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EVALUATION OF THE EFFECTS OF ORGANIC AND INORGANIC FERTILIZERS ON *CAPSICUM ANNUUM* L.

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ABSTRACT

Capsicum annuum L. is also known as the universal spice of India since it is grown in many regions of the country. It has high commercial value because of its two principle characteristics such as pungency and color due to the chemical constituents like Capsaicin and Capsanthin respectively. Balanced nutrients are mandatory for better quality and quantity of the chilli crop production. In the present study, plant of Capsicum annuum L. was treated with four different organic and inorganic fertilizers. The morphological features were evaluated during the experiment and soil analysis was carried out to evaluate the changes in the nutrient content of the soil.

Keywords: *Capsicum annuum L., organic and inorganic fertilizers, soil analysis*

1. INTRODUCTION

Capsicum annuum L. (Chilli) is cultivated throughout the tropical and subtropical regions of the globe (Kumar *et al.,* 2021). It is considered among the significant commercial spices of India. Chilli is a member of family Solanaceae and belongs to the genus *Capsicum* (Koshale *et al.,* 2018; Gangadhar and Devakumar, 2020). It has remarkable nutritional value as it contains several bioactive compounds like high amount of Vitamin A, C, E and is rich in folic acid and potassium. Even the amount of Vitamin C is higher in the fresh green chilli than citrus fruits (Kumar *et al.,* 2021). Capsaicin – an alkaloid is responsible for the pungency of chilli. Due to these bioactive constituents, chilli contains several pharmacological properties which are very beneficial for health (Reddy *et al.,* 2017). There are many factors that influence the growth and yield of the crop among which fertility of the soil plays a vital role in the crop production. Production can be increased by the application of various organic or inorganic fertilizers which provides necessary nutrients for the plant growth (Dileep and Sasikala, 2009). It has been reported that continuous and careless application of inorganic fertilizer can cause various problems related to soil fertility, quality of the crop and also indirectly it affects the human health. While organic fertilizers enhance the organic matter content, physical, chemical and biological properties of the soil (Bilal *et al.,* 2019). So, this experiment was conducted to find out the effects of organic and inorganic fertilizers on *Capsicum annuum* L.

2. MATERIALS AND METHODS

2.1. Fertilizers used for the treatment- In the present experiment 4 different fertilizers were used i.e., Leaf compost**,** cow dung, kitchen waste compost and inorganic fertilizer. 1 set was left completely untreated and this was considered as the control set.

2.2. Preparation of organic fertilizers

2.2.1. Preparation of the dry leaf compost-

Leaf wastes are created in great amounts from the fallen leaves. Burning and landfilling have been practiced as conventional methods for discarding the leaf wastes. Both the methods have hazardous effects on environment. On the other hand, decomposition or degradation of dry leaves can be done by the various microorganisms. Further these decomposed materials can be used as organic matter and applied to the soil for nutrient augmentation (Karnchanawong and Supudom, 2011; Vasanthi *et al.*, 2013).

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Leaves of different plants were collected and allowed to dry in sunlight for 1 day. Dried leaves were crushed to decrease the size and for enlarging the surface area per unit volume of the leaves, that can further enhance the process of degradation. Then leaves were transferred into a clay pot and slightly pressed, after that some soil and little water was added on the surface of the leaves to maintain moisture as it is very essential for the decomposition process. Other factors like temperature, oxygen and C/N ratio also affect this process (Inyim, 2019). The pot was covered with thick sheets of paper and was further set for the decomposition process. In the interval of 2-3 days, water was added to the pot to speed up the decaying process. It took around 25 days for the complete decomposition of the leaves.

2.2.2. Kitchen waste compost

Wastes from the kitchen (peels of potato, onion and waste of brinjal, coriander) were collected which are known for their good nitrogen content. One clay pot was taken with some soil and kitchen wastes were transferred into the pot. Upper surface of the waste was also covered by soil and water was added to maintain the moisture. The process of decomposition requires good amount of moisture content, so water was frequently added to the pot and frequent turning of the waste was also carried out to provide equal amount of oxygen and moisture content. The compost was ready around in 35 days (Haydar and Masood, 2011).

