Advances in Social Sciences and Management
November 2023, Vol-1, No-11, pp. 18-24

Effectiveness of Solutions on Soilless Production of Lettuce Grown in Makurdi and Plateau, Nigeria

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Abstract:
The experiment aimed to investigate the effectiveness of solutions on the growth and yield of lettuce grown in Makurdi and Plateau, Nigeria. The experiment is laid in a randomized complete block design with three replications. The treatments used are organic nutrient source, inorganic nutrients source and control, a variety used where (Loose-leaf and Butter-head). During the investigation, some physiological variables, such as growth, plant height and the number of leaves, leaves diameter were measured. Other characteristics like dry weight, plant girth weight, root length, fresh weight and overall yield were also recorded. The results of the investigation revealed that lettuce generally responded to nutrient solution. All the parameter studies have significantly ($P \leq 0.05$) responded to the nutrient solutions with inorganic nutrients solutions recorded higher in both growth and yield-related character such, as plant height (10.00cm), the number of leaves (20.05), dry weight (10.17g), girth weight (48.22g) and yield (30.10kg/ha). On varieties Loose-leaf out performed Butter-head in both growth, yield and yield related characters such as plant height (9.45cm), the number of leaves (20.20), dry weight (10.92g), girth weight (32.27g), root weight (18.27g), fresh weight (42.27g) and yield (14.92kg/ha) and Jos location was superior in both growth and yield related characters. Based on the results obtained it can be suggested that lettuce farmers use inorganic nutrient solution which is better in both growth and yield characteristics leading to optimum yield in lettuce cultivation in the study areas.

Keywords: lettuce, Nutrient, Solutions and Variety

INTRODUCTION

Lettuce (Lactuca sativa) is a member of the Asteraceae (or Compositae) family and has an annual life cycle. It is the only cultivated species of the approximately 100 species in the genus Lactuca, most of which are indigenous to Asia and Africa. The genus is diverse, encompassing annual, biennial, perennial, and occasionally shrubby plants. Most are diploid, but there are a few polyploids. Lettuce (Lactuca sativa) is one of the most important vegetables in human diet. Lettuce comes in a wide variety of types, including romaine, butter-head, and iceberg. It is a cool-season crop that that grows best in cooler climates. Lettuce is a source of vitamin A and C. and it is also a good source of fiber. Weiss *et al*., 2015). The plant is full of vitamins vegetables in human diet and minerals with lots of fiber which facilitates colon peristalsis. Lettuce is 26th among 39 vegetables and fruits of nutrition value and is fourth of consumption. It's the most popular salad crop in the world and fruits of nutrition value and is fourth of consumption. It's the most popular salad crop in the world and because of used crude, its vitamin sinter to human body without change. Nigeria is currently rank 28th in the world in terms of lettuce production according the United Nations food and agriculture organization (FAO, 2009). Lettuce is full of vitamin A and minerals like Ca and Fe. It is mostly used as salad with other salad vegetables like tomato, carrot,

cucumber and usually served alone or with other salad vegetables (Hasan *et al*., 2017). Kaiser & Ernst (2016) Lettuce (Lactuca sativa) is one of the hydroponic vegetables most frequently cultivated. Hydroponics is plant growing technique without using soil. Hydroponics is the technique of growing plants using a water-based nutrient solution rather than soil, and can include an aggregate substrate, or growing media, such as vermiculite, coconut coir, or perlite. Hydroponic production systems are used by small farmers, hobbyists, and commercial enterprise. The Kratky Method is a simplified hydroponic system in which the plants are suspended above a reservoir containing a nutrient solution. As the plants access the water, the nutrient solution levels fall. As the solution levels get lower, the roots of the plant grow downwards to access more resources. These nutrient solutions are change after 4 to 5 weeks. The reasons are that there may not be enough nutrient available for the plant, and to be able to take care of oxygen in the soil. Global population growth has increased the need for food production, especially in the agricultural sector significantly (Albaji *et al*., 2014, Neissi *et al*., 2020). Since agriculture is among one of the sectors that consume the most water, this increase in production could have an adverse effect on water resources. Water resources can be used more efficiently through the production of greenhouse crops because there is better control of environmental conditions for crop production (Rosa-Rodriguez *et al*., 2020). Plants can only be cultivated in a nutrient solution (liquid culture) or grow by an inert medium (culture of aggregates). In both systems, the irrigation water supplies all the nutritional needs of the crops (Kaiser & Ernst, 2016). A direct light-intensity effect on fresh weight and an indirect one on nutritional value (ascorbic acid) of lettuce were also evidence (kosma, 2013.) The objectives of this work are to determine the effect of nutrient solution on the growth and yield of lettuce, to compare the effectiveness of organic and inorganic nutrient solution medium on growing lettuce using kratky hydroponic method and to determine the interactions between inorganic and organic nutrient solution.

