Effects of Bat (*Hipposideros Pomona* Andersen, 1918) Guano in Compare with Cowdung on the Growth and Yield of Tomato Plant (*Solanum lycopersicum*(L.)) in Magway

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Abstract

Fertilizer applications were critical to crop production and food security in Myanmar. While organic farms are mostly used livestock manure, compost and bat guano are widely applied. There were no records concerned with the efficacy of bat guano compare with cowdung on some cultivated plants in Magway. Therefore, the present study was carried out within the specific area from January, 2020 to August, 2020. This was tested twice in four- month crops of two economically important plant, tomato (*Solanum lycopersicum*(L.)). Five treatments were employed in the trial: a control (T_0 treatment), 100% bat guano (T_1 treatment), 50% bat guano + 50% soil (T_2 treatment), 100% cowdung (T_3 treatment), and 50% cowdung + 50% soil (T_4 treatment). Results indicated that bat guano applications enhance in plant growth compared to control, all plants in guano treatment exhibited greater growth rates. In the first and second time experiments of tomato plants, the maximum plant height, number of leaves, number of branches, length of leaves, breadth of leaves, number of buds and flowers ,number of fruits and weight of fruits were found more in T_2 treatment than those of other treatments, (T_0, T_1, T_3 and T_4). Additional trails are recommended to elucidate any longer term and cumulative benefit that might accrue from the use of bat guano as a plant fertilizer.

Key word: Bat guano, cowdung, effect, growth and tomato plant.

Introduction

Bat guano is the excrement produced by cave- dwelling bats and can be used as an organic fertilizer. Bat guano is a very rich fertilizer due to its high content of carbon and three vital primary macronutrients: nitrogen, phosphorus and potassium (N-P- K). The use of bat guano in cultivation positively affects plant growth (Thi Sothearen *et al*., 2014). Bat guano is considered to be a rich organic fertilizer and offers significant economic benefits (Mehedi *et al*., 2012).

Cow manure fertilizer makes an excellent growing medium for garden plants. The use of cattle manure or cowdung in the garden is a popular practice in many rural areas. Cowdung contains three (nitrogen, phosphorus and potassium) of the most important nutrients that plants need for their healthy growth (Ajay alias Mangtu Ram, 2017).

Natural soil plays a major role in the process, a transfer of energy in plants. Farmers tend to apply soil amendments that are rich in nutrient, i.e., NPK to enhance soil fertility and increase crop productivity (Ahmad *et al.*, 2016).

Tomato plants are one of the most widely grown vegetables in the world due to its high production and consumption volumes. A tomato is also an important vegetable crop of high utility in daily meals in Myanmar. All over the world, it is part of a healthy diet because it contains calcium and vitamin K which helps maintain strong bones. It also contain vitamin B and potassium which helps reduce cholesterol levels and lowers blood pressure. Lycopene, an anti-oxidant that is popular known to fight against cancerous cell formation, is also found in tomatoes (Bhowmik *et al*., 2012).

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There is limited scientific research in Magway Region to study the growth of plant using different natural fertilizer although Magway is large producing area of agricultural commodities. The present study was carried out the effects of bat guano and cow dung using on the growth and yield of tomato plants.

- to assess the effectiveness of three treatments of bat guano, cowdung and control on tomato plants.

Materials and Methods

Study site

The present study was carried out in Zay-Lai-Soe quarter, in Magway. Geographically, the experimental site is located at latitude 20°08′ 56.20″ N, longitude 94°55′20.35″E (Fig. 1).

Source: from Google Earth, 2020

Fig.1 Location map of the study site

Study period

The experiment was carried out during January, 2020 to August, 2020.

Sources of fertilizers

The *Hipposideros pomona* Andersen, 1918 guano were obtained from Thitsar-Man-Taing monastery cave, Kant-Kaw-Ta-Htaung Pagoda, in Magway. Cowdung was obtained from Kyauk-Tan village, Minbu Township respectively (Plate. 1).

Experimented plants

The seedlings of tomato were purchased from Kyauk-Tan village, Minbu Township (Plate. 1).

Experimental design and treatments

The experimental soil (450 ft^2) was ploughed on flat at 6 inches depth. Plots were delimitated using fragments of small wood. An experimental unit was a $1m^2$ plot, comprising 10 lines separated 0.8 m apart. Planting lines were oriented toward plot's slope to avoid leaching.

