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Response of Conventional and Non-conventional Organic Sources and Industrial By-products for Yield and NPK Uptake of Radish

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A B S T R A C T

Radish (*Raphanus sativus* L.) is one of the important root vegetables cultivated in India mainly for its tender which are used as salad or cooked vegetable. The soil was collected from Vallampadugai farmer's field, Chidambaram taluk, Tamil Nadu having sandy loam texture pH 7.6, EC 1.37 dSm^{-1} (*Typic Ustifluvents*). Regarding the available nutrient status, it was low in KMnO4, medium in Olsen-P and NH_4OAc-K. The pot experiment was conducted in Department of Soil Science and Agricultural Chemistry, Annamalai University to evaluate the response of radish (*Raphanus sativus* L.) with conventional, non-conventional organic sources and industrial by-products combined with inorganic fertilizers. The recommended dose of fertilizers, conventional organic source (FYM 12.5 and 25 t ha^{-1}), non-conventional organic source (Municipal solid waste compost 5 and 10 t $ha^{-1+),}$ industrial by-products (Rice husk ash and bagasse ash @ 5 and 10 t ha^{-1}) are used as treatments. There were nine treatments combinations replicated thrice in CRD. The results showed that application of 100% RDF + FYM @ 25 t ha^{-1}, significantly recorded root yield (845.9 g pot^{-1}) and shoot yield (501.9 g pot^{-1}), dry matter of shoot (46.06 g pot^{-1}) and dry matter of root (84.54 g pot^{-1}). Oven dried samples of root and shoot were analyzed for NPK uptake and expressed in g pot^{-1}. The application of 100% RDF + FYM @ 25 t ha^{-1} registered maximum nitrogen uptake of root and shoot was recorded 2.28 g pot^{-1} and 6.84 g pot^{-1}, phosphorus uptake of root and shoots was recorded 1.86 g pot^{-1} and 1.82 g pot^{-1} respectively. The application of 100% RDF + Bagasse ash @ 10 t ha^{-1}, recorded the highest potassium uptake of root and shoot which was 3.1 g pot^{-1} 3.12 g pot^{-1} respectively.

***Key words*: Radish, FYM, Bagasse ash, Root yield, NPK uptake**

Radish (*Raphanus sativus* L.) is an edible root vegetables Radishes are grown and consumed, being mostly eaten raw as a crunchy salad vegetable with a Pungent odour. Being a short duration crop it has the ability to fit well under intensive agriculture production system. Radish was cultivated in an area of 0.209 million ha and production of 3.061 million tonnes in India [1]. Being a short duration and quick growing crop, the root growth should be rapid and uninterrupted. Hence, for the production of good quality radish, optimum nutrition through organic and inorganic are essential for sustainable production. Organic agriculture practices rely upon recycling of crop residues, animal manure, farm organic residues and wastes etc. [2]. In view of higher cost of synthetic fertilizers and their contribution to poor health of soil and water it becomes imperative to for alternative and cheaper sources like organic manures and industrial by-products. Within this background, the present investigation was carried out to study the effect of conventional, non-conventional organic sources, industrial by-products on yield and NPK uptake of radish.

Municipal solid waste is largely made up of kitchen and yard waste and their composting has been adopted by many municipalities. Composting of municipal solid waste is seen as a method of diverting organic waste materials from landfills while creating a product, at relatively low cost

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that is suitable for agriculture purpose [3]. This trend may be attributed to economic and environment factors such a municipal landfill capacity costs associated with land filling and transportation of materials, adoption of legislation to protect the environment, decrease the use of commercial inorganic fertilizers, increasing the capacity for house hold waste recycling and improved quality of composted products [4]. In aerobic composting the bacterial conversion of the organic present in municipal solid waste in the presence of air under hot and moist condition is called composting and the final product obtained after bacterial activity is called compost (humus), which has very high agricultural value it is used as organic manure and it is non-odorous and free of pathogens [5].

Organic matter plays an important role in the improvement of soil physical properties such as the promotion of soil aggregation, improved permeability and moisture holding capacity, the most valued part in organic matter, well decomposed FYM or compost is humus as a chemically identifiable and stable product, outcome of microbial metabolites, laboratory studies have shown that low molecular weight substance from humus are also taken by the plants [6]. The recent energy crisis and hike in prices of the inorganic fertilizer, necessitate the use of organic manures and industrial by-products in crop production. In this context an attempt was made to augment radish cultivation practice by incorporation of FYM in to the normal fertilizer input requirement. Bagasse ash is a type of organic wastes which obtained from sugar industry during the process of sugar production. Researchers considers bagasse ash as a good source of micronutrients like, Fe, Mn, Zn and Cu [7]. It can also be used as soil additive in agriculture farming having its capacity to supply the plants with small amounts of nutrients [8].

