

Original Research Article

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## Yield and Water Productivity Response of Rice to Application of Urban Compost

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### ABSTRACT

The present research was conducted with an objective to study the influence of varying rates of urban compost in combination with recommended dosage of fertilizers (RDF) on yield and yield components of rice variety, BPT 5204. Field experiments were carried out for three years during *rabi* 2012-2015. The experiment was laid out in a randomized complete block design with three replicates. The urban compost was procured from two different dumping yard sources of Hyderabad. One is from Jawahar nagar dumping yard, which was established during 2002 and the second source is Autonagar, which is a more than 50 years old dumping yard. There were eight treatments comprising recommended dose of N,P,K (120:60:40 N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O kg ha<sup>-1</sup>), RDF + Farm Yard Manure (10 t ha<sup>-1</sup>), three rates of urban compost from Jawahar nagar (2.5, 5 and 10 t ha<sup>-1</sup>) + RDF and three rates of urban compost from Autonagar (2.5, 5 and 10 t ha<sup>-1</sup>) + RDF. Grain yield, straw yield, total dry matter yield, harvest index and water productivity were determined. Pooled data analysis results revealed that the beneficial effects of application of urban compost were enhanced at increased rates of application. The performance of rice was superior on the field fertilized with RDF plus 10 t ha<sup>-1</sup> urban compost from Jawahar nagar which was comparable to RDF plus 10 t ha<sup>-1</sup> urban compost from Autonagar. The highest grain yield (6,095 kg ha<sup>-1</sup>), straw yield (9926 kg ha<sup>-1</sup>), total dry matter yield (16021 kg ha<sup>-1</sup>), harvest index (37.63 %) and water productivity (7.73 kg ha<sup>-1</sup>) were recorded in plots applied with RDF + 10 t ha<sup>-1</sup> urban compost from Jawahar nagar. Therefore, it is evident that yield of rice can be increased significantly with the combined use of urban compost and chemical fertilizers.

#### Keywords

Inorganic fertilizers, Urban compost, Rice yield, Harvest index, Water productivity

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### Introduction

Rice (*Oryza sativa* L.) is an important staple food for billions of people. To assure food security in the rice-consuming countries of the world, farmers must produce more rice of

better quality to meet the demands of consumers in coming years (Peng and Yang, 2003). However, the average yield of rice has been stagnant and remained lower than the production potential. The causes of low yield of rice include low soil fertility, low organic

matter status, conventional cultivation system, improper management and the hazards of the climatic aberration. Soil fertility deterioration has become a major constraint to higher crop production. The increasing land use intensity with inadequate and unbalanced use of chemical fertilizers together with little or no use of organic manures have caused severe fertility deterioration of soils resulting in stagnating or even declining of crop productivity. Since organic matter is the fundamental resource for improving soil health, management of soil organic matter has now become a major issue in dealing with the problem of soil fertility and productivity.

A suitable combination of organic and inorganic source of nutrients is necessary for sustainable agriculture that can ensure food production with high quality (Reganold *et al.*, 1990). Integrated use of organic manure and chemical fertilizer would be quite promising not only in providing greater stability in production, but also in maintaining better soil fertility (Nambiar, 1991). Thus, it is necessary to find out site specific integrated use of nutrients from organic and inorganic sources for sustainable crop production.

With the development of modern societies in which raw consumerism and the culture of “throwaway” is on the agenda, the problem of urban solid waste is becoming ever greater. Land filling disposal of wastes contributes flooding, breeding of insect and rodent vectors, the spread of diseases and polluting ground water quality. Using a good strategy such as composting process, solid wastes can be converted into useful products for improvement of soils properties (Hashemimajd *et al.*, 2004; Sohrabi Yourtchi *et al.*, 2013). Urban compost can be considered as a valuable source of nitrogen (N), phosphorous (P), essential trace elements, and organic matter that will improve soil physical properties and plant

nutritional status (Bertoldi *et al.*, 1996; Zinati *et al.*, 2004; Kabirinejad and Hoodaji 2012). Furthermore, use of urban compost can reduce the agricultural demands for water, fertilizers and pesticides (Hoitink *et al.*, 1997; Weltzien, 1989; Sahin and Bolukbasi, 2009). Composting also extends the life of the municipal landfill by diverting organic materials from landfills to agricultural lands.