Each of the following five plants treatment was applied two replication times; T_0 control, (400 g), T_1 with 100% bat guano (51 g), T_2 with 50% bat guano (25.5 g) + 50% soil

(200 g), T_3 with 100% cow dung (90 g), T_4 with 50% cowdung (45 g) +50% soil (200 g). Five plants were cultivated from each unit plot.

Analysis on guano, cowdung and soil

Before growing the plants, guano, cowdung and soil were analyzed at University of Research Center in Yangon.

Data collection

Growth parameters (height of the plant, number of buds per plant and flowers per plant) and yield (number of fruits and weight of the fruits) were collected from all the plants in each plot. The experiment was performed two replications every four months. In each replication same amount of guano and cowdung were applied as describe in above.

Plant height

Plant height was measured from the sample plants in centimeter from the ground level to the tip of the longest stem and mean value was calculated. Plant height was recorded every 14 days of planting up to 112 days to observe the growth rate of the plants. Mean value of the five plants were calculated for each unit plot and expressed in centimeter (cm).

Number of leaves

In each replication mean value of the five leaves from the five selected plants was calculated in each unit plot. The total number of leaves per plant were counted every 14 days of planting up to 112 days to observe number of leaves, length of leaves and breadth of leaves.

Number of buds and flowers

The number of buds and flowers were counted from the five sample plants periodically during flowering season. Average number of flowers and buds were recorded. Mean value of the buds and flowers of five selected plants were calculated in each unit plot.

Number of fruits

The number of fruits per plant were recorded from the five sample plants. Number of leaves, buds, flowers and fruits were recorded for two replications.

Fruit length

The length of fruit was measured with a measuring tape and 25 fruits (five fruit per plant) of marketable size fruits were selected from each plot and their average was calculated in centimeter (cm).

Fruit diameter

A total of five fruits from selected five plants were randomly collected to measure the diameter of fruits using measuring tapes; i.e. 25 fruits were measured in each plots. The weight of the fruits were also noted.

Data analysis

Statistical analysis of the data was carried out using microsoft excel.

Results

Analysis of chemical parameters in tested bat guano, cowdung and soil

The result recorded in Table 1 shows that the bat guano composition was made up of phosphorus(P)(11.663%), iron (Fe) (15.892%), calcium (Ca)(13.668%), sulfur(S) (8.478%)

and slightly copper(Cu) (0.373%) and with a total potassium(K)content of 25.543% respectively . Nitrogen(N) content was not observed in bat guano.

The cowdung used for the experiment contains phosphorus (P)(3.111%), potassium(K)(11.933%), iron (Fe) (16.380%),calcium(Ca)(47.925%), sulfur(S) (2.351%) and slightly content copper (Cu)(0.318%). Nitrogen (N) content was not found in cowdung.The soil composition was made up of phosphorus (P) (10.202%) and iron (Fe) (11.651%), calcium (Ca)andcopper (Cu) contents were very low and tested at 4.6630%and 0.046% respectively. In soil, nitrogen (N) and phosphorus (P) content was not included (Table.1 and fig. 2).

The effect of bat guano, cowdung and control (soil) on tomato plant height and number of branches

Plant performances in first crop

The plant height was recorded from every 14 days of planting up to 112days.The maximum plant height was found in T_2 treatment (252.55cm) which was similar to T_0 treatment (243.12cm) and T_3 treatment (202.37cm). The minimum plant height was observed in T_4 treatment (176.50cm) which was similar to T_1 treatment (195.02cm).

The maximum number of branches (64.00) was found in T_2 treatment which was similar to T_0 treatment (62.25), followed by T_4 treatment (52.00) and T_3 treatment (51.00) respectively. The manimum number of branches was found in T_1 treatment (46.00) (Table.2).

Plant performances in second crop

The maximum plant height (74.08cm) observed in T_2 treatment followed by T_1 treatment (64.58cm) which was followed to T_4 treatment (61.50cm). The minimum plant height was derived from T_0 treatment (58.33cm) which was similar to T_3 treatment (59.58cm).

The maximum number of branches (13.83) was observed in T_2 treatment which was identical to T_4 treatment (13.66), T_1 treatment (12.83) and T_3 treatment (11.25) respectively. The minimum number of branches was found in T_0 treatment (10.25) (Table.2).

