Advances in Crop Science and Technology

Choudhary et al., Adv Crop Sci Tech 2017, 5:3
DOI: 10.4172/2329-8863.1000292

Research Article OMICS International

Crop Yield and Soil Characteristics as Affected by Composts from Different Organic Materials with Spent Wash

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Received date: May 27, 2017; **Accepted date:** June 01, 2017; **Published date:** June 08, 2017

Abstract

Compost application in soil increases the supply of nutrients to the crops. Compost from different organic materials like municipal solid waste and sugarcane press mud are rich source of nutrients which are essential for plant growth. The application of municipal solid waste compost (MSWC) and sugarcane press mud compost are rapidly becoming popular worldwide to enhance and sustain soil organic matter and crop productivity. A pot experiment was conducted to study the nutrients availability and uptake by the plants by the application of two different composts with spent wash. The treatments was as: T_1 Chemical fertilizer N,P,K recommended; T_2 Sugarcane press mud compost at 2.5 t ha^{-1}; T_3 Sugarcane press mud compost at 5 t ha^{-1}; T_4 Municipal solid waste compost at 2.5 t ha^{-1}; T_5 Municipal solid waste compost at 5 t ha^{-1}; T_6 Sugarcane press mud compost (2.5 t ha^{-1})+Spent wash (10%); T_7 Sugarcane press mud compost (5 t ha^{-1})+Spent wash (10%); T_8 Municipal solid waste compost (2.5 t ha^{-1})+spent wash (10%); T_9 Municipal solid waste compost (5 t ha^{-1})+spent wash (10%); T_{10} Spent wash (10%) The experiment was arranged in completely randomized design (CRD) with three replications. Compost and soil in all treatments was analyzed for N, P, K, Zn, Cu, Fe and Mn. The information generated from this work was helpful to estimate the importance of municipal solid waste compost and sugarcane press mud compost with spent wash on nutrient availability in soil and plant system and to observe the response of tomato crop to compost application. The results showed that availability of all macro and micro nutrients was high in Treatment receiving MSWC at the rate of 5 t ha^{-1} with 10% spent wash irrigation.

Keywords: Crop yield; Soil characteristics; Organic materials; Compost; Spent wash; Sugarcane press mud