The highest biomass yield of boro rice (BRRI dhan50) viz., 925 g m<sup>-2</sup> was recorded in the plants applied with 10 ton ha<sup>-1</sup> of MSW compost and 100% RDF. The same treatment demonstrated the highest grain yield (6.3t/ha) and straw yield (9.90 t ha<sup>-1</sup>). Only MSW application compost even at 20 ton/ha was not comparable with recommended dose of fertilizer in producing rice yield (Aktar *et al.*, 2018). Kavitha and Subramanian, 2007 reported that the growth attributes viz., plant height, leaf area index, number of tillers and dry matter production increased significantly due to the application of enriched municipal solid waste compost (EMSWC). The highest grain yield and straw yield were observed in the treatment combination of 25% of enriched compost and 75% of recommended dose of inorganic fertilizer with value of 5.22 and 8.65 t ha<sup>-1</sup>, respectively. Application of 5 t ha<sup>-1</sup> enriched MSWC in combination with 25% N through inorganic fertilizer recorded grain yield of 4.33 t ha<sup>-1</sup>. The lowest grain yield (3.78 t ha<sup>-1</sup>) was recorded in treatment where the compost was applied alone. The potential of municipal solid waste compost (MSWC) was evaluated for rice cultivar using municipal solid waste compost (MSWC) and cow dung manure (CDM), with or without urea (U), and fertilizers (F). Dry matter accumulation was highest with CDM + U, followed by MSWC + U and F. Panicle length was the largest and thousand-grain-weight were the highest for F.

Application of CDM alone gave 30% higher grain yield over MSWC but the latter, along with urea, increased grain yield by 49% over MSWC alone (Bhattacharyya and Chakraborty 2003). Thus, there has been a growing interest in the use of urban compost as a source of nutrients in rice. This trial was, therefore, conducted to study the effect of combined application of urban compost and inorganic fertilizers on the growth and yield of rice variety BPT 5204.

### **Materials and methods**

Field experiments were conducted at College farm, PJTSAU, Rajendranagar to investigate the effect of urban compost in combination with inorganic fertilizers on the yield and water productivity of rice during *rabi* 2012-2015. Experiments were laid out in a randomized complete block design (RCBD) with three replicates. Rice variety BPT 5204 was used for the study. The net plot size was 13.0m x 6.0 m. Twenty five days old nursery of was transplanted in standing water with 20 cm row to row and 15 cm plant to plant distance. The different treatments used were:

T1- Recommended dose of N,P,K (RDF)

T2-RDF+ Farm Yard Manure (10 t/ha)

T3- RDF + Urban Compost - I (2.5 t/ha)

T4- RDF + Urban Compost - I (5.0 t/ha)

T5- RDF + Urban Compost - I (10.0 t/ha)

T6-RDF+ Urban Compost -II (2.5 t/ha)

T7- RDF+ Urban Compost -II (5.0 t/ha)

T8- RDF + Urban Compost -II (10.0 t/ha)

The urban compost was procured from two different dumping yard of Hyderabad. One

from Jawahar nagar (Urban Compost - I) where urban waste is managed in a scientific way by segregating the different materials, recycling of non biodegradable waste materials (plastic, metals, etc.) and composting bio degradable waste. Other from Autonagar (Urban Compost -II) which is a more than 50 years old dumping yard, where urban waste was just dumped without segregating bio degradable and non biodegradable waste material. The compost was formed naturally over a period of time. The compost from this place was collected just by screening.

The compost from both the sources were applied at three different rates (2.5, 5 and 10 t ha<sup>-1</sup>) along with recommended dose of N,P,K (120:60:40 N,P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O kg ha<sup>-1</sup>). All other agronomic practices were kept uniform to keep the crop free from pests. At maturity grain yield, straw yield, total dry matter yield, harvest index and water productivity were measured. Data pertaining to various parameters were tabulated and subjected to statistical analysis for interpretation of results.

### **Results and Discussion**

Analysis of data showed that all the yield and water productivity of rice was significantly affected by urban compost in combination with inorganic fertilizers (Table 1). Results indicated that the beneficial effects of application of urban compost were enhanced at increased rates of application (Fig. 1).

