



Advances in Research
8(3): 1-6, 2016; Article no.AIR.29940
ISSN: 2348-0394, NLM ID: 101666096



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Variety and NPK Rate Effect on Growth and Yield of Cabbage (*Brassica oleracea L.*) in the Bediese Soil Series at Asante Mampong in Ghana

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Authors' contributions

This work was carried out in collaboration between all authors. Author KNH conceived the research idea, designed the study, wrote the protocol and conducted the initial literature search. Author AO performed the data analysis and wrote the first draft of the manuscript. Author MMD did the internal review and thoroughly modified the manuscript for submission. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AIR/2016/29940

Editor(s):

(1) Marco Trevisan, Faculty of Agricultural Sciences, Institute of Agricultural and Environmental Chemistry, Catholic University of the Sacred Heart, Italy.

Reviewers:

(1) Mrityunjoy Biswas, Sylhet Agricultural University, Bangladesh.

(2) Felix M. Chipjola, Ministry of Agriculture, Malawi.

Complete Peer review History: <http://www.sciencedomain.org/review-history/17486>

Short Research Article

Received 5th October 2016

Accepted 6th December 2016

Published 10th January 2017

ABSTRACT

Cabbage is one of the major vegetables cultivated on large scale in Asante Mampong for sale in the Ashanti Region and beyond. Low yield due to low yielding cultivars and inappropriate use of fertilizers is a setback in cabbage production in the area. The growth and yield response of three cabbage varieties to three NPK (15:15:15) rates was evaluated in a 3 x 3 factorial experiment conducted in Asante Mampong, Ghana in 2015. The cabbage varieties (Sahel F1, Fortune and Super Cross) and NPK rates (90 kg/ha, 120 kg/ha and 150 kg/ha) were arranged in a randomized complete block design with three replications. With the exception of root weight, there was no significant interaction effect of the treatments on the parameters studied. Although the number of leaves per plant was similar among the fertilizer rates, the higher NPK rates resulted in more

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leaves. The application of 120 kg/ha NPK gave the greatest yield (28.1 t/ha) and this was 18.9% and 17.8% more than the 150 kg/ha and 90 kg/ha rates respectively. The variety, Fortune, had the greatest head circumference, head diameter and head weight and it gave the greatest yield (29.2 t/ha). Application of 120 kg/ha NPK (15:15:15) and cultivation of the Fortune variety could help increase the yield and possibly income of cabbage growers in Asante Mampong.

Keywords: Cabbage varieties; NPK rates; yield components; yield.

1. INTRODUCTION

Cabbage is one of the green leafy vegetables grown under temperate and tropical climatic conditions [1], and some improved varieties can be grown throughout the year in the tropics [2]. Cabbage is high in water content, fibre, protein, calcium and iron, and a rich source of vitamins A and C [2,3].

Cabbage types vary in terms of leaf colours, head shapes and maturity period [4]. Varieties of cabbage with a short growing season are more advantageous for meeting early market demands [3].

Cabbage can grow well in a wide range of soils when provided with adequate moisture and fertiliser. Even though natural soil has large amount of nutrients reserved for plant growth, only a little amount as a result of chemical and physical process is released yearly. Optimally, cabbage requires 60 – 90 kg NPK per hectare [5] but [6,7] found that higher cabbage yield was obtained at 60 kg N/ha supplied from organic fertilizer sources (neem) and NPK fertilizer. Different soils and NPK rates are likely to influence growth and yield of different cabbage varieties differently. [8] reported that yield and quality of cabbage were influenced by soil and nutrient status. [9] also reported that head size was influenced by variety and fertilizer application.

Fortune, Sahel F1 and Super cross are newly introduced varieties in Mampong Municipality. However, effect of fertilizer application rate on the performance of these varieties in the Bediese soil series in Asante Mampong has not been evaluated. The objective of this study, therefore, was to evaluate the growth, yield and quality of the three cabbage varieties at different NPK rates.

