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Growth and Yield Performance of Radish (*Raphanus sativus* L.) 'cv' 'SNOW WHITE' in Response to Varying Levels of Vermicast Applications

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Abstract- This study was conducted at the garden area of the Sunrise Residence Hall of Central Mindanao University, University Town, Musuan, Bukidnon, Philippines from December 2013 to March 2014 to evaluate the effect of different varying levels of vermicasts on the growth and yield of radish cv 'Snow White' under CMU, Musuan, Bukidnon condition. This study was laid-out in a Randomized Block Design (RCBD) with five (5) treatments and three (3) replications, as follows: T_1 (control-5g/plant 14-14-14), T_2 (5t/ha vermicast), T_3 (10 t/ha vermicast), T_4 (15 t/ha vemicast) and T_5 (20 t/ha vermicast). Result revealed that plant height, number of leaves, tuber length, tuber diameter and pest resistance were not significantly affected by the applications of varying levels of vermicast and as well as the inorganic fertilizer. However, even with their statistical insignificance, Treatment 4 (15t/ha vermicast) obtained the tallest plant (39.67 cm),most number of leaves (13.42 or 14 leaves), largest tuber (2.91 cm), and most resistant against pests and diseases (1.00 rating). Meanwhile, the longest tuber was garnered by T_3 with 19.73 cm, while T_4 measuring at 19.58 cm long. On the plot yield and the total tuber yield showed Treatment 4 obtaining the highest plot yield with 1.32 kg and 10.15 t/ha tuber yield. The effects of vermicast which were already decomposed had made available for plant use. It had somehow performed at par or even better with those using inorganic fertilizer. With the high cost incurred in using vermicast in hectare basis, Treatment 1 (using inorganic fertilizer) obtained the highest ROI with 355.22 %, followed by T_2, T_3, T_4 and T_5 with 210.20%, 177.22%, 122.96% and 52.79%, respectively. However, using vermicast in radish production would increase the return on investment in the succeeding seasons since a decreasing amount of vermicast would be added to the area.

Index Terms- *radish, pest resistance, return on investment, 'cv' Snow White, tuber, vermicast*

I. Introduction

Radish (*Raphanus sativus* L.) belongs to the family Brassicaceae. It is a popular root vegetable 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 tones (Anon, 1995).

Radish is grown for its young tender tuberous root which is consumed either cooked or raw. It is a good source of Vitamin C (ascorbic acid) and minerals like calcium, potassium and phosphorus. It has got 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 (George, 1999).

Radish is predominantly a cool season vegetable crop. But, Asiatic types can tolerate higher temperature than European varieties. Being a cool season crop, it is sown during winter from September to January in northern plains. In the mild climate of peninsular India, radish can be grown almost all the year round except for few months of summer. It is an annual or biennial crop depending upon the type for the purpose it is grown (PCARRD, 2009).

The growth and yield of radish greatly depends on soil and climatic conditions. Different varieties have different soil and climatic requirements for their optimum performance. Among the agro-techniques, nutrition is one of the main factors which govern the growth and yield of radish. Nutrition requirement of the crop varies with soil type, soil fertility, agro-climatic conditions and varieties. Being a short-duration and quick growing crop, the root growth should be rapid and uninterrupted. Hence, for the production of good quality radish optimum fertilization through organic, inorganic and biofertilizers are essential (Dhanajaya, 2007).

Vermicast or vermicompost was identified as the best alternative with regard to industrial and economic viability. It also proved itself as "natures wonder product" to restore soil health and nutritional value in food. The presence of earthworms in soil ecosystems is an indicator of the well-being of a system. Earthworms has the unique ability to convert elements such as minerals, nutrients and microbes from soil or composting systems into an excretion that contains the vastest amount of plant nutrients, microbes and growth elements that do exist. The excretion is called vermicast or vermicompost (http://www.capevermicast.com/vermicast.php).

Vermicompost provides vital macronutrients (N, P2O5, K2O, Ca and Mg) and micronutrients Fe, Mn, Zn and Cu). The chemical analysis of vermicast reveals that the N, P2O5, K2O content was 0.8, 1.1, 0.5, respectively (TINDAL, 1993 as cited by Namalata, 2011) and this analysis would vary vermicast sources depending upon on the materials used in vermicomposting.

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, vermicast, poultry manure and biofertilizer uses has become necessary.

