

The Effect of Organic Manure and Days of Incorporation on the Growth and Yield of Lettuce (*Lactuca sativa* L.) Grown in Jos Plateau State, Nigeria

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ABSTRACT

The experiment aimed to evaluate effect of organic manure on the growth and yield of lettuce (*Lactuca sativa* L.) grown in Jos Plateau State, Nigeria. The treatments used are organic manure source (Poultry dropping, Cow dung, goat manure, dung site and control) and time of inclusion (5, 10 and 15 days before transplanting) was adopted for the experiment. The experiment is laid in a randomized complete block design with three replications, with 12 plots in a block and 45 plots for the whole experiment. Data were collected from the following parameters, plant height, plant diameter, number of leaves, leaf area (LA), net assimilation rate (NAR), crop growth rate (CGR), fresh weight, and dry weight. All the study parameters of lettuce were significantly different ($P < 0.05$) on both organic manure, days of inclusion and season. Poultry droppings produce plant height (25.73), plant diameter (8.42), number of leaves (32.02), leaf area index (16.75), net assimilation rate (4.67), crop growth rate (3.20), fresh weight (6.65 ha⁻¹), and dry weight (4.23 ha⁻¹) when compared with other sources of nutrient. Similarly maximum plant height (23.32), plant diameter (6.66), number of leaves (31.86), leaf area (15.19), net assimilation rate (3.32), crop growth rate (3.54), fresh weight (5.79 ha⁻¹), and dry weight (4.00 ha⁻¹) was recorded in lettuce plant treated with organic manure of 5 days of inclusion. On seasons, higher plant height (25.83), plant diameter (8.23), number of leaves (31.34), leaf area (15.32), net assimilation rate (4.00), crop growth rate (3.61), fresh weight (7.01 ha⁻¹), and dry weight (5.99 ha⁻¹) was obtained in 2021 as against 2020 season. Based on the results obtained, it can be recommended to lettuce farmers in the locality the use of poultry manure and 5 days of inclusion for optimum growth and yield of lettuce.

Keywords: Lettuce, Days of inclusion, Organic manure

INTRODUCTION

Lettuce (*Lactuca sativa* L.) is an annual plant belongs to the family Compositae one of the important vegetables in salad crop. It is the most well-liked salad crops in the world. It is a native of Europe, Asia and northern Africa and has been cultivated for many decades. The term lettuce also is used to refer to the edible, succulent leaves which commonly are eaten raw as salads, but also may be eaten cooked (Katz and Weaver, 2003). It is popular for its delicate, crispy, texture slightly bitter taste as fresh condition. Lettuce is a rich source of antioxidants, Vitamin A and C and phytochemicals which are anti-carcinogenic. It also provides some dietary fibre, carbohydrates, protein, copper, vitamins and minerals largely found in the leaf. Lettuce is usually consumed as a salad or shredded in a salad mix of onion, tomato, cheese and basil. It is usually used as salad with tomato, carrot, cucumber or other salad vegetable (Masarirambi et al., 2010). Organic manure can serve as alternative practice to inorganic fertilizers. Excessive application of chemical fertilizers may affect soil health and sustainable productivity (VirgineTenshia and Singram, 2005; Ali et al., 2011a 2011b; Arif et al., 2012 and Munsif et al., 2011; Ali et al., 2012). Emerging contaminants; Agro-chemicals (fertilizers and pesticides) were reported to be presence in the food we produce, water bodies and soil. In the last decade, Agro-chemicals and fertilizer production have increased due to wide acceptance of modern agriculture. These have raised increasing worries about the potential risks to human health, soil and ecosystems. Hence, it is important to control these contaminants from the point source (by using organic source of nutrient in cultivating our crops). If point source is treated, it is obvious that the use of organic manure not only benefits the environment and human health, but also greatly improves microbial activities, financial condition of the farming family and decreases the cost of production. Vegetable cultivated through organic farming/ nutrient source is gaining acceptance in developing countries like Nigeria (Ngakou et al., 2008). Consumers prefer crop cultivated mostly from organic source of nutrient as compared to inorganic nutrient which enhances the quality of produce and not harmful to consumers. Organic source of nutrient on the other hand has some advantage over the chemical sources of nutrient as such; organic source due to its availability and the benefits it gives to soil unlike the chemical fertilizer which is expensive and poses danger to the soil and humans who consume crop grown from them over time (Walingo 2005). Early application of organic manure to the soil plays an important role in the chemical, physical and biological properties of the soil, it's also decreasing the bulk density of the soil while it increases the moisture content of the soil, water holding capacity of the soil, permeability (infiltration rate), soil structure and soil porosity (Madina et al., 2021). The chemical properties of the soil like hydrogen-ions, exchangeable cat-ions, total organic carbon, total phosphorus and total potassium can be increased by the type and level of the application of organic manure to the soil. The biological properties of the soil can be improved by early application of organic manure during land preparation or basal application increases microbial activity, leading to release of nutrients for plant adsorption (Yusuf and Paul 2018). Therefore, in this work, removal of emerging contaminant which is chemical fertilizer is the main aim of the work with the following objective. To determine the organic source for lettuce production, to determine the appropriate day of inclusion of such organic nutrient, to determine the interaction between nutrients sources and days of inclusion.

