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Evaluation of a soil incubation studies for assessing soil properties under Maize Variety VNR-4211

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ABSTRACT: The incubation experiment was conducted with conventional organic resources like vermicompost ,non-conventional organic source like municipal solid waste compost and industrial by products like rice husk ash, lignite flyash with chemical fertilizers are used to study the release pattern of nutrients. For this incubation experiment,the soil was collected from Varugupettai village having clay loam ,pH 7.6 ,EC 0.31 dS m^{-1} (Typic Haplusterts).Regarding the available nutrient status, it was low in alkaline $KMnO_4$ –N, high in Olsen-P and medium in NH_4OAc-K. The treatments constituting nine following T_1 - Control 100 % RDF, T_2 - 100 % RDF + Municipal Solid Waste Compost @ 5 t ha^{-1}, T_3-100 % RDF + Municipal Solid Waste Compost @ 10 t ha^{-1} , T_4 -100 % RDF + Vermicompost @ 2.5 t ha^{-1} , T_5 - 100 % RDF + Vermicompost @ 5 t ha^{-1} , T_6 -100 % RDF + Bagasse Ash @ 5 t ha^{-1} , T_7 - 100 % RDF + Bagasse Ash @ 10 t ha^{-1} , T_8 - 100 % RDF + Lignite Flyash @ 5 t ha^{-1}, T_9 - 100 % RDF + Lignite Flyash @ 10 t ha^{-1} . Periodic soil samples at 30,60 and 90 days after incubation (DAI) were taken and analyzed for pH ,EC, organic carbon ,available NPK. The results of the incubation experiment showed that 100 % NPK + Vermicompost @ 5 t ha^{-1} was most efficient in increasing NPK availability in soil. These treatments were repeated and studied in pot experiment to evaluate their efficiency in increasing the yield of maize and improvement in soil nutrient availability.

KEYWORDS: Incubation, Lignite Flyash, Baggase, Maize.

I. INTRODUCTION

Maize (*Zea mays* L.) known as queen of cereals ,also called corn is one of the most important cereal crops of the world . Maize ranks as the major grain crop world wide. Maize ,which is the only food cereal crop that can be grown in different seasons require moderate climate for growth .In India maize crop stand up as the third cash crop after wheat and rice .Maize is not only used as human food and animal feed ,but is as well commonly used in several other industries as a raw material (Hareesh *et al.* 2016) .In India maize cultivation is taken up in an area of 8.69 million hectares with an annual production of 21.81 million tonnes (Agriculture statistics at a glance 2016).Composting is the controlled biological process to turning organic waste into soil conditioner .In nature , organic matter such as wood ,paper ,animal waste and plant material is decomposed by bacteria (Shamim Banu and Kanagasabai 2012).Vermicompost maintains a steady mineral balance ,improves nutrient availability for rejuvenating the soil ,in addition of reduction of pathogenic organisms too (Geeta Utekar and Hanamantrao Deshmukh 2016).The Lignite Flyash of NLC serves as supplementary source of essential plant nutrients and is also effective in the reclamation of waste degraded land and mine spoil (Saranraj 2015).Bagasse ash is a good source of micronutrients like Fe, Mn ,Zn and Cu and also high concentration of P and K. (Dotaniya *et al.*, 2016) .

II. MATERIALS AND METHODS

An incubation experiment was conducted with an objective of studying the effects of nutrient management on the release pattern of nutrients from conventional and non-conventional organic sources, industrial by-products and inorganic fertilizer.200 g of 2 mm sieved soil sample was filled in 250 ml (depth 9cm,diameter 21cm) plastic containers. The treatment details are given below. Each treatment was replicated thrice .The soil was incubated at room temperature for 90 days at field capacity. The design followed was Completely Randomized design(CRD).

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III. RESULTS AND DISCUSSION

The application of conventional,non-conventional organic sources recorded lowest pH value at all three stages of incubation period **(Table 1)** .Among organic sources,application of 100 % RDF + Vermicompost @ 5 t ha^{-1} (T_5) recorded the lowest pH of the soil at all three stages of incubation period .The lowest pH values observed with this treatment were (T_5) 7.1 at 30 DAI , 7.0 at 60 DAI and 6.9 at 90 DAI .Among the industrial byproducts the highest pH at all stages with 100% RDF + Bagasse Ash @ 10 t ha^{-1} (T_7) registered 8.1 at 30 DAI , 8.2 at 60 DAI and 8.3 at 90 DAI.

Table 1.Effect of conventional, non-conventional organic sources and industrial by-products on soil pH in incubation experiment.

