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Influence of Poultry manure and Sugarcane molasses on the growth and yield of Radish (*Raphanus sativus*) L.var. "Beeralu Rabu"

Narmhikaa N *

Department of Biosystems Technology, Faculty of Technology, Eastern University, Sri Lanka.

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Abstract

A pot experiment was carried out to determine the effect of poultry manure and sugarcane molasses on the growth and yield of Radish (*Raphanus sativus*) L.var. "Beeralu Rabu". This experiment was designed in a completely randomized design (CRD) with ten replications. Treatments were Recommended NPK inorganic fertilizers (T1), 10 t/ha Poultry manure, Half dosage of recommended NPK(T2), 10 t/ha Poultry manure ,1 t/ha Sugarcane molasses , Half dosage of recommended NPK(T3): 10 t/ha Poultry manure, 2 t/ha Sugarcane molasses ,Half dosage of recommended NPK(T4),10 t/ha Poultry manure, 3 t/ha Sugarcane molasses , Half dosage of recommended NPK (T5), 10 t/ha Poultry manure , 4 t/ha Sugarcane molasses , Half dosage of recommended NPK (T6).Results revealed that plants grown in 10 t/ha Poultry manure, 3 t/ha Sugarcane molasses , Half dosage of recommended NPK (T5) showed significantly ($p < 0.05$) better performance in the measured growth parameters viz. Plant height (34.7cm), Number of Leaves , Diameter of the edible root (4.96 cm) , Fresh weight of the edible root (39.28 g), Chlorophyll content ,Fresh weight of shoot (19.85 g)and Dry weight of shoot (4.02 g) of the Radish plant while the lowest performance was observed in control (T1). Therefore, it could be concluded that 10 t/ha Poultry manure, 3 t/ha Sugarcane molasses, Half dosage of recommended NPK (T5) can be used to enhance the growth of Radish (*Raphanus sativus*) L.var. "Beeralu Rabu"

Keywords: Leaf area; Sugarcane Molasses; Edible root; Radish; Poultry manure

1. Introduction

Radish (*Raphanus sativus* L.) is a member of Brassicaceae, genus Raphanus and species sativus and include both annual and biennial type. It is one of the most vital and popular root vegetable crop grown in tropical, sub-tropical and temperate regions of the world. Since it is rich in nutrient content and highly contributes to the agricultural economy. The surface color of radish can vary from white in Asia to red in Europe through purple green and black (15), while its flesh is white in most European and Asian crops (9).The edible part of radish is mainly the root. However, the consumption rate of leaves and sprouts is increasing (2,12). The root is typically consumed in salads, but it can also be cooked or salted together with other vegetables and fruits (9). Dried or canned pickles can also be processed from radish roots (12,15), which are most generally consumed in Asia (19). Leaves and sprouts are usually eaten raw as part of salads. Generally, radish is low in calories and a good source of calcium, magnesium, copper, manganese, potassium, vitamin B6, vitamin C, and folate (8)

Due to the Global awareness for the hazard of enduring use of chemical fertilizer more farmers are shifting to organic fertilizer. Continuous application of synthetic fertilizer may lead to soil acidity, human health problems, and soil degradation since they release nutrients at a faster rate. Increasing costs of synthetic fertilizers have made them generally unreasonable to most resource-poor, small-scale growers. Organic manure can be a substitute to synthetic fertilizers. Organic manure application maintains crop quality by supplies the requisite amount of essential nutrients;

* Corresponding author: Narmhikaa.N
Department of Biosystems Technology,Faculty of Technology,Eastern University, Sri Lanka.

improves soil structure, water holding capacity, porosity, bulk density, moisture retention; increases microbial population; (25). In spite of the large quantities of plant nutrients contained in synthetic fertilizers, compared to organic nutrients, the presence of growth promoting factors in organic fertilizers make them essential in enhancing soil fertility and crop productivity (22).Poultry manure is defined as a valuable fertilizer and can be s a suitable alternate to chemical fertilizer.