Paddy husk ash is a highly available amendment in large quantities. It has reasonable quantities of Ca, Mg, K, Na and other essential elements including P & very little N. The ash increases the soil pH, thereby increasing available phosphorus, it improves the aeration in the crop root zone and also increase the water holding capacity and level of exchangeable potassium and magnesium [9]. In order to utilize conventional source like FYM, non-conventional sources like municipal solid waste compost, industrial by-products like bagasse ash and rice husk ash are used to study in radish crop with the following objective. To investigate the influence of conventional, non-conventional organic sources industrial by-products and inorganic fertilizers on yield and NPK uptake of radish in pot experiment.

MATERIALS AND METHODS

The studies involved pot experiment at Department of Soil Science and Agricultural Chemistry, Annamalai University with radish as a test crop.

Municipal solid waste compost

The organic materials mainly vegetable, fruit and kitchen waste were separated manually and subjected to turned windrows composting process. The composition of municipal solid waste compost is furnished in (Table 1).

Table 1 NPK composition of materials

Materials	Organic carbon (g kg^{-1})	Total N (%)	Total P (%)	Total K (%)
Municipal solid waste compost	270	1.13	2.92	0.53
Farmyard manure	183	0.79	0.42	0.80
Bagasse ash	7.1	0.015	0.0048	0.022
Rice husk ash	–	–	0.09	0.92

Farmyard manure (FYM)

To prepared FYM a trench size of 6.9 m × 1.5 m × 1.0 m was formed under shade. Urine-soaked refuse along with dung was collected and placed in the trench. From one end of the trench filling was done with daily collections of dung when the trends was filled up to a height of 0.45 m above ground level, the top of the heap was made in dome shape and plastered with cow dung slurry. The manure became ready to use as FYM in about four months period after plastering. The composition of FYM prepared and used in the experiment is furnished in (Table 1).

Bagasse ash

Bagasse ash is a type of organic wastes which obtained from sugar industry during the period of sugar production. It is a by-product generated at industrial plants using biomass as energy sources. The resulting bagasse ash is an alkaline material namely of nitrogen (N), that containing other elements such as potassium (K), and phosphorus (P), which are required for plants. The bagasse ash in dry form collected from Sethiyathoppe co-operative sugar mill, Tamil Nadu in the experiment. The properties and composition of bagasse ash 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 in fired furnace of conventional and modern rice mills. It was obtained from modern rice mills nearby area and used in the experiment. The chemical composition is provided in (Table 2).

Sampling of organic amendments and industrial by-products

The organic sources were collected mixed thoroughly and made into heaps. Reduced the hulk to one kg level by quartering these final homogenous samples were subjected to organic carbon and NPK analysis (Table 2).

Table 2 Methods sampling of organic amendments, industrial by-products, NPK content of radish

S. No.	Parameters	Method	References
1	Organic carbon	Chromic acid wet digestion method	Walkley and Black (1934)
2	Total nitrogen	Micro-Kjeldahl method	Humphries (1956)
3	Total phosphorus	Vanado molybdate yellow colour method	Jackson (1973)
4	Total potassium	Flame photometer	Jackson (1973)

Collection of soil sample

The soil samples were collected from Vallampadugai village, Chidambaram taluk, Cuddalore district, to conduct pot experiment.

Pot experiment

A pot experiment was carried out to study the effect of soil application of RDF as control, RDF with municipal solid waste compost @ 5 and 10 t ha^{-1}, RDF with farmyard manure @ 12.5 and 25 t ha^{-1}, RDF with rice husk ash @ 5 and 10 t ha^{-1}, RDF with bagasse ash 5 and 10 t ha^{-1}, on the growth, yield and nutrient uptake of radish as well as response level of soil application of above conventional, non-conventional organic sources and industrial by-products to radish. The experiment was conducted in a completely randomized design with the following nine treatments and each treatment was replicated 3 times. Twenty kg of air-dried processes soil was filled in 32 m × 25 cm cement pots. A uniform NPK dose of 100:50:50 kg ha^{-1} was applied to all the pots through urea, super phosphate and muriate of potash. Radish var. Pusa Chetki were maintained in each pot. Plants in three replication were allowed to grow up to maturity and three replication were harvested on 45 DAS. Treatment details of the pot culture experiment:

