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Research Paper

Effects of bat guano on some yield parameters of wheat

Kevser Karagöz[1]* and Abdurrahman Hanay[2]

[1]Toprak Gübre ve Su Kaynakları Merkez Araştırma Enstitüsü, Ankara.
[2]Atatürk Üniversitesi, Ziraat Fakültesi, Tarımsal Yapılar ve Sulama Bölümü, Erzurum.

*Corresponding author. E-mail: zmmelekevser@gmail.com.

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ABSTRACT

The use of organic materials has gained great importance in recent years. In terms of sustainability of agricultural production, the effects of two organic materials, bat guano and farmyard manure, on the yield parameters of wheat plant, which is one of the main food sources, were examined in this study. Organic materials were applied at 5 application levels 0 (control), 5, 10, 15 and 20 kg / ha, on weight basis, respectively. The study was carried out in the year, 2011 to 2013 as a field application according in a Completely Randomized Block Design (CRBD) in the trial area of the Eastern Anatolia Agricultural Research Institute, Soil and Water Resources, (Erzurum) Campus. According to the results of the research it was found that bat guano proved to be more effective than farmyard manure by increasing thousand grain weight by 6%, number of spikes in m^2 by 66%, stem yield by 87%, grain yield by 35%, plant height by 8.4% and hectoliter weight by 5%.

Keywords: Bat guano, yield of wheat, organic matter.

INTRODUCTION

It is commonly known that addition on organic materials into soil improves the physical, chemical and biological properties of soil. These materials constitute the contents of organic matter and decomposition products, a nutrient-rich environment for plants without compromising the ecological balance of the soil in the long term. Using artificial fertilizers containing artificial plant nutrients as well as, using organic waste has become increasingly widespread. Thus, during the last century the fertilizer industry developed many production-enhancing synthetic products known as "chemical fertilizers". These must be added before processing the soil, taking into account the amount needed during processing.

Excessive addition of chemical nutrient elements into the soil often has a reducing effect on fertility as well as having an effect in disrupting the natural balance of the soil (Gültekin and Örgün, 1994). It was proved by scientific investigations that excessive chemical fertilization has adverse effects on human health. For instance, chemical fertilization with excessive nitrogen increases in nitrate accumulation in the plant is harmful to human health (Demirtaş, 2005).

The use of chemical fertilizers and pesticides has many negative effects on soil, water, air and consumers. The residue problem, the circulation of the residue by the food chain, and the resistance problem are derivation problems, not so easy to solve (Gültekin and Örgün, 1994). Organic (ecological) farming practices have been developed in recent years based on using chemical fertilizers and agricultural warfare drugs as little as possible or not at all, replacing these with organic fertilizers and biological warfare methods that have the same function in order to eliminate all these negative effects (Anonymous, 2011a).

Organic agriculture is a form of agriculture implementing only the commonly used organic materials which are barn stubble, compost and organic waste. Organic matter takes place among the most important vital necessities of soil in terms of yield and nutritional value. Organic wastes ranging from stallion to tobacco powder and from water algae to tea dregs improve the structure, water and air relationship of soil, meet the nutrient needs of plants as well as functioning to increase the microbiological activity of the soil (Candemir, 2005).

Bat guano is an organic waste discovered in Turkey in

Figure 1: Satellite photograph of the application site at the Eastern Anatolia Agricultural Research Soil Water Campus.

recent years and its effect on plant yield parameters are still under investigation. In this study, the effects of bat enrichment on some yield parameters of wheat plant, which is one of the basic nutrient sources of Turkish people and which occupies an important place in the economy of the region and the whole country, were investigated.

MATERIALS AND METHODS

Soil and climate properties of the application area

This research was conducted between the years on 2011 to 2013 in land conditions in the application area of the Erzurum Eastern Anatolia Agricultural Research Institute, Soil and Water Resources Campus. Figure 1 shows Satellite photograph of the application site at the Eastern Anatolia Agricultural Research Soil Water Campus.

The application area has a medium permeable. The land is problem-free in terms of stoniness, salinity, sodium-content and erosion (Sevim, 1988). Continental climate type as the characteristic feature of the Eastern Anatolia Region dominates in Erzurum Plain. Winters are very cold and long, summers are hot, dry and short in this vicinity. According to the 74-year climate data of Erzurum, average rainfall is 436 mm with the maximum rainfall in May and minimum in August. The average temperature is 6.0°C with August as the warmest month and December as the coldest. The annual evaporation is 987 mm, the average relative humidity is 64%, and the average number of snow covered days is 112 days (DMI-Meteorological Services of Turkey, 2007). The soil body is loamy (SCL) and its organic matter content is 1.71%, while useful water capacity (UWC) is 7%.

