



Effect of organic and inorganic fertilizer on the growth, yield and quality of *Raphanus sativus* L. (Radish)

Tamilselvi Duraisamy, Susila Sugumar, Selvakumar Muniraj, Vasanthy Muthunarayanan*

Water and Solid Waste Processing Lab, Department of Environmental Biotechnology, School of Environmental Sciences, Bharathidasan University, Tiruchirappalli, Tamil Nadu, India

Abstract

The process of composting and vermicomposting is highly preferred for the management of solid wastes of different origin, namely industrial sludge, vegetable waste, food waste, fruit waste etc., This work was proposed to manage the industrial sludge namely distillery sludge, vegetable waste by subjecting them for composting and vermicomposting. However, preference exists for the usage of chemical fertilizers due to their higher efficiency. Hence this study includes such Chemical fertilizer too. Compost and Vermicompost were applied to small replicated field plots planted with *Raphanus sativus* L. (Radish) and the optimized doses of compost prepared from industrial namely, distillery sludge (DSC), vermicompost prepared from distillery sludge (DSV) and vermicompost prepared from vegetable waste (VV) (100g/sq.ft) and chemical fertilizer (CF) (10g/ sq.ft) were added and the plants grown without fertilizers were considered as a control (WOF). The results showed significant increases in whole plant fresh and dry weights, number of leaf and also the fruit yields was higher from the plots treated with DSV when compared with others. The maximum fresh weight of whole plant and root was 182.33g, 87.39g with DSV and a minimum 153.32g, 43.13g was found with WOF respectively. Treatment DSV produced the maximum dry weight of whole plant and root in 60g, 10g and the minimum 18g, 8g was found in WOF. Mineral status also increased from plot treated with DSV than with the others. Such plant growth and increased fruit yields could be partially due to large increase in soil microbial biomass after vermicompost applications, leading to production of hormones or humates in the vermicompost acting as plant-growth regulators independent of nutrient supply.

Keywords: *Raphanus sativus* L., fertilizer, vermicompost, heavy metals

Introduction

Radish (*Raphanus sativus* L.) belongs to the family *Brassicaceae*. It is a popular root vegetable cultivated in both tropical and temperate regions. It can be cultivated under cover for early production but large scale production in field is more common in India. In Karnataka, radish is grown in 8,278 ha with a production of 3,60,093 tonnes [1]. Radish is grown for their young tender tuberous roots which are consumed either cooked or raw. It is reported to be a good source of vitamin C (ascorbic acid) and minerals like calcium, potassium and phosphorus [2, 3, 4]. It is well known for its refreshing and diuretic properties. In homeopathy, it is used for neurological headache, sleeplessness and chronic diarrhea. The roots are also useful in urinary complaints and piles. The leaves of radish are good source for extraction of protein on a commercial scale and radish seeds are potential source of non-drying fatty oil suitable for soap making illuminating and edible purposes [2, 3, 4].

Hence, for the production of good quality radish optimum fertilization through organic, inorganic and bio-fertilizers are highly essential. Organic agriculture is derived as a production system which largely excludes or completely avoids the use of synthetically compounded pesticides, fertilizers, growth regulators, preservatives and livestock feed additives. Organic agricultural practices thus rely upon recycling of crop residues, animal manure, off-farm organic residues and wastes. Organic agriculture is currently gaining movement in India due to the individual as well as the group

efforts to conserve environments and to avoid contamination of the farm produce from the use of chemical fertilizers and pesticides. The important tenet of organic food movement is that it promotes ecological soundness and paves a way for the sustainable use of natural resources, also facilitates the maintenance of crop diversity. The problem of high cost of chemical fertilizers fully meet out nutrient requirement of crop by single source therefore integrated nutrient management such as organic matters like farmyard manure, vermicompost, poultry manure and biofertilizer uses has become necessary. Of course, literature cites that Vermicompost provides vital macronutrients (N, P₂O₅, K₂O, Ca and Mg) and micronutrients Fe, Mn, Zn and Cu). Under normal agro-climatic conditions, the variety which is most suitable and in which organic manure is supplied are the two chief factors which influence yield and quality of radish.

