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Bio-fertilizer management of *Abelmoschus esculentus* under La Union conditions, Philippines

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Abstract

The response of okra *(Abelmoschus esculentus)* was tested using four organic foliar fertilizers as supplement to 50% commercial fertilizer application. Treatments were compared in three replicates composed of 10 sample plants at a distance of 60cm x 60cm between hills and rows respectively. Growth and yield parameters such as plant height at flowering, number of pods per hill, weight and length of pod per hill and weight of marketable and non-marketable yield was measured. No significant differences observed on all the parameters tested except on the weight of non-marketable yield where plants applied with 50% RRCF plus supplementation of sargassum tea as foliar fertilizer had the least number of infested pods because of the presence of pesticidal and insecticidal effect on okra plants. In conclusion, reducing the recommended rate commercial fertilizer of 50% and supplement it with vermicompost tea, sheep manure tea, silkworm tea, sargassum tea is possible and thus recommended for a sustainable and eco-friendly vegetable farming.

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Introduction

Organic vegetable production is geared to the current thrust of the government, the Organic Agriculture Act of 2010 to promote, propagate, develop further and implement the practice of organic agriculture in the Philippines that will cumulatively condition and enrich the fertility of the soil, increase farm productivity, reduce pollution and destruction of the environment, prevent the depletion of natural resources, further protect the health of farmers, consumers, and the general public, and save on imported farm inputs. Towards this end, a comprehensive program for the promotion of community-based organic agriculture systems which include, among others, farmer-produced purely organic fertilizers such as compost, pesticides and other farm inputs, together with a nationwide educational and promotional campaign for their use and processing as well as adoption of organic agriculture system as a viable alternative shall be undertaken (Philippine R.A. 2010).

Today, more farmers are becoming aware of the good economic benefits that could be gained from organic agricultural production. Likewise, there was an increasing trend of people consuming organically produced vegetables due to the health benefits that could be derived from it because organic fertilizer and botanical plants have elements and insecticidal properties that are not harmful to human and are abundantly available in the locality. The use of organic fertilizers and pesticides will benefit the small farmers due to its low cost and availability as well as the consumers too because of its nutritive value and assurance of no hazard from chemicals.

Okra scientifically known as *Abelmoschus esculentus* is a favourite ingredient of pinakbet, a native dish of Filipinos. Therefore, the continuous conduct of study on organic production is very crucial in attaining the goal of the government for food security and healthy population through sustainable crop production or good agricultural practices (GAP). Seaweed extract could be applied either individually as seed priming prior to sowing, seedlings root dipping prior to transplant, root or soil drenching and foliar spraying or combined of two or more methods of application. The recommended method of application, times of application and the rate of application were greatly differed according to the plant variety and growth stages (Papenfus *et al*., 2013; Lola-Luz *et al*., 2014). In this concern, Matysiak *et al.* (2011) revealed that the stimulatory effects of seaweed extract application were found to be more pronounced when applied at the early stage of plant growth.

The presence of beneficial microorganisms like Azotobacter, Rhizobium and Phosphorus-solubilizing bacteria (PSB), and Nitrobacter present in vermicompost as cited by Abalos and Sampaga (2013) helps improve quality of soil, thereby improving plant growth and development. Combination of organic fertilizers (vermicompost + vermiwash) had great influence on the nutritional value of the fruits. The fruits had greater percentage of fat and protein compared to those grown with chemical fertilizers. The vermiwash and vermicompost combination also had significant influence on the biochemical characteristics of soil with marked improvement in micronutrient contents as reported by Ansari and Sukhraj (2010). Sheep manure on the other hand, when decomposed increases both macro and micro nutrients as well as enhances the physico-chemical properties of the soil. The innovative organic fertilizer from mulberry silkworm (Bombyx mori L.) breeding waste is a cheap source of organic waste which give very positive results on the plants yield. Further reported that, best results of fertilization were obtained in silkworm manure fertilization in dose Mg ha^{-1} Lochynska and Frankowski (2011). This study was conducted to determine the effectiveness of bio-organic foliar fertilizers such as vermicompost tea, sheep manure tea, silkworm manure tea and Sargassum tea on the growth and yield of okra. Specifically, it aims to determine if the full recommended rate inorganic fertilizer for okra could be reduce to 50% and supplement it with different bio-organic fertilizers, and to determine the best bio-organic fertilizer that could supplement the 50% recommended inorganic fertilizer for okra.