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 + Farmyard manure @ 12.5 t ha^{-1}
T_5 – 100% RDF + Farmyard manure @ 25 t ha^{-1}
T_6 – 100% RDF + Rice husk ash @ 5 t ha^{-1}
T_7 – 100% RDF + Rice husk ash @ 10 t ha^{-1}
T_8 – 100% RDF + Bagasse ash @ 5 t ha^{-1}
T_9 – 100% RDF + Bagasse ash @ 10 t ha^{-1}

Plants in each pot was observed and the mean yield was recorded.

Root yield pot^{-1}

The root yield from each plant was recorded at the time of harvest. The mean root weight obtained in each treatment was expressed in g pot^{-1}.

Shoot yield pot^{-1}

The shoot yield from each labeled plant was recorded at the time of harvest. The mean shoot weight obtained in each treatment was expressed in g pot^{-1}.

Dry matter production (g pot^{-1})

The plants maintained in each treatment were pulled out at time of harvest for the estimation of dry matter production. The plant samples were washed with distilled water, root and leaves were separated and dried in hot air oven at 60°±2°C constant weight after recording the fresh weight of samples.

Preparation and analysis of root and shoot samples

Root samples

The tubers in each treatment were washed in distilled water, oven dried at 70°C. The root samples were also grounded in a Wiley mill. The root samples were analyzed for NPK contents (Table 4).

Shoot samples

The plant samples were collected at harvest stage of radish. The plant samples were washed in dilute HCl and then with distilled water and were oven dried in oven at 70°C. The samples were cut into pieces and powdered by using Wiley mill. Standard procedures were followed for analyzing, NPK content in shoot sample of radish (Table 4).

Uptake of N, P and K

The uptake of individual nutrients by the root and shoot was calculated by multiplying the nutrient of root and shoot by their dry weight and expressed in g pot^{-1}.

$$\text{NPK uptake} = \frac{\text{Nutrient content (\%)} \times \text{Dry weight of sample (g pot}^{-1})}{100}$$

Soil samples collected at Vallampadugai just before the start of experiment. The soil pH and electrical conductivity (EC) were determined in 1:2.5 soil: water suspension [10]. Soil texture was determined by Bouyoucos hydrometer method. Organic carbon (0.2 mm sieved) was determined by wet oxidation method of [11]. For available N was determined by alkaline permanganate method [12]. For available P, soil sample was extracted with 0.5 M $NaHCO_3$ [13]. Available K was determined by extracting soil with 1N NH_4OAc followed by measuring the K content using a flame photometer [14-10]. The cation exchange capacity (CEC) was determined by 1N NH_4OAc extract [15].

Statistical analysis

The data obtained from pot experiment and the analytical data obtained from chemical analysis of soil and plant samples were subjected to statistical scrutiny. The statistical analysis were done by using AGRES and AGDATA package through computer.

RESULTS AND DISCUSSION

Physico-chemical properties of experiment soil

The composite soil at 0-15 cm collected from Vallampadugai was analyzed for the various physico-chemical properties. The textural composition of the soil was sandy loam. The experimental soil of Vallampadugai comes under the taxonomical classification *Typic ustifluvents.* The cation exchange capacity was 9.4 [cmol (p$^+$) kg^{-1}]. The soil pH is 7.6 with EC of 1.37 dSm^{-1}. The organic carbon content was 2.15 g kg^{-1} and was low in status. The available nitrogen was 168 kg ha^{-1} and was low in status. The available phosphorus and potassium content of the soil were 21 and 187 kg ha^{-1} respectively were medium in status.

Root and shoot yield of radish

The results of study clearly revealed that application of 100% RDF + FYM @ 25 t ha^{-1} (T_5) registered root yield (845.9 g pot^{-1}), shoot yield (501.9 g pot^{-1}) (Table 3). The results were such that although application of organic manures maintained good health of soil, they were slow to release adequate nutrients timely. The role of organic manure in enhancing the growth characters is well known and they have a positive relationship with growth as indicated in the present study. Organic manures were efficient than inorganic fertilizers, whereas the combined as of organic with inorganic fertilizer was considered to be superior to the use of organic fertilizer alone [16]. The possible reasons for yield and the yield contributing parameters may be attributed to FYM application along with chemical fertilizers which resulted in sustainable plant healthy system. The increased yield is attributed to solubilization effect of plant nutrients by addition of FYM as evidenced by increase in uptake of NPK, Ca and Mg. Residual effect of FYM also helped in increasing, the nutrients absorption capacity of plants [17]. The better efficiency in combination with inorganic fertilizers might be directly the fact that organic manures would provided the micronutrients. Among the industrial by-products to application of 100% RDF + Bagasse ash @ 10 t ha^{-1} registered 645.99 g pot^{-1} (Table 3). This is due to the supply of nutrients. This is due to the conducive physical environment leading to better aeration, increase in soil moisture holding capacity, not activity, nutrient absorption and consequent complementary effect due to bagasse ash have resulted [18].

