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Correlational Analysis between Growth and Yield Parameters of Cabbage (*Brassica oleracea*) as Affected by Organic Manure and Inorganic Fertilizer in Jos

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Authors' contributions

This work was carried out in collaboration among all authors. Author MOS designed the study and wrote the protocol. Author III performed the statistical analysis and wrote the first draft of the manuscript. Author AM managed the analyses of the study. Author ASD managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aim: To determine the correlation between the growth and yield parameters of cabbage grown with organic manure and inorganic fertilizer.
Study Design: The experimental design consist of randomized complete block design with five treatments which were replicated four times.
Location and Duration: The experiment was conducted at the experimental field of Federal College of Forestry, Jos, during the 2018/2019 raining season.
Methods: Land clearing was done and the land was properly demarcated based on the different treatments and replicates. Cabbage seeds were first planted in a nursery bed and later transplanted onto the experimental plots. Data was taken on the plant height, leaf count, cabbage head diameter and head weight. The data collected were subjected to analysis of variance (ANOVA) using SPSS

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version 23 and Duncan Multiple Range Test, used to separate the means were significance occurred.
Results: The result of the correlation coefficient of growth and yield showed that a strong correlation exist between plant height and cabbage head weight ($r = 0.681$ and 0.648) at $P \leq 0.01$. Plant height was also positively correlated with head weight ($r = 0.365$, $P \leq 0.05$) and head weight was as well and positively correlated with head diameter at ($r = 0.501$, $P \leq 0.05$).
Conclusion: Based on the results obtained, it can be concluded that application of organic manure and inorganic fertilizer has positive correlations between the growth and the yield parameters of cabbage.

Keywords: Correlational analysis; yield parameters; cabbage; organic manure; inorganic fertilizer.

1. INTRODUCTION

The demand for organically grown foods is increasing daily all over the world. More people demand for organically grown crops due to their rich source of vitamins, minerals and because of their phytochemical contents which provide the body with defense against diseases. Also, the continuous use of chemical fertilizers, herbicides, pesticides and insecticides produce residual effects which can lead to leaf necrosis, chlorosis and even death of plants (Saladin and Clément, 2011). All these have made people to divert their interest to the consumption of organically grown food crops.

Cabbage (*Brassica oleracea*) is an important vegetable grown in the winter and widely consumed due to its numerous nutritional components. Cabbage belongs to the cruciferous plant family. It is a biennial crop but it is grown as an annual crop, unless its production is for seed. Cabbage grows mostly under wide range of environmental conditions and in all temperate, tropical and sub-tropical regions, but the most suitable condition is cool moist climatic condition [1]. Globally, cabbage and other brassica vegetables are cultivated on an area of 2.51 million hectares and the total world production is estimated at 71.45 million tonnes. Cabbage is mostly cultivated in Northern part of Nigeria, especially in Plateau State which is the highest producer of Cabbage in Nigeria [2]. Cabbage is known for its abundant nutrients such as vitamin C, vitamin K, minerals, fibres and small amount of proteins [3] with reasonable quantity of glucosinolates [4]. Phytochemical analysis of cabbage has been reported to reveal its anticancer role through its isothiocyanate compound present. It has abundant of vitamin C of about 44% and 72% of vitamin K for every 100 gram serving (USDA). Some of the medicinal functions of cabbage include good eye sight, maintenance of good skin and also help in lowering the body cholesterol [5].

In order to achieve good yield, cabbage cultivation requires nutrients that must be applied in the correct proportion [6]. Cultivation of crops, making use of different manures brings variations in the yield output [7]. Farmers mostly rely on the use of inorganic fertilizer for their cultivation. This is because, inorganic fertilizer acts rapidly in supplying nutrients to the soil, unlike organic manure which takes time to mineralize before their nutrients can be available for crop use. Despite its slow mineralization process, organic manure are preferred by some other farmers due to their non-residual effect and their rich nutrient addition to the crops. Some researchers have reported the role of different sources of manure on the nutritional content of crops and their role on the phytochemical constituents of such crops [8,7]. The aim for this research therefore is to examine the different organic manures and inorganic fertilizer usage for the cultivation of cabbage.

2. MATERIALS AND METHODS

2.1 Study Area

The experiment was carried out on the experimental field of Federal College of Forestry, Jos. Jos is located in Plateau State of Nigeria and it is a middle belt region in Northern part of the country. Jos city exist on a plateau in Nigeria on an elevated region at about 1200 m height, with 7-11º North latitude and 7-11º East longitude. The soil is sandy loam, with light to dark brown colour. The annual rainfall is about 1340 mm, with a temperature range of 10-32ºC [9].