2. MATERIALS AND METHODS

The field experiment was conducted at the Teaching and Research Farm of the College of Agriculture Education, University of Education, Winneba, Asante Mampong campus

from June 2015 to September 2015. Asante Mampong (7°45'N, 1°24'W) is at 402 m above mean sea level and is located in the forest-savannah transition agro-ecological zone. The area has a bimodal rainfall pattern with the major rainy season from March to July and the minor rainy season from mid-August to November. There is usually a long dry harmattan season from December to March. The soils belong to the Bediese series, which is sandy loam, well drained with a thin layer of organic matter, deep yellowish red, friable and free from stones [10] and classified as Chromic Luvisol according to the [11] soil classification.

The top 0-30 cm soils at the experimental plots were collected and analysed for their chemical properties before transplanting.

The three varieties of cabbage and three levels of NPK fertilizer (15:15:15) were arranged in a randomized complete block design (RCBD) and replicated three times giving a total of nine treatments on twenty-seven experimental beds. Treatment combinations were Sahel F1, Fortune and Super Cross cabbage varieties and NPK rates at 90 kg/ha (Control), 120 kg/ha and 150 kg/ha.

Seeds were sown in drills on a well-prepared nursery seedbeds which were 2 m long, 0.8 m wide and about 0.2 m high. Separate beds were prepared for each variety. The 35 days old seedlings were transplanted to the field at a plant spacing of 80 cm between rows and 60 cm within-row. Each plot was 2.5 m X 2.0 m and contained four rows of cabbage plants. The NPK (15-15-15) fertilizer were applied one week after transplanting. Watering was done regularly as and when necessary and weeding was done with a hoe whenever necessary. Cymethoate Super EC insecticide (a.i. 36 g cypermethrin and 400 g dimethoate per litre) at the rate of 50 ml per 15 litre of water in a knapsack sprayer was applied to control cabbage worms at 10 days intervals after transplanting.

Data were collected on number of leaves per plant, mean head weight, head diameter and

head yield. Number of leaves per plant (i.e. total count of leaves per plant) was measured at maturity from four randomly selected plants from the two middle rows of each plot. Plant root weight, stem diameter, stem length, core length, head circumference, head diameter, head weight and yield were recorded from four plants harvested from the two middle rows.

All data were analysed by analysis of variance techniques for a factorial experiment arranged in RCBD using the SAS statistical package version 12.

3. RESULTS AND DISCUSSION

3.1 Soil Chemical Properties

The pH of the soil was 5.4, organic carbon 0.47%, organic matter 0.81% and total nitrogen 0.06%. The exchangeable cations, especially, Ca, Mg, K and Na were 2.48, 0.93, 0.24 and 0.21 me/100 g respectively.

3.2 Growth Parameters

The number of leaves per plant differed significantly $p < 0.05$ among the varieties and fertilizer rates. Fortune had the highest number of leaves per plant at 1, 2 and 3 weeks while the application of NPK at 120 kg/ha gave the highest number of leaves at the 1, 2 and 3 weeks after transplanting (Fig. 1 and 2). The least number of leaves per plant was recorded in Super Cross while the plants applied with 90 kg/ha NPK had the least number of leaves at the 1, 2 and 3 weeks after transplanting.

Different crop varieties possess varying genotypic and phenotypic traits and these probably led to the differences in leaf number since the varieties were grown under the same environmental conditions [12]. The highest number of leaves observed in plants applied with 120 kg/ha NPK indicates that 120 kg/ha adequately improved the availability of sufficient nutrients which enhanced photosynthesis and plant. [4] studied the effect of eight fertilizer types on growth and yield of two cabbage varieties and found that the varieties responded differently to the fertilizer types in terms of growth parameters and yield.

Fortune had the greatest root weight and there was variety and fertilizer interaction effect on root weight (Table 1).