Thus, this study was conducted to evaluate the effect of different varying levels of vermicasts on the growth and yield of radish cv 'Snow White' under CMU, Musuan, Bukidnon condition. Specifically, it aimed to determine the horticultural parameters as affected by inorganic fertilizer and varying levels of vermicast applications, to determine the yield and its components; and to compare its cost and return analysis.

II. Materials and Methods

This study was conducted at the garden area of Sunrise Residence Hall (Graduate Dormitory) of Central Mindanao University, Musuan, Maramag, Bukidnon from December 2013 to March 2014.

The different materials used in this study were bolos, garden soils, seeds of radish, bamboo stick, plastic twines, petiel pens, ruler, calculator, sheets of paper, weighing balance, 14-14-14 and vermicast fertilizers.

This study was laid-out using a Randomized Complete Block Design (RCBD) with five (5) treatments and three (3) replications. The different treatments are as follows: T_1 - Control (6 t/ha or 5 grams/hill, 14-14-14), T_2 -5 t/ha vermicast, T_3 -10 t/ha vermicast, T_4 -15 t/ha vermicast, and T_5-20 t/ha vermicast.

The study utilized 4.5m wide x 5.5 m long (25.75 sq.m.) to accommodate fifteen (15) plots with a dimension of 0.6 m x 0.6 m. each. Each plot was sown with at least 3 seeds per hill with 4 hills per treatment combination equidistantly sown from each other. All the plots were laid-out in 3 blocks with 5 treatments within blocks. The distance of plots within blocks was 25 cm., while between blocks was 50 cm. The whole experimental area was enclosed with plastic twines.

Soil samples were collected from the bulk of the media used for the study for soil analysis such pH, N, P, K and organic matter before the conduct of the study.

The experimental area was cleaned. Fifteen (15) plots were prepared for the study. Each plot was placed in accordance with the lay-out of the study. The distance of pots within blocks was 25 cm., while between blocks is 50cm. The whole experimental area was, then, enclosed with plastic twines.

Three to five seeds were sown in each hill, with four hills per plot. Thinning was done as soon as seedlings were already established in the area bearing at least 3 leaves. Three seedlings were maintained throughout the study.

Different levels of vermicast were applied directly incorporating with soil before planting with Treatment 1 – 5 g/seed; Treatment 2, 5 t/ha; Treatment 3, 10 t/ha; Treatment 4, 15 t/ha; and Treatment 5, 20 t/ha. If rainfall was not regular, sufficient irrigation was applied to maintain a continuous supply of moisture throughout the root zone. Sprinkler was used for irrigation.

Removal of weeds from the area was done along with cultivation to facilitate proper aeration and growth of experimental area. Labeling on the experimental plots on treatment combinations was done before planting.

Cultural control methods including cultivation and hand weeding were used to prevent the occurrence of pests and diseases. No pesticide was used during the conduct of the study. Harvesting was done at 40 – 45 days from sowing.

Among the data gathered were the plant height, number of leaves, resistance to insect pests and diseases, length and diameter of tubers, tuber yield and cost and return analysis.

The analysis of variance (ANOVA) in Randomized Complete Block Design (RCBD) was used to determine the level of significance. The Tukey Test was used to test significance differences among treatment means (Silva, 2009).

III. Results and Discussion

Plant height and number of leaves. The mean plant height and number of leaves of radish 'cv' Snow White in response to varying levels of vermicast applications are presented in Table 1. Statistical analysis revealed that there were no significant differences observed among treatment means of both parameters.

However, for plant height, it was observed that Treatment 4 (15t/ha of vermicast) obtained the tallest height with 39.67 cm. The shortest was garnered by those plants in Treatment 2 being fertilized with 5t/ha vermicast.

For the number of leaves, it showed that radish in Treatment 4 (15 t/ha vermicast) obtained the most with 13.42 or 14 leaves per plant. The fewest was garnered by those fertilized with 10 t/ha (T3) with 11.125 or 12. However, their differences were not that statistically far from the rest of the treatments.

Though statistically insignificant, it was revealed that as the higher the amount of vermicast at the interval of 5 t/ha being applied to radish plants, the respective heights of plants likewise increased. Depending upon the substrates used for vermicomposting for the African Night Crawler worms in CMU, the vermicats usually consist of various macro and microelements essential for plant growth, in increasing plant heights (PUVEP, 2008). It has biologically active and abundant beneficial bacteria, enzymes and nutrients. By incorporating vermicast into crop or plant growth production, it can significantly increase yields and has also shown disease-suppressive qualities (http://www.earthworm.co.za/nutricast/nutricast-information/).

