Quantifying the Influence of Enriched Urban Compost and Wastes on soil Physico-Chemical and Biological Parameters of Bettahalli village, Bangalore North taluk: A Quantitative Analysis.

Abstract

Enriched urban compost enhances soil for sustainable agriculture, improving structure, water dynamics, nutrient release, microbial life, and contributing to climate change mitigation. The present study was carried out in 2022 late winter to assess the impact of enriched urban compost and wastes on soil properties. Collected Soil samples were analyzed for physical, chemical, and biological properties pre and post-maize harvest. Enriched urban compost treatments showed a slight reduction in bulk density. Increased Moisture holding capacity, pH, electrical conductivity, organic carbon, and magnesium remained mostly unchanged.

Nitrogen, phosphorus, and potassium increased significantly with enriched compost, promoting sustained nutrient release. Available sulfur rose with compost addition. DTPA-extractable Cu, Zn, Fe, Mn, and B were significantly higher with enriched compost. Chromium, nickel, lead, and cadmium remained below critical limits. Dehydrogenase and urease activities were significantly higher with enriched compost, indicating enhanced microbial action. Acid phosphatase activity increased, likely due to elevated phosphorus levels in organics, supporting P solubilizers.

Enriched urban compost enhances soil properties, promoting agricultural sustainability through climate change mitigation, improved structure, and enhanced nutrient release. Advisably, incorporating enriched urban compost into agricultural practices optimizes soil health, fosters sustainable nutrient management, and supports microbial activities, thereby enhancing agricultural productivity.

Key word: Urban Compost,soil properties, soil fertility,electrical conductivity

Introduction

Enriched urban compost and waste materials play a pivotal role in transforming soil's properties, offering a holistic approach to sustainable agriculture and environmental stewardship (Ayilara *et al*., 2020). The addition of enriched compost significantly influences soil structure. Compost is rich in organic matter and acts as a binding agent, fostering the development of soil aggregates. This aggregation enhances soil porosity, allowing for improved water infiltration and retention. In sandy soils, the organic matter in compost acts like a sponge, preventing rapid drainage and aiding in water retention. In contrast, in clayey soils, compost facilitates better aeration and drainage, mitigating issues related to waterlogging.

The chemical implications of enriched urban compost are equally profound. Compost serves as a nutrient reservoir, containing essential elements such as nitrogen, phosphorus, potassium, and micronutrients. These nutrients are released gradually as the organic matter decomposes, providing a sustained and balanced source of nutrition for plants. Importantly, the organic matter in compost also acts as a pH buffer, helping to stabilize soil pH levels. This is particularly beneficial in urban areas where soils may be prone to acidification due to pollution or industrial activities.

Biologically, the introduction of enriched compost to soil has far-reaching implications. Compost is a rich source of microbial life, including bacteria, fungi, and other microorganisms that enhance the soil's biological diversity and activity. The microbial communities in compost aid in breaking down organic matter, releasing nutrients in forms that plants can readily absorb (Paredes *et al*., 2022). Additionally, these microorganisms play a crucial role in suppressing soil-borne pathogens, thereby promoting plant health. Moreover, the incorporation of enriched compost and waste materials into urban soils contributes to carbon sequestration. Organic matter in compost is a storehouse of carbon, and by adding compost to the soil, carbon is sequestered, mitigating the effects of climate change. This dual benefit of enhancing soil fertility and contributing to climate change mitigation underscores the importance of utilizing enriched compost in urban agriculture. By considering the above importance, the present study is undertaken to assess the effects of enriched urban compost and wastes on soil physicochemical and biological properties.

Material and Methods

The experiment was taken up during late winter 2022 at Bettahalli, Bangalore North taluk, situated in the Eastern Dry Zone of Karnataka. Soil samples were collected at a depth of 0–15 cm both before sowing and after crop harvest. These samples were air-dried, powdered, sieved through a 2 mm sieve, and stored in polythene bags. Standard procedures (Table 1) were applied to analyze various physical and chemical properties of the soil. Additionally, for the assessment of biological properties, soil samples were obtained before sowing and at the 50 percent flowering stage.

