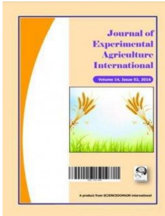

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Effect of Compost Amendment on Plant Growth and Yield of Radish (*Raphanus sativus* L.)

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Authors' contributions

This work was carried out in collaboration between both authors. Author EA designed the study, wrote the protocol, collected the data and wrote the first draft of the manuscript. Author BWA reviewed the experimental design, analyzed the data and wrote the final manuscript. Both authors read and approved the final manuscript.

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ABSTRACT

Aim: To assess the effect of different levels of compost on plant growth and yield of radish.
Study Design: The pot experiment was carried out using a randomised complete block design with four treatments and five replicates.
Place and Duration of Study: The experiment was conducted in a greenhouse at the Horticultural Centre, Charles Sturt University, Orange, New South Wales, Australia, between September and November, 2016.
Methods: The treatments were 25%, 50%, 100% and 0% (control) compost: soil mixture designated as S_L, S_M, S_H and S. respectively. Data collected included: plant height, stem girth, root length, fresh plant weight, and dry plant weight.
Results: No significant differences were found among the various levels of compost with respect to all the measured parameters. All the levels of compost performed significantly better than the no compost control in all parameters measured.

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Conclusion: Compost improved crop growth and yield. Since the 25% compost gave results similar to the 50% and the 100% compost, it can be concluded that the 25% compost provided enough soil nutrients for plant growth and yield. The results merit further work, especially on large scale field studies using lower levels of compost below those in the current study.

Keywords: Compost; soil amendment; radish; organic matter; inorganic fertilizer.

1. INTRODUCTION

Human activity on land is of global significance [1]. The earth's land surface has been modified, thus, altering ecosystem structure and functioning, diminishing the ability of ecosystems to continually provide valuable resources such as food, freshwater and forest resources, and services related to climate regulation, air quality, water quality and soil nutrient resources [2]. Intensive agriculture leads to soil nutrient loss which has negative effects on crop productivity resulting in insufficient food production to feed the rising global population. To achieve global sufficiency in response of the rising food, feed and fibre requirements, there is increase in agrochemical inputs including chemical fertilizers in crop production [3,4]. Whilst chemical fertilizers may quickly release nutrients into soil for crop use, they may have negative impacts on the soil physical and chemical properties, soil fauna, ground water and the ecosystem when they are present in excess quantities. For instance, inorganic fertilizers have been found to increase the concentration of hydrogen ions in freshwater ecosystems without much acid-neutralizing capacity, resulting in acidification of those systems [5]. In addition, it stimulates the development, maintenance and proliferation of primary producers, resulting in eutrophication of aquatic ecosystems. Inorganic fertilizers at higher levels may impair the ability of aquatic animals to survive, grow and reproduce [6]. Inorganic nitrogen pollution of ground and surface waters can also induce adverse effects on human health and economy [5]. High amounts of nitrate use lead to loss of biodiversity and changes in species compositions in ecosystems [6].

Global total fertilizers consumption is expected to increase by 32.1% and reach 226,150,381 Mt by 2030, an average annual growth of 1.33% by 2030 [3]. Again, total consumption of nitrogenous, phosphate, and potash fertilizers in the world would increase by 37.5, 25.8, and 21.2% respectively, compared to the current levels and reach 141,800,601, 50,961,129, and 33,388,650 Mt by 2030 [3]. Whilst total fertilizer consumption in developing countries is expected to increase to 52.8% and reach 156,727,886 Mt by 2030 to sustain food self-sufficiency, most of the farmers especially those in Sub-Saharan Africa are poor and cannot afford the high cost of inorganic fertilizers [7]. The high economic and ecological costs associated with the use of inorganic fertilizers make them unattractive to those conscious of ecological sustainability. There is therefore the need for alternative soil fertility amendment methods to ensure high crop productivity, and simultaneously ensure ecological sustainability.

The use of compost is a natural and ecological means of improving soil fertility for improved crop yield [8]. Incorporation of compost into the soil serves as a basis for the nutrition of soil microbes, and therefore increases their activities [9]. The activities of soil microbes release nutrients such as nitrogen, phosphorus and sulphur into the soil and make them available for plant use [10]. Application of compost contributes to the stabilization of soil aggregate framework and hence improves soil structure, porosity and density., This leads to the reducing of soil runoff and erosion, thereby creating a better plant root environment [11]. Compost increases soil water holding capacity and plant water availability, reduces evaporation, and decreases leaching of nutrients. It also prevents plant diseases, and acts as a long-term slow release fertilizer [12,13].

