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TJAS Tikrit Journal for Agricultural Sciences

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The Effects of Mature and Immature Chicken Manure in the Growth and Yield of Lettuce Plant (*Lactuca sativa L.*)

ABSTRACT

Different age of chicken manure may create a different effect on growth and production of plants. The reason for conducting the study was to determine the response of lettuce (Lactuca sativa L.) for mature chicken manure (old); its age was 6 months, and immature chicken manure; its age was less than 10 days. The research consisted of eleven treatments. Five deferent levels included 50, 75, 100, 125 and 150 grams per plant (g plant-1) were used for each type of chicken manure (mature and immature) plus control treatment, and three replications were conducted for each treatment. The parameters of fresh weight (edible part only), leaves number, head diameter and plant length were recorded, at harvesting period. Also, the fresh weight has been converted to lettuce's yield ton hectare-1 (ton h-1). The result indicated that applying the old chicken manure (except 50 g plant-1) caused a significant decrease ($P< 0.05$) in fresh weight, leave number, head diameter and the yield of lettuce. However, lettuce supplied with high levels of immature chicken manure exhibited significant increase ($P< 0.05$) in fresh weight, plant length and the yield. Lettuce fertilized with 150 g plant-1 of immature chicken manure produced 68.48 ton h-1 which was 18 tons higher compared to only 50.20 ton h-1 in control's plot. Based on the obtained result, avoiding application old chicken manure and utilization fresh manure in order to stimulate vegetative growth and lettuce yield are recommended.

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INTRODUCTION

Lettuce (*Lactuca sativa L.*) is one of the most desirable vegetable and widely consumed in the world. It belongs to the Asteraceae family (Peiris and Weerakkody,2015). Its leaves contain a height level of antioxidants, vitamin A, and vitamin C (Masarirambi et al., 2012b). The plants has been classified under the leafy vegetable group which is known to well respond to the organic manure (Hossain and Ryu, 2017). Therefore, it seems that applying organic manure has a major impact on enhancement of vegetative growth and increasing fresh weight of lettuce.

The response of lettuce to chicken manure fertilizer has been already examined by some studies. Masarirambi et al (2010) found that the production of red lettuce (Veneza Roka) could be more feasible with chicken manure compared to lettuce treated with other types of organic or inorganic fertilizers. The chicken manure- treated plants are of higher quality in term of vegetative growth including number of leaves, leaf area index, height and marketable yield. Masarirambi et al (2012a) stated that lettuce fertilized with chicken manure have recorded higher leaves number and fresh weight compared to the lettuce grown with kraal (cattle) manure and inorganic fertilizer. The positive effect of chicken manure on lettuce growth was also confirmed by Masarirambi et al

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(2012b) who indicated that the lettuce with higher length, higher yield and maximum leaves number can be obtained when chicken manure was used. Consequently, it has been proven that the most appropriate fertilizer for lettuce production is chicken manure.

On the other hand, the amount of poultry manure is rising annually because of increasing poultry population. The enormous poultry manure produced could be recycled by utilizing as a nutrient source of plant production to preserve the sustainability of agricultural system (Amanullah et al., 2010). Masarirambi et al. (2012a) and Amanullah et al. (2010) stated that poultry manure contains all the major elements required for plants which included nitrogen, potassium, calcium, phosphorous, boron, iron, manganese, and magnesium (Mg). In general, organic fertilizer can reduce soil erosion, stimulate beneficial organism, and increase water-holding capacity (Magagula et al., 2010). In spite of existence of all essential elements, poultry manure has long been recognized by high nitrogen content (Mahadeen, 2009) because it is considered a rich source of protein and amino acid (Chen and Jiang, 2014). Therefore, the protection of N content in poultry manure should be considered seriously.

