# GROWTH, YIELD AND QUALITY OF LETTUCE (*Lactuca sativa* L.) SUPPLIED WITH POULTRY AND NPK FERTILIZERS AT VOM, NIGERIA.

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**Abstract**
An experiment was conducted during the dry seasons of 2009 and 2010 at the vegetable garden of the National Veterinary Research Institute, Vom in Plateau State, Nigeria to evaluate the effect of nitrogenous fertilizer and poultry manure application on the growth, yield and quality of lettuce. Five treatments comprising three rates (50, 100 and 150 kg N $ha^{-1}$) of nitrogen using 20-10-10 NPK fertilizer, 20 tonnes $ha^{-1}$ of poultry fertilizer and a control were evaluated. Randomized complete block design (RCBD) replicated four times was utilised for the trial. Fertilizer application significantly ($p < 0.05$) increased plant height, number of leaves, root length and herbage yield of lettuce. Among the nitrogenous treatments, 100 kg N $ha^{-1}$ was favourable to lettuce based on response at 5 weeks after transplanting (WAT). Poultry manure (fertilizer) supplied at 20 tonnes $ha^{-1}$ was statistically superior ($p < 0.05$) to other treatments for root length and weight of lettuce at 5 WAT and superior ($p < 0.05$) to 50 kg N $ha^{-1}$ for herbage yield at 8 WAT. The crude protein (CP) and ash concentrations in lettuce produced with poultry fertilizer were 2.5 % and 107.8 % higher than the CP and ash concentrations of lettuce grown with inorganic fertilizer. In addition, the crude fibre (CF) concentration of organic lettuce was 12.4 % lower than that of inorganic lettuce. Poultry manure may be used instead of NPK fertilizer for higher quality lettuce production.
**Keywords:** Lettuce, rate of application, poultry manure, NPK fertilizer**,** Vom-Nigeria

## Introduction

Lettuce a commonly grown vegetable in Vom, Nigeria is consumed by humans but produced at the National Veterinary Research Institute (NVRI) Vom, for feeding micro-livestock such as rabbit guinea pig, mice etc. Lettuce is rich in vitamin A (carotene), vitamin C (ascorbic acid), calcium and iron (Ananda and Ahundeniya, 2012) including protein and carbohydrate (Tindall, 1986). Lettuce may be grown under rain-fed condition or with irrigation facility and also with hydroponic system in controlled environment (Ananda and Ahundeniya, 2012; Valenzuela *et al*., 2012). In Hawaii-USA, lettuce is commonly grown on bare ground culture with sprinkler irrigation (Valenzuela *et al*., 2012). Fertilizer application affects growth and yield of lettuce (Masarirambi *et al*., 2012a). In small and medium scale production typical in Vom and other lettuce growing areas of Nigeria, fertilizer application for lettuce is carried out based on visual guess work estimation which is inconsistent and vary among farmers, localities and availability of inputs especially NPK fertilizer. Although such an un-standardized method of fertilizer application may pose no problem for experienced farmers, their margin of profitability may likely be low. Consequently, new vegetable producers venture into lettuce production without a reliable guide for fertilizer application since no specific recommendation is in place for lettuce production in Vom. In Thailand, 81 kg N $ha^{-1}$ is recommended for lettuce production (Paudel *et al*., 2004).

On the other hand, because organic vegetable production is appreciated world-wide (Masarirambi *et al*., 2012a; Kantashula *et al*., 2006), it is imperative to compare the growth, yield and quality of lettuce obtained with conventional inorganic fertilizers commonly practiced in Vom, against an alternative organic fertilizer such as poultry manure. Moreover, poultry manure is readily available in Vom and other parts of Plateau State due to the rising trend in establishment of poultry farms relative to large ruminant livestock farms. Chicken manure is a valuable fertilizer for pasture grasses, small grains and various vegetable crops (Masarirambi *et al*., 2012b). The objective of this study therefore, was to evaluate the effects of poultry fertilizer and different rate of NPK fertilizer on the growth, yield and quality of lettuce.