Organic material characteristics used in the research

One of the two organic materials used in the research, bat guano that was obtained from the caves located in the region of Province of Hatay, was purchased from the market as a commercial product registered under the trade mark approval code TR-26-OG-001 and farmyard manure, while the other organic material was obtained from the farm of the Eastern Anatolia Agricultural Research Institute (Erzurum). Table 1 show the characteristics of bat guano and farmyard manure used in the study.

Test plant

Yıldırım, wheat plant registered by Eastern Anatolia Agricultural Research Institute, was used in the research. Yıldırım is a white and spiky kind of bread wheat (Anonymous, 2011b).

Method

Application methods and doses of fertilizers

Application doses of fertilizers were calculated and these fertilizers were spread on the plots and thereafter mixed with rotary machine to the 15 cm depth of soil (Table 2). After the land surface was leveled with a disc plow, the

Table 1: Characteristics of the bat guano* and the farmyard manure.

Parameters	Bat guano	Farmyard manure
Cadmium (mg/kg)	1.4	-
Copper (mg/kg)	217.6	-
Nickel (mg/kg)	23,4	-
Lead (mg/kg)	1,7	-
Zink (mg/kg)	704	-
Chromium (mg/kg)	12,2	-
Tin (mg/kg)	2,1	-
Total organic material (%)	67,3	49,7
Humidity (%)	14,7	-
Total Nitrogen (%)	8.2	1,14
Organic Nitrogen (%)	7.4	-
Total P_2O_5 (%)	2	0,75
Total K_2O (%)	0.5	0,68
Total ($N+P_2O_5$)	10.2	2
pH	4.0	7,60
Salinity (%)	1,3	2,96

*DÜZEN NORWEST (Environment, Food and Health Services Education Consulting Trade Co.).

Table 2: Application doses and abbreviations of organic materials used in the application.

Dose (kg/da)	Applications	
	BG (Bat Guano)	FM (Farmyard manure)
0	Control	
500	1	-
1000	2	-
1500	3	-
2000	4	-

seeder was regulated to 200 kg ha^{-1} seed density and winter wheat seeding was made allowing 12.5 cm for row width and 5 cm above rows (Anonymous, 2011c) and the drip irrigation system was set up in the application area. After these operations, neutron pipes were pushed into the depth of 1 m in the middle of each plot (Sevim, 1988) and humidity measurements were followed up throughout the application period with a neutron meter.

Yield parameters examined in the wheat plant are: 1) Thousand grain weight (g).2) Stem yield (kg ha^{-1}); 3) Grain yield (kg ha^{-1}); 4) Plant height and 5) Hectoliter weight.

The amount of irrigation water was calculated taking into account the field capacity (fc) and wilting point (wp) values of soil and was performed at phenological periods. In the first period of the application (2011 to 2012), the missing moisture in the 0 to 60 cm soil profile for the first irrigation was determined as 112 mm and the first irrigation was done on October 7, 2011. The second irrigation was made on June, 1st 2012 in the stalking period with the amount of water to compensate soil to the field capacity as 117 mm. Third irrigation on June, 15th 2012 at the earing period with 125 mm. The fourth irrigation was made on July, 6th 2012 at the milk deposition period with 132 mm and the soil depth of 0 to 90 cm was raised to field capacity. Harvest in the first period of the application was performed on 07 August, 2012.

During the second period of the application (2012 to 2013), the weeds were plucked out, the land was raked and the surface of the soil smoothened with rotary machines. A seed bed at a depth of 2.5 cm was prepared with a seeder, and winter wheat seeding was made on September, 18th 2012 according to the sowing norms of 20 kg / da allowing 12.5 cm between rows and 5 cm above rows.

In the second period of the application (2012 to 2013), the first irrigation was made on September, 20th 2012 as 100 mm. The second irrigation was made on June, 3rd 2013 in the stalking period as 126 mm. The third irrigation was made at the earing period as 132 mm. The last irrigation was made on July, 6th 2013 at the milk deposition period as126 mm and the soil depth of 0 to 90 cm raised to field

