



Influence of Conventional and Non-conventional Organic Sources of Plant Nutrients and Industrial Refuse for Yield and Quality Enhancement of Radish

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ABSTRACT

Background: India generates about 50 million tons of municipal solid wastes (MSW) every year. Composting MSW is viewed as a low-cost method of diverting organic wastes from landfills in to a valuable product of agricultural importance. Farm yard manure (FYM) is an organic matter rich with a small quantity of nitrogen, while rice hull ash is a good source of plant nutrients particularly of potash. Bagasse ash is a waste obtained from sugar industries and is capable of supplying significant amount of plant nutrients. The present investigation aimed to study the effect of organic sources of plant nutrients and industrial waste on yield and quality of radish as a supplementary source of plant nutrients.

Methods: A pot trial investigation was carried out during 2019 at Annamalai University, Chidambaram, Tamil Nadu to study the influence of conventional and non-conventional organic sources of plant nutrients and industrial refuse on yield and quality of radish. Under this trial, FYM (12.5 t ha⁻¹), municipal solid waste compost (25 t ha⁻¹), rice hull ash (5 t ha⁻¹), bagasse ash (10 t ha⁻¹) with 100% RDF and 75% RDF were tried.

Result: The present investigation under pot trial showed that the maximum radish root yield, shoot yield and quality were observed due to the application of organic sources of plant nutrients of both conventional and non-conventional organic sources and industrial refuse.

Key words: Bagasse ash, FYM, House hold solid waste compost, Radish, Rice hull ash.

INTRODUCTION

Radish is a unique root vegetables cultivated in India, mainly for its tender roots, which are consumed as vegetable. Being a short duration crop it has the ability to suit well into multiple cropping under intensive agriculture cropping system. Radish cultivated in an area of 208550 ha with a production of 3061 metric tonnes in India (Horticultural Statistics at a Glance, 2018). Rapid mechanization and opportunities in India cities mobilized the people from villages to cities, which led to overcrowding of population in Indian cities, which generate huge quantity of house hold solid waste daily. The waste quantity is anticipated to increase at alarming significance in near future as the country ventures industrialization (Sharma and Shah, 2005). It is largely comprised of kitchen waste and its composting has been implemented by many municipalities by sophisticated technologies. Composting of house hold solid refuse is an appropriate approach of disposing of organic waste from dumping on ground, while synthesizing a product at low cost should be accomplished for agriculture purpose (Wolkoswki, 2003). Compost plays major role in the enhancement of soil physical properties such as promotion of soil aggregation, improved permeability and water holding capacity (WHC) (Schnitzer and Khan, 1972). Bagasse is a multipurpose by-product obtained from sugar industries. The use of bagasse in agriculture as manure is now-a-days becoming an established practice. Researchers considered

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sugarcane bagasse ash a fine source of micronutrients (Anguissola *et al.*, 1999).

In rice producing regions, a traditional waste material obtained as a by-product in bulk from rice mills is called rice hull. It is utilized as a combustible material for boiler, electricity generation and after flaming, rice husk is ended up as rice hull ash and it is available in sizeable quantities. It has sizable quantities of K, Ca, Mg, Na and other essential elements like P and N. The ash increase the soil pH, it meliorate oxygenation in the root region and improves WHC (AICOAF, 2001). In a view to utilize conventional organics

like FYM, non-conventional sources like house hold waste compost; industrial by-products like bagasse ash and rice hull ash as a source of nutrients, present investigation is programmed to study their effect on radish yield and quality under pot experiment.

MATERIALS AND METHODS

House hold waste compost

Big size imperishable waste is manually collected to composting yard. Individual households deliver segregated imperishable waste separately driving by door-to-collection by the municipal organization, which are formed into heaps. The organic materials mainly vegetable, fruit and kitchen waste were parted manually and exposed to turn windrows composting process. Aeration to the pile was typically provided by physical turning of waste of a heap of manually parted mixed house hold solid waste of 4' height, 8' breadth formed on concrete ground by composting windrows type and was sprayed with water periodically to maintain the moisture at 50% and turned manually utmost for three days during first 6 weeks of composting. On 7th week onwards, the moisture content was allowed to fall down, when ideal bio-solids putrefaction is attained and the process is finished in about 8 weeks. Subsequently, it was cured for additional three weeks period without turning. The finished compost was then screened out and weighed. The NPK composition of house hold waste compost (HSWC) made is furnished in (Table 1).

