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# Study of conventional and non-conventional organic sources and industrial by-products for yield maximization and yield attributes of radish in alluvial soil

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**Abstract**
Radish is one of the important root vegetables cultivated in India for its tender roots which are used as salad or cooked vegetable. Soil was collected from Vallampadugai, Chidambaram taluk farmer's field having sandy loam soil texture, pH 7, EC 1.37 $dSm^{-1}$, (*Typic ustifluvents*). Pot experiment was conducted in Department of Soil Science and Agricultural Chemistry, Annamalai University to evaluate the root yield of radish. The treatments were $T_1$ – 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 @ 5 t $ha^{-1}$, $T_8$ – 100% RDF + Bagasse ash @ 5 t $ha^{-1}$, $T_9$ – 100% RDF + Bagasse ash @ 10 t $ha^{-1}$. There were nine treatment combination replicated thrice in CRD. The result showed that yield attributes *viz.*, root length (19.4 cm), single root weight (281.9 g $plant^{-1}$) and shoot yield (501.9 g $plant^{-1}$). The maximum root yield $pot^{-1}$ (845.9 g $pot^{-1}$) was recorded in treatment receiving 100% RDF + FYM @ 12.5 t $ha^{-1}$ ($T_5$).

**Keywords:** Radish, Municipal solid waste compost, FYM, Rice husk and Bagasse ash.

## Introduction
Radish (*Raphanus sativus* L.) is one of the important root vegetables cultivated in India, mainly for its tender roots which are used as salad or cooked vegetable. Being a short duration crop it has the ability to fit well into multiple cropping under intensive agriculture production system. Radish recorded a production of 2898 metric tonnes in India (nhb.gov.in, 2017) [4].

Rapid industrialization and population explosion in India has led to the migration of people from village to cities which generate huge quantity municipal solid waste (MSW) daily. The MSW amount is expected to increase significance in the near future as the country strives to attain an industrialization nature status by the year 2020 (Sharma and Shah, 2005) [9]. Municipal solid waste (MSW) is largely made up to kitchen and yard waste and their composting has been adopted by many municipalities. Composting of MSW is seen as a method of diverting organic waste materials from landfills while creating a product, at relatively low cost that is suitable for agriculture purpose (Wolkoswki, 2003).

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 (Schnitzer and Khan, 1972) [7].

Bagasse ash is a type of organic wastes which obtained from sugar industry during the process of sugar production. Basically we use Bagasse also in agriculture as organic fertilizer for crop improvement is now-a-days becoming an established practice. Research considered bagasse ash a good source of micronutrients like Fe, Mn, Zn and Cu (Anguissola *et al.*, 1999) [3].

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 and very little N. The ash increase 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 exchangeable potassium and magnesium (AICOAF, 2001) [1].

In order to utilize conventional organics 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. The investigate the influence of conventional, non-conventional organic sources industrial by-products and inorganic fertilizers on yield and yield attributes of radish in pot experiment.

## Materials

### *Municipal solid waste compost*

Big size non-biodegradable waste like plastics, rubber, metals *etc.* are manually removed at composting yard prior to compost termed as partially segregated waste compost. Individual households deliver segregated biodegradable waste separately driving door-to-collection by municipal organization, which are formed into heaps. The organic materials mainly vegetable, fruit and kitchen waste were separated manually and subjected to turn windrows composting process. Aeration typically in the heap was provided by manually turning of waste a heap of manually separated 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 funnel manually every 3-5 days for first 6 weeks of composting cycle. From the seventh week, the moisture was allowed to drop when optimum bio-solids decomposition was achieved. The process was completed in about 8-9 weeks. After this period the compost was allowed to cure for additional 3 weeks without turning. The finished compost was the screened out and weight. The NPK composition of municipal solid waste (MSWC) used 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 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 trench was filled up to a height of 0.45 m above ground level, the top of the heap was made in to 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 source. 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, India used in the experiment. The NPK 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 NPK composition is provided in Table 1.

**Table 1:** NPK and organic carbon content of municipal solid waste compost, FYM, Sugarcane Bagasse ash and Rice husk ash

| S. No. | Materials | Organic carbon content | Total | | |
|---|---|---|---|---|---|
| | | | N (%) | P (%) | K (%) |
| 1 | Municipal solid 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 husk ash | - | - | 0.09 | 0.92 |

### Collection of soil samples

The soil sample were collected from Vallampadugai village of Cuddalore district, Tamil Nadu, India to conduct pot experiments. The physico-chemical properties of experimental soil are presented in Table 2.

