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Research Application Summary

Comparative effect of farm yard manure and chemical fertilizer on growth and yield of cabbage in volcanic soils of Northern Rwanda

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Abstract

In Rwanda, cabbages are facing numerous problems including low soil fertility which leads to their low yield. The main objective of this study was to compare the effects of organic manure and mineral fertilizer NPK (17-17-17) on growth and yield of cabbage in volcanic soils of Northern Province of Rwanda. Accordingly, field experiment was established in a randomized complete block design with 5 treatments and 3 replications. These treatments were: T1(control with 5t/ha of FYM +0 kg/ha of NPK17-17-17); T2(5t/ha of FYM + 100kg/ha of NPK17-17-17); T3(5t/ha of FYM+150kg/ha of NPK17-17-17); T4(5t/ha of FYM + 200kg/ha of NPK17-17-17) and T5(5t/ha of FYM + 250kg/ha of NPK17-17-17). The results showed that the concentration of exchangeable K+ increased at the end of the after-field experiment. The soil nitrogen was very high on treatment 5 and high on treatment 4. The results on growth characteristics and yield of the headed cabbages showed that T5, the soil nitrogen content was very high on some treatments and high on other treatments. The results on growth characteristics and yield of the headed cabbages showed that T5 had the highest yield (32.5 t/ha) followed by T4 with 25t/ha. The combination of 5t/ha of farm yard manure and 250kg/ha of NPK 17-17-17 can be adopted by farmers to increase cabbage production in Busogo Soils.

Key words: Cabbage, growth, manure, NPK, yield

Résumé

Au Rwanda, les choux sont confrontés à de nombreux problèmes dont la faible fertilité des sols qui entraîne leur faible rendement. L'objectif principal de cette étude était de comparer les effets de la fumure organique et de l'engrais minéral NPK (17-17-17) sur la croissance et le rendement du chou dans les sols volcaniques de la province du Nord du Rwanda. En conséquence, l'expérience sur le terrain a été établie dans une conception en blocs complets randomisés avec 5 traitements et 3 répétitions. Ces traitements étaient : T1 (témoin avec 5 t/ha de FYM + 0 kg/ha de NPK17-17-17) ; T2(5t/ha de FYM + 100kg/ha de NPK17-17-17); T3(5t/ha de FYM+150kg/ha de NPK17-17-17); T4(5t/ha de FYM + 200kg/ha de NPK17-17-17) et T5(5t/ha de FYM + 250kg/ha de NPK17-17-17). Les résultats ont montré que la concentration de K+ échangeable augmentait à

la fin de l'expérience après champ. L'azote du sol était très élevé sur le traitement 5 et élevé sur le traitement 4. Les résultats sur les caractéristiques de croissance et le rendement des choux pommés ont montré que T5, la teneur en azote du sol était très élevée sur certains traitements et élevée sur d'autres traitements. Les résultats sur les caractéristiques de croissance et le rendement des choux pommés ont montré que T5 avait le rendement le plus élevé (32,5 t/ha) suivi de T4 avec 25 t/ha. La combinaison de 5 t/ha de fumier de ferme et de 250 kg/ha de NPK 17-17-17 peut être adoptée par les agriculteurs pour augmenter la production de choux dans les sols de Busogo.

Mots clés : Chou, croissance, fumier, NPK, rendement

Introduction

The African continent currently experiences food shortages brought about mainly due to demographic exploitation, insufficiency of cultivated areas and using inappropriate agricultural techniques. Often farmers are applying excessive cultivation without replenishing nutrients (Oldewage-Theron and Egal, 2021). According to Simonne *et al*. (2017), the need for fertilizers application to enhance crop productivity to meet the increasing food demand in developing countries, particularly in Sub Sahara Africa is urgently needed. This is because there is seldom a crop production system in the tropics which does not require the external addition of plant nutrients, especially nitrogen, phosphorus, potassium through mineral fertilizers (Shang *et al*., 2014). The main purpose of applying fertilizers is to supply nutrients in concentrated and readily available form in order to get higher yields from fertilizer responsive crops. Further, fertilizers contribute to the overall supply of particular nutrient elements in the medium and help to attain an adequate concentration in the soil solution(Scholberg *et al*., 2013). Therefore, the objective of this study was to determine the effect of farm yard manure and different doses of NPK17-17-17 fertilizer in the soil of Busogo zone in Northern Rwanda in order to set up appropriate and suitable dose of fertilizers to be used for cabbage production which would help in sustaining food.

