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Research Paper

Effect of Compost and Industrial By-Products on Fruit Yield and Soil Nutrient Status in Brinjal

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ABSTRACT

Brinjal or eggplant is widely known as aubergine. 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 fly ash with chemical fertilizers are used to study the release pattern of nutrients. The soil was sandy soil pH 7.83, EC 0.22 dSm^{-1} (*Typic udisamments*). The conventional and non-conventional organic sources registered pH of 7.5 and EC of 0.16 dSm^{-1} and the highest organic carbon content (4.2 g kg ha^{-1}), $KMnO_4$-N (147.5 mg kg^{-1}), Olsen-P (7.1 mg kg^{-1}) and NH_4OAc (74.53 mg kg^{-1}) in the treatment receiving 75% RDF and vermicompost @ 5 t ha^{-1}. The pot experiment was conducted in Department of Soil Science and Agricultural Chemistry, Annamalai University to evaluate the yield of brinjal and post-harvest nutrient NPK status. Pot experiment were conducted at the same set of treatment. The highest fruit yield (937.23 g plant^{-1}) and highest post-harvest organic carbon (3.5 g kg^{-1}), Nitrogen (146 mg kg^{-1}), Phosphorus (7.15 mg kg^{-1}) and Potassium (77.48 mg kg^{-1}) were recorded in the treatment applied with 75% RDF and vermicompost @ 5 t ha^{-1}.

***Key words*: Brinjal, Municipal solid waste compost, Vermicompost, Rice husk ash, Lignite flyash**

Brinjal (*Solanum melongena* L.) can be grown in almost all parts of India except higher altitudes, all the year round. In India brinjal cultivation is taken up in an area of 0.73 million hectares with an annual production of 12.80 million tonnes with its productivity of 17.5 t ha^{-1} [1]. Municipal Waste (MSW) is largely made up of kitchen and yard waste and its composting has been adopted by many municipalities. Composting municipal solid waste is seen as a method of diverting organic waste material from landfills which creating a product, at relatively low cost that is suitable for agricultural purposes [2]. In aerobic composting the bacterial conversion of the organics presents in municipal solid waste in the presence of air under hot and moist condition in called composting and the final product obtained after bacterial activity is called compost (humus), which has very high agricultural value it is used as fertilizer and it is non-odorous and free of pathogen [3]. Organic manures play a vital role in improving the fertility and productivity of soils. Earthworms are the friends of farmers. They not only aerate the soil, but also helps in producing soil fertility. The recycling of organic waste through vermicomposting helps to minimizing environmental pollution and increase soil fertility for sustainable agriculture [4]. Vermicompost contains high percentage of humus substances (humic acid, fulvic acid) that contribute to maximum chemical reaction [5]. Fly ash a coal combustion residue is an amorphous Ferro aluminium silicate with a matrix very similar to soil. Addition of Fly ash may improve the physico-chemical properties as well as nutritional quality of the soil and the extent of change depends on soil and Fly ash properties [6]. Rice husk is one of the agro industrial waste by-product used as fuel in rice mill industry. Rice husk ash consist silica with significant amounts of P, K, S, Fe, Ca, Mg and Na [7]. The application of composts and industrial by-products influence soil organic matter and nutrient cycling and increase soil NPK levels. In order to utilize conventional organic source like Vermicompost, non-conventional source like municipal solid waste compost, industrial by-products like Lignite Fly Ash and Rice husk ash are used to study nutrient release pattern through incubation experiment, and influence of treatments to evaluate fruit yield and post-harvest organic carbon NPK status in pot experiment under coastal saline soil.

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MATERIALS AND METHODS

Municipal solid waste compost

Municipal solid waste compost (termed as partially segregated waste compost) were reported manually and subjected to turned windrows composting process. A heap of manually reported mixed municipal solid waste of 4′ height, 8′

breadth was placed on paved ground on composting windrow type and was watered regularly to maintain moisture level between 50-60% and turned manually every 3-5 days for first 6 weeks of composting cycle. From the 7th week, the moisture was allowed to drop when optimum bio-solids decomposition was achieved. The process was completed in about 8-9 weeks without turning. The chemical composition of municipal solid waste compost used in furnished in (Table 1).