Materials and Methods

Field experiment

The field experiments were carried out at the home garden, Virudachalam, cuddalore (Dt), Tamil Nadu, India. The experiment had five treatments: control (WOF), inorganic fertilizer (Urea, CF); industrial sludge compost (DSC), vegetable waste vermicompost (VV), industrial sludge vermicompost (DSV). Seeds of *Rapinussativus* L. plants were sown in the garden soil 10 cm in-between and at 10 seeds per trial; 25 rows, 1.5 m in length and 1 m in width is has been showed Fig 1. The recommended doses of

composts (100g/sq.ft) and inorganic fertilizers (10g/ sq.ft) were added before planting the soil.

The experiment layout was a randomized complete block design, with three replicates of each treatment. Data were subjected to convenient statistical analysis for the calculations of mean, variance and standard error employing Prism software.

Growth parameters

Number of leaves

The number of leaves was counted from randomly selected and labeled plants. Then the average number of leaves per plant was worked out.

Leaf area per plant (cm²)

Leaf area per plant (cm²) was estimated by using leaf area meter (LICOR 3000) in randomly selected plant and was expressed in square centimeters.

Yield parameters

Root length (cm)

Length of root of all five randomly selected and labeled plants was recorded and the mean values were computed.

Fresh weight of leaves (g)

Fresh weight of leaves per plant was recorded from the five randomly selected and labeled plants and the mean values were computed.

Dry matter content of leaves (g)

The leaves collected from the labeled plants were kept in a hot air oven at 700°C for 24 hours and their dry weight was recorded.

Fresh weight of roots (g)

Fresh weight of root from five randomly selected and labeled plants was recorded and the mean values were computed.

Dry matter content of roots

The roots collected from the five labeled plants were kept in hot air oven at 700°C for 24 hours and their dry weight was recorded.

Total fresh weight of plants (g)

Total fresh weight of five randomly selected plants was recorded and the mean values were computed.

Total dry weight of plants (g)

The five labeled plants were collected and kept in hot air oven at 700°C for 24 hours and their dry weight was recorded.

Results

Germination and yield studies

Radish (*Rapinus sativus L.*) is a plant vegetable, hence, it is a nutrient rich vegetable because it contains high amount of Vitamin C, carotene and it is a good medicine for cold, flu, fever, cough, respiratory problems, and digestive disorders. The present investigations included the comparison of the yield parameters of compost, vermicompost and chemical fertilizer grown plants *Raphanus sativus L.* (RADISH).

Table 1: Physiochemical characterization of field soil for the cultivation of the *Raphanus sativus L.* (RADISH)

Parameters	Quantity
pH	8.9±0.2
EC (µs/mos)	936±0.39
Alkalinity (mg/l)	70± 0.13
Phosphorus (%)	0.012±0.003
Organic carbon (%)	1.81±0.016
Total Nitrogen (%)	0.21±0.01
Potassium (mg/g)	0.002±0.001
Sodium (mg/g)	0.003±0.001
Total magnesium (mg/g)	0.0013±0.002
Calcium (mg/g)	0.002±0.001
Total organic matter	3.120±0.21
C:N ratio	8.61±0.51

Table 2: Amount of Heavy metals present in the soil used for the growth of *Raphanus sativus L.* (RADISH)

Parameters	Amount present in soil (µg/kg)	Desirable Limit Indian standard (Awashthi, 2000)
Copper	8±0.01	135-270
Cadmium	0.1±0.001	3-6
Fe	8.6±0.26	-
Manganese	10±0.34	-
Zinc	150±1.58	300-600

Table 3: Different growth parameters of the WOF, VV, DSC, DSV and CF grown *Raphanussativus L.* (RADISH)