2.2 Materials

The materials for this experimental study include cabbage seeds, which were certified seeds obtained from the Plateau Agricultural Development Program (PADP). The manures are goat droppings, cow droppings and poultry

droppings and all were obtained from various animal farms within Jos metropolis. N.P.K. fertilizer was equally obtained from PADP, at Dogon Dutse in Jos. Every other planting material such as hoe, cutlass, measuring tape, watering can, pegs etc; were all gotten from the Crop Production Technology Department at Federal College of Forestry, Jos.

2.3 Experimental Design

Randomized Complete Block Design (RCBD) was the experimental design used, with five treatments (T_0, T_1, T_2, T_3, T_4) and replicated four times.

i. T_0 = Control experiment in which no manure or fertilizer was applied
ii. T_1 = consisted of 40 g of NPK 15:15:15 fertilizer applied per 4 m^2 plot
iii. T_2 = Cow dung manure was applied at the rate of 8 kg per 4 m^2 plot
iv. T_3 = Poultry droppings manure was applied at the rate of 8 kg per 4 m^2 plot
v. T_4 = Goat dropping manure was applied at the rate of 8 kg per 4 m^2

2.4 Agronomic Practices

i. Land Preparation: Bush was cleared with the use of cutlass and after which the debris were removed from the farm. Hoe was used to remove stumps and the soil was loosened for easy planting to take place.
ii. Bed Making and Manure Application: A nursery bed of 2 m x 2 m was made to raise the cabbage seedlings. 20 beds of 2 m x 2 m was used for the five treatments and replicates. The manures were applied according to the treatments at 3 weeks before transplanting of the seedlings. The total land area of 10.5 mx 13 m was used for the experiment.
iii. Planting: the seeds were first planted on a nursery bed and were allowed to germinate and grow to a height of about 12 cm at 5 weeks in the nursery. The seedlings were then transplanted at a distance of 40 cm x 40 cm inter row spacing and intra row spacing respectively. Fertilizer was applied at 3 weeks after the transplanting.
iv. Weeding: this was done manually with the use of hoe and it was carried out twice before maturity at 3 weeks interval.
V. Harvesting: as signs of maturity became conspicuous, harvesting was done with the use of knife to cut the cabbage from the base.

2.5 Data Collection

Data was collected from 3 sampled plants from each of the plots. These plants were picked at random from each of the plots and were then tagged. Plant height, leaf count, head weight and head diameter were the data collected at 2 weeks interval, starting from the first data collected.

i. Plant Height: the height of each of the tagged plants was measured with the use of a meter rule. This was taken from the base of the plant to the top most part of the leaf and data was recorded at 2 weeks after transplanting (2WAT), 4WAT, 6WAT, 8WAT and 10WAT.
ii. Leaf Count: Each leaf from the tagged plants were counted per plant. The average was taken from the 3 sampled plants. This reading was taken and recorded at 2weeks after transplanting (2WAT), 4WAT, 6WAT, 8WAT and 10WAT respectively.
iii. Head Diameter: a Vernier caliper was used to measure the diameter of the cabbage heads immediately after harvesting.
iv. Head Weight: the weight of the cabbage head was taken after harvesting with the use of a weighing balance.

2.6 Statistical Analysis

All data collected were subjected to analysis of variance (ANOVA) at 5% level of significance using statistical package (SPSS) version 23. Duncan multiple range test was used to separate the means.

3. RESULTS AND DISCUSSION

3.1 Results

The correlation coefficient of growth and yield parameters of cabbage is presented in Table 1. Plant height gave positive correlations with head diameter ($r = 0.681$ and 0.648, $P \leq 0.01$), at 8 and 10 weeks after planting. Also, plant height was positively correlated with head weight ($r = 0.365$, $P \leq 0.05$). Total head diameter was also positively correlated with head weight ($r = 0.501$, $P \leq 0.05$). According to Simpson [10] increases

in plant height, number of pods plant^{-1} and canopy size all brought about increases in pod yield. Also the very strong ($P < 0.01$) and positive correlation coefficient between plant dry matter and stover N confirm other research findings of Bell, et al. [11] and Boote, et al. [12] who indicated that groundnut plant dry matter was positively and correlated with stover N. Mohan Kumar [13] reorted that plant height exhibited positive association with seed yield and similar results were reported by Tyagi, et al. [14], Ramesh, et al. [15], Rahul, et al. [16]. The seed yield can be improve through increasing plant height, because it exhibited a positive association with days to 50 per cent flowering, days to maturity, number of secondary branches, number of cluster per plant, number of pods per plant, pod length, number of grains per pod.

The regression model between growth and yield component of cabbage is shown in Fig. 1. The model indicates that it is good for predicting head diameter. This shows that only 41.9% (R^2 = 0.419) of the increase in head diameter could be attributed to an increase in the plant height of cabbage. The model also shows that as the height of the cabbage increases, as a result of the applied manure so also will the diameter of the cabbage head increase (Fig. 1).