Radish (*Raphanus sativus* L.) is an important vegetable whose growth and yield depends on soil nutrient conditions. Soils enriched with nutrients such as nitrogen, phosphorus, and potassium through the addition of organic, and inorganic fertilizers influence the growth and yield of the crop [14]. However, due to the higher cost of synthetic fertilizers and contribution to poor health of soil and water, organic fertilizers including compost are preferred to chemical fertilizers. Different levels of compost in the soil have varying effects on crop growth and yield. For instance, sorghum yield increased by 45% on 5Mgha^{-1} plots compared to no compost plots whilst yield was, however, three times higher on a 10 Mgha^{-1} compost plots [8]. This study therefore aimed at finding out how growth and yield of radish respond to different levels of compost in the soil.

2. MATERIALS AND METHODS

2.1 Study Area

The pot experiment was conducted in a greenhouse at the Horticultural Centre, Charles Sturt University, Orange, New South Wales (NSW), Australia.

2.2 Experimental Design and Layout

The pot experiment was designed in a randomised complete block with four treatments and five replications. The treatments were 25%, 50%, 100% and 0% (control) compost: soil mixture designated as S_L, S_M, S_H and S respectively. The soil used contained 94% sand, 2.2% silt and 3.8% clay. The compost made from a combination of straw, chicken manure, and grass clippings was obtained from Bunnings Warehouse, Orange, NSW. Some chemical properties of the soil and compost used is presented in Table 1. *Raphanus sativus* cv. Mila was used. Radish seeds were sown in 4 litre pots at 1.5cm depth, with 2 seeds, 7cm apart in each pot. The radish plants were grown for 8 weeks at a 12 hour day and a 12-hour night regime, with day temperature of 24°C and night temperature of 18°C. The plants were irrigated once every 24 hours.

2.3 Crop Growth and Yield Component Parameters

Data collected included plant height, stem girth, root length, fresh plant weight, and dry plant weight. Plant height and stem girth data were taken one week, four weeks and eight weeks after germination. Root length, fresh weight and dry weight of radish were determined at harvest. One plant was randomly selected from each pot and tagged for all data recordings. Plant height and root length were measured using a ruler. Stem girth was measured by winding a thread around the stem of the plant and stretching the thread on the ruler to determine the measurement. Fresh plant weight was determined by cleaning the plant to remove all traces of soil and weighing with an electronic weight scale. Dry plant weight was obtained by putting plants that were used to obtain the fresh weights in an envelope and drying in an oven at 60°C until constant weights were obtained for each sample after three consecutive weighing.

2.4 Data Analysis

The data collected were subjected to analysis of variance (ANOVA) using SPSS, IBM version 20. Treatment means were compared using the least significant difference (LSD) test at 5% significance level.

3. RESULTS

3.1 Effect and Level of Compost Amendment on Plant Height, and Stem Girth

The application of different levels of compost did not result in significant (P=0.05) effect in plant height and stem girth among all the compost levels. However, all levels of compost were significantly better than the no compost treatment in plant height and stem girth the first, fourth and eighth week after germination (Table 2).

3.2 Effect and Level of Compost Amendment on Root Length

Whilst there were slight observable differences in root length, no significant differences were observed among the compost treatments in root length and weight. However, all the levels of compost treatments were significantly (P=.05) better than the no compost control with respect to root length (Table 3).

3.3 Effect and Level of Compost Amendment on Fresh Plant Weight, and Dry Plant Weight

No significant differences were observed among the various levels of compost in both fresh and dry plant weight of radish. All the levels of compost produced plant weights that were significantly (P=.05) better than the no compost control; (Table 3).

4. DISCUSSION

Compost application was important in enhancing growth and yield of radish. The results which indicated consistent lower values for the control (no compost) treatments showed that the compost provided some amount of nutrients needed for the growth and yield of the radish. In an experiment to investigate the potential of compost for soil improvement, Aggelides and Londra [15] applied organic fertilizer produced from composting 62% town waste, 21% sewage sludge, and 17% sawdust by volume at the rates of 0 (control), 75, 150, and 300 m3ha-1 to loamy and clay soils. The results of their experiment

Table 1. Some chemical properties of soil and compost used in the experiment

	pH	N (%)	C (%)	C/N	P (%)	K cmol(+)/kg	Ca cmol(+)/kg	Mg cmol(+)/kg	EC (mS/cm)
Soil	6.0	0.25	0.91	3.64	0.63	0.12	0.31	0.19	0.14
Compost	6.7	1.33	14.84	11.16	1.27	2.49	4.32	3.51	2.32