MATERIAL AND METHOD

The experiment was carried out in Jos at (9° 50'N 11° 09'E). The experiment aimed to evaluate effect of organic manure and days of inclusion on the growth and yield of lettuce (*Lactuca sativa* L.) grown in Jos, Plateau State Nigeria, during the 2020 and 2021 rainy season. Organic source (Poultry dropping, goat manure, Cow dung, dung site and control) was used. Poultry dropping applied at the rate of 20 tones/ha and poultry dropping (95% Dry Matter, Organic Material 52%, Total Nitrogen 7.2%, Total Phosphorus 3.10% and Total Potassium 2.22%), Goat manure (Dry matter 50%, Organic Material 40%, Total Nitrogen 3.5%, Total Phosphorus 2.0% and Total Potassium 2.1%), Cow dung (Dry matter 20%, Organic Material 22%, Total Nitrogen 10.0%, Total Phosphorus 0.5% and Total Potassium 0.5%) and dung site (Dry matter 30%, Organic Material 22%, Total Nitrogen 15.0%, Total Phosphorus 0.7% and Total Potassium 1.0%) All the organic manure are collected from animal kept under intensive care and was allowed to undergo partial decomposition for three months following the recommendation of Bello (2015) before it was used for the experiment, The seeds were raised in a nursery before transplanting to the field, the size of nursery bed was 2m x 2m and 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 in 5-8 days after sowing days after sowing (DAS). The seedlings were transplanted in the main field after 20-25 days after sawing (DAS), the nursery establishment is important because directly sowing of seeds may not germinate well. Experiment was laid in a randomized complete block design (RCBD) with three replicate, a 4m² plot was laid out with 1m between plots and 1m between blocks. There were 4 plots each within a block which gave the total number of 12 plots for the study, a spacing of 15 by 75cm was adopted for the research, Agronomic practice such as weeding was done manually at 2 and 4 weeks after planting to ensure weed free plots, all the data were collected within the net plot of 4m² where a total of 5 plants were tagged for data collection within each net plot. During the investigation, some physiological variables, such as growth, plant height (as taken with the aid of measuring tape from the base of the plant to the tip), the number of leaves (were counted). Other characters like plant diameter (were measured with a venier caliper), leaf area index (using a formula below), crop growth rate (using a formula below), net assimilation rate (using a formula below) fresh weight (weight with digital weighing scale) and dry weight (weight with digital weighing scale) were also recorded. All data collected were subjected to analysis of variance (ANOVA), while least significant difference (LSD) at 5% level of probability was used in separating the means.

Formula for leaf area index

$$LAI = \frac{\text{total leaf area}}{\text{Unit land area}}$$

Formula for Crop growth rate is given as

$$CGR = \frac{W_2 - W_1}{P(t_2 - t_1)}$$

Where, P = Ground area, W₁ = Dry weight of plant/m² recorded at time t₁, W₂ = Dry weight of plant/m² recorded at time t₂, t₁ and t₂ were the interval of time, respectively and it is expressed in g/m²/day.

