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# The effects of different organic fertilizers on the vegetative growth and fruit yield of baby marrow (*Cucurbita pepo* L.) in Luyengo, Eswatini

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## Abstract

Despite fetching good prices in foreign trade, there is insufficient information on organic production of baby marrow in Eswatini. A field experiment was carried out at the Horticulture Farm, University of Eswatini during the 2019/2020 planting season to assess the effectiveness of biocompost and vermicompost on the vegetative growth and fruit yield of baby marrow. Significant differences in plant height, number of leaves, flowers, fruits and fruit length among the different fertilizer treatments were observed. Baby marrow plants in the control had the highest plant height (57.9 cm) and number of leaves (25.0). The highest leaf length (28.6 cm) was obtained from plants supplied with 10.0 tons/ha vermicompost and leaf width (29.8 cm) was achieved from plants fertilized using 7.5 tons/ha biocompost. More flowers (18.0) were observed from the control plants with less flowering (12.0) from plants provided with 5.0 tons/ha biocompost. The highest fresh fruit mass (20.4 g) was attained from plants grown using 7.5 tons/ha vermicompost, while the lowest (16.0g) was recorded from those fertilized using 5.0 tons/ha biocompost. The highest dry matter content (65.1%) was obtained from plants cultivated using 5.0 tons/ha biocompost. For maximum baby marrow fresh fruit yield, vermicompost at 7.5 tons/ha should be used.

***Keywords:*** Baby Marrow; Vegetative Growth; Fruit Yield; Biocompost; Vermicompost



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## 1. Introduction

Baby marrow (*Cucurbita pepo* L.) is a species in the family of squash (Cucurbitaceae) that is popular all over the world. It includes many common kitchen squash varieties including acorn squash, pumpkin, zucchini and patty pans. Numerous cucurbit crops are economically important worldwide. Cucurbits are consumed in different ways as fruits or vegetables, providing essential nutrients and dietary fibre (McCreight, 2016). In Zimbabwe, Some of the cultivated cucurbits include the cucumber (*Cucumis melo* L.), the watermelon (*Citrullus lanatus* (Tunb.) Matsum. and Nakai), the melon (*Cucumis melo* L.), the pumpkin (*Cucurbita maxima* Duch.), the butternut (*Cucurbita moschata* Duch.) and the baby marrow (*Cucurbita pepo* L.). They are widely grown by both commercial and smallholder farmers as food and cash crops (Karavina et al., 2020). A zucchini is a thin-skinned cultivar of what in Britain and Ireland is referred to as a marrow while in South Africa is called baby marrow (Gareth, 2010). Zucchini is mostly grown in North America, Central America, Mexico and the United Kingdom. However, it is becoming widely available in export stores across the world due to its numerous culinary applications and nutrient dense competition. This vegetable is used not only as a food source in soups, stews and stand-alone side dishes, but also as an element in poultices for scratches, salves for rheumatism, and as a number of other traditional medicine applications (Dias et al., 2015). Zucchini has various health benefits to humans as well as medicinal potentials, it is an important vegetable as its fruit, flowers and leaves are edible, and the peel is where most of the nutrients are hence peeling of the skin is not recommended (Mohammed et al., 2011).

Baby marrow is herbaceous, frost sensitive, trailing, tendril-bearing vine, bearing large palmate leaves and prominent fruits. Only the female flowers can bear fruit and honeybees are the primary pollinators. The fruit grows from the base of the female flower on a short stem. Once fruit is set, baby marrow (zucchini) can grow up to 2.5 cm per day (Schonbeck and Farmer, 2010). It is rich in nutrients and bioactive compounds contents such as phenolics, flavonoids, vitamins (including β-carotene, vitamin A, vitamin B2, ά-tocoperol, vitamin C, and vitamin E), amino acids, carbohydrates and minerals (especially potassium), and it is low energy content (about 17 kcal/100 g of fresh fruit) and has a large amount of fibre (Graifernberg, 1996). Baby marrow is a low-calorie vegetable that provides a high level of nutrients and is particularly important in the diets of certain cultural groups. It is a significant source of vitamin A, and C, dietary fiber, calcium and iron (Dias et al., 2015).

Lime and fertilizers are not always easy options for small-scale and resource-poor farmers (Deborah, 2006). The widespread adoption of synthetic fertilizers and associated agricultural practices has a host of unintended consequences to our environment, the quality of food, and the sustainability of our food system. Synthetic fertilization does not build up soil organic matter. There is increasing concern about interrelated environmental problems such as soil degradation, desertification, erosion, and accelerated greenhouse effects and climate change. The decline in organic matter content of many soils is becoming a major process of soil degradation. Degraded soils are not fertile and thus cannot maintain sustainable production. At the same time, the production of urban and industrial organic waste materials is widespread. Therefore, strategies for recycling such organic waste in agriculture must be developed (Diacono and Montemurro, 2010).

Plants fed with synthetic fertilizers in poor soils have a weak root system, making them vulnerable to drought and disease, requiring increased irrigation and application of pesticides (Chandini *et al*., 2019). Over time, synthetic fertilized soil deteriorates and compacts, losing its spongy, absorptive qualities. This leads to erosion and promotes rapid runoff. Instead of slowly retaining water in the soil and plant roots, water runs off through the hardpan carrying substantial amount of nutrients into waterways. Thus, synthetic fertilizers degrade land and water resources and create an increasing cycle of dependence. Deborah (2006) confirmed that degraded soil lacks trace nutrients that make food nutritious.

Organic fertilizers are used to reduce compounds toxicity (such as nitrates) produced by conventional fertilizers in vegetables like baby marrow, hence improving the quality of cucurbits vegetables produced and as well as human health. Increased consumer awareness of food safety issues and environmental concerns has contributed to the development of organic farming over the last few years (Worthington, 2001). The demand for organic food production is increasing because of its ability to maintain health without the risk of synthetic enzymes and hormones, or other chemical effects on food. Biogas slurry is one of the best organic fertilizers to revitalize soils, since it is a rich source of both plant nutrients and organic matter. By using this source as an organic fertilizer, it is possible to reduce the use of the chemical fertilizers by up to 50%, which will reduce the production costs as well as increase the soil fertility for high crop productivity (Islam et al., 2010). In order to maximize the use of fertilizers economically and reduce the traces of chemical fertilizers in the environment, biofertilizers are considered as a promising alternative approach for maize and other crops (Gao et al., 2020). These biofertilizers are mainly based on beneficial microorganisms in a viable state applied to seed or soil aiming to increase soil fertility and plant growth by increasing the number and biological activity of desired microorganisms in the rhizosphere. As soil is a complex system which can be affected by several factors (Alhaj Hamoud et al., 2019) improving such beneficial microbial communities in the soil is an important factor in the biogeochemical cycling of both inorganic and organic nutrients, specifically, in the rhizosphere zone which can increase the availability of nutrients to plants and also improve the soil quality (Jeffries et al., 2003).