Treatments	Soil reaction (pH)		
	30 DAI	60 DAI	90 DAI
T_1 - Control 100 % RDF	7.5	7.4	7.2
T_2 - 100 % RDF + Municipal Solid Waste Compost @ 5 t ha^{-1}	7.4	7.3	7.1
T_3 - 100 % RDF + Municipal Solid Waste Compost @ 10 t ha^{-1}	7.4	7.3	7.2
T_4 - 100 % RDF + Vermicompost @ 2.5 t ha^{-1}	7.3	7.2	7.1
T_5 - 100 % RDF + Vermicompost @ 5 t ha^{-1}	7.1	7.0	6.9
T_6 - 100 % RDF + Bagasse Ash @ 5 t ha^{-1}	8.0	8.1	8.2
T_7 - 100 % RDF + Bagasse Ash @ 10 t ha^{-1}	8.1	8.2	8.3
T_8 - 100 % RDF + Lignite Flyash @ 5 t ha^{-1}	7.8	7.9	8.0
T_9 - 100 % RDF + Lignite Flyash @ 10 t ha^{-1}	7.9	8.0	8.1
Mean	7.6	7.6	7.5
S.Ed.	0.36	0.38	0.40
CD (p=0.05)	0.76	0.80	0.84

The application of conventional ,non- conventional and industrial by-products increased the EC value **(Table 2).**The treatment (T_1) control (100 % RDF) recorded lowest values of 0.3,0.31 and 0.32 d Sm^{-1} at 30, 60 and 90 DAI.This was followed by the ascending order treatments T_6 (0.39 d Sm^{-1}) , T_7 (0.4 d Sm^{-1}) , T_8 (0.36 d Sm^{-1}) , T_9 (0.37 d Sm^{-1}) , T_4 (0.58 d Sm^{-1}) , T_5 (0.59 d Sm^{-1}) ,T_2 (0.66 d Sm^{-1}) and T_3 (0.67 d Sm^{-1}) at 90 DAI respectively.

Table 2.Effect of conventional ,non-conventional organic sources and industrial by-products on soil EC in incubation experiment

Treatments	Electrical conductivity (d Sm^{-1})		
	30 DAI	60 DAI	90 DAI
T_1 - Control 100 % RDF	0.30	0.31	0.32
T_2 - 100 % RDF + Municipal Solid Waste Compost @ 5 t ha^{-1}	0.61	0.63	0.66
T_3 - 100 % RDF + Municipal Solid Waste Compost @ 10 t ha^{-1}	0.62	0.65	0.67

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T_4 - 100 % RDF + Vermicompost @ 2.5 t ha^{-1}	0.53	0.56	0.58
T_5 - 100 % RDF + Vermicompost @ 5 t ha^{-1}	0.57	0.57	0.59
T_6 - 100 % RDF + Bagasse Ash @ 5 t ha^{-1}	0.35	0.37	0.39
T_7 - 100 % RDF + Bagasse Ash @ 10 t ha^{-1}	0.36	0.38	0.40
T_8 - 100 % RDF + Lignite Flyash @ 5 t ha^{-1}	0.32	0.34	0.36
T_9 - 100 % RDF + Lignite Flyash @ 10 t ha^{-1}	0.33	0.35	0.37
Mean	0.44	0.46	0.48
S.Ed.	0.03	0.04	0.04
CD(p= 0.05)	0.06	0.08	0.10

Organic carbon

All the treatments significantly contributed for increasing the organic carbon content of the soil ,an essential factor for soil fertility and productivity improved .Though all the treatments were efficient in increasing the organic carbon status ,the influence of vermicompost was found superior followed by municipal solid waste compost application **(Table 3)** .The application of 100% RDF + Vermicompost @ 5 t ha^{-1} (T_5) recorded significantly highest organic carbon of 5.2 ,5.6 and 5.9 g kg^{-1} at 30 , 60 and 90 DAI respectively .Application of 100 % RDF + Vermicompost @ 5 t ha^{-1} (T_4) was on par with T_5 recorded 5.1 ,5.5 and 5.7 g kg^{-1} at 30 ,60 and 90 DAI . This was followed by the treatment T_3 and T_2 registered 5.5 and 5.3 respectively at 90 DAI .Through out the incubation period , control treatment (T_1) registered lowest organic carbon of 4.3 ,4.2 and 4.1 g kg^{-1} at 30 , 60 and 90 DAI .