Table 1 Nutrient composition of municipal solid waste compost, vermicompost lignite fly ash and rice husk ash

Name of compost industrial by-product	Nutrient content (%)			
	Organic carbon (g kg^{-1})	Total N (%)	Total P (%)	Total K (%)
Municipal solid waste compost	119	0.63	0.16	0.46
Vermicompost	298	1.82	0.76	1.64
Lignite Fly ash	–	0.00029	–	0.0042
Rice husk ash	–	–	0.09	0.92

Vermicompost

Pressmud vermicompost it was prepared by pit method (5 m × 4 m × 0.5 m). Pressmud was spread to 30 cm height in shade and allowed to decompose. After one month, the temperature subsides, the cow dung slurry (1:10 dung: water) was added and thoroughly turned and mixed. At this stage earthworms were allowed into it (1000 number t^{-1}) and optimum moisture of about 50 per cent was maintained. After eight weeks the compost was ready and used in experiment. The chemical composition of pressmud compost used in furnished in (Table 1).

Fly ash

Fly ash is generated by the combustion of lignite in thermal power plant. The Lignite Flyash (LFA) in dry form collected from Neyveli Lignite Corporation (NLC), Neyveli, Tamil Nadu was used to in the experiment. The composition of lignite flyash used is furnished in (Table 1).

Rice husk ash

Rice husk ash (RHA) also called husk char or black ash is the resultant product of burning rice husk is husk fired furnace of conventional and modern rice mill. It was obtained from modern rice mill nearly and used in the experiment. The chemical composition is provided in (Table 1). The organic sources were collected, mixed thoroughly and made into heaps. The homogenous samples from heaps were drawn by means of a scoop from different parts viz. front, middle and back and different parts. Reduced the bulk to one kg level by quartering. These final homogeneous samples were subjected to various analysis (Table 2). The soil sample were collected from Killai village of Cuddalore district, Tamil Nadu to conduct, incubation and pot experiments.

Table 2 Method of analysis of organic manures and industrial by-products

Parameters	Methodology	References
Total nitrogen	Micro-Kjeldahl method (Diacid extraction H_2SO_4:$HClO_4$ in 9:4) ratio	[8]
Total phosphorus	Vanadomolybdate yellow colour method (Triple acid extraction HNO_3:H_2SO_4:$HClO_4$ in 9:2:1 ratio)	[9]
Total potassium	Flame photometry (Triple acid extract)	

Laboratory incubation experiments

The incubation experiments were conducted at Department of Soil Science and Agricultural Chemistry using conventional and non-conventional organic sources, industrial by-products and inorganic fertilizer. 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 9 cm, diameter 21 cm) 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 treatment constitutes like, 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 + Vermicompost @ 2.5 t ha^{-1}; T_5 – 75% RDF + Vermicompost @ 5 t ha^{-1}; T_6 – 100% RDF + Rice husk ash @ 5 t ha^{-1}; T_7 – 75% RDF + Rice husk ash @ 10 t ha^{-1}; T_8 + 100% RDF + Lignite fly ash @ 5 t ha^{-1}; T_9 + 75% RDF + Lignite fly ash @ 10 t ha^{-1}. The soil samples were drawn at 90 DAI and analysed for pH, EC, organic carbon and available NPK content. The design followed was completely randomized design (CRD) and replicated three times.

Table 3 Method of analysis of soil

Parameters	Methodology	References
A. Mechanical Fraction		
Textural fraction	International pipette method	[10]
Soil colour	Munsell soil colour chart	[11]
B. Physico-chemical Properties		
pH	Potentiometry (1:2.5 soil water suspension)	[9]
Electrical conductivity	Conductometry (1:2.5 soil: water suspension)	[9]
Cation exchange capacity (CEC)	Neutral normal ammonium acetate method	[9]
C. Chemical analysis		
Organic carbon	Chromic acid wet digestion method	[12]
Available nitrogen ($KMnO_4$-N)	Alkaline permanganate method	[13]
Available phosphorus (Olsen-P)	Ascorbic acid modification of the molybdate blue method	[14]
Available potassium (NH_4OAC-K)	Flame photometer (1N NH_4OAC extract)	[15]

Table 4 Physico-chemical properties of experimental soil

Properties	Value obtained
Physical Properties	
Textural class	Sandy soil
Taxonomic classification	*Typic udisamments*
Chemical Properties	
Soil pH	7.83
EC (dSm^{-1})	0.22
CEC (Cmol (p^+) kg^{-1})	8.2
Organic carbon (g kg^{-1})	2.8
Alkaline $KMnO_4$-N (kg ha^{-1})	257
Olsen-P (kg ha^{-1})	10.2
NH_4OAC-K (kg ha^{-1})	117