The effect of bat guano, cowdung and control (soil) on tomato plant number of leaves, length of leaves and breath of leaves

Plant performances in first crop

The maximum numbers of leaves (65.25) was found in T_2 treatment and the minimum numbers of leaves (49.25) at T_1 treatment and T_o treatment (58.25) which is identical with T_3 treatment (53.00) and T_4 treatment(54.75).

The maximum length of leaves (166.00cm) was found in the T_2 treatment which was identical to T_0 treatment (165.62cm). The minimum length of leaves (133.32cm) was observed in T_3 treatment which was identical to T_4 treatment (134.82cm) and T_1 treatment (138.75cm).

The maximum breadth of leaves (92.15cm) was observed inT_2 treatment which is identical with T_0 treatment (90.97cm) and the minimum breadth of leaves (73.37cm) was found from T_3 treatment which was identical with T_1 treatment (75.45cm) and T_4 treatment (75.47cm) respectively (Table.3).

Plant performances in second crop

The maximum number of leaves was found in the case of T_2 treatment (11.0) while T_0 treatment (10.83), T_1 treatment (10.83) and T_4 treatment (10.88) were identical. The minimum number of leaves was observed in T_3 treatment (9.83).

The maximum length of leaves was observed in T_2 treatment (42.33cm) and T_0 treatment (37.13cm) and T_1 treatment (35.31cm) were identical. The minimum length of leaves was observed in (26.0 6cm) T_3 treatment while T_4 treatment (29.26 cm) was identical. The maximum breadth of leaves was found in T_2 (20.13cm) while T_1 treatment (18.51cm), T_3 treatment (18.35cm) and T_4 treatment (18.48cm) was observed identical. The minimum breadth of leaves was found in T_0 treatment (17.0 cm) (Table 3).

The effect of bat guano, cowdung and control (soil) on tomato plant number of buds and flowers

Plant performances in first crop

The maximum number of buds (199.66) was observed in T_2 treatment which was similar to T_3 treatment (147.33), T_0 treatment (126.00) and T_4 treatment (117.66) respectively. The minimum number of buds were found in T_1 treatment (88.66).

The maximum number of flowers (163.00) was derived from T_2 treatment which was identical to T_3 treatment (137.00), followed by T_0 treatment (93.00) and T_1 treatment (81.00). The minimum number of flowers found in T_4 treatment (62.00) (Table.4).

Plant performances in second crop

The maximum number of buds are found in T_2 treatment (50.33) followed by T_1 treatment (40.80), T_4 treatment (38.00), and T_3 treatment (37.66) respectively. The minimum number of buds was observed in T_0 treatment (25.00).

The maximum number of flowers are derived from T_2 treatment (40.20), followed by T_1 treatment (35.20). The minimum number of flowers were found in T_0 treatment (17.40) while T_3 treatment was observed in (29.50) which are similar to T_4 treatment (29.20) (Table 4).

The effect of bat guano, cowdung and control (soil) on tomato plant number of fruits, weight of fruits, length of fruits and girth of fruits

Plant performances in first crop

The maximum number of fruit was found in T_2 treatment (139.14) followed by T_1 treatment (75.50), T_3 treatment (69.52), and T_4 treatment (55.00) while the minimum number of fruit was derived from T_0 treatment (45.05).

The maximum weight of fruits was collected from T_2 treatment (1006.50g) followed by T_4 treatment (794.00g) which was similar to T_3 treatment (729.50g) and T_1 treatment (712.50 g) the minimum fruit weight was observed in T_0 treatment (562.00 g).

The maximum length of fruits (32.80cm) was found from T_2 treatment which was similar to T_1 treatment (31.65cm) followed by T_3 treatment (28.85cm). The minimum length of fruit (26.50cm) was collected from T_0 treatment which was similar to T_4 treatment (26.90cm).

The maximum girth of fruit was recorded by T_2 treatment (81.50cm) followed by T_1 treatment (76.00cm), T_4 treatment (71.00cm) and T_3 treatment (71.30cm). The minimum girth of fruit was observed by T_0 treatment (65.00cm)(Table.5).

Plant performances in second crop

The maximum number of fruits (35.00) was collected from T_2 treatment followed by T_1 treatment (29.33) which was similar to T_4 treatment (27.00) and T_3 treatment (23.00) respectively. The minimum number of fruits was found in T_0 treatment (15.33).