Nitrogen (N) can enhance and stimulate plant growth (Uko et al., 2013). It is a main component of amino acids and then in building blocks of plant proteins, as well as it is an essential contributor of making chlorophyll and increasing the rate of photosynthesis (Hameed and Lattif, 2019; Taiz and Zeiger, 2006). Moreover, it is an integral part of nucleic acids (DNA and RNA), enzymes, coenzymes, hormones and vitamins (Hossain and Ryu, 2017). Thus, plant growth and development are stimulated by providing sufficient N. Many factors have effect on the amount and availability of nutrient content of poultry manure such as moisture content, age and food of poultry, and time period of the manure as well (Amanullah et al., 2010; Peiris and Weerakkody 2015). Time period of the manure is one of the most important factors which play an essential role in the availability of N content of manure. The available nitrogen mainly has been released from organic manure as a form of Ammonium (NH_4^+) rather than nitrate (NO_3^-) (Eghball et al., 2002). N supplied in the form of nitrate is frequently much more effective on the plant growth than ammonium form (Hachiya and Sakakibara, 2017). For this reason, as time goes some of N will be volatilized. The percentage of N in poultry manure is normally between 3-5%, and 40% of N could be lost after only one month (Amanullah et al., 2010). Wolf et al., (1988) pointed out that the process of N lost is so faster and after a period of 11 days, 37% of total N has been volatilized as well as some amount of N is reduced due to immobilization after 1-2 weeks. According to Ritz and Merka (2009) after approximately 45 days, only 40-70% of total N is available.

The place of manure storage is also an effective factor. When manure is exposed to the weather, it decomposes rapidly and as a result N is less available to the crop after several days. At hot and dry condition, one fourth of total N is lost within one week (Mitchell and Donald, 1995). Not only N is reduced in composed manure but also some of potassium is lost rapidly by leaching (Ritz and Merka,2009). Mitchell and Donald (1995) pointed out that the rate of NPK changes from 3-3-2 in fresh manure to 1.5-3-1 in composed broiler litter respectively. In other words, the rate of potassium is also reduced to a half in composed chicken compare to fresh manure.

Farmers utilize accumulated chicken manure which has been exposed to the weather for several months rather than fresh manure. While, as time goes nitrogen content in chicken manure generally decline because of immobilization, leaching and volatilization. To our knowledge, the effect of manure lifespan on the lettuce growth has not been studied yet. The aim of current study is to evaluate the effect of decomposition (mature) and non-decompose (immature) of chicken manure on yield and vegetative growth of lettuce and also to determine appropriate concentration of the manure to obtain optimum growth and yield of lettuce.

Hypothesis

Providing both types of chicken manure (mature and immature) could be beneficial to increase vegetative growth and yield of lettuce compare to non-treated plant (control).

MATERIA AND METHODS

This field experiment was carried out at Bakrajo Technical Institute, Sulaimani Polytechnic University, Sulaymaniyah, during 2017-2018. This location was at 838 m above sea level (Abdulla

et al., 2015). The structure of the soil was analyzed before planting. The soil type was clay loam (table 1.). The composition used was also inspected (table 2).

Table (1) some chemical and physical properties of the soil-Bakrajo location

Properties	Sand gKg^{-1}	Silt gKg^{-1}	Clay gKg^{-1}	EC dsm^{-1}	pH	N $mgKg^{-1}$	Available p $mgKg^{-1}$	Soluble K^+ $(mM.L^{-1})$
Sample	121.3	457.6	421.1	0.34	7.1	0.14	31.2	0.29

Soil analyzed by: Directorate of agricultural research Center in Sulaymaniyah- 2017

Table (2) Some chemical properties of chicken manure

Sample	Properties					
	EC dSm^{-1}	PH	N $mgKg^{-1}$	P $mgKg^{-1}$	Available P $mgKg^{-1}$	K^+ $mM.L^{-1}$
immature chicken manure	1.2	6.73	5.82	0.512	1144.22	2.1
mature chicken manure	1.7	6.82	3.75	0.732	852.85	4

Chicken manure analyzed by: Directorate of agricultural research Center in Sulaymaniyah- 2017

Plant material

The seeds of *Lactuca sativa* (Var.Argeto) was sowed in greenhouse on 2/10/2018. Four weeks after, the seedlings were transplanted in to the field. The space between the plants was 40*40 cm. The plants grew under temperature at 10-30 ºC. Regarding to irrigation, the experiment depended on rain only during the experiment period.