## Materials and Method

The experiment was carried out during the dry seasons of 2009 and 2010 in the vegetable garden of the National Veterinary Research Institute (NVRI), Vom. The experimental site is located on latitude 09° 44' N and longitude 08° 47'E at an altitude of 1239.4 m above sea level. The soil of the experimental plots falls in the Entisols-orthents or Regosols order based on the USDA or FAO/UNESCO classifications respectively (Enwezor *et al*., 1989) and is of ferallictic cambisol developed from volcanic rocks (Enwezor *et al*., 1990). Three rates (50, 100 and 150 kg N $ha^{-1}$) using 20-10-10 NPK fertilizer, 20 tonnes $ha^{-1}$ poultry fertilizer and no fertilizer (control) were 5 treatments fitted into a randomized complete block design (RCBD) and replicated four times.

Each year Iceberg lettuce (variety Eden) seeds were raised on nursery beds for 6 weeks before transplanting into 2 m x 3 m experimental plots. The seedlings were transplanted to 30 cm intra-row and 30 cm inter-row spacing giving a plot population of approximately 108 stands. Five days before transplanting (WAT), poultry fertilizer was applied at 20 tonnes $ha^{-1}$ to the respective plots. A first dose of

NPK fertilizer was applied at 2 WAT whereas the second dose was applied at 4 WAT to the respective plots. After transplanting, sprinkler irrigation and manual hoe weeding were carried out as required to provide water and control weeds respectively. Insect pests and disease organisms were monitored and controlled as part of routine cultural practice.

Four parameters (plant height, number of leaves; root length and herbage yield of lettuce) were measured at 5 and 8 WAT on the basis of 5 randomly selected plants. The sampled plants were weighed with a digital scale (Escali professional) and recorded as herbage yield (HY) which was converted to kg $ha^{-1}$. Lettuce harvested at 8 WAT was bulked on the basis of NPK (inorganic) or poultry manure (organic) products, sub-sampled for determination of proximate and mineral composition (AOAC, 1990) to estimate nutrient quality. The 2 year data were combined and subjected to one way Analysis of Variance (ANOVA) using the SAS statistical software (SAS, 2001) to determine the significance ($p < 0.05$) of treatment effects. The Least Significant Difference (LSD) test was used to separate the means.

**Results**

Fertilizer significantly ($p < 0.05$) affected all the growth parameters at 5 WAT (Table 1). The tallest ($p < 0.05$) lettuce plants were produced with 100 kg N $ha^{-1}$ followed by 20 t $ha^{-1}$ poultry fertilizer. Plants fertilized with poultry manure were significantly taller than those in the control treatment but statistically similar in height to those fertilized with 50 kg N $ha^{-1}$ and 150 kg N $ha^{-1}$. The number of leaves produced with 100 kg N $ha^{-1}$ and poultry manure was statistically similar. The 50 kg N $ha^{-1}$, 150 kg N $ha^{-1}$ and control treatments produced the fewest number of leaves and were at par. Plants grown with poultry manure exhibited the longest ($p < 0.05$) roots. Poultry manure and 100 kg N $ha^{-1}$ treatments significantly surpassed control treatment in root length. The 50, 100 and 150 kg N $ha^{-1}$ treatments produced plants with statistically similar root length. Lettuce produced with poultry manure was significantly heavier than that produced with 50 kg N ha-1, 100 kg N $ha^{-1}$, 150 kg N $ha^{-1}$ and control treatments by 370 %, 34.3 %, 153.1 % and 338.7 %, respectively.