Poultry manure application increases N level in the soil and improve exchangeable cations (1). Poultry manure contains all essential plant nutrients such as nitrogen (N), phosphorous (P), potassium (K), calcium (Ca), magnesium (Mg), sulfur(S), manganese (Mn), copper (Cu), zinc (Zn), chlorine (Cl), boron (B), iron (Fe), and molybdenum (Mo that are used by plants) (10).Sugarcane is one of the economically vital agricultural crops grown in tropical regions (4). Sugarcane Molasses are a byproduct of sugar industries which have been used in agriculture as an organic source of fertilizer. It contains sugar, minerals, vitamins, ash and polyphenols (27,4). Nutrient uptake efficiency and soil biological activity in crop cultivation have been accelerated by the use of sugar beet molasses (20). Application of organic manures (farmyard manure and compost) in combination with inorganic fertilizers was more pronounced in potato compared with that of organic manures alone (24).Therefore, this experiment was aimed to determine the effect of the combined application of Poultry manure and sugarcane molasses with a reduced level of nitrogen (N)phosphorus (P) and Pottasium(K) inorganic fertilizer on the growth and yield of Radish (*Raphanus sativus* L.) and also to find out the optimum rate of molasses with 10 t/ha of Goat manure as a basal application for a high yield of Radish (*Raphanus sativus* L.) in sandy regosol. The finding is useful to Radish (*Raphanus sativus* L.) growers for obtaining high yield with less use of inorganic fertilizer.

2. Material and methods

A pot experiment was conducted in Batticaloa District, Sri Lanka. The site was located at an elevation of 100 m above mean sea level. It belongs to the agro-ecological region of low country dry zone in Sri Lanka. The Type of soil is sandy regosol which contains 22 N kg/ha, 235 kg/haP2O5 and 224 kg/ha K2O .The annual mean rainfall of the district varies from 1600 mm to 2100 mm. The average temperature ranges from 28 ^{o}C to 32 ^{o}C and the humidity ranges from 65% to 86%.The experiment consisted of six treatments and was laid out in a completely randomized design (CRD) with ten replications. Treatments included in this experiment are as follows.

- T1: Recommended NPK inorganic fertilizers;
- T2: 10 t/ha PM+ 0 t/ha SM + 50% NPK
- T3: 10 t/ha PM + 1 t/ha SM + 50% NPK
- T4: 10 t/ha PM + 2 t/ha SM + 50% NPK
- T5: 10 t/ha PM + 3 t/ha SM + 50% NPK
- T6: 10 t/ha PM + 4 t/ha SM + 50% NPK
- PM: Poultry manure;
- SM: Sugarcane molasses;
- 50% NPK: Half dosage of recommended NPK

The polybags (30cm height and 30 cm diameter) were filled with soil mixture, and holes were madeat the side and base of each polybag to facilitate the drainage of water. Seeds of Radish (*Raphanus sativus*) L.var."Beeralu Rabu" were collected from the Department of Agriculture, Sri Lanka. Two seeds were placed in each polybag, but only one healthy seedling was maintained in each polybag one week after seedling emergence. Inorganic fertilizers as basal (125 kg/ha urea, 200 kg/ha triple super phosphate, 75 kg/ha muriate of potash) and top dressing (125 kg/ha urea,75 kg/ha muriate of potash) were applied to control treatment (T1) as recommended by the Department of Agriculture, Sri Lanka. Other treatments, that is, T2-T6, 10 t/ha Poultry manure and 0–4 t/ha sugarcane molasses with half dosage of recommended NPK were applied as described above. Irrigation was done twice a day in the morning and evening by using a watering can. The number of leaves per plant was counted. Diameter of the edible root was measured with the aid of a verniercalliper. The chlorophyll content of leaves was measured using a chlorophyll meter (SPAD 502 plus). The shoot (above-ground level plant part) and edible root portion of each plant in all treatments were separated and their fresh weights (g) were measured. These materials were cut into small pieces, separately dried at 105^{0}C for1 hour in an oven, and their dry weight (g) was recorded using an electronic balance. Harvesting was done at 75 days after planting.

All the collected data for each parameter were analyzed by analysis of variance using the SAS 9.1 statistical software package. The treatment mean was compared by the Tukey's test at the 5%significance level.

3. Results and discussion

3.1. Plant height

Figure 1 shows the average plant height of the Radish crop in each treatment. The analysis of data on average plant height showed that application of10 t/ha of poultry manure, 3 t/ha of sugarcane molasses and 50% of TSP(T5)significantly exhibited maximum plant height (34.7cm), whereas T1 (inorganic fertilizers as control) had a minimum value of 17.5 cm among all the treatments . It might be due to the higher amount of potassium and other essential micro nutrients such as Ca ,Mg and S available in poultry manure and Sugarcane molasses. Molasses supplies carbohydrates and alters C: N ratio which affects soil microbial ecology and lowers plant parasitic nematodes as well as provides favorable effects on plant growth (23) .This results were supported by Jackson who reported that application of Poultry manure had significantly increased plant growth since it contains sufficient amount of water soluble and exchangeable potassium and magnesium. T6 treatment (10 t/ha of goat manure, 4 t/ha of sugar masses and 50% TSP) produced significantly shorter plants as compared to T5. This may be due to excess potassium ion from the applied fertilizer hinder the absorption of calcium and magnesium ions . Excess ions in nutrient solutions decreased plant growth (26). High K concentrations in the soil solution inhibit Mg uptake and may induce Mg deficiency in plants (28)

