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Complementary influence of inorganic fertilizer and sargassum liquid foliar fertilizer to the development and yield of ridged spongegourd (*Luffa acutangula*)

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Abstract

The perennial problem in farming is low yield due to depleted soil brought by over-farming. Hence, the use of supplement such Sargassum liquid fertilizer is necessary to augment the lacking nutrients. Sargassum seaweeds are abundant and were just drifted on the shore during high tide. Sargassum seaweeds were collected and fermented into liquid fertilizer. The study was conducted to determine the synergistic effects of inorganic fertilizer and Sargassum liquid foliar fertilizer to the spongegourd. The experiment was laid out in three blocks and the treatments are as follows; Factor A (IF - Inorganic Fertilizer): IF0 (No IF), IF1 (50% IF), IF2 (75% IF), IF3 (100% IF); Factor B (SLFF - Sargassum Liquid Foliar Fertilizer): SLFF0 (No SLFF), SLFF1 (1 SLFF concentrate: 5 Water), SLFF2 (1 SLFF concentrate: 10 Water), SLFF3 (1 SLFF concentrate: 15 Water), SLFF4 (1 SLFF concentrate: 20 Water). Analysis of variance (ANOVA) of the gathered data and pairwise comparison was done to determine the significant differences among and between the treatment means respectively. Result shows that the treatment IF3 X SLFF3 of the spongegourd was the earliest to have harvestable fruits at 48.00 DAT, highest yield (23.48 tha-1), highest net income (PhP290,079) and highest ROI (161.46%).

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Introduction

Vegetable production is among the major source of income of people directly involved in farming and marketing in Ilocos Region because the bulk of supplies are produced from the Ilocos Region in the Philippines. Spongegourd is one among the vegetable planted by the farmers. Ridge spongegourd (*Luffa acutangula*) is a warm and sun loving vegetable that can be grown throughout the year. This vine vegetable can be grown both in tropical and subtropical climatic conditions and it is believed to be originated from America (Mazali and Alves, 2005). The sponge gourd is a fibrous vegetable since the fruit is composed of cellulose, hemicelluloses and lignin (Rowell *et al.*, 2002). The color of the fruit is green, long and has several ridges along its length. This vegetable is very nutritious because it is rich with various nutrients such vitamins, minerals, protein and high amount of dietary fibers which are all necessary for good health.

Frequent cropping enhanced nutrient depletion from the soil even if the recommended dosage of fertilizer were applied because not all the amount of fertilizer was fully utilized by the plant due to losses such as volatilization and leaching or fixation. The imbalanced amount of nutrients applied could negatively affect the productiveness of the soils (Saleque *et al.*, 2004).

The current conditions of most soil tilled for food production are now considered in an alarming condition. There was a huge depletion of soil nutrients due to frequent farming that more nutrients were drawn from the soil than it was replenished during every cropping period. This condition had great effects to the capability of the soil in food production resulting to low crop yield. The nutrients that remained in the soil during the previous cropping is not sufficient for the next cropping period if not replenished to sustain the growth of the plant to produce optimum yield.

The application of fertilizer is very important in crop production to provide the necessary plant nutrition to attain high yield, which has also great contribution in the soil environment (Ding *et al.*, 2017). The combined application of both inorganic fertilizers and organic crop waste can greatly contribute soil organic carbon and increases crop yield (Yang *et al.*, 2014).

Many measures had been initiated by many concerned groups to restore the productivity of the soil, however, some failed due to lacked of inputs or it was constrained by their high cost.

Other farmers used solely the inorganic fertilizer in every cropping period however, the desired yield or the optimum yield of the crop was not attained because the crop did not fully utilize the applied inorganic fertilizer due to many factors that affects its availability in the soil such as the pH, CEC, OM content, moisture, etc. Regarding to the availability of nutrients, the deficiency of single macronutrient or any of the micronutrients even in minute quantity has a great effect to the growth and yield of the plants.

