three times. Total plots: 5x 3=15 plots. Plot size was 4 m x4m=16 m^2. Thus the experimental field is 19mx13m= 247m^2. As shown in the figure 1 below, the plots were separated with the paths of 1 m, between replications and 0.5m between treatments. Thus the total plots of experiment are 135 m^2 and 1 m of borders is provided around the experiment field on which courgettes is grown. The following treatments were applied: Treatment 1: 0t/ha; Treatment 2: 1.5t/ha; Treatment 2: 3t/ha; Treatment 3:4.5t/ha and Treatment 4:6t/ha. The different parameters collected were

Plant height was measured five times with interval of one week by using a ruler. Plant height was measured from base of the soil to the lowest leaf. The length and width of leaves were measured from 30th days to 58th days after planting. A sample of four plants was taken for each treatment on the marked leaves by using black cold. This parameter was measured by using ruler. Then after the leaf area (LA) was calculated from leaf length and leaf width by using this equation LA=0.88L*w-4.27 (Flavio and Marcos, 2005). The numbers of male and female flowers were counted on four plants in each treatment. It was taken two week before first harvesting. During harvest, the fresh mass of fruits harvested on four in every treatment was determined by weighting. The dry mass of harvested fruits was taken after drying the harvested fruit in each treatment at 150^{o}C for 8 hours. The fresh biomass were determined at 95th days after sowing by cutting four plant from the ground surface of soil and the weight of dry biomass was taken after drying plant in the oven at 150 ^{o}C for 10 hours.

Data was organized by using excel program while JMP 5.1 was used for statistical evaluations. The results were subjected to one-way analysis of variance randomized block design with the significance of the means comparison with a Duncan multiple range Test at 5%.

3. RESULTS

Effects of poultry manure rates on plant height (cm) of courgette:

The effect of different poultry manure rates on plant height of courgette varied with time, all rates of poultry manure cause an increase of plant height by 8.4 - 24.2 cm (table 3). A summary of the analysis of variance determining the effect of different poultry manure rates during 30th days to 58th days after sowing shows that they are highly significantly

influence plant height of *Cucurbita pepo* L. between five poultry manure rates because P≤0.0001. At 30th days after sowing (DAS) the plants that was subjected with 6 t/ha of poultry manure were significantly taller than plants that received 0 tons to 4.5 tons per hectare, with the mean height of 12.1 cm while the plants treated with 3 t/ha and 4.5 t/ha were not significant at 0.05. However, at 37 DAS courgettes plant height increased from 5 cm where 0 t/ha poultry manure was applied to 14.4 and 15.3 cm where poultry manure was applied at the rate of 4.5 and 6 t/ha. From 44 DAS the height of plants treated with 3 t/ha, 4.5 t/ha and 6t/ha were not significant at P=0.05 but are high significantly to control.

Plant height of courgette was positively influenced by poultry manure rates (table 3). Poultry manure applied at 6t/ha, 4.5t/ha and 3t/ha show the increase of plant height compared to that was receive 0t/ha. However, at 51DAS plants that received 6 t/ha were the tallest (22.4 cm) followed by 4.5 t/ha (21.1 cm) and then 3t/ha (20.4 cm) although these differences were not significant. At 58 DAS the mean height of plants are not significant at 0.05 except the plants subjected with zero tons per hectare.

Table.1: effect of poultry manure rates on plant height of courgette

Poultry manure rates	30 DAS	37 DAS	44 DAS	51 DAS	58 DAS
0 t/ha	4.4d*	5d	5.8c	7.0c	10.5b
1.5 t/ha	8.4c	10.7c	16.2b	18.3b	19.6a
3 t/ha	9.3bc	13.6b	18.0ab	20.4ab	22.0a
4.5 t/ha	10.7b	14.4ab	18.3ab	21.1ab	22.9a
6 t/ha	12.1a	15.3a	19.1a	22.4a	24.2a

*means not connected by the same letter within the column are significantly different according to Tukey HSD test at P≤0.05.