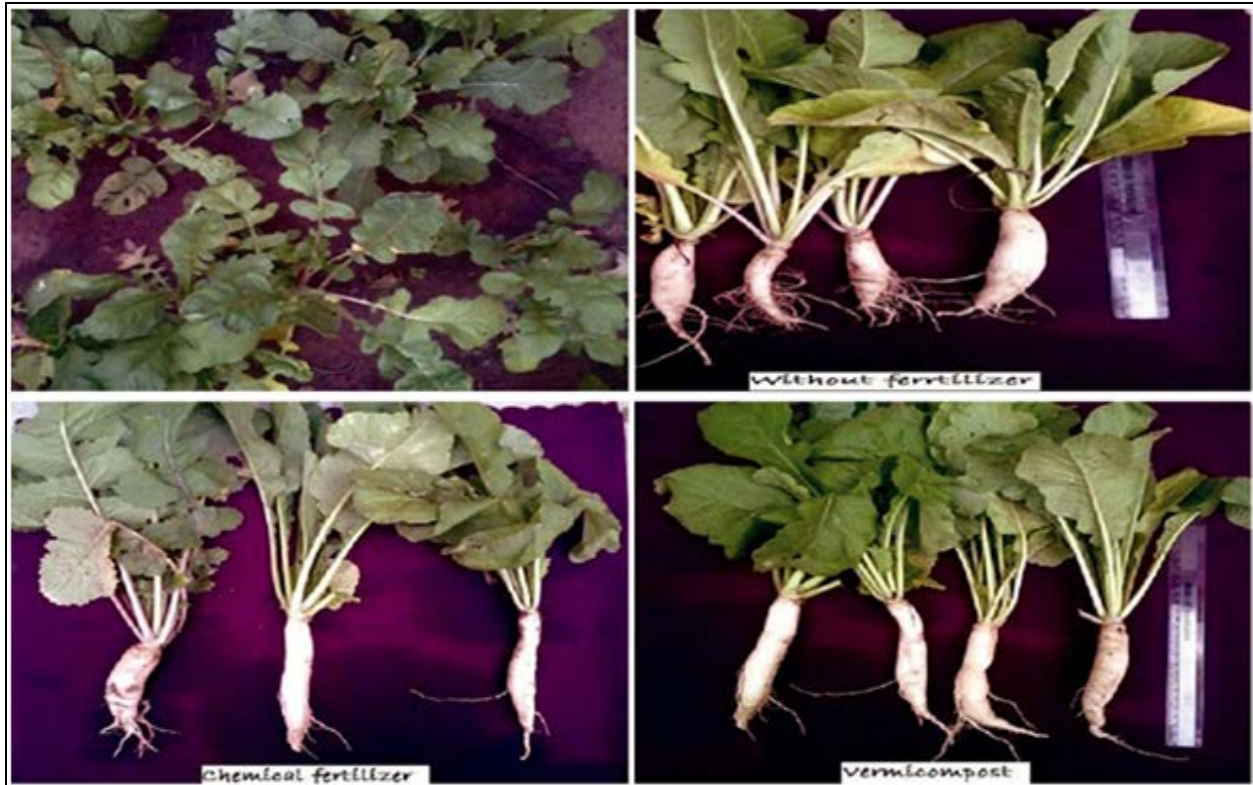
Sample	Whole plant height (cm)	Leaf length (cm)	Leaf width (cm)	Root length (cm)	No. of Leaf	Fresh weight of whole plant (g)	Fresh weight of Root (g)	Total dry weight of whole plant (g)
WOF	28±0.66	11±0.33	8±0.58	10±0.19	8±0.16	153±1.32	43±0.13	18±0.1
VV	39±1.08	11±0.66	10± 0.8	11±0.24	11±0.86	160±0.21	45±0.25	34±0.23
DSC	34±0.16	12±0.25	10±0.41	13±0.02	11±0.66	160±1.15	57±0.58	34±0.23
DSV	38±0.58	15±0.25	10±0.91	13±0.15	21±1.33	182±1.33	87±0.39	60±0.41
CF	28±0.26	10±0.75	8±0.83	10±0.14	10±0.83	160±2.25	54±0.66	28±0.2