Introduction

The use of compost in the soil is appropriate way for maintaining organic matter and nutrient elements of the soil required for plants development. The result of compost on the quantity of micro elements in the soil and found that soils with compost application confirmed a better concentration of zinc, copper and iron as compared to chemical fertilizer treated soils. In the same way, other research investigating the cause of fertilizers and compost on the chemical properties of the soil, the quantity of Iron in the compost applied was greater than that in control and fertilizer treatment. The use of MSW compost with other materials of organic carbon for agricultural and horticultural purposes tends to positive changes in the physical, chemical, physico-chemical and biological properties of soil, and this consequently increases plant yield. Spent wash is extremely rich in natural component and have high BOD value. Due to its richness in nutrients its application for the agricultural uses is very common. The use of spent wash increase in organic matter, nutrient and soluble carbon has been formerly reported. Application of spent wash for the agriculture purposes also keep away from many ecological risks connected with the water pollution [1]. Use of spent wash in agriculture prevents water pollution and also a rich source of fertilizer. Spent wash with tube well water increase the uptake of nutrients in leafy vegetables of cabbage and mint leaf, condiments and root vegetables, leaf vegetables nutrients of pulses in untreated and treated soil [2]. Onwudiwe et al. [3] studied the effect of composted (MSW) on some soil physical properties and also the effect of combined application of MSW and NPK 20:10:10 fertilizer on maize. Results showed that maize yield was significantly increased by the application of MSW. Combined application of MSW and NPK fertilizer resulted to higher yield in maize than sole application of either MSW or NPK fertilizer and combined application of MSW with NPK performed better than sole application of either MSW or NPK fertilizer. Kavitha and Subramanian conducted that enrichment process of compost with spent wash increased the nutritive value of compost. The higher nitrogen content (1.75%) and phosphorus content (1.16%) was observed in the compost enriched with spent wash. Zahra et al. [4] investigated the effect of compost. The results showed that the fertilizer treatments and the years of application had significant effects on the concentration of micro elements in medicinal plant of mint and also in soils. T_6 which is 40 t/ha showed high amount of micronutrients in the soil and also in the plant. Xin et al. conducted a field experiment with to maize hybrids during 2002-2003 in Taiwan, Shandong, and china. Five fertilizer treatments were designed as: wheat straw (7500 kg ha^{-1})+12 rotted chicken manure (120 kg ha^{-1}), rotted chicken manure (5500 kg ha^{-1})+N fertilizer (120 kg ha^{-1}), high N fertilizer (600 kg ha^{-1}), medium N fertilize (300 kg ha^{-1}), and control treatment (no fertilizer). The effects were investigated on yield of maize and physicochemical properties of topsoil. However, first year yield of maize was not enhanced by wheat straw+N fertilizer. Both hybrids showed similar responses to the different treatments. Onwudiwe et al. [3] studied the effect of composted (MSW) on some soil physical properties and also the effect of combined application of MSW and NPK 20:10:10 fertilizer on maize. Results showed that maize yield was significantly increased by the application of MSW. Combined application of MSW and NPK fertilizer resulted to higher yield in maize than sole application of either MSW or NPK fertilizer and combined application of MSW with NPK performed better than sole application of either MSW or NPK fertilizer. Mohammad et al. [5] carried out the experiment. Results showed that addition of organic fertilizers at rate of 20 ton ha^{-1} significantly increased tomato growth and yield compared to control. Compost and poultry manure had a synergistic effect on both fresh and dry weights of tomato shoots and roots and compared to other treatments. They concluded that use of organic fertilizers especially in composted form had positive effect on soil health and fertility, which consequents increase yield in long term can be expected. Sukanya and Meli reported the response of wheat to graded dilution of distillery effluent on nutrient content, uptake and availability of nutrients in soil. Results indicated that a higher dilution level of 1:50 recorded significantly higher yield (52.59 q ha^{-1}) than other dilution levels. The nutrient contents in plants showed significant variation due to dilution levels. However, total nutrient uptake by Crop was significantly higher at 1:50 dilution level as it produced maximum biomass and economic yield.

Materials and Methods

The present study was carried out at PMAS-Arid Agriculture University, Rawalpindi in 2013-14. Municipal solid waste compost, sugarcane press mud compost and spent wash was collected from Lahore compost (Pvt) Ltd., Lahore, and Shakarganj Mills (Pvt) Ltd, Jhang, respectively. Experiment was conducted in 2013 to check the effect of municipal solid waste compost and sugarcane press mud compost with spent wash on yield of Tomato and soil fertility. The experiment design was Completely Randomized Design (CRD). The tomatoes were sown in pots with three replications. Following treatments were applied.

T_1=Control,

T_2=Chemical fertilizer N, P, K (120, 90, 60 kg ha^{-1}),

T_3=Sugarcane press mud compost at 2.5 t ha^{-1},

T_4=Sugarcane press mud compost at5 t ha^{-1},

T_5=Municipal solid waste compost at 2.5 t ha^{-1},

T_6=Municipal solid waste compost at 5 t ha^{-1},

T_7=Sugarcane press mud compost (2.5 t ha^{-1})+spent wash (10%),

T_8=Sugarcane press mud compost (5 t ha^{-1})+spent wash (10%),

T_9=Municipal solid waste compost (2.5 t ha^{-1})+spent wash (10%),

T_{10}=Municipal solid waste compost (5 t ha^{-1})+spent wash (10%),

T_{11}=Spent wash (10%).