Effects of poultry manure rates on leaf area (cm^2) of courgette:

A summary of the analysis of variance determining the effect of poultry manure rates on leaf area of courgettes during 30th days to 58 DAS shows that the influence of poultry manure rates on leaf area was high significant (P≤0.0001). The results of mean comparison by using Tukey HSD at 5% (table 4) showed that the lowest the leaf area (9.1cm^2) was obtained in control while the biggest was obtained in the plant received a rate of 6 t/ha. The rate of 6 t/ha and 4.5 t/ha significantly increased the leaf area of courgettes compared to courgettes that did not receive any rate (control). At 51 and 58 DAS, poultry manure rate also significantly influence the leaf area. The plants subjected with 6 t/ha and 4.5 t/ha were significantly bigger than plants did not receive any rate (0t/ha).

Table.2: Effects of poultry manure rates on leaf area (cm^2) of courgette

Poultry manure rates	30 DAS	37 DAS	44 DAS	51 DAS	58 DAS
0 t/ha	9.1c*	19.7b	28.4c	52.9d	64c
1.5 t/ha	105.8b	217.3a	281.2b	361.0c	385.5b
3 t/ha	124.3ab	262.6a	391.1ab	491.1b	399b
4.5 t/ha	135.0ab	292a	444.5a	581.2ab	626.0ab
6 t/ha	137.5a	315.1a	501.9a	610.9a	670.2a

*Means not connected by the same letter within the column are significantly different according to Turkey HSD test at P≤0.05

Effects of poultry manure rates on number of male and female flower of courgette:

A summary of analysis of variance on number of male and female flowers were highly significant (P<0.001). The result of statistical analysis shown in table 5 the number of male and female flower increased as a poultry manure increased. Statistically higher number of male flower (12) was recorded plant subjected with 4.5 and 6 t/ha followed by 3 t/ha (10) all those three treatment are not significant at P≤0.05. Minimum number of male flower (2) was recorded in control. The maximum female flower (5) was observed in treatments of 6 t/ha and 4.5 t/ha both are not significant at P≤0.05 followed by 3 t/ha and 1.5 t/ha with an average female flower of 4, 3 respectively. The lowest number of female flower (2) was recorded in plant did not receive any rate.

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Table.3: Effects of poultry manure rates on number of male and female flower of courgette

Poultry manure rates	Number of male	Number of female
0 t/ha	2c*	2c
1.5 t/ha	8b	3b
3 t/ha	10ab	5ab
4.5 t/ha	12a	5a
6 t/ha	12a	5a

*Means not connected by the same letter within the column are significantly different according to Tukey HSD test at P≤0.05.

Effects of poultry manure rates on fresh yield (t/ha) of courgette:

The effect of different poultry manure rates on yield was highly significant difference because P<0.0001.The highest yield (49.8 t/ha) was obtained in the plant treated with six tons per hectare followed by 4.5 t/ha (47.9 t/ha), 3t/ha (38.1 t/ha), 1.5 t/ha (36.5 t/ha), the lowest yield was obtained as 5.6 t/ha in the zero poultry manure rate application i.e. control (table 6). When the poultry manure rate increased from 4.5 t/ha to 6 t/ha, fresh yield tended to increase, although this was not significant at P≤ 0.05 and also an increase of 1.5 to 3 t/ha both was not significant at P≤0.05.

