Effect of Storage and Poultry Manure Dosage on Soil Nitrate (NO_3^-) and Ammonium (NH_4^+) Availability, N-Uptake, and Yield of Head Lettuce (*Lactuca Sativa*, L.) Grown on Typic Calciaquolls

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***Abstract*—** *The objective of this experiment was to investigate the effect of storage and poultry manure dosage on soil nitrate (NO_3^-) and ammonium (NH_4^+) availability, N-uptake, and yield of Head lettuce (Lactuca sativa, L.) grown on Typic Calciaquoll. Data obtained from the experiment of seven treatments with four replications were subjected to Randomized Block Design. The observation conducted in three times i.e. 4 Week After Plant (WAP), 6 WAP, and 8 WAP. The treatments were: (1) without poultry manure (control), (2) dry poultry manure (DPM) with 12,5 g dosage, (3) DPM with 25 g dosage, (4) DPM with 37,5 g dosage, (5) fresh poultry manure (FPM) with 12,5 g dosage, (6) FPM with 25 g dosage, (7) FPM with 37,5 g dosage. The results of experiment showed that there were significantly effects of storage and poultry manure dosage on soil nitrate and ammonium, N-uptake, and yield of head lettuce. The treatment combination of DPM 37,5 g showed the highest value on soil nitrate and ammonium in 4 WAP, N-uptake in 6 and 8 WAP, and the yield of head lettuce in 6 and 8 WAP. The treatment combination of FPM 37,5 g showed the highest value on soil nitrate and ammonium in 6 and 8 WAP, N-uptake in 4 WAP, and the yield of Head lettuce in 4 WAP. Generally, it concluded that the dry poultry manure (DPM) had the better effects than the fresh poultry manure (FPM) on yield of head lettuce.*

***Keywords*— Ammonium, Head lettuce, Nitrate, Poultry manure, Yield.**

I. INTRODUCTION

Fertilization is one of the most significant agricultural practices used to improve the yield and quality of traditional crops. The need to use renewable forms of energy and reduce costs of fertilizing crops has revived the use of organic fertilizers worldwide (Seifritz 1982).Manure improves the chemical, physical and biological characteristics of soils (Yolcu et al., 2010) and increases the yield and quality of crops. For example, use of organic manures alongside inorganic fertilizers often lead to increased soil organic matter (SOM), soil structure, water holding capacity and improved nutrient cycling and helps to maintain soil nutrient status, caution exchange capacity (CEC) and soil's biological activity (Saha et al., 2008). Although chemical fertilizers are important input to get higher crop productivity, but over reliance on chemical fertilizers is associated with decline in some soil properties and crop yields over time (Hepperly et al., 2009).

Poultry manure is known to give increased yields of many different crops. Increases in the demand for poultry products have led to rapid and concentrated growth of the industry, which has caused excessive manure supplies in certain areas. For sustainable management of poultry manure, it is important to understand the chemical composition of manure and reactions of manure with soil nutrients (Amanullah, 2019). Furthermore, organic manure activates many species of living organisms which release phytohormones and may stimulate the plant growth and absorption of nutrient (Naguib and Aziz, 2004).

Recent studies show that poultry manure applied to cropping systems affected in improvement of soil properties, whereby able to support the growth and production of the plant. More than it, the using of poultry manure will ensure the sustainability of soil productivity. Poultry manure has the highest nitrogen contents than the others animal manure (Rismunandar, 1981) whereas Slykes (1932 in Foth 1998) stated that in poultry category, it is the second position after sheep manure in nitrogen nutrient level. The high value of its nitrogen contents is proper to be applied as one of input materials for both organic and anorganic farming systems. Nitrogen is one of essential nutrients for the plant growth, it is one of the primary elements in protein and nucleic acid formation (Tisdale, et al. 1993).Nitrogen has fastest effect on cereals production (Brady, 1999).

The objectives of this experiment were to investigate the effect of storage and poultry manure dosage on soil nitrate (NO_3^-) and ammonium (NH_4^+), N-uptake, and yield of Head lettuce (*Lactuca sativa*, L.) grown on Typic Calciaquolls.

