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Influence of urban compost on the yield and water productivity of green gram (*Vigna Radiate* L.)

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Abstract
Field experiments were conducted to study the influence of varying rates of urban compost in combination with recommended dosage of fertilizers (RDF) on yield and water productivity of green gram variety, LGG – 460. 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_2O_5 and K_2O kg ha^{-1}), RDF + Farm Yard Manure (5.0 t ha^{-1}), three rates of urban compost from Jawahar nagar (1.25, 2.5 and 5 t ha^{-1}) + RDF and three rates of urban compost from Autonagar (1.25, 2.5 and 5 t ha^{-1}) + RDF. Seed yield, Bhusa yield, total dry matter yield, harvest index and water productivity were determined. Perusal of pooled data indicated that the crop applied with urban compost from Autonagar (Urban Compost–II) @ 5.0 t ha^{-1} along with RDF of 20:50:0 N, P_2O_5 and K_2O kg ha^{-1} recorded significantly higher seed yield of 386.3 kg ha^{-1} and were on par with the urban compost from Jawaharnagar (Urban Compost –I) @ 5.0 t ha^{-1} along with RDF. Significantly lower yield of 256.7 kg ha^{-1} was recorded with crop received RDF of 20:50:0 N, P_2O_5 and K_2O kg ha^{-1} and was on par with application of FYM 5t ha^{-1} and urban compost of both sources @ 1.25 t ha^{-1}. Therefore, application of urban compost @ 5 t ha^{-1} with 100 % of the recommended dose of NPK fertilizers can be practiced for profitable green gram production.

Keywords: inorganic fertilizers, urban compost, green gram yield, harvest index

Introduction
Green gram (*Vigna radiata* L.) is one of the most important pulse crops grown in India. Green gram is short duration, drought tolerant pulse crop which also commonly known as "Mung bean". Average yield of pulses is very low in India compared to other countries due to abrupt climatic changes, poor crop stand, imbalanced nutrition and vulnerability to pests and diseases. The integrated plant nutrient system helps in improving and maintenance of soil fertility for sustaining crop productivity. Use of organic manures alone, as a substitute to chemical fertilizers is not profitable and will not be enough to maintain the present levels of crop productivity of high yielding varieties. Use of organic manures along with inorganic fertilizers leads to increase in productivity and also sustain the soil health for a longer period (Gawai and Pawar, 2006) [7]. Municipal solid waste (MSW) is a mixed waste from residential, commercial, institutional and industrial sources. Continuous application of MSW load has many effects on the air, water and soil as well as public health (Chatterjee, 2010) [6]. Incineration of MSW generally produces significant amounts of polluting flue gases, and also gives rise to toxic solid residues. Composting of MSW is an alternative to incineration and disposal in landfills (Alidadi *et al*., 2008) [2]. Agricultural lands amended with municipal solid waste compost (MSWC) can be a way to return the organic matter to soil and minimize the risk of environmental pollution. Various studies have demonstrated improvements in soil fertility using a variety of compost material (Parvaresh *et al*., 2004; Parthasarathi *et al*., 2008; Ogwueleka, 2009) [16, 15, 14]. Kasthuri *et al*. (2011) [10] reported the utilization of urban compost successfully improved the physical and chemical properties of soil and the growth of green gram. The conclusions from the previous studies showed the benefits of using urban compost as an organic soil amendment may be seen in agricultural land, but compost should only be applied to soil after it has been characterized and shown to be safe (Ogwueleka, 2009) [14]. Therefore, the overall objective of the present study was to evaluate the effect of urban compost on yield of green gram.

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 of green gram during *rabi* 2012-2015. Experiments were laid out in a randomized complete block design (RCBD) with three replicates. Green gram variety LGG – 460 was used for the study. Each plot measured 5.1m x 3.6 m with 30 cm row to row and 10 cm plant to plant distance. The different treatments used were:

T1- Recommended dose of N,P,K (RDF)
T2-RDF+ Farm Yard Manure (5 t/ha)
T3- RDF + Urban Compost - I (1.25 t/ha)
T4- RDF + Urban Compost - I (2.5 t/ha)
T5- RDF + Urban Compost - I (5.0 t/ha)
T6-RDF+ Urban Compost -II (1.25 t/ha)
T7- RDF+ Urban Compost -II (2.5 t/ha)
T8- RDF + Urban Compost –II (5.0 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-bio degradable 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 bio degradable 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 (1.25, 2.5 and 5 t ha^{-1}) along with recommended dose of N,P,K (20:50:0 N,P_2O_5 and K_2O kg ha^{-1}). All other agronomic practices were kept uniform to keep the crop free from pests. Five plants were selected randomly from each plot for sampling purposes and observations were recorded. The weight of cleaned seeds and bhusa from each net plot was recorded in grams per plot and then converted into kg per hectare. The harvest index is the ratio of economic (seed) yield out of total biological (seed + straw) yield which is expressed in percentage. It estimates the partitioning of the dry matter between seed and straw. Data pertaining to various parameters were tabulated and subjected to statistical analysis for interpretation of results.