Table 4: Amount of Heavy metals present in the samples (WOF, VV, DSC, DSV and CF) which used for the growth of *Raphanussativus L.* (RADISH)

Parameters (µg/g)	WOF	VV	DSC	DSV	CF	Indian standard (Awashthi, 2000)
Fe	4.6±0.65	4.9±0.41	5±0.003	5.6±0.002	6±0.006	-
Zn	2.2±0.005	2.3±0.005	2±0.004	2.5±0.001	2±0.004	50
Copper	0.69±0.003	0.7±0.006	0.7±0.003	0.9±0.003	1±0.01	30
Manganese	1±0.01	1±0.01	1.5±0.012	1±0.01	1±0.01	-
Cadmium	0.2±0.001	0.3±0.002	0.10±0.002	0.4±0.002	1.3±0.01	1.5

Table 5: shows the summarized results of essential mineral level present in the (WOF, VV, DSC, DSV and CF) grown *Raphanus sativus L.* (RADISH)

Parameters (mg/g)	WOF	VV	DSC	DSV	CF
Phosphorus	0.178±0.023	0.196±0.006	0.192±0.012	0.215±0.016	0.185±0.001
Potassium	2.3±0.018	2.53±0.047	2.5±0.035	2.65±0.46	2.45±0.35
Sodium	0.39±0.12	0.54±0.002	0.49±0.011	0.58±0.001	0.49±0.003
Calcium	0.020±0.001	0.028±0.002	0.026±0.002	0.030±0.002	0.024±0.002
Magnesium	0.105±0.005	0.106±0.03	0.108±0.03	0.113±0.02	0.110±0.001

**Fig 1:** Comparison of the growth and yield rate of the *Raphanus sativus L.* (RADISH) used with CF, WOF and VC.

Discussion

Morphological characteristics of organic and inorganically grown plant

Health problems, quality consciousness and degradation of natural resources in the environment have thrown new challenges. Due to these burning problems, organic manure is gaining lot of importance towards achieving sustainability in crop production. Use of organic manures is inherent in Indian farming system. However, after the advent of chemical fertilizers, the importance of organic manuring has received least attention among the farming community, leading to increased toxicity in soil and far produce.

The use of organic manures in soil not only increase the fertility and moisture holding capacity of the soil, but also plays an important role in soil water conservation by their binding and aggregation properties. Moreover, they are helpful in balancing nutrient availability for growing plants and boost the production and quality of the crops. Several attempts have been made to increase the yield potential of root crops, but they are concerned with use of chemical fertilizers. Unfortunately, not only the productivity potential is low but the quality is also deteriorating [5]. Hence, it is time to think not only of increasing the production potential but also to improve the quality by applying advancement in scientific production to meet the increasing demand and boost up the export earnings. In any crop production

programme, the main factor to be considered for better returns is to lower the cost of production without compromising on the yield and quality of the crop. This can be accomplished through selection of a variety suitable for the region and by reducing the application of inorganic fertilizers. In this direction an attempt was made to see the performance of radish varieties with organic manures under controlled condition. The results obtained are discussed here under.

Growth and yield parameters

In this investigation, Radish plant was tried. Among the growth parameters studied, the organically grown radish significantly showed highest number of leaves and fruit. However, the differences were not statistically significant and is shown in tables 3. The highest total length of radish is 13cm in DSV and DSC and the lowest total length 10.1cm in CF were recorded. Treatment DSV produced the maximum number of leaves 21.33 and the minimum 8.16 was found in WOF. The highest leaf length (15cm) was also found in DSV and lowest in CF (10.75cm). These results were supported by Lingaiah *et al* [6] with respect to number of leaves. Poultry manure at 1.25t/ha (50%) + vermicompost @ 1.75t/ha (50%) treated plant significantly resulted in greater number of leaves. The increase in number of leaves may be due to the macro and micronutrient availability with