MATERIAL AND METHOD

The experiment was carried out at The University of Agriculture, Makurdi (6° 11′-7° 41′N Latitude and 7° 21′ - 8° 37′E Longitude) and Jos at (9° 31′- 90 50`N Latitude and 10° 41′N-110 09`E Longitude. The experiment aimed to investigate the effectiveness of solutions on the growth and yield of lettuce grown in Makurdi and Plateau, Nigeria. The experiment is laid in a randomized complete block design with three replications. The treatments used are organic nutrient source, inorganic nutrients source and control), a variety used where (Loose-leaf and Butter-head) the experiment during the 2021 rainy season. Organic nutrient source is as follows Chemical content (pH: 6.5-7.5; EC: 2.6 - 4.1; Organic Carbon: 16.6 - 33.9 %; Total N: 0.95 - 1.7 %, P: 0.4%, K: 0.4%) Physical content (Moisture: 30 - 45 %; water holding capacity: 3 - 4 g; porosity: 60 - 72 %; Bulk density: 420 - 655 kg m^3) as recommendation by Bello (2015) and chemical nutrients solution as follows 120grams of NPK, 180grams of Calcium Nitrate, 60grams of Epson salt and 500ml of distilled water before it was used for the experiment. Dissolve 120grams of NPK, 180grams of Calcium Nitrate and 60grams of Epson salt separately in a warm 250ml of distilled water to allow it dissolve completely. NPK and Calcium nitrate solution are combined (solution A) and Epson solution (solution B), add 2.5ml of solution A and solution B after 5minutes in a 1liter of water to form a nutrient solution which the plants are placed in. The seeds were raised in transplanting tray before placing in nutrient solutions. The soil of the nursery was prepared well at a 3:2 ratio of soil and organic manure then it was treated for pathogen by covering it with polythene tightly and kept for 10 days, irrigated twice a day (morning and evening) to ensure good germination and establishment, the seeds germinated between five and eight days after sowing (DAS). The seedlings were transplanted to the nutrient solutions 21-25 days after sowing (DAS). The experiment was laid out in a randomized complete block design (RCBD) with three replicates. A

nutrient solution was formulated in a container and each treatment place according to the design. There were 4 containers of nutrient solutions in each block replicated 3 times which gave the total number of 12 plots for the study. Five (5) plants were tagged for data collection following (Berry, 2012) method. During the investigation, physiological variables, such as growth in the increase in mass and size of the plant which involve the multiplication of cells plant height (measured from the base of the plant to the tip), and the number of leaves ("Definition"). Other characters like root length ("is a part of a vascular plant underground"), and aerial weight ("is the mass/weight of fibre per unit area) root weight ("dry mass of the root of a plant divided by the total dry mass of the entire plant"), root diameter ("the line connecting the root of the teeth of a cylinder gear is the root circle divided by two"), harvest index and (total final output of harvest) were also recorded. All data collected were subjected to a two-way analysis of variance (ANOVA), when treatments were found significantly different, the least significant difference (LSD) at a 5% level of probability was used in separating the mean.

RESULT AND DISCUSSION

Table 1 is the effect of solutions on the production of lettuce grown in Makurdi and Plateau, Nigeria were significant difference (P<0.05) was observer in both variety and nutrient solution. On variety, loose-leaf out performed butter-head in plant height, number of leaves, leaf diameter and leaf length, this could be attributed to the genetic make-up of the variety, this finding is in agreement with the work of Andreani *et al*., (2003) who stated that genetic make-up of some variety can bring variability in crop vegetative growth, he further added that cultural practice and adaptability might also cause such effect, Kawamura-Aoyama (2014) reported that cultivars grown in hydroponic systems frequently have more open heads than those cultivated on soil often purchased at the grocery store, this can be a good option because they are less susceptible to tip burn and produce more yield and could be the reason for this variability.