3.3 Yield Parameters

Yield parameters were significantly ($p < 0.05$) influenced by cabbage varieties. Fortune had the greatest stem diameter and stem length while Sahel F1 produced the highest stem and core lengths. The least performance in all parameters was observed in Super Cross. Fortune had the largest head circumference and head weight yield, followed by Super Cross while Sahel F1 had the largest head diameter. Fertilizer rates did not influence the yield component of the cabbage varieties in our experiment (Table 1).

Table 1. Variety and NPK effect on root weight

Treatment	Root weight (g)
Variety	
Fortune	54.8
Sahel F1	42.8
Super cross	42.6
Mean	46.7
LSD (0.05)	8.43
Fertilizer (kg/ha)	
90 kg/ha	46.6
120 kg/ha	49.8
150 kg/ha	43.8
Mean	46.7
LSD (0.05)	NS
Variety x Fertilizer interaction	14.6
CV (%)	18.0

Table 2. Variety and NPK effect on root weight, stem diameter, stem length and core length

Treatment	Stem diameter (cm)	Stem length (cm)	Core length (cm)
Variety			
Fortune	3.5	7.1	6.3
Sahel F1	3.1	8.1	7.3
Super cross	3.2	7.0	5.7
Mean	3.2	7.4	6.4
LSD (0.05)	0.3	0.9	0.8
Fertilizer (kg/ha)			
90 kg/ha	3.2	7.3	6.2
120 kg/ha	3.3	7.4	6.6
150 kg/ha	3.3	7.4	6.5
Mean	3.3	7.4	6.4
LSD (0.05)	NS	NS	NS
Variety x Fertilizer interaction	NS	NS	NS
CV (%)	9.9	12.2	12.9

Although there were no significant differences ($p>0.05$) among fertilizer rates on the yield components, the application of 120 kg/ha NPK gave 28.1 t/ha, which was 18.9% and 17.8% more than the 150 kg/ha and 90 kg/ha respectively (Table 2).

Shika and Doug [5] recommended the application range between 60 – 90 kg of NPK (15: 15:15) per hectare for any cabbage. Our study, however, revealed that this is inadequate for improving the growth and yield of cabbage in the soil conditions of our study location. The significant ($p<0.05$) difference among varieties in terms of stem length is consistent with the results of [13]. This variation can be attributed to

the phenotypical characteristic of the varieties. The no significant difference in NPK rates on stem length is not consistent with [14] who reported that different fertilizers affected stem length. The Fortune variety had the highest yields of 29.2 t/ha which was 23.9% and 22.9% more than Sahel F and Super Cross respectively. The global average yield of cabbage is estimated at 27.8 t/ha [15]. Average head weights varied among three varieties ranging from 1.88 kg in Fortune to 0.96 kg in Sahel F. The head weights and size are consistent with [16], who reported that cabbages for the fresh market must have high head densities, small to medium-sized heads.

Table 3. Variety and NPK effect on head circumference, diameter, weight and yield

Treatment	Head circumference (cm)	Head diameter (cm)	Head weight (kg)	Yield (t/ha)
Variety				
Fortune	62.7	9.0	1.877	29.2
Sahel F1	43.7	10.2	0.958	22.2
Super cross	55.2	8.0	1.098	22.5
Mean	53.9	9.1	1.311	24.6
LSD (0.05)	6.0	0.5	0.402	5.7
Fertilizer (kg/ha)				
90 kg/ha	52.8	8.9	1.172	23.1
120 kg/ha	54.4	9.0	1.316	28.1
150 kg/ha	54.4	9.3	1.444	22.8
Mean	53.9	9.1	1.311	24.7
LSD (0.05)	NS	NS	NS	5.7
Variety x fertilizer interaction	NS	NS	NS	NS
CV (%)	11.1	5.6	30.7	9.8