#### **Grain yield (kg ha<sup>-1</sup>)**

The analysis of data after rice crop indicated that the plots fertilized with urban compost from Jawahar nagar (Urban Compost-I) @ 10.0 t ha<sup>-1</sup> along with RDF of 120:60:40 N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O kg ha<sup>-1</sup> recorded significantly higher grain yield of 6,095 kg ha<sup>-1</sup> followed by the plots applied with urban compost from

Autonagar (Urban Compost –II) @ 10.0 t ha<sup>-1</sup> along with RDF of 120:60:40 N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O kg ha<sup>-1</sup> and were on par with urban compost application @ 5.0 t ha<sup>-1</sup> and significantly superior over rest of the treatments. Significantly lower yield of 4,635 kg ha<sup>-1</sup> was recorded in plots applied with RDF of 120:60:40 N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O kg ha<sup>-1</sup> and was on par with application of FYM 10 t ha<sup>-1</sup> and urban compost of both sources @ 2.5 t ha<sup>-1</sup>. The pronounced effect of yield of rice might be due to the decomposition of compost which forms easily available nutrients like N, P, K as well as micronutrients such as Zn, Fe, Mn and Cu. Compost act as a slow releasing fertilizer and it supplies plant nutrients slowly but continuously (Kavitha and Subramanian 2007).

### **Straw yield (kg ha<sup>-1</sup>)**

Application of Urban Compost–I @ 10.0 t ha<sup>-1</sup> along with RDF produced significantly higher straw yield over other treatments. The straw yield due to the different treatments ranged from 12,838 to 16,021 kg ha<sup>-1</sup>. The highest straw yield of 16,021 kg ha<sup>-1</sup> was obtained in the treatment T<sub>5</sub> (Urban Compost–I @ 10.0 t ha<sup>-1</sup> + RDF). The lowest straw yield of 12,838 kg ha<sup>-1</sup> was recorded in the treatment T<sub>1</sub> (RDF). The straw yields of rice in all the treatments were always higher to the corresponding grain yields. Rice plants treated with urban compost encouraged rapid vegetative growth leading to the production of higher straw yield.

### **Total dry matter yield (kg ha<sup>-1</sup>)**

Maximum total dry matter yield (16,021 kg ha<sup>-1</sup>) was recorded in T<sub>5</sub> (Urban Compost–I @ 10.0 t ha<sup>-1</sup> +RDF) which was statistically at par with T<sub>8</sub> (Urban Compost–II @ 10.0 t ha<sup>-1</sup> +RDF). Significantly lowest total dry matter yield (12,837.67 kg ha<sup>-1</sup>) was obtained from

T<sub>1</sub> (RDF). Higher total dry matter yield might be due to the increase in growth and yield attributes. Maximum dry matter accumulation recorded from plots receiving urban compost could be due to better mineralization of urban compost and synchronization of nutrient release with crop growth stage, this timely nutrient availability might have increased the crop growth rate and dry matter partitioning in stem and leaves.

### **Harvest index (%)**

Harvest index (HI) is the ratio of grain yield to total above ground plant yield. According to a pooled data, urban compost I @ 10 t ha<sup>-1</sup> + RDF had highest HI (37.63 %) followed by urban compost II @ 10 t ha<sup>-1</sup> + RDF (36.67 %). Higher yield and harvest index of urban compost I @ 10 t ha<sup>-1</sup> + RDF indicates better partitioning of photosynthetic substance to economic yield. Appreciably high harvest index shows the efficiency of converting biological yield into economic yield.

### **Water productivity (kg ha<sup>-1</sup>)**

Analysis of the effects of treatments on rice water productivity indicated that water productivity, kilograms of grain yield produced per millimeter of water used, differed significantly among treatments in all years. The lowest water productivity of 6.01 kg ha<sup>-1</sup> was obtained from the treatment T<sub>1</sub> (RDF). The treatment T<sub>5</sub> (Urban Compost–I @ 10.0 t ha<sup>-1</sup> +RDF) consistently had the highest water productivity of 7.73 kg ha<sup>-1</sup>. Our results indicated that urban compost application increased water productivity in all three years compared to the application of only RDF. Increased water productivity in the urban compost treatment observed here was due to increased supply of nutrient and improved soil properties that are crucial to higher crop root growth and increased productivity (Schlegel *et al.*, 2015).