Table 1: Effect of solutions on the production of lettuce grown in Makurdi and Plateau, Nigeria

Variety (V)	Plant height (cm)	No. of leaves	Leaf diameter (cm)	leaf length (cm)
Loose-leaf	9.15	20.44	28.93	19.12
Butter-head	7.43	16.13	24.18	21.49
F-LSD (0.05)	1.31	2.08	2.01	2.02
Solution (S)				
Organic	7.70	14.25	23.46	20.19
Inorganic	9.23	20.27	26.27	18.37
F-LSD (0.05)	1.23	3.23	2.09	1.91
Location (L)				
Jos	9.90	22.34	22.20	19.91
Benue	8.01	20.00	20.02	21.11
Interaction	1.02	1.03	1.07	2.01
VXG	NS	*	NS	NS
GXL	NS	NS	NS	NS
VXL	NS	NS	NS	NS

No.= number, LSD= Least Significant Differences at 5% Level of Probability, * = 95% level of probability

On solution, inorganic performed significantly higher in plant height, number of leaves, leaf diameter and leaf length, this could be related to electric conductivity in the solutions. This work collaborates with the finding of Atkin *et al* (2004) who reported that inorganic nutrients solution is mobile and easily absorb and assimilated faster to organic solution and have ability to resist

changes in pH known as the buffer capacity, and source water differs in its buffer capacity due to dissolved elements.

On location, Jos location gave the highest plant height, number of leaves, leaf diameter and leaf length, this could be related to climatic condition and ability of the plant assimilate the readily available, these result is in conformity with the finding of Ruedas (2019) who stated that lettuce strive well in lower climatic condition and higher temperature, relative humidity affect the growth and seed production.

Table 2: Effect of solutions on the production of lettuce grown in Makurdi and Plateau, Nigeria were significant difference (P<0.05) was observer in both variety and nutrient solution. On variety, loose-leaf out performed butter-head in girth weight, root length, fresh weight and over-all yield, this could be linked to the fact that genetic variability could have caused such difference and probably environmental factors this result conforms with the work of Santos (2018) who stated that genetic variability, adaptation to the environment and cultural practice, not only affect overall yield but also yield related characters positively. On solution, inorganic performed significantly higher in girth weight, root length, fresh weight and over-all yield, this could be related to nutrient elements in the solutions. This work collaborates with the finding of Batista *et al* (2012) who reported that inorganic nutrients solution are mobile and easily absorb and assimilated faster to organic solution, Jones (2005) is a par with the finding of this work where he reported organic solution having more trace elements when compared to inorganic nutrient where they have only three major element and as such should have recorded weightier girth, lengthier root, higher fresh weight and over-all yield he added that nutrient solutions for soilless systems are often based on the source water, which can contain a range of dissolved minerals. Some of these minerals are plant nutrients that can be used, but nutrients could be present in larger quantities than plants require. High levels of some minerals, such as calcium and carbonate, can interfere with solution formulation, pH management or nutrient uptake by the plants. Jordon *et al*. (2018) reported higher yield of 2.18–2.58 kg m for hydroponic lettuce grown with inorganic nutrient source which was lower than the yield obtained in organic nutrient source in this study.

Table 2: Effect of solutions on the production of lettuce grown in Makurdi and Plateau, Nigeria

Variety (V)	Girth weight (g)	Root length (cm)	Fresh weight (g)	Yield/ha (kg)
Loose-leaf	32.22	12.24	89.13	14.92
Butter-head	30.12	10.11	63.14	12.19
F-LSD (0.05)	1.91	2.03	19.01	1.92
Solution (S)				
Organic	29.70	11.25	68.41	11.19
Inorganic	33.93	12.27	82.20	15.37
F-LSD (0.05)	3.23	1.13	17.09	2.91
Location (L)				
Benue	29.50	10.14	62.61	11.99
Jos	32.21	12.10	80.12	15.11
Interaction	2.13	1.73	18.07	2.12
VXG	NS	NS	*	*
GXL	NS	NS	NS	NS
VXL	NS	NS	NS	NS

No.= number, LSD= Least Significant Differences at 5% Level of Probability, * = 95% level

On location, Jos location gave the highest in girth weight, root length, fresh weight and over-all yield, this could be related to locational temperature, solar radiation and relative humidity, this result is in conformity with the finding of Madina *et al*., (2023) who stated that cabbage and lettuce produce well in when the temperature is between 18-25^{o} c and appreciably sun rays and 70-80% relative humidity, he added that these climatic factors do not affect only the over-all yield but also yield related character as reported in this work, Kang *et al* (2013) stated that light intensity plays a vital role girth weight, fresh weight and over all yield of lettuce.