In addition to the biofertilizers, the use of organic fertilizers can also reduce the application of chemical fertilizers to a great extent. The increasing interest in using renewable energy, the production and subsequent use of biomass energy as an important organic source is gaining momentum, as observed by (Zheng et al., 2016). Research has shown that using organic-inorganic compound fertilizers can not only decrease the use of chemical fertilizer but also promote the efficiency and sustainability of agricultural ecosystems over a long period of time (Zhao et al., 2016). Increase in application of inorganic fertilizers in agriculture has deteriorated the soil quality. Vermicompost as a soil conditioner is emerging as a potential end use for maintaining soil productivity (Ahirwar and Hussain, 2015).

To increase the soil fertility in a sustainable manner, the use of organic compost as fertilizer instead of inorganic fertilizer application is done. Moreover, organic farming is greatly beneficial and is more economically viable than inorganic farming. Organic farming controls pests and diseases without harming the environment, prevents pollution and increases soil fertility, so that crop produce contains adequate nutrients and better marketable price will be offered (Schonbeck and Farmer, 2010). Furthermore, the longer the soil is fed with organic fertilizers, the better its composition and texture as organic fertilizers continue to improve the soil long after the plants have taken the nutrients.

Organic waste has traditionally been considered as a source of pollution and has not been sufficiently evaluated as a by-product of agricultural activity which could produce organic fertilizer by vermicomposting. Vermicomposting increases soil fertility without polluting the soil as well as the quantity and quality of the harvested products (Hernardez et al., 2010). However, various limitations of using organic fertilizers have been pointed out, such as the difficult access to trustworthy sources of information and the lack of specific research, thus most local farmers use commercial (synthetic) fertilizers (Hernardez et al., 2010). Traditional agriculture is currently characterized by excessive inputs of chemical fertilizers. The excessive use of the synthetic fertilizers results in numerous negative effects on the environment including degrading soil quality due to loss of soil organic matter, food poisoning and losses of agricultural biodiversity (Guo et al., 2015). Usage of chemical fertilizers causes great impact on the environment and the cost is increasing with years. Organic farming can reduce the costs and the burden on the environment. Organic fertilizers are recommended as they are eco-friendly, non-toxic and recycled biological product.

Vermicomposts are finely divided peat-like materials with high porosity, aeration, drainage, and water-holding capacity (Edwards and Burrows, 1988). They have greatly increased surface areas, providing more microsites for microbial decomposing organisms, and strong adsorption and retention of nutrients (Shiwei and Fuzhen, 1991). Albanell et al. (1988) reported that vermicomposts tends to have pH values near neutrality which may be due to the presence of carbon dioxide and organic acids produced during microbial metabolism. It was also reported that their moisture content was reduced progressively during vermicomposting giving final moisture contents between 45 and 60%, the ideal moisture contents for land-applied composts (Edwards, 1983). Vermicompost contains most nutrients in plant available form such as nitrates, phosphates and exchangeable calcium and soluble potassium befitting the requirement of the recipient plant (Azarmi et al., 2008). Vermicompost has been found to provide nutrients essential for building up of molecules in plants to induce better growth, greater capacity to fight disease and encounter obnoxious chemical substances available in the vicinity of the plants (Erdal et al., 2006).

Vermicompost is a product of biodegradation and stabilization of organic materials by interaction between earthworms and microorganisms. It is a finely-divided, peat-like material, with high porosity, aeration, drainage, water holding capacity and microbial activity, which make it an excellent soil conditioner (Edwards, 1998). Addition of different vermicomposts, produced from different sources, like cattle manure, pig manure, food waste, poultry waste etc., increases the rate of germination and growth, and yield of many high value crops (Atiyeh et al., 2000). Vermicompost contains plant-growth regulating materials, such as humic acids and plant growth regulators like auxins, gibberellins and cytokinins, which are responsible for increased plant growth and yield of many crops (Atiyeh et al., 2002). Vermicompost provides large particulate surface areas that provide many microsites for microbial activities and for strong retention of nutrients (Shiwei and Fuzhen, 1991). Vermicompost application also suppresses the growth of many fungi, like Pythium, Rhizoctonia and Verticillium, as a result, many plant diseases are suppressed when vermicompost is applied in ample quantity in the field (Raja and Veerakumari, 2013). Sometimes, vermicompost also controls the population of plant parasitic nematodes (Arancon et al., 2006). Hence, vermicompost exhibits similar effects on growth and yield of plants as shown by soil-applied inorganic fertilizers or plant growth regulators or hormones (Muscolo et al., 1999).

Biocompost has gained importance since the chemical fertilizers and pesticides cause a lot of environmental problems, health hazards and soil degradation (Ghugare et al., 1988). It has been reported that the application of biofertilizer encouraged plant growth and productivity of many crops (Abdalla et al., 2001; Adam et al., 2002). Research on the use of organic fertilizer materials such as biocompost, vermicompost, animal wastes, chicken manure, pig manure, and goat droppings are important for reducing pollution and environmental hazards such as leaching. Moreover, such research is also important in improving baby vegetables yield and reducing inorganic fertilizer use. There is limited research on the cultivation practices of baby marrow in Eswatini. Due to this limited information, the field trial adopted plant spacing recommended by gardening in the South Africa website. Baby marrow producers have been forced to rely on their own knowledge and experience when making agronomic decisions. The field trial also used 2:3:3 (38) inorganic fertilizer yet there are other basal dressing fertilizers which could still be used to verify the full potential of growing baby marrow. Agronomic studies conducted on baby marrow in other ecological regions (outside Eswatini) show a possibility of improvement in production in response to cultivation practises. However, it is difficult to adopt recommendations from other regions since the influence of agro climate and genotypic differences have been reported in various crops. Therefore, there is a need to conduct studies to determine cultivation practices that have the potential of improving production of baby marrow under Eswatini agro-ecological zones. The potential production of baby marrow in Eswatini lies in the hands of small-scale farmers. Apart from their limited resources, they have little knowledge about the proper use of organic fertilizers. Currently, in Eswatini, there is no known study yet carried out to evaluate the potential benefits of organic fertilizer materials in baby marrow production under field conditions. Therefore, there is a need to evaluate different organic fertilizers for the production of baby marrow under normal field conditions that will help improve vegetative growth and fruit yield. Organic fertilizers have been used in baby vegetable production specifically in the application of directly brewed compost extract in the nutrient solution to improve the yield and quality of baby leaf red lettuce growing in a floating system (Gimenez et al., 2020). However, there is little or no information of its use specifically on baby marrow probably due to the short production cycle of the vegetable crop. The use of organic fertilizers like biocompost and vermicompost has been reported to increase the yield and quality of crops (Bryan and Lance, 1991). This research was designed to investigate the effects of organic fertilizers on the vegetative growth and fruit yield of baby marrow as a first step towards organic vegetable production in Eswatini.