2.2.3. Cow dung

Dried cow dung was collected and used in the powder form for the treatments.

2.2.4. Inorganic fertilizer details

Urea fertilizer containing 46% Nitrogen was brought from the market and applied as inorganic fertilizer.

Treatments were given to the plants of *Capsicum annuum* L. at the interval of 7 days and observations were noted for 7, 14, 21, 28 and 35 days respectively. All plants were treated with specific amount of organic and inorganic fertilizers for 5 weeks (**Figure 1**). Only watering was done in the control set. Soil analysis was conducted after evaluating the morphological changes respectively.

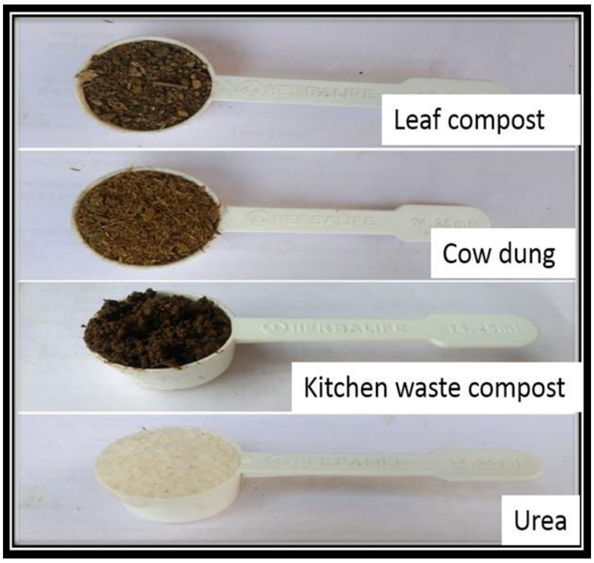

Figure 1: Amount of the fertilizers used for the treatment

2.3. Soil analysis

Soil analysis was conducted following the methodology of Panchal *et al.* (2021) for soil analysis after completion of the treatments.

2.3.1. Preparation of soil solution

The plants of chilli were grown in 5 different sets, 1 set was of control in which no treatment was provided. The other 4 sets were treated with the various fertilizers. After 5 weeks soil samples from each set were collected. 10 gm. of soil was weighed and to this 100 ml of distilled water was added. This procedure was carried out for each set separately. The soil solutions were kept for 24 hours. Whatman filter paper no “1” (9 cm) was used for filtration of the soil solutions. The filtered solutions were further used for analysis such as pH, chlorinity, organic matter and alkalinity (Chaurasia and Gupta, 2014; McCauley *et al.*, 2009).

2.3.2. Test for pH

The test for pH was carried out using pH strips. The pH strip was first dipped in distilled water for appraisal, the colour of the strip remained unchanged. It was concluded that the pH of the solution was 7. Similarly, for each set the pH was determined using the pH strips. The colour variation of the strip exhibited the pH of the solution. The results were noted respectively [8].

2.3.3. Test for Chloride content

10 ml soil solution was taken into a conical flask to this 1ml of Potassium chromate indicator was added. The solution turned yellow in color. Further the solution was titrated with 0.02 N Silver nitrate solution until the yellow color of solution changed to pinkish yellow color. Reading of biuret was noted. Similarly, all the soil solutions were titrated one by one.
Preparation of silver nitrate solution: 3.397 gm. of silver nitrate was added to 1000 ml of distilled water.
Preparation of potassium chromate indicator: 1gm potassium chromate was dissolved into 20 ml of distilled water.
Formula for chloride content test:
Cal (mg/l) = (A-B) × N × 35.45 × 1000/Volume of sample
N = Grams solute / volume solvent in litre × equivalent weight