Based on the data, plants fertilized with vermicast obtained higher heights and even more number of leaves as compared with those fertilized by inorganic fertilizer. At 30 t/ha vermicompost plus 200 kg N per ha recorded the highest plant heights and number of leaves were seen in onions (Namalata, 20011). This means that vermicast fertilizer can still be at par or even performed better than those inorganic ones.

Table 1. Mean height (cm) and number of leaves of radish 'cv' Snow White in response to varying levels of vermicast applications

Treatments	Mean Height	Mean Number of Leaves
T1- (Control -5t/ha 14-14-14)	37.22	12.25
T2 - (5t/ha vermicast)	36.86	12.63
T3 - (10t/ha vermicast)	38.83	11.25
T4 - (15t/ha vermicast)	39.67	13.42
T5 - (20t/ha vermicast)	39.28	12.29
c.v. (%)	13.02	10.51
F-test	n.s.	n.s.

Length and diameter of tubers. Statistical analysis showed that the mean length and diameter of tubers of radish 'cv' Snow White were not significantly influenced by the varying levels of vermicast as well as the inorganic fertilizer (Table 2).

The longest tuber was obtained by those radishes fertilized with 10 t/ha vermicast (T_3) with 19.73 cm. and was not significantly far from the rest of the treatments. The shortest tuber was obtained in Treatment 1 (control) with 16.86 cm. For the mean diameter, the largest tuber was garnered by those fertilized with 15 t/ha vermicast with 2.91 cm, while the smallest was in Treatment 1 (control) with 2.08 cm.

It seems that the sizes of the tubers fertilized with organic fertilizers (vermicast) and inorganic one (14-14-14) had more or less did not vary from each other. This means that as per values, radishes have better responses as compared with those fertilized by inorganic ones. Though, they were not that statistically far from each other. As the amount of vermicast applications increased, the lengths and diameters of radish tubers likewise increased even at 5 t/ha intervals, though statistically insignificant (Cabaraban, 2012).

Table 2. Mean length (cm) and diameter (cm) of radish 'cv' Snow White in response to varying levels of vermicast applications

Treatments	Mean Length	Mean Diameter
T1- (Control -5t/ha 14-14-14)	16.86	2.08
T2 - (5t/ha vermicast)	18.10	2.39
T3 - (10t/ha vermicast)	19.73	2.37
T4 - (15t/ha vermicast)	19.58	2.91
T5 - (20t/ha vermicast)	18.99	2.31
c.v. (%)	21.20	18.83
F-test	n.s.	n.s.

Resistance to insect pests and diseases. Table 3 presents the mean resistance rating to insect pests and diseases of radish. Statistical analysis revealed no significant differences observed among treatment means regardless of the application of the varying levels of vermicast and inorganic fertilizer. However, Treatment 4 (15 t/ha vermicast) showed the most resistant plants against insect pests and diseases with a resistance rating of 1.0. The control treatment (T_1) with inorganic fertilizer applied obtained the lowest resistance rating of 1.67 or 2.0 described as moderately resistant which showed some slight damage shown in some parts of the plants. It appeared, further, that radishes fertilized with inorganic fertilizer were bit susceptible to pest infestation. According to PCARRD (2009), vermicast contains growth-promoting and disease-preventing or suppressive properties in addition to major and plant nutrients.

Table 3. Mean resistance to insect pests and diseases of radish 'cv' Snow White in response to varying levels of vermicast applications

Treatments	Mean resistance
T1- (Control -5t/ha 14-14-14)	1.67
T2 - (5t/ha vermicast)	1.50
T3 - (10t/ha vermicast)	1.53
T4 - (15t/ha vermicast)	1.00
T5 - (20t/ha vermicast)	1.11
c.v. (%)	20.75
Level of significance	n.s.

Rating scale: 1 – no damage of pests and diseases (resistant),
2 – slight damage shown in some parts of plants (moderately resistant)
3- moderate damage shown in most parts of plants (susceptible)

Plot yield and total tuber yield. The plot yield and total tuber yield are shown in Table 5 These yield components were significantly affected by the varying levels of vermicast and inorganic fertilizer applications. Statistical analysis showed that there were significant differences observed among treatment means.

For the plot yield, Treatment 4 (15t/ha) obtained the highest with 1.32 kg in 0.36 sq.m. plot. It was, however, significantly far from those in Treatments T_3, T_5 and T_1 with 1.21, 1.14 and 1.11 kg, respectively. The lowest was obtained by Treatment 2 (5 t/ha vermicast) with only 0.87 kg.

