

Impact of Solid Wastes Treatment on Growth Pattern of *Capsicum annum* and Soil Properties

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Abstract The treatment of organic solid wastes in agricultural fields in order to reduce the pollution of soil and to decrease dependence on application of inorganic fertilizers has attained new prospects in present scenario. The present study envisage treatment of sugarcane bagasse, fish scales, flower wastes and pineapple peels in soil and observed the impact on growth pattern of *Capsicum annum* and the soil therein. It was observed that there was a maximum increase in height (1.67cm), number of leaves (9) and biomass (0.73g) of the crop due to treatment of flower wastes. There was also an increase in the number of leaves (3) and biomass (0.33g) in the crop due to treatment of pineapple peels. No positive impact of treatment of sugarcane bagasse and fish scales on the crop was found. However there was an overall increase in the level of soil moisture, organic C, total N, available P and exchangeable K in the soil due to treatment of the four types of wastes.

Keywords Fish scales, Flower waste, Pineapple peels, Sugarcane bagasse.

Introduction

It is becoming accepted that there should not be organic materials that are classified as wastes. For sustainable development, resources must be recycled, and that especially applies for organic materials of municipal and agro industrial origins. Soils in many parts of the world are increasingly stressed from long-term cultivation practices, and the resulting losses of soil C are leading to inevitable degradations of soil structure [1]. Organic matter can be added to soil by incorporating plant material, animal residues, manure, sewage sludge or MSW. These additions as well as the agricultural management practices can affect soil microbial communities. Changes in microbial communities can in turn influence soil fertility and plant growth by increasing nutrient availability and turnover, disease incidence or disease suppression [2]. The present study was carried out in order to investigate the influence of four types of organic wastes on the soil as well as the growth pattern of chilli (*Capsicum annum*).

Materials and Methods

Study site

The study was carried out in Dhanamanjuri College of Science located in Imphal West district of Manipur. The site is situated at an elevation of 790m above the mean sea level. It lies between 24°30' N to 25°00' N latitudes and 93°45' E to 94°15' E longitudes. The annual rainfall ranges from 108.5 cm to 143.4 cm. The average temperature is 20.4°C.

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Table 1. Height, no. of leaves and biomass of *Capsicum annum* in different treatments ($\pm$ standard error).

Sl. No.	Treatments	Height (cm)	No. of leaves	Biomass (g)
1.	Control	20.66 $\pm$ 4.64	16 $\pm$ 4.32	1.13 $\pm$ 0.09
2.	Sugarcane b.	11.80 $\pm$ 2.94	8 $\pm$ 4.96	0.6 $\pm$ 0.28
3.	Fish s.	7.66 $\pm$ 1.24	3 $\pm$ 2.16	0.26 $\pm$ 0.09
4.	Flower w.	22.33 $\pm$ 1.24	25 $\pm$ 6.12	1.86 $\pm$ 0.25
5.	Pineapple p.	20.66 $\pm$ 4.50	19 $\pm$ 4.78	1.46 $\pm$ 0.25

Treatment of wastes

Four types of municipal solid wastes namely : Sugarcane bagasse (Sb), fish scales (Fs), flower wastes (Fw) and pineapple peels (Pp) were collected and air dried till constant weight and shredded into small pieces. Sixteen earthen pots were filled up with the wastes and dried soil at a ratio of 50g of each type of dried and shredded wastes with one kg of dried soil making four pots for each types of wastes treatment. Another four pots were filled up with soil without any wastes treatment in order to make control pots (C). All the twenty pots were kept for one month in order to stabilise the wastes in the treated pots.

Crop plantation

Twenty saplings of *Capsicum annum* having same growth stage were collected and planted in the pots in the month of June, 2016. They were watered regularly and the growth pattern based upon the increase in height and number of leaves were recorded twice in a month for four months. The productivity of the crop was computed by taking the dry weight of the whole plant including the fruits after harvesting the crop.

Analysis of soil

The soil samples from the different pots were collected at the end of the experiment and determined for pH by using pH meter, moisture content by using oven dry method, organic C by following Walkley and Black's method, total N by Kjeldahl's Digestion Method, available P by using Olsen's method given in Anderson and Ingram [3] and exchangeable potassium K by using Flame Photometer. The data obtained

Table 2. Change in height, no. of leaves and biomass in *Capsicum annum* due to treatment.

Sl. No.	Treatments	Height (cm)	No. of leaves	Biomass (g)
1.	Sugarcane b.	-9.6	-8	-0.50
2.	Fish w.	-13.0	-13	-0.87
3.	Flower w.	1.67	9	0.73
4.	Pineapple p.	0	3	0.33

were statistically analyzed for finding significance of variation and correlation between the plant and soil characteristics due to treatment of wastes materials.