Materials and methods

Experimental lay-out

The study was laid out following the Randomized Complete Block Design (RCBD) with three blocks and 10 sample plants per treatment with a total of 30 sample plants per treatments and a total of 180 plants for the whole study. The treatments were T_0-100% Recommended Rate Commercial Fertilizer (RRCF), T_1-50% RRCF + Sprayed with Vermicompost Tea, T_2-50% RRCF + Sprayed with Sheep Manure Tea , T_3-50% RRCF + Sprayed with Silkworm Manure Tea, T_4-50% RRCF + Sprayed with Sargassum Tea and T_5- 50% RRCF + Sprayed with Crop Giant Foliar Fertilizer.

Experimental location

The experimental area was located at the Casiaman Research Farm of Don Mariano Marcos Memorial State University, North La Union Campus (DMMMSU-NLUC), Sapilang, Bacnotan, La Union, Philippines. It was conducted from November 2017 to February 2018.

Land preparation, planting, irrigation and fertilizer application

Prior to land preparation, soil sample was taken at random from the different parts of the experimental area for soil analysis. The experimental area was cleared from any debris and was rotavated using a hand tractor. The distance of planting used was 60cm x 60cm between hills and rows. Two seeds per hill were used. Replanting of missing hills was done immediately upon noticed to have uniform growth. The newly sown okra seeds were irrigated immediately after transplanting. Succeeding irrigation was done once every two weeks for 1 month and every week thereafter. The first side dress was done 3 weeks after sowing (WAS) using recommended rate of complete fertilizer which is 1 tablespoon (5g) per hill, second side-dress was done at 6WAS and the last side-dress was done at 9WAS.

Experimental materials, treatment preparation and application

Vermicompost preparation

The vermicompost was collected from the DMMMSU-NLUC ATE-Elementary Laboratory School Vermicomposting Project. The required amount of vermicompost was soaked in a pail filled with water for seven days to ferment. For every 1 kilogram of vermicompost, five liters tap water is required. After soaking, the vermicompost tea was strained using fine cloth. One liter of tea concentrate was diluted to 10 liters water. One liter of diluted tea manure was sprayed to the plants every week starting 1 month after sowing.

Sargassum preparation

The sargassum seaweed extract was processed and secured at DMMMSU-FRTI. One cup (240ml) of the concentrated tea was diluted with six liters of tap water. For every one liter of the solution, it was sprayed to the plants every week starting at 1 month after sowing and every week thereafter.

Sheep and silkworm manure preparation

The sheep manure was collected from the DMMMSU-NLUC Sheep Project and the sheep manure was secured at the Sericulture Research and Development Institute (SRDI) of the Don Mariano Marcos Memorial State University, Bacnotan, La Union, Philippines. The required amount of sheep and silkworm manure was pulverized prior to soaking. One kilogram of manure (sheep and silkworm) was separately soaked in a pail filled with five liters of tap water for seven days to ferment, and then it was strained using a fine cloth. One liter of tea concentrate was diluted to 10 liters of water. The mixture was sprayed to the experimental plants starting at 1 month after sowing and every week thereafter.

Crop giant application

The solution was mixed based on the label of the foliar fertilizer and sprayed to the okra plants 1 month after sowing and every two weeks thereafter.

Statistical analysis

All the data gathered was analysed using the Analysis of Variance (ANOVA). The significant difference between treatment means was tested using the Duncan's Multiple Range Test (DMRT) at a significant level of 0.05 (5%).

Results and discussions

Growth parameters

Plant height at flowering and number of days from sowing to flowering of okra sprayed with different manure tea is shown in Table 1. Results of the analysis showed no significant differences on the different treatment used. Plants fertilized with 100% of the recommended inorganic fertilizer (control) was the tallest (40.43cm) and the shortest was obtained from plants fertilized with 50% RRCF and sprayed with Vermicompost tea. The insignificant results imply that reducing the recommended rate to 50% and supplement it with bio-organic foliar fertilizer would give comparable effect in terms of growth such as plant height and number of days to flowering of okra. The nutrients present in the different bio-organic fertilizers are already enough to supplement the other 50% recommended inorganic fertilizer in okra. These results complement to the findings reported by Hariadia *et al.* (2016) that the addition of manure on soil has increases leaf area and electrical potential difference compared to the maize grown in a mere soil media. It is concluded that renewable fertilizer such as cow and goat manure was important in increasing plant growth.

Table 1. Plant height (cm) at flowering and number of days from sowing to flowering of okra sprayed with different bio-organic fertilizer.