The maximum weight of fruits was observed in T_2 treatment (286.50g) which was identical to T_1 treatment (251.00 g) and T_4 treatment (239.00 g). The minimum fruits weight was collected from T_0 treatment (117.50g) which was similar to T_3 treatment (193.50g).

The maximum length of fruits (8.05cm) was recorded from T_2 treatment followed by T_1 treatment (7.20cm) which was identical to T_4 treatment (7.10cm). The minimum length of fruits was found in T_3 treatment (6.40cm) which was similar to T_0 treatment (6.25cm).

The maximum girth of fruits was collected from T_2 treatment (14.50cm) which was identical to T_4 treatment (13.25cm) followed by T_1 treatment (12.50cm) and T_3 treatment (12.10cm). The minimum girth of fruit was observed in T_0 treatment (11.25cm) (Table 5).

Table .1 Analysis of nutrients in tested organic fertilizers

No.	Analytical Item	Unit	Bat guano	Cowdung	Natural soil
1	Total N	%	-	-	-
2	Total P	%	11.663	3.111	-
3	Total K	%	25.543	11.933	10.202
4	Total Fe	%	15.892	16.380	11.651
5	Total Ca	%	13.668	47.925	4.660
6	Total Cu	%	0.373	0.318	0.046
7	Total S	%	8.478	2.351	-

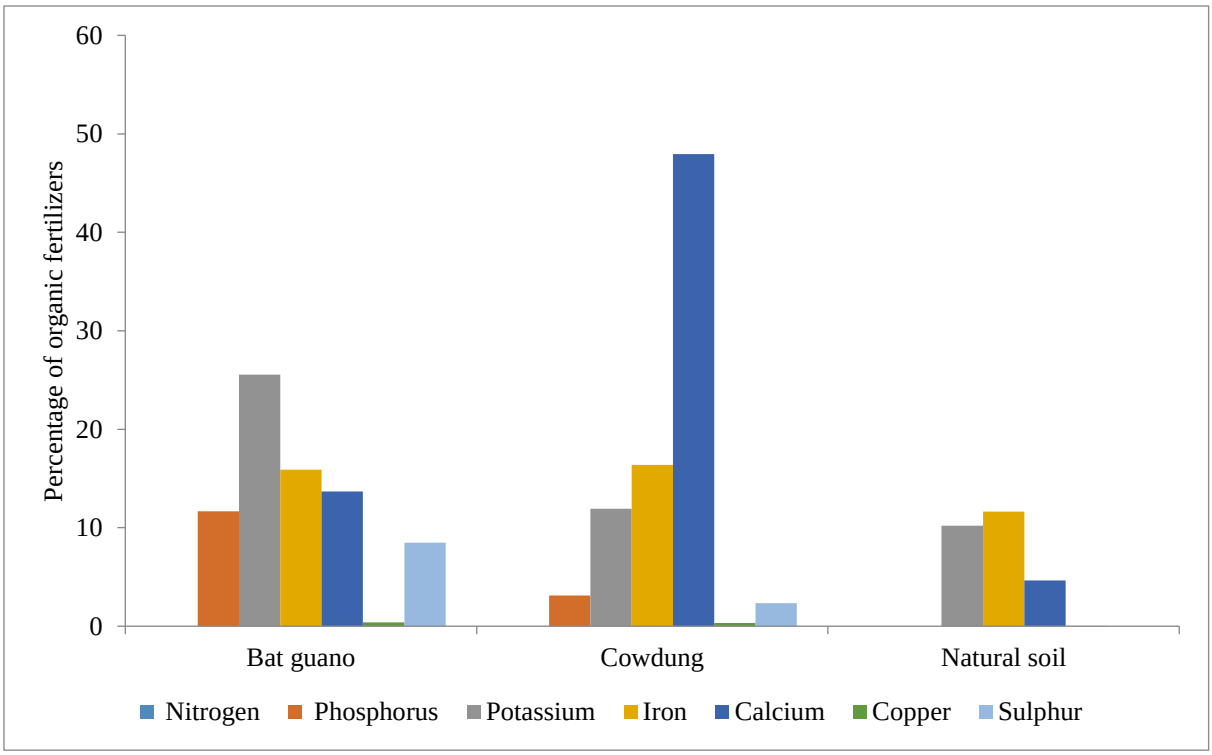

Fig. 2 Analysis of nutrients in tested organic fertilizers

Table 2 The effect of guano, cowdung and control (soil) on tomato plant height and number of branches

