Plant Archives Volume 21, No 1, 2021 pp. 259-263 *e-ISSN:2581-6063 (online), ISSN:0972-5210*

Plant Archives

Journal home page: www.plantarchives.org

DOI Url: https://doi.org/10.51470/PLANTARCHIVES.2021.v21.no1.036

INFLUENCE OF CONVENTIONAL AND NON-CONVENTIONAL ORGANIC SOURCES AND INDUSTRIAL REFUSE FOR YIELD AND QUALITY ATTRIBUTES OF RADISH

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(Date of Receiving-29-09-2020; Date of Acceptance-24-12-2020)

ABSTRACT

Radish is a unique root vegetable cultivated in India for its tender roots, consumed as a salad or cooked vegetable. The soil was collected from Vallampadugai, Chidambaram taluk farmer's field having sandy loam soil texture, pH 7.0, EC 1.37 dSm^{-1}, (textural class: Typic ustifluvents). A pot experiment was executed out in the pot culture yard of Annamalai University. Organic sources viz., FYM (12.5 and 25 t ha^{-1}), non-conventional organic sources viz., household solid waste compost (12.5 and 25 t ha^{-1}) and industrial refuse viz., rice hull ash (5 and 10 t ha^{-1}) and bagasse ash (5 and 10 t ha^{-1}) with 100% RDF and 75% RDF. There were 9 treatment combinations replicated thrice in CRD. The results showed that maximum root yield (845.9g pot^{-1}) and shoot yield (501.9 g pot^{-1}) were recorded in treatment, receiving 75% RDF + FYM @ 25 t ha^{-1} (T5). The highest chlorophyll content (1.38 mg g^{-1}), total carbohydrates (4.76%), ascorbic acid (15.9 mg kg^{-1}), and crude protein (0.85%) were registered in T5 (75% RDF+FYM @ 25 t ha^{-1}).

Keywords: Radish, Household solid waste compost, FYM, Rice hull ash and bagasse ash

INTRODUCTION

Radish (*Raphanus sativus*) is a unique important root vegetable cultivated in India, mainly for its tender roots, which are consumed as a vegetable. Being a short-duration crop, it can suit well into multiple cropping under an intensive agriculture production system. Radish recorded the area of 208.55 x 000 ha and production of 3061 metric tonnes in India (Horticultural Statistics at a Glance 2018). Rapid mechanization and overpopulation in India lead to mobilize the people from the village to cities which generate a huge quantity of household solid waste daily. The waste quantity is anticipated in higher significance in the near future as the country ventures industrialization nature status (Sharma and Shah, 2005). It is primarily made up of kitchen waste, and composting has been implemented by many municipalities. Composting of solid household refuse is an approach of disporting organic waste materials from dumping ground while synthesizing a product at a low cost that is accomplished for agriculture purposes (Wolkoswki, 2003). Compost plays the main role in the enhancement of soil properties such as the promotion of soil aggregation, improved permeability, and WHC, the most valued part in organic matter, is humus as a chemically identifiable and stable product, outcome of microbial metabolites, laboratory studies have unveiled that low molecular weight substance from humus are also taken by the crops (Schnitzer and Khan, 1972).

Bagasse Ash is a multipurpose by-product manufactured from the sugar industry. Basically, we use bagasse also in agriculture as manure for crop improvement is nowadays becoming an established practice. The research considered sugarcane bagasse ash an acceptable source of micronutrients (Anguissola *et al.,* 1999).

In the rice-producing regions, a traditional waste material called a rice hull is obtained as a by-product in bulk amounts from rice mills. It is utilized as a combustible substance for boiler and electricity generation, and after flaming, rice husk is ended up as rice hull ash. It is a highly available amendment in sizeable quantities. It has rational quantities of K, Ca, Mg, Na, and other necessary elements, including P and very marginal N. The ash increase the soil pH, meliorate oxygenation in the root region and also improves the WHC (AICOAF, 2001). In a view to utilizing conventional organics like FYM, non-conventional sources like household waste compost; industrial by-products like bagasse ash and rice hull ash are used to study radish crop with the following objectives. The investigations were done on the efficacy of conventional, non-conventional organic sources, industrial by-products, and fertilizers on yield and radish quality in a pot experiment.