**Table 1: Effect of fertilizer on growth and yield of lettuce at 5 weeks after transplanting**

| Fertilizer | PH (cm) | NOL | RL (cm) | HY (kg $ha^{-1}$) |
|---|---|---|---|---|
| Control | 6.3 | 7.0 | 7.3 | 25.0 |
| Poultry manure | 7.8 | 11.8 | 14.0 | 109.7 |
| NPK 50 kg N $ha^{-1}$ | 6.8 | 8.3 | 9.0 | 23.3 |
| NPK 100 kg N $ha^{-1}$ | 10.0 | 10.8 | 9.3 | 81.7 |
| NPK 150 kg N $ha^{-1}$ | 8.5 | 8.0 | 8.0 | 43.3 |
| Significance | * | * | * | * |
| $LSD_{0.05}$ | 1.45 | 2.66 | 1.85 | 19.70 |

Means in the same column followed by the same letter(s) are not significantly different (P≤0.05). PH=Plant height, NOL=Number of leaves, RL-Root length, HY=Herbage yield

At 8 WAT, effect of fertilizer on plant height and root length of lettuce on one hand and on number of leaves and herbage yield of lettuce on the other hand was similar. However, only plants fertilized with 150 kg N $ha^{-1}$ were superior to control in terms of plant height. In the same vein, number of leaves was only significant with poultry manure application. For number of leaves, there was no significant difference among other treatments (Table 2). The proximate composition values presented in Table 3 show that lettuce produced with organic fertilizer had higher crude protein (CP) and Ash but lower crude fibre (CF), ether extract and calcium concentrations compared to lettuce that received inorganic fertilization.

**Table 2: Effect of fertilizer on growth and yield of lettuce at 8 weeks after transplanting**

| Fertilizer | PH (cm) | NOL | RL (cm) | HY (kg $ha^{-1}$) |
|---|---|---|---|---|
| Control | 17.0 | 16.3 | 10.2 | 268.3 |
| Poultry manure | 22.0 | 26.0 | 12.8 | 1266.8 |
| NPK 50kg N $ha^{-1}$ | 20.0 | 19.5 | 13.3 | 587.0 |
| NPK 100 kg N $ha^{-1}$ | 22.3 | 21.0 | 14.3 | 830.0 |
| NPK 150 kg N $ha^{-1}$ | 24.8 | 21.8 | 12.0 | 826.8 |
| Significance | * | * | ns | * |
| $LSD_{0.05}$ | 5.51 | 5.97 | | 1026.5 |

Means in the same column followed by the same letter(s) are not significantly different (P≤0.05). PH=Plant height, NOL=Number of leaves, RL-Root length, HY=Herbage yield

**Table 3: Proximate composition (%) of inorganic and organic lettuce**

| Lettuce | CP | CF | EE | Ash | Ca | P |
|---|---|---|---|---|---|---|
| Inorganic | 15.8 | 29.9 | 5.1 | 11.5 | 2.5 | 0.1 |
| Organic | 16.2 | 26.2 | 4.5 | 23.9 | 1.7 | 0.3 |

CP=Crude protein, CF=Crude fibre, EE=Ether extract,

**Discussion**

The study reaffirmed that fertilizer application is required for lettuce production in Vom as in other areas within (Ogbodo *et al*., 2010) and outside (Paudel *et al*., 2004; Masarirambi *et al*., 2010) Nigeria. This finding is buttressed by the observation that plant height, number of leaves, root length and herbage yield of lettuce were significantly increased by fertilizer. The study also indicated that applied fertilizers furnished lettuce with sufficient nutrients for growth. Fertilizer provides nitrogen, phosphorus and potassium which plants require for vegetative growth, energy transformations and enzymatic activities respectively (Jones, 2003). Furthermore, the plants attained uniform maturity within the stipulated 10 weeks maturation period for Eden variety of lettuce. Head lettuce cultivars mature within 60-85 days from transplanting while loose leaf types are harvested within 35-50 days from planting (Tindall, 1983). This also implies that the nitrogen supplied was sufficient for the crop. Moreover, the compound fertilizer which supplied nitrogen, to the lettuce crop invariably provided the phosphorus required which further promoted growth and yield. In England, yields of lettuce were significantly reduced when soil solution phosphorus was below 1 ppm (Valenzuela *et al.,* 2012). This infers that when inorganic fertilization is adopted for lettuce production, a compound rather than a single fertilizer is preferable.