The compost and wastes were enriched with the liquid microbial consortium, Twelve days before sowing, nine treatments (Table 2) involving various combinations of enriched and unenriched FYM, sewage sludge, urban solid waste compost, and humanure compost were applied. The basal dose of 50% N and 100% of P, K, and Zn fertilizers were supplied, remaining nitrogen was top-dressed 30 days after sowing.

The study followed a Randomized Complete Block Design (RCBD) with three replications. The cultivation of the maize hybrid BRMH-8 adhered to recommended cultural practices.

Table 1. Methods followed for analysis of Enriched Urban Compost and Waste on Soil Physico-Chemical and Biological Parameters

Parameter	**Method**	**Reference**
Physical properties		
MWHC (%), Bulk density	Keen Raczkowski Cup	Piper, 1966
Chemical properties		
pH (1:2.5)	Potentiometry	Jackson, 1973
EC (dS m^{-1})	Conductometry	Jackson, 1973
Organic carbon	Wet oxidation	Walkley and Black, 1934
Available Nitrogen	Alkaline permanganate	Subbiah and Asija ,1956
Available Phosphorus	Spectrophotometry	Bray and Kurtz, 1945
Available Potassium	Flame photometery	Page *et al*, 1982
Exchangeable Calcium and Magnesium	Complexometric titration method	Jackson, 1973
Available Sulphur	Turbidometry	Black, 1965
Hot water-soluble Boron	Azomethane-H	Dhyan Singh *et al*. 2005
DTPA extractable micronutrients & heavy metals	Atomic Absorption	Lindsay and Norvell, 1978
Biological Parameters		
Estimation of Urease Activity	KCL-AG_2 SO_4 solution	Eivazi and Tabatabai, 1977
Estimation of Dehydrogenase activity	2-3-5-triphenyl tetrazolium chloride reduction method	Casida *et al* ., 1964
Estimation of Phosphatase activity	p-nitrophenyl phosphatase method	Eivazi and Tabatabai, 1977

Table 2: The nine different treatment combinations are as follows

T_1	Control
T_2	100% NPK + FYM @ 7.5 t ha^{-1} (POP)
T_3	100 % NPK + 7.5t ha^{-1} HC
T_4	100 % NPK + 7.5t ha^{-1} USWC
T_5	100 % NPK + 7.5t ha^{-1} SS
T_6	75 % NPK + 7.5t ha^{-1} Microbial enriched HC
T_7	75% NPK + 7.5t ha^{-1} Microbial enriched USWC
T_8	75 % NPK + 7.5t ha^{-1} Microbial enriched SS
T_9	75 %+ NPK + 7.5t ha^{-1} Microbial enriched FYM

Note: 10Kg of ZnSO4 per ha was added in T2 to T9 treatments USWC: Urban Solid Waste Compost, SS: Sewage Sludge FYM: Farm Yard Manure
HC: Humanure Compost

Table 3: Initial physicochemical and biological properties of the experimental site

Sl. No.	Parameters	Values
Physical properties		
01	Bulk density (Mg m^{-3})	1.47
02	MWHC (%)	36.51
Chemical properties		
01	pH (1:2.5)	5.36
02	EC (dS m^{-1})	0.02
03	Organic Carbon (%)	0.68
04	Avail. N (kg ha^{-1})	183.97
05	Avail. P_2O_5 (kg ha^{-1})	45.32
06	Avail. K_2O (kg ha^{-1})	240.16
07	Exchangeable Ca [C mol (p+) $kg^{-1}$of soil]	4.52
08	Exchangeable Mg [C mol (p+) kg^{-1} of soil]	2.21
09	Available S (mg kg^{-1})	13.25
10	Hot water-soluble B (mg kg^{-1})	0.36
11	DTPA extractable Fe (mg kg^{-1})	9.46
12	DTPA extractable Mn (mg kg^{-1})	8.24
13	DTPA extractable Zn (mg kg^{-1})	1.98
14	DTPA extractable Cu (mg kg^{-1})	0.66
15	DTPA extractable Ni (mg kg^{-1})	0.68
16	DTPA extractable Cr (mg kg^{-1})	0.27
17	DTPA extractable Pb (mg kg^{-1})	1.69
18	DTPA extractable Cd (mg kg^{-1})	0.032
Biological properties		
01	Dehydrogenase (µg TPF g^{-1} soil 24 h^{-1})	25.74
02	Urease (µg NH_4- N g^{-1} soil h^{-1})	16.59
03	Acid Phosphatase (µg PNP g^{-1} soil h^{-1})	32.11