II. MATERIAL AND METHOD

This experiment was conducted in the Greenhouse of Horticulture Faculty of Fachhochschule Erfurt, Germany. The experimental design was Randomized Block Design, consist of seven treatments with four replications. The treatments were: (1) without poultry manure (control), (2) dry poultry manure (DPM) with 12,5 g dosage, (3) dry poultry manure (DPM)with 25 g dosage, (4) dry poultry manure (DPM) with 37,5 g dosage, (5) fresh poultry manure (FPM) with 12,5 g dosage, (6) fresh poultry manure (FPM) with 25 g dosage, (7) fresh poultry manure (FPM) with 37,5 g dosage. The examinations were observed in three times i.e. 4 Week After Plant (WAP), 6 WAP, and 8 WAP. The soil was Typic Calciaquolls.

The dry poultry manure was incubated under 20 ºC for six day before using in the seventh day, while the fresh poultry manure was taken in the morning and used as fertilizer in the afternoon. Soil samples were taken using soil sampler to examine soil nitrate (NO_3^-) and ammonium (NH_4^+) from each pot in every observation time and were analyzed using Flow Colorimetry Method. The plant samples were collected from each pot to examine N-uptake and fresh weight of the plant. N-uptake measurements were obtained using The Kjehdahl Method and fresh weight was measured by the analytical scales. Completed data was statistically analyzed, followed by mean separation with Duncan's New Multiple Range Test.

III. RESULT AND DISCUSSION

3.1 Effect of Treatment on Soil Nitrate (NO_3^-) and Ammonium (NH_4^+)

Based on statistical analysis, showed that there were any effect of treatment on soil nitrate (Table 1) and Ammonium (Table 2). In 4 WAP observation, almost all of the treatments showed the significant effect compared with control. Generally, the dry poultry manure treatments showed the higher value on soil nitrate and ammonium compared with fresh poultry manure treatments (at the same dosage) due to decomposition process in the terms of incubation on dry poultry manure increased its nutrients content. The dry poultry manure that has been decomposed contain approximately 2 % N and 1,7 % K_2O, P_2O_5 (Cooke, 1972). Generally It is higher than nutrients content of animal manure, that only contain about 0,5 % N, K_2O, and 0,25 % P_2O_5. Sarief (1993) concluded that application of manure will be better when it has been incubated for 1 until 2 week before planting, due to its higher nutrients content.

TABLE 1
THE EFFECT OF STORAGE AND POULTRY MANURE DOSAGE ON AVAILABILITY OF NITRATE (NO_3^-) IN SOIL (PPM)

No.	Treatments	Time of Observation		
		4 WAP	6 WAP	8 WAP
1.	Control	0.2600 a	0.1000 a	0.1000 a
2.	DPM 12.5 g	0.5125 b	0.1375 c	0.1300 b
3.	DPM 25 g	0.8200 d	0.1625 d	0.1525 c
4.	DPM 37.5 g	1.4025 e	0.1775 e	0.1700 cd
5.	FPM12.5 g	0.2250 a	0.1200 b	0.1175 ab
6.	FPM 25 g	0.4175 b	0.1575 d	0.1625 c
7.	FPM37.5 g	0.7075 c	0.1975 f	0.1900 d

Note: : same letters represent insignificant values at 5 % level by Duncan's Multiple Range Test.

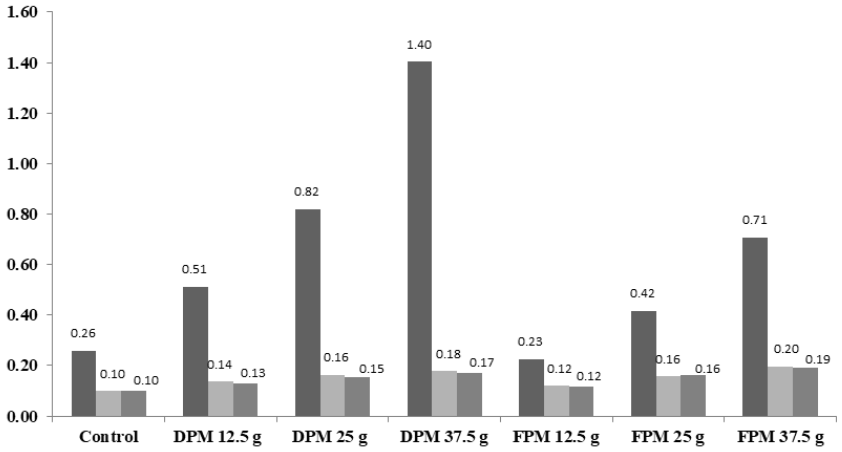

FIGURE 1: The Effect of Storage and Poultry Manure Dosage on Availability of Nitrate (NO_3^-) in Soil (ppm)

The contribution of inorganic nitrogen in the soil due to the manure being applied which was consistent with that reported by Walker and Bernal (2008) who noted that soil improved with manure increased significantly nitrogen due to the fact that in the process of decomposition of manure generated nitrites and nitrates that are incorporated into the soil. In all cases the nitrogen availability increased and the highest availability of N found from poultry manure. The result might be due to improvement of other physical and chemical properties for organic manure application.