**Table 2:** Physico-chemical properties of experimental soil

| S. No. | Properties | Values obtained |
|---|---|---|
| **I** | **Physical Properties** | |
| | Textural class | Sandy soil |
| | Taxonomic classification | *Typic ustifluvent* |
| | Bulk density (Mg $m^{-3}$) | 1.6 |
| | Particle density (Mg $m^{-3}$) | 2.65 |
| | Pore space (%) | 39.3 |
| | Soil colour | 10 YR 7/4 – dry soil |
| | | 10 YR 2/1 wet soil |
| **II** | **Chemical Properties** | |
| | pH | 7.6 |
| | EC (dS $m^{-1}$) | 1.37 |
| | CEC [c mol($p^+$) $kg^{-1}$] | 9.4 |
| | Exchangeable carbon [c mol($p^+$) $kg^{-1}$] | 2.15 |
| | Alkaline $KMnO_4$-N (kg $ha^{-1}$) | 168 |
| | Olsen-P (kg $ha^{-1}$) | 21.00 |
| | $NH_4OAC$-K (kg $ha^{-1}$) | 187 |

### Pot experiment
20 kg of air-dried processed soil was filled in 32 cm × 25 cm cement pots.
The experiment was conducted in a completely randomized design with the following nine treatments and each treatment was replicated 3 times.

### 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 + Farm Yard Manure @ 12.5 t $ha^{-1}$
$T_5$ – 100% RDF + Farm Yard 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 @ 5 t $ha^{-1}$
$T_9$ – 100% RDF + Bagasse @ 10 t $ha^{-1}$

### Yield attributes
Representative plants in each pot were labelled and the observation on yield attributes were recorded.

### Root length (cm)
The length of the root tuber was measured at the time of and expressed in centimeters (cm). The mean tuber length obtained in each treatment was expressed in cm.

### Root weight plant$^{-1}$
The weight of the tuber from each labelled plant was recorded at the time of harvest. The mean tuber weight obtained in each treatment was expressed in gram (g).

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

## Research and Discussion
### Yield attributes
### Root length and root weight
The data on root length plant$^{-1}$ is given in Table 3. The mean root length ranged from 11.4 to 19.4 cm and root weight from 185 to 281.9 g plant$^{-1}$. The root length was highest registered 19.4 cm and root weight (281.9 g plant$^{-1}$) where the plants were applied with 100% RDF + FYM @ 25 t ha$^{-1}$. The results were such that although application of organic manures maintained good health of soil, they were slow to release adequate nutrients timely increased yield parameters (Prem Sekhar and Rajashree, 2009) [6].
Among the industrial by-products the application of 100% RDF + Rice husk ash @ 10 t ha$^{-1}$ registered root length of 17.5 cm and root weight of 216.5 g plant$^{-1}$. This is due to the conjunctive of rice husk ash and inorganic fertilizers accumulate and increased the availability of nutrients and the released nutrients from the mineralization process of increased yield parameters (Paul Okon *et al.*, 2005) [5].

**Table 3:** Effect of conventional, non-conventional organic sources and industrial by-products on root length plant$^{-1}$, root weight plant$^{-1}$ in radish root

| Treatments | Root length plant$^{-1}$ (cm) | Root weight plant$^{-1}$ (g) |
|---|---|---|
| $T_1$ – Control 100% RDF | 11.4 | 197.2 |
| $T_2$ – 100% RDF + Municipal Solid Waste Compost @ 5 t $ha^{-1}$ | 17.9 | 250.0 |
| $T_3$ – 100% RDF + Municipal Solid Waste Compost @ 10 t $ha^{-1}$ | 18.4 | 253.9 |
| $T_4$ – 100% RDF + Farmyard manure @ 12.5 t $ha^{-1}$ | 18.9 | 268.5 |
| $T_5$ – 100% RDF + Farmyard manure @ 25 t $ha^{-1}$ | 19.4 | 281.9 |
| $T_6$ – 100% RDF + Rice husk ash @ 5 t $ha^{-1}$ | 16.9 | 202.7 |
| $T_7$ – 100% RDF + Rice husk Ash @ 10 t $ha^{-1}$ | 17.5 | 216.5 |
| $T_8$ – 100% RDF + Bagasse ash @ 5 t $ha^{-1}$ | 16.4 | 181.9 |
| $T_9$ – 100% RDF + Bagasse ash @ 10 t $ha^{-1}$ | 17.2 | 185.0 |
| Mean | 17.1 | 225.46 |
| S.Ed. | 1.13 | 14.80 |
| CD (P=0.05) | 2.38 | 31.09 |