Soil parameters

Electrical conductivity of the soil solution was determined by conductivity meter. Soil pH was determined using soil to water ratio of 1:2.5 suspension [6]. Soil texture was determined by Bouyoucos Hydrometer method [7]. Total organic carbon was determined by the procedure described by Nelson and Sommers [8]. Nitrate nitrogen was determined by transnitration of salicylic acid method and absorbance was recorded using spectrophotometer at 410 nm. Available phosphorus (P) was determined by Olsen's method and transmittance was recorded by using Spectrophotometer [9]. Extractable K was determined using neutral 1N ammonium acetate. Micronutrients (Zn, Cu, Fe and Mn) was determined by using digested extract by ammonium bicarbonate-DTPA on atomic absorption spectrophotometer at suitable wavelengths of 880 and 420 nm.

Plant parameters

Plant samples was taken at harvesting stage for macronutrients (N, P and K), micronutrients (Fe, Cu, Zn and Mn) uptake determination. Plant sample was oven dried at 60-70°C up to constant weight. The oven dried sample was ground to powder form and stored in clean dry plastic bottle. Total Nitrogen (N) and total Phosphorus (P) was determined by colorimetric analysis of digested plant samples and absorbance of samples was measured using spectrophotometer at 665 nm and 880 nm respectively [10]. Total potassium and micronutrients (Fe, Cu, Zn and Mn) was determined by dry ashing [11].

Results and Discussion

Soil reaction

The results showed that different compost with spent wash effect the soil pH. The maximum soil pH (7.55) was observed chemical fertilizer application, followed by (7.51) pH in control. The lowest soil pH (7.42) was recorded in municipal solid waste compost with 10% spent wash application. This data correlate with which said that organic fertilizers slightly decrease the pH of soil, which was due to the release of H^+ ions during the nitrification process of organic and inorganic fertilizers.

Electrical conductivity

The data showed that EC of soil was significantly varied with treatments. The highest EC was recorded (0.16 dS m^{-1}) in two treatments, one which has application of NPK chemical fertilizers and second having only spent wash application. Sarir et al. reported that inorganic fertilizers slightly increase the soil EC. Chidankumar et al. [2] said that the application of spent wash to the soil causes increase in soil EC.

Soil organic matter

The data indicate that there was significant increase in soil organic matter content by the application of inorganic and organic fertilizers. The lowest organic matter was recorded in control that was 0.52%. Among different compost treatments the minimum organic matter was in treatment with sugarcane press mud compost at 2.5 t ha^{-1}. The highest organic matter content was recorded in treatment receiving municipal solid waste compost in addition with 10% spent wash. Mohammad et al. [5] reported that application of organic amendments raised the soil organic contents.

These results are due to compost application, as the organic material present in compost is decomposed, it increases the organic carbon stock in soil. This effect was due to the high negative charge of organic matter and increased C/N ratio. This is important for retaining nutrients and making them available to plants. Fibrous nature and high carbohydrate content in spent wash may also be a rich source of carbon in it which ultimately after application to the soil increases carbon in soil.

Nitrate nitrogen

Among all the treatments the highest contents of soil nitrogen (10.71 mg kg^{-1}) were with municipal soild waste compost (MSWC) applied at the rate of 5 t ha^{-1} along with 10% spent wash in irrigation water. It was followed by MSWC at the rate of 2.5 t ha^{-1} with 10% spent wash (SW) having 10.47 mg kg^{-1} N concentration. The lowest concentration (7.11 mg kg^{-1}) was recorded with the treatment of sugarcane press mud compost (SPMC) at the rate of 2.5 t ha^{-1}. There was significant difference between compost along with SW and chemical fertilizer.

When applied at 5 t ha^{-1} SPMC as compared to 2.5 t ha^{-1} SPMC, there was significant difference observed. Similarly, when 5 t ha^{-1} against 2.5 t ha^{-1} MSWC was applied significant increase (7.57 mg kg-1) was recorded in nitrate nitrogen. Significant increase was recorded when compost along with spent wash was applied compared to compost without spent wash. Zafar et al. [12] conducted an experiment to study the effect of compost on nitrate nitrogen. Results showed that among different rates of compost there was significant increase in nitrate nitrogen and highest improvement (7.65 mg kg^{-1}) was recorded in highest rate of compost applied. The distillery spent wash is essentially a plant extract and contains high level of plant nutrients which were made available to the plants, thus resulting in better growth, development and yield of the crop.