In terms of rate of application, the study showed that 100 kg N $ha^{-1}$ is appropriate for lettuce production at Vom, Nigeria. Consequently, 100 kg N $ha^{-1}$ could be adopted as a starting point for future studies on lettuce or for routine lettuce production at Vom prior to agro-economic evaluation to determine the profitability of this rate of application. However, it is notable that 100 kg N $ha^{-1}$ is higher than the 80 kg N $ha^{-1}$ used by Ogbodo *et al*. (2010) for lettuce production at 3 locations in South Eastern Nigeria. This difference may be ascribed to variation in the inherent soil fertility between the agro-ecological zones in which the studies were conducted. The greater variation in response by lettuce to fertilizer application observed at 5 WAT compared to 8 WAT may be attributed to physiological factors and probably also to delay in fertilizer application. At 5 WAT, the seedlings were still at the juvenile or active growth stage whereas at 8 WAT the plants were nearer maturity and therefore at the lag stage in the sigmoid crop growth curve. In the lag stage of crop growth, plants may exhibit slower growth rate and luxury consumption of nutrients (Mitchell, 1970). Lettuce matures in 6 to 12 weeks after planting depending on cultivar (Tindall, 1983) and 70 - 80 % of the total NPK nutrient uptake by head lettuce occurs during the last three weeks of growth (Valenzuela *et al*., 2012). Therefore fertilization of lettuce should be carried out much earlier than 4 weeks after transplanting to enable adequate mineralization of fertilizer for plant nutrient uptake and utilization in dry matter production. In Hawaii-USA, 227-409 kg of NPK 10-30-10 is applied before planting lettuce and 159 kg $NH_4SO_4$ is side-dressed 3-4 weeks after planting lettuce. (Valenzuela *et al*., 2012).

This study affirms that poultry manure applied at 20 tonnes $ha^{-1}$ is adequate for lettuce production having shown superiority over inorganic fertilizer at 5 WAT and furnished similar results with inorganic fertilizer at 8 WAT for NOL, RL and HY. This infers that short duration (35-42 days) lettuce required for feeding experimental animals in Vom may be produced successfully with poultry manure. However, even when long duration (60-85 days) head lettuce is grown to harvest maturity for human consumption, results from this study indicate that poultry manure is quite adequate. This could be attributed to the large quantities of available phosphorus and available potassium contained in chicken manure. Masarirambi *et al*. (2012a) reported 4685 µg kg and 2149 µg kg of available P and K, respectively in chicken manure. In the existing study, lettuce supplied with poultry manure obtained a marketable yield of 1266.8 kg $ha^{-1}$ whereas Masarirambi *et al*. (2012b) reported mean marketable yields of 1.96 and 1.69 t $ha^{-1}$ for lettuce supplied with 60 and 40 tonnes $ha^{-1}$ of chicken manure, respectively. The difference may be due primarily to the higher rate of application which translated into more nutrients in the study at Swaziland. The variation may also be associated with difference between varieties tested i.e. Tania at Swaziland versus Eden at Vom. However, it also connotes that lettuce can respond to higher rates of organic and inorganic fertilization which could be tested in future studies. This study showed that as in other related studies, marketable yield of lettuce produced with poultry manure was substantially higher (by 69.3 %) than that produced with inorganic fertilizer collectively. Masarirambi *et al*. (2010) reported that chicken manure was first while an inorganic control

was last among four fertilizers tested on lettuce in Swaziland. The study also showed that quality of organic lettuce is higher than that of inorganic lettuce in terms of crude protein, ash and crude fibre concentrations. These findings are consistent with reports by workers such as Xu *et al*. (2005) and Magkos *et al.* (2003).

**Conclusion**

A rate of either 100 kg N $ha^{-1}$ of NPK fertilizer or 20 tonnes $ha^{-1}$ of poultry manure is adequate for lettuce production in Vom, Nigeria. Poultry fertilizer can suitably replace NPK fertilizer for lettuce production. Marketable yield and quality of lettuce were enhanced by poultry fertilizer. Higher rates with earlier times of fertilizer application should be evaluated in subsequent studies.