vermicompost [7]. Thannunathan *et al* [8] reported that application of vermicompost appears to be a very effective amendment in onion. The increased number of leaves and leaf area in Bhunmyalaki (*Phyllanthus amarus* Schum) with the application of poultry manures and along with biofertilizers were recorded by Chezhiyan *et al* [9]. Organic manure application has recorded significantly higher values for number of leaves and leaf area. Though higher values were recorded than for the chemical fertilizer, and the differences were not significant.

Yield parameters

In this investigation fresh weight of leaves, dry weight of leaves, total fresh weight, total dry weight of whole plant and higher root length while *Pusachetki* recorded significantly high fresh weight of root, high dry weight of root and root diameter. The results were shown in table 4. The maximum fresh weight of whole plant and root was 182.33g, 87.39g in DSV2 and minimum 153.32g, 43.13g was found in WOF respectively. Treatment DSV2 produced the maximum dry weight of whole plant and root in 60g, 10g and the minimum 18g, 8g was found in WOF. Similar results also were reported by Parthasarathy [10]. Babalad [11] highlighted for chilli plant, that the highest dry weight and total dry matter was recorded by applying poultry manure. Yadav *et al* [12] reported that the increase in fresh weight of leaves, roots and whole plant may be due to higher level of nitrogen from inorganic and biofertilizers. The higher level of fresh weight may be due to nitrogen which could stimulate the amino acids synthesis resulting in building complex proteins and help in promoting the growth of crop [13].

Yadav *et al* [12] also reported that the root volume or root diameter of chilli has increased due to the application of vermicompost along with other organic manures. The increase in bulb diameter and length may be attributed to solubilization of plant nutrients by addition of vermicompost, FYM leading to increased uptake of NPK [14]. The results are in agreement with the findings of the onion [15, 7]. Finally, the growth of root may depend upon the water and nutrient availability as well by external applications of hormones [16]. Root growth and lateral root formation are found to be good when grown in nutrient-rich environments and in the presence of hormones especially auxins; which could stimulate the plant growth, root development, butt formation etc., [17]. It is therefore evident that development of such morphology in the radish plants was favoured after the application of nutrient-rich and biologically-active substrates like compost and vermicompost as compared to CF and WOF.

The results obtained in this study clearly indicate that radish respond well to application of organic manures. In general, the treatment with DSC, DSV and VV had significantly resulted in greater values for root diameter, root yield and dry matter production of roots than the chemical fertilizer.

Effect of Heavy metals in organically grown radish

Organically in particular DSC and DSV as well as VV, WOF and CF grown radish though accumulated heavy metals like Cu, Cd, Zn, Fe and Mn their presence is observed within the limit of Indian standards as shown in table 5. So, in this regard distillery sludge based vermicompost could be used for promoting plant growth when compared with chemical fertilizer.

Mineral status on organically and inorganically grown radish

In this investigation highest content of mineral was found in plants grown with DSV2 than in the others. The mineral content was as follows: The amount of phosphorus was 0.215mg/g, potassium - 2.65mg/g, sodium - 0.58mg/g, calcium - 0.030mg/g, magnesium - 0.113mg/g and minimum values were recorded in WOF and the values are phosphorus - 0.178mg/g, potassium - 2.3mg/g, sodium - 0.39mg/g, calcium - 0.020, magnesium - 0.105mg/g.

Conclusion

The results make us understand that the organic manure treatment has resulted in highest economic yield. Though, application of DSC, DSV and VV were on par with each other regarding enhancement of plant growth and yield of radish, application of organic manures was found to be the best than the chemical fertilizer and control. In case of radish, our result also confirms that organically grown plant showed high level of Phenolics activities than that grown with chemical fertilizer.

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Conflict of Interest

The author(s) declare that they have no conflict of interest.

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