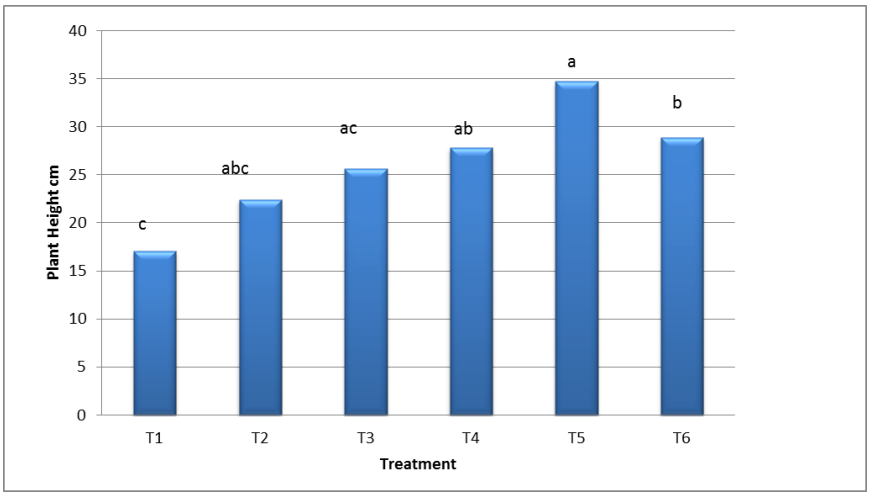

Figure 1 The effect Poultry manure, molasses and 50% NPK application on the average plant height of Radish(*Raphanus sativus)* L.var."Beeralu Rabu"

3.2. Number of Leaves

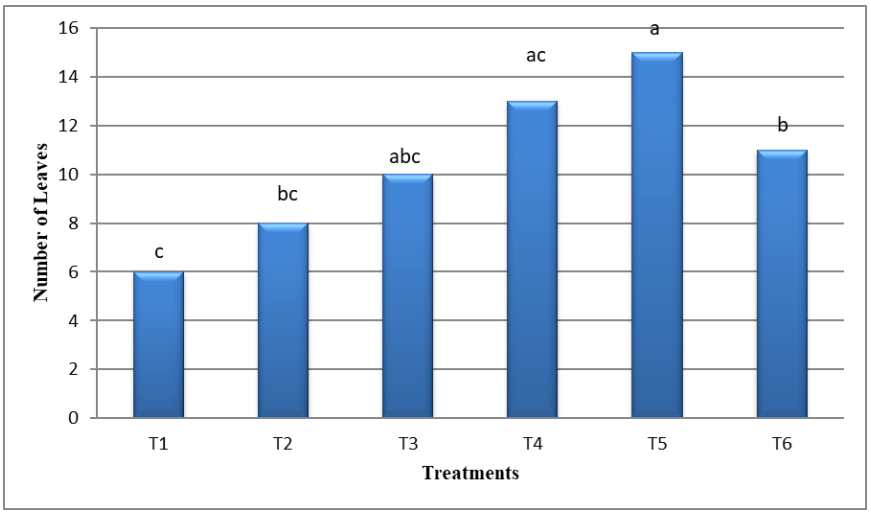

Figure 2 The effect of Poultry manure, molasses and 50% NPK application on the average number of Radish (*Raphanus sativus*) L.var."Beeralu Rabu" leaves.

Results obtained revealed that there was a significant ($p< 0.05$) differences among the Treatments. Minimum number of leaves was recorded in T1 while maximum number of leaves were recorded in T5.This might be due to the continuous release of the N,P,K in the combined application of poultry manure and Sugarcane molasses which satisfied the nutritional needs of Radish. Poultry manure is very rich animal manure that boosts soil productivity better than other organic manures and exchangeable cations (7). Application of molasses improve soil structure and an increase in the biological activity of beneficial micro-organisms such as soil fungi, following partial sterilization of the soil (30).In this study, the number of leaves per plant was increased to a certain limit then declined as observed in the lower number of leaves in T6 compared to T5 molasses contains large quantities of fermentable sugars that can temporarily immobilize or tie up plant available nitrogen in organic form, causing leaf yellowing due to transient N deficiency (30). This would be the reason for lower number of leaves was observed in T6 compared to T5.