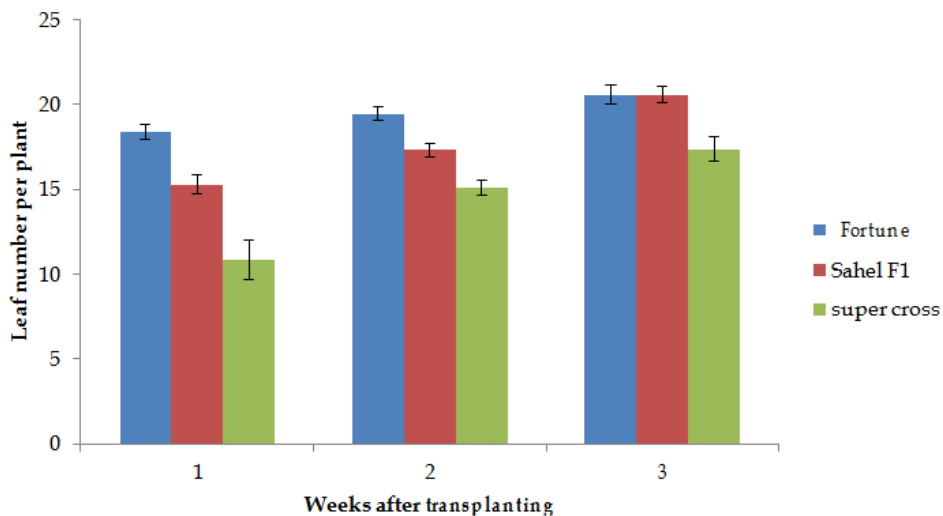


Fig. 1. Varietal effect on number of leaves per plant

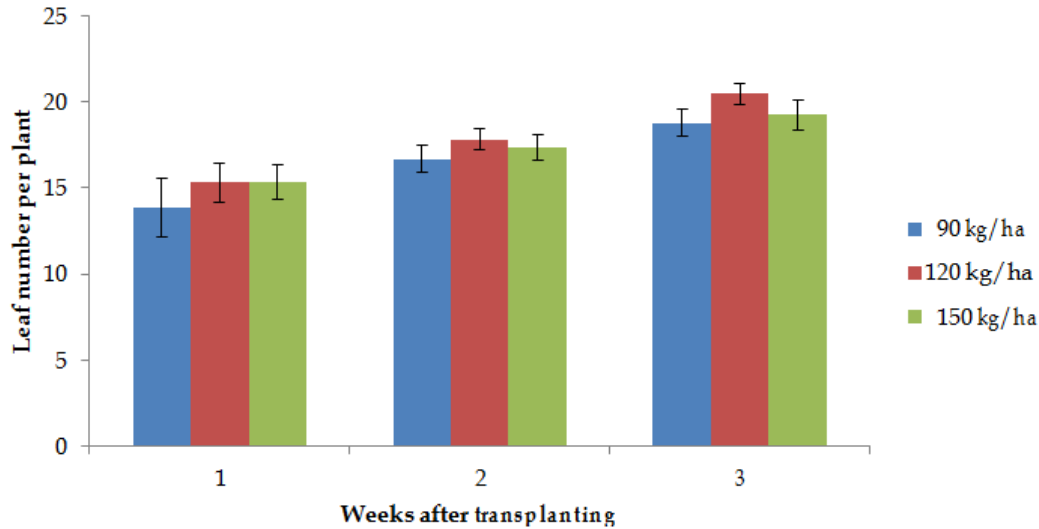


Fig. 2. NPK rates effect on number of leaves per plant

According to [9], head sizes of cabbage is influenced by variety and fertilizer application.

4. CONCLUSION AND RECOMMENDATION

The results of the experiment have shown that Fortune variety had the biggest heads and also gave the greatest yield and could be recommended for commercial cabbage growers in Asante Mampong. The application of 120 kg/ha NPK promoted the growth of the crop and resulted in the greatest yield of cabbage compared with 90 kg and 150 kg rates.

ACKNOWLEDGEMENT

The authors acknowledge Mr. Kassim Mumuni, Mr. Francis Besea and Mr. Mike for their invaluable assistance in the field layout, transplanting and data collection.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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