2.3.4. Test for Alkalinity Content

10 ml soil solution was taken into a conical flask to this 2-3 drops of phenolphthalein indicator was added. The solution turned pink in color. Further the solution was titrated with 0.02 N Sulphuric acid solution until the solution turned colorless. Reading of biuret was noted. Further 2-3 drops of methyl orange indicator were added into the colorless solution of the flask, the solution turned yellow in colour. The titration was further carried out using the 0.02 N sulphuric acid solution until the solution turned orange in color. Similarly, for all the soil solutions the alkalinity test was conducted.
Preparation of 0.02 N sulphuric acid solution: 0.5 ml concentrated sulphuric acid was added to distilled water and 500 ml volume was made. 37
Preparation of phenolphthalein indicator: 0.5 gm. phenolphthalein was dissolved in 50% ethanol solution.
Formula for alkalinity test:
Total alkalinity (T), alkalinity for phenolphthalein (P) and alkalinity for methyl orange (M) was calculated as described below and shown in mg/l as CaCO3.
Phenolphthalein alkalinity (mg/l as CaCO3) = A× N × 1000/ Volume of sample
Methyl orange alkalinity (mg/l as CaCO3) = (B-A) × 1000/ Volume of sample
Total alkalinity (mg/l as CaCO3) = B × N × 1000/ Volume of sample

2.3.5. Test for Organic matter

10 ml soil solution was taken into a conical flask to this 0.2 ml Potassium dichromate solution was added. Further, 0.4 ml Sulphuric acid, 4 ml distilled water, 0.2 ml Phosphoric acid, 0.004 gm. Sodium fluoride and 0.02 ml Diphenylamine indicator were added into the flask containing the soil solution. Titration of this solution was carried out using Ferrous ammonium sulphate until the color of solution turned brilliant green. Similar procedure was followed for all the soil solutions for evaluating organic matter.
Ferrous ammonium sulphate solution preparation: 12.5 ml concentrated Sulphuric acid was added to distilled water and total volume was made up to 500 ml. 12.56 gm. ferrous ammonium sulphate was dissolved in this solution. Further distilled water was added and final volume was made up to 625 ml.
Preparation of Diphenylamine indicator: 0.5 gm. diphenylamine was added to 10 ml of distilled water then 90 ml sulphuric acid was added to the solution.
Preparation of Potassium dichromate solution: 4.904 gm. potassium dichromate was dissolved in 100 ml distilled water.
Formula for organic matter content:
OM (mg/l) = 6.791/ W $(1-T_1/T_2)$ × 10
OM (%) = 6.791 / W $(1-T_1/T_2)$
Carbon (%) = 6.791 / W × 1.724 $(1-T_1/T_2)$

3. RESULTS

3.1. Parameters and morphological observations of the *Capsicum annuum* L. plant

Different parameters like length of the stems, number of leaves, length of leaves and number of branches were observed for the evaluation of morphological features.

Table 1- 4 represents the morphological observations of the plant for 5 weeks

Table 1: Length of the stems in centimeter

Week	Control	Leaf Compost	Cow Dung	Kitchen Waste Compost	Urea (Inorganic)
0	18.3	5.2	8.3	6.1	7.8
1	20	5.5	8.7	6.4	8.1
2	20.2	6.9	10.4	8.6	8.3
3	20.6	7.1	10.7	9	8.6
4	21	7.6	13.5	11.2	-
5	21.7	8.8	14	11.8	-

Table 2: Number of leaves

Week	Control	Leaf Compost	Cow Dung	Kitchen Waste Compost	Urea (Inorganic)
0	25	6	9	7	8
1	30	8	12	9	12
2	35	9	14	10	13
3	39	10	24	15	14
4	39	10	28	21	-
5	37	11	28	26	-

Table 3: Length of leaves

Week	Control	Leaf Compost	Cow Dung	Kitchen Waste Compost	Urea (Inorganic)
0	2.52	1.9	2.35	2.17	2.41
1	2.43	1.77	1.96	2.22	2.27
2	2.17	2.04	1.70	2.52	1.97
3	2.15	2.08	1.46	1.78	1.22
4	2.14	2.34	1.53	1.70	-
5	2.08	2.37	1.48	1.61	-

Table 4: Number of branches

Week	Control	Leaf Compost	Cow Dung	Kitchen Waste Compost	Urea (Inorganic)
2	9	0	7	3	0
3	9	0	7	6	0
4	9	0	8	8	-
5	12	1	8	11	-

Figure 2& 3 represents the changes in the plants that was observed during the experimental period.