Table 3 Effect of conventional, non-conventional organic sources and industrial by-products on root and shoot yield (g pot^{-1}) weight in radish

Treatments	Root yield (g pot^{-1})	Shoot yield (g pot^{-1})
T_1 – Control – 100 RDF	591.9	351.3
T_2 – 100% RDF + Municipal Solid Waste Compost @ 5 t ha^{-1}	750.9	470.0
T_3 – 100% RDF + Municipal Solid Waste Compost @ 10 t ha^{-1}	761.9	488.9
T_4 – 100% RDF + Farmyard manure @ 12.5 t ha^{-1}	805.9	491.9
T_5 – 100% RDF + Farmyard manure @ 25 t ha^{-1}	845.9	501.9
T_6 – 100% RDF + Rice husk ash @ 5 t ha^{-1}	585.0	427.9
T_7 – 100% RDF + Rice husk ash @ 10 t ha^{-1}	630.0	435.9
T_8 – 100% RDF + Bagasse ash @ 5 t ha^{-1}	645.9	417.9
T_9 – 100% RDF + Bagasse ash @ 10 t ha^{-1}	555.0	420.0
S.Ed.	44.63	29.23
CD (P=0.05)	93.77	61.41

Dry matter production

Dry weight of root

The maximum dry matter of root (84.54 g pot^{-1}) was found in treatment T_5 (100% RDF + FYM @ 25 t ha^{-1}) (Table 4). FYM and inorganic fertilizer treatment had significant effect on root dry weight. Organic manures had an advantage in supplying other macro and micronutrients elements not contained in NPK fertilizer in the long term as well as slow releasing nature [19].

Table 4 Effect of conventional, non-conventional organic sources and industrial by-products on dry root and shoot weight (g pot^{-1})

Treatments	Dry root weight (g pot^{-1})	Dry shoot weight (g pot^{-1})
T_1 – Control – 100 RDF	45.74	28.16
T_2 – 100% RDF + Municipal Solid Waste Compost @ 5 t ha^{-1}	58.18	42.26
T_3 – 100% RDF + Municipal Solid Waste Compost @ 10 t ha^{-1}	71.23	43.96
T_4 – 100% RDF + Farmyard manure @ 12.5 t ha^{-1}	78.47	44.66
T_5 – 100% RDF + Farmyard manure @ 25 t ha^{-1}	84.54	49.06
T_6 – 100% RDF + Rice husk ash @ 5 t ha^{-1}	47.47	37.5
T_7 – 100% RDF + Rice husk ash @ 10 t ha^{-1}	48.47	37.66
T_8 – 100% RDF + Bagasse ash @ 5 t ha^{-1}	45.94	34.76
T_9 – 100% RDF + Bagasse ash @ 10 t ha^{-1}	46.27	35.36
S.Ed.	3.91	2.59
CD (P=0.05)	8.23	5.45

Dry weight of shoot

The dry matter shoot yield of radish was significantly influenced by application of conventional, non-conventional organic sources and industrial by-products (Table 4). The mean dry weight of shoot pot^{-1} varied from, 28.16 to 49.06 g pot^{-1}. The highest value recorded in pot that received 100% RDF + FYM @ 25 t ha^{-1} (T_5) and was significantly superior to the rest of the treatments. The increased in dry weight of shoot revealed that beneficial effect of organic manures as evidenced by higher values of total dry matter production per plant and higher dry matter accumulation in leaves [20].