TABLE 2
THE EFFECT OF STORAGE AND POULTRY MANURE DOSAGE ON AVAILABILITY OF AMMONIUM (NH_4^+) IN SOIL (PPM)

No.	Treatments	Time of Observation		
		4 WAP	6 WAP	8 WAP
1.	Control	0.1000 a	0.1000 a	0.1000 a
2.	DPM 12.5 g	0.1125 ab	0.1150 a	0.1050 ab
3.	DPM 25 g	0.1325 c	0.1325 b	0.1175 b
4.	DPM 37.5 g	0.1650 d	0.1500 c	0.1325 c
5.	FPM12.5 g	0.1000 a	0.1075 a	0.1150 ab
6.	FPM 25 g	0.1175 b	0.1350 b	0.1425 c
7.	FPM37.5 g	0.1450 c	0.1775 d	0.1600 d

Note: same letters represent insignificant values at 5 % level by Duncan's Multiple Range Test.

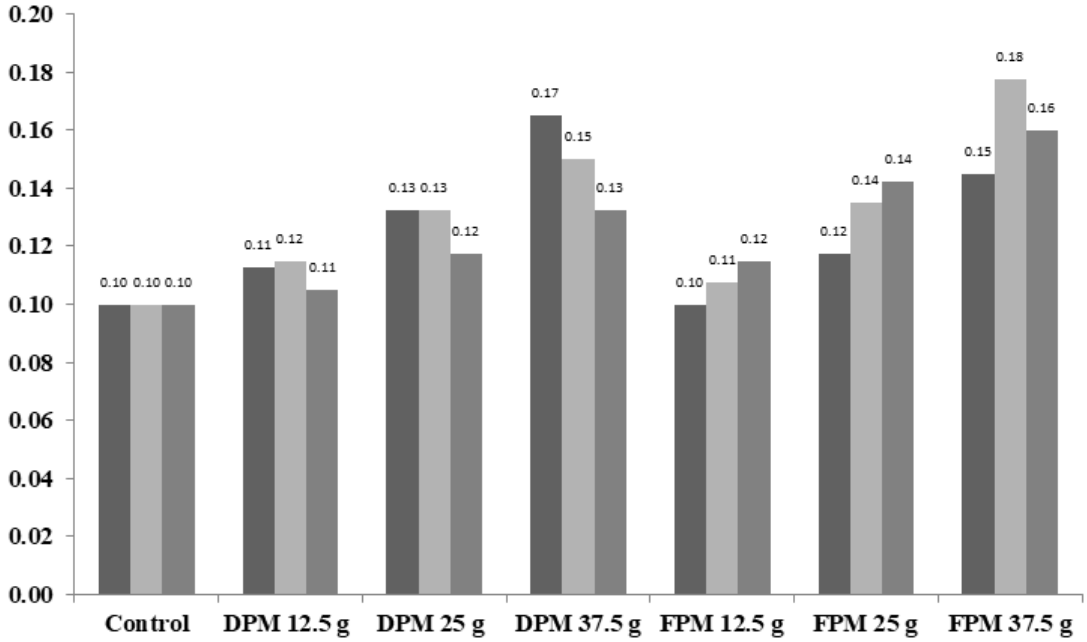

FIGURE 2: The Effect of Storage and Poultry Manure Dosage on Availability of Ammonium (NH_4^+) in Soil (ppm)

3.2 Effect of Treatment on N-Uptake

Based on statistical analysis, showed that there were any effects of treatment on N-uptake (Table 3). In all of observation time showed that all treatments were significantly different compared with control, it proved that nutrient uptake by the plant are different depend on the type of plant, soil nutrients content, and environment factors (Donahue, 1958). N-uptake increase continuously along of the plant growth phase. Russel (1973) concluded that N, P, K, and Ca fastly absorbed by plant in initial growth, and it will be higher in the dry materials forming. The highest value of N-uptake can be reached in 6 and 8 WAP.