## 2. Materials and methods

### 2.1. Planting materials

Baby marrow cultivar “HY-Green” seeds were purchased from the National Agricultural Marketing Board (NAMBOARD) Farm Shop in Matsapha, Eswatini.

## 2.2. Site description and experimental design

The field experiment was carried out in the Horticultural Department Farm, Faculty of Agriculture, Luyengo Campus, at the University of Eswatini. The farm is located at Luyengo, Manzini region, in the Middleveld agro-ecological zone. Luyengo is located at latitude 26.5°34´S and longitude 31.2°34´E with an average altitude of 750 m above sea level. Annual mean precipitation was 813.1 mm with rain between October to April. The average summer temperature was 27°C and winter temperature 15°C. The experiment was laid out in a Randomized Complete Block Design (RCBD) and each treatment was replicated four times. The treatments are allocated randomly to the experimental units within each block independently such that each treatment occurs once. The randomized complete block designs differ from the completely randomized designs in that the experimental units are grouped into blocks according to known or suspected variation which is isolated by the blocks. The design also permits complete flexibility because it can accommodate any number of treatments and blocks depending on available resources. Moreover, RCBD allows relatively easy statistical analyses even with missing data as well as calculation of unbiased error for specific treatments. The experiment comprised of three treatments namely; biocompost, vermicompost which were applied at different application rates and an inorganic fertilizer, NPK [2:3:2 (38)] fertilizer used as a control using 10 grams per planting station. The two types of organic fertilizers (biocompost and vermicompost) were applied two weeks before planting at 5.0, 7.5 and 10.0 tonnesha$^{-1}$ each. Biocompost was purchased from Linne International Trade Company, Siphofaneni, Eswatini with vermicompost purchased from Nhlangano Farmers Training Centre, Nhlangano, Eswatini. The experimental plots were 2.5 × 2.5 m in size separated by 0.5 m pathways. A total of 28 experimental plots were used.

## 2.3. Data collection

Data was collected every week starting from three weeks after germination (WAG) until the final harvest. The data included number of leaves, number of flowers, plant height, leaf width, leaf length, number of fruits, fresh and dry mass of leaves. Fresh and dry masses of leaves were determined after harvesting using a balance scale (Intelligent Weighing Laboratory Classic PC-15001). For dry mass, four plants from each replication were sampled, oven dried using an oven (Biochrom LTD, Leeds, England) at 70°C for 48 hours. For the total number of leaves, only fully expanded leaves of baby marrow were counted from four selected plants in each replication. The plant height was measured using a meter rule from 3 WAG and thereafter every week until final harvest from four tagged plants per replication. Number of flowers and fruits were counted from the 3 WAG and thereafter, every week. Fruits were weighed using a balance scale to measure fruit length, a tape measure was used and for the fruit diameter, a vernier caliper was used.

## 2.4. Data analysis

All agronomic yield and dry matter data were expressed as means. Agronomic and yield traits data from the different fertilizer sources were pooled and analyzed using one-way ANOVA Analysis of variance was performed by using the ANOVA procedure of the SAS 9.3 (SAS Institute, Cary NC). Significant differences between fertilizer treatments means were determined by Duncan's New Multiple Range Test (DNMRT) at the level of P=0.05.

## 3. Results and discussion

### 3.1. Soil, vermicompost and biocompost nutrient contents

The result of the textural analysis of the soil from the experiment site showed that the soil pH, exchangeable acidity (meq/100g), available phosphorus and potassium (mg/kg) were 7.13, 0.26, 38.4 and 345 respectively (Table 1). Chemical properties of vermicompost and biocompost used in the experiment are shown in Tables 2 and 3. The pH of the soil was 7.13 which showed that the soil of the site was suitable for baby marrow production which is within a range of 6.0-7.5 (Boeckmann, 2019). The soils of the experimental site are classified under Malkerns series and the soil texture is sandy clay loam (Murdoch, 1970).

**Table 1.** Soil chemical and physical properties of the experimental site

| Textural class | pH (water) | Exchangeable Acidity (meq/100g) | Available Phosphorus (P) (mg/kg) | Available Potassium (K) (mg/kg) |
|---|---|---|---|---|
| Loam soil | 7.13 | 0.26 | 38.4 | 345 |

**Table 2.** Chemical properties of vermicompost used in the experiment

| Elements | Ca (mg/kg) | P (mg/kg) | Zn (%) | Cu (mg/kg) | Fe (mg/kg) | K (%) |
|---|---|---|---|---|---|---|
| Vermicompost | 1.7 | 31.17 | 0.75 | 31 | 37.1 | 1.5 |

*Note: Ca = Calcium; P = Phosphorus; Zn = Zinc; Cu = Copper; Fe = Iron; K = Potassium*

**Table 3.** Chemical properties of biocompost used in the experiment

| Elements | Organic carbon (%) | N (%) | P (%) | K (%) | Fe (mg/kg) | Mn (mg/kg) | Zn (mg/kg) | Cu (mg/kg) |
|---|---|---|---|---|---|---|---|---|
| Composition | 19.5 | 1.3 | 2.84 | 1.64 | 7280 | 306 | 58 | 120 |

*Note: N = Nitrogen; P = Phosphorus; K = Potassium; Fe = Iron; Mn = Manganese; Zn = Zinc; Cu = Copper*