MATERIALS AND METHODS

Household waste compost: Big size imperishable waste is manually removed at composting yard preceding to compost termed as partially segregated waste compost. Individual households deliver segregated indestructible waste separately, driving door-to-collection by the municipal organization, formed into heaps. The organic materials, mainly vegetable, fruit, and kitchen waste, were parted manually and exposed to turn windrows composting process. Aeration typically in a pile was provided by physically turning of waste a heap of manually parted mixed household solid waste of 4′ height, 8′ breadth was placed on the concreted ground on composting windrows type and was sprayed water to maintain moisture level at 50% and turned manually utmost for three days for first 6 weeks of composting. From the 7th week, the moisture was allowed to fall when ideal bio-solids putrefaction was attained. The process was finished in about 8 weeks. Subsequently, it was cured for additional three weeks without turning. The ended compost was screened out and weighed. The NPK composition of household waste compost (HSWC) used is furnished in Table 1.

Farmyard manure (FYM): To prepare FYM, a trench size of 6.9 m x 1.5 m x 1.0 m was formed under shade. Urine soaked refuses together with dung was gathered and placed in the trench. From the one corner of the trench, the filling was done with daily collections of dung; when the trench was loaded to the elevated extent of 0.45 m above floor level, the top of the heap was made into dome shape and coated with cattle dung slurry. The manure became ready for usage as FYM in four months period after plastering. The composition of FYM prepared and utilized in the experiment is furnished in Table 1.

Bagasse ash: It is a type of organic wastes which were obtained from sugar industries. It is a refuse generated at industrial plants using biomass as an energy power source. The resulting bagasse ash is an alkaline material, namely of nitrogen (N), that contains potassium (K), and phosphorus (P), which are needed for plants. It is in dry form collected from Sethiyathoppe Co-operative Sugar Mill, Tamil Nadu, utilized in the experiment. The NPK composition of bagasse ash utilized is furnished in Table 1.

Rice hull ash: It is also called husk char or black ash is the resultant product of flaming rice husk in fired furnace of conventional and modern rice mills. It was procured from modern rice mills nearby area and utilized in the experiment. The NPK composition is provided in Table 1.

Sampling of organic sources and industrial refuse: The treatment samples 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 at different depths. Reduced the bulk to one kg level by quartering. Those final homogenous samples were exposed to various analyses (Table 2).

Collection of soil samples: The soil was gathered from Vallampadugai village of Chidambaram taluk, Tamil Nadu, to conduct pot experiment. The physico-chemical properties of soil are provided in Table 3. Standard methodologies are adopted for evaluating soil properties.

Pot experiment: Twenty kg of processed soil was filled up in 32 cm x 25 cm cement pots.Radish variety -Pusa Chetki is used in the experiment. The trial was conducted in a completely randomized design with the following nine treatments and each treatment was repeated 3 times.

Treatment details of the pot trial experiment: T_1 – Control – 100% Recommended dose of fertilizer (50:100:50 kg of NPK ha^{-1}); T_2 –T_1+ House Hold Waste Compost @ 7.5 t ha^{-1}; T_3 – 75% Recommended dose of fertilizer + House Hold Waste Compost @12.5tha^{-1}; T_4 –T_1+Farm yard manure @ 12.5 t ha^{-1}; T_5 – 75% Recommended dose of fertilizer + Farm yard manure @ 25 t ha^{-1}; T_6 –T1+ Rice Hull Ash @ 7.5 t ha^{-1}; T_7 – 75% Recommended dose of fertilizer+ Rice Hull Ash @ 12.5 t ha^{-1}; T_8 –T_1+ Bagasse Ash @ 7.5 t ha^{-1}; T_9 – 75% Recommended dose of fertilizer + Bagasse Ash @ 12.5 t ha^{-1}

Root yield pot^{-1}: The root yield from every plant was recorded during the time of harvest. The mean root weight obtained in each treatment was noted as g pot^{-1}.

Shoot yield pot^{-1}: The shoot yield from each labelled plant was recorded during the time of harvest. The mean shoot weight obtained in each treatment was noted as g pot^{-1}.

Quality attributes

Total chlorophyll content: Leaf samples at 25 DAS were evaluated for total chlorophyll content by acetone extraction method as suggested by Arnon (1949).

Total carbohydrate content: The root was analyzed by Anthrone method (Hedge and Hofreiter, 1962) and expressed in percentage.

Crude protein content: The root was computed by multiplying to nitrogen content with the factor 6.25 (A.O.A.C, 1960) and expressed in percentage.

Ascorbic acid content (mg 100 g^{-1}): The root was evaluated by A.O.A.C. method (1975) and expressed in mg 100 g^{-1} of fresh samples.

