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EFFICIENCY OF FERMENTED SEAWEED EXTRACT AS FOLIAR FERTILIZER AT VARYING FREQUENCY AND CONCENTRATION IN PEANUT (*Arachis hypogaea* L.) PRODUCTION

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ABSTRACT

Fermented seaweed extract (FSE) was used as fertilizer in peanut production at MSU Sulu –BARMM, Philippines. The experiment was set up in a 3 x 5 factorial in split-plot randomized complete block design (RCBD), with the main plot (A) as the frequency of the fertilizer applied - once a week, twice a week, and once a month while, the sub-plot (B) as the concentration at 5, 10, 15, and 20%. The application of fermented seaweed extract significantly influenced the growth parameters and yield responses in peanut production. The treatment combinations of once- and twice-a-week application of 5-10% fermented seaweed extract provided the best results in peanut growth and yield. FSE applied twice a week at 5% concentration gave the highest yield of 2.49 tons per hectare. Peanut applied with FSE once a week at a 5% concentration gave the lowest cost of expenses and the highest return on investment of 179%.

Keywords: fermented seaweed extract concentration, frequency of foliar application, peanut

INTRODUCTION

Peanut production in the Philippines has been fluctuating over the years due to insufficient and costly inputs. Several alternative plant nutrient amendments were utilized like organic fertilizers to increase production volume. In Southern Mindanao's Sulu Province, seaweed is commonly grown as a commodity and a source of income, making it one of the main regions for seaweed production, both for export and for domestic use. The most extensively traded species of seaweed is Agal (*Kappaphycus alvarezii*) (Dumilag 2019), characterized by its red and brown-colored varieties. According to several research, seaweed can be used as fertilizer. Govindasamy *et al.* (2018) reported that seaweed contains many nutrients like nitrogen, phosphate, potash, plant growth hormones, and other trace elements. The use of seaweed as organic fertilizer consequently improves soil fertility and enhances plant growth. It can be applied in several different forms, including refined liquid extract and dried, pulverized organic material (Raghunandan 2019). Sulu Province is along the southern part of Mindanao, Philippines, and the northern boundary of the Celebes Sea. It has a total area of 167,376 hectares, with 824,731 household population, and is the fifth largest island in the Philippines (PSA 2015). Sulu has 94,500 hectares of agricultural land, wherein the municipality of Patikul is the largest with 15,750 hectares. The province is predominantly agricultural with farming and fishing as the main sources of livelihood. Its fertile soil and ideal climate can grow a variety of crops and exotic fruits seldom found elsewhere in the country. Peanuts (*A. hypogaea* L.) are commonly planted by local farmers and consumed as boiled, peanut butter, roasted peanuts, peanut bars, oils, and candies. It is considered a vital source of nutrients, calories, minerals, antioxidants, and vitamins essential for optimum health. This

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commodity is usually intercropped with coconut and banana and is the alternative to cassava in other cropping seasons (DA-SAAD 2020).

Several studies report that seaweed liquid extract boosts plant growth and yield, develops tolerance to environmental stress, increases nutrient uptake from soil, and improves antioxidant properties. It also contains major and minor nutrients, amino acids, vitamins, cytokinin, auxin, and growth-promoting substances similar to abscisic acid. By engaging with important metabolic processes including protein synthesis and nucleic acid metabolism, seaweed extract significantly contributes to the internal mechanism of plant growth (Rathore *et al.* 2008).

With the vast seaweed production in Sulu province, several waste materials can be utilized as organic foliar fertilizers, given the nutrient composition of seaweeds. These natural resources can promote organic farming and able to reduce the cost of inputs in peanut production. Considering the reported benefits of the use of seaweed extract, this present study was conducted to determine the effect of fermented seaweed extract (FSE) as fertilizer at different frequencies and concentrations on peanut production. This study would benefit the farmers in Sulu by reducing the costs of chemical inputs and dependence on synthetic fertilizers (Awal *et al.* 2015).