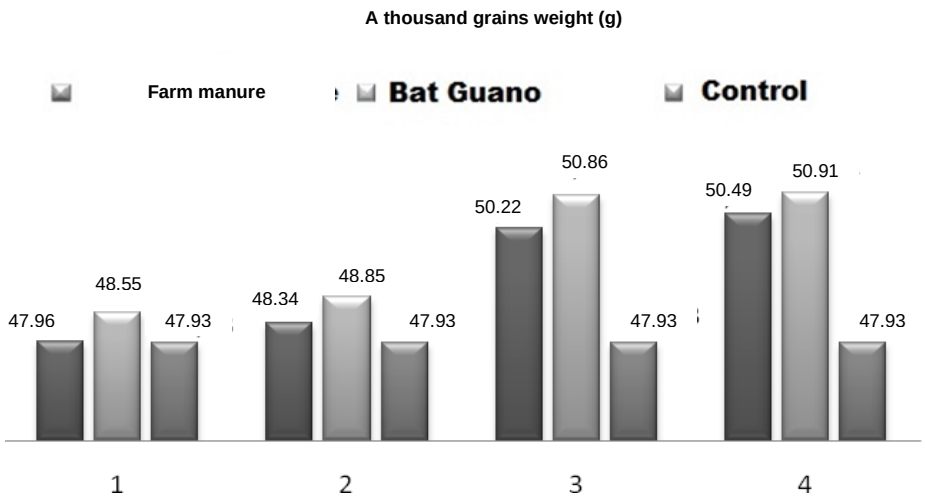

Figure 2: Distribution diagram of two-year average of one thousand grains in wheat.

capacity.

RESULTS

A thousand grain weight

When the average of the two years of the application was evaluated, it was seen that the values of one thousand grain weight in wheat increased from 48 (control) to 52 g (control) with the 20 kg ha^{-1} application dose (BG4) by bat guano application (Figure 2).

The ANNOVA results indicated that there were significantly differences among treatments and the 20 kg ha^{-1} application dose (BG4) of bat guano was found to be significantly different at the P <0.01 significance level. In the second year of the application, it was observed that the one thousand grain weight value in wheat showed an increase in P <0.01 significance level. Figure 2 shows the effect of applied organic materials on one thousand grain.

Grain yield

When the averages of the two-years of the application were evaluated, it was observed that the yield values in wheat increased from 740 (control)kg/da to 998 kg / da with 20 kg ha^{-1} application dose (BG4) (Figure 2). The equivalent dose of farmyard manure (FM) raised to 9.36 kg ha^{-1}. The 20 kg ha^{-1} application dose (BG4) of Bat Guano was found to be statistically different at the P<0.01 significance level among the applications. In the second year of the application, the grain yield values of wheat grain were found to increase at P <0.01 significance level. in Figure 3 shows the effects of the organic materials applied in the application on the grain yield values according to the application doses as compared.

In a study regarding the increase in plant yield conducted in Cambodia, it was stated that application of bat guano on different region-specific plants increased plant growth at a P <0.01 significant level. When bat guano was compared with chemical fertilizers, it was reported that bat guano was the application having the most important differences and that it produced higher growth rates in all plants (Sothearen et al., 2014).

Stem yield

According to the average of the two years of the application, the stem yield values of wheat increased from 38.29 (control) to 71.80 kg / da with the 20 kg ha^{-1} application dose (BG4) of Bat Guano (Figure 3). According to the results obtained through variance analysis and multiple comparison, the 200 kg/da application dose (BG4) of bat guano among the applications was found to be significantly different at the P <0.01 significance level. In the second year of the application, stem yield values of wheat were found to increase at a significant level of P <0.01. Figure 4 shows the effects of the organic materials applied in the application on the stem yield values according to the application doses as compared.

Plant height

Upon the evaluation of the average of the two years of the application, it was observed that the height values, which is an important parameter in wheat yield, increased from 90 (control) to 103 cm with 20 kg ha^{-1} application dose (BG4) of bat guano. According to the results obtained through variance analysis and multiple comparison, the 20 kg ha^{-1} application dose (BG4) of bat guano among the applications was found to be significantly different at the P <0.05 significant level. In the second year of the application, height values of wheat were found to increase at a