TABLE 3
THE EFFECT OF STORAGE AND POULTRY MANURE DOSAGE ON N-UPTAKE

No.	Treatments	Time of Observation		
		4 WAP	6 WAP	8 WAP
1.	Control	0.6650 a	1.6875 a	2.1925 a
2.	DPM 12.5 g	1.3675 b	5.1050 c	5.5775 b
3.	DPM 25 g	2.3025 c	8.2725 d	8.7125 c
4.	DPM 37.5 g	2.7650 cd	9.0600 d	10.8150 d
5.	FPM12.5 g	1.3775 b	3.6075 b	6.2150 b
6.	FPM 25 g	1.9475 bc	5.8450 c	8.7750 c
7.	FPM37.5 g	3.3775 d	8.5200 d	10.7925 d

Note: Same letters represent insignificant values at 5 % level by Duncan's Multiple Range Test.

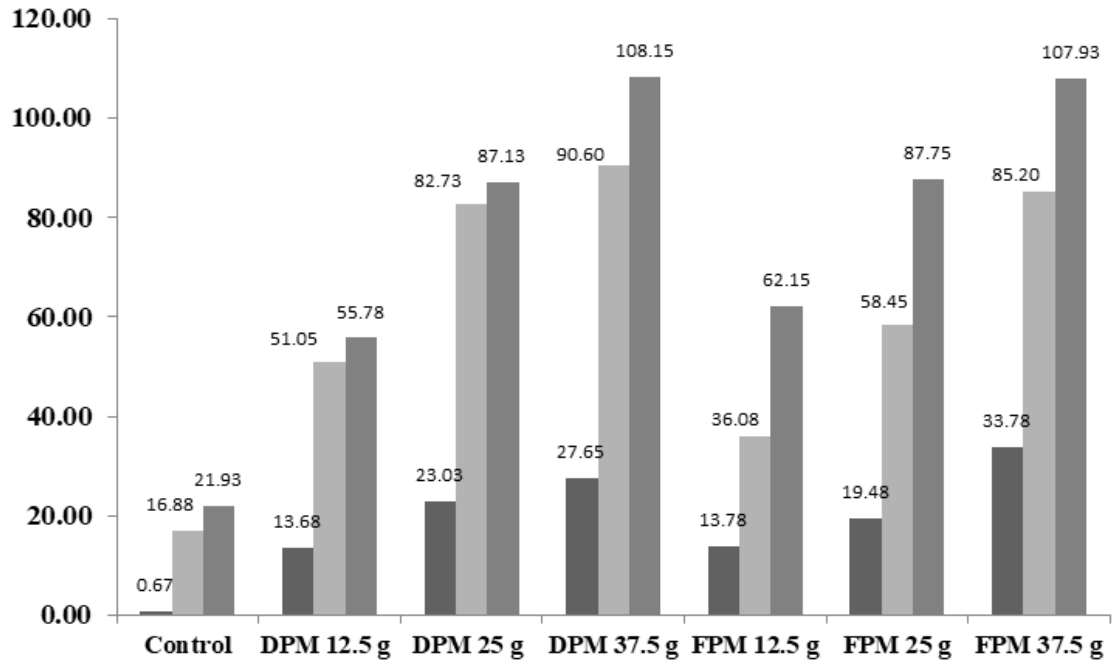

FIGURE 3: The Effect of Storage and Poultry Manure Dosage on N-Uptake (mg/kg)

3.3 Effect of Treatment on Yield of Head Lettuce (Fresh Weight)

Table 4 showed that almost all treatments were significantly different compared with control. The high value of yield in fertilization treatments showed the roles of soil nutrients availability on the plant growth. The high dosage of fertilizer will increase soil nutrients and then will increase plant production. Nitrogen is the primary element of protein and nucleic acid forming and it directly involved in the protoplasm forming (Tisdale et al.1993). The dry poultry manure treatment with 37.5 g dosage showed the highest value on yield of Head Lettuce in 8 WAP.