These results are due to incorporation of compost along with spent wash in soil which enhances the soil ammonium nitrogen concentration and soil nitrate nitrogen concentration. The enhancement in soil ammonium nitrogen and nitrate nitrogen might be due to the inherent higher value of N in the compost with spent wash. Since the compost was rich in nitrogen, the build-up of NO_3-N and NH_4-N in the soil was due to the release of mineralizable nitrogen from the constituents in the compost by the nitrification process. Release of N from compost in the soil is controlled by the balance among immobilisation of mineral N (nitrate, nitrite, and ammonium) into microbial biomass, mineralization of organic N (from manure and biomass) to mineral forms, and losses of N via leaching, ammonia volatilization, and volatile losses of NO and N through denitrification.

Available phosphorus

Among all the treatments, the lowest soil available phosphorus concentration (4.45 mg kg^{-1}) was recorded with treatment of only 10% spent wash application. It was followed by the treatment SPMC at the rate of 2.5 t ha^{-1} having 4.65 mg kg^{-1} concentration of available phosphorus.

The highest concentration of soil available phosphorus (6.40 mg kg^{-1}) among all treatments was recorded with MSWC at rate of 5 t ha^{-1} along with 10 % SW. It was followed by chemical fertilizers having 6.17 mg kg^{-1} phosphorus concentration (Table 1). When we applied 5 t ha^{-1} SPMC compared to 2.5 t ha^{-1} SPMC, there was significant difference observed.

Treatments	pH	EC	SOM	N	P	K	Fe	Mn	Cu	Zn
T_1	7.51	0.10	0.52	6.81	4.26	96.10	1.95	1.09	0.25	0.74
T_2	7.55	0.16	0.79	8.66	6.17	124.20	1.91	0.96	0.22	0.78
T_3	7.46	0.12	0.60	7.11	4.65	103.51	2.06	1.16	0.30	0.84
T_4	7.51	0.12	0.76	7.66	4.81	110.29	2.13	1.25	0.34	0.92
T_5	7.44	0.13	0.64	7.29	4.78	109.37	2.10	1.19	0.30	0.88
T_6	7.52	0.14	0.78	7.57	4.97	118.52	2.16	1.29	0.36	0.96
T_7	7.52	0.15	0.86	9.77	5.11	129.97	2.15	1.25	0.35	1.03
T_8	7.53	0.16	0.97	9.88	5.47	137.84	2.24	1.33	0.41	1.10
T_9	7.44	0.15	0.87	10.47	5.62	133.63	2.23	1.35	0.37	1.07
T_{10}	7.42	0.15	1.04	10.71	6.40	142.62	2.33	1.44	0.46	1.13
T_{11}	7.45	0.16	0.85	7.21	4.45	131.70	2.16	1.25	0.34	0.95

Table 1: Effect of MSWC and SPMC along with spent wash on soil EC (dSm^{-1}),SOM(%), N, P, K, Fe, Zn, Cu and Mn (mg kg^{-1}).

Likewise, when 5 t ha^{-1} against 2.5 t ha^{-1} MSWC was applied significant increase (4.97 mg kg^{-1}) was recorded in phosphorus. Significant increase was recorded when compost along with SW was applied compared to compost without spent wash. Kasthori et al. conducted a pot experiment to compare the effect of MSWC and SPMC with and without SW irrigation. The results showed that available phosphorus content was 5.65 mg kg^{-1} in only compost application and 7.10 mg kg^{-1} in compost along with SP irrigation. Municipal solid waste compost has been reported to effectively supply P to soil with soil P concentration increasing with increasing application rates. Plant uptake of P was increased with the addition of MSW compost and uptake increased with application rate specifically in strawberries and tomatoes.