For the total tuber yield per hectare, still Treatment 4 (15 t/ha vermicast) garnered the highest yield with 10.15 t/ha and was not significantly different from T_3, T_5 and T_1 with 9.35, 8.82 and 8.58 t/ha, respectively. The lowest was likewise obtained by Treatment 2 (5 t/ha vermicast) with 6.74 t/ha.

With higher values already obtained in the previous parameters, radishes in Treatment 4 gave good results in its yield. According to Namalata (2012) vermicompost/ vermicast provides vital macronutrients (N, P2O5, K2O, Ca and Mg) and micronutrients Fe, Mn, Zn and Cu.

Vermicast is a pure organic fertilizer or soil enhancer produced from crop residues and animal manure through the action of earthworms, vermi (African Night Crawler). It contains plant growth-promoting and disease-preventing properties in addition to major and minor plant nutrients. Basically, enhance soil fertility and ensure environment friendly production. Good for vegetable & agronomic plants, ornamentals and fruit crops. (http://mboard.pcarrd.dost. gov.ph/forum/viewtopic.php?id=11385).

Vermicast (biohumus) is a natural organic fertilizer. It is a natural means for recultivation of the soil. Vermicast is capable to bring back to life degraded fields and significantly increase fertility of soil. It is widely used for preparation of natural soil mixes. Research has shown that by incorporating Vermicast into crop or plant growth production it can significantly increase yields and has also shown disease suppressive qualities. (http://www.earthworm.co.za/nutricast/nutricast-information/).

Vermicast is a biologically active mount and abundance of beneficial bacteria, enzymes and nutrient as well remnants of plant material that were not digested by the earthworm (PUVEP, 2008).

Table 5. Mean plot yield (kg) and total yield (tons/ha) of radish 'cv' Snow White in response to varying levels of vermicast applications

Treatments	Plot Yield	Total Yield
T1- (Control -5t/ha 14-14-14)	1.11^{ab}	8.58^{ab}
T2 - (5t/ha vermicast)	0.87^{b}	6.74^{b}
T3 - (10t/ha vermicast)	1.21^{ab}	9.35^{ab}
T4 - (15t/ha vermicast)	1.32^{a}	10.15^{a}
T5 - (20t/ha vermicast)	1.14^{ab}	8.82^{ab}
c.v. (%)	12.05	12.00
Level of significance	*	*

Means of same column followed by common letters are not significantly different at 5% using Tukey Test.

Cost and return analysis. The cost and return analysis is presented in Table 5. Treatment 4 obtained the highest gross sales of US $ 5,398.94, while the lowest was in T_2 with US $3,585.11. Due to higher volume of vermicast spent in T_5, it tallied the highest expenses with US $3,070.64. Treatment 1 obtained the highest net return with US $3,561.28, while T_5 had the lowest with US $ 1,620.85. It followed that Treatment 1 obtained the highest return on investment (ROI) with 355.22%.

Though, Treatment 1 obtained the highest ROI, those treatments applied with varying levels of vermicast have great advantage in the long run since vermicast as an organic fertilizer provides utmost benefits for the improvement of the soil. The succeeding growing seasons would no longer be supplying another vermicast. Thus, there will already be reduction on the bulk of the expenses.

Table 6. Summary of the cost and return analysis (US $) of radish 'cv' Snow White in response to varying levels of vermicast applications

Treatments	Gross Sales	Total Expenses	Net Return	Return on Investment (%)
T1- (Control – 5t/ha 14-14-14)	4,563.83	1,002.55	3,561.28	355.22
T2- (5t/ha vermicast)	3,585.11	1,155.74	2,429.36	210.20
T3 - (10t/ha vermicast)	4,973.41	1,794.04	3,178.30	177.22
T4 - (15t/ha vermicast)	5,398.94	2,431.34	2,966.60	121.96
T5- (20t/ha vermicast)	4,691.49	3,070.64	1,620.85	52.79

US $ 0.532 /kg – prevailing farm gate price

IV. Conclusion

The consistent good results of T_4 (15 t/ha vermicast) in almost all of the parameters had given comfortable yields both for plot and total tuber yield from the rest of the treatment. The effects of vermicast which were already decomposed had made available for plant use. It had somehow performed at par or even better with those using inorganic fertilizer. However, the beneficial effects of vermicast as an organic fertilizer have sustaining effects to improve the quality of soil in the long run.

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