Treatments

Two types of chicken manure were used in the present study. The first type was mature chicken manure (6 months- old manure). The second was immature chicken manure (less than 10 days- fresh manure). The chicken manure was reserved from meat production chicken farm. Each type of chicken manure was used at five deferent levels including 50, 75, 100, 125 and 150 g $plant^{-1}$ g/p, 125 g/p and 150 g/p). Consequently, the study included 10 treatments as well as the control. The design used was Randomized Complete Block design (RCBD) with three replications.

The 11 treatments in the present study included

1- Control (no chicken manure applied)
2- 50 g $plant^{-1}$ mature chicken manure
3- 75 g $plant^{-1}$ mature chicken manure
4- 100 g $plant^{-1}$ mature chicken manure
5- 125 g $plant^{-1}$ mature chicken manure
6- 150 g $plant^{-1}$ mature chicken manure
7- 50 g $plant^{-1}$ immature chicken manure
8- 75 g $plant^{-1}$ immature chicken manure
9- 100 g $plant^{-1}$ immature chicken manure
10- 125 g $plant^{-1}$ immature chicken manure
11- 150 g $plant^{-1}$ immature chicken manure

The chicken manure was applied at two times. After 30 days of transplanting in the field, %50 of the manure. The other 50% was added 30 more days later.

Data collection and measurements

Lettuce plants were harvested in the mid of May 2018 and three plants were randomly selected from each treatment to measure the following traits:

Fresh weight (g): The edible part of lettuce was weighed without the root by digital balance.

Leaves number (leaf $plant^{-1}$): The total leaves number of each plant was recorded.

Head's diameter (cm): The width of overhead part of the plant was measured by measuring tape.

Plant length (cm): The length of vegetative part of each plant was recorded by using measuring tape.

Yield (ton h^{-1})**:** the average of fresh weight in each treatment was converted yield in hectare. Each hectare can be planted with 62500 plants. Then, the weight of lettuce in gram was also converted to ton per hectare.

Data analysis: The data were statistically analyzed by Graph-Pad Prism_ software 7.0 (WI, USA). The data between treatments applied were analyzed and taken as the factor. The means of treatments were compared using the least significant deference (L.S.D) at 0.05 level of significance.

RESULT AND DISCUSSION

The effect of mature chicken manure on fresh weight, leaves number, head diameter and plant length of lettuce is illustrated in table 3. The results indicated that there was a significant difference ($p \leq 0.05$) between control and plant treated with different doses of mature chicken manure except 50 g $plant^{-1}$ in term of fresh weight, yield and leaves number. Fresh weight and leaves number of lettuce have been noticeably decreased with application of mature chicken manure (75,100,125 and 150 g $plant^{-1}$) compare with control treatment. In addition, lettuce fertilized with 150 g $plant^{-1}$ of mature chicken manure caused to decline the yield from 50.20 ton h^{-1} at plot's control to 30.88 ton h^{-1}. Using of mature chicken manure also had a negative effect of head diameter of lettuce and a significant difference was observed between control's head diameter and all level of concentration of mature chicken manure. The head diameter of lettuce in control's plot was 19.7 cm, while it decreased to only 14.83 cm in plants treated with 150 g $plant^{-1}$. Negative effect of mature chicken manure on fresh weight, the yield, leaves number, and head diameter of lettuce might be related to high pH of the soil utilized in present study. As represented in table 1, the pH of the soil was 7.1. Hossain and Ryu (2017) mentioned that when the pH of soil is higher than 6.4 the solubility of organic matter increases. In addition, when the organic matter concentration increases, more mineral nitrogen is required to reach the optimum C:N (10-12:1) ratio. Otherwise, high level of organic matter in soil without providing sufficient amount of nitrogen created an obstacle in growth and development of lettuce. That is why, the result of current study showed that addition of mature manure led to decrease the fresh weight, yield, leaves number and head diameter of lettuce. This proved the fact that nitrogen content in old manure was too low (only 3.75 $mgkg^{-1}$) and most nitrogen content was lost before consumption (table 2). Declining leaves number also investigated on Amaranthus hybridus (Oyedeji et al., 2014).