Table 4. Effect of Enriched Urban Compost and wastes on Physico-chemical Properties afterharvest of Maize

Treatments	**BD (Mg m^{-3})**	**MWHC (%)**	**pH (1:2.5)**	**EC (dS m^{-1})**	**OC (%)**	**Avail. N (Kg ha^{-1})**	**Avail. P_2O_5 (Kg ha^{-1})**	**Avail. K_2O (Kg ha^{-1})**
T$_{1:}$ Control	1.50	35.42	5.30	0.016	0.66	120.41	34.41	174.70
T$_{2:}$ 100% NPK + FYM @ 7.5 t ha^{-1} (POP)	1.47	36.50	5.42	0.017	0.69	189.84	51.38	225.76
T$_3$:100 % NPK + 7.5 t ha^{-1} HC	1.46	36.92	5.40	0.020	0.70	196.25	50.89	228.25
T$_4$:100 % NPK + 7.5 t ha^{-1} USWC	1.47	37.35	5.42	0.019	0.69	205.84	52.22	230.66
T$_5$:100 % NPK + 7.5 t ha^{-1} SS	1.48	35.06	5.45	0.017	0.69	186.55	48.80	226.92
T$_6$:75 % NPK + 7.5 t ha^{-1} microbial enriched HC	1.43	37.12	5.41	0.018	0.68	219.94	58.30	237.62
T$_7$:75 % NPK + 7.5 t ha^{-1} microbial enriched USWC	1.42	38.91	5.42	0.021	0.72	231.98	60.68	238.06
T$_8$:75 % NPK + 7.5 t ha^{-1} microbial enriched SS	1.45	36.08	5.47	0.022	0.70	212.27	54.63	234.52
T$_9$:75 % NPK + 7.5 t ha^{-1} microbial enriched FYM	1.44	37.06	5.45	0.021	0.71	215.30	57.53	233.84
S.Em±	**0.03**	**0.76**	**0.08**	**0.003**	**0.01**	**1.45**	**1.79**	**3.24**
CD at 5%	**NS**	**NS**	**NS**	**NS**	**NS**	**4.35**	**5.38**	**9.71**
Initial	**1.47**	**36.51**	**5.36**	**0.020**	**0.68**	**183.97**	**45.32**	**240.16**

Table 5. Effect of Enriched Urban Compost and wastes on Physico-chemical Properties afterharvest of Maize

Treatments	Exch. Ca	Exch. Mg	Avail. S (mg kg^{-1})	DTPA-Cu (Mg kg^{-1})	DTPA-Zn (Mg kg^{-1})	DTPA-Fe (Mg kg^{-1})	DTPA-Mn (Mg kg^{-1})	Hot water-B (Mg kg^{-1})
	(c mol (p+) kg^{-1})							
T_1: Control	4.11	1.91	7.68	0.62	1.91	9.18	7.78	0.27
T_2: 100% NPK + FYM @ 7.5 t ha^{-1} (POP)	4.63	2.32	15.14	0.65	2.06	9.41	8.11	0.35
T_3: 100 % NPK + 7.5 t ha^{-1} HC	4.71	2.35	14.55	0.65	2.05	9.68	8.14	0.34
T_4: 100 % NPK + 7.5 t ha^{-1} USWC	4.90	2.38	15.22	0.64	2.04	9.80	8.20	0.35
T_5: 100 % NPK + 7.5 t ha^{-1} SS	4.33	2.18	13.02	0.62	2.03	9.35	8.09	0.31
T_6: 75 % NPK + 7.5 t ha^{-1} microbial enriched HC	5.30	2.51	16.20	0.69	2.10	10.14	8.26	0.37
T_7: 75 % NPK + 7.5 t ha^{-1} microbial enriched USWC	5.47	2.62	16.90	0.71	2.12	10.21	8.29	0.40
T_8: 75 % NPK + 7.5 t ha^{-1} microbial enriched SS	5.01	2.41	15.71	0.66	2.07	9.85	8.23	0.36
T_9: 75 % NPK + 7.5 t ha^{-1} microbial enriched FYM	5.17	2.45	16.41	0.67	2.09	10.01	8.27	0.39
S.Em±	**0.12**	**0.15**	**1.22**	**0.01**	**0.01**	**0.19**	**0.04**	**0.02**
CD at 5%	**0.36**	**NS**	**3.67**	**0.03**	**0.03**	**0.58**	**0.12**	**0.06**
Initial	**4.52**	**2.21**	**13.25**	**0.66**	**1.98**	**9.46**	**8.24**	**0.36**

