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Araştırma Makalesi / Research Article

Effect of Bat Guano on Cation Exchange Capacity, Some Macro Nutrient Content and Reaction of Soil (pH)*

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ABSTRACT: In this study, the effect of bat manure on the some macro element content, pH and cation exchange capacity (CEC) of soils was investigated in order to compare with the traditional method of livestockmanure. Both organic materials were applied at increasing doses of 0 (control); 5; 500; 1000; 1500; 2000 kg.da^{-1} and a wheat plant was used as the experiment plant. The study was carried out in the field of Soil and Water Resources of East Anatolia Agricultural Research Institute (Erzurum) between the years of 2011-2013 and the results were evaluated by LSD multiple comparison test according to the completely randomized block design. When the bat guano and livestock manure results of the study were compared to the control, the highest bat manure dose increased by content of the nitrogen (N) 32%, phosphorus (P) 407%, potassium (K) 61%, pH 3% and cation exchange capacity (CEC) 17% of the soil.

Keywords: Bat guano, Organic matter, Macro nutrients, Cation exchange capacity

Yarasa Gübresinin Bazı Makro Besin Elementi, Katyon Değişim Kapasitesi ve Toprak Reaksiyonu (pH) Üzerine Etkisi

ÖZ: Bu araştırmada yarasa gübresinin geleneksel yöntem olan çiftlik gübresi ile karşılaştırmak amacıyla toprakların bazı makro element içeriği, pH ve katyon değişim kapasitesine etkisi araştırılmıştır. Her iki organik materyal, ağırlık esasına göre artan dozlarda 0 (kontrol); 500; 1000; 1500; 2000 kg.da^{-1} olmak üzere 5 uygulama seviyesinde uygulanmıştır ve test bitkisi olarak buğday kullanılmıştır. Araştırma 2011-2013 yılları arasında Doğu Anadolu Tarımsal Araştırma Enstitüsü Toprak ve Su Kaynakları Yerleşkesi (Erzurum) deneme alanında yürütülmüş ve sonuçlar tam şansa bağlı bloklar deneme desenine göre LSD çoklu karşılaştırma testi ile değerlendirilmiştir. Araştırmanın yarasa ve çiftlik gübresi sonuçları kontrol konusu ile karşılaştırıldığında, en yüksek yarasa gübresi dozu toprakların azot içeriğini (N) % 32, fosfor içeriğini (P) % 407, potasyum içeriğini (K) % 61, pH % 3 ve katyon değişim kapasitesini (KDK) ise %17 arttırmıştır.

Anahtar kelimeler: Yarasa gübresi, Organik madde, Makro besin elementleri, Katyon değişim kapasitesi

INTRODUCTION

Scientists have searched for ways to increase the yield of agricultural areas and to ensure sustainability in agriculture in order to meet increasing food needs and used various materials as fertilizers for this purpose. In this context, new soil conditioners are being investigated and used in order to improve the quality parameters of the soil. In this process, various animal wastes and composts are used. These wastes and composts are regarded as sources of organic matter for the soil.

The physical, chemical and biological properties of the soil are largely influential in the emergence of the plant growth and genetic potential. It is possible to improve these physical, chemical and biological properties by adding regulators to the soil (Bender et al., 1998).

The use of organic wastes has been known for many years as a common method used to improve some properties of the soil. These organic wastes are also used as fertilizer at the same time. Fertilization is one of the most important cultural activities in agricultural production in order to increase efficiency in the unit area. Various materials are used as fertilizer. These fertilizer types can be classified into two groups, organic and chemical. Organic fertilizers are organic matter-containing fertilizers obtained

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from nature and they are various vegetable and animal waste such as compost, livestock manure, green manure. Chemical fertilizers are artificial fertilizers containing one or more nutrients (Demirtaş, 2005).

With the development of the fertilizer industry in the 18th century, chemical fertilizer became increasingly widespread in the world due to its cheap cost and high yield effect. This has caused the loss of ecological balance, especially in agricultural areas (Kincheloe, 1983).

The pesticides and fertilizers used have many negative effects on soil, water, air and living things in the long run (Gültekin and Örgün, 1994). The "organic or ecological agriculture" approach has emerged as a solution to these ongoing problems. Organic agriculture is an agricultural model based on ecological balance in order to restore the natural balance lost as a result of wrong applications in the ecological system. It is a form of production that recommends benefiting from organic and green fertilizing, crop rotation, parasites and predators, aiming to increase soil resistance, increase the quality of the plant and increase the quality of the product in agricultural production (Anonymous, 2011a).

Sources used as organic material are compost and organic wastes, especially the livestock manure. The oldest of these sources is the livestock manure. Organic wastes in terms of the yield potential of the soils and in terms of the amount of nutrients in the organic are the most vital necessities for the soil (Candemir, 2005).