The regression model between growth and yield component of cabbage is shown in Fig. 2. The model indicated that as the height of the cabbage increases, there is an increase in the head weight. It also shows that the rate of increase in the head weight is rapid with little increase in the plant height. The regression analysis indicated that this model is good for predicting head weight of cabbage from the height of the plant due to application of inorganic fertilizer and organic manure. This indicates that only 13.3% (R^2 = 0.133) of the increase in head weight could be attributed to an increase in the head weight of cabbage plant.

This result is similar to Ngwako and Mashiqa [17] who recorded growth attributes of wheat were significant in predicting the yield and positively associated. Deniz, et al. [18] found significant and positive association and equation of good fit between yield and growth attributes while working on barley in Turkey. Biscoe, et al. [19] and Gallagher, et al. [20] also found a predictive relationship between yield and yield components while working on cereals. Grain yield and number of grains per ear unit area were found to positively correlate in wheat by Brooking and Kirby [21].

The regression model for plant height of cabbage is as shown in Fig. 3. The model indicated that the height of cabbage can be predicted by the use of organic manure and inorganic fertilizer as indicated by the model. This model shows that 85.57% (R^2 = 0.8557) increase in the organic manure or inorganic fertilizer could bring an increase in the height of cabbage. This result is in line with the work of Ragagnin, et al. [22] in which their regression result was used in

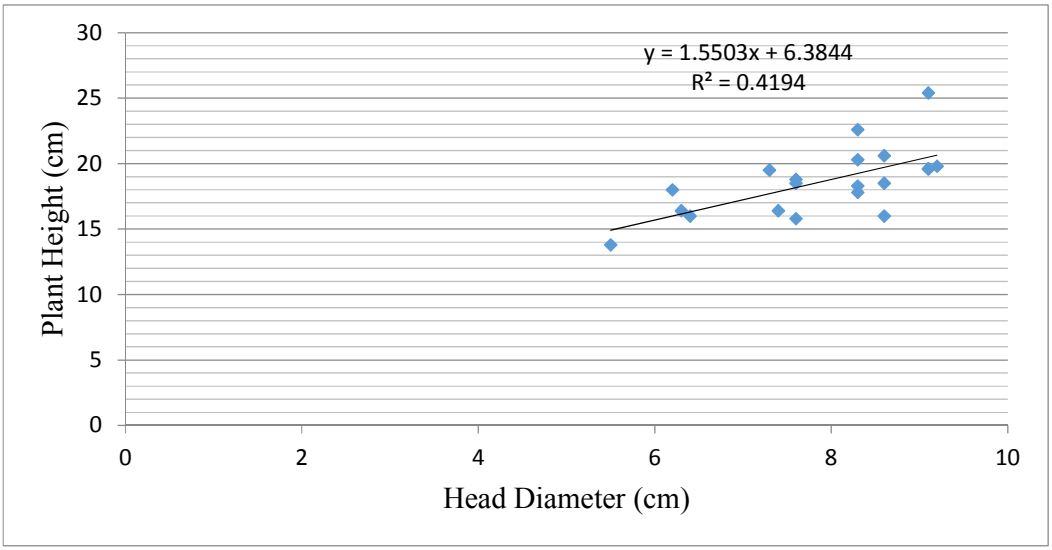

Fig. 1. Regression model between growth and yield components of cabbage as influenced by organic and inorganic fertilizer

Table 1. Correlation matrix for growth and yield components of cabbage

Variables	LC2WAP	LC4WAP	LC6WAP	LC8WAP	LC10WAP	PH2WAP	PH4WAP	PH6WAP	PH8WAP	PH10WAP	HD	HW
LC2WAP	1											
LC4WAP	0.291	1										
LC6WAP	-0.220	0.525*	1									
LC8WAP	-0.229	-0.047	0.557*	1								
LC10WAP	-0.247	-0.450*	0.271	0.546*	1							
PH2WAP	0.281	0.126	-0.051	-0.136	-0.157	1						
PH4WAP	0.213	0.609**	0.193	-0.450*	-0.488*	0.089	1					
PH6WAP	0.193	0.438	0.180	-0.222	-0.213	0.080	0.311	1				
PH8WAP	0.174	0.293	0.157	-0.130	0.100	-0.124	0.164	0.837**	1			
PH10WAP	0.119	0.288	0.212	-0.063	0.146	-0.235	0.031	0.757**	0.953**	1		
HD	0.244	0.193	-0.008	-0.303	0.144	-0.151	0.024	0.626	0.681**	0.648**	1	
HW	0.354	0.433	0.187	0.135	0.069	0.286	0.139	0.505	0.453	0.365*	0.501*	1