### 3.2. Plant height and number of leaves

With regard to plant height, there was a significant ($P \leq 0.05$) difference observed at 3 WAG among the different fertilizer treatments applied. However, at 4, 5 and 6 WAG, no significant ($P \geq 0.05$) differences were observed in mean plant height among the different fertilizer treatments. At 6 WAG, the highest plant height (57.9 cm) was obtained from plants fertilized using synthetic fertilizer (control), while the lowest plant height (37.5 cm) observed in those provided with 5.0 tons/ha biocompost application. The second highest plant height (45.3 cm) was obtained from plants fertilised with 5.0 tons/ha vermicompost. The mean number of leaves per plant showed significant difference (P≤0.05) among the different fertilizer treatments at 3, 4, 5 and 6 WAG. The highest number of leaves was observed in the control treatment at 3, 5 and 6 WAG (10.0, 20.0 and 25.0). In general, the plants in the control (inorganic fertilizer) had significantly higher number of leaves, with the least number of leaves observed at 3 and 6 WAG being (8.0 and 21.0) per plant respectively (Tables 4 and 5). The baby marrow plants grown using NPK [2:3:2 (38)] as a control, showed the highest vegetative growth in terms of plant height and number of leaves. However, baby marrow plants grown using 5.0 tons/ha biocompost showed the lowest plant height while the lowest mean number of leaves/plant was observed in those provided with 10.0 tons/ha of biocompost treatment. The highest vegetative growth (height and number of leaves) could probably be attributed to the rate and amount to which compound fertilizer releases the nutrients to the plant roots. The nutrients are dissolved and reach the plant roots cell quickly, right where they are needed in the plant. These results were similar to the findings of Fagbenro et al. (2015), where gliricidia biochar and inorganic NPK were used. The inorganic fertilizer in moringa had comparable effects on tree height, stem diameter, and dry-matter mass which increased with increase in application rates of the amendments. According to Sarwar et al. (2018), the application of compound fertilizer produced plants of more height, stem girth, more number of leaves, and maximum number of branches as compared to other treatments in *Moringa oleifera*. Despite non-significant differences in number of leaves in our study among the fertilizer treatments, the highest increase in the number of baby marrow leaves was obtained when using vermicompost. This corroborates findings of Chaudhary et al. (2013), where number of gladiolus leaves were increased in vermicompost application. There may be other factors which might also affect baby marrow vegetative growth, such as the genetic makeup of used variety, soil fertility, climatic conditions, quantity of daylight, light intensity, and growing season. Among these, genetic factors and soil fertility are more important. In a trial by Rahman et al. (2008) they noted that nitrogen fertilizer, either organic or inorganic, always affects vegetative growth of the fodder plant.

**Table 4.** Effects of fertilizer rates on plant height in baby marrow

| Fertilizer Rates (tons $ha^{-1}$) | Weeks after germination | | | |
|---|---|---|---|---|
| | 3 | 4 | 5 | 6 |
| Control - 0.167 | 24.5a[1] | 38.5a | 51.1a | 57.9a |
| V1 - 10.0 | 23.9a | 30.3b | 39.6b | 44.2b |
| V1 - 7.5 | 22.8a | 31.2b | 40.2b | 45.0b |
| V1 - 5.0 | 22.8a | 30.6b | 39.7b | 45.3b |
| B1 - 10.0 | 21.6a | 28.1b | 34.4bc | 40.5bc |
| B1 - 7.5 | 21.3a | 28.6b | 32.8c | 39.4bc |
| B1 - 5.0 | 21.2a | 28.8b | 32.1c | 37.5c |

*[1] Means with the same letters within the same column are non-significant at (P≤ 0.05) when using the Duncan's New Multiple Range Test (DNMRT). V1 = Vermicompost; B1 = Biocompost; tons/ha = tonnes per hectare*

**Table 5.** Effects of fertilizer rates on number of leaves in baby marrow

| Fertilizer Rates (tons $ha^{-1}$) | Weeks after germination | | | |
|---|---|---|---|---|
| | 3 | 4 | 5 | 6 |
| Control - 0.167 | 10.0a[1] | 18.0ab | 20.0a | 25.0a |
| V1- 10.0 | 9.0b | 17.0ab | 18.0bc | 24.0ab |
| V1- 7.5 | 8.0b | 17.0ab | 18.0b | 23.0b |
| V1- 5.0 | 8.0b | 18.0ab | 17.0bc | 22.0bc |
| B1- 10.0 | 8.0b | 18.0a | 17.0c | 21.0c |
| B1- 7.5 | 9.0b | 16.0b | 17.0bc | 21.0c |
| B1- 5.0 | 9.0b | 17.0ab | 17.0bc | 21.0c |

*[1]Means with the same letters within the same column are non-significant at (P≤ 0.05) when using the Duncan's New Multiple Range Test (DNMRT). V1 = Vermicompost; B1 = Biocompost; tons/ha = tonnes per hectare*

## 3.3. Leaf length and width

The leaf length in baby marrow did not show any significant (P>0.05) difference at 3 WAG among the different fertilizer treatments applied. However, from 4, 5, and 6 WAG, significant (P≤0.05) differences were observed in plant leaf length among the different fertilizer treatments. At 6 WAG in the 10.0 tons/ha vermicompost treatment, plants showed the highest leaf length (28.6 cm) with the lowest leaf length (26.1 cm) observed in 5.0 tons/ha vermicompost application. For the mean leaf width, there were significant WAG differences observed at 3, 4, and 5 WAG. However, at 6 WAG, there was no significant (P>0.05) difference observed among the different fertilizer treatments applied. At 6 WAG, the plants provided with 7.5 tons/ha biocompost had the higher leaf width (29.8 cm) while the lowest leaf width (27.8 cm) was observed in the control treatment plants (Tables 6 and 7). The non-significant differences in leaf length of the baby marrow plants among the treatments in our study corroborates with the field trial results of Mahmud (2018) in vermicompost amendment on nutritional status of sandy loam soil, growth performance, and yield of pineapple (Ananas comosus var. MD2) under field conditions. The significant differences observed in our study on leaf width matches that of Adiloglu et al. (2018) where significant rise in number of leaves, leaf size, leaf width, and the plant fresh weight was observed upon the increasing doses of vermicompost application in lettuce.

## 3.4. Number of flowers, fruits, fruit length, fresh fruit mass and yield

With respect to number of flowers per plant, significant differences (P≤0.05) were observed in number of flowers at 4, 5 and 6 WAG among the different fertilizer treatments. The highest number of flowers was observed in the control treatment plants at 4 and 6 WAG (14.0, 18.0, respectively) with the lowest number of flowers at 4 and 6 WAG were observed in plants supplied with 5.0 tons/ha biocompost application (1.0, 12.0, respectively). For mean fruit number there was no significant (P>0.05) difference observed at 4 WAG among the different fertilizer treatments applied. However, at 5 and 6 WAG, significant (P<0.05) differences were observed in the number of fruits among the different fertilizer treatments. At 6 WAG the control plants showed a higher number of fruits (11.0) with the lowest number of fruits (8.0) observed in plants grown using 5.0 tons/ha biocompost. The mean fruit length showed no significant (P>0.05) difference at 5 WAG among the different fertilizer treatments. However, at 6 WAG, there was a significant (P<0.05) difference in the fruit length. The control plants showed the highest fruit length (12.0 cm) with the lowest fruit length (9.0 cm) observed in 5.0 tons/ha biocompost application. With regard to fruit mass, there were significant (P<0.05) differences among the different fertilizer treatments. The 7.5 tons/ha vermicompost application showed the highest fruit mass (20.4g) with the lowest fruit mass observed in 5.0 tons/ha biocompost application (16.0g). Moreover, with regard to fruit yield there was a significant difference (P≤0.05) among the different fertilizer treatments. The highest fruit yield (339.8 kg/h) was observed in plants grown using 7.5 tons/ha vermicompost application with the lowest fruit yield (267.4 kg/ha) observed in those supplied with 5.0 tons/ha biocompost (Figures 1,2,3,4 and 5).