Materials and Methods

The crop tested was cabbage. The choice of this crop was due to its adaptation in all regions of Rwanda, its role to fight malnutrition and its short vegetative cycle. The mineral fertilizer used in this study, was NPK 17-17-17. This fertilizer contains nitrogen, phosphorus and potassium as essential elements for plant growth. The different doses of this mineral fertilizer were 0,100,150,200, 250 kg/ha respectively, as T1, T2, T3, T4, T5 treatments except in T1 where there was no use of this fertilizer.

For land preparation and leveling, hand hoe; rake; pods and ropes were used in the operation. After cultivation the soil was leveled and the material which cannot decay were removed then after that the fertilizers were applied.

Field experimental design and experiment management. The seedlings were transplanted after four weeks of sowing and were 10cm high. The spacing between one plant to another was 40 cm in rows with 60 cm between the rows. Farm yard manure (25t/ha) was applied and incorporated

into the soil by cultivating, and this was done three weeks before transplanting. Weeding was done two times during the experiment in the 3rd and 6th weeks after transplanting using hoe in order to allow water infiltration and aeration into the soil. Chemicals (diazinon) and pesticides were used to control pest and diseases. Experimental design was Randomized Complete Blocks Design (RCBD) with five treatments and three replications.

Analysis of soil samples. After field experiment, the soil testing was done in order to determine the nutrients status of soil from the field experiment. The soil testing was done on the following elements: soil PH (water), organic carbon, nitrogen content, Available phosphorus; Exchangeable Potassium, Calcium and Magnesium. The soil samples were dried in the open air and sieved with sieves of 2mm and 0. 5mm.The soil reaction (pH water) was measured in the distilled water. The readings of the pH value with pH-meter were taken after 15 minutes of shaking (agitation) the mixture of soil and water. The organic carbon was determined by means of modified method of Walkley and Black. The carbon percentage was estimated using oxidization by the potassium dichromate in the presence of the concentrated sulfuric acid. Phosphoruslevel was also determined by using photo colorimetric method of Bray II. The exchangeable bases were extracted by a normal solution of ammonium acetate at pH 7. The content of the soil solution in Ca2+ and Mg2+ cations was determined by titrating with EDTA (Ethyl Diamine Tetracetic Acid). For the K+, the reading was made by the atomic broadcast spectrophotometer.

The data were analyzed by performing an Analysis of Variance (ANOVA) and the means of significant effects were separated using SAS software.

Results and Discussion

Soil analysis. The results of the soil analysis are shown in Table 1.

Plant heights. The mean height ranges between 13.3 cm and 22cm at 30 days after planting (DAP) with the general mean of 17. 92cm. At 45 DAP, the mean height of cabbages ranged between 16.6cm and 24.3cm while it varies from 22cm to 29.3cm at 60 DAP. At 30th day, the highest mean height of plant was observed on T5(22cm) while T1 had the lowest mean height of cabbages(13.3cm). At 45th day, the highest mean height of cabbages was observed on T5(24.3cm) while T1 had the lowest value(16.6cm). At 60th day, the highest mean height of cabbages was observed on T5 (29.3cm) while T3 had the lowest value (22cm). The results showed that there is a highly significant difference between treatment ($P=0.003$), ($P<0.001$), ($P=0.003$) respectively at 5% level. The letters on the graph below shows the significantly different among the treatment. Mean of a treatment with the A letter is different from a treatment with a mean with a letter B. But if two or more treatments share the same letter(s) it means they are not significantly different from each other. The figure 1 below shows that the treatments T5 and T4 with letter A and AB perform better comparing to the others. whereas T1 with letter C had the poorest performance.