Results on the effect of immature chicken manure on the plant parameters are presented in table 4. The result showed that addition of low concentration of immature chicken manure (50 g $plant^{-1}$) had no effect on lettuce weight compare to control. While, when the concentration of the manure increased to more than 50 g $plant^{-1}$ (75'100, 125 and 150 g $plant^{-1}$), a significant increase was found ($p \leq 0.05$) in fresh weight of lettuce compare to control. The highest dose of the immature of chicken manure (150 g $plant^{-1}$) produced the maximum weight (1096 g) which is approximately 300 g higher than control's weight. Regarding to leaves number, in spite of producing 11 leaves more with application of 125 g $plant^{-1}$ and 10 leaves more with addition 150 g $plant^{-1}$ of immature of chicken manure compare to control, statically significant difference was not found between control and treatments. Furthermore, Lettuce yields increased with increased levels of immature chicken manure and therefore a significant difference ($p \leq 0.05$) was recorded between control and the concentrations of 75,100, 125 and 150 g $plant^{-1}$ in term of lettuce yield. Using 150 g $plant^{-1}$ of immature chicken manure produced 68.48 tons/ hectare which is above 18 tons higher than control (50.20 ton h^{-1}). Increased the fresh weight, yield and leaves number by applying immature manure compared to control could be connected to the existence of high nitrogen content (5.82 $mgkg^{-1}$) in the fresh manure (table 2). That has been useful to provide optimum C:N ratio and stimulate vegetative growth (Hossain and Ryu, 2017). In addition, there was no significant difference between treated and untreated (control) plants in head diameter.

Both kinds of applied chicken manure had a positive effect on plant height of lettuce compared to untreated plants. However, the highest plants were obtained under higher level of immature manure (125 and 150 g $plant^{-1}$). All treated lettuce was significantly higher compared to

control. The increase in lettuce height due to chicken manure could be correlated to the fact that chicken fertilizer is able to stimulate the formation of auxin hormone. This hormone is responsible of promoting stem elongation and softening the cell wall of plant (Riyana et al., 2018). Enhancement of plant height with addition of chicken manure has been also found in other crops such as Waterleaf (Talinum fructicosum (L.) juss (Uko et al., 2013), lettuce (Masarirambi et al., 2012b), red lettuce (Masarirambi et al., 2010) and maize (*Zea mays saccharata*) (Amos et al., 2013).

Table (3) The effect of mature chicken manure treatments on the parameters

		Mature Chicken manure					
	Plant parameter	control	50 g plant-1	75 g plant-1	100 g plant-1	125 g plant-1	150 g plant-1
Parameters (Mean ± STDEV)	**Fresh weight of plant (g)**	803.83±116.23 a	800.2±72.84 a	669.8±25.46 b	648.3±91.2 b	703±54.84 c	494.5±63.57 d
	leaves number leaf p^{-1}	60.5±7.18 a	54.3±6.57 a	39.3±6.12 b	42.7±2.62 b	48.7±3.94 c	44.3±5.39 b
	head diameter (cm)	19.7±1.69 a	15.2±1.3 b	15.5±2.13 b	15.5±2.29 b	16.5±1.5 c	14.83±2.19 d
	plant length (cm)	26.83±2.4 a	39.5±1.3 b	32.5±0.76 c	35.3±2.62 c	38.83±4.37 d	36.7±2.54 c
	Yield of lettuce ton h-1	50.20±7.26 a	50.00±4.55 a	41.84±1.59 b	40.48±5.70 b	43.92±5.78 c	30.88±3.97 d

The results were given as Mean Values ± Standard Deviation, and different letters were to indicate a statistical difference ($p \leq 0.05$) compared to the value of the same parameter in the control group.