The lacking nutrients could be corrected by supplementing or spraying the required nutrients to the leaves of the plants such as Sargassum seaweed liquid foliar fertilizer. Seaweed has a great potential to promote the growth and yield because of the high nutrient contents, the presence of phytohormones, vitamins and enzymes too. Seaweeds are priceless resources from the seas with several uses as well as in today's agriculture. It was believed that extracts from various seaweeds species were already used a long time ago in agriculture to boost plant growth and to increase the yield (Nanda, 2022).

Sargassum seaweeds is one among the endemic seaweeds and are abundantly found at the shallow seas of the Philippines archipelago. Moreover, the availability of Sargassum seaweeds was not yet a problem because this seaweed had no commercial uses yet so it is still under-utilized.

Therefore, the objectives of the study are as follows: a) to evaluate the effects of the application of different rates of inorganic fertilizer to the development and fruit yield of spongegourd, b) to evaluate the effects of spraying different concentrations of Sargassum liquid

foliar fertilizer to the development and fruit yield of spongegourd, c) to evaluate the interaction effects of the different rates of inorganic fertilizer and Sargassum liquid foliar fertilizer to the development and fruit yield of the spongegourd, and d) to determine the profitability of producing spongegourd as affected by the application of inorganic fertilizer and Sargassum liquid foliar fertilizer.

Materials and methods

Research design

The study was conducted at the Research Farm of the Don Mariano Marcos Memorial State University, Bacnotan, La Union, Philippines. It was laid-out in three blocks and the treatments were arranged employing the 4 × 5 Factorial Randomized Complete Block Design (Factorial RCBD).

Land preparation

The area was cleared from unnecessary objects then plowed and harrowed twice to reduce the sizes of the clods. The interval of the first and second plowing and harrowing was one week to allow natural sterilization through exposure of the soil to sunlight.

Preparation of potting media and sowing

The sowing media for the spongegourd was a mixture of 1:1:2 sand, rice hull and garden soil respectively. They were mixed properly then sterilized by heating on an old plain G.I. sheet. During sterilization, the sowing media was turned occasionally throughout the process and then let it cool. After cooling, the media was poured into the polyethylene potting bags measuring 4 × 4 inches with remaining two inches unfilled from the top of the bag.

The variety of ridged spongegourd used in the study was Primera F1. Prior to sowing, the seeds were soaked in fresh water for 12 hours and then wrapped with clean moist cloth within three days or until their primary roots were emerged. The cloth was kept moisten every day to ensure higher germination rate. Once the primary roots had emerged, the seeds were sown immediately. Only one seed with emerged primary root was sown in every potting bag. Proper cultural management was done uniformly to all the seedlings until they were ready for transplanting.

Treatments

The study was a two factorial experiment which consist of the following treatments.

Factor A [Inorganic Fertilizer (IF)]: IF_0–Control (Not Applied with Inorganic fertilizer); IF_1–Applied with 50% of the Recommended Rate of Inorganic Fertilizer; IF_2- Applied with 75% of the Recommended Rate of Inorganic Fertilizer; IF_3–100% of the Recommended Rate of Inorganic Fertilizer

Factor B [Sargassum Liquid Foliar Fertilizer (SLFF)]: $SLFF_0$–Control (Not Sprayed with Sargassum Liquid Foliar Fertilizer); $SLFF_1$–Sprayed with 1 Portion Sargassum Liquid Fertilizer Concentrate: 5 Portion Water; $SLFF_2$- Sprayed with 1 Portion Sargassum Liquid Fertilizer Concentrate: 10 Portion Water; $SLFF_3$- Sprayed with 1 Portion Sargassum Liquid Fertilizer Concentrate: 15 Portion Water; $SLFF_4$- Sprayed with 1 Portion Sargassum Liquid Fertilizer Concentrate: 20 Portion Water

Transplanting

To ensure higher survival rate of the seedlings when transplanted in the field, they were hardened by gradually exposing to sunlight within ten days, watering was gradually reduced then stopped within three to four days until the schedule of transplanting. In a plot, there were four rows with ten seedlings planted in each row. There were 40 seedlings planted in every plot with a distance of 1.0 m and 1.0 m between hills and between rows respectively. Only one seedling was planted per hill.