Table 1. Soil characteristics before the experiment

Considered parameters	pH water	C%	N%	Soil O.M	Mg2+ Cmol/kg	K+cmol/kg	Ca+cmol/kg	CEC
values	6.29	2.75	0.1	4.74	1.7	4.5	0.26	12.3
interpretation	Slightly acid	Weak	Moderately humified	Middle	Middle	Middle	Middle	Middle

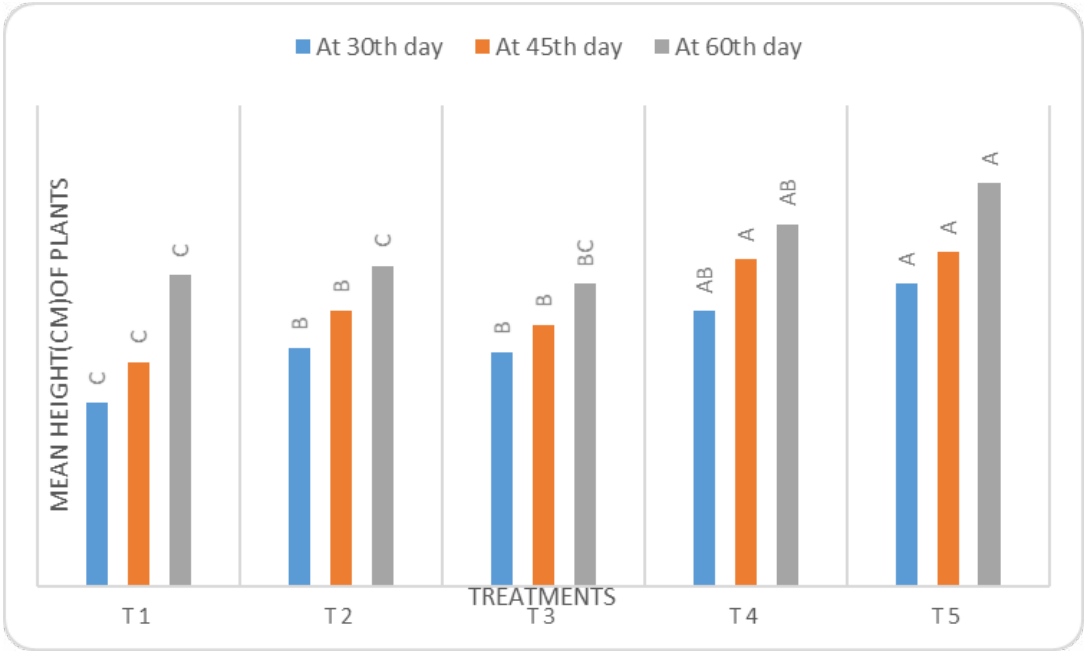

Figure 1. Effect of FYM and NPK on heights of cabbage after 30; 45 and 60 days of planting

The letters in the Table below shows the significantly different among the treatment. The results showed that there was a significant difference between treatment (p = 0.014) at 5% level. The Table shows that the treatments with mean of letter A (T5) and T4 had the best performance Whereas the poorest treatment (T1) with the mean of 7.33 leaves.

Length of leaves per plants of cabbages. The results obtained showed that there is a significant difference between treatments (p=0.015), (p<0.001), (p<0.001) at 5% level respectively. The table below shows that the treatments are having letters A, AB, BC and C which indicates the difference in means. The treatment T5 with mean of letter A shows the best result; AB shows the mean length of leaves on T4; BC shows the mean length of leaves on T3 and T2. Considering treatment mean, T5 and T4 are best performing treatments because with respectively means of 19.33 and 17.67 cm length whereas the poorest treatment is T1 which has mean 13.33cm length.

Table 2. Average number of leaves per plant of cabbage

Treatment	Mean number of leaves (cm)	
	30DAP	60DAP
T5	13.0[a]	21.67[a]
T4	12.0[a]	21.33[a]
T3	10.67[a]	20.00[a]
T2	10.0[ab]	19.33[a]
T1	7.33[c]	16.00[b]
LSD ($\alpha \leq 0.05$)		

DAP= Days after planting
T1=5 t/ha FYM, 0NPK
T2=5 t/ha FYM, 100 kg/ha
T3=5t/ha FYM, 150 kg/ha
T4=5t/ha FYM + 250 kg/ha NPK 17-17-17
T5=5t/ha FYM + 200 kg/ha NPK 17-17-17