Table 1: Effect of urban compost on grain, straw, total dry matter production, harvest index and water productivity of rice during rabi 2012- 15

Treatments	Grain yield (kg ha <sup>-1</sup> )				Straw yield (kg ha <sup>-1</sup> )				Total dry matter yield (kg ha <sup>-1</sup> )			
	2012-13	2013-14	2014-15	mean	2012-13	2013-14	2014-15	mean	2012-13	2013-14	2014-15	mean
<b>T1-RDF</b>	2684	5351	5869	4635	8024	9368	7217	8203	10708	14719	13086	12838
<b>T2-FYM (10.0)</b>	3009	5678	6671	5119	8417	9450	8510	8792	11426	15128	15181	13912
<b>T3-UC-I (2.5)</b>	2556	5419	6386	4787	8161	9872	8000	8678	10718	15291	14386	13465
<b>T4-UC-I (5.0)</b>	2911	6114	7294	5440	9351	9967	8919	9412	12262	16081	16213	14852
<b>T5-UC-I (10.0)</b>	3982	6754	7550	6095	9577	11383	8817	9926	13559	18137	16367	16021
<b>T6-UC-II (2.5)</b>	2783	5379	5984	4715	8338	10240	7489	8689	11121	15618	13474	13404
<b>T7-UC-II (5.0)</b>	3294	5882	6584	5253	9292	10294	8374	9320	12586	16176	14958	14573
<b>T8-UC-II (10.0)</b>	3736	6291	6958	5662	9746	11111	8170	9676	13483	17402	15128	15338
<b>SE. m</b>	185	112	334	140	416	374	390	180	435	393	578	260
<b>CD</b>	561	341	1015	426	1263	1134	NS	546	1320	1193	1754	790