Results and Discussion

The crop in the pots treated with Fw have maximum height (22.33 cm) and least height in Fs treated pots (7.66 cm) (Table 1). There was significant variation in the height of the crop among the treated pots ($F_{3,8} = 4.11$; $p < 0.05$). The out growth of total number of leaves was also maximum in Fw treated pots (25) and least in Fs treated pots (3). The change in growth pattern of the crop was computed by taking the difference between treated and control pots. It was found that there was increase of height in the crops only in the Fw treated pots (Table 2) with an increase of 1.67 cm. The number of leaves increased in both Fw treated pots (9) as well as in Pp treated pots (3).

Maximum amount of biomass was recorded in Fw treated pots (1.86g) and least in Fs treated pots (0.26). There was an increase in biomass of the crop in Fw (0.73g) and Pp (0.33g) treated pots. Significant variation in the biomass was found among the treated pots ($F_{3,8} = 20.70$; $p < 0.01$).

The soil moisture was found to increase in all the treated pots when compared with the control pots (Table 3). Maximum soil moisture was observed in Sb treated pots (25.37%) and minimum in the C pots (5.63%). There was maximum increase in soil moisture in Sb treated pots (19.74%) and minimum in Fs treated pots (2.49%).

Bulk density was maximum in the control pots (1.2 g/cm³) and minimum in Fs treated pots (1.07g/cm³) indicating there was an overall decrease in bulk

Table 3. Soil physico-chemical properties ($\pm$ standard error) of control and treated pots.

Sl. No.	Trea.	Moisture (%)	Bulk density (g/cm ³)	pH	Organic C (%)	Total N (kg/ha)	Available P (kg/ha)	Excha. K (kg/ha)
1.	C	5.63 $\pm$ 0.66	1.2 $\pm$ 0.008	7.1 $\pm$ 0.08	0.30 $\pm$ 0.00	167.33 $\pm$ 14.6	0.66 $\pm$ 0.04	19.33 $\pm$ 4.64
2.	Sb	25.37 $\pm$ 2.79	1.16 $\pm$ 0.03	7.10 $\pm$ 0.06	0.46 $\pm$ 0.04	177.66 $\pm$ 14.6	1.40 $\pm$ 0.71	66.33 $\pm$ 4.10
3.	Fs	8.12 $\pm$ 2.38	1.07 $\pm$ 0.00	6.75 $\pm$ 0.02	0.33 $\pm$ 0.04	355.33 $\pm$ 29.2	18.36 $\pm$ 1.26	35.00 $\pm$ 5.88
4.	Fw	24.89 $\pm$ 0.32	1.16 $\pm$ 0.05	6.97 $\pm$ 0.01	0.43 $\pm$ 0.12	386.66 $\pm$ 39.1	7.26 $\pm$ 2.65	123.00 $\pm$ 16.5
5.	Pp	18.93 $\pm$ 4.70	1.08 $\pm$ 0.04	7.00 $\pm$ 0.08	0.46 $\pm$ 0.04	209.33 $\pm$ 15.0	3.16 $\pm$ 0.20	119.00 $\pm$ 4.32

density in all the treated pots compared to the control. Maximum decrease in bulk density was observed in Fs and Fw treated pots and minimum in Sb treated pots (Table 4). The pH of the soil was found to be lower in the treated pots compared to the control pots. Significant variation of soil pH was observed among the treated pots ($F_{3,8} = 8.95$; $p < 0.05$).

Total soil organic C was found to be maximum in the Pp and Sb treated pots whereas minimum was observed in control pots. There was an increase in organic C in all the treated pots. Maximum increase of 0.16% was observed in Sb and Pp treated pots. Minimum increase was observed in Fs treated pots with 0.03%. Research on the effect of different doses of raw municipal solid waste in Mediterranean semi-arid conditions, ranging between 65 and 260 t/ha demonstrated that 17 years after a single application of the organic amendment there was an average increase of 70% in organic matter content [4].

Total N was also found to increase in all the treated pots. Maximum increase was observed in Fw treated pots (219.33 kg/ha) followed by Fs (188.00 kg/ha) and least in Sb treated pots (10.00 kg/ha). Significant variation of soil organic C was observed among the treated pots ($F_{3,8} = 35.43$; $p < 0.05$). Available P was found to increase maximum in Fs (17.70 kg/ha) and

minimum in Sb (0.74 kg/ha). Significant variation of available P was observed among the treated pots ($F_{3,8} = 57.80$; $p < 0.05$).

Maximum increase in exchangeable K was observed in Fw treated pots (103.67 kg/ha) followed by Pp treated pots (99.67 kg/ha). Significant variation of exchangeable K was observed among the treated pots ($F_{3,8} = 61.62$; $p < 0.05$).