Pot experiment

The performance of conventional and non-conventional organic sources and industrial by-products were evaluated. The soil used for pot experiment was initially analyzed the physico-chemical properties (Table 4). The pot experiment was conducted at pot culture yard of the Department of Soil Science and Agricultural Chemistry, Annamalai University, Annamalainagar using the same light textured soil collected from Killai village. Fertilizer recommendation 100:75:75 kg N, P_2O_5 and K_2O ha^{-1} was adopted. The required quantities of N, P, K were supplied through urea, DAP and muriate of potash. The brinjal seedlings variety, Annamalai was raised in beds separately. On 25th day the one seedling were transplanted to experimental pots. Proper care was taken to protect the crop from pests and disease. The composts and industrial by products were applied basally. The same set of treatments in pot culture was followed as per incubation experiment. Soil sample were collected just before the start the pot experiment to determine physico-chemical properties of experimental soil. Standard procedures were followed at each harvest, fruits per plant were weighed in an electronic balance and the sum of total yield was expressed in g $plant^{-1}$. Standard procedures were followed in the post-harvest soil samples were analyzed for organic carbon and available NPK (Table 3). The statistical design adopted was completely randomized design (CRD) and it is replicated thrice. The statistical analysis were done by using AGRES and AGDATA package through computer.

RESULTS AND DISCUSSION

Incubation experiment

pH and EC

It is obvious that improvement in chemical properties of soil is the prerequisite for better crop nutrition. All the conventional, non-conventional organic sources and industrial by-products used in the incubation experiment significantly improved the chemical properties of soil. In the incubation experiment carried out, the conventional organic source greatly reduced the soil reaction (pH) and electrical conductivity of the coastal soil. The initial soil had the pH of 7.83 and EC of 0.22 dSm^{-1}. Due to the application of 75% RDF + Vermicompost @ 5 t ha^{-1} a reduction in soil pH value of 7.45 at 90 DAI was noticed. The EC value observed with the treatment T_5 recorded lowest EC of 0.16 dSm^{-1} at 90 DAI (Table 5). The favourable reduction in pH and EC could be attributed to the prolonged decomposition of added conventional and non-conventional organic sources. During the process of decomposition, a significant quantity of CO_2 is liberated and the decomposed product contains appreciable amounts of organic acid that consequently contributed to the reduction in pH and EC. The mineralization process during the decomposition of conventional and non-conventional organic sources favoured the reduction in pH and EC [16].

Table 5 Effect of conventional, non-conventional organic sources and industrial by-products on soil pH in incubation experiment

Treatments	Soil reaction (pH)	Electrical conductivity (dSm^{-1})
T_1 – Control 100% RDF	7.61	0.20
T_2 – 100% RDF + Municipal Solid Waste Compost @ 5 t ha^{-1}	7.56	0.29
T_3 – 75% RDF + Municipal Solid Waste Compost @ 10 t ha^{-1}	7.51	0.30
T_4 – 100% RDF + Vermicompost @ 2.5 t ha^{-1}	7.46	0.17
T_5 – 75% RDF + Vermicompost @ 5 t ha^{-1}	7.45	0.16
T_6 – 100% RDF + Rice husk ash @ 5 t ha^{-1}	7.84	0.30
T_7 – 75% RDF + Rice husk Ash @ 10 t ha^{-1}	7.86	0.30
T_8 – 100% RDF + Lignite Flyash @ 5 t ha^{-1}	7.88	0.32
T_9 – 75% RDF + Lignite Flyash @ 10 t ha^{-1}	7.89	0.33
Mean	7.67	0.26
S.Ed.	0.01	0.01
CD (P=0.05)	0.02	0.02

Organic carbon

The organic carbon content of the experimental soil was 2.8 g kg^{-1} and rated low. The organic carbon content of the incubated soil was greatly influenced by the added conventional and non-conventional organic sources. The increase in organic carbon content of soil was in the range of 2.7 to 4.2 g kg^{-1} in the incubation experiment with organic sources. Among treatments, 75% RDF + Vermicompost @ 5 t ha^{-1} excelled all the treatments by recording 4.2 g kg^{-1} at 90 DAI (Table 6). The reduced pH and EC in incubation experiments might have helped for better proliferation of soil microbes and enhanced the decomposition of added conventional and non-conventional organic sources and increased the organic carbon status. Increased organic carbon content of soil due to the application of conventional and non-conventional organic sources [17].