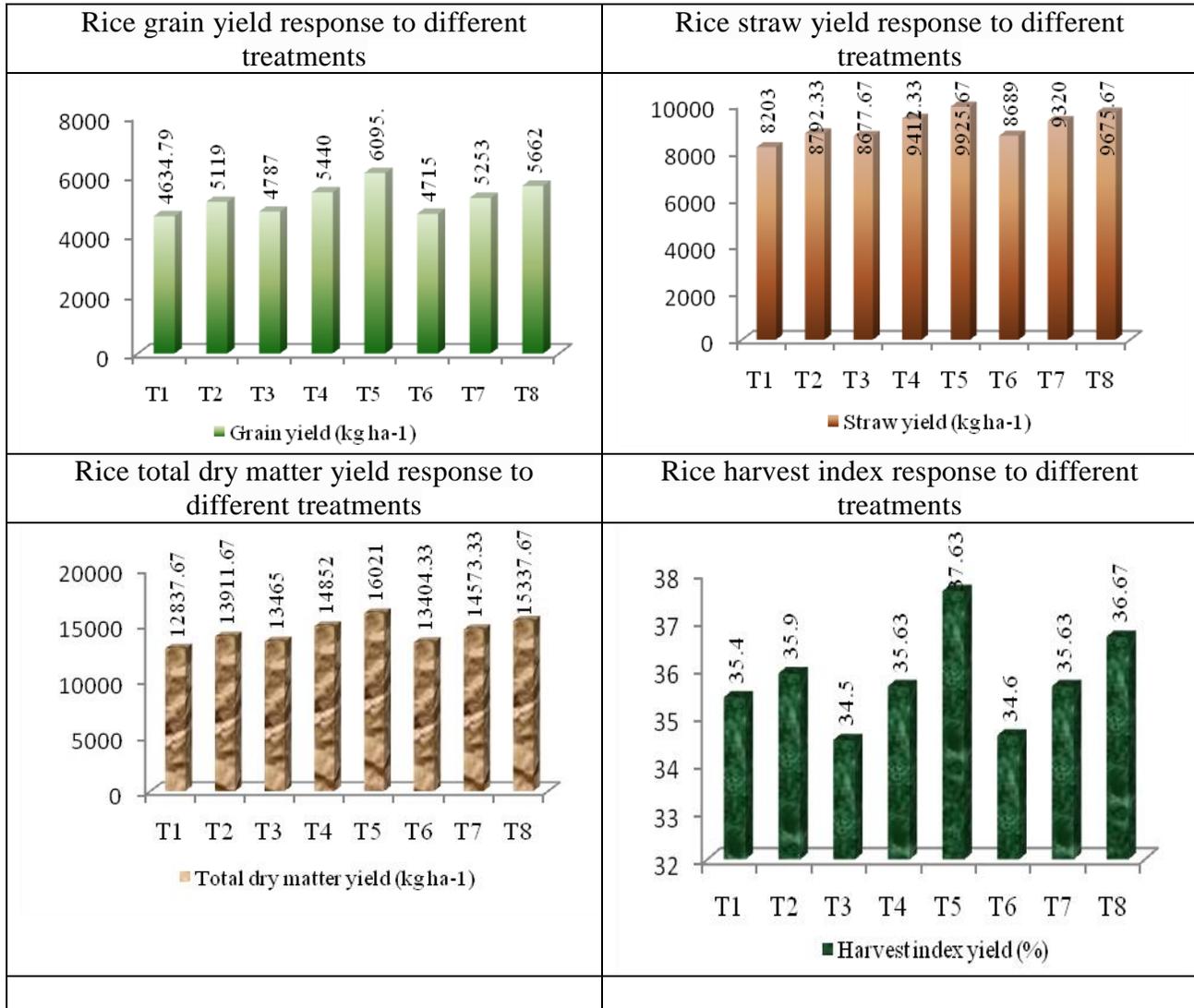
Treatments	Harvest index yield (%)				Water productivity* (kg ha <sup>-1</sup> )			
	2012-13	2013-14	2014-15	Pooled mean	2012-13	2013-14	2014-15	Pooled mean
<b>T1-RDF</b>	25.0	36.4	44.8	36.1	1.61	3.22	3.33	2.73
<b>T2-FYM (10.0)</b>	26.3	37.5	43.9	36.8	1.80	3.42	3.79	3.02
<b>T3-UC-I (2.5)</b>	23.8	35.4	44.3	35.5	1.53	3.26	3.63	2.82
<b>T4-UC-I (5.0)</b>	23.8	38.0	45.1	36.6	1.74	3.68	4.14	3.21
<b>T5-UC-I (10.0)</b>	29.3	37.4	46.2	38.1	2.38	4.07	4.29	3.59
<b>T6-UC-II (2.5)</b>	25.0	34.4	44.4	35.2	1.67	3.24	3.40	2.78
<b>T7-UC-II (5.0)</b>	26.3	36.4	44.2	36.0	1.97	3.54	3.74	3.10
<b>T8-UC-II (10.0)</b>	27.8	36.2	46.0	36.9	2.24	3.79	3.95	3.34
<b>S.Em<sub>±</sub></b>	1.5	0.9	1.5	0.66	0.11	0.07	0.19	0.08
<b>CD</b>	NS	NS	NS	NS	0.34	0.21	0.58	0.25

\* U.C. I = Urban compost from Jawahar Nagar, Hyderabad, U.C. II = Urban compost from Autonagar, Hyderabad.

A common recommend dose of 120-60-40 kg N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O was applied to all the treatments.

\*Irrigation water applied and effective rain fall was 1670, 1660 and 1480mm, during 2012-13, 2013-14 and 2014-15, respectively.

**Fig.1**



T1- Recommended dose of N,P,K ( RDF), T2-RDF+ Farm Yard Manure ( 10 t/ha), T3- RDF + Urban Compost - I (2.5 t/ha), T4- RDF + Urban Compost - I (5.0 t/ha), T5- RDF + Urban Compost - I (10.0 t/ha), T6-RDF+ Urban Compost -II (2.5 t/ha), T7- RDF+ Urban Compost -II (5.0 t/ha) and T8- RDF + Urban Compost –II (10.0 t/ha).

From the above results it is concluded that combined application of urban compost along with recommended dose of fertilizers improves the yield of rice. Application of urban compost @ 10t ha<sup>-1</sup> in combination with 100% of the recommended dose of NPK fertilizers produced the maximum yield of rice variety BPT 5204 and the yield was considerably higher as compared to that obtained from the application of NPK

fertilizers at the recommended dose. The higher yield obtained with integrated use of urban compost and inorganic fertilizers was attributed to increased nutrient availability and uptake, resulting in higher grain yield, straw yield, total dry matter yield, harvest index and water productivity. Therefore, application of urban compost @ 10 t ha<sup>-1</sup> with 100% of the recommended dose of NPK fertilizers can be practiced for profitable rice production.

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