Farmyard manure (FYM)

To prepare FYM, a trench size of 6.9 m × 1.5 m × 1.0 m was formed under shade. Urine soaked refuses together with dung was gathered and placed in the trench. Filling of pit was done from one corner of the trench 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 in to dome shape and covered with cattle dung slurry and the manure is ready in four months after plastering. The composition of FYM prepared and utilized in the investigation is furnished in (Table 1).

Bagasse ash

It is a type of organic wastes obtained from sugar industries. It is a refuse generated at industrial plants when biomass is being used as power source. The resulting bagasse ash is an alkaline material contains nitrogen (N), phosphorus (P) and potassium (K). It was collected from Co-operative Sugar

Mill, Sethiyathoppe Tamil Nadu, in dry form and utilized in the experiment. The NPK composition of bagasse ash utilized in the study is furnished in (Table 1).

Rice hull ash

It is also called husk char or black ash and is a resultant product of flaming rice husk in fired furnace of conventional and modern rice mills. It was procured from modern rice mills near Chidambaram, Tamil Nadu and utilized in the experiment and their NPK content is furnished 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 and the bulk sample is reduced to one kg by quartering. The final homogenous samples were subjected to various analyses. Sample was digested in diacid mixture ($\text{HNO}_3:\text{HClO}_4$ 9:4) and analysed for total N (Humphries, 1956), P and K was digested in triacid mixture ($\text{HNO}_3:\text{H}_2\text{SO}_4:\text{HClO}_4$ 9:2:1) in the extract as per standard procedures analyzed for total P and total K (Jackson, 1973).

Collection of soil samples

The soil was gathered from Vallampadugai village of Chidambaram taluk, Tamil Nadu to conduct the pot experiment. A pot experiment conducted during 1st October 2019 to 15th November 2019 at Department of Soil Science and Agricultural Chemistry with radish as a test crop. The physico-chemical properties of soil used for the experiment are provided in (Table 2). Standard methodologies are adopted for evaluating the soil properties.

Pot experiment

Twenty kg of processed soil was filled up in 32 cm × 25 cm cement pots. The trial was conducted in a completely randomized design with the following nine treatments and each treatment was repeated 3 times.

Treatment details of pot trial experiment

T₁- Control-100% recommended dose of fertilizer (50:100:50 kg of NPK ha⁻¹); T₂ - T₁+ household waste compost @ 7.5 t ha⁻¹; T₃ - 75% recommended dose of fertilizer + household waste compost @12.5 t ha⁻¹; T₄ - T₁+ farm yard manure @ 12.5 t ha⁻¹; T₅ - 75% recommended dose of fertilizer + farm yard manure @ 25 t ha⁻¹; T₆ -T₁+ rice hull ash @ 7.5 t ha⁻¹; T₇ - 75% recommended dose of fertilizer+ rice hull ash @ 12.5 t ha⁻¹; T₈ -T₁+ bagasse

Table 1: Nutrient content of conventional and non-conventional organic sources and industrial refuse.

| Materials | Organic | Total | | |
|--------------------------|------------|-------|--------|-------|
| | carbon (%) | N (%) | P (%) | K (%) |
| House hold waste compost | 11.9 | 0.63 | 0.16 | 0.46 |
| Farm yard manure | 18.3 | 0.79 | 0.42 | 0.80 |
| Sugarcane bagasse ash | 0.71 | 0.015 | 0.0048 | 0.022 |
| Rice hull ash | - | - | 0.09 | 0.92 |

ash @ 7.5 t ha⁻¹; T₉ - 75% recommended dose of fertilizer + bagasse ash @ 12.5 t ha⁻¹.

Root yield pot⁻¹

The radish root yield from every plant of each treatment was recorded at 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 of each labeled plant was recorded during the time of harvest. The mean shoot weight obtained in each treatment was expressed in g pot⁻¹.

Quality attributes

Total chlorophyll content

Leaf samples drawn 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 for its carbohydrate content by Anthrone method (Hedge and Hofreiter, 1962) and expressed in percentage.

Table 2: Physico-chemical properties of experimental soil.

| Properties | Values |
|--|---------------------------|
| Physical Properties | |
| Textural class | Sandy loam soil |
| Taxonomic classification | <i>Typic ustifluvents</i> |
| Bulk density (Mg m ⁻³) | 1.6 |
| Particle density (Mg m ⁻³) | 2.65 |
| Pore space (%) | 39.3 |
| 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 ₄ OAC-K (kg ha ⁻¹) | 187 |

Crude protein content

The crude protein content of root was computed by multiplying its nitrogen content with a factor 6.25 (A.O.A.C, 1970) and expressed in percentage.