(NAR): It is increase in dry wt. of plant per unit leaf area per unit time. NAR is calculated from the following equation: -

$$NAR = \frac{(W_2 - W_1)(\log l_2 - \log l_1)}{(t_2 - t_1)(L_1 - L_2)}$$

Where L1 and L2 are total leaf are at time t1 and t2 respectively. W1 and W2 are total dry wt. time t1 and t2 respectively

RESULT AND DISCUSSION

Table 1 is the effects of organic nutrient and days of incorporation on the growth parameters of lettuce grown in Jos, plateau State, Nigeria where significant difference ($P < 0.05$) was recorded in both nutrient source and days of inclusion viz a viz seasons. On nutrient source the use of poultry drooping had higher plant height, number of leaves, leaf area index and crop growth rate. This could be related to high nutrient content in poultry manure when compared to other sources of organic manure. This finding is in agreement with the Michael et al., (2012) who recorded higher plant height, more number of leaves, leaf area and crop growth rate with plots treated with poultry droppings. Poultry manure increased leaf area more than the other application rates possibly because an increase in poultry manure was appropriate for increasing carbon content, water holding capacity, aggregation of soil and decrease of bulk density, all of which interplay to increase in plant height, number of leaves, leaf area index and crop growth rate. Similarly Adeniyani and Ojeniy (2005) reported that most crop vegetative growth is influence by available nutrient and ability of the crop to be able to absorb the nutrients mostly gotten form poultry dropping. Furthermore leaf area and crop growth rate it highly influences formation of plant essential molecules such as chlorophyll and protoplasm formation. The capability of poultry droppings to improve soil structure, retain nutrient and water, improves aeration aids better response in leaf area, crop growth and over all crop growth (Akanbi et al, 2006).

On days of inclusion, the application of organic manure in 5 days superseded other days of inclusion; this could probably be as a result early inclusion which lead to fast or early decomposition and the work of Togun and Akanbi (2003) who reported that early application of organic manure aid to fast decomposition and mineralization for fast released and uptake by plant for both vegetative growth and metabolic process. Similarly to the findings of (Fagimi and Odebode, 2007) who reported increased plant height, number of leaves, number of branches in pepper and cabbage resulting from application of early application and high rate of chicken manure.

It is obvious from the result obtained that 2021 season out-grow the 2020 season in term of vegetative growth, this could be linked to availability of nutrient, cultural practice, organic residual effects and also climatic factors as reported by Adenawoola and Adejero (2005).

Table 1 is the effects of organic nutrient and days of incorporation on the growth parameters of lettuce grown in Jos, plateau State, Nigeria

Nutrient source(N)	PH	NL	LA	CGR
DS	23.23	30.18	14.50	2.60
CD	22.28	28.12	12.00	1.55
PD	25.73	32.02	16.75	3.20
GM	20.00	29.91	13.88	1.90
Control	18.01	25.21	10.75	1.00
LSD (0.05)	1.20	1.10	1.62	0.02
DI (D)				
5	23.32	31.86	15.19	3.54
10	22.98	29.87	14.23	2.02
15	20.52	27.23	13.82	1.01
LSD (0.05)	1.02	1.18	1.31	0.08
Seasons (S)				
2020	23.43	27.91	12.13	2.51
2021	25.83	31.34	15.32	3.61
LSD(0.05)	1.12	2.12	1.81	1.01
Interaction				
N X D	NS	NS	NS	NS
D X S	NS	NS	NS	NS
N X S	NS	NS	NS	NS

CD= cow dung, PD=poultry dropping, GM=goat manure, DS=dung site, DI= days of inclusion, PH= plant height, NL=number of leaves, LA= leaf area, CGR= crop growth rate, NS= not significant.

Table 2 is the effects of organic nutrient and days of incorporation on yield and yield related parameters of lettuce grown in Jos, plateau State Nigeria, where significant difference ($P<0.05$) was recorded in both nutrient source and days of inclusion putting into consideration growing seasons. On nutrient source the use of poultry dropping shows superiority on net assimilation rate, plant diameter, and in both fresh and dry weight, this can be attributed to the fact that poultry dropping releases its nutrient gradually throughout the growing season, Ayeni et al., (2008) in his work reported that crop are highly influenced by nutrient availability, rate of absorption, ability to produce chlorophyll thereby increasing its net assimilation rate and plant diameter, in addition Protta (2010) reported that the increase in net assimilation rate and plant diameter of cabbage with the application of chicken manure may be due to its role in enhancing soil physical condition and availability of nutrients in poultry droppings. This result is in harmony with Togun and Akanbi (2003), Adenawoola and Adejoro (2005), on dry and fresh weight Arif et al., (2012) reported that application of chicken manure had improved tremendously on both dry and fresh matter weight, Rao (1991) reported that soil could be enriched with the decomposition of poultry manure materials into the soil before transplanting which increases total yield. Similarly Xu et al. (2002) study specified that vegetable grown with higher level of poultry manure give higher total yield as compare to low level of other organic manure. Plant fertilized with poultry manure had the highest growth parameter and marketable yield. Similar results have been reported by (Uddin et al., 2009). This could be

attributed to the nutrient content of the poultry droppings used. Cantaloupe (*Cucumis melo*) plants treated with chicken manure display comparatively higher profitable yield than those treated with other organic manure source (Ghanbarian et al., 2008). Similar results were gotten from (Ouda and Mahadeen, 2008) where poultry manure was found to increase pod yield of okra. It could be accredited due to the large amount of accessible phosphorus and available potassium contained in the chicken manure.