Bat guano is also among these organic wastes. Since bat guano is animal waste, it is content varies according to the region and diet of the bat (Karagöz, 2014). There are 39 species of bats connected to 5 families in Turkey. These species feed only on insects and fruit. For this reason, they prefer forest and agricultural areas for feeding and as shelter (Yorulmaz et al., 2018). The content of bat manure in different regions has been examined and mineral levels have been revealed. In the study, bat guano contents in Adana, Kırklareli, Aydın and Çorum provinces were examined. According to that; nitrogen content ranges between 0.97-5.60%, phosphorus ratio between 1.20-1.50%, potassium ratio between 0.25-0.63 and organic matter ratio between 24-79% (Altıntaş et al., 2005).

In order to increase the productivity of the soil and to ensure sustainable agricultural production, it is necessity to protect the presence of organic matter in the soil. The amount of organic matter in the soil is constantly decreasing by agricultural activities. The organic matter percentage of a large part of Turkey's agricultural soils (86.87%) is less than 3%. However, the organic matter content of 12,13% of the country is more than 3%. Organic matter content of 18.86% of Northeastern Anatolia, including Erzurum, is more than 3%, and the remaining 81.16% is less than 3% (Eyüpoğlu, 1999).

In this study were investigated effects of bat guano on the contents of nitrogen (N), phosphorus (P), potassium (K) of soils and soil reaction (pH) and cation exchange capacity (CEC) which effects using nutrient elements by plants directly.

MATERIAL AND METHOD

The study was carried out in the field of Soil and Water Resources of East Anatolia Agricultural Research Institute (Erzurum) for 24 months, two sesons, during the 2011 and 2013 under field conditions. The soils of the experiment area have medium permeability. It is an irrigated land and has no problem in terms of stoniness, salinity, sodium and erosion (Sevim, 1988). According to Erzurum's 74-year climate data, the average rainfall is 436 mm and the average temperature is 6.0 °C (DMI, 2008).

The bat guano (Agro Hold Inc. TR-26-OG-001) was obtained from an agricultural market. The other material, livestock manure, was suplied from the cattle farm of the Eastern Anatolian Agricultural Research Institute. The properties of these materials were shown in Table 1.

Table 1. Chemical properties of the materials used in the experiment

Parameters	Bat guano	Livestock manure
Organic Matter (%)	67,30	49,70
Total Nitrogen (%)	8,20	1,14
Total P_2O_5 (%)	2,00	0,75
Total K_2O (%)	0,50	0,68
C/N	8-15/1	-
pH	4,00	7,60
Salinity (%)	1,30	2,96

It used a wheat as known *Yildirim* in the study as a test plant. *Yildirim* has been registered by the Eastern Anatolia Agricultural Research Institute. Ears of this variety are white, stringy, grain white, hard and glassy. It has first-class bread quality. It is

recommended for irrigated areas (Anonymous, 2011b).

In the study; bat guano and livestock manure were calculated on the basis of weight and in the same and increasing doses; 0 (control), (1) 500, (2) 1000, (3) 1500 and (4) 2000 kgda^{-1}. The research was carried out under field conditions according to the experiment design of "Randomized Completely Block" (Karaman, 1971; Açıkgöz, 1993). With this system, 9 trials were distributed to the parcels as 3 replications randomly. A total of 27 plots, each having 6 m^2 area were used in the study and all the plots were distributed randomly. The bat guano and livestock manure was mixed to 15 cm depth of the soil. The contents of cation exchange capacity (CEC), macro element (N, P, K) and pH of soils were determined (Bremner and Mulvaney, 1982; Kacar, 2009). Soil samples were taken from the experiment area one week after harvest and their pH, macro element (N, P, K) and cation exchange capacity (CEC) values were determined (Page et al., 1982; Bremner and Mulvaney, 1982; Kacar, 2009).

Statistical analyses

The results obtained from the study were subjected to analysis of variance based on randomized blocks experiment model and LSD multiple comparison test was applied at significance level of P<0,05.

RESULTS AND DISCUSSION

Considering the average values in both seasons of the study, wıth bat guano dose (BG4) an increase at P<0.01 significance level was determined in the macro element (N, P, K) values of the soils (Table 2).

When the averages of both two production seasons during the 2011 and 2013 of the experiment were evaluated, the values of nitrogen (N) of the soils were increased from 0,096% (control) to 0,127% and phosphorus (P) values were increased from 18,93 (control) to 95,92 mg kg^{-1}, while potassium (K) values increased from 334,75 mg kg^{-1} (control) to 546,11 mg kg^{-1} by the highest bat guano application (BG4) (Table 3).

The amount of organic matter in the soil is directly related to the macro Elements that have a great influence on the enzyme activity, salt-water ratio, DNA and RNA of plants (Aktaş, 1995; Kacar, 1984; Güneş et al., 2002). Similar to the results obtained from 25-year study, organic fertilizer was applied to the soil, and it was reported that organic fertilizer has produced a significant increase in the amount of organic carbon and total nitrogen in the soil at the end of the study (Xiying et al., 2003). It has been reported that P and K values increased with organic wastes applied to the soil (Brohi et al., 1994).