$KMnO_4$-N

In the incubation experiment, the availability of N increased with the application of conventional, non-conventional organic sources. In the incubation experiment, application of 75% RDF + Vermicompost @ 5 t ha^{-1} (147.5 mg kg^{-1} at 90 DAI) registered significantly highest N availability (Table 6). The increased N availability with applied conventional, non-conventional organic sources might be due to the increased decomposition of conventional, non-conventional organic courses under favourable soil environment and due to reduced volatilization, leaching and denitrifying losses. The conventional, non-conventional organic sources treated soils act as harbour of number of microorganisms that are associated with fast decomposition and mineralization of organic materials in soil and thus the availability of N greatly increased [18].

Olsen-P

The increased olsen-P content due to application of conventional, non-conventional organic sources and industrial by products were well evidenced in the incubation experiment. The experimental soil exhibited low status of available phosphorus. The increased availability of phosphorus due to application of conventional and non-conventional organic sources and industrial by-products were in the range of 5.24 to 7.10 mg kg^{-1} at 90 DAI recorded in the treatment receiving 75% RDF and vermicompost @ 5 t ha^{-1} (Table 6). Generally, the content of the added inputs is the most important factor for phosphorus mineralization in the soil [19]. In the incubation studies municipal solid waste compost, vermicompost, rice husk ash and lignite fly ash were used as sources for supplementing 'P' nutrition. The vermicompost, municipal solid waste rice husk ash contained 0.76, 0.16 and 0.09%, total P respectively. During the process of decomposition and mineralization, the 'P' released from conventional, non-conventional organic sources and industrial by-products greatly contributed to its availability and this might expressed the superiority of municipal solid waste compost and vermicompost in increasing the phosphorus availability in soil. The field capacity of the incubated soil further stabilized the P mineralization by the way of its solubilizing effect on the decomposed product and proliferating phytase producing microbes [20].

Table 6 Effect of conventional, non-conventional organic sources and industrial by-products on organic carbon, alkaline $KMnO_4$, Olsen-P and NH_4OAC-K at 90 DAI in incubation experiment

Treatments	Organic carbon (g kg^{-1})	Soil N (mg kg^{-1})	Soil P (mg kg^{-1})	Soil K (mg kg^{-1})
T_1 – Control 100% RDF	2.7	130.0	5.24	59.41
T_2 – 100% RDF + Municipal Solid Waste Compost @ 5 t ha^{-1}	3.7	133.5	6.35	67.15
T_3 – 75% RDF + Municipal Solid Waste Compost @ 10 t ha^{-1}	3.9	144.5	6.47	73.13
T_4 – 100% RDF + Vermicompost @ 2.5 t ha^{-1}	4.0	145.0	6.71	69.02
T_5 – 75% RDF + Vermicompost @ 5 t ha^{-1}	4.2	147.5	7.10	74.53
T_6 – 100% RDF + Rice husk ash @ 5 t ha^{-1}	2.7	130.5	5.60	66.91
T_7 – 75% RDF + Rice husk Ash @ 10 t ha^{-1}	2.8	131.0	5.65	72.12
T_8 – 100% RDF + Lignite Flyash @ 5 t ha^{-1}	2.8	129.5	5.25	71.98
T_9 – 75% RDF + Lignite Flyash @ 10 t ha^{-1}	2.9	131.0	5.35	76.48
Mean	3.22	135.8	5.96	70.08
S.Ed.	0.16	2.15	0.03	0.49
CD (P=0.05)	0.33	4.52	0.06	1.03

NH_4OAC-K

Application of conventional, non-conventional organic sources, industrial by-products showed an improvement in the K content of soil. In incubation experiment, the highest K availability was observed with the application of 75% RDF + Lignite fly ash @ 10 t ha^{-1} which registered 74.53 mg kg^{-1} (Table 6). The other industrial by-products viz., rice husk ash, organic sources viz., vermicompost, municipal solid waste compost also improved the K status of soil. The conventional and non-conventional organic sources increased the K availability could be ascribed to the variation in the amounts of total K added through 'organic sources their rate and amount of mineralization [21].

