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Leaf Production and Dry Matter Accumulation In Radish (*Raphanus sativus* L.) to Different Levels of Organic Manures and Inorganic Fertilizer in Sand Regosol

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Abstract

Chemical fertilizers are applied to increase leaf related parameter, but it causes the adverse effect on soil environment and human health. To assess the comparative response of different level of organic manures and inorganic fertilizers on leaf production and dry matter accumulation in radish (*Raphanus sativus* L.) in Sandy Regosol, field experiment was conducted at the crop farm, Eastern University, Sri Lanka in 2018. The experiment was laid out using Randomized Complete Block Design (RCBD) with seven treatments and four replicates. Treatments were recommended inorganic fertilizer, and 8 t ha^{-1}, 6 t ha^{-1}, 4 t ha^{-1} and 2 t ha^{-1} cow dung with 2 t ha^{-1}, 4 t ha^{-1}, 6 t ha^{-1} and 8 t ha^{-1} compost as a basal and ½ dose of recommended fertilizer as a top dressing and 10 t ha^{-1} cowdung and 10 t ha^{-1} compost as a basal and ½ dose of recommended fertilizer as a top dressing. The present study suggested that different levels of cowdung and compost as a basal with half dose of inorganic fertilizer as top dressing gave similar results compared with recommended inorganic fertilizer in leaf development and dry matter accumulation in radish in sandy regosol.

Keywords: Compost, cowdung, inorganic fertilizer, radish

1. Introduction

Radish (*Raphanus sativus* L.) is one of the recognized vegetable crops belongs to family Brassicaceae. It is grown and consumed throughout the world as a crunchy salad vegetable (Jilani et al., 2010). The most popular part for eating is the tuberous root although the entire plant is edible and the tops can be used as a leafy vegetable. Over the past 15-20 years, a lot of effort made to find the better ways to grow crops on sandy soil. Further world population is growing in alarming rate and demand for food is also increasing quickly. Due to an increase in demand for the leafy vegetables as well as their economic reputation, it is very common that excessive doses of inorganic fertilizers are applied to vegetable fields to attain high harvest (Baitilwake et al., 2011). Extreme inorganic fertilizers weaken environmental, ecological sustainability and affect human health and wealth. Therefore replacement of chemical fertilizers by the organic manures or limited chemical fertilizers usage is vital for sustainability of agriculture production for future generation. Increasing soil organic matter is the key to improve cultivation in sandy soil. The organic manure is economically viable and ecologically accepted manure which play a significant role in soil properties. Organic manures feed the soil and maintain sustainability in the agro ecosystem. Application of organic fertilizers to agricultural soils is an important practice for increasing crop yield. It supply micronutrients and improves soil structure, water holding capacity, increase the availability of nutrients as well as change properties of soil suit for cultivation. Objective of this study is to study the comparative response of different levels of organic manures with inorganic fertilizer on leaf production and dry matter accumulation of radish in sandy regosol.

2. Materials and Methods

The field experiment was conducted at the crop farm, Eastern University, Sri Lanka in 2018 to assess the comparative response of different level of organic manures and inorganic fertilizers on leaf production and dry matter accumulation in Radish (*Raphanus sativus* L.) in Sandy Regosol. The experiment was laid out using Randomized Complete Block Design (RCBD) with seven treatments and four replicates. Treatments were recommended inorganic fertilizer (T_1), and 8 t ha^{-1}, 6 t ha^{-1}, 4 t ha^{-1} and 2 t ha^{-1} cow dung with 2 t ha^{-1}, 4 t ha^{-1}, 6 t ha^{-1} and 8 t ha^{-1} compost as a basal and ½ dose of recommended fertilizer as a top dressing (T_3-T_6) and 10 t ha^{-1} cowdung (T_2) and 10 t ha^{-1} compost (T_7) as a basal and ½ dose of recommended fertilizer as a top dressing. Parameters such as plant height, number of leaves $plant^{-1}$, chlorophyll content in leaf, leaf area, leaf area index and dry weight of leaf were recorded and data were analyzed using statistical soft wares.

3. Results and Discussion

3.1. Plant height

Plant height is a vital part in plant ecological system. It is strongly correlated with life span and time to maturity, and is a major determinant of a species' ability to compete for light (Moles et al., 2009). There was a significant difference (p<0.01) at 2nd and 4th week after planting is shown in Table 1. Tallest seedling was recorded in T_2 (10.15 cm) followed by T_1 (9.65 cm) while shortest seedlings were recorded in T_3 (6.35 cm) at 2nd week after planting. At 4th week after planting, average plant height ranged from 16.58 cm (T_5) to 11.63 cm (T7). However, T_1, T_2, T_4, T_5 and T_6 were statistically same in plant height at 4th week after planting. There was no significant difference (p>0.05) in plant height at 6th week after planting. It is agreeable with the findings of Eric (2016) stated that radish plant height was not significantly differ (p>0.05) when apply the vermicast at the rates from 5 t ha^{-1} to 20 t ha^{-1}.

