

The Effect of Chicken Manure on Plant Growth Nutrient Content and Yield of Lettuce

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Abstract: The harmful effects of chemicals used in agricultural production (such as pesticides, fertilizers) on human and public health have started to reveal themselves. In recent years, the usage rates of organic, organomineral, soil conditioners, and microbial fertilizers have increased in addition to chemical and farm fertilizers to increase the productivity in crop production. While the productivity of agricultural soils increases with the use of organic fertilizers, the improvement of soil properties plays a key role in ensuring the sustainability of soils, and obtaining healthy agricultural products. The use of organic fertilizer in soils changes the physical, chemical, and biological properties of soil in a positive way. Among the organic fertilizers, chicken fertilizers constitute an important place. In this study; the effect of different doses (300 kg da^{-1} , 500 kg^{-1}) of organic material obtained from chicken manure as organic fertilizer on plant growth, yield, and nutrient content of lettuce were investigated. The experiment was carried out as a pot test under greenhouse conditions in Malatya. Applied two doses of organic fertilizer were compared with chemical fertilization. As a result of this study, organic fertilizer applications, which does not have as much acidity and smell as chicken manure, has revealed the possibilities of using organic manure in vegetable growing.

Keywords: Chicken manure, lettuce (*Lactuca sativa*), nutrient element contents, plant development, organic fertilizer, yield.

1. Introduction

Fertilization, which has a share of approximately 10-15% in agricultural production costs, increases yield by nearly 50%. However, while chemical fertilizers applied unconsciously and unbalanced to increase the

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yield, this increases the cost of production, and also it threatens human, plant, and animal health by mixing with ground and surface waters. Although the effective role of organic fertilizers in protecting and improving soil fertility is well known, the use of these fertilizers is below the desired level.

The organic matter ratios of agricultural soils and the status of plant nutrients are very important in terms of sustainable agriculture and increasing plant productivity. Sustainability of soil fertility is possible by the suitability of its physical, chemical and biological structure for plant production and fertilization in a balanced way. The correction of the deteriorated structure in the soil and the compensation of the missing nutrients can be met by using organic and chemical fertilizers in a way that compensates for each other's effects and together. In recent years, the use of organic, organomineral, soil conditioners, and microbial fertilizers have increased in addition to chemical and farm fertilizers to increase productivity in plant production. Organic fertilizers are defined as fertilizers that contain plant nutrients as organic compounds and their main purpose is to improve the physical and chemical properties of the soil and facilitate plant nutrient uptake. Organic fertilizers used in agricultural production are not only useful for the plant they are applied to, but also they can provide a better environment for the next plant production that will be made. They also increase the water and nutrient holding capacity of the soil and the cation exchange capacity. Since nitrogen loss by washing in organic fertilizers is less than chemical fertilizers, they are also important for environmental protection [1]. The use of organic fertilizers in the soil positively changes the physical, chemical, and biological properties of the soil, and chicken manure is an important organic fertilizer.

Waste that causes environmental problems in livestock farms has an important economic potential. It is possible to use most of the animal wastes in areas such as fertilizer and feed production. Therefore, the utilization of livestock wastes will reduce the environmental pressure and the idle economic resource will be evaluated [2]. Since chicken manure is a fertilizer of organic origin, it is a good source of nutrients rich in other plant nutrients in addition to the N it contains especially for plants, as well as a good breeding material recently used as an additive in animal feeding and improving the physical properties of the soil. The amount of chicken manure increases day by day due to the increase in chicken breeding. The fact that 65% of the nitrogen in chicken manure, 50% of phosphorus, and 75% of potassium can be used by the plant in the first year of fertilizer application [3] also increases the importance of this fertilizer. Therefore, chicken manure is an important source of organic fertilizer that would significantly be benefited in plant growing.