Table 6. Effect of enriched urban compost and wastes on soil DTPA-Extractable Heavy metals Chromium, Nickel, Lead, and Cadmium after harvest of maize

Treatments	DTPA-Cr (Mg kg^{-1})	DTPA-Ni (Mg kg^{-1})	DTPA-Pb (Mg kg^{-1})	DTPA-Cd (Mg kg^{-1})
T_1: Control	0.269	0.647	1.694	0.031
T_2: 100% NPK + FYM @ 7.5 t ha^{-1} (POP)	0.274	0.693	1.696	0.033
T_3: 100 % NPK + 7.5 t ha^{-1} HC	0.272	0.693	1.711	0.032
T_4: 100 % NPK + 7.5 t ha^{-1} USWC	0.271	0.700	1.698	0.031
T_5: 100 % NPK + 7.5 t ha^{-1} SS	0.276	0.723	1.708	0.032
T_6: 75 % NPK + 7.5 t ha^{-1} microbial enriched HC	0.278	0.712	1.719	0.033
T_7: 75 % NPK + 7.5 t ha^{-1} microbial enriched USWC	0.277	0.715	1.713	0.034
T_8: 75 % NPK + 7.5 t ha^{-1} microbial enriched SS	0.279	0.740	1.714	0.033
T_9: 75 % NPK + 7.5 t ha^{-1} microbial enriched FYM	0.273	0.712	1.712	0.032
S.Em±	**0.002**	**0.016**	**0.008**	**0.001**
CD at 5%	**NS**	**NS**	**NS**	**NS**
Initial	**0.27**	**0.68**	**1.69**	**0.032**

Note: 10Kg of ZnSO4 per ha was added in T_2 to T_9 treatments

*HC= Humanure Compost

*USWC= Urban Solid Waste Compost

*SS= Sewage Sludge

*FYM=Farm Yard Manure

Table 7. Effect of enriched urban compost and wastes on biological parameters at 50 % flowering stage of maize crop

Treatments	Dehydrogenase activity (μg TPF g^{-1} soil 24 h^{-1})	Urease (μg NH_4- N g^{-1} soil h^{-1})	Acid phosphatase (μg PNP g^{-1} soil h^{-1})
T_1: Control	32.96	23.16	52.50
T_2: 100% NPK + FYM @ 7.5 t ha^{-1} (POP)	60.85	45.66	70.31
T_3: 100 % NPK + 7.5 t ha^{-1} HC	65.28	49.23	74.49
T_4: 100 % NPK + 7.5 t ha^{-1} USWC	69.52	53.74	79.73
T_5: 100 % NPK + 7.5 t ha^{-1} SS	58.55	39.62	59.45
T_6: 75 % NPK + 7.5 t ha^{-1} microbial enriched HC	84.91	68.34	114.25
T_7: 75 % NPK + 7.5 t ha^{-1} microbial enriched USWC	95.17	72.31	125.07
T_8: 75 % NPK + 7.5 t ha^{-1} microbial enriched SS	70.94	60.04	98.53
T_9: 75 % NPK + 7.5 t ha^{-1} microbial enriched FYM	76.11	65.14	105.26
S.Em±	**1.04**	**0.15**	**3.73**
CD at 5 %	**3.11**	**0.44**	**11.19**
Initial	**25.74**	**16.59**	**32.11**

Note: 10Kg of ZnSO4 per ha was added in T2 to T9 treatments

*HC= Humanure Compost

*USWC= Urban Solid Waste Compost

*SS= Sewage Sludge

*FYM=Farm Yard Manure

Results and Discussion

Soil samples from the experimental site were collected and analyzed for physical, chemical, and biological properties before sowing and after harvest of maize crop were presented in Table 3, 4, and 5 respectively. Bulk density varied between 1.42 Mg m-3 (T_7: 75 % NPK + 7.5 t ha-1 microbial enriched USWC) and 1.50 Mg m-3 (T_1: Absolute control). Despite this range, there was no significant difference from the initial value of 1.47 Mg m-3. The lack of significant variation may be attributed to the insufficient seasonal use of organics, in agreement with Meena et al. (2006). However, plots treated with enriched urban compost experienced a slight reduction in bulk density. This reduction could be due to the increased organic carbon content from higher doses of urban compost, enhancing soil aggregation and porosity.