Table 3: Interaction between variety solution and location on the production of lettuce grown in Makurdi and Jos, were significant difference was recorded in the interaction between variety, yield component and also location, where a perfect interaction was observed between variety and solutions where Loose-leaf and inorganic solution gave the highest in Number of leaves, Fresh weight and Yield in both locations, this is not far from the facts that varietal variability, nutrient and environmental factors might have led to this difference, this finding agrees with the work of Ekpo *et al*., (2016) who reported same in lettuce production stating that yield and yield related characters are products or are mostly influenced by the plants genetic make-up, nutrient, cultural practice and environmental factors.

On the table 3, there is also a significant difference in location where Jos performed better than Makurdi in all the parameters under consideration these could be link to environmental factors such as temperature, relative humidity and solar radiation. This finding is supported by Williams and Nelson (2014) who reported that crops perform well in both vegetative and reproductive stage when the required weather is optimized, bearing in mind that each crop has a particular weather (temperature, relative humidity and sunlight) they strive well. Kano *et al*., (2021) reported that the time between nutrient tank changes varies by crop, season and size of container. It is common to change the solution at one- to two-week intervals for many actively growing crops in the main part of the season and location.

Table 3: Interaction between variety solution and location on the production of lettuce grown in Makurdi and Plateau, Nigeria

Location	**Variety (V)**	Number of leaves	Fresh weight (g)	Yield/ha(kg)
	Loose-leaf	19.28	73.23	11.12
	Butter-head	16.63	61.18	10.09
	F-LSD (0.05)	2.01	10.01	1.03
Benue	**Solutions (S)**			
	Organic	17.41	67.46	9.29
	Inorganic	19.75	83.27	10.07
	F-LSD (0.05)	2.43	20.09	1.11
	Loose-leaf	20.21	78.43	11.89
	Butter-head	17.91	61.28	12.00
	F-LSD (0.05)	2.29	19.00	1.03
Jos	**Solutions (S)**			
	Organic	17.91	67.46	11.12
	Inorganic	21.91	85.17	13.17
	F-LSD (0.05)	2.41	20.07	1.65

LSD= Least Significant Differences at 5% Level of Probability, * = 95% level of probability

CONCLUSION

From the result obtained in this work, it is clear that the lettuce can be raised hydroponically using solution from organic source, a significantly difference was observed in both nutrients solutions were the use of inorganic shows superiority in both growth and yield/ yield related characters, the use of Loose-leaf was better than Butter-head in all the parameters measured, location and weather also affected the production of lettuce were Jos was better than Makurdi location, it can be suggested that lettuce be cultivated in a control environment like the green houses. It can therefore be recommended that the cultivation of loose-leaf variety lettuce under inorganic and organic solution since the yield margin is not much by farmers in the study area.

References

Atkin, K.; Nichols, M.A. Organic hydroponics. Acta Hortic. 2004, hydroponic culture of lettuce 648, *Horticultura Brasileira* 121–127. [CrossRef]

Andrade Jr., V.C., Yuri, J.E., Nunes, U.R., Pimenta, F.L., Matos, C.S.M., Florio, F.C.A. and Madeira, D.M. (2005) Use of cover types for lettuce crop. *Horticultura Brasi-leira*, 23, 899-903

Andreani Jr., R. and Galbiati Neto, P. (2003) Evaluation influence of death cover under lettuce crop development at Fernandópolis-SP region. *Horticultura Brasileira*, 21, 2.

Albaji, R.L., Passos, J.C., Fernandes, D.M., Büll, L.T., Cezar, V.R.S. and Goto, R. (2014) Doses effects and organic compounds types in lettuce crop in two soils un- der protect environment. *Horticultura Brasileira*, 22, 28-34. http://dx.doi.org/10.1590/S0102-05362004000100006

Batista, M.A.V., Vieira, L.A., de Souza, J.P., de Freitas, J.D.B. and Bezerra Neto, F. (2012) Effect of different sources of fertlization on lettuce crop in Igaratu-CE mu- nicipality. *Revista Caatinga*, *Mossoró*, 25, 8-11.

