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RESPONSE OF CONVENTIONAL, NON-CONVENTIONAL ORGANIC SOURCES AND INDUSTRIAL BY-PRODUCTS ON YIELD AND NPK UPTAKE IN MAIZE

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Abstract

Field experiment was conducted with conventional organic sources like Bio-compost, non-conventional organic sources like municipal solid waste compost and industrial by-products *viz.,* bagasse ash and rice husk ash with chemical fertilizers. The soil was coarse loamy with pH of 8.1, EC (0.160 dSm^{-1}) and classified as *Typic Ustropept*. Regarding the available nutrient status it was 116 kg ha^{-1} in alkaline $KMnO_4$-N, 15 kg ha^{-1} in Olsen P and 235.00 kg ha^{-1} in NH_4OAC-K. The treatments were T_1-Control 100% RDF, T_2-100% RDF + Municipal Solid Waste Compost @5 t ha^{-1}, T_3-75% RDF + Municipal Solid Waste Compost @10 t ha^{-1}, T_4-100% RDF + Bio-compost @ 2.5t ha^{-1}, T_5-75% RDF + Bio-compost @ 5t ha^{-1}, T_6-100% RDF + Bagasse Ash @ 5 t ha^{-1}, T_7-75% RDF + Bagasse Ash @ 10 t ha^{-1}, T_8-100% RDF + Rice Husk Ash @ 5 t ha^{-1}, T_9-75% RDF + Rice Husk Ash @ 10 t ha^{-1}. The results showed that the application of 75% RDF + Municipal Solid Waste Compost @ 10 t ha^{-1} registered the grain yield (10.09 t ha^{-1}) and stover yield (11.55 t ha^{-1}). The combined application of 75% RDF + Municipal Solid Waste Compost @ 10 t ha^{-1} recorded the grain N uptake (135.62 kg ha^{-1}), P uptake (23.60 kg ha^{-1}), K uptake (26.29 kg ha^{-1}) and stover uptake of NPK as 44.48, 12.10 and 78.66 kg ha^{-1}.

Key words : Municipal Solid Waste Compost, Rice Husk Ash, Bagasse Ash, Bio-compost and Maize.

Introduction

Maize (*Zea mays*) is a cereal crop grown all around the world. Even though the maize consumption by humans as food is minimum when compared to other cereals, it gains the importance with increase in poultry feed. In India, it has its scope due to its ability to grow throughout the year and its adaptability to the sub continental climatic conditions and also because of our country's cattle and poultry populations, as it acts as a good feed source. In India maize cultivation is taken up in an area of 8.9 million hectares with an annual production of 23.00 million tonnes and productivity of 2.5 t ha^{-1}. (Agriculture statistics at a glance 2017). Waste is generated from consumer-based lifestyle (Hoornweg and Bhada-Tata, 2012), that are generated from all our daily activities in a large variety of wastes (European Information and Observation Network, 2013). Currently, 3 billion residents of world cities generate about 1.2 kg solid wastes per capita per day (i.e. 1.3 billion t year^{-1}). By 2025, these numbers will likely increase to 4.3 billion urban residents generating about 1.42 kg municipal solid waste (MSW) per capita per day (i.e. 2.2 billion t year^{-1}). Waste generation rates will be more than double over the next twenty years in lower income countries. Waste management costs have been increased about five times in low-income countries and four times in lower-middle income countries. Pressmud as bio compost used to maintain soil fertility and enhance crop production because it is rich in sugar and contains appreciable amount of essential plant nutrients *viz.,* organic carbon, nitrogen, phosphorus, potassium, calcium and magnesium along with traces of micronutrients *viz*., Zn, Fe, Cu and Mn (Banulekha, 2007) so the beneficial effect of this bio compost for enhancing the soil fertility and thereby improving the crop productivity is well established. Bagasse is an important agro-industrial waste by-product that is generally used as a fuel in sugar

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milling industry. The resulting boiler ash is usually sent to landfill or accumulated in uncultivated areas close to the plants and no particular use is made of this by-product (Pita 2009). However, the increasing costs imposed to control landfills and the decreased areas available for them are forcing industry to find alternative methods of disposal (Cabral *et al*., 2008). The ash is an alkaline material, nearly free of nitrogen (N) but containing other elements, such as potassium (K), calcium (Ca), magnesium (Mg) and phosphorus (P), which are required for plant nutrition (Augusto *et al*., 2008). The ash has been reported to improve nutrient availability in soil. Rice husk is a by-product of the rice milling. About 100 millions of tons of husk per year are produced worldwide (Alhassan *et al.,* 2007). The burning volatilizes the organic compounds and moisture of rice husk and about 20% of the mass remains as rice husk ash (RHA). If all rice husks had been burned, it would annually produce about 20 millions of tons of RHA worldwide. To value this residue is an alternative to its final disposition with environmental benefit (Leonardo Behak 2017). The experiment was conducted to study the response of above conventional (bio-compost), nonconventional (municipal solid waste compost) organic sources and industrial by products such as rice husk ash and bagasse ash on yield maximization and NPK uptake in maize.