### Root yield pot$^{-1}$ and shoot yield pot$^{-1}$
The data on the effect of conventional, non-conventional organic sources and industrial by-products on root yield were presented in Table 4. There was significant variation between treatments on root yield pot$^{-1}$ and it ranged from 55 g to 845.9 g pot$^{-1}$. Among the treatment, highest root yield pot$^{-1}$ was registered by the application of 100% RDF + FYM @ 25 t ha$^{-1}$ ($T_5$), which registered root yield of 845.9 g pot$^{-1}$ (Fig. 1) $R^2$ = 0.7323.
The data on shoot yield (Fig 1) showed significantly differences were observed among the conventional, non-conventional organic sources and industrial by-products and this treatment ranged from 351.3 to 501.9 g pot$^{-1}$. Among the treatments the highest shoot yield 501.9 g pot$^{-1}$ was recorded which was applied with 100% RDF + FYM @ 25 t ha$^{-1}$ ($T_5$).
The role of organic manures in enhancing the growth characters is well known as 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 (Sharma and Singh, 1991) [10]. The possible reasons for yield and 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 colubilization effect of plant nutrients by addition of FYM as evidenced by increase in uptake of N, P, K, Ca and Mg. Residual effect of FYM also helped in increasing, the nutrients adsorption capacity of plants (Sharma, 2000). The better efficiency in combination with inorganic fertilizers might be directly the fact that organic manures would have provided the micronutrients. The organic manures supply

helped the plant metabolic activity through the supply of such important micronutrients in the early crop growth phase, which in turn encouraged early vigorous growth (Anburani and Manivannan, 2002) [2]. Superimposition of farm yard manure over the inorganic fertilizer had a spetular effect on the crop yield which was higher as compared to other treatments. This increase in yield with NPK and FYM could be attributed to improve vegetative growth, better availability of nutrients vital growth period and greater synthesis of carbohydrate and their translocation. Moreover FYM also supplied additional nutrients and improvement in soil physical properties, which led to better soil physical health. The higher yield of the crop due to inorganic and organic combinations may be attributed to the balanced C/N ratio. Similar findings were also noticed by Shelke *et al.* (2001) [11].

Among the industrial by-products the application of 100% RDF + Rice Husk ash @ 10 t $ha^{-1}$ ($T_7$) registered root yield of 630 g $pot^{-1}$ and shoot yield of 435.9 g $pot^{-1}$. This is due to the supply of nutrients, conducive physical environment leading to better aeration increase in soil moisture holding capacity, root activity and nutrient absorption and the consequent complementary effect in rice husk ash have resulted in higher root and shoot yield (Karmakar *et al.*, 2009) [4].

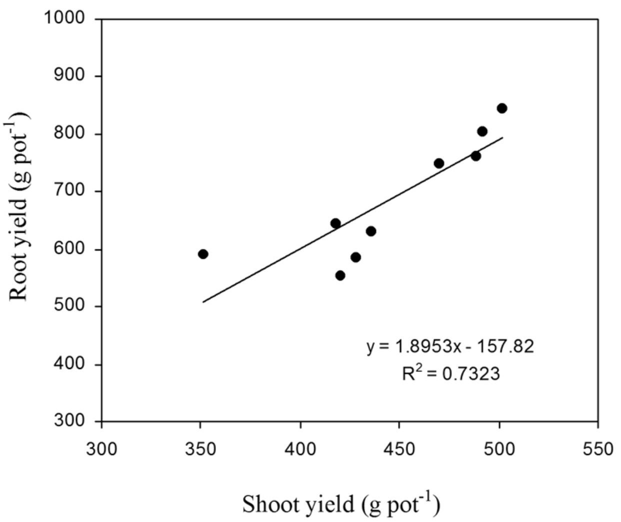


**Fig 1:** Linear relationship of root yield with shoot yield

## Conclusion

1. Considering the salient findings in perspective, the study revealed that application of 100% RDF with FYM @ 25 t $ha^{-1}$ ($T_5$) was found to be the best combination for maximizing yield attributes and yield of radish.
2. Utilization of conventional (FYM), non-conventional (municipal solid waste compost) and industrial by-products (sugarcane bagasse ash and rice husk ash) helped in increasing yield of radish, so that yield gap can be fulfilled.

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