Ascorbic acid content (mg 100 g⁻¹)

The root was evaluated for its ascorbic acid content by A.O.A.C. (1970) and expressed in mg 100 g⁻¹ of fresh samples.

The data were analysed using AGDATA and AGRES software. Experimental design was adopted based on Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Yield

Root and shoot yield of radish pot⁻¹

The data on the efficacy of conventional, non-conventional organic sources and industrial refuse on root yield of radish were furnished in (Table 3). There was a significant variation among treatments on root yield pot⁻¹ and it ranged from 555 g to 845.9 g pot⁻¹. Among the treatments, highest root yield pot⁻¹ was registered under the treatment T₅, which registered a root yield of 845.9 g pot⁻¹. The data on shoot yield (Table 4) showed significant differences among the conventional, non-conventional organic sources of plant nutrients and industrial refuses and it ranged from 351.3 to 501.9 g pot⁻¹. Among the treatments, the highest shoot yield 501.9 g pot⁻¹ was registered in treatment T₅. This was confirmed in the present study (Fig 1) by significant linear relationship observed between root yield with shoot yield ($Y=1.8953x-157.82$ $R^2=0.7323$). The role of manures in intensifying the growth parameters of radish is well known as they have a positive relationship with growth as observed in the experimental study. A similar finding was earlier reported by Sharma and Singh (1991); Rahevar *et al.* (2015). The increased root yield of radish is ascribed to solubilizing effect of plant nutrients by the inclusion of FYM and reflected in the uptake of NPK, Ca and Mg. Residual effect of FYM also helped in increasing the nutrient assimilation of plants. Superimposition of FYM with fertilizer had a spectacular influence on crop yield, which was greater than with rest of

Table 3: Effect of conventional, non-conventional organic sources and industrial refuse on root and shoot yield of radish.

| Treatment | Root yield (g pot ⁻¹) | Shoot yield (g pot ⁻¹) |
|---|--------------------------------------|---------------------------------------|
| T ₁ - Control-100% Recommended dose of fertilizer (50:100:50 kg of NPK ha ⁻¹) | 591.9 | 351.3 |
| T ₂ - T ₁ + House hold waste compost @ 7.5 t ha ⁻¹ | 750.0 | 470.0 |
| T ₃ - 75% Recommended dose of fertilizer + House hold waste compost @12.5 t ha ⁻¹ | 761.9 | 488.9 |
| T ₄ - T ₁ + Farm yard manure @ 12.5 t ha ⁻¹ | 805.9 | 491.9 |
| T ₅ - 75% Recommended dose of fertilizer + Farm yard manure @ 25 t ha ⁻¹ | 845.9 | 501.9 |
| T ₆ - T ₁ + Rice hull ash @ 7.5 t ha ⁻¹ | 585.0 | 427.9 |
| T ₇ - 75% Recommended dose of fertilizer + Rice hull ash @ 12.5 t ha ⁻¹ | 630.0 | 435.9 |
| T ₈ - T ₁ + Bagasse ash @ 7.5 t ha ⁻¹ | 645.9 | 417.9 |
| T ₉ - 75% Recommended dose of fertilizer + Bagasse ash @ 12.5 t ha ⁻¹ | 555.0 | 420.0 |
| S.Ed | 44.63 | 29.23 |
| CD (p=0.05) | 93.77 | 61.41 |

the treatments. This improvement in crop yield with NPK and FYM could be due to improved vegetative growth and carbohydrate translocation. The maximum yield due to INM combinations may be associated to the balanced C/N ratio (Shelke *et al.* 2001). Among the industrial by-products, T₇ registered a root yield of 630 g pot⁻¹ and a shoot yield of 435.9 g pot⁻¹. This is because of contribution of nutrients, in addition to improvement in soil physical environment leading to better soil WHC and subsequent effect of rice hull ash have resulted in maximum root and shoot yield (Karmakar *et al.*, 2009; Prabhakar Reddy *et al.*, 2010).

Quality attributes

Chlorophyll content

The maximum chlorophyll content of 1.38 mg g⁻¹ (Table 4) was registered in treatment T₅. The fertilizers together with conventional, non-conventional organic sources and industrial refuse influenced the chlorophyll content of radish significantly. Chlorophyll in a plant is the key for the production of plant metabolic products *viz.*, proteins, glucosides, tannins, tetraterpenoids. The chlorophyll of crop greatly influences the production of specialized metabolites and other necessary plant constituents. Improvement in chlorophyll content of radish may be due to greater availability and uptake of nutrients by the plants. (Rajakumaran *et al.*, 2015).