None, of the treatments were found to be non-significant with respect to the maximum water-holding capacity of soil after the harvest of the crop. Higher soil moisture content was observed in the plots treated with enriched urban compostand wastes. This might be attributed to the increased specific surface area due to an increase in the relative number of micropores by application of organic sources and thereby an increase in moisture holding capacity of soil as reported by Hernando *et al*. (1989). The physical properties of the soil did not vary significantly between treatments. This lack of variation might be attributed to the slow nature of changes in physical properties, requiring an extended period of time for crop cultivation with these treatments to effectively alter the soil's physical characteristics.

None, of the treatments showed significant differences in soil pH after crop harvest. The increased pH in T_8 resulted from carbon mineralization in sewage sludge, leading to the production of OH^- ions through ligand exchange. Additionally, the introduction of basic cations like K^+, Ca^{2+}, and Mg^{2+} contributed to this increase, aligning with the observations of Mkhabela and Warman (2005).

None, of the treatments exhibited significant differences in soil electrical conductivity after crop harvest. Nevertheless, a slight increase in EC was observed in treatments utilizing enriched urban compost and wastes. This could be attributed to the mineralization and release of bi-carbonates, Fe, Mn, and NH_3 content, leading to the subsequent formation of soluble salts of calcium.

No significant differences were observed in the organic carbon content of the soil after harvest. A slight increase in organic carbon content compared to the initial value was noted, The variation in OC status among the treatments was linked to the differential rate of oxidation of organic matter by microbes. The addition of compost and FYM (Farm Yard Manure) enhanced soil organic carbon due to mineralization

The available nitrogen (N) content displayed significant variation among treatments after harvest, especially with the application of enriched urban composts and wastes. The treatment with 75% NPK + 7.5 t ha-1 microbial enriched USWC (T_7) recorded a significantly higher N content of 231.98 kg ha-1, followed by (T_6) 75% NPK + 7.5 t ha-1 microbial enriched HC with 219.94 kg ha-1. In contrast, the control (T_1) exhibited a lower N content of 120.41 kg ha-1. This increase can be attributed to the release of nitrogen through the mineralization. Additionally, microbial enrichment, particularly nitrogen-fixing microorganisms, may have contributed to the fixation of atmospheric nitrogen and the conversion of organically bound nitrogen into an inorganic form (Bhardwaj *et al.*, 2014). In addition to these factors, the inoculation of a liquid microbial consortium into urban compost and wastes aids in maintaining a soil environment rich in various micro and macronutrients. These include nitrogen fixation, phosphate, and potassium solubilization or mineralization (Bhardwaj *et al.*, 2014).

Significant differences were observed among the treatments in terms of the soil's available phosphorus content. The application of 75% NPK + 7.5 t ha-1 microbial enriched USWC (T_7) resulted in a significantly higher P_2O_5 content of 60.68 kg ha-1. This finding was on par with the treatment in 75% NPK + 7.5 t ha-1 microbial enriched HC (T6: 58.30 kg ha-1) and 75% NPK + 7.5 t ha-1 microbial enriched FYM (T9: 57.53 kg ha-1). In contrast, the absolute control (34.41 kg ha-1) recorded significantly lower available phosphorus.

The increase in available phosphorus may be attributed to the release of phosphorus from fixed forms, facilitated by the heightened population of soil microflora and organic matter. The elevated available phosphorus in plots treated with enriched urban composts and wastes could be linked to the higher phosphorus content in these materials. Additionally, the decomposition of compost and wastes, accompanied by the release of various acids and root exudations, may have solubilized native phosphorus, a process potentially accelerated by phosphate-solubilizing bacteria (PSB). According to Zhang *et al.*, (2006), the application of municipal solid waste compost effectively supplied phosphorus to the soil by reducing phosphorus fixation through the chelation of organic ligands, forming phosphor-humate complexes, and increasing soil phosphorus concentration with higher application rates.