3.3. Diameter of the edible root

The diameter value of the edible root Radish (*Raphanus sativus*) L var."Beeralu Rabu in each treatment is shown in Table 1. There was a significant difference ($P<0.01$) in the diameter of Radish among the treatments. A high average value(4.96 cm) of the root diameter was attained in T5 (10 t/ha PM + 3 t/ha SM + 50% NPK)The reason may be due to the application of molasses increased uptake of Zn, Cu, Fe and Mn . The use of a diluted solution of molasses will increase nutrient uptake and yield of leafy vegetables(3) .Low root diameter value of the edible root Radish was recorded in T6A higher rate of potassium interfere with the calcium Ion absorbtion by plants (11). However calcium is very important for fundamental physiological functions in plant structure and signalling (6). The dry mass of the shoot and root was high in plants grown with high calcium concentrations (5). This would be the reason for lower root diameter was observed in T6.

Table 1 The effect of Poultry manure, molasses and 50% NPK application on the average diameter and Fresh weight of edible root (g) of Radish (*Raphanus sativus*)L.var."Beeralu Rabu

Treatment	**Diameter of Radish (*Raphanus sativus)L.*var."Beeralu Rabu" (cm)**	**Fresh weight of edible root (g) of Radish (*Raphanus sativus)L.*var."Beeralu Rabu"**
T1	2.12±0.23ab	21.29±1.52c
T2	2.74±0.34b	23.29±0.64d
T3	3.92±0.22b	28.04±0.77cd
T4	4.14±0.20a	36.28±1.36a
T5	4.96±0.17ab	39.28±1.47ab
T6	2.40±0.27ab	30.18±0.31bc
F test	P<0.01	P<0.0001

The value represents the mean ± standard error of replicates. Means followed by the same letters in each column are not significantly different according to the Tukey's test at the 5% significance level.

3.4. Fresh weight of the edible root

The fresh weight of the edible root Radish (*Raphanus sativus*)L. per plant is shown in Table 1.There was a significant difference ($P<0.0001$) in the fresh weight of the beetroot among the treatments. The fresh weight of the root ranged from 21.29 g to 39.28 g. The combined application of 10 t/ha PM + 3 t/ha SM + 50% NPK had a higher root weight than the other treatments .Foliar application of molasses increased uptake of Zn, Cu, Fe and Mn in corn and wheat (17) .Molasses contains high levels of sugar and its fermentation causes productions of CO2 (14). Releasing of CO2 from fermentation of molasses creates an additional carbon source to the plant (18) and thus,photorespiration rate of the plants reduced and net photosynthesis increase (16).These might be the reasons for highest edible root weight was observed in T5. The application of molasses enhances the primary nutrient uptake and yield of leafy vegetables(3). The lowest fresh weight was recorded in T1. This might be due to the adhesive properties of the molasses, airborne dust and particles readily adhere to the leaves and could decrease stomatal conductance (21). Foliar application of molasses at high doses showed negative effects on sugar beet (*Beta vulgaris* L.) growth(21).

3.5. Chlorophyll content

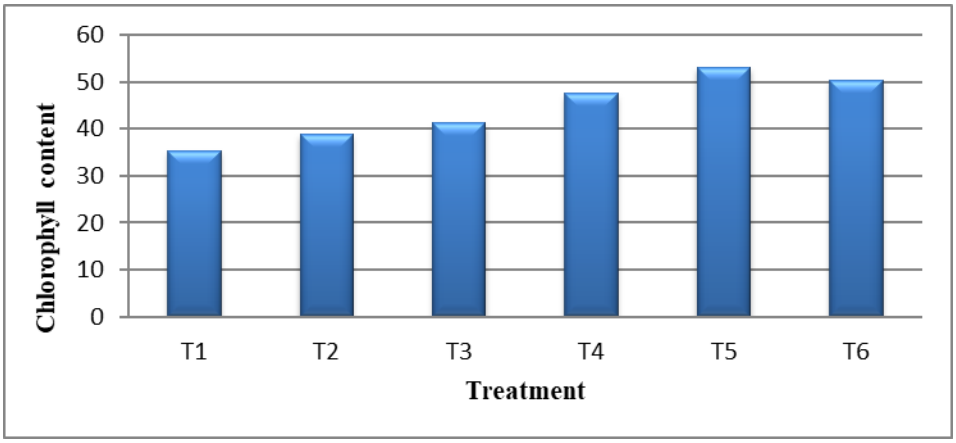

Figure 3 The effect of Poultry manure, molasses and 50% NPK application on the average chlorophyll content of Radish (*Raphanus sativus*) L.var."Beeralu Rabu" leaves.