MATERIALS AND METHODS

This study was conducted in the experimental field of Mindanao State University-Sulu, College of Agriculture, Patikul Extension Demo Farm in Patikul, Sulu. The field had a total area of 189 m², and the experiment lasted for five months (January - May 2022). The experiment is a 3 x 5 factorial in Split-plot Randomized Complete Block Design (RCBD). The different frequency applications of FSE represent Factor A (Main plot) while the different concentration rates of seaweed extract represent Factor B (Subplots). All treatment combinations were replicated three times (Table 1).

Soil sampling was done to analyze the nutrient status of the soil. Collection of samples was randomly taken in the experimental area before plowing and the composite samples were air-dried, pulverized, sieved (2 mm wire mesh), and submitted to the Regional Soils Laboratory-Bureau of Soils, Port Area, Zamboanga City for soil analysis. The field was prepared by plowing, followed by harrowing to pulverize the soil. The area was leveled and laid out in a split-plot experimental design. Plots were subsequently covered with plastic mulch to prevent weeds from growing. Furrows were measured to have a proper distance for planting. Then, the seeds were soaked in water before planting to attain good germination. The seeds were sown 30 cm between rows and 40 cm between hills with a planting depth of 2 to 3 cm and covered with fine soil in a row-hill method of planting.

The seaweed extracts of *Kappaphycus alvarezii,* a red alga belonging to the family *Solieraceae* and the common species grown in the locality*,* were used in the study. The collected samples and other materials were washed several times using tap water to remove dirt. The samples were homogenized and fermented using molasses (only) for about a month. Lacto-fermentation was used in the study as the usual method in the fermentation process according to the review done by Ahmad *et al.* (2020) and Wang *et al.* (2021). The ratio used in the fermentation is 1:1, or 1 kg of ground seaweed added with 1 liter of molasses based on the study by Pascual *et al.* (2020). After fermentation, the extract was strained with a fine mesh cloth to separate the solid from the liquid extract. The FSE was applied through foliar spray according to treatment concentration and frequency of application. FSE was diluted with water and applied to the crop up to the peak of the peanut's last flowering period (8-10 weeks) (Figure 1).

Table 1 The 3 x 5 factorial treatments of the study using the Fermented Seaweed Extract (FSE) in peanut production, MSU-Sulu, BARMM, Philippines

Factor A (Frequency application)	Factor B (Concentration of application)
A1 – Once a week	B1 – control/ No fertilizer
A2 – Twice a week	B2 – 5% seaweed extract concentration
A3 – Once a month	B3 - 10% seaweed extract concentration
	B4 - 15% seaweed extract concentration
	B5 - 20% seaweed extract concentration