Materials and Methods

A field experiment was conducted to study the response of conventional, non-conventional organic sources and industrial by-products in yield maximization of maize. The conventional source Bio-compost was collected from sugar mill and nonconventional source municipal solid waste compost was composted manually from wastes collected from nearby township. The industrial by products bagasse ash from sugar mill and rice husk ash from rice mill was collected and all of those are analysed for its nutrient compositions and used as basal application to experimental plot. The nutrient composition of Municipal solid waste compost, Bio-compost, Bagasse ash and Rice husk ash are given in table 1. The experiment was conducted in a Randomized Block Design (RBD) at the farmer's field in Karapadi village, Sathyamangalam taluk, Erode district located in Western Zone of Tamilnadu at 11°20' 47.7" N latitude, 77°11' 53.6" E longitude and at an altitude of 577.6 meters above mean sea level during the month of April to June 2018. The composite soil at 0-15 cm collected from the farmer's field in Karapadi village, Sathyamangalam taluk, Erode district were analysed for various physico-chemical properties (Table 2). The textural composition of soil was coarse loamy. The experimental soil of Karapadi comes under the taxonomical classification *Typic Ustropept*. The soil pH was 8.1 with EC of 0.160 dsm^{-1}. The cation exchange capacity was 18 [cmol (P^+) kg^{-1}]. The organic carbon content was 2.7 g kg^{-1}. The available nitrogen, phosphorus and potassium content of the soil were 116.0 (low), 15.0 (low) and 235.00 (medium) kg ha^{-1} respectively in soil fertility.

Table 1: Properties of Municipal Solid Waste Compost, Bio-compost, Bagasse Ash and Rice Husk Ash.

S.No	Properties	MSWC	BC	BA	RHA
1	pH	8.19	6.89	9.05	10.22
2	EC (dS m^{-1})	3.71	3.65	1.90	1.235
3	Organic carbon (g kg^{-1})	270	201	71.5	-
4	Total Nitrogen (%)	1.13	1.2	0.014	-
5	Total Phosphorus (%)	2.92	2.87	0.0052	0.24
6	Total Potassium (%)	0.53	1.7	0.024	0.31

*MSWC-Municipal Solid Waste Compost, BC- Bio-Compost, BA- Bagasse Ash, RHA- Rice Husk Ash.

Table 2: Initial soil status

A	MECHANICAL PROPERTIES	Content
1.	Clay (%)	16
2.	Silt (%)	12
3.	Sand (%)	72
4.	Textural classification	Coarse loamy
5.	Taxonomical classification	*Typic Ustropept*
B	PHYSICAL PROPERTIES	
1.	Bulk density (Mg m^{-3})	1.54
2.	Particle density (Mg m^{-3})	2.53
3.	Pore space (%)	42
C	PHYSIO-CHEMICAL PROPERTIES	
1.	pH	8.1
2.	EC (dsm^{-1})	0.16
3.	CEC [cmol (P^+) kg^{-1}]	18
D	CHEMICAL PROPERTIES	
1.	Organic carbon (g kg^{-1})	2.7 g kg^{-1} (low)
2.	$KMnO_4$ nitrogen (kg ha^{-1})	116 (low)
3.	Olsen phosphorus (kg ha^{-1})	15 (low)
4.	NH_4OAC potassium (kg ha^{-1})	235 (medium)

Results and Discussion

The highest grain yield of 10.0 t ha^{-1} was recorded in the treatment T_3 (75% RDF + MSWC @ 10 t ha^{-1}) (Table 3). The increase in yield with application of MSWC and chemical fertilizers could be attributed to better total uptake of essential nutrients and its transformation to economic parts as well as improvement in yield attributing characters. The present findings are in accordance with that of Yolou *et al.,* (2015). Among the industrial by-products the application of 100% RDF + RHA @ 5t ha^{-1} (T_8) registered highest yield. This is due to the supply of nutrients, conducive physical environment leading to better aeration, increase in soil moisture holding capacity, root

Table 3: Effect of conventional nonconventional organic sources and industrial by-products on Grain and Stover yield

Treatments	Yield	
	Grain yield (t ha^{-1})	Stover yield (t ha^{-1})
T_1 - Control 100% RDF	8.9	9.67
T_2 - 100% RDF + Municipal Solid Waste Compost @ 5 t ha^{-1}	9.7	11.26
T_3 - 75% RDF + Municipal Solid Waste Compost @10 t ha^{-1}	9.5	10.66
T_5 - 75% RDF + Bio-compost @ 5 t ha^{-1}	9.7	11.18
T_6 - 100% RDF + Bagasse Ash @ 5 t ha^{-1}	9.2	9.83
T_7 - 75% RDF + Bagasse Ash @ 10 t ha^{-1}	8.7	9.41
T_8 - 100% RDF + Rice Husk Ash @ 5 t ha^{-1}	9.4	10.54
T_9 - 75% RDF + Rice Husk Ash @ 10 t ha^{-1}	9.1	10.34
Mean	9.3	10.49
S.Ed	0.38	0.43
CD (p = 0.05)	0.8	0.91