Lettuce is a vegetable consumed as salad and fresh greens that can be grown all year round under the open field and greenhouse conditions. Lettuce leaves have low caloric content and it contains 94-95% water [4]. Lettuce shows quality development in a shorter time in soils where organic matter is applied and it is a vegetable that grows well in soils rich in organic matter [5]. In a study conducted in 2000, the effects of

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liquid chicken manure and solid chicken manure, were investigated in lettuce farming, increasing doses of organic fertilizers were applied increased the yield of the plant compared to the soil where no application was made [6]. Also, it was determined that lettuce is a vegetable that responds well to organic fertilization in studies related to the use of different organic fertilizers [7-9].

In the present study, the effect of different doses of organic material (300 kg da⁻¹, 500 kg da⁻¹) obtained from chicken manure as organic fertilizer was investigated on lettuce plant growth, yield, and nutrient content. These two doses of organic fertilizer were compared with chemical fertilization. This organic material is produced by a private enterprise (Abanoğulları Worm Fertilizer Production Farm), it is a solid form of fertilizer. The pungent odor and acidity of chicken manure are removed and it is more suitable for use in plant production. The study is important in terms of the utilization of chicken feces in chicken farms and bringing them into production as an organic fertilizer.

2. Materials and Methods

The experiment was carried out as a pot experiment in the polycarbonate Research and Application Greenhouse in Malatya Turgut Ozal University. 'Presidential Yedikule' lettuce variety (from Syngenta) was used as the plant material. In chicken manure (CM), two different doses, were used at 300 kg da⁻¹ and 500 kg da⁻¹ doses and compared with chemical fertilization. The doses were recommended to us by the farmer from whom the fertilizer was supplied and by the Soil and Plant Nutrition Department, based on the results of the analysis and preliminary experiment. As the chicken manure, dried chicken manure which was subjected to acid and odor removal process was obtained from a private enterprise (Abanoğulları Worm Fertilizer Production Farm). In chemical fertilization (CF), the doses were calculated as 15 kg da⁻¹ N, 10 kg da⁻¹ P, 18 kg da⁻¹ K [4]. Lettuce seedlings were planted in 4 liter pots on November 15. We used as experimental design randomized blocks. In the experiment have 3 applications and 4 repetitive, and with total 120 plants were studied (Figure 1). Each application is considered as one block. The analysis results of the used soil and organic chicken manure are presented in Table 1.

Lettuce samples were harvested on March 22. Measurements and analysis in plants include leaf length (cm), number of leaves, root collar diameter (mm), root length (cm), root and leaf age and dry weight (g), while measurements and analysis leaves include plant nutrient analyses (N, P, K, Ca, Mg, Zn, Fe, Cu, Mn). Also, yield values were calculated in kg/da. Plant nutrient analysis in leaves comprised the "Khjeldal" method for N, and "Barton" method for P analyses [10]. For other elements, leaf samples were burned according to the dry combustion method [11-12] and diluted with HCl. The obtained samples were read in an

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atomic absorption spectrophotometer. The data obtained in the experiment were subjected to statistical analyzes using JMP 8.0 software and the mean values were compared according to the LSD test.

Table 1

	Results of the soil analysis in the experimental area	
	Soil	Chicken manure
Saturation	96.8	181.5
pH	7.45	7.30
EC μ S/cm	1753	5160
Lime %	31.53	9.18
Organic Matter	5.1	31.1
P ₂ O ₅ (kg/da)	22.00	141.97
K ₂ O (kg/da)	134.71	4876.13
Fe (ppm)	69.87	301.98
Zn (ppm)	4.10	203.83
Cu (ppm)	2.29	298.91
Mn (ppm)	21.05	118.01
Ca (ppm)	7028	3750
Mg (ppm)	1074.3	1871.8



Fig. 1 Lettuce plants in the experimental pots

3. Results and Discussion

Measurement and yield results of the applications are presented in Table 2. Examining the results, it was seen that the sole application of chicken manure was not sufficient in terms of the parameters related to both yield and plant development. This fact would be caused also because of the doses were low. In the parameters of root length, root wet and dry weight, both doses of chicken manure were found higher than those of the chemical fertilization application. However, the values of chemically fertilized plants were found to be higher and different from chicken manure applications in the aerial part development and yield results.