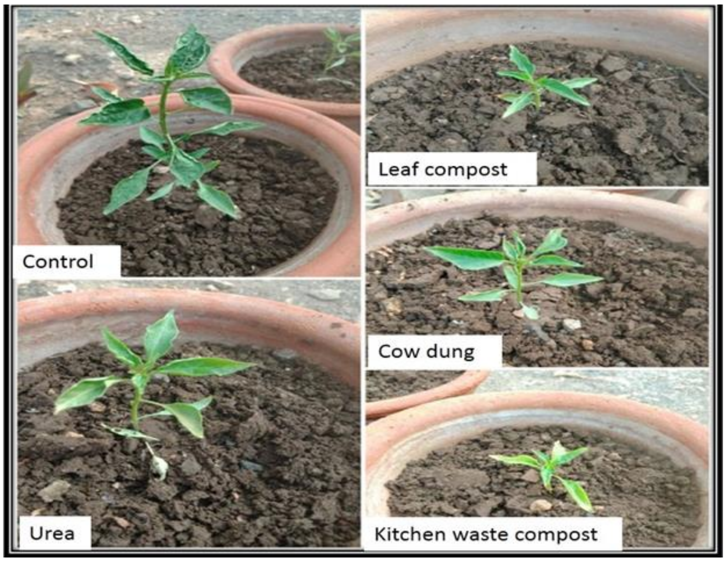

Figure 2: Plants on the day of 1st treatment

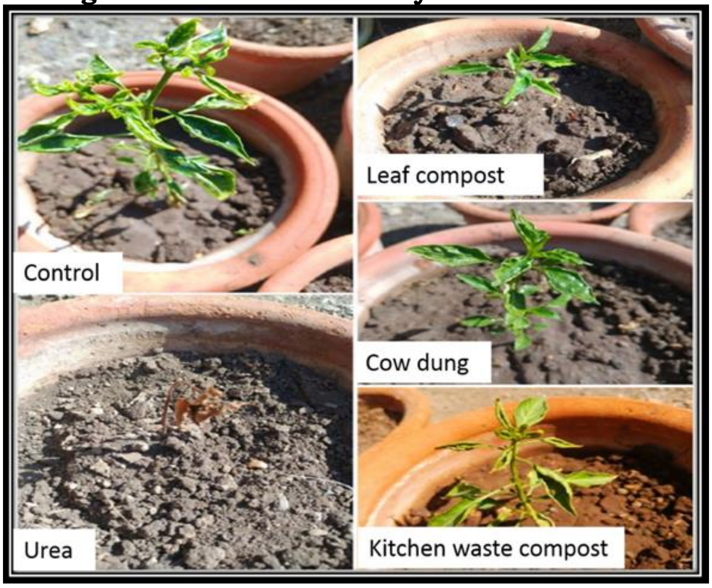

Figure 3: Treated plants on week 5

The highest length of the stem was observed in the control set followed by the cow dung treated set and lowest in the set treated with leaf compost. After that Number of leaves were observed in which the result obtained was as follows- Control> Cow dung > Kitchen waste compost> Leaf compost> Urea. The overall result for the average length of the leaves was as follows- Leaf compost> Control> Kitchen waste compost> Cow dung> Urea. The set of control showed the highest number of branches followed by the kitchen waste compost set, cow dung and leaf compost set. The set treated with urea did not contain any branches during the experiment.

3.2. Result of soil analysis

Table 5-8 and **Figure 4-7** represents the results of soil analysis (pH, Chlorinity, Alkalinity and Organic Matter content) after the completion of given treatments.

Table 5: Results of pH test for all solutions

Sr. No.	Sample Description	pH
1	Distilled water	7
2	Control	6
3	Leaf compost	10
4	Cow dung	6
5	Kitchen waste compost	8
6	Urea	9

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It is clearly observed from the **Table 5** that the control and the cow dung treated set displayed acidic pH, while the pH of kitchen waste compost, urea and leaf compost treated set were basic.