These results are due to increase in availability of the phosphorus with the organic acids released during decomposition of municipal solid waste compost, which formed stable complexes or chelates with cations responsible for phosphorus fixation and in turn could have increased its availability. The application of compost reduced the phosphorus fixation in the soil and increased the microbial activity, thus making it more available to the plants.

Extractable potassium

Contents of extractable potassium in soil are presented in Table 1. The highest extractable potassium concentration (142.62 mg kg^{-1}) was recorded with MSWC at the rate of 5 t ha^{-1} along with 10% SW irrigation. It was followed by 137.84 mg kg^{-1} in the soil with SPMC along with 10% SW. The lowest potassium concentration (96.10 mg kg^{-1}) was recorded in control. When applied 5 t ha^{-1} SPMC compared to 2.5 t ha^{-1} SPMC, there was significant difference observed. Similarly when 5 t ha^{-1} against 2.5 t ha^{-1} MSWC was applied significant increase was recorded in potassium content. This highest potassium content was due to the spent wash application, which have high amount of potassium concentration. Kavitha and Subramanian conducted an experiment to study the effect of enriched compost application compare with compost. Results showed that enriched compost showed highest potassium content (140.35 mg kg^{-1}). These results are due to the treatments that are a rich source of K, probably due to the large proportion of woody plant material and kitchen refuse in the raw material and composition of spent wash as it is highly enriched with potassium due to sugarcane as it requires high application of inorganic K fertilizers for sweetness. When spent wash is applied to soil potassium is more available to plants then other nutrients in soil.

Zinc: According to the data among all treatments highest Cu concentration (0.46 mg kg^{-1}) was recorded with MSWC at the rate of 5 t ha^{-1} along with 10% spent wash. The minimum Zn concentration (0.22 mg kg^{-1}) was recorded with chemical fertilizer application. Among different rates of compost, there was significant difference was recorded. Compost at the rate of 5 t ha^{-1} was significantly high compare to compost at rate of 2.5 t ha^{-1}. Significant increase was recorded when compost along with SW was applied compared to compost without spent wash. Kochakinezhad et al. conducted an experiment to compare the effect of four different fertilizers on tomato. The results showed that zinc concentration was high (0.90 mg kg^{-1}) in MSWC at the rate of 5 t ha^{-1}. Municipal solid waste compost tended to increase total soil Zn concentrations when compared to unamended controls. It has been reported that only a small fraction of Zn in MSW compost was leachable, however, some research reported some downward movement of Zn through the profile when MSW compost was applied.

Copper: According to the data the highest Cu concentration (0.46 mg kg^{-1}) was recorded with MSWC at the rate of 5 t ha^{-1} along with 10% spent wash. The minimum Cu concentration (0.22 mg kg^{-1}) was recorded with chemical fertilizer application. Compost at the rate of 5 t ha^{-1} was significantly high compare to compost at rate of 2.5 t ha^{-1}. Significant increase was recorded when compost along with SW was applied compared to compost without spent wash. Kochakinezhad et al. conducted an experiment to compare the effect of four different fertilizers (chemical fertilizers, MSWC, SPMC and cattle manure) on tomato. The results showed that copper concentration was high (0.40 mg kg^{-1}) in MSWC at the rate of 5 t ha^{-1}.

Total and extractable soil Cu concentrations have been reported to increase when soil was amended with MSW compost and Cu has the potential to move down the soil profile. Subsequent use of spent wash irrigation enriches the soil fertility without any adverse effect. Spent wash contains adequate amount of copper that is available to plants hence increases copper contents in soil.

Manganese: Among all treatments highest Mn concentration (1.44 mg kg^{-1}) was recorded with MSWC at the rate of 5 t ha^{-1} along with 10% SW. The lowest Mn concentration (0.96 mg kg^{-1}) was recorded with chemical fertilizer application. Compost at the rate of 5 t ha^{-1} was significantly high compare to compost at rate of 2.5 t ha^{-1}. Significant increase was recorded when compost along with SW was applied compared to compost without spent wash. Tonfack et al. studied the effect of organic and inorganic fertilizers on soil micro nutrients availability. The results showed that manganese content was lowest with chemical fertilizer application. Total soil Mn concentrations tended to increase with addition of MSW compost. The largest portion of Mn in soil treated with MSW compost was found to be bound in the iron manganese fraction, which is unavailable to plants.