Results and Discussion

Analysis of data showed that the yield and water productivity of green gram was significantly affected by urban compost in combination with inorganic fertilizers (Table 1). In general, all the parameters were increased with increasing amendments.

Seed yield (kg ha^{-1})

The statistical analysis of data showed that there were significant differences between treatments for seed yield. Significantly maximum seed yield of 386.3 kg ha^{-1} was recorded in treatment T_8 which was applied with urban compost from Autonagar (Urban Compost –II) @ 5.0 t ha^{-1} along with RDF of 20:50:0 N, P_2O_5 and K_2O kg ha^{-1} and were on par with the urban compost from Jawaharnagar (Urban Compost –I) @ 5.0 t ha^{-1} along with RDF (Table 1). Significantly lower yield of 256.7 kg ha^{-1} was recorded with crop received RDF of 20:50:0 N, P_2O_5 and K_2O kg ha^{-1} and was on par with application of FYM 5t ha^{-1} and urban compost of both sources @ 1.25 t ha^{-1}. Significantly increased grain yield in green gram because of urban compost and inorganic fertilizers application could be ascribed to their direct influence on dry matter production at successive stages by virtue of increased photosynthetic efficiency. While indirect influence seems to be due to increase in plant height. The increase in plant height might be due to the enhanced nutrient level in the compost and fertilizer, which leads to the continuous availability of nutrients in available form to the plants. Similar results were reported by Ali *et al.* (2003) [1] in tomato, the application of 25% rice straw compost gave the highest stem length followed by 50% and then 75% compost whereas, 100% peat and compost decreased plant height with no significant differences between them. Obreza and Reeder, 1994 [13] found that the application of 112 t ha^{-1} municipal solid waste compost 90 days before planting increased watermelon production by 30% as compared to South West Florida commercial average. Reddy (2000) [17] also demonstrated that application of compost at 20 t ha^{-1} produces significantly higher yields of brinjal and bhendi crops. The results can also be evident from the findings of Hadas *et al*. (2004) [8] that grain yield of wheat and other rainfed crops were responded well to mulching with composted municipal solid waste.

Bhusa yield (kg ha^{-1})

The maximum bhusa yield of 922.33 kg ha^{-1} was recorded in T_5 viz., urban compost from Jawaharnagar (Urban Compost – I) @ 5.0 t ha^{-1} along with RDF of 20:50:0 N, P_2O_5 and K_2O kg ha^{-1} and were on par with the urban compost from Autonagar (Urban Compost –II) @ 5.0 t ha^{-1} along with RDF (Table 1). The lowest bhusa yield of 733.7 kg ha^{-1} was recorded in the treatment T_1 (RDF). The bhusa yield of green gram was significantly increased with increasing levels of urban conpost. The overall improvement in crop growth under the influence of optimum nutrition involving combination of urban compost and inorganic fertilizers could be ascribed to their potential role in modifying soil and plant environment conducive for better development of both morphological and biochemical component of the plant growth that increase efficiently of physiological processes of plant system.

Total dry matter yield (kg ha^{-1})

Maximum total dry matter yield (1298 kg ha^{-1}) was recorded in T_8 (Urban Compost–II @ 5.0 t ha^{-1} +RDF) which was statistically at par with T_5 (Urban Compost–I @ 5.0 t ha^{-1} +RDF). Significantly lowest total dry matter yield (990.7 kg ha^{-1}) was obtained from T_1 (RDF). Higher total dry matter yield might be due to the increase in growth and yield attributes. Dry matter production is a function of nutrients availability and uptake by the plant (Ibeawuchi *et al*., 2007) [9], environmental and genetic factors (Amin 2011) [3]. The higher dry matter accumulation with addition of urban compost might possibly since manure provides macro and micro nutrients to soil, improves soil properties and water use efficiency, better soil fertility might have increased the photosynthetic efficiency and partitioning of photo assimilates (Baiyeri and Tenkouano 2008) [5]. These findings are fully supported by (Ayeni and Adetunji 2010) [4] who concluded that manure incorporation into the soil supply essential nutrients (N, P, K, Ca, Mg, Fe, Cu, Mn and Zn) to the maize crop, that resulted in maximum dry matter production with higher rates of manure.