Treatment	Number of plants	Plant performances in first crop		Plant performances in second crop	
		Plant height(cm) (Mean±SD)	Number of branches (Mean±SD)	Plant height(cm) (Mean±SD)	Number of branches (Mean±SD)
T_0	5	243.12±147.55	62.25 ±17.69	58.33 ± 20.36	10.25 ±4.34
T_1	5	195.02±151.22	46.00 ±11.22	64.58 ±23.63	12.83 ±5.24
T_2	5	252.55 ±147.99	64.00 ±25.49	74.08 ±23.86	13.83 ± 6.25
T_3	5	202.37 ± 139.14	51.00 ± 14.88	59.58 ±15.82	11.25 ± 4.46
T_4	5	176.50 ± 84.55	52.00 ±10.55	61.50 ± 20.81	13.66 ± 7.03

Table 3 The effect of guano, cowdung and control (soil) on tomato plant (number of leaves, length of leaves and breadth of leaves)

Treatment	Number of plants	Plant performances in first crop			Plant performances in second crop		
		Number of leaves (Mean±SD)	Length of leaves (cm) (Mean±SD)	Breadth of Leaves (cm) (Mean±SD)	Number of leaves (Mean±SD)	Length of leaves (Mean±SD)	Breadth of leaves (Mean±SD)
T_0	5	58.25 ± 9.41	165.62±51.69	90.97 ± 29.46	10.83 ±4.31	37.13±13.32	17.0 0±7.03
T_1	5	49.25 ±13.79	138.75±59.71	75.45 ± 33.57	10.83 ±4.01	35.31±10.14	18.51 ±7.20
T_2	5	65.25 ±13.30	166.00±52.26	92.15 ±29.77	11.00±4.20	42.33±16.98	20.13 ±6.68
T_3	5	53.00 ±13.83	133.32 ± 42.72	73.37 ±24.65	9.83 ± 3.93	26.06 ±6.23	18.35 ±6.22
T_4	5	54.75 ± 8.01	134.82 ± 31.47	75.47 ±21.02	10.88 ±3.54	29.26 ±6.60	18.48 ±5.65

Table 4 The effect of guano, cowdung and control (soil) on tomato plant number of buds and flowers

Treatment	Number of plants	Plant performances in first crop		Plant performances in second crop	
		Number of buds (Mean±SD)	Number of flowers (Mean±SD)	Number of buds (Mean±SD)	Number of flowers (Mean±SD)
T_0	5	126.00±69.41	93.00 ±61.00	25.00 ± 3.79	17.40 ± 0.80
T_1	5	88.66 ± 56.34	81.00 ±61.00	40.80 ± 1.91	35.20 ±6.93
T_2	5	199.66 ± 92.83	163.00 ±109.93	50.33 ± 4.64	40.20 ± 4.00
T_3	5	147.33 ±96.24	137.00 ±101.03	37.66± 6.01	29.50 ± 4.71
T_4	5	117.66 ± 56.40	62.00 ± 42.16	38.00 ± 11.28	29.20 ± 3.65

Table 5 The effect of guano, cowdung and control (soil) on tomato plant number of fruits, length of fruits, girth of fruits and weight of fruits

Treat-ment	Number of plants	Plant performances in first crop				Plant performances in second crop			
		Number of fruits (Mean±SD)	Length of fruits(cm) (Mean±SD)	Girth of fruits(cm) (Mean±SD)	Weight of fruits(g) (Mean±SD)	Number of fruits (Mean±SD)	Length of fruits(cm) (Mean±SD)	Girth of fruits(cm) (Mean±SD)	Weight of fruits(g) (Mean±SD)
T_0	5	45.05 ±2.21	26.50 ±1.00	65.00 ± 5.00	562.00 ± 38.00	15.33 ± 0.50	6.25 ±0.25	11.25 ± 0.25	117.50 ± 5.20
T_1	5	75.50± 15.50	31.65 ±0.35	76.00 ± 0.50	712.50 ± 32.50	29.33 ± 2.49	7.20± 0.10	12.50 ±0.50	251.00± 2.00
T_2	5	139.14 ± 19.57	32.80 ± 0.60	81.50 ±1.00	1006.50±48.00	35.00 ±10.67	8.05 ±0.25	14.50 ±0.50	286.50 ±6.50
T_3	5	69.52 ±2.50	28.85 ±2.35	71.3 0±1.20	729.50± 38.50	23.00 ± 0.81	6.4 0 ± 0.10	12.1 0 ±0.10	193.5 0±5.50
T_4	5	55.0 0 ±1.50	26.9 0 ±1.40	71.00 ±1.50	794.0 0± 36.00	27.00 ±9.20	7.1 0 ± 0.20	13.25 ±0.25	239.0 0±5.00