Treatments	Plant height (cm) at flowering	No. of days from sowing to flowering
T_0 – 100% RRCF Control	40.43	51.47
T_1 – 50% RRCF + Sprayed with Vermicompost Tea	35.27	51.73
T_2 – 50% RRCF + Sprayed with Sheep Manure Tea	39.48	51.87
T_3 – 50% RRCF + Sprayed with Silkworm Tea	37.05	51.40
T_4 – 50% RRCF + Sprayed with Sargassum Tea	39.09	48.93
T_5 – 50% RRCF + Sprayed with Crop Giant	40.08	35.40

Yield parameters

Presented in table 2 is the number and weight of okra pod per hill and number of non-marketable pod per hill as affected by the fertilization of different bio-organic foliar fertilizers. Plants fertilized with 50% RRCF and supplemented with different bio-organic foliar fertilizer have the same yield in terms of number and weight of pods. The highest yield in terms of number of pod were obtained from plants applied with 50% RRCF and sprayed with sheep manure tea with 32.83 and in terms of weight of pod per hill, the highest was obtained from plants applied with 50%RRCF and sprayed with vermicompost tea. However, the observed difference in number and weight of pods per hill is not enough to cause a significant statistical difference over the plants applied with full or 100% recommended inorganic fertilizer. Moreover, 50% RRCF and supplementation to different bio-organic fertilizers had comparable yield to plants applied with 50%RRCF + application of inorganic foliar fertilizer (crop giant). It is evident that the macronutrient contribution from sheep manure and silkworm manure as one source of bio-organic fertilizer is high and cannot be ignored. Although there are differences in the way manure is managed and used, it still remains a low cost soil fertility investment niche which farmers can exploit provided they have livestock as cited by Tiamiyu *et al.* (2012). Several researchers have reported that the application of organic waste leads to improved structural stability, lower bulk density of the soil by increasing both the organic fractioning of the soil and a balance between fine and coarse pores, organic manures improve moisture retention, water infiltration rate and the hydraulic conductivity of soil (Tisdale *et al.*, 1990; Young, 1997) as cited by Ofosu-Anim *et al.* (2006).

Yield in terms of number of non- marketable pod per hill revealed a significant statistical difference. Plants applied with 50% RRCF and sprayed with sheep manure tea, silkworm manure tea and crop giant gave the highest number of non-marketable pods per hill with a means of 0.73, 0.73 and 0.80 respectively and was found comparable to plants applied with 100% RRCF and to those plants applied with 50% RRCF and sprayed with Vermicompost tea. Plants applied with 50% RRCF and sprayed with Sargassum tea extract had the least number of non-marketable pods per hill.

This might be attributed by the fact that Sargassum extract contains pesticidal and insecticidal effects on crops that increase resistance of the plants to some pests such as red spider mite and aphids, the major insect pest attacking okra. These findings conform to the study of Ammar *et al.* (2017) that seaweed extracts also showed an ameliorating effect on plant tolerance to different environmental stress conditions and increasing plant resistance to pathogens and nematodes. Seaweed extracts as natural plant growth stimulant could be significantly used as a good agricultural practice in sustainable and organic crop production.

Table 2. Number and weight of okra and number of non-marketable pod per hill as affected by spraying organic fertilizers.

Treatments	No. of Pod per hill	Weight (kg) of pods per hill	No. of Non-Marketable pod per hill
T_0 – 100% RRCF	29.50	.86	0.60 ab
T_1 – 50% RRCF + prayed with Vermicompost Tea	29.08	1.001	0.47 ab
T_2 – 50% RRCF + Sprayed with Sheep Manure Tea	32.83	.844	0.73 a
T_3 – 50% RRCF + Sprayed with Silkworm Tea	26.00	.76	0.73 a
T_4 – 50% RRCF + Sprayed with Sargassum Tea	26.50	.96	0.27 b
T_5 – 50% RRCF + Sprayed with Crop Giant	25.92	.96	0.80 a

Recent trend of organic farming has exploited the possible application of seaweed as organic/bio-fertilizer in agriculture as such many studies have demonstrated the benefits of seaweed in enhancing the plant growth and productivity. Added to this, they are known to be a promising soil conditioner, protect the plants under abiotic and biotic stress and increase plant resistance against pest and diseases (Raghunadan *et al.*, 2019). Further, the obtained results sharply indicates that seaweed soaked seeds gave significantly the higher values of all measured characters than water soaked seeds. It was highly apparent that the foliar spraying treatment of the highest rate of seaweed extract (3ml/l) gave significantly the best values of all studied characters compared to the other treatments. Based on the foregoing results, it can be concluded that 50% of the recommended rate commercial fertilizer for okra could be supplemented by the different bio-organic foliar fertilizer used.

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Conflict of interest

The researchers declare with full confidence that there is no conflict of interest among themselves.

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