Legend: LC = Leaf Count, WAP = Weeks After Planting, PH = Plant Height, HD = Head Diameter, HW = Head Weight

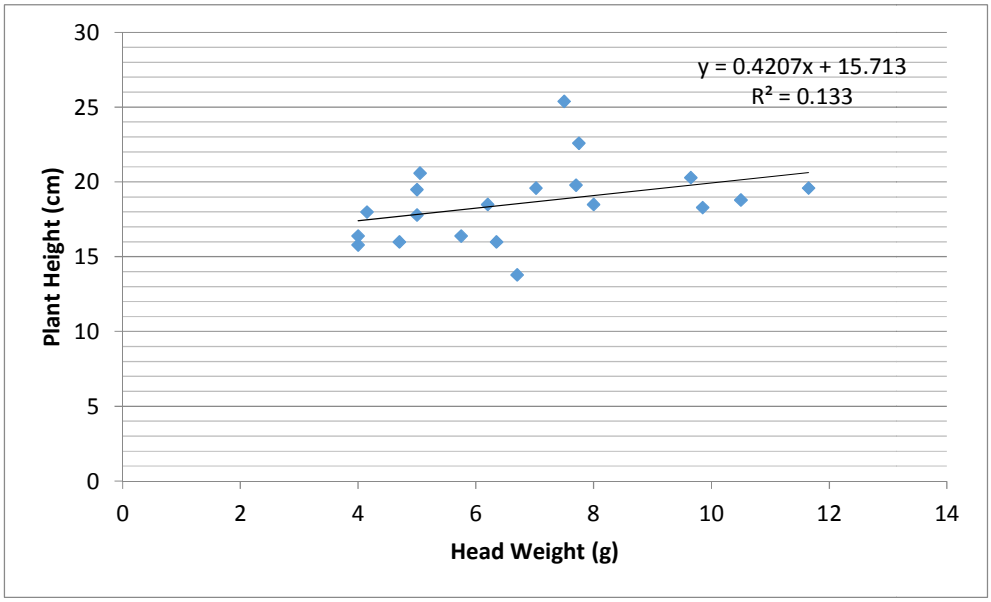

Fig. 2. Regression model between head diameter and head weight of cabbage as influenced by organic and inorganic fertilizer

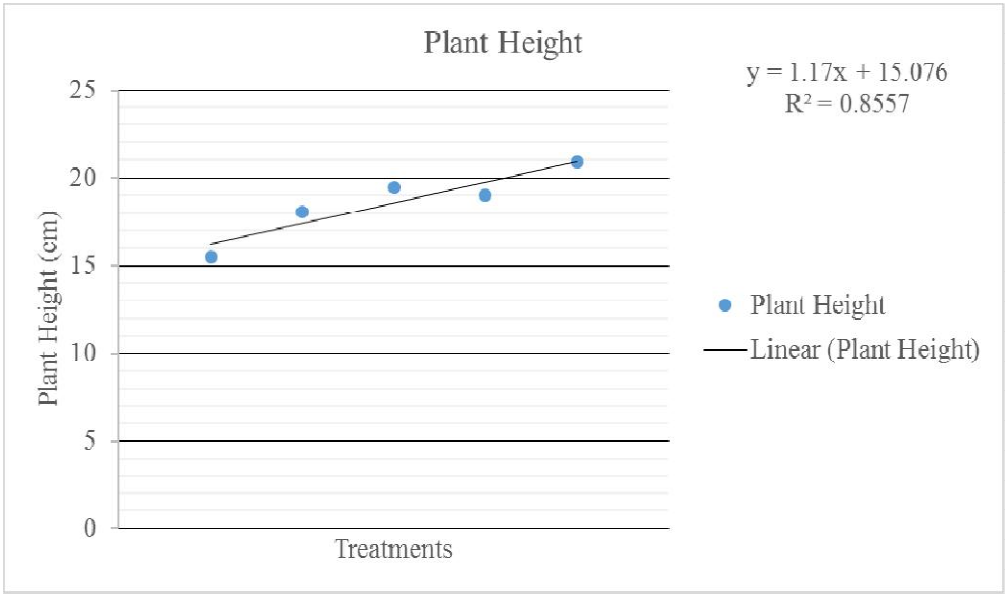

Fig. 3. Regression model for plant height as influenced by organic manure and inorganic fertilizer

predicting plant height of soybeans as a result of poultry manure used at different stages of the soybeans plant.

4. CONCLUSION

There is correlative relationship between the height of cabbage and the yield based on the use of organic manure and inorganic fertilizer. The regression model also pointed out that the increase in the head diameter could be attributed to the increase in the plant height. The regression model between the head diameter and head weight also shows that increase in the head weight could be attributed to the increase in head diameter.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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