A. T_0 treatment (control) | B. T_1 treatment (100% bat guano) | C. T_2 treatment (50%bat guano)

D. T_3 treatment (100% cowdung) | E. T_4 treatment (50%cowdung)

Plate 1 Cultivation of tomato plants using guano, cowdung and control

Discussion

In the present study, application of T_2 treatment (50% bat guano+50% soil) enhances growth of tomato plants. Tomato plants growth increases in two replication results of plant height (252.55cm and 74.08cm).The findings of this study are consistent with the study by Shetty, *et al.* (2013) in India who reported that the effect of bat guano on the growth of plant height and branches. Choudhary and Kumar (2013) also mentioned that tomato plant treated with organic fertilizer showed more (height, branches) than other fertilizer treated plants. Therefore the present result agrees to Shetty, *et al*. (2013) and Choudhary and Kumar, (2013).

Elamin and Elagib (2001) reported the significant differences between bat guano and other manure. In two replication results, the maximum number of leaves were (65.25) and (11.00), length of leaves,were (166.00cm) and (42.33cm), breadth of leaves,were (92.15cm) and (20.13cm) respectively by T_2 treatment. Therefore this result agrees to above authors.

Akande *et al*., 2006 reported that the application of organic manure increases the nutrient status of the soil and yield of tomato in the tropics. NPK fertilizer synthesizes phosphorus that was a component of nucleic acid. It helps in the production of large number of blossoms in the early growth of tomatoes and early setting of fruits and seeds. Khan (2014) who reported that bat guano stimulated buds and flowers, increasing the number and biomass of the flowers produced in tomato plant. In the present study, number of buds and flowers showed statistically variation due to the application of different organic sources of nutrients. In two replication experiments, the higher number of buds and flowers were found in T_2

treatment.T_2 treatment increased the number of flowers and buds than other treatments.So, the present finding agrees with the reports of previous researchers.

Ullah *et al*. (2008) found the higher number of fruit per plant from the treatment combination bat guano. Bat guano and other recommended doses of fertilizers helps to proper growth of plants. As a result, number of fruit plants increased in this combination. Chanda (2011) also suggested that the higher number of fruits per plant from bat guano supplemented with NPK treated plots. Thi Sothearen *et al*. (2014) reported that the bat guano produces the higher number of fruits per plant than other fertilizer. Number of fruits of tomato showed differences from the application of bat guano and cowdung fertilizers. In two replication results, the maximum number of fruits were observed in T_2 treatment (139.14and 35.00) and weight of fruits (1006.50g and 286.50g) respectively. Therefore, the results of present study are in agreement with the findings of above authors.

In tomato plants, T_2 treatment was found as the best fertilizer for tomatoes. Two experiments were performed to confirm the results and in both cases, T_2 treatment was found to be optimal. Therefore, using T_2 treatment in tomato cultivation can be beneficial for crop growers.+

Conclusion

The results obtained from tomato plants were responded well to the application of compared to bat guano, cowdung and control treatment in the study. Application of bat guano had a significant effect on plant height, number of branches, number of leaves, length of leaves, breadth of leaves, number of buds, number of flowers, number of fruits, length of fruits, girth of fruit and weight of fruits per plant.

In this experiment, T_2 treatment containing bat guano 50% and natural soil 50% showed better at tomato plant height, number of branches, number of leaves, length of leaves, breadth of leaves, number of buds, number of flowers, number of fruits, length of fruits, girth of fruits and weight of fruits. According to these experimental cultivates, it is best for the tomato plant to grow with 50% bat guano.

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