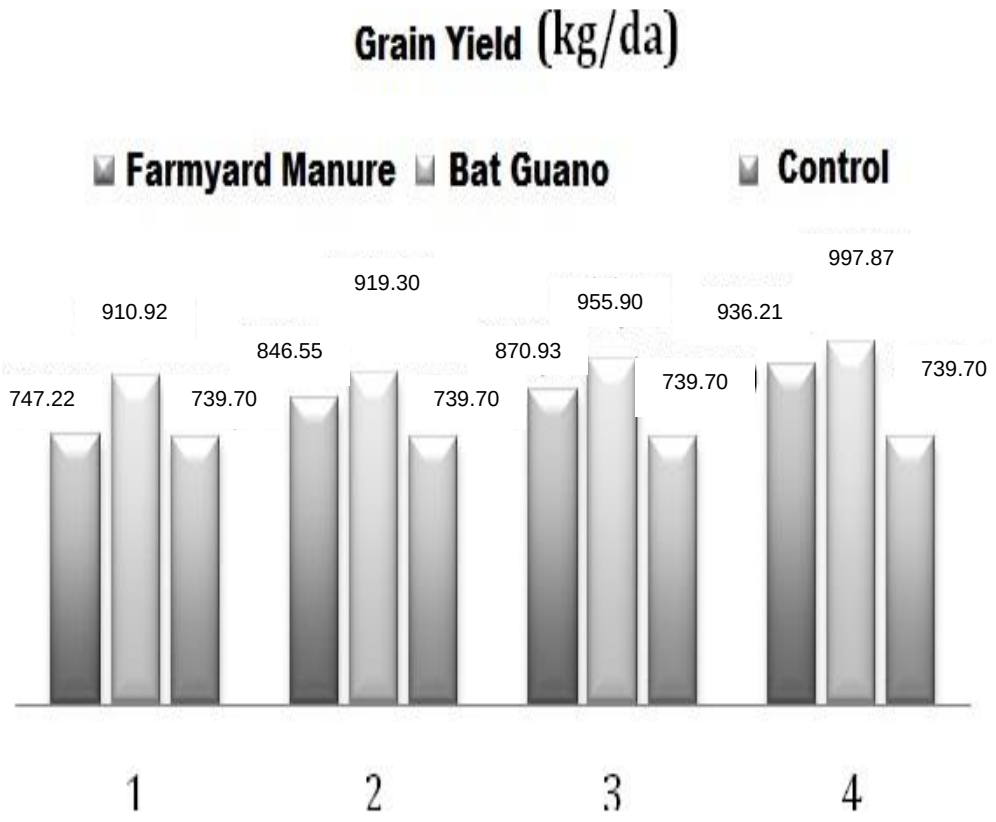

Figure 3: The two-year average distribution diagram of grain yield values iof wheat.

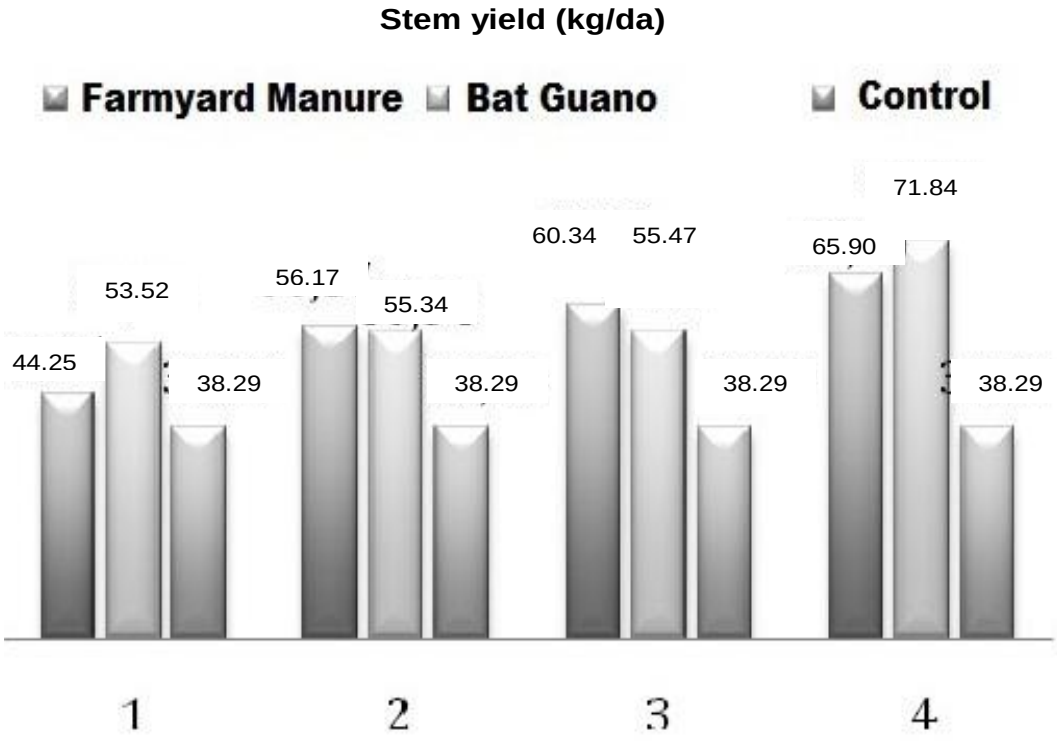

Figure 4: Two-year average distribution diagram of stem yield values of wheat.