Table 2

The effect of fertilizer applications on some plant growth parameters and yield in lettuce									
Application	Root length (cm)	Leaf length (cm)	Root wet weight (g)	Root dry weight (g)	Leaf wet weight (g)	Leaf dry weight (g)	Leaf counts (piece/plant)	Stem diameter (mm)	Yield (kg da ⁻¹)
CM-300 kg/da	30.38 a	23.83 b	28.25ns	5.47ns	118.11 b	10.12 b	18.88 b	49.61 b	2299 b
CM-500kg/da	31.55 a	25.33 ab	29.38ns	5.80 ns	126.64 b	16.20 b	19.77 b	54.44 b	2364 b
CF	19.11 b	27.66 a	24.77ns	5.08ns	210.45 a	16.61 a	26.22 a	60.11 a	3171 a
prob<F	0,0007**	0,0136*	ns	ns	<,0001***	<,0001***	0,0003**	0,0022**	0,0004**

The differences between the means are shown in separate letters.

***:p<0.001; **:p<0.01; *:p<0.05 ns: non-significant

The nutrient analysis results and reference values [13] of lettuce leaves are presented in Table 3. There were no statistically significant differences between the applications in terms of nutrients. Similar to our study, Polat *et al.*, [14] concluded that solid chicken manure+liquid chicken manure applied in the amount of 300 kg da⁻¹ on the lettuce plant were the plants with the highest head weight [15]. However, the 500 kg da⁻¹ dose of chicken manure application yielded close results to plants that received chemical fertilization. Especially in microelement uptake, the results of the applications were close to each other.

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Table 3

The effect of fertilizer applications on plant nutrient content of lettuce leaves									
Application	N	P	K	Mg	Ca	Fe	Zn	Cu	Mn
	(%)	(%)	(%)	(%)	(%)	(ppm)	(ppm)	(ppm)	(ppm)
CM- 300kg/da	3.95	0.25	4.42	0.43	1.82	45.3	20.3	4.5	48.0
CM-500kg/da	4.11	0.28	4.55	0.48	1.85	50.9	21.1	4.8	52.4
CF	4.32	0.32	5.13	0.55	1.91	49.2	21.5	4.8	54.7
Reference Values	3.50-4.50	0.45-0.50	5.50-6.20	0.6-0.8	2 -2.80	40-100	20-250	5-25	11-250

The most important change over time in fertilizer use in agriculture is the increasing use of dose [16]. Increasing their use should be supported due to the positive effects of organic fertilizers in improving soil properties and increasing the availability of nutrients. Especially in areas where soil organic matter is low, these applications can be repeated for years in order to increase soil quality so that sustainable production can be possibly achieved. In a study conducted to find the effects of animal manure on different crops, chicken manure was reported to be significantly richer in plant nutrients than other animal fertilizers [17]. The fact that approximately 90% of the organic nitrogen in chicken manure is mineralized in the first year has been stated as the reason for good results in terms of N in plants and soil [18]. In the results of the present study, applications in terms of N content gave close results. Since chicken manure was used at low doses in the present study, the results were not higher than those obtained in chemical fertilization, however, the N provided to the plant by chicken manure provides is very close to the chemical fertilizer application. Unlike our study, Duyar [19] have reported that, with the application of chicken manure, a significant increase was determined in N in the lettuce plant. Kaplan *et al.*, [20] have reported that chicken manure applications caused a decrease in soil pH, EC, and K content, and an increase in N, P, Ca, Mg, Fe and Mn content from autumn to spring. Ewulo *et al.*, [15] and Adekiya and Agbede [21] reported that the chicken manure they applied in tomato plant increased the N, P, K, Ca and Mg contents in the leaves of the plant. Steiner *et al.*, [22] found that chicken manure applied in different doses increased soil pH, phosphorus, calcium and magnesium contents. Şahin [23] determined that chicken manure had positive effects on the changeable Fe and Cu content in soil where olive farming was carried out. Adekiya and Ojeniyi [24] have reported that chicken manure improved the physical properties of the soil and increased the availability of nutrients. They concluded that chicken manure is an excellent source of nutrients and can be included in many fertilizer programs, reporting that the value of chicken manure is varied not only in terms of nutritional content but also in terms of management and processing costs. Contrary to this study, Masrirambi *et al.*, [25] found that lettuce plant applied with chicken manure increased the leaf surface area,