Organic fertilizer including cow manure chicken litter and sheep manure may be used for crop production as a substitute of synthetic fertilizers (Ovsthus et al. 2015; Xie et al. 2018). Organic fertilizers improve soil fertility without leaving residual effects in the soil and are cheaper compared to synthetic fertilizers (Dandas et al. 2008; Naeem et al. 2006). Organic fertilizers contain sugars proteins amino acids and organic humic and non-humic acids which contribute directly or indirectly to plant growth and development (Fartusi. 2003).Chicken litter which is an excellent source of N. P. and K and provides many secondary nutrients and amino acids that plants require for enhanced photosynthesis cell division cell enlargement (Al-Jebarii. 2017).

TABLE 4
THE EFFECT OF STORAGE AND POULTRY MANURE DOSAGE ON YIELD OF HEAD LETTUCE (FRESH WEIGHT IN GRAM)

No.	Treatments	Time of Observation		
		4 WAP	6 WAP	8 WAP
1.	(1) without poultry manure (control)	3,8000 a	9,4000 a	16,3200 a
2.	(2) dry poultry manure with 12,5 g dosage	7,6975 b	21,5625 b	44,2725 c
3.	(3) dry poultry manure with 25 g dosage	12,8225 c	43,0250 d	75,2725 e
4.	(4) dry poultry manure with 37,5 g dosage	15,0225 cd	48,8750 d	98,3875 f
5.	(5) fresh poultry manure with 12,5 g dosage	7,3050 ab	22,9750 b	35,5075 b
6.	(6) fresh poultry manure with 25 g dosage	10,3100 bc	32,0750 c	60,5250 d
7.	(7) fresh poultry manure with 37,5 g dosage	17,5800 d	45,6500 d	74,1500 e

Note: Same letters represent insignificant values at 5 % level by Duncan's Multiple Range Test.

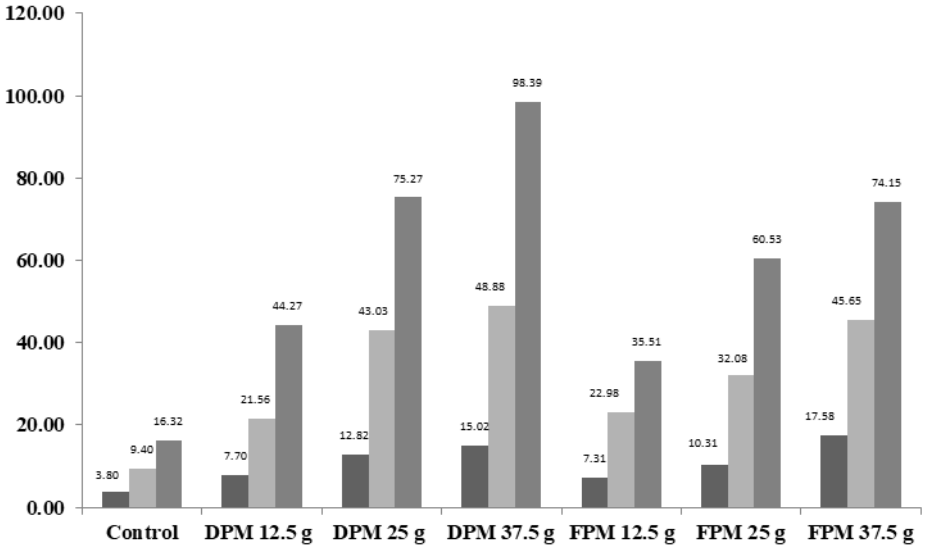

FIGURE 4: The Effect of Storage and Poultry Manure Dosage on Yield of Head Lettuce (Fresh Weight in Gram)

IV. CONCLUSION

The treatment combination of dry poultry manure with 37.5 dosage showed the highest value on soil nitrate and ammonium in 4 WAP.N-uptake in 6 and 8 WAP and the yield of Head lettuce in 6 and 8 WAP. The treatment combination of fresh poultry manure with 37.5 g dosage showed the highest value on soil nitrate and ammonium in 6 and 8 WAP.N-uptake in 4 WAP and the yield of Head lettuce in 4 WAP. Generally it showed that the dry poultry manure showed the better effects than the fresh poultry manure on yield of Head lettuce.

ACKNOWLEDGEMENTS

The authors would like to thank the anonymous reviewers for valuable comments on the manuscript, and the staff of the Laboratory of Soil Chemistry Fachhochschule Erfurt Germany, for their assistance on some analysis work.

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