Table 1: Plant height (cm) of radish at different weeks

Treatments	2nd week after planting	4th week after planting	6th week after planting
T_1	9.65±0.11^{a}	16.10±0.80^{a}	23.65±0.80
T_2	10.15±0.04^{a}	15.10±0.42^{a}	20.63±0.57
T_3	6.35±0.04^{d}	12.60±0.52^{bc}	20.33±1.08
T_4	7.55±0.18^{c}	15.41±0.92^{a}	22.38±0.67
T_5	8.75±0.32^{b}	16.58±0.75^{a}	22.17±0.94
T_6	8.00±0.07^{c}	14.60±0.44^{ab}	21.27±1.57
T_7	8.55±0.18^{b}	11.63±1.03^{c}	22.30±1.07
F test	**	**	ns

Value represent mean±standard error of four replicates; F test: **: p<0.01; ns: not significant; Means followed by the same letter in each column are not significantly different according to the Duncan's multiple range test at 5% level

3.2. No. of leaves plants^{-1}

Instead of large physical dimensions of the sources, optimum and more stable functional efficiency at moderate source size are more advantageous to realize the potential sink size under field conditions (Islam et al., 2016). Crop growth relies on photosynthesis and the growth rate directly reveal photosynthetic rate (Evans, 2013). Shoot growth and leaf production is an vital process which affect yield of crops. Number of leaves per plant at weekly interval is shown in Table 2. Combination of organic manures and or inorganic fertilizer which have not been significantly affected the number of leaves 2nd and 6th weeks after planting is confirmed with P values 0.399 and 0.176 and chi square values of 6.22 and 8.96 respectively. Similar findings were noted by Asgar et al. (2006) stated that number of leaves was observed statistically same in recommended nitrogen fertilizer and in the treatments where enriched compost was applied in integration with different levels of chemical fertilizer.

Table 2: Number of leaves per radish plant at different weeks

Treatments	2nd week after planting	4th week after planting	6th week after planting
T_1	5	9	16
T_2	5	10	14
T_3	5	8	17
T_4	5	9	15
T_5	5	10	16
T_6	5	9	16
T_7	5	8	13
p value	0.399	0.021	0.176
Chi square	6.22	14.93	8.96

3.3. Chlorophyll content

Chlorophyll in leaf is a useful parameter which used to detect nitrogen deficiencies (Blackmer and Schepers, 1995) and helps to maintain healthy plants. Also positive association between photosynthetic rate and chlorophyll content was reported by Nagaraj et al. (2002). Significant difference (p<0.01) was observed at 2nd weeks after planting. It was high in T_3 followed by T_6, while low in T_1. The result is agreeable with Ghosh et al. (2004) stated that total chlorophyll content was higher in organically treated plots than that in 100% NPK. However, there was no significant difference (p>0.05) in chlorophyll content of leaves at 4th and 6th week after planting is shown in Table 3.

Table 3: Chlorophyll content of radish at different week

Treatments	2nd week after planting	4th week after planting	6th week after planting
T_1	34.70±0.42^{g}	47.81±1.25	47.67±1.28
T_2	39.05±0.74^{d}	44.29±2.37	45.45±1.17
T_3	43.65±0.39^{a}	45.93±1.06	46.57±1.95
T_4	39.70±0.42^{c}	45.98±1.93	44.86±1.08
T_5	37.25±0.88^{f}	47.05±2.82	47.60±2.34
T_6	43.05±0.39^{b}	43.33±1.79	48.98±0.68
T_7	38.95±0.18^{e}	43.38±1.22	48.92±1.87
F value	**	ns	ns

Value represent mean±standard error of four replicates; F test: **: p<0.01; ns: not significant; Means followed by the same letter in each column are not significantly different according to the Duncan's multiple range test at 5% level

3.4. Leaf area

Leaf area is a vital variable in models for predicting crop growth and dry matter production in agriculture. The reduction of growth is often accompanied by reduction of photosynthetic pigments and lower photosynthetic rate and it is largely attributed to the reduction in light interception due the reduced leaf area. Leaf area influences the interception and utilization of solar radiation of crop and consequently, the dry matter production (Boote et al., 1998). Photosynthetic light absorption, carbon uptake and assimilation, transpiration of water and emission of volatile organic compounds are nearly exclusively performed via leaf surfaces (Fleck et al., 2009). The leaf area of tested treatments is given in Table 4. There was significant difference in leaf area at 2nd (p<0.05) and 4th (p<0.01) weeks after planting. At 4th weeks after planting the maximum value of 435.18 cm^2 was recorded in T_1 followed by T_5 (321.65 cm^2). Maximum leaf area in T_1 may be the reason for applied full dose of topdressing at 3rd week to the T_1 and ½ dose for other treatments. However no significant in leaf area was noted at 6th week after planting. Leaf area estimates and the quantity of photo synthetically active radiation captured by plant canopies are required in evapotranspiration and crop yield models (Asrar et al., 1984).