The statistical analyses were done by using AGRES and AGDATA package through computer.

RESULTS AND DISCUSSION

Yield

Root yield pot^{-1} and shoot yield pot^{-1}: The data on the effectiveness of conventional, non-conventional organic sources and industrial refuse on root yield were provided in Table 4. There was significant variation between treatments on root yield pot^{-1} and it ranged from 555 g to 845.9 g pot^{-1}. Among the treatment, highest root yield pot^{-1} was registered in treatment T_5, which registered root yield of 845.9 g pot^{-1} (Fig. 1) $R^2 = 0.7323$. The data on shoot yield (Table 5) showed significantly differences were noticed among the conventional, non-conventional biological sources and industrial refuses and this treatment ranged from 351.3 to 501.9 g pot^{-1}. Among the treatments

Table 1. NPK and organic carbon content of house hold waste compost, Farm yard manure , Sugarcane Bagasse ash and Rice hull ash

S. No.	Materials	organic carbon content	Total		
			N (%)	P (%)	K (%)
1	House Hold Waste Compost	11.9	0.63	0.16	0.46
2	Farmyard manure	18.3	0.79	0.42	0.80
3	Sugarcane Bagasse Ash	0.71	0.015	0.0048	0.022
4	Rice Hull Ash	-	-	0.09	0.92

Table 2. Methodology for analysis of organic sources and industrial refuse

S. No.	Parameters	Method	References
1	Total nitrogen	Micro-kjeldahl method (Diacid extraction H_2SO_4:$HClO_4$ in 9:4 ratio)	Humphries (1956)
2	Total phosphorus	Vanodomolybdate yellow colour method (Triple acid extraction HNO_3:H_2SO_4:$HClO_4$ in 9:2:1 ratio)	Jackson (1973)
3	Total potassium	Flame photometry (Tri-acid extract)	Jackson (1973)

Table3. Physico-chemical properties of experimental soil

S. No.	Properties	Values obtained
I	***Physical Properties***	
	Textural class	Sandy loam soil
	Taxonomic classification	Typic ustifluvents
	Bulk density (Mg m^{-3})	1.6
	Particle density (Mg m^{-3})	2.65
	Pore space (%)	39.3
II	***Chemical Properties***	
	pH	7.6
	EC (dS m^{-1})	1.37
	CEC [c mol(p+) kg^{-1}]	9.4
	Organic carbon (g kg^{-1})	2.15
	Alkaline $KMnO_4$-N (kg ha^{-1})	168
	Olsen-P (kg ha^{-1})	21.00
	NH_4OAC-K (kg ha^{-1})	187

Table 4. Effect of conventional, non-conventional organic sources and industrial refuse on root and shoot yield

Treatments (g pot^{-1})	Root yield (g pot^{-1})	Shoot yield
T1	591.9	351.3
T2	750.0	470.0
T3	761.9	488.9
T4	805.9	491.9
T5	845.9	501.9
T6	585.0	427.9
T7	630.0	435.9
T8	645.9	417.9
T9	555.0	420.0
S.Ed.	44.63	29.23
CD (P=0.05)	93.77	61.41

Table 5. Effect of conventional, non-conventional organic sources and industrial refuse on chlorophyll content of leaf, quality attributes of radish root

Treatments	Chlorophyll content (mg g-1)	Total carbohydrate (%)	Ascorbic acid (mg kg-1)	Crude protein(%)
T1	1.09	4.06	14.46	0.50
T2	1.22	4.46	14.68	0.72
T3	1.25	4.66	14.81	0.73
T4	1.28	4.56	15.81	0.81
T5	1.38	4.76	15.90	0.85
T6	1.9	4.66	14.59	0.63
T7	1.25	4.66	14.60	0.62
T8	1.14	4.26	15.48	0.61
T9	1.16	4.26	14.51	0.60
S.Ed.	0.08	0.28	0.96	0.04
CD (P=0.05)	NS	NS	NS	0.08