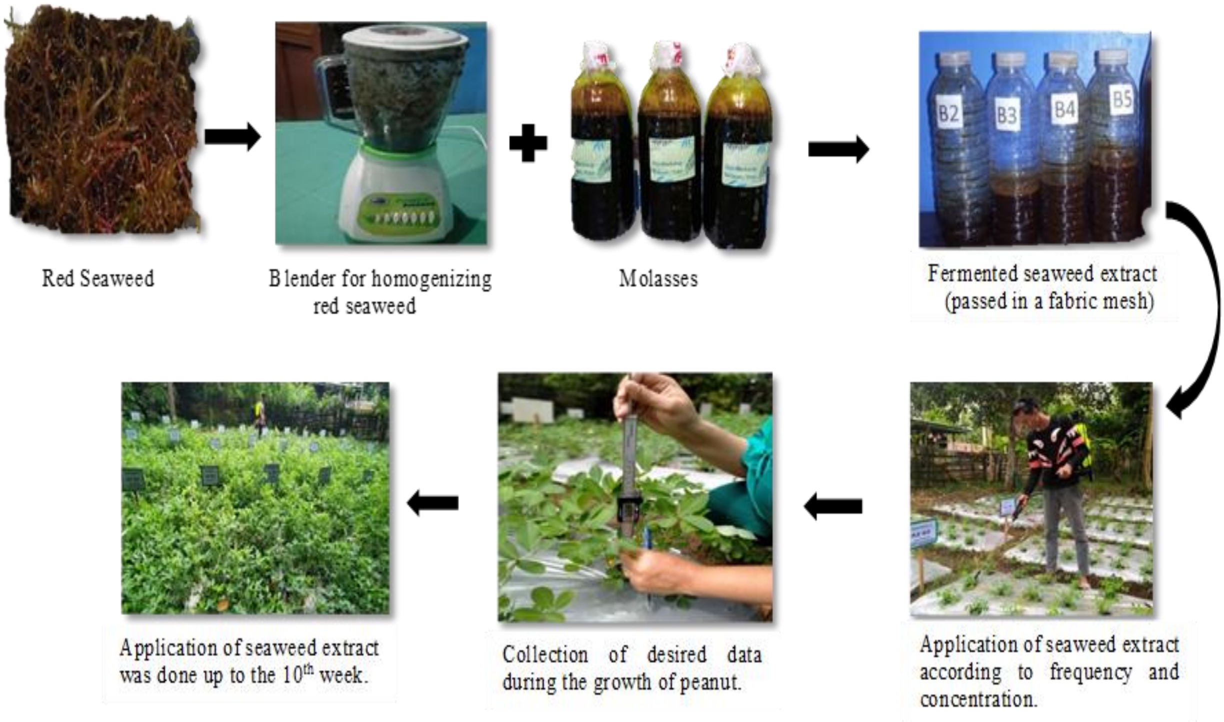

Figure 1 Fermented seaweed extract (FSE) preparation and application in peanut plants

Monitoring of insect pests and diseases was done every week and the control measures depended on the pests' infestation. Harvesting was done 113 days after planting, and the harvested pods were separated according to treatments. The data collected were the following: plant height (cm)per week, number of branches per plant per month, number of days to flower (about 50% plants per plot flowering), number of flowers per plant, number of pods per plant, number of seeds per pod, yield per hectare (tons/ha) by using the formula (1), and the cost and return analysis based on the return on investment (ROI) formula (2).

$$Yield\ per\ Hectare\ \left(\frac{ton}{ha}\right) = \frac{\text{Yield per Plot (Kg)}}{\text{plot size (m2)}} \times \frac{ton}{1{,}000\ kg} \times \frac{10{,}000\ m2}{ha} \quad (1)$$

$$Return\ of\ Investment\ (ROI) = \frac{\text{Net Income}}{\text{Cost of Production}} \times 100 \quad (2)$$

The data were analyzed using Analysis of Variance (ANOVA) in Split-plot Randomized Complete Block design (RCBD) through SPSS. Treatment means with significant differences were compared using Tukey's Honestly Significant Difference (HSD) Test.

RESULTS AND DISCUSSION

Plant Height (cm)

The responses of peanuts in the FSE application showed remarkable differences according to concentration and frequency (Table 2). This proves that FSE contains macronutrients that influence the growth of the test plants. Based on the FSE analysis, it contains enough phosphorus (0.15% P_2O_5) and potassium (2.46% K_2O) but less nitrogen (0.30% N), which influenced the bio-responses of peanuts. Plant height is a crucial characteristic that reflects overall growth and is widely used to predict biomass or final yield.