On days of inclusion, the inclusion on 5 days had outperformed the other days on inclusion (10 and 15), this is true because early inclusion of organic manure to the soil facilitate fast release of nutrient for plant assimilation, this work is in conformity with the work of Michael et al., (2012) who reported that early inclusion of organic manure particularly using basal application at land preparation releases it nutrient fast for plant assimilation which is later translated to vegetative growth and over all yield, he added that plants utilized nutrient from organic source applied in the previous year when applied late. On season the cultivation of lettuce in 2020 out performed that of 2021 in net assimilation rate, plant diameter, fresh and dry weight. This is true because climatic condition like temperature, rainfall, relative humidity, wind might have caused the difference as reported by Masarirambi et al., (2010) he further added that cultural practice, residual effect, soil condition can also be a factor in the difference,

Table 2 is the effects of organic nutrient and days of incorporation on yield and yield related parameters of lettuce grown in Jos, plateau State, Nigeria

Nutrient source	NAR	PD	FW(t/ha)	DW(t/ha)
DS	3.23	6.28	4.88	3.11
CD	2.28	5.32	2.78	1.54
PD	4.67	8.42	6.65	4.23
GM	2.00	4.61	3.20	2.50
Control	1.01	3.11	1.10	0.91
LSD (0.05)	0.20	0.32	0.42	0.02
DI (D)				
5	3.32	6.66	5.79	4.00
10	2.98	5.97	4.13	3.61
15	1.91	4.22	3.22	2.00
LSD (0.05)	0.22	0.52	0.21	0.68
Seasons (S)				
2020	2.98	7.01	5.82	4.22
2021	4.00	8.23	7.01	5.99
LSD (0.05)	1.23	1.11	1.15	1.12
Interaction				
N X D	NS	*	*	NS
D X S	NS	*	*	NS
N X S	NS	*	*	NS

CD= cow dung, PD=poultry dropping, GM=goat manure, DS=dung site, NS= not significant, NAR= net assimilation rate, PD=plant diameter, FW= fresh weight, DW=dry weight.

Table 3 records an Interaction between organic nutrient source and days of application on plant diameter of lettuce grown in Jos, with a poultry droppings and 5 days of inclusion having higher plant diameter, this probably can be as a result of early inclusion during land and also availability of organic manure, this work is supported by the report of Ewulo et al., (2008) Who reported that poultry dropping have high amount of nitrogen which plays an important role is plant growth, increase in plant diameter and crop yield, knowing fully that nitrogen is the main constituent of all amino acids in proteins and lipids that acting as a structural compounds of the chloroplast, photosynthetic activities. (Badr and Fekry, 1998; Arisha and Bradisi, 1999).

TABLE 3. Interaction between organic nutrient source and days of application on plant diameter of lettuce grown in Jos

Nutrient source	Days of inclusion		
	5	10	15
DS	6.23	4.28	3.88
CD	5.28	3.32	2.78
PD	7.67	5.42	4.65
GM	5.00	4.61	3.20
Control	1.01	4.11	1.10
LSD (0.05)	0.41	0.23	0.52

CD= cow dung, PD=poultry dropping, GM=goat manure, DS=dung site, LSD= least significant difference.

Table 4 shows an interaction between organic nutrient source and days of application on fresh weight of lettuce grown in Jos, where significant difference ($P < 0.05$) was recorded in poultry dropping at 5 days of inclusion, this could be attributed to the fact that high and readily available nutrient applied early under goes fast decomposition/mineralization and releases its nutrient for plant utilization which in turn improves crop yield. This finding agrees with the work of Olaniyi, (2000) who reported best yield attributes obtained from organomineral manure attributed to rapid mineralization of N from organic manure and steady release of N in organic fertilizer which might have met the N requirement of crop at critical stages. This reaffirms the work of Maheshbabu et al., (2007) who reported that manure acts as nutrient reservoir and upon decomposition is released slowly during entire growth periods leading to higher yield and yield components. This result also is in line with that of Aliyu (2002, 2003) who reported significant response in yield to different types of manure rate application and source. The significant response of growth parameters, yield attributes and yield to fertilizer demonstrated poultry droppings influences lettuce yield positively.