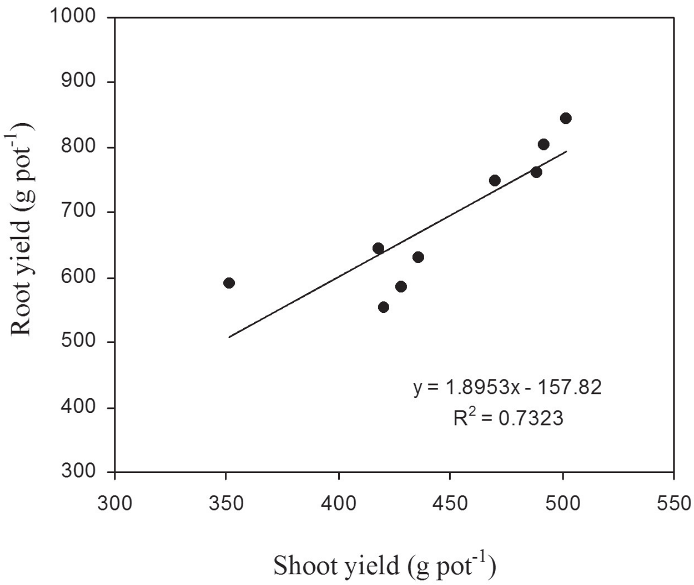

Fig 1. Linear relationship of root yield with shoot yield

the highest shoot yield 501.9 g pot^{-1} was registered in treatment T_5. The role of bio manures in intensifying the growth parameters is well known as they have a positive relationship with growth as indicated in the experimental study. The integrated nutrient components (organic manures and fertilizers) contain nutrients in available form to plants was justified to be better utilization of organic manures (Sharma and Singh, 1991). The increased yield is ascribed to solubilize the capability of plant nutrients by inclusion of FYM as corroborated by increase in uptake of NPK, Ca and Mg. Residual influence of FYM also helped in increasing, the nutrient assimilation of plants. Superimposition of FYM over the inorganic fertilizer had a spectacular influence on the crop yield which was greater than with rest of treatments. This improvement in yield with NPK and FYM could be assigned to improve vegetative growth, and carbohydrate translocation. The maximum yield of the crop due to INM combinations may be associated to the balanced C/N ratio (Shelke *et al.,* 2001). Among the industrial by-products T_7 registered root yield of 630 g pot^{-1} and shoot yield of 435.9 g pot^{-1}. This is because of the contribution of nutrients which is good for physical environment leading to better oxygenation increase in soil WHC , and the subsequent effect in rice hull ash have materialized in maximum root and shoot yield (Karmakar *et al.,* 2009).

Quality attributes

Chlorophyll content: The maximum chlorophyll content of 1.38 mg g^{-1} (Table5) was registered in treatment T_5. The inorganic fertilizers together with conventional, non-conventional organic sources and industrial refuse influenced significantly. Chlorophyll in a plant is to takeup light –usually sunlight. Through photosynthesis, the plant utilizes the stored energy to convert CO_2 and H_2O into glucose, a type of sugar. The metabolic products *viz.,* proteins, glucosides, tannins, tetraterpenoids are the specialized metabolites. The appearance of chlorophyll in the crop greatly influences the production-of specialized metabolites and other necessary plant constituents. Improvement in chlorophyll content may be caused by greater availability and uptake of NP nutrients by plants. Phosphorus might have improved the uptake of nitrogen by plants due to which chlorophyll content increased. (Rajakumaran *et al.,* 2015).

Crude protein: Crude protein content of radish root was remarkably increased by the supply of conventional, non-conventional bio sources and industrial refuse. The maximum crude protein content of 0.85% (Table 5) in radish root was registered in the treatment (T_5) could be because of supplemental supply of FYM which contribute the available nitrogen and resulted in assimilation of crude protein. (Sunanda *et al.,* 2014).

Total carbohydrate content: Carbohydrate content in radish root was remarkably increased by the supply of conventional, non-conventional bio sources and industrial refuses. The treatment T_5 registered the maximum total carbohydrate of 4.76% (Table5). Supply of FYM together with fertilizers resulted in healthy growth of the crop and gave the cloudy green colour of the foliage. This favoured the carbon fixation of the plants and great synthesis 'of carbohydrates. Similar result, were observed by Garhwal *et al.,* (2014).

Ascorbic acid content: From the outcome of the present investigation, it was evident that the ascorbic acid content 15.90 mg kg^{-1} in radish root registered in T_5 than any other treatment combination tried (Table 5). It could be inferred that compost enhanced their efficiency of growth encouraging substances which accelerate the physiological process like reduction of dehydro ascorbic acid which promote synthesis of presence of vitamin C. Similar observation was observed (Hisham Aziz Amran *et al.,* 2014).

ACKNOWLEDGEMENT

We thank Annamalai University authorities for providing pot culture yard to conduct pot experiment.

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