A significantly higher available potassium level was observed with 75% NPK + 7.5 t ha-1 microbial enriched USWC (T_7: 238.06 kg ha-1), which was on par with the T_4 (230.66 kg ha-1), T_6 (237.62 kg ha-1), T_8 (234.52 kg ha-1), and T_9 (233.84 kg ha-1). These findings align with the results of Sangakkara et al. (2014), who reported that microbial inoculants increased soil nitrogen, potassium, organic carbon, and soil respiration, highlighting the advantages of enhancing soil microbial life. The significant increase in potassium content is attributed to the release of potassium from composts and the solubilization of mineral-bound or native potassium. Additionally, the application of composts led to the prevention of leaching losses by retaining more potassium through organic colloids. Similar findings were reported by Biswas (2014), demonstrating a significant increase in available potassium through the inoculation of a potassium mobilizer (*Frateuria aurentia)* into compost.

A notable elevation in exchangeable calcium levels was observed in the treatment involving 75% NPK + 7.5 t ha-1 of microbial enriched USWC (T7: 5.47 C mol (p+) kg-1). This finding was on par with the treatments with 75% NPK + 7.5 t ha-1 of microbial enriched HC (T6: 5.30 C mol (p+) kg-1) and 75% NPK + 7.5 t ha-1 of microbial enriched FYM (T9: 5.17 C mol (p+) kg-1). In contrast, significantly lower values of exchangeable calcium were observed in the absolute control (T1) at 4.11 C mol (p+) kg-1.

There were no significant differences in exchangeable magnesium content in the soil observed with the application of various treatments after the maize crop harvest (Table 4). However, a numerically higher value (2.62 C mol (p+) kg-1) was recorded with the application of 75% NPK + 7.5 t ha-1 microbial enriched USWC (T_7). The quantity of magnesium remaining in the soil is influenced by both the amount of magnesium applied to the soil and the amount taken up by the crop. The elevated levels of calcium and magnesium in treatments with organic sources may be attributed to the influence of dissolved carbon dioxide and organic acids on the native $CaCO_3$ in the soil. The addition of organic sources could have led to an increase in calcium and magnesium in the soil. These findings align with the results of Dotaniya *et al*., (2016).

Significantly, higher available sulphur was recorded in treatment with 75 % NPK + 7.5 t ha^{-1} microbial enriched USWC (T_7) 16.90 mg kg^{-1}. However, it was found to be on par with all the treatments except T_1 (control) with 7.68 mg kg^{-1}. Available sulphur might have increased due to the addition of bio-enriched urban compost and wastes along with inorganic fertilizers, which favors microbial oxidation and thus renders available sulphur (Sinha and Vipin Kumar, 2016). During the decomposition of organic matter, the organic sulphur compounds are broken down to simpler compounds i.e. inorganic sulphur, and thus increase in available sulphur in the soil. Zhang *et al*., (2006) recorded an increase in soil S concentration as a result of the mineralization of municipal solid waste compost.

The application of enriched urban composts and wastes had a significant impact on DTPA-extractable Cu, with the highest copper content observed in 75% NPK + 7.5 t ha-1 microbial enriched USWC (T_7: 0.71 mg kg-1), followed by T_6, T_9, and T_8. The control (T_1) had a lower Cu content of 0.62 mg kg-1.

Similarly, significantly higher zinc (2.12 mg kg-1) was recorded in T_7, followed by T_6, T_9, and T_8. DTPA-extractable zinc was significantly lower in the control (T_1: 1.91 mg kg-1). These results align with Sebastio *et al*., (2000), who observed a significant increase in Cu with the application of organic manures. Additionally, higher iron content was noted in T_7 (10.21 mg kg-1), similar to T_3, T_4, T_6, $T_{8,}$ and T_9, while the control T_1 had significantly lower iron (9.18 mg kg-1). The organic amendments such as organic manures, facilitated the release of iron from the native soil through chelating agents, aligning with the findings of Sharma *et al*., (2001). Enriched urban composts exhibited high iron content, possibly due to enhanced microbial activity, preventing iron precipitation, fixation, and oxidation