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leaf number, dry and fresh weight. Ayuaet *et al.*, [26] found that the plant to which chicken manure was applied had larger leaves in a study comparing chicken manure, Mavuno manure and fertilizer-free plants. Polat *et al.*, [14] investigated the effects of different organic fertilizers in terms of yield in their study on lettuce plant and stated that they obtained the highest yield in Solid Chicken Manure+Liquid Chicken Manure application. Sönmez *et al.*, [27] concluded that a good yield can be obtained in the application of 600 kg da⁻¹ of chicken manure per hectare applied on tomato plants and 1200 kg per declare application is effective in increasing the nutrient content in the fruit. It is known that it provides significant increases in yield, especially due to the increase of the effectiveness of chemical fertilizers throughout the world. The effect of inorganic fertilization and chicken manure applications on the N, P and K nutrient content of tomato leaves was not statistically significant. However, considering that 5 times less N and 2 times less K are given to the soil with chicken manure, it is seen that it is effective in reducing environmental damages such as environmental protection and groundwater pollution [28]. The use of organic fertilizers, especially in leaves and freshly consumed salad group vegetables, is important for human health. In this context, our aim in the research is to ensure that the used chicken manure, which is important in human nutrition, is produced in a healthier way and within the scope of food safety since breeding, rather than obtaining more efficiency and quality from chemical fertilizer applications.

4. Conclusion

In this study, it was tried to observe the changes in the development, yield and quality characteristics of lettuce plant with different doses of chicken manure. According to the results of the present study, regarding the use of chicken manure in lettuce cultivation, it can be recommended using it in terms of improving soil structure and being a source of organic matter to the soil. However, these doses are not solely sufficient for proper lettuce farming. Better results were obtained from plants with chemical fertilization. Especially in areas where soil organic matter is low, these practices can be repeated for years to increase soil quality and sustainable production. Chicken manure was included in the applications without any processing in other studies. For this reason, it is possible that it does not show similarity with our results and that the yield is higher than other applications due to the nutrients it contains. Since the material we used in our experiment was a material that has not been studied before, the doses were kept low so that it would not harm the raw consumed lettuce. According to our trial results; regarding the use of chicken manure in lettuce cultivation, we can recommend its use in terms of improving soil structure and being a source of organic matter in the soil, but these doses alone are not sufficient for cultivation. Better results were obtained from plants with chemical

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fertilization. In future studies, low doses of this material may be added to chemical fertilization. This application can be preferred both to improve the soil structure and to use the organic matter source and chemical fertilizer dose low. It can be thought of as the application of farm manure to the soil before aquaculture, and top fertilization with chemical fertilizers is made during aquaculture. Or it is also possible to use it alone, because lettuce needs more nitrogen fertilization because its vegetation period is short, a vegetable and green leaf is consumed. Dose adjustment can be made to be sufficient in terms of organic matter and nutritional element content. In this study, the doses are low because it is both a pot experiment and the recommendation of the private company that brought the material to us for testing. After all; it can be preferred to chemical fertilization because organic materials improve the structure of the soil, help uptake of nutrients and are one of the environmentally friendly techniques. On the other hand, since it is a material that can be used directly in organic agriculture, it will also be preferred by organic producers.

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