The growth pattern of *Capsicum annum* was found to have significant correlation specially with exchangeable K of soil (Table 5). Since Fw treated pots showed maximum increase in exchangeable K followed by Pp, the growth pattern of the crop also corresponds significantly with the change pattern of exc. K change.

Although there was an increase of soil moisture content, organic C, total N, available P and exchangeable K in all the treatments the response of the crop depends upon the availability of mostly on the availability of exc. K in soil. Based upon the growth, the crop showed negative response on the soil treatment of sugarcane bagasse and fish scales. Although there was no significant correlation with the crop and soil organic C the role of the wastes in increasing organic C content of soil is an important aspect. Soil organic

Table 4. Change in soil physico-chemical properties due to treatment of wastes.

Sl. No.	Treat.	Moisture (%)	Bulk density (g/cm ³)	pH	Organic C (%)	Total N (kg/ha)	Available P (kg/ha)	Excha. K (kg/ha)
1.	Sb	19.74	-0.04	0	0.16	10.0	0.74	47.00
2.	Fs	2.49	-0.13	-0.35	0.03	188.0	17.7	15.67
3.	Fw	19.26	-0.13	0.13	0.13	219.44	6.6	103.67
4.	Pp	13.3	-0.12	-0.1	0.16	42.0	2.5	99.67

Table 5. Pearson's coefficient of correlation (r) between crop and soil characteristics (n=4), *indicates significance at $p < 0.05$.

	Soil moisture (%)	Organic C (%)	Total N (kg/ha)	Available P (kg/ha)	Excha K (kg/ha)
Height	0.60	0.63	0.06	-0.53	0.99*
No. of leaves	0.60	0.57	0.19	-0.46	0.97*
Biomass	0.58	0.56	0.49	-0.46	0.97*

material applications increased the organic C stock and therefore increased the cation exchange capacity. This effect was due to the high negative charge of organic matter. This is important for retaining nutrients and making available to plants [5–7]. Soil rich in organic matter are less prone to erosion than soils with low content, such as those which predominate in arid and semi-arid areas [8]. Several organic amendments long lasting application can enhance soil available K, extractable P and particularly organic C [9].

In the short period of four months and limited area of the earthen pots, treatment of flower wastes on the crop *Capsicum annum* have profound influence on its productivity. The response of the crop to other types of wastes may not be significant as limited root spread of chilli or brinjal will not be able to take the advantage of the slow release of nutrients from organic sources which diffuses gradually and moves slowly to different layers [10].

From the above findings it can be concluded that flower wastes which are abundant near holy shrines can be safely treated in soil and cultivation of *Capsicum annum* can be done.

References

1. Clapp CE, Hayes MHB, Simpson AJ, Kingery WL (2005) The chemistry of soil organic matter. In : Tabatabai A, Sparks DL (eds). Chemical processes in soils. Soil Sc Soc Am, Mad, pp 1—150.
2. Pankhurst CE, Blair BL, Magarey RC, Stirling GR, Bell MJ, Garside AL (2005) Effect of rotation breaks and organic matter amendments on the capacity of soils to develop biological suppression towards soil organisms associated with yield decline of sugarcane Appl Soil Ecol 28 : 271—282.
3. Anderson J, Ingram JSI (1993) Tropical soil biology and fertility. Handbook of methods CAB Int, London, UK, Pp 302.
4. Batisda F, Kandeler E, Hernandez T, Garcia C (2008) Long-term effect of municipal solid waste on microbial abundance and humus associated enzyme activities under semiarid conditions. Microb Ecol 55 : 651—661.
5. Ros M, Klammer S, Knapp B, Aichberger K, Insam H (2006) Long term effects of compost amendment of soil on functional and structural diversity and microbial activity. Soil Use Manage 22 : 209—218.
6. Weber J, Karczewska A, Drozd J, Licznar M, Licznar S, Jamroz E, Kocowicz A (2007) Agricultural and ecological aspects of a sandy soil as affected by the application of municipal solid waste compost. Soil Biol Biochem 39 : 1294—1302.
7. Kaur T, Brar BS, Dhillon NS (2008) Soil organic matter dynamics as affected by long-term use of organic and inorganic fertilizers under maize-wheat cropping system. Nutr Cycl Agroecosys 81 : 59—69.
8. Duran Zuazo VH, Rodriguez Pleguezuelo CR (2008) Soil-erosion and runoff prevention by plant covers. A review. Agron Sustain Dev 28 : 65—86.
9. Diacono M, Montemurro F (2010) Long-term effects of organic amendments on soil fertility. A review. Agron Sustain Dev 30 : 401—422.
10. Pradeepkumar T, Bonny BP, Midhila R, John J, Divya MR, Roch CV (2017) Effect of organic and inorganic nutrient sources on the yield of selected tropical vegetables. Scientia Horti 224 : 84—92.