NPK content uptake by radish crop

Nitrogen content and uptake

The N content of root (2.69%) and shoot (13.89%) was recorded in treatment T_5 and there is no significant effect (Table 5). The highest nitrogen root uptake (2.28 g pot^{-1}) and shoot uptake (6.84 g pot^{-1}) was observed in T_5 (100% RDF + FYM @ 25 t ha^{-1}). Increase in N uptake might be due to additional amount of nutrients supplied by conventional, non-conventional organic sources improving physical and chemical properties of soil. This may be due to significant of the soil available nitrogen due to FYM resulting in higher accumulation of nitrogen in soil, besides additional supply of nitrogen through FYM. The application of FYM improved physico-chemical properties of soil along with increased mineralization of nitrogen which resulted in more nitrogen uptake [21].

Table 5 Effect of conventional, non-conventional organic sources and industrial by-products on NPK content (%) and uptake (g pot^{-1})

Treatments	Root content (%)			Root uptake (g pot^{-1})			Shoot content (%)			Shoot uptake (g pot^{-1})		
	N	P	K	N	P	K	N	P	K	N	P	K
T_1	2.5	2.04	4.89	1.18	0.95	2.69	13.69	3.39	8.15	3.87	0.95	2.23
T_2	2.61	2.12	4.96	1.52	1.23	2.48	13.81	3.63	8.21	5.86	1.53	3.39
T_3	2.63	2.13	4.97	1.88	1.52	3.55	13.84	3.64	8.34	6.2	1.63	3.61
T_4	2.67	2.14	5.68	2.10	1.68	4.5	13.87	3.69	8.47	6.12	1.62	3.61
T_5	2.69	2.19	5.79	2.28	1.86	4.91	13.89	3.79	8.39	6.84	1.82	3.99
T_6	2.55	2.06	4.92	1.17	0.96	2.26	13.75	3.46	8.40	5.17	1.3	3.06
T_7	2.57	2.06	4.93	1.25	1.00	2.39	13.79	3.47	8.47	5.21	1.31	3.07
T_8	2.54	2.09	5.94	1.17	0.96	2.74	13.71	3.51	8.50	4.78	1.22	2.86
T_9	2.56	2.10	5.95	1.18	0.97	2.76	13.8	3.53	8.51	4.89	1.28	2.92
S.Ed.	0.16	0.13	0.35	0.2	0.16	0.42	0.9	0.23	0.54	0.71	0.18	0.36
CD (P=0.05)	NS	NS	0.73	0.43	0.35	0.88	NS	NS	NS	1.5	0.38	0.77

Phosphorus content and uptake

The P content of root (2.19%) and shoot (3.79%) was recorded highest in treatment T_5 and there is no significant effect (Table 5). The uptake of phosphorus was maximum in treatment T_5 100% RDF + FYM @ 25 t ha^{-1} with root uptake of 1.86 g pot^{-1} and shoot uptake of 1.82 g pot^{-1}. Further phosphorus status of soil increased due to lower utilization of phosphorus by crop from the applied sources. FYM additions resulted in the important of physiological and biological properties of the soil and reduced the activities of phosphorus complexing agents to make more phosphorus available to the crop which ultimately increase its uptake [22]. Such results have also observed by Chatterjee and Bandyopadhyay (2014). Among the industrial by-products, highest root uptake (3.53 g pot^{-1}) and shoot uptake (1.28 g pot^{-1}). This stimulative effect may be due to the role of potassium on production of enzyme activity and enhanced translocation, assimilation and photosynthesis [23].

Potassium content and uptake

The K content of root (5.95%) was recorded in treatment T_9 receiving 100% RDF + Bagasse ash @ 10 t ha^{-1} and show significant effect (Table 5). The K content of shoot does not show significant effect. The highest K content of shoot (8.51%) was recorded in treatment T_9. The uptake of potassium was maximum in treatment T_9 100% RDF + Bagasse ash @ 10 t ha^{-1} with root uptake of (2.76 g pot^{-1}) and shoot uptake of (3.12 g pot^{-1}). This could be ascribed to the accumulation of dry matter content in the plant in above treatment. This particular treatment could have increased the exchangeable and water-soluble potassium. In bagasse ash application along with 100% RDF, the K content of the shoot biomass was significantly greater than that of the other amendments [24].

CONCLUSION

Considering the salient findings in perspective, the study revealed that application of 100% RDF with FYM @ 25 t ha^{-1} was found to be the best combination for maximizing the yield and NPK uptake in radish.