Berry, E.Q., Souza, R.J., Cruz, M.C.M., Marques, V.B. and França, A.C. (2012) Lettuce and arugula yield in consorted systems under organic and mineral fertilization. *Horticultura Brasileira*, 28, 36-40. http://dx.doi.org/10.1590/S0102-05362010000100007

Ekpo, U.; Ross, A.B.; Camargo-Valero, M.A.; Williams, P.T. A comparison of product yields and inorganic content in process streams following thermal hydrolysis and hydrothermal processing of microalgae, manure and diges tate. Bioresour. Technol. 2016,200, 951–960. [CrossRef]

FAO (Food and Agriculture Organization of the United Nations) 2009. Lettuce Production up in 2000. FAO/GIEWS-Food Outlook, No.5, November 2000, 10 p

Shinohara, M.; Aoyama, C.; Fujiwara, K.; Watanabe, A.; Ohmori, H.; Uehara, Y.; Takano, M. Microbial mineralization of organic nitrogen into nitrate to allow the use of organic fertilizer in hydroponics. Soil Sci. Plant Nutr. 2011, 57, 190–203. [CrossRef]

Jones, J.B. Hydroponics A Practical Guide for the Soilless Grower, 2nd ed.; CRC Press: Boca Raton, FL, USA, 2005; Volume 53, ISBN 9788578110796.

Jordan, E.Q., Souza, R.J., Cruz, M.C.M., Marques, V.B. and França, A.C. (2010) Lettuce and arugula yield in consorted systems under organic and mineral fertilization. *HorticulturaBrasileira*, 28, 36-40. http://dx.doi.org/10.1590/S0102-05362010000100007

Kaiser, C.; and Ernst, M. (2016) Study on the hydroponic culture of lettuce with microbiallydegraded solid food waste as a nitrate source. Jpn. Agric. Res., 48, 71–76. [CrossRef]

Kano, K.; Kitazawa, H.; Suzuki, K.; Widiastuti, A.; Odani, H.; Zhou, S.; Chinta, Y.D.; Eguchi, Y.; Shinohara, M.; Sato, T. (2021) Effects ofOrganic Fertilizer on Bok Choy Growth and Quality in Hydroponic Cultures. Agronomy 2021, 11, 491. [CrossRef]

Kosma, R. (2013) Doses effects and organic compounds types in lettuce crop in two soils un- der protect environment. *Horticultura Brasileira*, 22, 28-34. http://dx.doi.org/10.1590/S0102-05362004000100006

Kang, J.H.; KrishnaKumar, S.; Atulba, S.L.S.; Jeong, B.R.; Hwang, S.J. (2013) Light intensity and photoperiod influence the growth and development of hydroponically grown leaf lettuce in a closed-type plant factory system. Hortic. Environ. Biotechnol. 2013, 54, 501–509. [CrossRef]

Madina P, Michael O. A. and Iyough, D. D (2023) Productivity of cabbage (Brassica oleracea L.) as affected by organic manure and varieties grown in Jos Plateau State, Nigeria. Journal of Agricultural Science and Food Technology Vol. 9 (1), pp. 1-5, January 2023.

Neissi, S.; Hoeberechts, J.; Fontana, E. (2020) Comparison between traditional and soilless culture systems to produce rocket (Eruca sativa) with low nitrate content. In International Symposium on Soilless Culture and Hydroponics; International Society for Horticultural Science: Leuven, Belgium, 2020; Volume 697, pp. 549–555.

Nelson, J.S. (2014) Challenges of using organic fertilizers in hydroponic production systems. In Proceedings of the Symposium on Water, Eco-Efficiency and Transformation of Organic Waste in Horticultural Production, Brisbane, Australia,17–22 August 2014; Volume 1112, pp. 365–370

Ruedas HL (2019). Analysis of the chemical composition of some organic manure and their effect on the yield and composition of pepper. Crop Res, 23: 362-8.

Santos, R.H.S., Casali, V.W.D., Conde, A.R. and Miranda, L.C.G. (2018) Lettuce quality growth with organic compound. *Horticultura Brasileira*, 12, 29-32.

Weiss, D.S., Nomura, E.S. and Garcia, V.A. (2009) Yield and nutrient concentration in lettuce, depending on the organic and mineral fertilizers. *Revista Ceres*, 56, 332- 335.