Iron: Among all treatments highest Fe concentration (2.33 mg kg^{-1}) was recorded with MSWC at the rate of 5 t ha^{-1} along with 10% SW. The lowest Fe concentration (1.91 mg kg^{-1}) was recorded with chemical fertilizer application. Among different rates of compost, there was significant difference was recorded. Compost at the rate of 5 t ha^{-1} was significantly high compare to compost at rate of 2.5 t ha^{-1}. Significant increase was recorded when compost along with SW was applied compared to compost without SW. Kumar et al. [13] studied the effect of SPMC and MSWC on soil micro nutrients availability. The results showed that iron content was highest 2.45 with MSWC at the rate of 10 t ha^{-1}.

These results might be due to the application of compost because municipal solid waste compost contains considerable amount of iron contents. The iron present in compost releases in soil when compost applied and iron is available to plants. Irrigation with diluted distillery spent wash for tomato releases high amount of iron to soil due to its composition. This iron might be more available to plant as compare to raw water irrigation [2].

Total nitrogen

The maximum total nitrogen concentration 3.91% was observed in municipal solid waste compost at 5 t ha^{-1} with spent wash treatment. While the minimum total nitrogen contents 2.73% was recorded in control. Among different compost the maximum nitrogen contents 3.24% was observed in municipal solid waste compost at 5 t ha^{-1} followed by 3.14% in sugarcane press mud compost at 5 t ha^{-1} treatment, while the minimum nitrogen concentration 2.95% was observed in sugarcane press mud compost at 2.5 t ha^{-1} treatment. The findings of Mohammad et al. are in favor of my result. Their study indicates that the application of organic and inorganic fertilizer application increase nitrogen contents in tomato plant. Compost applied at the rate of 5 t ha^{-1} give high contents of nitrogen (3.30%).

These results are due to the positive effect of organic fertilizers added to soil may be attributed to stimulating the activity of bacteria which promote the released availability of N in the soil and enhances nitrogen absorption by tomato roots. Incorporation of compost with spent wash in soil which enhances the soil ammonium nitrogen concentration and soil nitrate nitrogen concentration. The enhancement in soil ammonium nitrogen and nitrate nitrogen might be due to the inherent higher value of N in the compost with spent wash. Since the spent wash is rich in nitrogen and this nitrogen is taken up by the plants through water increases N contents in plant.

Total phosphorus

The minimum phosphorus concentration 0.45% was observed in control, while the maximum nitrogen 0.73% was recorded in NPK chemical fertilizer treatment. In only composts application the maximum nitrogen 0.63% was observed in municipal solid waste

Citation: Choudhary AN, Farooq MS, Zeeshan M, Khan G, Choudhary TK, et al. (2017) Crop Yield and Soil Characteristics as Affected by Composts from Different Organic Materials with Spent Wash. Adv Crop Sci Tech 5: 292. doi:10.4172/2329-8863.1000292

compost at 5 t ha^{-1}, followed by 0.59% in sugarcane press mud compost at 5 t ha^{-1}. The minimum phosphorus 0.51% was recorded in sugarcane press mud compost at 2.5 t ha^{-1}. Sukanya and Meli conducted an experiment to check the effect of organic amendments on macro nutrients concentration in tomato plants (Table 2). The results showed that high rate of organic fertilizer increase phosphorus contents (0.57 %) in plant. Plant uptake of phosphorus increased with the addition of MSW compost and uptake increased with application rate specifically in strawberries and tomatoes.