Table 7 Effect of conventional, non-conventional organic sources and industrial by-products on brinjal fruit yield g $plant^{-1}$

Treatments	Fruit yield (g $plant^{-1}$)
T_1 – Control 100% RDF	815.3
T_2 – 100% RDF + Municipal Solid Waste Compost @ 5 t ha^{-1}	884.6
T_3 – 75% RDF + Municipal Solid Waste Compost @ 10 t ha^{-1}	908.6
T_4 – 100% RDF + Vermicompost @ 2.5 t ha^{-1}	916.3
T_5 – 75% RDF + Vermicompost @ 5 t ha^{-1}	934.2
T_6 – 100% RDF + Rice husk ash @ 5 t ha^{-1}	835.6
T_7 – 75% RDF + Rice husk Ash @ 10 t ha^{-1}	862.3
T_8 – 100% RDF + Lignite Flyash @ 5 t ha^{-1}	826.6
T_9 – 75% RDF + Lignite Flyash @ 10 t ha^{-1}	831.3
Mean	868.3
S.Ed.	2.3
CD (P=0.05)	4.9

Fruit yield

The present study revealed that application of 75% RDF + Vermicompost @ 5 t ha^{-1} (T_5) registered highest mean fruit yield of 934.2 g $plant^{-1}$ (Table 7). The results were such that although application of organic manures maintained the good health of soil, they were slow to release adequate nutrients timely. The combined application of conventional, non-conventional organic sources, industrial by-products and fertilizers may supply the nutrients timely and also maintain the suitable condition for flowering, fruiting and growth [22]. The probable reason for increased fruit yield per plant, might be due to the optimum growing environment, better utilization of in organic nitrogen due to presence of vermicompost, municipal solid waste compost thereby enhancing synthesis of growth hormones viz. IAA, cytokinin, auxins etc. The phytohoromones stimulate fruit growth and induce changes in fruit morphology, which in turn improve the assimilation of nutrients and water, more photosynthesis and enhanced food accumulation in edible parts. The role of integrating chemical fertilizers with conventional, non-conventional organic sources, industrial by-products for obtaining higher productivity providing greater stability in production [23].

Soil post-harvest soil nutrient status

Soil organic carbon

The organic carbon content of the soil, which is essential factor for sustaining the soil productivity was significantly increased with the application of conventional and non-conventional organic sources. With the application of municipal solid waste compost and vermicompost the content of organic carbon in soil increased to the tune of 2.6 to 3.5 g kg^{-1} in pot experiment (Fig 1). The application of 100 per cent NPK through fertilizers slightly increased the organic carbon content of the soil. The increased organic carbon content of the soil was due to the application of different kind of organic sources. Under most environmental conditions, soil organic carbon decreases with continuous farming without manure application [24]. Organic sources are known to increase plant biomass yields due to their positive effects on physico-chemical soil condition.

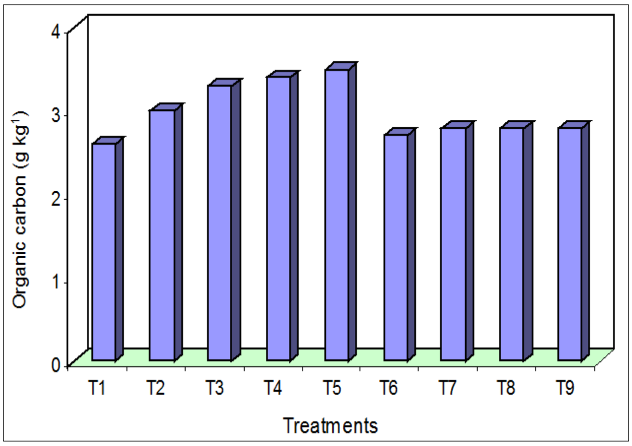

Fig 1 Effect of conventional, non-conventional organic sources and industrial by-products on post-harvest organic carbon status (g kg^{-1})

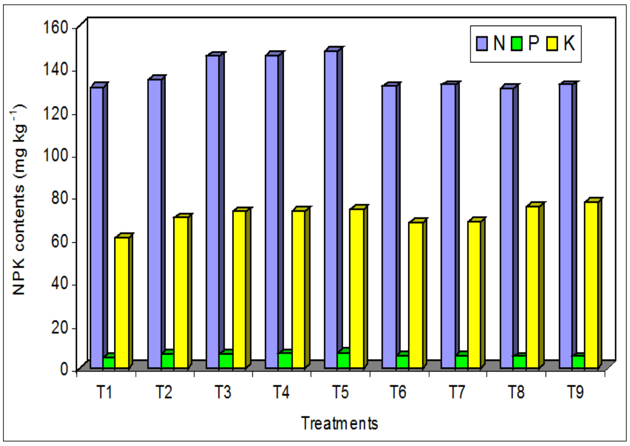

Fig 2 Effect of conventional, non-conventional organic sources and industrial by-products on available NPK contents of soil (mg kg^{-1})