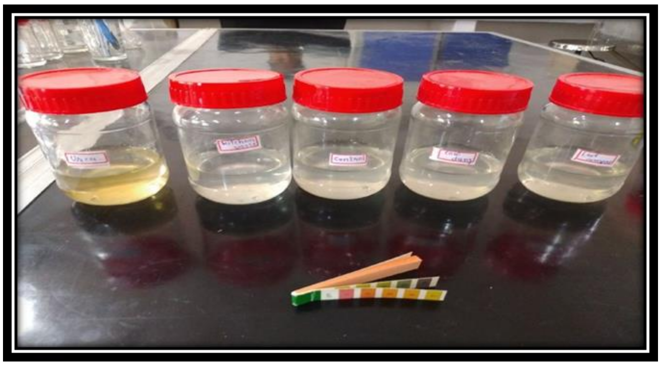

Figure 4: pH analysis of all solutions using pH strip

Table 6: Results Chlorinity test for all solutions

Sr. No.	**Sample description**	**Normality of $AgNO_3$**	**$AgNO_3$ used for sample (ml) A**	**$AgNO_3$ used for blank (ml) B**	**Chlorinity (mg/l) (A-B)**	**Chlorinity content (ppm)**
1	Control	0.02	0.9	0.4	0.5	33.67
2	Leaf compost	0.02	0.8	0.4	0.4	26.94
3	Cow dung	0.02	0.9	0.4	0.5	33.67
4	Kitchen waste compost	0.02	0.8	0.4	0.4	26.94
5	Urea	0.02	1	0.4	0.6	40.41

The chlorinity content of the control set and cow dung treated set was 33.67 ppm respectively. Whereas, 26.94 ppm was the chlorinity content of leaf compost and kitchen waste compost treated set. The highest chlorinity content was found in the urea treated set, i.e., 40.41 ppm.

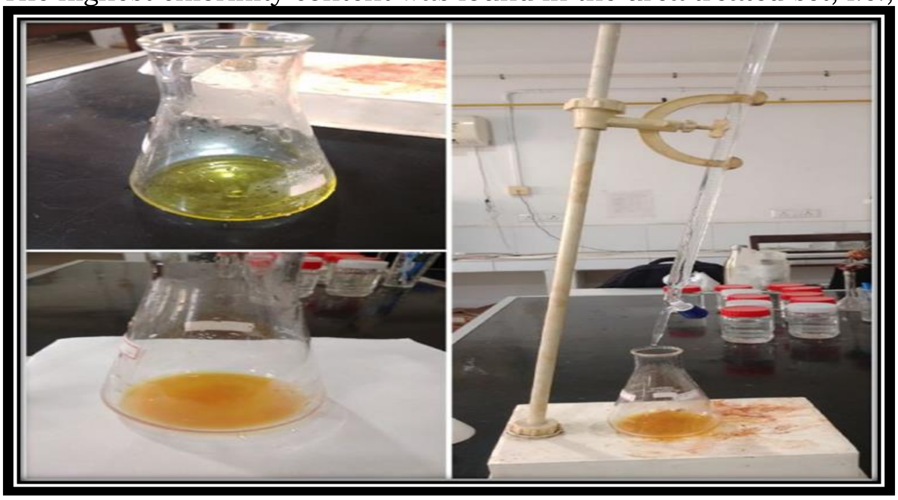

Figure 5: Test for chlorinity of soil solutions

Table 7: Alkalinity of all solutions

Sr. No.	**Sample description**	**H_2SO_4 used with phenolphthalein indicator (ml) A**	**H_2SO_4 used with methyl orange indicator (ml) B (A+B)**	**Phenolphthalein alkalinity (mg/l as $CaCO_3$)**	**Methyl orange alkalinity (mg/l as $CaCO_3$)**	**Total alkalinity (mg/l as $CaCO_3$)**
1	Control	0.2	1.8	0.4	160	3.6

2	Leaf compost	0.4	3.5	0.8	310	7
3	Cow dung	0.5	2.2	1	170	4.4
4	Kitchen waste compost	0.2	1.4	0.4	120	2.8
5	Urea	0.5	3.6	1	310	7.2

The alkalinity content was as follows- Urea> Leaf compost>Cow dung> Control>Kitchen waste. The highest alkalinity content was of the urea treated set and the lowest of the kitchen waste treated set.