Table 4: Leaf area of radish at different week

Treat-ments	2nd week after planting	4th week after planting	6th week after planting
T_1	23.89±1.69^{ab}	435.18±7.26^{a}	785.16±71.08
T_2	26.27±0.98^{a}	283.12±9.04^{c}	1317.04±308.18
T_3	17.98±1.32^{c}	176.25±4.27^{e}	1287.74±215.47
T_4	24.94±1.38^{ab}	209.30±3.58^{d}	1407.44±246.81
T_5	26.21±1.33^{a}	321.65±4.53^{b}	1235.66±256.90
T_6	22.58±1.03^{abc}	263.713±6.73^{c}	1080.36±177.83
T_7	20.68±0.97^{bc}	158.45±5.53^{f}	1077.55±378.21
F value	*	**	ns

Value represent mean±standard error of four replicates; F test: **: p<0.01; ns: not significant; Means followed by the same letter in each column are not significantly different according to the Duncan's multiple range test at 5% level

3.5. *Leaf area index (LAI)*

LAI is an important structural property of vegetation. Because leaf surfaces are the primary border of energy and mass exchange, canopy interception, evapotranspiration, and gross photosynthesis are directly proportional to LAI. LAI of tested treatments is given in Table 5. At 2nd week after planting, maximum of 0.612 (T_7) and minimum of 0.81 (T_2) were noted. As regards to 4th week after planting leaf area index in T_1 was maximum (0.538) and minimum in T_4 (0.267). No significant differences among tested treatment in LAI at 6th week after planting.

3.6. *Dry weight of leaves*

There is a significantly different (p<0.05) among tested treatment in leaves dry weight at 2nd and 4th week after planting is shown in Table 6. Highest leaves dry weight was recorded in T_1 (2.02 g) followed by T_5 (1.83 g) at 4th week after planting. However, no significant differences (p>0.05) was noted at 6th week after planting. In contrast to this study, Priyadarshani et al. (2013) stated that both compost and inorganic fertilizer treatments had significant effect on the shoot and root dry weights.

Table 5: Leaf area index of radish at different week

Treat-ments	2nd week after planting	4th week after planting	6th week after planting
T_1	0.085±0.043^{b}	0.538±0.042^{a}	0.69±0.09
T_2	0.081±0.003^{b}	0.368±0.045^{b}	0.97±0.21
T_3	0.125±0.003^{b}	0.357±0.035^{b}	1.15±0.22
T_4	0.153±0.005^{b}	0.267±0.060^{c}	0.94±0.20
T_5	0.127±0.004^{b}	0.369±0.060^{b}	0.82±0.10
T_6	0.114±0.005^{b}	0.370±0.060^{b}	0.85±0.11
T_7	0.612±0.234^{a}	0.377±0.053^{b}	0.82±0.10
F value	*	**	ns

Value represent mean±standard error of four replicates; F test: **: p<0.01; ns: not significant; Means followed by the same letter in each column are not significantly different according to the Duncan's multiple range test at 5% level

Table 6: Leaves dry weight of radish at different weeks

Treat-ments	2nd week after planting	4th week after planting	6th week after planting
T_1	0.16±0.030^{ab}	2.02±0.45^{a}	6.53±0.40
T_2	0.21±0.006^{a}	1.37±0.30^{abc}	6.00±1.40
T_3	0.10±0.004^{b}	0.68±0.06^{c}	4.96±0.50
T_4	0.17±0.010^{ab}	1.15±0.18^{bc}	5.41±0.40
T_5	0.16±0.010^{ab}	1.83±0.24^{ab}	5.19±0.32
T_6	0.14±0.020^{ab}	0.81±0.08^{c}	5.58±0.67
T_7	0.11±0.011^{b}	0.68±0.15^{c}	4.66±0.61
F value	*	**	ns

Value represent mean±standard error of four replicates; F test: **: p<0.01; ns: not significant; Means followed by the same letter in each column are not significantly different according to the Duncan's multiple range test at 5% level

4. Conclusion

Plant height, number of leaves, chlorophyll content, leaf area, leaf area index and dry weight of leaves were not significantly differ among the tested treatments at 6th week after planting. Different levels of cowdung and compost as a basal with half dose of inorganic fertilizer as top dressing gave similar results compared with recommended inorganic fertilizer. And there is possibility to reduce the use of inorganic fertilizer without affecting the leaf development and dry matter accumulation in radish in sandy regosol.

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