Chlorophyll is an important photosynthetic pigment to the plant, largely determining photosynthetic capacity and hence plant growth. There was a significant variation (P<0.05) in the chlorophyll content of leaves, as shown in Figure 3. The leaf chlorophyll content ranged from 35.40 (T1) to 53.17.Chlorophyll content was significantly (p<0.05) higher in treatment 5(T5) compared with other treatments It may be due to the requisite amount of plant nutrients received by plants. Foliar application of molasses increased uptake of Zn, Cu, Fe and Mn in corn and wheat compared to the control (17). The use of a diluted solution of molasses will increase nutrient uptake and yield of leafy vegetables like cabbage (3). Use of molasses increased total nitrogen and potassium and decreased available phosphorus in soil (13).A remarkable difference (P<0.05) of Chlorophyll content was observed between T5 and T6 treatments. It might be due to the higher K+ concentration that has been variously reported to work antagonistically against Na+, Ca2+, and Mg2+ uptake (29). Increased potassium supply interferes with the uptake of the other nutrients, particularly nitrogen High K concentrations in the soil solution inhibit Mg uptake and may induce Mg deficiency in plants (28).

3.6. Shoot weight of the Radish plant

Table 2 The effect of Poultry manure, molasses and 50% NPK application on the average shoot weight of the Radish(*Raphanus sativus)* L.var."Beeralu Rabu" plant.

Treatment	Fresh weight of shoot (g)	Dry weight of shoot (cm)
T1	10.25 g±0.17ab	1.82 g±1.55c
T2	11.42g±0.52c	1.99g±0.23ab
T3	13.56g±0.23ab	2.09g±0.18ab
T4	17.82g±1.82c	3.15g±0.17ab
T5	19.85 g±1.42c	4.02 g±1.52c
T6	17.45g±1.52c	3.41g±0.26ab
F test	P<0.01	P<0.05

The value represents the mean ± standard error of replicates. Means followed by the same letters in each column are not significantly different according to the Tukey's test at the 5% significance level.

Fresh and dry weights of the shoot (above-ground level plant part) per plant are given in Table 2. Significant differences in both fresh (P<0.01) and dry (P<0.05) weights of the shoot were observed among the treatments. The values of fresh (19.85 g) and dry (4.02 g) shoot weights obtained in T5 were higher than those in other treatments while lower values (10.25 g and 1.82 g respectively) were recorded in T1. The observed increase in total Fresh and dry weights of the shoot in response to the poultry manure application could be attributed to the increase leaf area /plant which increased photosynthetic area and improved solar radiation interception that enhanced accumulation of photosynthates.

4. Conclusion

The results reveal that the application of 10 t/ha of poultry manure, 3 t/ha of sugarcane molasses and 50% of TSP(T5)significantly exhibited maximum plant height (34.7cm), whereas T1 (inorganic fertilizers as control) had a minimum value of plant height (17.5 cm) among all the treatments . Maximum number of leaves were recorded in T5(10 t/ha of poultry manure, 3 t/ha of sugarcane molasses and 50% of TSP) followed by T4,T6,T3,T2,T1. The root diameter of Radish (*Raphanus sativus* L.var."Beeralu Rabu") remarkably influenced by the application of different rate of sugarcane molasses. A high average value (4.96 cm) of the root diameter was attained in T5 (10 t/ha PM + 3 t/ha SM + 50% NPK) while the minimum the root diameter was attained in T1. The combined application of 10 t/ha PM + 3 t/ha SM + 50% NPK had a higher root weight than the other treatments Significant differences in both fresh ($P<0.01$) and dry($P<0.05$) weights of the shoot were observed among the treatments. The values of fresh (19.85 g) and dry (4.02 g) shoot weights obtained in T5 were higher than those in other treatments while lower values (10.25 g and 1.82 g respectively) were recorded in T1. . Based on these results, it could be concluded that highest yield could be obtained by the application of the of10 t/ha of poultry manure, 3 t/ha of sugarcane molasses and 50% of TSP(T5 as basal dressing and as top dressing in Radish (*Raphanus sativus*) L.var."Beeralu Rabu" cultivation than the recommended chemical fertilizer.. Moreover, it can be suggested that organic s resources can be used as a replacement for inorganic fertilizer since organic manure is eco-friendly. A further study is necessary to evaluate the quality of Radish (*Raphanus sativus*) L.var."Beeralu Rabu"

Compliance with ethical standards

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