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**References**

Ananda,M.A.I.D. and Ahundeniya,W.M.K.B.W. (2012). Effect of different hydroponic systems and media on growth of lettuce (*Lactuca sativa*) under protected culture. *http:www.goviya.ik/agri-learning.*

AOAC (Association of Official Analytical Chemists). (1990). Official Methods of Analysis. Vol 1, 15th edition.Washington,DC.

Enwezor,W.O.,Udo ,E.J.,Ayoade,K.A.,Adepetu,J.A. and Chude,V.O. (1990). A review of soil and fertilizer use research in Nigeria. Vol. 4, Midddle belt zone, Fed Min of Agriculture and Natural Resources. 217pp.

Enwezor,W.O.,Udo ,E.J.Usoroh, N.J., Ayoade, K.A., Adepetu,J.A., Chude,V.O. and Udegbe, C.I (1989). *Fertilizer use and management practices for crops in Nigeria*. Series No 2. Federal Ministry of Agriculture, water resources and rural development. 163pp.

Jones, J.B. (2003).*Agronomic Handbook: Management of crops, soils and their fertility*. CRC Press New York. 450pp.

Kantashula, E., Sileshi, G.,Mafongoya, P.L. and Banda, J. (2006). Farmer participatory evaluation of the potential for organic vegetable production in the wetlands of Zambia. *Outlook Agric* 35(4):299-305.

Magkos, F., Arvaniti, F and Zampelas, A. (2003). Organic food: Nutritious food or food for thought? A review of evidence. *International Journal of Food Science and Nutrition* 54: 357-371.

Masarirambi, M.T., Dlamini, P, Wahome, P.K. and Oseni, T.O. (2012a). Effects of chicken manure on growth, yield and quality of lettuce (Lactuca sativa L.) 'Taina' under a lath house in a semi-arid sub-tropical environment. *American-Eurasian Journal of Agriculture and Environmental Science* 12 (3): 399-406.

Masarirambi, M.T., Hiawe, M.M., Oseni, O.T. and Sibiya, T.E.(2010).Effects of organic fertilizers on growth, yield, quality and sensory evaluation of red lettuce(*Lactuca sativa* L.) 'Veneza Roxa'. *Agriculture and Biology Journal of North America* 1(6):1319-1324.

Masarirambi, M.T., Mbokazi, B.M., Wahome, P.K. and Oseni, T.O. (2012b). Effects of kraal manure, chicken manure and inorganic fertilizer on growth and yield of lettuce (Lactuca sativa L var Commander) in a semi-arid environment *Asian Journal of Agricultural Sciences* 4 (1) : 58-64.

Mitchell, R.L. (1970). *Crop Growth and Culture*. The Iowa State University Press. Ames, Iowa. 349pp.

Ogbodo, E.N., Okorie, P.O. and Utobo, E.B. (2010). Growth and yield of lettuce(*Lactuca sativa* L.) at Abakaliki agro-ecological zone of South Eastern Nigeria. *World Journal of Agricultural Sciences* 6(2):141-148.

Paudel, K.P, Sukprakarn, S, Sidathani, K. And Osotsapar, Y. (2004). Effects of organic manures on production of lettuce (*Lactuca sativa* L.) in reference to chemical fertilizer. *Kasetsart Journal of Natural Science* 38 : 31-37.

SAS (Statistical Analysis System) (2002). *Guides for personal computers*. Version 9.00(Ed). SAS Institute Inc., Cary, NC.USA.

Tindall H.D. (1986). *Commercial Vegetable Growing*. Oxford University Press. London. 300pp.

Valenzuela, H., Kratky, B and Cho, J. (2012). Lettuce production guidelines for Hawaii *http:www.extent.hawaii.edu/kbase/reports/ lettuce_prod.htm.* Accessed in July 2012.

Xu, H.L., Wang, R., Xu, R.Y., Mridha, M.A.U. and Goyal, S. (2005) Yield and quality of leafy vegetables grown ewith organic fertilizations. *Acta Hort* 627:25-33.