Cultural management

The spongegourd were irrigated immediately after transplanting and every week thereafter until the last harvesting. After two weeks from transplanting, the spongegourd had already recovered from the stress effect of the varied field conditions. One liter of Urea solution/hill from a mixture of 5g Urea/liter of water were drenched

per hill and they were side dressed with 10g per hill every three weeks interval throughout the vegetative and fruiting period or until the whole amount of the required fertilizer for the respective treatments were applied as per recommended rate based on the soil analysis result of the experimental area. Weeding was done occasionally depending on the growth of the weeds. The plants were alternately sprayed with different kinds of insecticides every three weeks interval during their growing period to early fruiting stage, but the spraying during the harvesting period was only done when need arises or at longer interval using a less toxic insecticides. Trellising was done after two weeks or when their vines begun to climb.

Fermentation of sargassum seaweed into liquid fertilizer

Only the Sargassum seaweeds drifted up by high tide along the seashore of Paraoir, Balaoan, La Union were collected then washed with fresh water and air dried in a shaded area or until their weight will remain constant. The dried seaweeds were then chopped and soaked in a container filled with fresh water for three months or until no solid particles were still floating. The ratio of dried Sargassum and fresh water was 1 kg: 10 liters, respectively. During fermentation, the Sargassum mixture was stirred occasionally.

The Sargassum tea was then filtered with cloth while the dilution of the tea concentrates was done on the day of spraying. The dilution of Sargassum liquid fertilizer concentrate into foliar fertilizer of the different treatments are as follows; $SLFF_1$ – 1 Sargassum Liquid Fertilizer Concentrate: 5 Water, $SLFF_2$ – 1 Sargassum Liquid Fertilizer Concentrate: 10 Water, $SLFF_3$ – 1 Sargassum Liquid Fertilizer Concentrate: 15 Water, $SLFF_4$ – 1 Sargassum Liquid Fertilizer Concentrate: 20 Water.

Spraying was done early in the morning. It was sprayed on the entire plants during their growing stage and to their leaves during their flowering to fruiting period. Spraying was done at two weeks interval throughout the life cycle of the plants (7x).

Harvesting

Fruits harvesting was done when they have already reached the ideal size and maturity. It was done every three days to avoid over maturity, to be more fruitful and to minimize the possible rate of damage cause by fruit borer and other sucking insects.

Data analysis

The number of days to initial fruit harvesting (DAT) is the number of days after transplanting when 50% of the plants within the plot of the respective treatments have harvestable fruits.

The computed fruit yield per hectare (tha^{-1}) was computed using the formula;

$$Computed\ yield = \frac{\frac{Actual\ yield, kg}{plot}}{Actual\ plot\ area, sq.m.}\ x \frac{10{,}000\ sq.m.}{ha}\ x\ \frac{1\ ton}{1{,}000\ kg}$$

The computed net income per hectare (PhP) was computed using the formula;

$$Comp.net\ income = \frac{Comp.net\ income, PhP}{ha} - \frac{Comp.cost\ of\ prodtn, PhP}{ha}$$

The Return on Investment (ROI, %) was computed using the formula;

$$ROI, \% = \frac{\frac{Comp.net\ income,\ PhP}{ha}}{\frac{Comp.cost\ of\ production,\ PhP}{ha}}\ x\ 100$$

Statistical analysis

The statistical design used in the study is 4 × 5 Factorial Randomized Complete Block Design (Factorial RCBD). Analysis of variance (ANOVA) was done to determine the significant differences among the treatments and the Tukey's Honest Significant Difference (HSD) Test was also used to compare the significant differences between the treatment means.