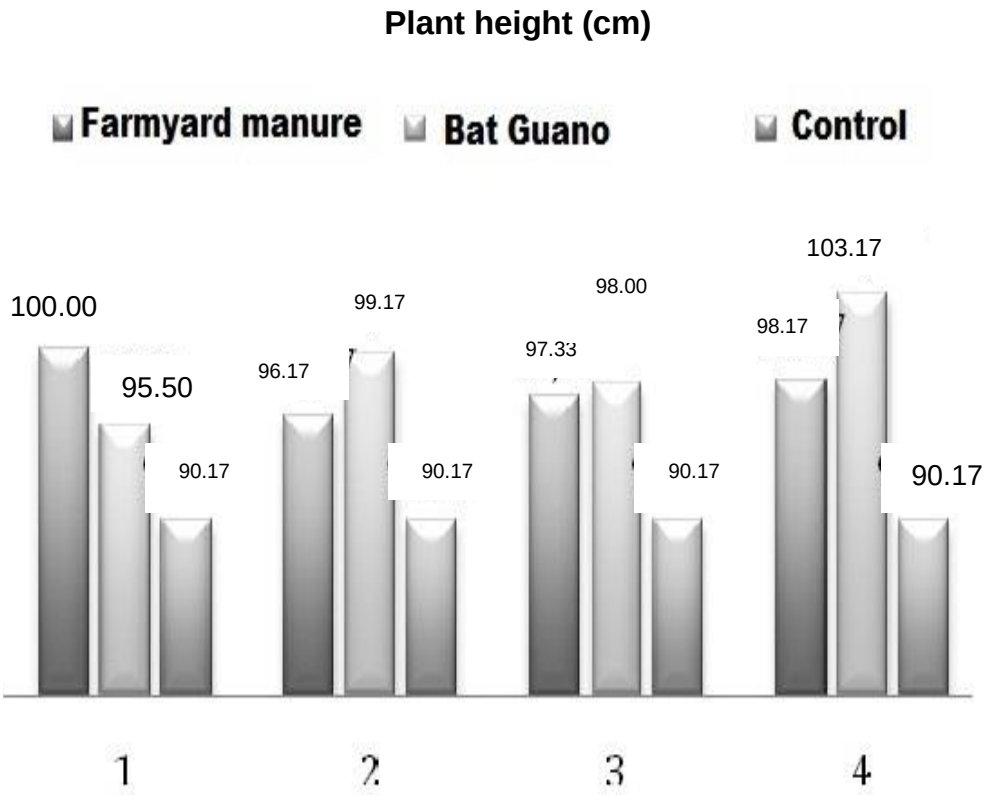

Figure 5: Two-year average distribution diagram of plant height values of wheat.

significant level of P <0.01.

Similar to the present study, conducted to investigate the increase in wheat yield occurring according to increasing doses of bat guano, it was found that bat guano significantly increased the yield as compared to chemical fertilizers and control applications (Ridine et al., 2014). Figure 5 show the effects of the organic materials applied in the application on the stem height values according to the application doses were compared.

Hectoliter weight

Upon the evaluation of the average of the two years of the application, it was observed that the height values, which is an important parameter in wheat yield, increased from 80 (control) to 84 cm with 20 kg ha^{-1} application dose (BG4) of bat guano (Figure 6). According to the results obtained through variance analysis and multiple comparisons, no significant difference was found among the applications and it was observed that in the second year of the application, the hectoliter values of wheat increased at a significance level of P<0.01.

It was reported that the hectoliter weight of wheat being high meant that protein and flour yield were high and that hectoliter weight showed differences depending on species and kind of the plant, applications, and technological conditions. (Çelik et al., 1996). in Fig. 6, The effects of the organic materials applied in the application on the hectoliter values according to the application doses were compared.

DISCUSSION

In the study, bat guano and farmyard manure were applied at four application levels 0, 5, 10, 15 and 20 kg ha^{-1}, respectively. According to the results obtained from the study, it was observed that the highest application dose of bat guano 20 kg ha^{-1} had more positive effects on the yield parameters of wheat plant than the farmyard manure. It was observed that 20 kg ha^{-1} application dose increased the one thousand grain weight by 6%, stem yield by 87%, grain yield by 35%, plant height by 8.4%, and hectoliter weight by 5%. Thus, it proved to be more effective than farmyard manure.

In the study, it was observed that bat guano had more positive effects on the yield parameters of wheat plants than conventional method (farmyard manure). Significant increases were observed in the yield parameters of the wheat plant (P <0.05).

According to the results obtained from this research, bat guano, a new material for Turkish agriculture, can be used as an alternative organic material to farmyard manure to

increase crop yield in agricultural production.

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