activity and nutrient absorption and the consequent complementary effect in rice husk ash have resulted in higher grain yield of 9.4 t ha^{-1}. This was in line with the findings of Saranya *et al.,* (2016). Among treatments the highest Stover yield of 11.55 t ha^{-1} was recorded in the treatment T_3 (75% RDF + MSWC @ 10 t ha^{-1}) (Table 3). The significant increase in yield is due to the addition of municipal solid waste compost to an agricultural soil increased the contents of nutrients available for plants and some enzymatic activities directly associated to biochemical and microbiological transformation in soil. The beneficial changes in soil properties with compost amended treatments positively affect the stover yield (Aggdida and Londra 2000). Among the industrial by products the highest stover yield was recorded in the treatment T_8 (10.54 t ha^{-1}). This may be due to Rice husk ash resulted in higher concentration in maize stover and in turn better growth of crop. (Priyadharshini and Seran 2009).

The maximum grain nitrogen uptake of 135.02 kg ha^{-1} and stover uptake of 44.48 kg ha^{-1} was recorded in the treatment T_3 (Table 4). It is very probable that the beneficial effect of compost in boosting yield and N uptake of maize can be attributed to the N supplied by compost. The compost induced increase in N uptake generally paralleled the yield increase. It is very probable that the beneficial effect of compost in boosting yield and N uptake of maize can be attributed to the n supplied by compost (Abie Horrocks *et al.,* 2016). The highest grain phosphorus uptake (23.6 kg ha^{-1}) and stover uptake of 12.1 kg ha^{-1} were recorded in the treatment T_3 (Table 4). These studies provide an insight in understanding how municipal solid waste compost result in agronomically feasible, environmentally served in sustainable production system by maintaining and enhancing soil fertility status, reducing nutrient losses and improving nutrients uptake in plants resulting in improved crop production. (Muhammad Atif Jamil *et al.,* 2018). The maximum potassium grain uptake of 26.29 kg ha^{-1} and stover uptake of 78.66 kg ha^{-1} was recorded in the treatment T_3 (75% RDF + MSWC @ 10 t ha^{-1}) (Table 3). The incorporation of municipal solid waste compost leads to significant increase in plant potassium content. Generally it has been claimed that potassium is present in compost in an easily assimilated form. (Kavitha and Subramanian, 2007). Among the industrial by-products the highest K uptake in grain and stover (21.89 and 65.0 kg ha^{-1}) recorded in treatment T_8 receiving 100% RDF + Rice Husk Ash @ 5 t ha^{-1}. The increase in uptake were accompanied by significant increase in P and K content in soil due to application of rice husk ash (Thind *et al.,* 2012). This was possibly due to better root growth,

Table 4 : Effect of conventional nonconventional organic sources and industrial by-products on yield maximization of maize.

Treatments	Grain uptake			Stover uptake		
	N(kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})	N (kg ha^{-1})	P (kg ha^{-1})	K(kg ha^{-1})
T_1- 100 % RDF	106.05	16.00	19.55	33.79	8.67	58.88
T_2-100 % RDF +MSWC @ 5 t ha^{-1}	126.59	22.26	24.81	41.38	11.20	72.37
T_3-75 % RDF +MSWC @10 t ha^{-1}	135.02	23.60	26.29	44.48	12.10	78.66
T_4-100 % RDF + BC @ 2.5 t ha^{-1}	119.44	20.33	22.98	40.22	10.62	70.20
T_5-75% RDF + BC @ 5 t ha^{-1}	119.92	20.24	22.88	39.42	10.56	72.57
T_6-100 % RDF + BA @ 5 t ha^{-1}	113.18	18.16	21.17	35.02	9.27	64.18
T_7 -75 % RDF + BA @ 10 t ha^{-1}	99.67	14.64	17.83	32.97	8.43	59.76
T_8-100 % RDF + RHA @ 5 t ha^{-1}	118.21	18.66	21.89	36.72	9.54	65.00
T_9-75 % RDF + RHA @ 10 t ha^{-1}	106.95	16.73	19.92	33.82	8.94	60.06
Mean	116.12	18.95	21.92	37.54	9.93	66.84
S.Ed	9.48	1.56	1.84	3.10	0.81	4.49
CD (p = 0.05)	20.10	3.31	3.90	6.57	1.72	9.53

enhanced nutrient supply and a conclusive physical environment created by additivity of RHA. (Sushmita munda *et al*., 2010).

Conclusion

Considering the salient findings in perspective, the study revealed that application of 75% RDF + municipal solid waste compost @ 10 t ha^{-1} (T_3) was found to be best combination for maximizing maize grain, stover yield, and NPK uptake of grain and stover.

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