Soil nitrogen

The results of pot experiment indicated that application of 100% RDF + Vermicompost @ 5 t ha^{-1} (T_5) rated best in recording the highest N availability in soil. It registered 148 mg kg^{-1} in the post-harvest soil analysis of pot experiment (Fig 2). It might be attributed to the release of nitrogen to the soil because of congenial environment for soil organism involved in nitrogen transformation. Application of organics increased the nitrogen content in soil [25].

Soil phosphorus

The experiment soil showed low available 'P' status of 10.2 kg ha^{-1}. The coastal soil is variable depending on the nature of parent material and physico-chemical properties of soil. In the present investigation the profound influence of all conventional and non-conventional organic sources in increasing Olsen-P in coastal soil was well documented. Among treatments addition of 75% RDF + Vermicompost @ 5 t ha^{-1} (T_5) significantly increased the Olsen-P in soil. The result of pot experiment also indicated the usefulness of this treatment in increasing the P availability to 7.15 mg kg^{-1} (Fig 2). The use of organic manures are very beneficial for 'P' management of coastal soils as they improve the physical condition and increase the availability of soil phosphates [26]. Manures are always such more effective than soluble inorganic P fertilizers in increasing the available P in soil [27].

Soil potassium

Generally, the coastal soils contain adequate amount of available potassium [28]. The increase in K concentration in soil due to application of conventional, non-conventional organic sources and industrial by-products was well evidenced in the present investigation. Among treatments, application of 75% RDF + Lignite fly ash @ 10 t ha^{-1} (T_9) recorded the highest K concentration (Fig 2). This treatment recorded 75.58 mg kg^{-1} at the harvest stage. The addition of lignite fly ash increased the available potassium content markedly in soil. It might be due to the higher K_2O content of fly ash (8.3%) compared to other organic sources. Application of both organic and inorganic fertilizers brought changes in soil properties and also influenced the availability of native nutrients [29].

CONCLUSIONS

Considering the salient findings in perspectives the study revealed that application of 75% RDF with vermicompost @ 5 t ha^{-1} (T_5) was found to be best in reduction in soil pH and EC and increase in organic carbon, $KMnO_4$-N, Olsen-P and $KMnO_4$-N in the incubation study. Regarding pot culture trial treatment receiving 75% RDF with vermicompost registered highest fruit yield of 934.2 g plant^{-1} and improvement in post-harvest available NPK.

LITERATURE CITED

1. Anonymous. 2018. *Horticultural Statistics at a Glance*. 2018. agricoop.nic.in.
2. Shamim BS, Kangasabai S. 2012. Solid waste management in Tamil Nadu, An overview. *Int. J. Bus. Mgmt Econ. Inform. Technol*. 4(1): 91-95.
3. Mufeed S, Kateel A, Gauhor M, Trivedi RC. 2008. Municipal solid waste management in Indian cities – A review. *Waste Management Review* 28: 459-467.