Table (4) The effect of immature chicken manure treatments on the parameters

		Immature Chicken manure					
	Plant parameter	control	50 g plant-1	75 g plant-1	100 g plant-1	125 g plant-1	150 g plant-1
Parameters (Mean ± STDEV)	**Fresh weight of plant (g)**	803.83±116.23 a	806.83±62. 4 a	870.3±54.5 b	992.83±76.1 c	1077±154.4 c	1096.3±134 c
	leaves number leaf p^{-1}	60.5±7.18 a	64 ±3.82 a	60.3±10.19 a	63.3±7.41 a	71.2±6.79 a	70.5±7.8 a
	head diameter (cm)	19.7±1.69 a	19±1.0 a	16.83±2.73 a	21±2.82 a	20.66±3.49 a	21.16±2.11 a
	plant length (cm)	26.83±2.4 a	38.6±2.56 b	32±3.1 c	38.5±3.14 c	41.5±3.1 d	42.5±2.75 d
	Yield of lettuce ton h^{-1}	50.20±7.26 a	50.40±3.9 a	54.36±3.40 b	62.04±4.75 c	67.28±9.65 c	68.48±8.42 c

The results were given as Mean Values ± Standard Deviation, and the different letters were to indicate a statistical difference ($p \leq 0.05$) compared to the value of the same parameter in the control group.

CONCLUSION AND RECOMMENDATION

It can be concluded that fresh weight, yield, leaves number and head diameter of lettuce plant were significantly decreased by adding all levels of mature chicken manure compared to control. The results of the current study were contrary to the hypothesis, which stated that providing mature chicken manure could be beneficial to increase vegetative growth and yield of lettuce compared to un-treated plants (control). In contrast, using high dose of immature can increase lettuce yield and fresh weight considerably and produce a little more leaves number compared to untreated plants. Based on the results, it is recommended that chicken manure should be used as immature for lettuce in order to prevent loss in nitrogen content before absorbing from the plants.

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تأثير روث الدجاج المتحلل وغير المتحلل فى النمو الخضرى و انتاج نبات الخس (*Lactuca sativa L.*)

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الكلمات المفتاحية:
الخس، روث الدجاج المتحلل، غير المتحلل، التسميد العضوي،

الخلاصة

نبات الخس (*Lactuca sativa* L.) واحداً من الخضراوات المرغوبة والتى تزرع بكثرة في كوردستان العراق . و روث الدجاج هو أحد مصادر الاسمدة العضوية لحقول النبات, كونه يعد مصدراً طبيعيا للنيتروجين ومحفزا للنمو الخضري. يستخدم المزارعون روث الدجاج المتراكم الذي تعرض للتجوية (التحلل) لعدة أشهر بدلاً من الروث الطازج(غير المتحلل). بينما ، مع مرور الوقت ، ينخفض محتواه من النيتروجين بسبب عمليات الغسل والتطاير فضلاً عن المعدنة. ان اختلاف عمر روث الدجاج ينتج عنه تاثيرات مختلفة فى نمو وانتاج النبات. هدفت الدراسة الى تقدير استجابة نبات الخس للتسميد بروث الدجاج المتحلل 6 اشهر و الغير المتحلل بعمره اقل من 10 ايام.

ضمت الدراسة احدى عشرة معاملة, خمسة منها بالأوزان (125.100.75.50 .150) غم نبات$^{-1}$ باستخدام الروث الطازج و مثلها للروث القديم فضلاً عن معاملة المقارنة صممت التجربة بتصميم القطاعات العشوائية الكاملة و بثلاث مكررات. واظهرت النتائج ان اضافة روث الدجاج المتحلل بجميع الاوزان ماعدا (50) غم نبات$^{-1}$ ادى الى خفض معنوي لكل من الوزن الطري، عدد الاوراق, قطر رأس وكذلك الحاصل، لكن تزويد نبات الخس بالتراكيز العالية لروث الدجاج غير المتحلل سببت زيادة معنوية الوزن الطري و الحاصل. أنتاج الخس الذي تم تسميده ب ١٥٠ غم نبات$^{-1}$ من سماد روث دجاج غير المتحلل كان ٦٨,٤٨ طن هكتار$^{-1}$ الذي يزيد ب ١٨ طن عن انتاج الخس بمعاملة الكونترول الذي كان انتاجه ٥٠,٢٠ طن هكتار$^{-1}$. بالاستناد على النتائج التي تمت الحصول عليها ، يوصى بتجنب استخدام روث الدجاج المتحلل واستخدام روث غير المتحلل من أجل تحفيز النمو الخضري لنبات الخس.