Harvest index (%)

Urban compost from Autonagar (Urban Compost –II)
applied at the rate of 2.5 t ha^{-1} along with RDF resulted maximum harvest index (30.0 %), followed by 5 t ha^{-1} (29.6

%) when compared to the minimum harvest index (24.6 %) recorded from plots applied with urban compost from Jawaharnagar (Urban Compost –I) @ 1.25 t ha^{-1} along with RDF. The physiological efficiency of crop plants in converting photosynthetic products into grain yield is termed as harvest index (Khaliq *et al*., 2004) [11]. Higher harvest index were recorded from urban compost incremental levels. This increased harvest index with higher urban compost levels could be associated with enhanced soil cation exchange capacity, increased C, N, and P content, and lowered hydraulic conductivity of soil, That might had improved photosynthetic efficiency (Liu *et al*., 2004) and enhanced assimilates translocation to economic portion (Smaling *et al*., 2002) [19] which all have direct effects on seed yield, that might have resulted in higher harvest index.

Water productivity (kg ha^{-1})

Water is a most important and crucial resource base in agriculture. At present, the universal water crises is being experienced seriously in all sectors of life including agriculture. Therefore, it is imperative to evaluate the water-use efficiency of varying cropping systems tested under different nutrient management practices. Analysis of the effects of treatments on green gram 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 0.77 kg ha^{-1} was obtained from the treatment T_1 (RDF). The treatment T_8 (Urban Compost–II @ 5.0 t ha^{-1} +RDF) consistently had the highest water productivity of 1.06 kg ha^{-1} which was on par with the treatment T_5 (Urban Compost–I @ 5.0 t ha^{-1} +RDF). Our results indicated that urban compost application increased water productivity 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) [18].

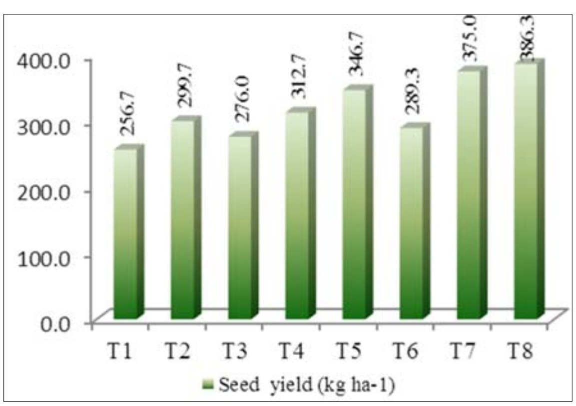
Table 1: Effect of urban compost on seed and bhusa yield of green gram during *rabi*, 2012-15

Treatments	Seed yield (kg ha^{-1})				Bhusa yield (kg ha^{-1})			
	2012-13	2013-14	2014-15	mean	2012-13	2013-14	2014-15	mean
T1-RDF	355	225	190	257	732	829	640	733
T2-FYM (5.0)	412	265	222	300	881	938	735	852
T3-UC-I (1.25)	401	231	196	276	840	895	751	829
T4-UC-I (2.5)	455	253	230	313	921	945	767	878
T5-UC-I (5.0)	447	270	323	347	989	1000	778	922
T6-UC-II (1.25)	347	324	197	289	813	878	720	804
T7-UC-II (2.5)	458	386	281	375	921	947	730	866
T8-UC-II (5.0)	466	403	290	386	1016	978	741	912
S.Em±	26	11	13	13	56	41	24	35
C.D. (5%)	78	33	39	39	170	NS	71	105

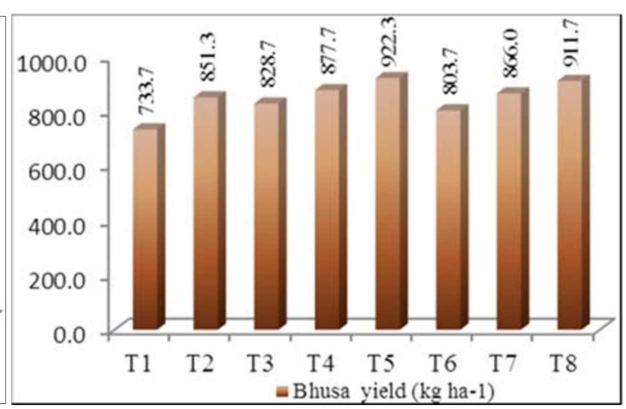
Table 2: Effect of urban compost on total dry matter production, harvest index and water productivity of green gram uring *rabi*, 2012-15