LITERATURE CITED

1. Anonymous. 2018. Horticultural Statistics at a Glance. Horticulture statistics division Department of Agricultural, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers; Welfare, Government of India.
2. Choudhary BR, Fageria MS, Dhaka RS. 2002. Role of growth hormones in chillies: A review. *Agric. Review* 23(2): 145-148.
3. Wolkowski. 2003. Nitrogen management consideration for land spreading municipal solid waste compost. *Jr. Environ. Qual.* 32: 1844-1850.
4. Hansel TG, Bhander T, Christensen Bruun S, Jensen L. 2006. Life cycling modeling of environmental impacts of application of processed organic municipal solid waste on agricultural land (EASTE WASTE). *Waste Manag. Research* 124: 154-166.
5. Sharholy M, Ahmed K, Mahmood G, Trieeli RC. 2008. Municipal solid waste management in Indian cities: A review. *Waste Manag. Research* 28: 249-467.
6. Schnitzer M, Khan U. 1972. *Humic Substances in the Environment*. Marcel Dekker, New York.
7. Anguissola S, Silva S, Botteschi G. 1999. Effect of fly ash on the availability of Zn, Cu, Ni and Cd to chi-cory. *Agrc. Ecosys. Environ*. 72: 159-163.
8. Carlson CL, Adriano DC. 1993. Environmental impacts of coal combustion on residues. *Journal of Environ. Quality* 22: 227-247.
9. AICOAF. 2001. Application of rice husk charcoal, food and fertilizer technology center for the Asian and Pacific region leaflet for agriculture: Practical technologies 4. Association for International Cooperation in Agriculture and Forestry, Japan.

10. Jackson ML. 1973. *Soil Chemical Analysis*. Prentice Hall of Indian Pvt. Ltd., New Delhi.
11. Walkey A, Black AI. 1934. An examination the of the degtierrit method for determination of soil organic matter and a proposed modification of the chromic acid titration method. *Soil Science* 37: 29-38.
12. Subbiah BV, Asija GL. 1956. A rapid procedure for estimation of available nitrogen in soils. *Current Science* 25: 259-260.
13. Watnabe FS, Olsen SR. 1965. Test of an ascorbic acid method for determining phosphorus in water and $NaHCO_3$ extracts from soil. *Soil Sci. Soc. Am. Journal* 29(6): 677-678.
14. Standord S, English L. 1949. Use of flame photometer in rapid soil tests of K and Ca. *Agronomy Journal* 41: 446-447.
15. Chapman HD. 1965. *Cation-exchange Capacity*. *In:* Black, C.A. (Ed.) methods of soil analysis – Chemical and microbiological properties. *Agronomy* 9: 891-901.
16. Devi M, Sharma U, Garima, Kumari Y. 2018. Effect of integrated nutrient management on soil physico-chemical properties and yield of capsicum. *Int. Jr. Curr. Microbiol. Appl. Science* 7(5): 363-372.
17. Sharma JP, Rattan P, Kumar S. 2012. Response of vegetable crops to use of integrated nutrient management practices. *SABB Jr. Food Agric. Science* 2(1): 15-18.
18. Qasim JM, Umar M, Abdus SM. 2004. Impact of organic wastes (Bagasse ash) on the yield of wheat (*Triticum aestivum* L.) in a calcareous soil. *Int. Jr. Agric. Biology* 6(3): 468-479.
19. Kumar D, Kumar N. 2016. Effect of farmyard manure (FYM), NPK and algal fertilizers on the growth and biomass of vetiver grass. *Int. Jr. Eng. Appl. Science* 3(3): 85-89.
20. Patel NK. 2014. Integrated nutrient management in little gourd. *M. Sc. (Agriculture) Thesis*, submitted to Department of Vegetable Science, Aspee College of Horticulture and Forestry, Narsari Agricultural University, Navsari, Gujarat.
21. Sharma N, Shukla YR, Singh K, Mehta DK. 2020. Soil fertility, nutrient uptake and yield of bell pepper as influenced by conjoint application of organic and inorganic fertilizers. *Commun. Soil Sci. Plant Analysis* 51(12): 1626-1640.
22. Chatterjee R, Bandyopadhyay S. 2014. Studies on effect of organic, inorganic and biofertilizers on plant nutrient status and availability of major nutrients in tomato. *Int. Jr. Bio-res. Stress Management* 5(1): 93-97.
23. Hundal HS, Thind SS. 1993. Release of phosphorus in flooded soil amended with green manure. *Jr. Indian Soc. Soil Science* 41: 782-783.
24. Pita V, Vascolor E, Fernandacral, Riheiro HM. 2012. Effect of ash from sugarcane bagasse and wood combustion on crop growth and soil properties. *Arch. Agron. Soil Science* 58(1): 206-212.