Table 3.Effect of conventional ,non-conventional organic sources and industrial by-products on organic carbon in incubation experiment

Treatments	Organic carbon (g kg^{-1})		
	30 DAI	**60 DAI**	**90 DAI**
T_1 - Control 100 % RDF	4.3	4.2	4.1
T_2 - 100 % RDF + Municipal Solid Waste Compost @ 5 t ha^{-1}	4.7	5.1	5.3
T_3 - 100 % RDF + Municipal Solid Waste Compost @ 10 t ha^{-1}	4.8	5.2	5.5
T_4 - 100 % RDF + Vermicompost @ 2.5 t ha^{-1}	5.1	5.5	5.7
T_5 - 100 % RDF + Vermicompost @ 5 t ha^{-1}	5.2	5.6	5.9
T_6 - 100 % RDF + Bagasse Ash @ 5 t ha^{-1}	4.4	4.7	4.8
T_7 - 100 % RDF + Bagasse Ash @ 10 t ha^{-1}	4.5	4.8	4.9
T_8 - 100 % RDF + Lignite Flyash @ 5 t ha^{-1}	4.1	4.3	4.3
T_9 - 100 % RDF + Lignite Flyash @ 10 t ha^{-1}	4.2	4.4	4.6
Mean	4.5	4.8	5.0
S.Ed.	0.27	0.31	0.29
CD (p= 0.05)	0.58	0.67	0.62

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$KMnO_4$- Nitrogen

The influence of various conventional ,non- conventional organic sources and industrial by products in increasing the fertility of soil by the way of increased availability of nitrogen at all stages of incubation study was well evidenced in the present investigation **(Table 4) .** The highest nitrogen content in the soil was recorded as 138.1 ,141.1 and 142.7 mg kg^{-1} at 30 ,60 and 90 DAI respectively which received 100% RDF + Vermicompost @ 5 t ha^{-1} (T_5).This was followed by application of 100 % RDF + Vermicompost @ 2.5 t ha^{-1} (T_4) recorded 130.3 ,140.7 and 141.3 mg kg^{-1} at the same period of sampling .The control (T_1) maintained the lowest $KMnO_4$ -N content of 117.1 ,117.9 and 118.1 mg kg^{-1} at 30 ,60 and 90 DAI.

Table 4.Effect of conventional ,non-conventional organic sources and industrial by-products on Alkaline $KMnO_4$-N in incubation experiment

Treatments	Soil Nitrogen (mg kg^{-1})		
	30 DAI	**60 DAI**	**90 DAI**
T_1 - Control 100 % RDF	117.1	117.9	118.1
T_2 - 100 % RDF + Municipal Solid Waste Compost @ 5 t ha^{-1}	125.3	129.1	130.3
T_3 - 100 % RDF + Municipal Solid Waste Compost @ 10 t ha^{-1}	128.1	130.1	131.7
T_4 - 100 % RDF + Vermicompost @ 2.5 t ha^{-1}	130.3	140.7	141.3
T_5 - 100 % RDF + Vermicompost @ 5 t ha^{-1}	138.1	141.1	142.7
T_6 - 100 % RDF + Bagasse Ash @ 5 t ha^{-1}	118.1	118.9	113.5
T_7 - 100 % RDF + Bagasse Ash @ 10 t ha^{-1}	118.9	119.1	119.1
T_8 - 100 % RDF + Lignite Flyash @ 5 t ha^{-1}	117.9	118.1	118.3
T_9 - 100 % RDF + Lignite Flyash @ 10 t ha^{-1}	118.1	118.3	118.5
Mean	123.5	125.9	125.9
S.Ed.	7.07	7.21	7.01
CD (p= 0.05)	14.86	15.16	14.73

Olsen-Phosphorus

The positive influence of conventional ,non- conventional organic sources and industrial by-products on soil available P was observed in the incubation experiment **(Table 5).** The highest available P in soil was recorded with T_5 (100 % RDF + Vermicompost @ 5 t ha^{-1}.The Olsen-P recorded was 19.7 mg kg^{-1} at 30 DAI ,20.0 mg kg^{-1} at 60 DAI and 20.1 mg kg^{-1} at 90 DAI with this treatment (T_5) .This was followed by the treatment (T_4) which received 100 % RDF + Vermicompost application @ 2.5 t ha^{-1} recorded 19.6 ,19.8 and 20 mg kg^{-1} at 30 ,60 and 90 DAI .The treatment T_1 (Control) recorded the lowest Olsen-P content of 18.5 ,18.6 and 18.6 mg kg^{-1} at 30 , 60 and 90 DAI respectively .