**Table 6.** Effects of fertilizer rates on leaf length (cm) in baby marrow

| Fertilizer Rates (tons/ha) | Weeks after germination | | | |
|---|---|---|---|---|
| | 3 | 4 | 5 | 6 |
| Control - 0.167 | 9.6a[1] | 17.3a | 21.1ab | 26.5ab |
| V1- 10.0 | 9.6a | 17.4a | 22.9ab | 28.6a |
| V1- 7.5 | 8.6a | 16.3ab | 21.9ab | 28.0ab |
| V1- 5.0 | 8.2a | 15.3b | 20.6b | 26.1b |
| B1- 10.0 | 8.9a | 16.5ab | 22.9ab | 28.3ab |
| B1- 7.5 | 9.8a | 15.8ab | 23.3a | 28.3ab |
| B1- 5.0 | 8.5a | 17.3a | 21.7ab | 27.0ab |

*[1]Means with the same letters within the same column are non-significant at (P≤ 0.05) when using the Duncan's New Multiple Range Test (DNMRT). V1 = Vermicompost; B1 = Biocompost; tons/ha = tonnes per hectare*

**Table 7.** Effects of fertilizer rates on leaf width (cm) in baby marrow

| Fertilizer Rates (tons/ha) | Weeks after germination | | | |
|---|---|---|---|---|
| | 3 | 4 | 5 | 6 |
| Control - 0.167 | 11.0bc[1] | 18.0ab | 22.7bc | 27.8a |
| V1- 10.0 | 10.2c | 16.6ab | 22.4bc | 28.5a |
| V1- 7.5 | 9.8c | 16.8ab | 21.5c | 29.4a |
| V1- 5.0 | 9.9c | 17.7ab | 23.3bc | 28.2a |
| B1- 10.0 | 15.0a | 18.3a | 24.3ab | 28.2a |
| B1- 7.5 | 12.1b | 16.3b | 25.7a | 29.8a |
| B1- 5.0 | 10.0c | 17.3ab | 23.3bc | 28.1a |

*[1]Means with the same letters within the same column are non-significant at (P≤ 0.05) when using the Duncan's New Multiple Range Test (DNMRT). V1 = Vermicompost; B1 = Biocompost; tons/ha = tonnes per hectare*

The study showed an increase in flower number and fresh fruit mass from application of vermicompost. This pattern was observed by Arancon et al. (2003) in strawberry where there were increased leaf areas, numbers of strawberry suckers, numbers of flowers, shoot weights, and total marketable strawberry yields in plots treated with vermicompost compared to those that received inorganic fertilizers only. The improvements in plant growth and increases in fruit yields could be due partially to large increases in soil microbial biomass after vermicompost applications, leading to production of hormones or humates in the vermicomposts acting as plant-growth regulators independent of nutrient supply.

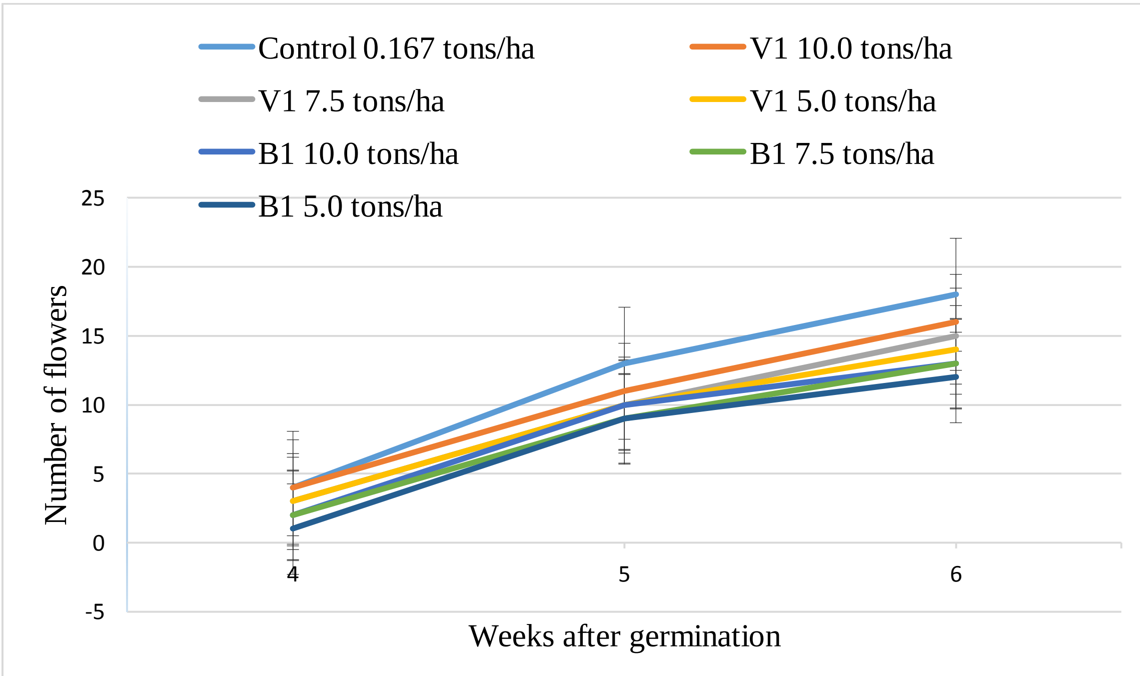


**Figure 1.** Effects of different organic fertilizers on number of flowers at 4, 5 and 6 weeks after germination. Vertical bars represent standard error below and above the means at P≤0.05. V1 = Vermicompost; B1 = Biocompost; tons/ha = tonnes per hectare

## 3.5. Fresh and dry shoot mass and dry matter content

The fresh shoot mass showed significant (P<0.05) difference among the different fertilizer treatments. In plants grown using 10.0 tons/ha vermicompost, the fresh shoot mass (55.6 g) was observed while those grown using 5.0 tons/ha biocompost, the fresh shoot mass (28.1 g) was obtained. The dry shoot mass showed a significant (P<0.05) difference (P≤0.05) among the different fertilizer treatments. In plants grown using 10.0 tons/ha vermicompost, the dry shoot mass (26.0g) was obtained, while in those provided with 5.0 tons/ha biocompost the dry shoot mass of 17.8 g was observed. The shoot dry matter content also showed a significant (P<0.05) difference among the different fertilizer treatments. The highest shoots dry matter content (65.0%) was observed in plants provided with 5.0 tons/ha biocompost while the lowest shoots dry matter content (45.0%) observed in those supplied with 7.5 tons/ha vermicompost (Figures 6, 7 and 8).