Treatments	N	P	K	Fe	Mn	Cu	Zn
T_1	2.73	0.45	4.51	413.2	87.4	22.3	7 1
T_2	3.31	0.73	5.02	289.9	74.3	15.57	54
T_3	2.95	0.51	4.62	459.5	96.4	28.67	80
T_4	3.14	0.59	4.77	498.7	129.2	36.2	90
T_5	3.04	0.53	4.8	476.3	97.8	31.4	87
T_6	3.24	0.63	4.92	528.9	147.4	38.7	96
T_7	3.36	0.53	5.19	532.8	223.6	32.4	137
T_8	3.5	0.62	5.43	558.4	284.3	39.7	219
T_9	3.76	0.58	5.37	541.7	236.8	34.4	185
T_{10}	3.91	0.69	5.65	588.4	296.8	41.03	273
T_{11}	3.27	0.53	5.09	446.9	102.6	24.8	80

Table 2: Effect of MSWC and SPMC with spent wash on nutrient concentration in tomato plant N, P and K (%); Fe, Zn, Cu and Zn (mg kg^{-1}).

Total potassium

The maximum potassium concentration 5.65% was observed in soil treated with municipal solid waste compost at 5 t ha^{-1} with 10% spent wash irrigation and the minimum potassium 4.51% was recorded in control. Among different composts the maximum potassium 4.92% was observed in municipal solid waste compost and minimum 4.62% in sugarcane press mud compost (Table 3). These results are in the line of Sukanya and Meli. Large amount of potassium was due to the spent wash application because spent wash is so rich in potassium. Potassium nutrition is generally improved when plants were supplied with organic fertilization like compost.

Treatments	Plant Height(inches)	No. of Plants	Yield (g)
T_1	22.3	8.33	291.67
T_2	31.66	14.33	556.67
T_3	26.33	12.66	381.67
T_4	29.33	14.33	493.45
T_5	30.43	13.66	426.33
T_6	34.54	16	560.00
T_7	42.66	17.66	681.87
T_8	41.66	19.66	818.33
T_9	40.33	19	678.45
T_{10}	42.66	22.33	1013.3
T_{11}	32.33	13.33	533.54

Table 3: Effect o municipal solid waste compost and sugarcane press mud compost with swash on growth of t.

Zinc: The maximum zinc concentration 273 mg kg^{-1} was observed with municipal solid waste compost at 5 t ha^{-1} with 10% spent wash and minimum 54 mg kg^{-1} in NPK chemical fertilizers. Among different composts the maximum zinc concentration 96 mg kg^{-1} was observed in municipal solid waste compost and minimum in sugarcane press mud compost at 2.5 t ha^{-1}. When applied 5 t ha^{-1} SPMC compared to 2.5 t ha^{-1} SPMC, there was significant difference observed. Similarly when 5 t ha^{-1} against 2.5 t ha^{-1} MSWC was applied significant increase (96 mg kg^{-1}) was recorded. Significant increase was recorded when compost along with spent wash was applied compared to compost without spent wash. Kochakinezhad et al. made experiment on tomato crop to compare the effect of organic amendments and chemical fertilizers on tomato crop. The highest contents (101 mg kg^{-1}) was recorded in compost.

The addition of organic amendments to the soil leads to increase the Zn concentration in tomato plants. Compost and spent wash are rich in micro nutrients and their uptake is also enhanced through these amendments [12]. This was due to increased quantity of effluent added in the form of irrigation and mineralization induced through microorganisms.

Copper: The maximum copper concentration (41.03 mg kg^{-1}) was observed in treatment receiving municipal solid waste compost at 5 t ha^{-1} with 10% spent wash irrigation, followed by (39.7 mg kg^{-1}) in sugarcane press mud compost at 5 t ha^{-1} with 10% spent wash. The minimum copper concentration (15.57 mg kg^{-1}) was observed in NPK chemical fertilizer.

These results are due to addition of compost along with spent wash provided extra copper. Although the composts were good sources of copper the amount contained in the relatively small amount of compost added in comparison to the quantity. Spent wash release reasonable amount of copper in soil and that copper is taken up by plants through water [14].