Treatments	Total dry matter yield (kg ha^{-1})				Harvest index yield (%)				Water productivity (kg mm^{-1})			
	2012-13	2013-14	2014-15	mean	2012-13	2013-14	2014-15	mean	2012-13	2013-14	2014-15	mean
T1-RDF	1087	1054	831	990	32.9	21.5	23.0	26.1	0.96	0.68	0.68	0.74
T2-FYM (10.0)	1293	1204	958	1151	32.0	22.1	23.2	26.0	1.14	0.80	0.6	0.86
T3-UC-I (2.5)	1241	1126	947	1105	32.4	20.6	20.7	25.0	1.11	0.70	0.5	0.79
T4-UC-I (5.0)	1377	1199	998	1191	33.2	21.1	23.1	26.3	1.26	0.76	0.6	0.90
T5-UC-I (10.0)	1436	1270	1101	1269	31.2	21.3	29.3	27.3	1.24	0.81	0.9	0.99
T6-UC-II (2.5)	1160	1202	916	1093	30.0	27.0	21.5	26.5	0.96	0.98	0.6	0.83
T7-UC-II (5.0)	1379	1333	1011	1241	33.2	28.9	27.8	30.2	1.27	1.16	0.8	1.07
T8-UC-II (10.0)	1482	1381	1031	1298	31.4	29.2	28.2	29.8	1.29	1.21	0.8	1.11
S.Em±	58	39	21	33	2.2	1.3	1.3	1.4	0.07	0.03	0.04	0.04
C.D. (5%)	176	118	64	100	NS	3.8	4.1	NS	0.22	0.10	0.11	0.11

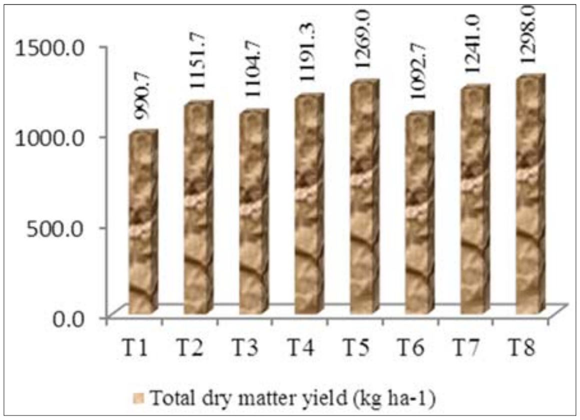
* U.C. I = Urban compost from Jawahar Nagar, Hyderabad, U.C. II = Urban compost from Autonagar, Hyderabad. A common recommend dose of 20-50-0 kg N-P_2O_5-K_2O was applied to all the treatments



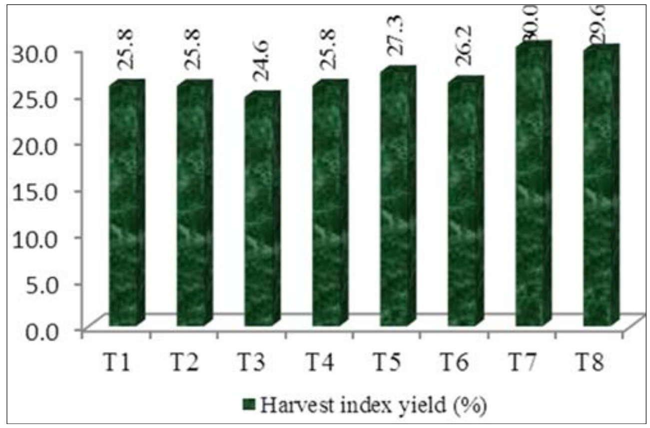
Green gram seed yield response to different treatments



Green gram bhusa yield response to different treatments



Green gram total dry matter yield response to different treatments



Green gram harvest index response to different treatments

T1- Recommended dose of N,P,K (RDF), T2- RDF+ Farm Yard Manure (5 t/ha), T3- RDF + Urban Compost - I (1.25 t/ha), T4- RDF + Urban Compost - I (2.5 t/ha), T5- RDF + Urban Compost - I (5.0 t/ha), T6-RDF+ Urban Compost -II (1.25 t/ha), T7- RDF+ Urban Compost -II (2.5 t/ha) and T8- RDF + Urban Compost –II (5.0 t/ha).

Conclusion

The integrated use of urban compost with inorganic fertilizer sources significantly improved yield and yield components of green gram. Significantly higher seed yield of green gram was obtained from integration of urban compost @ 5.0 t ha^{-1} and RDF of 20:50:0 N, P_2O_5 and K_2O kg ha^{-1}. Therefore, the application of urban compost @ 5.0 t ha^{-1} with recommended NPK fertilizer rate was suggested for optimum seed yield and profitable green gram production.

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