The mean shoots fresh and dry mass as well as percent shoot dry matter content of baby marrow was highest in organic manures and least in fertilizer (inorganic fertilizer). These results are in agreement with the study by Azarmi et al. (2008) and Kashem et al. (2015), who reported that growth performance of tomato was better in the vermicompost amended soil pots than the plants grown in the inorganic fertilizer amended soil pots. A study by Magkos et al. (2003) evaluated the dry matter content of several vegetables and found that organically cultivated vegetable crops had higher dry matter content than those grown inorganically.

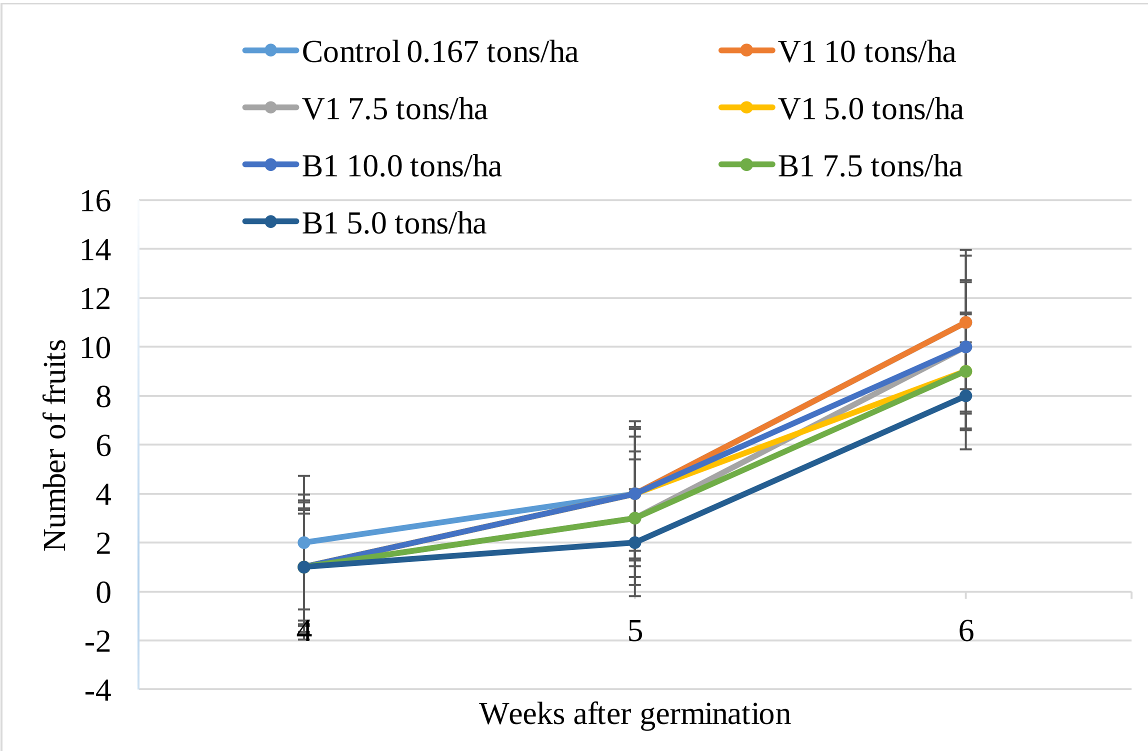


**Figure 2.** Effects of different organic fertilizers on number of fruits at 4, 5 and 6 WAG. Vertical bars represent standard error below and above the means at P≤0.05. V1 = Vermicompost; B1 = Biocompost; tons/ha = tonnes per hectare

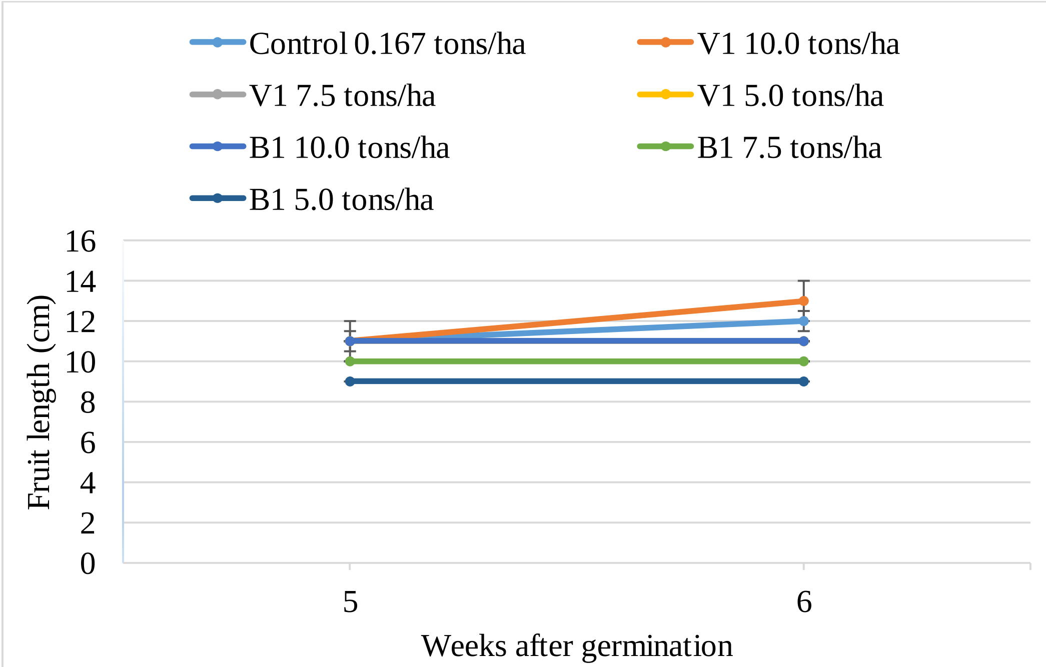


**Figure 3.** Effects of different organic fertilizers on fruit length at 5 and 6 WAG. Vertical bars represent standard error below and above the means at P≤0.05. V1 = Vermicompost; B1 = Biocompost; tons/ha = tonnes per hectare