Table 3. Length of leaves of cabbages at (30, 45 and 60) day after planting

Treatment	Mean length of leaves (cm)	Mean length of leaves (cm)	Mean length of leaves (cm)
	30DAP	45DAP	60DAP
T5	19.33[a]	23.67[a]	27.0[a]
T4	17.67[ab]	22.67[a]	26.33[a]
T2	15.67[bc]	19.0[b]	21.33[b]
T3	15.33[bc]	18.0[b]	19.67[bc]
T1	13.33[c]	15.67[c]	16.67[c]

T1=5 t/ha FYM, 0NPK
T2=5 t/ha FYM, 100 kg/ha
T3=5t/ha FYM, 150 kg/ha
T4=5t/ha FYM + 250 kg/ha NPK 17-17-17
T5=5t/ha FYM + 200 kg/ha NPK 17-17-17

Table 4. Effect of FYM and NPK fertilizer on the yield of headed cabbage

Treatment	Mean yield(t/ha) of cabbages
T5	32.3[a]
T4	25[b]
T3	24[b]
T2	22.43[b]
T1	17.6[c]

T1=5 t/ha FYM, 0NPK
T2=5 t/ha FYM, 100 kg/ha
T3=5t/ha FYM, 150 kg/ha
T4=5t/ha FYM + 250 kg/ha NPK 17-17-17
T5=5t/ha FYM + 200 kg/ha NPK 17-17-17

Conclussions

The continuous cultivation of land in Rwanda has resulted in depletion of soil fertility. The main task to scientists and students in agricultural science is the maintenance of soil productivity and higher crop yields and by promotiing the preservation of soil and plant genetic resources. The study that was undertaken with the main objective of finding out the effect of farm yard manure and different doses of NPK (17-17-17) fertilizers on soil properties and yield of cabbage in Busogo zone. An experiment was conducted under randomized complete block design with five treatments and three replications. The headed cabbage was grown as test crop. Based on the results obtained on soil properties after field experiment, the concentration of exchangeable K+ increased after the experiment. This effect was probably due to application of Potassium-containing fertilizers (NPK) in the soil. The soil nitrogen content was very high on T5 (5t/ha of FYM + 250kg/ha of NPK17-17-17) and T4 (5t/ha of FYM + 200kg/ha of NPK17-17-17) and high on other treatments. Concerning the results on growth characteristics and yield of the headed cabbages, T5 (5t/ha of FYM + 250kg/ha of NPK17-17-17) followed by T4 (5t/ha of FYM + 200kg/ha of NPK17-17-17) gave the best results of 32.3t/ha and 25t/ha in comparison with the control T1 (17.6t/ha) and other treatments. Hence it is concluded that the combination of 5t/ha of farm yard manure and 250kg/ha of NPK17-17-17NPK 17-17-17 can be sensitized and adopted by farmers to increase the cabbage productions in soils of Busogo zone.

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References

Oldewage-Theron, W. and Egal, A. A. 2021. Is food insecurity a problem among the elderly in Sharpeville, South Africa? *Food Security* 13 (1): 71–81. https://doi.org/10.1007/s12571-020-

01125-9

Scholberg, J., Zotarelli, L., Dukes, M.D., Ozores-Hampton, M., Liu, G. and Tittonell, P., 2013. Enhancing fertilizer efficiency in high input cropping systems in Florida. pp. 143-174. In: *Sustainable Agriculture Reviews*. Springer, Dordrecht.

Shang, Q., Ling, N., Feng, X., Yang, X., Wu, P., Zou, J., Shen, Q. and Guo, S. 2014. Soil fertility and its significance to crop productivity and sustainability in typical agroecosystem: A summary of long-term fertilizer experiments in China. *Plant and Soil* 381 (1): 13–23. https://doi.org/10.1007/s11104-014-2089-6

Simonne, E. H., Gazula, A., Ozores-Hampton, M., DeValerio, J. and Hochmuth, R. C. 2017. Localized application of fertilizers in vegetable crop production. pp. 149–181. In: Tei F., Nicola S. and Benincasa, P. (Eds.), Advances in research on fertilization management of vegetable crops. Springer International Publishing. https://doi.org/10.1007/978-3-319-53626-2_6