Table 2. Result of Analysis of Variance and Effect tests of CEC, N,P,K and pH of soil

Properties		**P**	**SS**	**F**
Nitrogen (N)	Aplication	0,005**	0,011	3,55
	Block	0,137	0,002	2,12
Phosphorus (P)	Aplication	0,00**	39172,65	10,94
	Block	0,019	4050,15	4,52
Potassium (K)	Aplication	0,0005**	226386,81	4,97
	Block	0,2944	14458,91	1,27
CEC	Aplication	0,00**	166,62	6,74
	Block	0,0807	16,76	2,71
pH	Aplication	0,00**	0,24	7,28
	Block	0,147	0,02	2,03

Table 3. Multiple comparisons of soil CEC, N, P, K and pH values according to fertilizer doses

Application	**Doses (kg da^{-1})**	**N (%)**	**P (ppm)**	**K (ppm)**	**CEC (mel/100g)**	**pH**
LM1	500	0,107def	25,68c	411,18bc	38,38bc	7,95c
LM2	1000	0,107cde	27,79c	493,25ab	38,83b	8,06ab
LM3	1500	0,117abc	29,98c	496,82ab	38,85b	8,07ab
LM4	2000	0,119ab	34,91c	515,90a	38,93b	8,10a
K	0	0,096f	18,93c	334,75c	32,33d	7,91c
BG1	500	0,102ef	81,06ab	427,09b	36,58cd	8,05ab
BG2	1000	0,106def	69,50b	486,32ab	37,37bcd	8,00bc
BG3	1500	0,115bcd	69,96b	538,97a	38,84b	8,06ab
BG4	2000	0,127a	95,92a	546,11a	42,03a	8,13a

According to the variance analysis and multiple comparison results, the higest dose of bat guano (BG4) was found to be significantly different (P<0.01) among practice dose applications. In the second year of the experiment, it was determined that the CEC values of the soil showed an increase in P <0.01 significance level (Table 2). When the average values of the two years of the experiment were evaluated, the cation exchange capacity (CEC) values of the soil increased from 35 (control) to 42 mel/100g with 2000 kg.da^{-1} (BG4) application dose of bat guano (Table 3). The increase in CEC values is thought to depend on the organic matter content and pH values of the soil in the experimental area. When the study results were evaluated; the pH of the experimental soils varied between K: 7,91-BG4: 8,13 and according to the results of variance analysis; statistically significant (P< 0,01) differences were found among the applications (Table 2). The highest increase in the pH of the soil was obtained at the highest application dose of bat guano (BG4) (Table 3).

In a study carried out in Orta Gediz Basin (between Turgutlu and Salihli), organic farming and conventional farming practices were compared. As a result of the study, similar to the results obtained from this research, it was stated that the CEC values in the parcels with organic material were significantly higher than the other parcels (Ölgen et al., 2009).

In the study carried out in the western division region of Pala-Mayo, where the effect of chemical fertilizer and bat guano on the yield parameters of two corn varieties was compared. The interactions between chemical (N;P;K) and organic (bat guano) TZEE-W and TB maize growth and yield characteristics and fertilizer were evaluated. Depending on the fertilizer rate applied as a result of the study, the soil has increased the pH values from 5,91 to 7,92. Bat guano application subjects were found to be statistically significant (P <0.01) more than the other applications (Ridine et al., 2014).

In the study in which it was found that soil regulators increase the content of available potassium and organic fertilizers significantly increase the organic matter content, it was also found that organic fertilizers significantly increase the pH, potassium (K) and phosphorus (P) contents of the soil (Özyazici et al., 2010). In a study, increasing doses of different organic materials were used, was reported that all application subjects were effective at P <0.01 level on pH. As the level of application increased, the pH value of soil also increased (Alagöz et al., 2006).

CONCLUSION

It was observed the significant increases in the amaounts of macro nutrient element (N,P,K), CEC and pH values of the soils in which bat guano was applied. Considering the effects of the bat guano on CEC and pH and N, P, K, it will have a positive effect on the improvement of acidic soils and on the availability of nutrients in the soil. Since CEC means the increase of the possibility of plant nutrients to be captured by the plant in the soil. It has a direct impact on the increase of the availability of plant nutrients and so yield will increase in crop production. Thus, bat guano will play an important role in increasing the productivity of the soil, ensuring the sustainability of crop production and at the same time protecting the ecological balance.

With the determination of the soil improvement feature, an alternative product has been added to crop production as new organic material. Depending on the variable input costs in the market today, the costs of bat guano and livestock manure vary. Although the initial investment cost seems more costly than livestock manure, higher yields can be obtained from the same amounts of bat guano. Bat guano looks more economical in both the short and long term, especially for soils with poor organic matter content, such as Anatolian soils, which are not very good in productivity. As seen in this study; 2000 kg.da^{-1} dose of bat guano was more effective than the same dose of livestock manure. Given that a large reserve is also in Turkey will be an important contribution to agricultural practices in the long term.

Statement of Conflict of Interest

Authors have declared no conflict of interest.

Authors' Contributions

In this study, which is a part of the doctoral study; data collection, obtaining and interpretation of the results were done by KKS, consultancy was received from AH as a manager.

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