Table 4 Interaction between organic nutrient source and days of application on fresh weight of lettuce grown in Jos

Nutrient source	Days of inclusion		
	5	10	15
DS	5.23	4.28	3.88
CD	3.28	2.32	2.20
PD	6.67	5.42	4.65
GM	4.00	3.61	3.00
Control	2.51	2.00	1.00
LSD (0.05)	1.00	1.01	0.71

CD= cow dung, PD=poultry dropping, GM=goat manure, DS=dung site, LSD= least significant difference.

Table 5 is an interaction between season and days of inclusion on plant diameter of lettuce grown in Jos with 2021 rainy season and 5 days of inclusion having a significant differences ($P < 0.05$) when compared with other treatment used, this might be as a result of soil components, weather and cultural practice and early incorporation/ application of organic manure as reported by Ogunlela et al., (2005) in his work on carrot starting that weather condition, early application of manure particularly during land preparation viz a viz partial decomposition before incorporation influences fruit diameter, plant vegetative growth and over all yield.

Table 5 interaction between Season and Days of inclusion on plant diameter of lettuce grown in Jos, Nigeria.

Seasons	Days of Inclusion		
	5	10	15
2020	5.28	4.61	4.02
2021	6.00	5.73	5.00
LSD (0.05)	1.03	1.01	1.05

LSD= least significant difference.

Table 6 is an interaction between season and days of inclusion on fresh weight of lettuce grown in Jos with 2021 rainy season and 5 days of inclusion having a perfect interaction having higher fresh weight when compared with other treatment used, this could be related to early decomposition and high concentration of nutrient, this finding affirms the work of (AVRDC, 1994) who stated that fresh matter yield is proportional to the quantity of nutrient applied, nutrient released and nutrient absorption for leafy vegetables.

Table 6 Interaction between Season and Days of inclusion on fresh weight of lettuce grown in Jos.

Seasons	Days of Inclusion		
	5	10	15
2020	6.08	5.01	4.82
2021	7.00	6.23	5.51
LSD (0.05)	1.23	1.11	1.15

LSD= least significant difference.

Table 7 show an interaction between nutrient source and seasons on plant diameter of lettuce grown in Jos, Nigeria.

Where a perfect interaction is presented between poultry dropping and 2021 rainy season, this is not far from the fact that rainfall distribution, temperature, and cultural practice might have resulted to this variation as reported by Yusuf and Paul (2018) they further added that nutrients residual effect of the subsequent year affect crop yield positively particularly if is organic manure, beside adding humus to the soils.

Table 7 interaction between nutrient source and seasons on plant diameter of lettuce grown in Jos, Nigeria.

Nutrient source	SEASONS	
	2020	2021
DS	4.13	5.38
CD	2.48	3.42
PD	5.27	6.52
GM	3.20	4.71
Control	2.01	2.50
LSD (0.05)	1.02	1.00

CD= cow dung, PD=poultry dropping, GM=goat manure, DS=dung site, LSD= least significant difference.

Table 8 show an interaction between nutrient source and seasons on fresh weight of lettuce grown in Jos, Nigeria.

Where a perfect interaction is presented between poultry dropping and 2021 rainy season, this is not far from the fact that rainfall distribution, temperature, and cultural practice might have resulted to this variation as reported by Nwanojuo and Madina (2021) who added that manure source and composition influence yield and weight of fruit crop.

Table 8 interaction between nutrient source and seasons on fresh weight of lettuce grown in Jos, Nigeria.

Nutrient source	SEASONS	
	2020	2021
DS	3.21	5.91
CD	2.22	3.33
PD	5.16	6.43
GM	3.05	4.62
Control	2.13	2.30
LSD(0.05)	1.00	1.01

CD= cow dung, PD=poultry dropping, GM=goat manure, DS=dung site, LSD= least significant difference.

CONCLUSION

Based on the results obtained in this work, the cultivation of lettuce with the use of poultry dropping superseded cultivating it with other organic source, and 5 days of inclusion shows supremacy over 10 and 15 days of inclusion, it can be recommended to lettuce farmers in the locality the use of poultry manure and early days of inclusion like 5 days for optimum growth and yield of lettuce.

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