Results

Initial fruit harvesting

The availability and right amount of nutrients has great effects on the early development of the plants. Among the different kinds of fertilizers, the inorganic fertilizer can provide the right amount of nutrients at smaller quantity and it has an immediate effect once it was taken up by the plants. Result revealed significant differences among the treatments. The spongegourd applied with 100% recommended inorganic fertilizer (IF_3) was significantly the earliest to have harvestable fruits as compared to the other treatments at 50.07 days after transplanting (DAT), while the latest to produce harvestable fruits were those not applied with inorganic fertilizer (IF_0) at 58.00 DAT (Table 1).

Likewise, the spraying of Sargassum liquid foliar fertilizer has significant effects to the spongegourd. Analysis of variance revealed significant differences among the treatments. The spongegourd sprayed with 1 Sargassum Liquid Fertilizer Concentrate: 15 Water ($SLFF_3$) was the earliest to have harvestable fruits at 51.75 DAT which differed significantly to the other treatments, while those not sprayed with Sargassum tea ($SLFF_0$) was the latest to produce harvestable fruits at 55.00 DAT (Table 1).

Table 1. Number of days to initial fruit harvesting of ridged spongegourd as affected by the application of different rates of inorganic fertilizer and concentration of Sargassum liquid foliar fertilizer

Treatment	Number of days					
	Sargassum liquid foliar fertilizer					
Inorganic fertilizer	$SLFF_0$	$SLFF_1$	$SLFF_2$	$SLFF_3$	$SLFF_4$	Mean, IF
IF_0	59.67^{a}	58.33^{ab}	56.33^{bcd}	57.67^{abc}	58.00^{ab}	58.00^{a}
IF_1	55.67^{cd}	54.67^{de}	54.33^{def}	53.00^{efgh}	53.33^{efg}	54.20^{b}
IF_2	53.00^{efgh}	51.00^{hijk}	50.67^{ijk}	48.33^{lm}	52.33^{fghi}	51.07^{c}
IF_3	51.67^{ghij}	51.00^{hijk}	50.00^{jkl}	48.00^{m}	49.67^{klm}	50.07^{d}
Mean, SLFF	55.00^{a}	53.33^{b}	52.83^{b}	51.75^{c}	53.33^{b}	

*Means in a column followed by the same letter are not significantly different at 0.05 level of Tukey's Honest Significant Difference (HSD) Test.

Table 2. Yield of ridged spongegourd as affected by the application of different rates of inorganic fertilizer and concentration of Sargassum liquid foliar fertilizer

Treatment	Yield (tha^{-1})					
	Sargassum liquid foliar fertilizer					
Inorganic fertilizer	$SLFF_0$	$SLFF_1$	$SLFF_2$	$SLFF_3$	$SLFF_4$	Mean, IF
IF_0	9.47^{i}	10.09^{hi}	11.45^{ghi}	11.02^{ghi}	10.56^{hi}	10.52^{d}
IF_1	12.92^{fgh}	13.20^{efgh}	14.45^{defg}	13.59^{efgh}	13.27^{efgh}	13.49^{c}
IF_2	16.14^{cdef}	16.84^{cde}	17.26^{bcd}	17.90^{bcd}	16.81^{cde}	16.99^{b}
IF_3	18.64^{bc}	16.19^{cdef}	20.60^{ab}	23.48^{a}	23.02^{a}	20.99^{a}
Mean, SLFF	14.29^{bc}	14.09^{c}	15.94^{ab}	16.50^{a}	15.93^{ab}	

*Means in a column followed by the same letter are not significantly different at 0.05 level of Tukey's Honest Significant Difference (HSD) Test.

Further, the application of inorganic fertilizer and spraying with Sargassum tea has significant interaction effects on the initial fruit harvesting of spongegourd. The earliest to have harvestable fruits was those of treatment IF_3 x $SLFF_3$ with 48.00 DAT but comparable with treatments IF_2 x $SLFF_3$ and IF_3 x $SLFF_4$ with 48.33 DAT and 49.67 DAT respectively.