Crude protein

Crude protein content of radish root was remarkably increased by the conventional, non-conventional sources and industrial refuse. The maximum crude protein content of 0.85% (Table 4) in radish root was registered in treatment (T₅), this could be because of supplemental supply of FYM

could have contributed 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 plant nutrient sources and industrial refuses. The treatment T₅ registered the maximum total carbohydrate of 4.76% (Table 4). Supply of FYM together with fertilizers resulted in healthy growth of crop and recorded cloudy green colour of foliage. This favoured the carbon fixation of plants and resulted in great synthesis of carbohydrates. Similar result, were earlier observed by Garhwal *et al.* (2014).

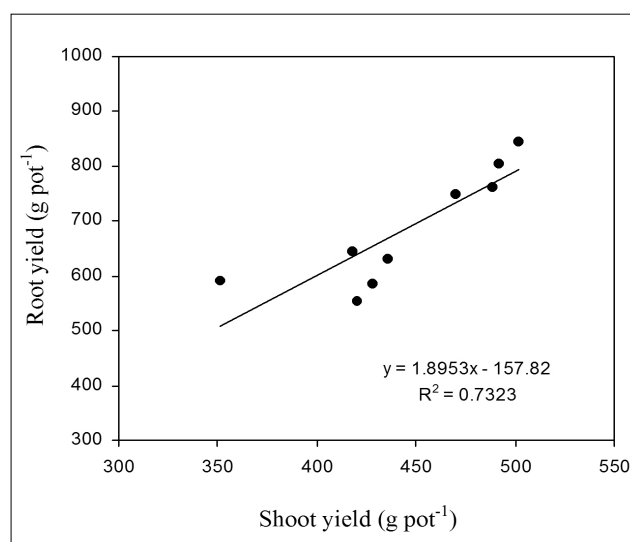


Fig 1: Linear relationship of root yield with shoot yield.

Table 4: Effect of conventional, non-conventional organic sources and industrial refuse on leaf chlorophyll content and, quality attributes of radish root.

| Treatments | Chlorophyll content (mg g ⁻¹) | Total carbohydrate (%) | Ascorbic acid (mg kg ⁻¹) | Crude protein (%) |
|---|---|------------------------|--------------------------------------|-------------------|
| T ₁ - Control-100% Recommended dose of fertilizer (50:100:50 kg of NPK ha ⁻¹) | 1.09 | 4.06 | 14.46 | 0.50 |
| T ₂ - T ₁ + House Hold Waste Compost @ 7.5 t ha ⁻¹ | 1.22 | 4.46 | 14.68 | 0.72 |
| T ₃ - 75% Recommended dose of fertilizer + House Hold Waste Compost @12.5tha ⁻¹ | 1.25 | 4.66 | 14.81 | 0.73 |
| T ₄ - T ₁ + Farm yard manure @ 12.5 t ha ⁻¹ | 1.28 | 4.56 | 15.81 | 0.81 |
| T ₅ - 75% Recommended dose of fertilizer + Farm yard manure @ 25 t ha ⁻¹ | 1.38 | 4.76 | 15.90 | 0.85 |
| T ₆ - T ₁ + Rice hull ash @ 7.5 t ha ⁻¹ | 1.9 | 4.66 | 14.59 | 0.63 |
| T ₇ - 75% Recommended dose of fertilizer + Rice hull ash @ 12.5 t ha ⁻¹ | 1.25 | 4.66 | 14.60 | 0.62 |
| T ₈ - T ₁ + Bagasse ash @ 7.5 t ha ⁻¹ | 1.14 | 4.26 | 15.48 | 0.61 |
| T ₉ - 75% Recommended dose of fertilizer + Bagasse ash @ 12.5 t ha ⁻¹ | 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 |

Ascorbic acid content

From the outcome of the present investigation, it was evident that the highest ascorbic acid content of 15.90 mg kg⁻¹ in radish root was registered in T₅ than any other treatments tried (Table 4). It could be inferred that compost enhanced the growth by encouraging substances, which accelerate the soil physiological process like reduction of dehydro ascorbic acid, which promote synthesis of vitamin C. Similar observation was earlier made by Hisham Aziz Amran *et al.* (2014); Prabhu *et al.* (2018).

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