Additionally, significantly higher DTPA-extractable manganese was noted in T_7 (8.29 mg kg-1), similar to T_4, T_6, T_8, and T_9, while the control T_1 had significantly lower manganese (7.78 mg kg-1). This increase may be attributed to the higher initial Mn content in the soil, and the application of enriched composts upon mineralization might have released native Mn. Moreover, significantly higher boron content was observed in T_7 (0.40 mg kg-1), on par with other treatments except T_5 and the control T_1. The slight increase in boron content was attributed to compost mineralization, causing a decrease in boron fixation and a significant release of boron in an available form, in agreement with Rangaraj *et al*., (2007). These results are consistent with Rodd *et al*.. (2002) who reported increased available soil boron with increased MSW compost.

There was a non-significant difference in DTPA-extractable chromium, nickel, lead, and cadmium with the application of enriched urban composts and wastes. They were found below the critical limit of 100 mg kg^{-1} as recomdations of WHO, (1996).

significantly higher dehydrogenase activity was observed during the 50% flowering stage in maize, particularly with 75% NPK + 7.5 t ha-1 microbial enriched USWC (T_7), recording 95.17 µg TPF g-1 soil 24 hr-1. In comparison to absolute control (T1: 32.96 µg TPF g-1 soil 24 hr-1). Dehydrogenase enzyme activity in soil serves as a crucial indicator of microbial activity, influenced by factors such as crop age, fertilizer addition, and soil characteristics. Microbial presence depends on various factors like chemical composition, moisture, pH, and structure, impacting nutrient transformations into available forms. The observed higher dehydrogenase activity with microbial consortia application is attributed to a combination of microorganisms promoting nitrogen fixation, mineralization, and nutrient solubilization, consequently increasing the microbial population in the soil. This aligns with findings by Yuvaraj (2016), indicating a positive correlation between organic carbon content, microbial population, and dehydrogenase activity.

It was observed that Significantly higher urease enzyme activity in the treatment of 75% NPK + 7.5 t ha-1 microbial enriched USWC (T_7), recording 72.31 µg NH4-N g-1 soil h-1, over the absolute control (T_1: 23.16 µg NH4-N g-1 soil h-1). Urease, pivotal in urea breakdown, exhibited increased activity in treatments involving urban compost and inorganic fertilizer, likely due to their higher nitrogen content and N release through compost mineralization. This aligns with Amanda Shylla (2012), who reported the addition of organics with chemical fertilizers led to increased urease activity. The higher nitrogen content in the soil stimulated microbial activity, resulting in enhanced urease activity.

Significantly higher acid phosphatase activity was observed with 75% NPK + 7.5 t ha-1 microbial enriched USWC (T_7), recording 125.07 µg PNP g-1 soil h-1, against the absolute control (T1: 52.50 µg PNP g-1 soil h-1). The application of organics into the soil enhanced mineralization, providing carbon as an energy source for P solubilizers. This increase in activity may be attributed to higher phosphorus levels from organics, promoting the proliferation of P solubilizers. The elevated enzyme activities in organically amended soils are often linked to increased organic substrate inputs, stimulating microbial growth and enzyme synthesis, These findings align with Kaur and Reddy (2014), who reported similar results using phosphate-solubilizing bacteria for maize crop yield.

Consulsion

The enriched compost treatments played a crucial role in promoting sustainable nutrient release, as evidenced by a substantial increase in nitrogen, phosphorus, potassium, and available sulfur. Additionally, the enriched compost significantly elevated the levels of DTPA-extractable Cu, Zn, Fe, Mn, and B, while keeping levels of chromium, nickel, lead, and cadmium below critical limits, ensuring the safety of the soil environment.

Recommendations:

Incorporation of enriched urban compost into agricultural practices for sustainable and enhanced soil health. This integration is crucial for optimizing soil structure, fostering sustainable nutrient management, and supporting microbial activities. Farmers and agricultural practitioners are advised to consider the enriched urban compost as a valuable resource for promoting agricultural sustainability, mitigating climate change impacts, and ultimately enhancing overall agricultural productivity. Regular monitoring and further research on the long-term effects of enriched urban compost application are also recommended to ensure its continued positive impact on soil quality and agricultural sustainability.

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