Fruit yield, tha^{-1}

The result revealed that the application of inorganic fertilizer has significant effects to the yield of spongegourd. The highest yield was produced by the plants applied with 100% of recommended inorganic fertilizer (IF_3) with 20.99 tha^{-1} fruits, while those not applied with fertilizer was the lowest with 10.52 tha^{-1} fruits (Table 2).

On the other hand, the spraying of the spongegourd with SLFF have significant effects to their yield. Statistical result revealed significant differences among the treatments. The spongegourd sprayed with $SLFF_3$ has the highest fruit yield with 16.49 t/ha fruits which is significantly differed to the other treatments, wherein those not sprayed with Sargassum tea ($SLFF_0$) was the lowest with 14.29 tha^{-1} (Table 2).

Further, analysis of variance revealed that the application of different rates of inorganic fertilizer and spraying with different concentrations of Sargassum liquid foliar fertilizer has significant interaction effects to the fruit yield of the spongegourd (Table 2). Result shows that the treatment IF_3 x $SLFF_3$ produced the highest yield with 23.48 tha^{-1} fruits but comparable to the yield of treatment IF_3 x $SLFF_4$ with 23.02 t/ha fruits.

Net income, PhP

The agricultural inputs were among the highest cost of production that affects the net income in crop production. Fertilizer is among the most utilized agricultural inputs such as the inorganic fertilizer which is the main source of nutrients that needed by the plants. The spongegourd applied with 100% RR Inorganic Fertilizer (IF_3) has the highest net income with PhP240,483.35, while those not applied with inorganic fertilizer (IF_0) had the lowest with PhP38,205.24 (Table 3).

Table 3. Net income of ridged spongegourd as affected by the application of different rates of inorganic fertilizer and concentration of Sargassum liquid foliar fertilizer

Treatment	Net income (PhP)					
	Sargassum liquid foliar fertilizer					
Inorganic fertilizer	$SLFF_0$	$SLFF_1$	$SLFF_2$	$SLFF_3$	$SLFF_4$	Mean, IF
IF_0	27,995	28,567	52,494	45,351	36,617	38,205
IF_1	93,938	83,082	111,064	95,187	90,851	94,824
IF_2	156,990	153,703	165,818	180,075	158,742	163,066
IF_3	200,203	199,308	231,278	290,079	281,546	240,483
Mean, SLFF	119,782	116,165	140,163	152,673	141,939	

Table 4. Return on investment (ROI) of ridged spongegourd as affected by the application of different rates of inorganic fertilizer and concentration of Sargassum tea

Treatment	Return on investment (%)					
	Sargassum liquid foliar fertilizer					
Inorganic fertilizer	$SLFF_0$	$SLFF_1$	$SLFF_2$	$SLFF_3$	$SLFF_4$	Mean, IF
IF_0	17.35	15.92	29.75	25.90	20.97	21.98
IF_1	57.19	45.75	62.44	53.92	51.62	54.18
IF_2	94.74	83.98	90.74	101.17	89.45	92.02
IF_3	115.95	108.03	127.97	161.46	158.52	134.39
Mean, SLFF	71.30	63.42	77.72	85.61	80.14	

Another form of fertilizer that usually used to supplement the micronutrients requirements of the plant is foliar fertilizer such as the Sargassum liquid foliar fertilizer. The result shows that the spongegourd sprayed with 1 Sargassum Liquid Foliar Fertilizer: 15 Water ($SLFF_3$) had the highest net income with PhP152,673.56 while those sprayed with 1 Sargassum Liquid Foliar Fertilizer: 5 Water ($SLFF_1$) has the lowest net income with PhP116,165.75 (Table 3).

In modern agriculture, the combined application of two form of fertilizer is commonly practice such as those from synthetic form and organic fertilizer. The study revealed that the spongegourd applied with 100% RR inorganic fertilizer and sprayed with 1 Sargassum liquid fertilizer concentrate: 15 water (IF_3 x $SLFF_3$) registered the highest net income (PhP290,079.69) and it was followed by those applied with 100% of recommended rate inorganic fertilizer and sprayed with 1 Sargassum liquid fertilizer

concentrate: 20 water (IF_3 x $SLFF_4$) amounting to PhP281,546.33, while the lowest was attained by those not applied with inorganic fertilizer and not sprayed with Sargassum liquid foliar fertilizer (IF_0 x $SLFF_0$) with 27,995 (Table 3).