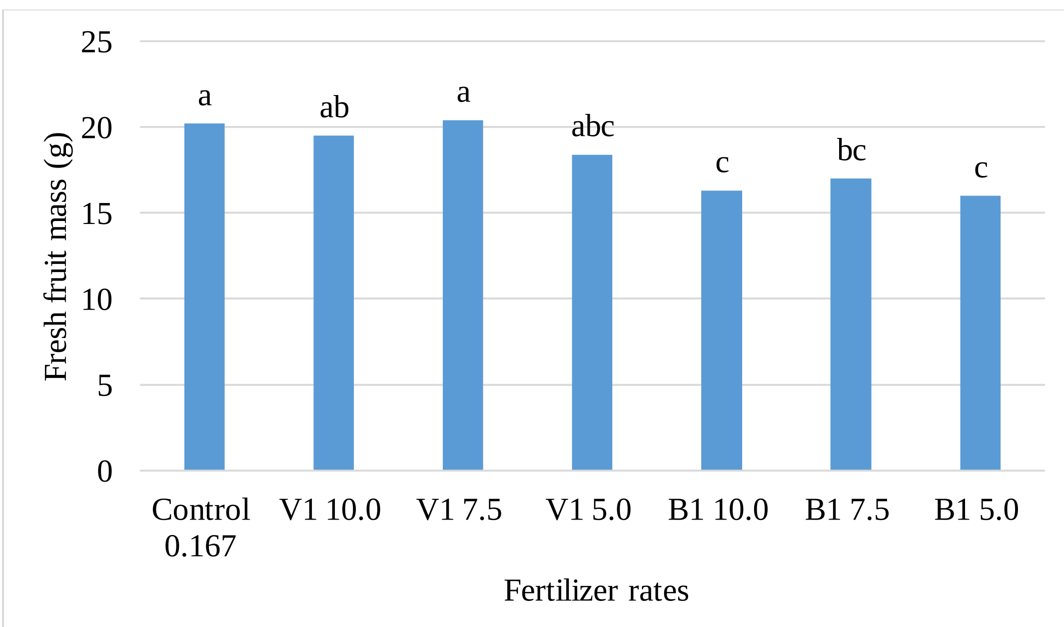


**Figure 4.** Effects of different organic fertilizers on fresh fruit mass at 6 WAG. Bars with the same letter are not significantly different from one another at P≤0.05 Mean separation by Duncan's New Multiple Range Test. V1 = Vermicompost; B1 = Biocompost; tons/ha = tonnes per hectare

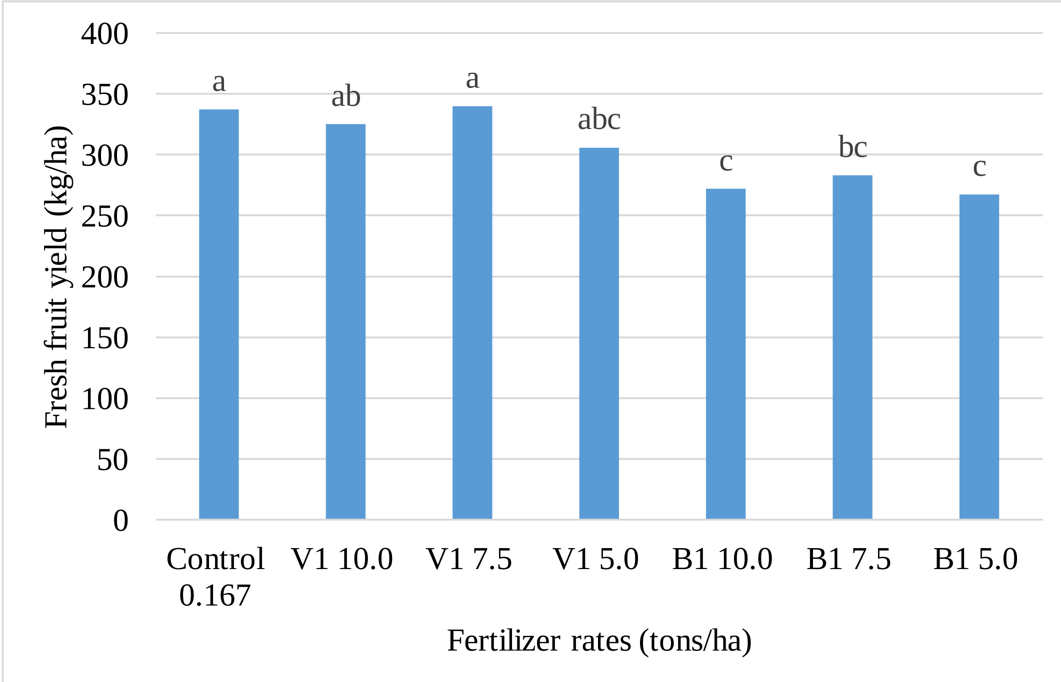


**Figure 5.** Effects of different organic fertilizers on fresh fruit yield at 6 WAG. Bars with the same letter are not significantly different from one another at P≤0.05 Mean separation by Duncan's New Multiple Range Test. V1 = Vermicompost; B1 = Biocompost; tons/ha = tonnes per hectare

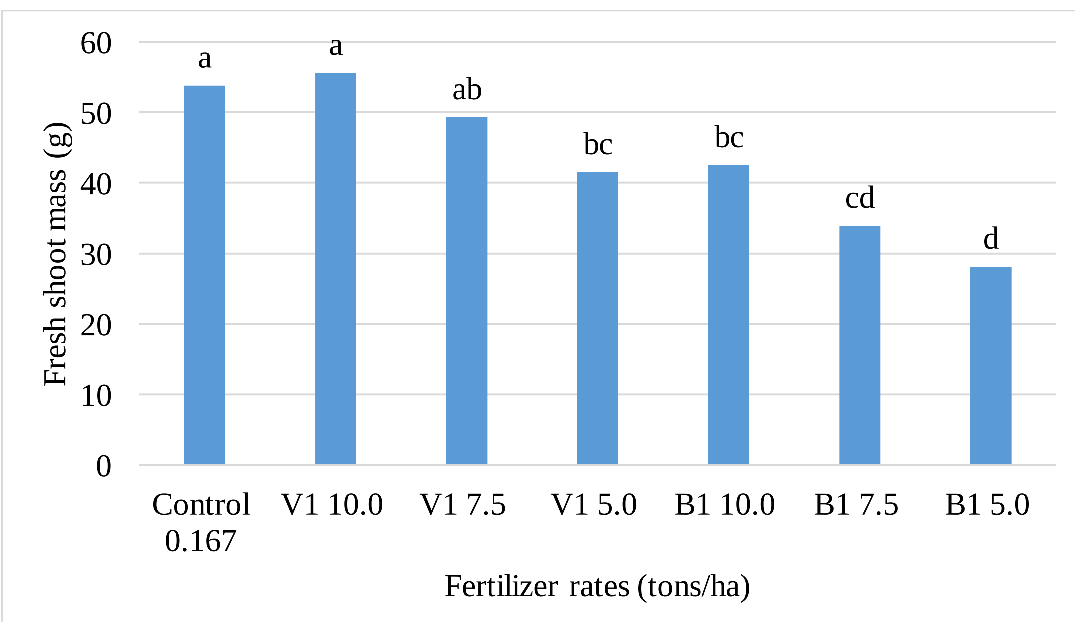


**Figure 6.** Effects of different organic fertilizers on fresh shoot mass at 6 WAG. Bars with the same letter are not significantly different from one another at P≤0.05 Mean separation by Duncan's New Multiple Range Test. V1 = Vermicompost; B1 = Biocompost; tons/ha = tonnes per hectare