4. Prabhu M, Rameshkumar A, Balasubramanian V, Jagadeesan R, Ponnuswami V. 2010. Vermicompost and vegetable production. *The Asian Jr. Horti*. 4(2): 541-544.
5. Mihai L, Viorel M, Flavea AT, Dorin EB. 2014. The potential use of vermicompost on orchards. Bulletin of University of Agricultural Sciences and Veterinary Medicine. *Cluj-Napoca. Horticulture* 7(1): 56-58.
6. Pandey VC, Singh N. 2010. Impact of fly ash incorporation in soil systems. *Agriculture, Ecosystems and Environment* 136(1): 16-27.
7. Thind HS, Yadvinder S, Bijay S, Varinderpal S, Sharma S, Vashistha M, Singh G. 2012. Land application of rice husk ash, bagasse ash and coal fly ash: effects on crop productivity and nutrient uptake in rice–wheat system on an alkaline loamy sand. *Field Crops Research* 135: 137-144.
8. Humphries EC. 1956. *Mineral Components and Ash Analysis. In:* Modern methods of plant analysis. Springer – Verlag, Berlin, 1. pp 468-502.
9. Jackson ML. 1973. *Soil Chemical Analysis*. Prentice Hall India, Pvt. Ltd., New Delhi. pp 498.
10. Piper CS. 1966. *Soil and Plant Analysis*. Hans Publisher, Bombay.
11. U.S. Department of Agriculture Hand Book-18-Soil survey Manual, 2000. Munsell soil colour chart. Determination of soil colour, Revised washable edition, 617, Little Britain Road, New Windosor, New York, 12553.
12. Walkley A, Black IA. 1934. An examination of the Degtjareff method for determining soil organic matter and a proposed modification of the chronic acid titration method. *Soil Science* 37: 29-38.
13. Subbiah BV, Asija GC. 1956. A rapid procedure for the estimation of available nitrogen in soils. *Current Science* 25: 259.
14. Watanabe FS, Olsen SR. 1965. Test of an ascorbic acid method for data mining phosphorus in water and $NaHCO_3$ extracts form the soil. *Soil Sci. Soc. Am. Jr*. 29: 677-678.
15. Stanford G, English L. 1949. Use of the flame photometer in rapid soil tests for K and Ca. *Agronomy Journal* 41: 446-447.
16. Singaravel R, Prasath V. 2004. Effect of bio-resources on the nutrient availability and microbial in degraded coastal saline soil. *Ecoprint* 8: 103-105.
17. Manna MC, Swarup A, Wanjari RH, Ravankar HN, Mishra B, Saha MN, Sahi DK, Sarah PA. 2005. Long term effect of fertilizers and manner application on soil organic carbon stages. Soil quality and yield and sustainability under but humid and semi-arid tropical India. *Field Crop Res*. 93: 264-280.
18. Clarson D, Ramaswamy PP, Sree Ramulu US. 1984. Influence of amendments on rice in a sodic soil. *Madras Agrl. Jr*. 71(10): 681-684.
19. Hundal HS, Thind SS. 1993. Release of phosphorus in flooded in amended with green manure. *Journal of Ind. Soc. Soil Science* 41: 782-783.
20. Bokhtian SM, Paul GC, Rashid MA, Mafilym Rahman ABM. 2001. Effect of pressmud and inorganic nitrogen on soil fertility and yield of sugarcane grown in high ranges river flood plain soils of Bangladesh Indian Sugar. *SAARC Jr. Agri*. 52(7): 235-241.
21. Singh Y, Singh B, Timsina J. 2005. Crop residue management for nutrient cycling and improving soil productivity in rice-based cropping systems in the tropics. *Advances in Agronomy* 85: 267-407.
22. Ullah MS, Islam S, Islam M, Haque T. 2008. Effects of organic manures and chemical fertilizers on the yield of brinjal and soil properties. *Journal of Bangladesh Agricultural University* 6: 271-276.
23. Abd El-Mouty MM, Ali AH, Rizk FA. 2001. Potato yield as affected by the interaction between bio and organic fertilizers Egypt. *Jr. Appl. Sci*. 16(6): 267-286.
24. Oadas JM. 1984. Soil organic matter and structural stability, mechanisms and implication for management. *Plant Soil* 76: 213-224.
25. Balaji SK. 1994. Effect of vermicompost on growth and flower yield of China after (*Callistephus chinensis*). *M. Sc. (Agriculture) Thesis,* Dharwad, Karnataka.
26. Bandyopadhyay BK, Rao DLN. 2001. Integrated plant nutrient management in saline soil. *Jr. Ind. Soc. Coastal Agric. Res.* 19: 35-38.
27. Rajkumar K. 2011. Study on the effect of nutrient management on yield and quality of maize. *M. Sc. (Agriculture) Thesis,* Annamalai University, Annamalainagar, Tamil Nadu.
28. Bandyopadhyay BK, Bandyopadhyay AK, Bargava GP. 1985. Characterization of soil and potassium and quantity intensity relationship of potassium in some coastal soils. *Jr. Ind. Soc. Soil Sci.* 33: 548-554.
29. Kumarajit SRK, Singh HA, Changte Z, Gopiman SM. 2005. Integrated management of azolla, vermicompost and urea on yield and nutrient uptake of rice and soil fertility. *Jr. Ind. Soc. Soil Sci*. 53(1): 107-110.