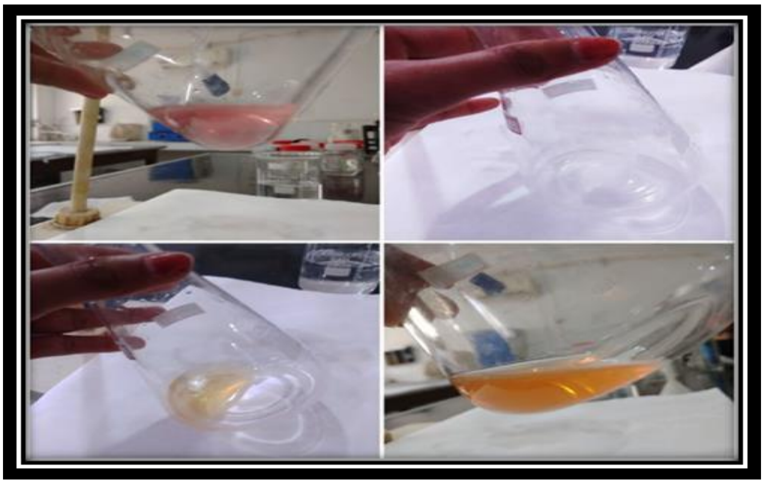

Figure 6: Test for alkalinity of soil solutions

Table 8: Organic matter of soil solutions

Sr. No	**Sample**	**OM(mg/l)**	**OM (%)**	**Carbon (%)**
1	Control	0.101	1.01	0.59
2	Leaf compost	6.791	67.91	6.791
3	Cow dung	0.08	0.8	0.47
4	Kitchen waste compost	6.791	67.91	6.791
5	Urea	0.135	1.35	0.78

Table 8 shows the organic matter content of all the solutions in which organic matter content of leaf compost and kitchen waste compost treated set were higher as compared to other soil solutions.

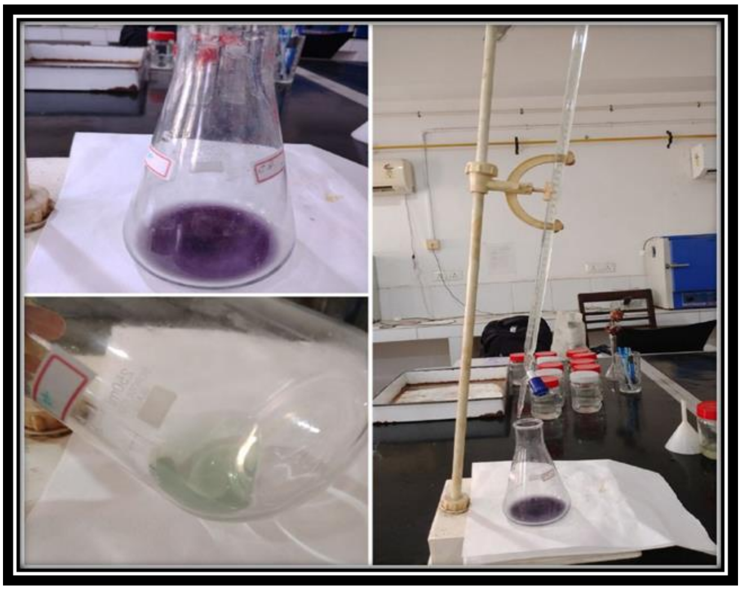

Figure 7: Test for organic matter of soil solutions

4. DISCUSSION

Adhikari *et al.* (2016) investigated the effect of different organic manures on growth and yield of sweet pepper (*Capsicum annuum* L.). The plants were treated with fertilizers such as chemical fertilizer, vermi-compost, goat manure, farm yard manure, poultry manure and commercial organic fertilizer. The best result was obtained from the vermicompost and poultry manure, while goat manure, farm yard manure and control set showed less growth and almost similar results with each other. Poor results were displayed by the chemical fertilizer and commercial organic fertilizer. These observed results support our experimental work, as in our study also we found that the set treated with urea showed the poorest result among all the sets.