Manganese: The maximum iron contents (236.80 mg kg^{-1}) was observed in treatment receiving municipal solid waste compost at 5 t ha^{-1} with 10% spent wash irrigation, followed by (284.3 mg kg^{-1}) in sugarcane press mud compost at 5 t ha^{-1} with 10% spent wash. The minimum copper concentration (74.3 mg kg^{-1}) was observed in NPK chemical fertilizer. Kochakinezhad et al. conducted an experiment on tomato crop to test the effect of chemical fertilizers and compost on yield and plant nutrient concentration. The results about manganese were 150 mg kg^{-1} was observed in compost application.

These results are due to the application of compost and spent wash increase soil Mn contents and that Mn taken up by plants. So Mn concentration in plant will be more as compare to others.

Iron: The maximum manganese contents (588.4 mg kg^{-1}) was observed in treatment receiving municipal solid waste compost at 5 t ha-1 with 10% spent wash irrigation, followed by (558.4 mg kg^{-1}) in sugarcane press mud compost at 5 t ha^{-1} with 10% spent wash. The minimum copper concentration 289.9 mg kg^{-1} was observed in NPK chemical fertilizer. When SPMC applied at rate of 5 t ha^{-1} compared to 2.5 t ha^{-1} SPMC, there was significant difference observed. Similarly when 5 t ha^{-1} against 2.5 t ha^{-1} MSWC was applied significant increase (528.9 mg kg^{-1}) was recorded. Significant increase was recorded when compost along with spent wash was applied compared to compost without spent wash.

These results are due to the addition of organic amendments to the soil leads to increase the Fe concentration in tomato plants. Compost and spent wash are rich in micro nutrients and their uptake is also enhanced through these amendments. This was due to increased quantity of effluent added in the form of irrigation and mineralization induced through microorganisms.

Plant height

The maximum plant height 42.66 inches was recorded in soil treated with municipal solid waste compost 5 t ha^{-1} with 10% spent wash irrigation followed by 41.66 inches in sugarcane press mud compost at 5 t ha^{-1} with 10% spent wash. The minimum plant height 22.3 inches was observed in control. The statistical analysis of data about plant height showed that treatments were significant among each other.

The results showed that height of tomato plant was increased with application of fertilizers weather organic or inorganic fertilizers. Adekiya and Agbede [15] made an experiment on tomato and results showed that maximum plant height 40.65 inches was recorded when poultry litre was applied. These results are due to the plants are able to absorb maximum amount of nutrients from the soil and spent wash resulting increase in good growth.

Number of fruits per plant

The maximum No. of fruit per plant 22.33 was recorded in soil treated with municipal solid waste compost 5 t ha^{-1} with 10% spent wash irrigation followed by 19.66 in sugarcane press mud compost at 5 t ha^{-1} with 10% spent wash. The minimum No. of fruit per plant was observed in control (Table 1). Mohammad et al. [5] conducted an experiment on tomato crop and results indicate that maximum No. of fruits was obtain from maximum compost application.

Tomato yield

The minimum fruit weight 291.67 g was recorded in control followed by 381.67 g in soil treated by sugarcane press mud compost at 2.5 t ha^{-1}. The maximum fruit weight per plant 1013.3 g was observed in treatment received municipal solid waste compost at 5 t ha^{-1} with 10% spent wash irrigation followed by 678.33 g in sugarcane press mud compost at 5 t ha^{-1} with 10% spent wash irrigation. These results may be due to the fact that the spent wash treated soil is enriched with the plant nutrients N.P.K. and spent wash increase soil enzymatic activity ultimately increase the plant growth and yield. The distillery spent wash is essentially a plant extract and contain high level of plant nutrients which were made available to the plants, thus resulting in better growth, development yield of the crop.

Conclusion

The results of two different compost along with spent wash showed better results as compare to single compost application. Compost along with spent wash give better plant growth same good crop production. Spent wash can be used as organic fertilizer in diluted form.

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