EC = Electrical Conductivity

Table 2. Compost level's effect on mean (±SE) plant height and stem girth in Orange NSW, Australia

Weeks after germination	Plant height (cm)				Stem girth (cm)			
	S_H	S_M	S_L	S	S_H	S_M	S_L	S
1	3.02 ± 0.086a	3.10 ± 0.707a	2.94 ± 0.051a	2.16 ± 0.678b	0.62 ± 0.037a	0.66 ± 0.051a	0.58 ± 0.037a	0.40 ± 0.045b
4	5.22 ± 0.206a	5.34 ± 0.121a	5.16 ± 0.136a	3.88 ± 0.086b	1.44 ± 0.051a	1.54 ± 0.051a	1.38 ± 0.058a	0.84 ± 0.051b
8	8.80 ± 0.084a	9.02 ± 0.107a	8.62 ± 0.086a	5.14 ± 0.112b	2.22 ± 0.058a	2.38 ± 0.086a	2.08 ± 0.049a	1.38 ± 0.037b

means with different letters are significantly different

Table 3. Effect and level of compost amendment on root length, fresh plant weight and dry plant weight

Treatment	Root length (cm)	Fresh plant weight (g)	Dry plant weight (g)
S_H	4.88 ± 0.116a	7.91 ± 0.163a	0.73 ± 0.026a
S_M	4.80 ± 0.114a	8.14 ± 0.112a	0.78 ± 0.014a
S_L	4.42 ± 0.074a	7.54 ± 0.181a	0.70 ± 0.030a
S	2.90 ± 0.105b	4.87 ± 0.092b	0.41 ± 0.001b

means with different letters are significantly different showed that the chemical properties of the soils were affected directly by the amendment with compost. The physical properties of the soils were also improved in all cases, as far as the saturated and unsaturated hydraulic conductivity, water retention capacity, bulk density, total porosity, pore size distribution, soil resistance to penetration, aggregation and aggregate stability, were concerned. The results of this study are consistent with earlier studies. For instance, Ofosu-Badu et al. [16] obtained the lowest head yield, poor growth and quality of cabbages in a no compost treatment compared to the compost treatments.

The different levels of compost were similar (no significant difference) in supporting the growth and yield of radish. This means that, the lowest level of compost (25%) provided adequate amount of soil nutrients similar to the highest (100%) level of compost. Even though there were no significant differences in the level of compost treatment among all the parameters measured, it could be observed that the 50% compost gave slightly higher parameters compared to the other levels. This might be due to the fact that the 50% compost supplied the optimum amount of soil nutrients whilst the 100% compost provided the nutrients in excess and rendered the soil too heavy for optimum gaseous exchanges. In an experiment to determine the optimum level of compost for the growth and yield of tomatoes with a range of increasing concentrations, 0%, 5%, 10%, 25%, 50% and 100% by volume of pig manure, it was found that growth of tomato seedlings in the potting mixtures containing 100% pig manure was reduced, probably as a result of high soluble salt concentrations and poorer porosity and aeration [17].

Growth and yield increase of radish might have been due to improved soil biological and physical properties, and increased micronutrient content in the compost than in the no compost treatments. The results of this study are in conformity with the findings of many research works [18-21]. For instance, Kumar et al [22] found that application of vermicompost + poultry manure (50% each) provided significantly higher values for plant height, root length, fresh plant weight and dry plant weight of radish compared to the control (no compost application). Randy and Politud [23] also obtained similar results for the root length, and plant height of radish.

Where applicable, organic fertilizers such as compost should be applied for soil amendment instead of chemical fertilizers. It has been found that crop fertilization can affect susceptibility of crops to pestiferous insects by altering plant tissue nutrient levels [24]. The ability of a crop plant to resist pests and diseases is positively related to optimal physical, chemical and mainly biological properties of soil. Plants on soils with the right amounts of organic matter resist pests better than soils with imbalanced organic matter. Crops grown in soils with optimum levels of organic matter generally exhibit lower abundance of several insect herbivores. However, farming practices, such as excessive use of inorganic fertilizers, can cause nutrient imbalances and lower pest resistance [24].

5. CONCLUSION

In conclusion, the study has shown that compost amendment to the soil has positive effect on radish growth and yield. Since all levels of compost in this study showed similar results, it is expected that the minimum level of compost (25%) could be used to enhance soil fertility levels for radish production. Since 25% compost gave results similar to the 50% and 100% composts, further work using levels of below 25% should be conducted to ascertain the lowest level of compost needed for radish production.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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