In another experiment conducted by Reddy *et al.* (2017) on the plant of *Capsicum annuum* L. it was observed that among the various treatments given to the plant the best result was obtained from the combination of vermicompost 2.5 t/ha and farm yard manure 12.5 t/ha. Reddy and colleagues had given the treatments of vermicompost 2.5 t/ha, cow dung 10 t/ha, leaf manure 5 t/ha + cow dung 10 t/ha, leaf manure 5 t/ha, neem cake 1 t/ha, vermicompost 2.5 t/ha + farm yard manure 12.5 t/ha, poultry manure 1.5 t/ha and night soil 5 t/ha respectively to the plants of *Capsicum annuum* L. Maximum plant height, higher number of leaves and primary branches were seen in the plant which was treated with the combination of vermicompost 2.5 t/ha and farm yard manure 12.5 t/ha. Whereas, in our experiment the best result was observed in the cow dung set after the control set for the height of the stems and number of leaves. The length of the leaves was highest in the control set followed by the leaf compost treated set and the number of branches were found highest in the control set followed by the kitchen waste compost set.

Olowokere (2014) studied the effect of organic and inorganic fertilizers on *capsicum* spp. The plants were treated with 9 different fertilizers. T_1-T_8 (0, 2, 4, 6, 8, 10, 12, and 14 t/ha) were treated with organo mineral fertilizer and T_9 plant was treated with chemical fertilizer containing 60 kg Nitrogen, 19.8 kg Phosphorus and 39.6 kg Potassium/ha after 7 days of transplanting. At the end of the experiment soil analysis was conducted. The result displayed that the set of chemical fertilizer had pH of 7.09 and it was more acidic than other sets of fertilizers while in the present study the result was different, the pH of urea (chemical fertilizer) set was 9 thus, it was basic. The T_7 set which was treated with 12 t/ha organo mineral fertilizer had shown the highest pH among all the sets similarly in our experiment highest pH was found in the set of leaf compost.

Ewulo *et al.* (2007) worked on *Capsicum annuum* L. for observing the comparative effect of cow dung manure and leaf nutrient on soil. T_1 set was of control and T_2-T_6 sets were treated with different fertilizers. Four plants (T_2-T_5) were treated with cow dung at the rate of 2.5, 5, 7.5 and 10 t/ha respectively and T_6 was treated with 250 kg/ha NPK fertilizer. Result of this experiment and soil analysis revealed that the pH of T_3, T_4, and T_5 set was 6.5 which was similar to our experiment as we found the cow dung treated set with pH 6. The T_6 set showed 5.7 pH which did not match with the current study. They also determined organic matter of the soil samples which revealed the highest organic matter (%) in T_5 set which was treated with 10 t/ha cow dung. The organic matter of T_6 set was 2.76 and it was almost similar to the set of control. In this case our results varied greatly as the organic matter content of urea was observed higher than that of the cow dung treated set.

CONCLUSION

The result of the present study revealed that the application of cow dung fertilizer provided more nutrients to the plant and decreased the pH of soil. Cow dung is known for its mineral contents like nitrogen, potassium, calcium, phosphorus and magnesium. Apart from that the use of leaf compost and kitchen waste compost showed crucial and significant effects on the growth of the *Capsicum annuum* L. plant and increased the organic matter content of the soil. Whereas the plant treated with urea (inorganic fertilizer) displayed poor results and could not survive after the 3rd week of the treatment. Thus, in terms of morphological features and soil analysis, this study supports the application of organic fertilizers as a source of nutrient for better production of chili pepper along with the conservation of soil properties.

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