ROI, %

The return on investment (ROI) is a very useful tool in determining the profitability of entrepreneurial endeavor such as crop production. It is usually measured the percentage of income from the cost of production. The study found out that the spongegourd applied with 100% recommended inorganic fertilizer (IF_3) has the highest ROI with 134.39% while those not applied with fertilizer (IF_0) has the lowest ROI with 21.98% (Table 4). Likewise, the spongegourd sprayed with a dilution of 1 Sargassum liquid fertilizer concentrate: 15 water ($SLFF_3$) has the highest ROI with 85.61% while those sprayed with 1 Sargassum Liquid Fertilizer Concentrate: 5 water ($SLFF_1$) has the lowest with 63.42% (Table 4).

Further, the study also found out that simultaneously application of inorganic fertilizer and Sargassum liquid foliar fertilizer had great contribution on the profitability of the spongegourd. The treatment IF_3 x $SLFF_3$ registered the highest ROI (161.46%) and it was followed by the treatment IF_3 x $SLFF_4$ with 158.52% (Table 4).

Discussion

The current issue in crop production is low yield and inferior quality of the produce. This problem usually emanates from the poor soil conditions which is the consequences of the continuous and frequent cultivation of the farm that depleted the soil with nutrients essential for the plants' growth and development. According to Matsumoto and Yamano (2009) that for soil which had been depleted with nutrients, the application of chemical fertilizers is very vital because chemical fertilizers can restore immediately the fertility and the applied nutrients can be readily absorbed by the plants when dissolved after application in the soil.

The early fruiting and higher yield of the spongegourd could be attributed to the right timing and application of all the required amount of inorganic fertilizer. It was proven that inorganic fertilizer enhances the rapid growth of plants due to its solubility in water that made it readily available in form that can be taken up by the plants immediately, which means that the effect is quick and fast. Moreover, in just a small quantity, it can provide all the amount of nutrients needed by the plants. The correct amount of inorganic fertilizer applied could possibly increases the soil organic matter (Han, 2016). Further, it increases root residues into organic matter (Han, 2016). Due to this some farmers prioritized the use of chemical fertilizer to increase their productivity.

Likewise, the spraying of Sargassum liquid foliar fertilizer had contribution to the early fruiting of the spongegourd. Seaweed fertilizer is considered organic that increase soil fertility and plant growth. The use of different species of seaweed as fertilizer has been practiced a long time. Seaweed fertilizer has a broad form of application, such as liquid extracts or dried and pulverized organic material (Raghunandan *et al.*, 2019; EL Boukhari *et al.*, 2020). According to Kaur (2020) that seaweeds has a wide use in agricultural production such as fertilizers, soil conditioners or amendments, growth enhancers or biostimulant. Seaweeds have high amounts of amino acids, macronutrients, micronutrients, vitamins, and phytohormones as growth regulators, e.g., auxins, cytokinins, and gibberellins, they contain besides phycocolloids of great commercial value. Likewise, there are also different species of Sargassum that has been used as fertilizer either composted or as liquid fertilizers. Like other seaweeds, it also enhanced plant growth and yield because it is a rich source of nutrients and growth promoting phytohormones (Sivasankari *et al.*, 2006).

According to Nedumaran (2017) that seaweed extracts are utilized to enhance seed germination and plant growth and to increase crop yield (Panda *et al.*,

2022; Parab, 2022) and increase nutrient uptake from soil. Seaweeds extracts are either used as drenched or foliar spray. In the study of Crouch (1992), it was found out that the application of liquid extracts as foliar spray has tremendous effect on the growth and early flowering of tomato plants.