In the first and second weeks, peanut plant height varies according to the treatment combinations. Early plant development average height ranged from 6.56 cm to 6.94 cm with FSE sprayed once or twice a week at concentrations of 10-15% (Table 2). FSE influenced the growth of peanuts, which conforms with the study conducted by Rathore *et al.* (2008). The plants were tall and robust compared with plants that received a monthly application of the same dose. Vigorous plants were produced as a result of the continuous application of seaweed extract during the third until the tenth week at a concentration of 10-15% applied once and twice a week. However, no statistical difference was found in FSE applied twice a week at 5- 10% concentration with 55.44 cm plant height. Shorter plants were observed from control or unapplied plots with FSE. The findings of the study revealed the influence of seaweed extracts having macro- and micronutrients including growth hormones, which revealed a similar effect to the study conducted by Prasad *et al.* (2010) and Rathore *et al.* (2008). FSE was reported to have enough phosphorus of about 34 ppm, magnesium and calcium of more than 450 ppm (Rathore *et al.* 2008), and micronutrients, which made a significant impact on legumes. Also, seaweed extracts have been used in several horticulture studies and are widely used as a solidifying agent in the nutrient media of plant tissue culture.

The flowering stage of peanuts started in the fourth week after planting showing yellow flowers that emerged around the basal portion of the plant (Table 3). The treatment combination of twice-a-week application at 10% FSE concentration (A2B3) initiated early flowering at 30.82 days. Still, it did not differ significantly with the treatment combination having twice the application of 5% FSE concentration (A2B2) with 31 days of flowering. The late flowering of peanuts was observed in control plots (A1B1 and A2B1) without FSE application at 32.98 and 32.62 days, respectively (Table 2).

The results showed that frequent application of seaweed extract at 5-10% concentration boosted the early flowering of peanuts. Plants sprayed with fermented seaweed extract once a month have a longer number of days to flower. It can be inferred that a lesser amount of FSE nutrients is received during plant growth and development (Table 3). These findings conform with the soybean experiment conducted by Rathore *et al.* (2009) applied with seaweed extract. This was possible due to the high phosphorus content of seaweed with 33.99 mg/L. It can be assumed that the early flowering of the peanut is due to the phosphorus content which is essential for plant flowering initiation and/or reproductive stage. Lalog (2011) mentioned that seaweed extract is rich in macro- and micronutrients that enhance the early flowering of peanut plants. It is environment-friendly, helps the growth of various crops and vegetables while improving the

Table 2 Plant height (cm) of peanut (*Arachis hypogaea* L.) taken every week as influenced by the different seaweed extract concentrations and frequency of application in MSU-Sulu, BARMM, Philippines

Fermented Seaweed Extract (TREATMENTS)		**Plant Height (cm) per week ***									
Frequency Application (Factor A)	**Concentration (%) (Factor B)**	**1st**	**2nd**	**3rd**	**4th**	**5th**	**6th**	**7th**	**8th**	**9th**	**10th**
A 1 - Once a week (1x / wk)	B1 - 0	5.15d	11.55d	14.66cd	16.65d	20.73c	28.14d	41.74c	47.61f	51.04d	53.52b
	B2 - 5	5.44bc	11.86cd	13.66e	15.52e	18.63d	28.21d	41.04d	48.59d	51.90c	53.80b
	B3 - 10	6.58a	13.02a	15.95b	17.05cd	19.77cd	29.17bc	40.42e	49.01cd	50.88d	54.53a
	B4 - 15	6.94a	13.28a	15.79b	19.28a	20.77bc	29.67a	43.77b	49.99a	53.07b	53.92b
	B5 - 20	5.16d	11.63cd	14.15d	16.32d	20.50c	29.84a	39.82f	50.04a	53.17ab	53.53b
A2 - Twice a week (2x / wk)	B1 - 0	6.40ab	12.88a	14.59cd	16.61d	19.27d	28.20d	41.31cd	48.42d	50.50de	52.29d
	B2 - 5	6.65a	13.05a	14.98c	18.30b	20.63c	29.65a	44.38a	49.85a	53.79a	55.44a
	B3 - 10	6.84a	13.26a	16.61a	18.93a	23.53a	29.50a	39.70f	48.17de	50.63d	54.59a
	B4 - 15	5.39c	11.82c	14.55cd	17.38c	21.43b	29.24b	39.12g	49.41bc	50.94d	54.10b
	B5 - 20	6.56a	13.00a	14.70cd	18.54ab	23.13a	28.82c	39.22fg	49.42b	53.61a	54.81a
A3 - Once a month (1x / mo)	B1 - 0	6.35b	12.80a	14.33d	18.42ab	21.83b	28.63cd	38.19h	47.61fg	49.44f	53.15c
	B2 - 5	6.38b	12.82a	14.58cd	17.58c	20.17c	28.89c	42.24c	47.92ef	52.24c	54.54a
	B3 - 10	6.30b	12.64b	14.49cd	17.74bc	20.20c	28.58cd	38.64g	47.21g	50.07e	53.50b
	B4 - 15	5.79b	12.08c	14.31d	17.61c	21.50b	28.75c	43.24b	49.19c	50.84d	53.70b
	B5 - 20	5.98b	12.12c	14.90cd	17.07cd	20.47c	28.30cd	39.53f	48.07e	50.18e	53.36c
ANOVA (*Treatments*)		*	*	*	**	**	*	**	**	**	**
cv (%)		11.13	5.45	5.46	4.04	4.29	2.28	1.71	1.28	1.20	1.19