Table.4: Effects of poultry manure rates on fresh yield and edible dry mass (t/ha) (t/ha) of courgette

Poultry manure rates	Fresh Yield	Edible dried yield
0 t/ha	5.6c*	0.08c*
1.5 t/ha	36.5b	0.6b
3 t/ha	38.1b	0.7ab
4.5 t/ha	47.9a	0.7a
6 t/ha	49.8a	0.8a

*Means not connected by the same letter within the column are significantly different according to Tukey HSD test at P≤0.05

The results from analysis of variance show a higher significant difference on edible dried mass of courgette (P<.0001) among poultry manure rate. Edible dried mass increased significantly with an increase of poultry manure rate (table 7). The maximum edible dried mass (0.8 t/ha) was recorded in plants subjected with 6 t/ha of poultry manure closely followed by the plants treated with 4.5 t/ha (0.7 t/ha) and 3 t/ha (0.7 t/ha). These entire edible dried yields behaved no significantly difference at 0.05. Intermediate response was recorded in plants subjected with 1.5 t/ha (0.6 t/ha) and this was not significant at 0.05 with the plant receive the rate of 3 t/ha. The lowest edible dried mass (0.08 t/ha) was recorded in control.

Effects of poultry manure rates on total above ground fresh biomass (t/ha) of courgette:

The total above ground fresh biomass was significantly influenced by poultry manure rates. As poultry manure increased also above ground biomass increased (table 8). It was increasing from 8.87 t/ha to 60.07 t/ha. The best total above ground fresh biomass (60.07 t/ha) was recorded where the highest (6 t/ha) poultry manure rate was applied followed by the plants treated by 4.5 t/ha (59.5 t/ha), but this was not significant at 0.05. The mediate was recorded in the plants subjected with 3 t/ha (46.58 t/ha) and 1.5 t/ha (43.2 t/ha) also both was no significant at 0.05.The total above ground biomass of courgette any poultry manure was significantly greater than the control.

Table.5: Effects of poultry manure rates on total above ground fresh biomass (t/ha) of courgette

Poultry manure rates	Above ground biomass	Total above ground dry biomass
0 t/ha	8.87c*	1.2b*
1.5 t/ha	43.25b	1.9ab
3 t/ha	46.58b	2.3a
4.5 t/ha	59.50a	2.6a
6 t/ha	60.07a	2.8a

*Means not connected by the same letter within the column are significantly different according to Tukey HSD test at P≤0.05

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Effects of poultry manure rates on total above ground dry biomass (t/ha) of courgette:

A summary of analysis of variance show a higher significant difference (P=0.0019) between poultry manure rates.As shown in table 9, the total above ground dry biomass of courgette treated with zero tons per hectare was significantly lower than that treated with six tons per hectare. However, the above ground dry biomass of courgette treated with 6 t/ha, 4.5 t/ha, 3 t/ha not significant at $p \leq 0.05$ but the greater number was founded in the plant treated with 6 t/ha.

4. DISCUSION

The results observed in this study indicate that plant height of courgette at different stage of growth was significantly influenced by treatments. At 30 DAS heights of plants were ranged from 4.4 cm and 12.1 cm with the highest mean in the plants treated with 6 t/ha of poultry manure and the lowest in the control, the plants subjected with 0 t/ha, 1.5 t/ha and 3 t/ha at 30 DAS were not significant difference at P=0.05. At 37, 44, 51 DAS poultry manure rates also significantly affected plant. However, at 58 DAS plant height of courgette subjected with 1.5, 3, 4.5, 6 t/ha were not significant. This could be to macro element responsible for plant growth. Gupta, (2003) was reported the similar results on growth plants. A summary of analysis of variance determine the effect of poultry manure rates on plant height of *Cucurbita pepo* L. during 30 DAS to 58 DAS was high significant (P<0.001). The increase in plant height with poultry manure is mainly due to the reason of more availability of nutrients by poultry manure (Farhad *et al*., 2009). Omolayo *et al*., (2011) also reported that plant height of leaf amaranth increased with the application of different rate of poultry manure.