Micronutrients are best applied as foliar fertilizer to be fully utilized by the plants. Sargassum is full of micronutrients and those nutrients are well-known as a stimulant in the utilization of organic nutrients in the plants (Patil *et al.*, 2008). Moreover, the application of micronutrients can boost the resistance of the plants against abiotic pressure (Cakmak, 2008).

According to previous studies, foliar application is the most efficient method of application of micronutrients since they are needed in a small amount. Foliar applications of micronutrients are the most effective method of crop nourishment to boost the yield, improve quality and prolong the shelf life of the produce (Karthick *et al.*, 2018). Further, foliar fertilization can be applied throughout the growing season even with scarcity of water for irrigation because it utilizes only a small quantity of the nutrient solution requirements at various growth and development stages of the crop (Fernández and Eichert, 2009; Kannan, 2010). Foliar applications could facilitate to the quick absorption of nutrients, no soil interactions that affect nutrient uptake from the roots due to nutrient immobilization or fixation in the soil.

Moreover, foliar method of fertilizer application could stimulate the ability of the roots to absorb the nutrients from the soil (Fernández and Eichert, 2009; Kannan, 2010).

Nutrients uptake through the leaves is possibly much faster than uptake from the soil.

Moreover, foliar application is usually done to correct small nutrients deficiencies of the plants (Lester *et al.*, 2006; Fernández and Eichert, 2009; Kannan, 2010). Jaskulski (2007) stressed that there was a positive economic effect of foliar method of application during the growing stage of the vegetables which have also a direct impact on higher yield.

On the other hand, it was found out in other studies that combined application of inorganic and organic fertilizer has synergistic effects in enhancing growth and development and in increasing crop yield. In the past, there were problems observed regarding on the single approach method of application of either organic or inorganic fertilizers. Fertilizers applied singly could supplied all the necessary nutrients in right amount particularly on macronutrients. Inorganic fertilizer can provide the required amount of macronutrient in small quantity of fertilizer materials particularly the NPK but it lacked micronutrients. On the other hand, when organic fertilizers will be used, it required tons of organic materials to provide the required amount of macronutrients which is laborious and more expensive. The advantage of organic fertilizer was it contains various micronutrients. This started the combined application of organic and inorganic fertilizers to ensure that the required nutrients in improving the soil fertility and productivity (Nyalemegbe *et al.*, 2009) which is less expensive and it decreases the damage induced by inorganic fertilizers (Mungai *et al.*, 2009).

Organic and inorganic fertilizers have common purpose and great contributions in the long-term fertility and productivity of the soils (Simon and Czako, 2014).

Therefore, with the application of organic and inorganic fertilizer or in combinations not only improved growth and development of the spongegourd, rather it also increased the yield thereby gained higher profit. Advances in agriculture not only focus on the increase of yield but includes reduction of the cost of crop production, maintaining or improve soil quality, the use of right nutrients in adequate amount, and the proper method of application (Kannan, 2010).

Conclusion

The single application of the right amount of inorganic fertilizer (IF_3 – 100% of recommended inorganic fertilizer) had significant effects on the fruiting and yield of the spongegourd due to its immediate effects and right dosage of macronutrients applied.

Likewise, the spraying of the spongegourd with the right concentration of Sargassum liquid foliar fertilizer ($SLFF_3$ - 1 Sargassum liquid concentrate: 15 water) had significant effects too on the fruiting and yield of spongegourd due to the presence of micronutrients that augmented the deficiency and the presence of phytohormones that regulate the growth and development. Further, the combined application of inorganic and organic form of fertilizer (IF_3 x $SLFF_3$ - 100% of recommended inorganic fertilizer and 1 Sargassum liquid concentrate: 15 water) gave complementary effects due to complete supply of macro and micronutrients including phytohormones that enhanced the early fruiting and boosted the yield of the spongegourd. On the other hand, higher net income and ROI was also observed which could be attributed to the higher yield at lower cost of production of the spongegourd.

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