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Table 5.Effect of conventional ,non-conventional organic sources and industrial by-products on Olsen – P in Incubation experiment

Treatments	Soil Phosphorus (mg kg^{-1})		
	30 DAI	60 DAI	90 DAI
T_1 - Control 100 % RDF	18.5	18.6	18.6
T_2 - 100 % RDF + Municipal Solid Waste Compost @ 5 t ha^{-1}	19.0	19.1	19.3
T_3 - 100 % RDF + Municipal Solid Waste Compost @ 10 t ha^{-1}	19.0	19.2	19.4
T_4 - 100 % RDF + Vermicompost @ 2.5 t ha^{-1}	19.6	19.8	20.0
T_5 - 100 % RDF + Vermicompost @ 5 t ha^{-1}	19.7	20.0	20.1
T_6 - 100 % RDF + Bagasse Ash @ 5 t ha^{-1}	18.6	18.6	18.7
T_7 - 100 % RDF + Bagasse Ash @ 10 t ha^{-1}	18.6	18.7	18.7
T_8 - 100 % RDF + Lignite Flyash @ 5 t ha^{-1}	18.7	18.8	18.8
T_9 - 100 % RDF + Lignite Flyash @ 10 t ha^{-1}	18.8	18.9	18.9
Mean	18.9	19.0	19.1
S.Ed.	1.08	1.09	1.10
CD (P= 0.05)	2.28	2.29	2.32

NH_4OAc-K

Application of conventional ,non- conventional organic sources ,industrial by-products significantly increased the K content of the soil **(Table 6)** .The highest amount of NH_4OAc-K was noticed with T_3 application of 100 % RDF + Municipal Solid Waste Compost @ 10 t ha^{-1} .It registered 113.8,113.9 and 114.1 mg kg^{-1} of NH_4OAc- K at 30,60 and 90 DAI respectively .This was followed by the application of 100 % RDF + Municipal Solid Waste Compost @ 5 t ha^{-1} (T_2) which recorded 113.7,113.8 and 114 of NH_4OAc - K at 30,60 and 90 DAI .The control (T_1) recorded the lowest NH_4OAc- K content of 111.7,111.9 and 112.0 mg kg^{-1} at 30 ,60 and 90 DAI respectively.

Table 6.Effect of conventional ,non-conventional organic sources and industrial by-products on NH_4OAc-K in incubation experiment

Treatments	Soil Potassium (mg kg^{-1})		
	30 DAI	60 DAI	90 DAI
T_1 - Control 100 % RDF	111.7	111.9	112.0
T_2 - 100 % RDF + Municipal Solid Waste Compost @ 5 t ha^{-1}	113.7	113.8	114.0
T_3 - 100 % RDF + Municipal Solid Waste Compost @	113.8	113.9	114.1

10 t ha^{-1}			
T_4 - 100 % RDF + Vermicompost @ 2.5 t ha^{-1}	112.3	112.4	113.7
T_5 - 100 % RDF + Vermicompost @ 5 t ha^{-1}	112.5	112.6	113.8
T_6 - 100 % RDF + Bagasse Ash @ 5 t ha^{-1}	111.9	112.0	112.1
T_7 - 100 % RDF + Bagasse Ash @ 10 t ha^{-1}	112.0	112.1	112.2
T_8 - 100 % RDF + Lignite Flyash @ 5 t ha^{-1}	112.9	113.1	113.3
T_9 - 100 % RDF + Lignite Flyash @ 10 t ha^{-1}	113.1	113.3	113.4
Mean	112.6	112.7	113.1
S.Ed.	6.44	6.45	6.46
CD (P= 0.05)	13.54	13.57	13.58

IV. CONCLUSION

In the incubation experiment conventional and non- conventional organic sources decreased the pH of soil. Among organic sources application of 100 % RDF + Vermicompost @ 5 t ha^{-1} excelled other treatments by registering the lowest pH of 6.9 at 90 DAI.The Vermicompost application decreased the EC of soil. Among treatments application of control 100 % RDF recorded lowest EC OF 0.32 dS m^{-1} at 90 DAI.The organic carbon content of the soil significantly increased due to conventional and non conventional organic sources . The values ranged from 4.3 to 5.9 g kg^{-1} against 4.1 g kg^{-1} in control. The availability of $KMnO_4$-N and Olsen-P in the soil also increased with time of incubation. The increase in alkaline $KMnO_4$-N due to application of vermicompost @ 5 t ha^{-1} was to the tune of 142.7 mg kg^{-1} at 90 DAI .The increase in Olsen-P due to application of 100 % RDF + Vermicompost @ 5 tha^{-1} was to the tune of 20.1 mg kg^{-1} at 90 DAI. The NH_4OAc –K in the soil also increased with the time of incubation .The increase in NH_4OAc-K due to application of 100 % RDF + Municipal Solid Waste Compost @ 10 t ha^{-1} was to the tune of 114.1 mg kg^{-1} at 90 DAI.Considering the salient findings in perspective ,the study revealed that application of 100 % RDF with Vermicompost @ 5 t ha^{-1} (T_5) was found to be best combination for maximizing the nutrients quality of maize.

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