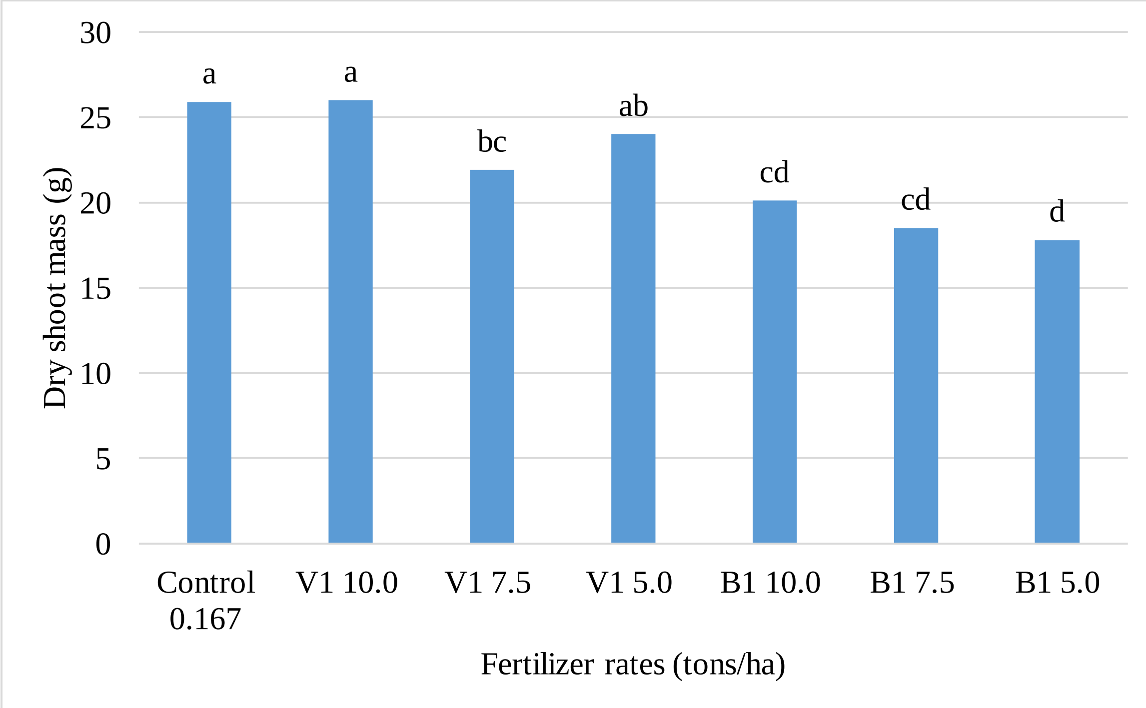


**Figure 7.** Effects of different organic fertilizers on dry shoot mass at 6 WAG. Bars with the same letter are not significantly different from one another at P≤0.05 Mean separation by Duncan's New Multiple Range Test. V1 = Vermicompost; B1 = Biocompost; tons/ha = tonnes per hectare

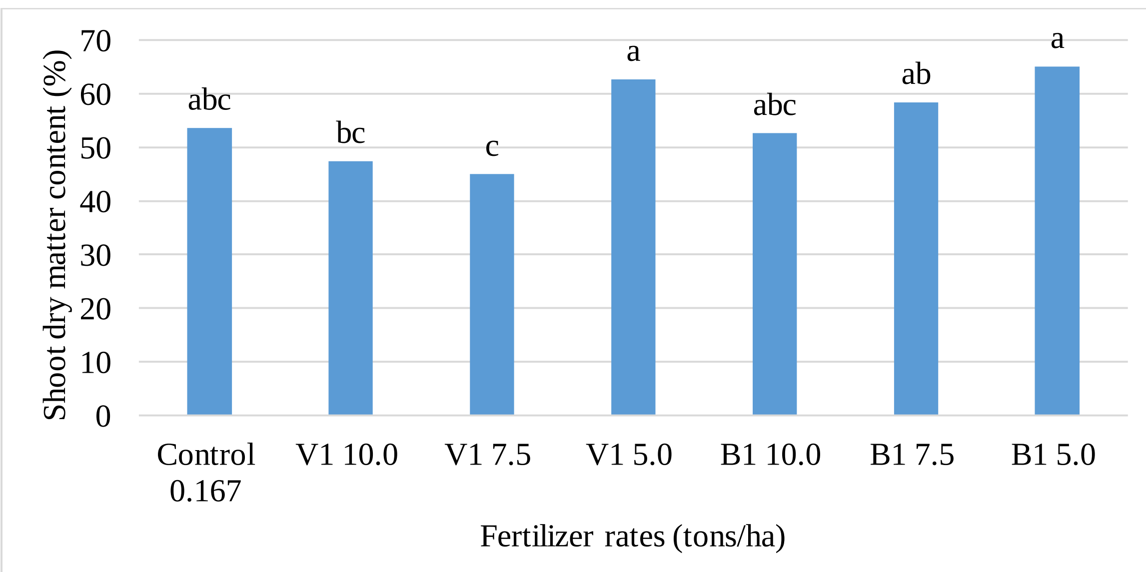


**Figure 8.** Effects of different organic fertilizers on dry matter content at 6 WAG. Bars with the same letter are not significantly different from one another at P≤0.05 Mean separation by Duncan's New Multiple Range Test. V1 = Vermicompost; B1 = Biocompost; tons/ha = tonnes per hectare

## 4. Conclusion

Baby marrow grown using vermicompost showed a significant increase in the vegetative and fresh fruit yield compared to biocompost and NPK 2:3:2 (38) fertilizer. This showed that farmers can organically improve their yields on baby marrow production using vermicompost at 7.5 tons $ha^{-1}$. Moreover, farmers can also use biocompost organic fertilizer in vegetable production but should be applied at a higher rate compared to the vermicompost. These two organic fertilizers can help in the production of organic vegetable crops in Eswatini.

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