The results on leaf area showed that there was very high significant difference between treatments (P< 0.0001). The highest leaf area of 670.2 centimeters square was recorded in the pants subjected with 6 t/ha of manure and the lowest leaf area of 64 cm^2 was recorded in control. Maryam *et al*. (2007) reported that leaf area increasing due to nitrogen fertilizer enhance leaf growth and photosynthesis and the effect of nitrogen on lettuce leaf area showed that in the first stages of growth leaf area was low but gradually, by increasing leaves growth, the leaf area increased and the difference between treatments was assessed. Aderi *et al*. (2011) also reported that leaf area increased of pumpkin increased with increase chicken manure rate in both 2009 and 2010. Maryam *et al*., (2007), enhanced availability of nitrogen with enhanced more leaf area resulting in higher photoassimilates and thereby are more dry accumulation.

The data recorded on male flower and female flower indicate that the number of male and female flower increased as poultry manure rate increased and all treatment was significant to the control. The biggest number of male and female flower was recorded in plants subjected with six tons per ha followed by 4.5 t/ha and 3t/ha respectively, however these treatments were not significant at 0.05; lowest number of male and female flower related to the control. This value indicate that without poultry manure rate, courgettes flowers was low while the application of poultry manure rate resulted increase numbers of flowers. Nitrogen concentration increased flower production of *Cucurbita pepo L*. (Rodrigo *et al*., 2012).

The effect of poultry manure rates on total yield of courgette was higher significant difference at $P \leq 0.05$ (P<0.0001). The yield increased as the poultry manure rates increased. Wijewardera, (2000) report that poultry manure application gave the highest yield of potato, cabbage and pole bean followed by boiler litter, droppings goat manure, cattle manure and pig manure. The application of decomposed poultry manure significantly ($P \leq 0.05$) increased cabbage yield by 31.7% and 26.4% in the year of 2003 and 2004 respectively compared to the 0 t/ha of decomposed poultry manure treatment (Ijoyah and Sophie, 2009). Malik *et al*. (20011) was explained that the number of fruit per plant could be due to balanced C/N ratio, decomposition, mineralization, availability of native and applied macro and micro-nutrients. They was also reported that all these might have accelerated the synthesis of carbohydrates and its better translocation from sink to source that might have led to an improvement in yield and yield related attributes.

The total above ground fresh biomass and total above ground dry biomass was significantly influenced by poultry manure rate. The above ground fresh biomass of plants subjected with 6 t/ha and 4.5 t/ha was significantly greater than plant received 0 t/ha. It was increased from 8.87 t/ha in control to 60.7 t/ha in treatment five. The above ground dry biomass increased as manure rate increased. The manure of 6 t/ha, 4.5 t/ha and 3 t/ha significantly influenced above ground dry biomass compared to the courgette did not received any rate. Averbeke *et al*. (2007) reported that the fresh and oven dry above ground biomass of *Brassica rapa* L. *subsp*, *Chinensis* and *Solanum retroflexum* increased with increasing nitrogen, potassium and phosphorus.

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5. CONCLUSION AND RECOMMENDATIONS

Present study has been oriented to assess effect of poultry manure rates on growth and yield parameters of *Cucurbita pepo* L. The poultry manure increased the growth and yield parameters of courgette. The applied rates were significantly influenced almost all the measured parameters but they was significant difference between poultry manure rate. In fact, plant height, leaf area, male and female flowers, fresh mass, dry mass and above ground biomass increased as poultry manure rate increased to 6 t/ha. However, for all observed parameters the rate of 6 t/ha was the most efficient followed by 4.5 t/ha. The results of statistical analysis show a significant difference between treatments and a positive effect on the growth and yield parameters of courgette. In this study the highest yield (49.8 t/ha) was obtained in the plant subjected with 6 t/ha of poultry manure followed by plant treated with the rate 4.5 t/ha (47.9 t/ha), although both treatments were not significant at 0.05 and the lowest yield 5.6 t/ha was obtained in the control. This research work recommends the poultry manure rate of 4.5 t/ha for the farmers to increase the productivity of courgette. The others studies on courgette postharvest technology and nutritional value is recommended.

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