**Mean of the same letter/s within a column is not significantly different based on Tukey's Honestly Significant Difference (HSD) Test*

Number of Days to Flower and Number of Flowers per Plant quality of soil, and increases crop growth and yield. Gomonet and Cagasan (2020) revealed similar results in peanut number of days to flowering ranging from 30 to 33 days. Most of the flowers were found in leaf axils on primary and secondary branches. Accordingly, several flowers can originate from each node and the number of flowers continued to increase until the plant reached peak bloom at about 60 to 70 days after emergence, and then flower development will begin to decline.

The number of flowers of peanut per plant ranged from 5 to 7 as shown in Table 3. The treatment combination of once-a-week application with 10% concentration (A1B3) of FSE had the highest number of flowers per plant with a mean of 6.29 but did not differ statistically with twice-a-week application of FSE concentration at 5 -20%. A low number of flowers were observed in plants without FSE application (control). The findings can be substantiated by the report of Lalog (2011) and the nutrient content of seaweed with a greater amount of phosphorus. In addition, the once-a-week application treatment of seaweed extract with 20% concentration (A1B5) got the lowest number of flowers with a mean of 5.18 (Table 3).

The results of the study were inconsistent with the outcome of other treatments with 20% concentration. This shows other factors most likely affected the flowering of peanuts in the treatment combination. Thus, it cannot be presumed that the higher concentration of seaweed extract will have a lesser effect on the flowering of peanuts. High temperature, low humidity, and excessive rainfall affect the response of plant flowering which most likely limit the number of flowers produced and reduce flower pollination. This can result in reduced yield and delayed pod set (Awal *et al.* 2015).

Number of Branches per Plant

The number of branches per plant was initially fewer in all treatments for the first month (Table 3). It sharply increased as the growth progressed to the third month after sowing as shown in Figure 2. The frequency of application and concentration of FSE played a significant role in the branch formation of peanuts for three consecutive months. The number of branches per plant was consistently higher in the twice-a-week application at 10% concentration (A2B3) from the first to the third month with a mean of 6.33, 10.00, and 14.67, respectively. However, in the third month, there were no significant differences among the treatment combinations having 10% concentration applied once a week of FSE (A1B3) in terms of the number of branches with 14.33 (Table 3 & Figure 2).

Table 3 The average number of days to flower, number of flowers per hill, and number of branches per plant of peanut (*Arachis hypogaea* L.) as influenced by the different seaweed extract concentrations and frequency of application in MSU-Sulu, BARMM, Philippines.

Fermented Seaweed Extract (TREATMENTS)		Number of Days to Flower*	Number. of Flowers per hill*	Number of Branches per plant*		
Frequency of Application (Factor A)	Concentration (%) (Factor B)			1 mo	2 mo	3 mo
A1 - Once a week (1x / wk)	B1 - 0	32.98a	5.29c	4.33d	7.33d	10.67f
	B2 - 5	31.07d	5.64b	5.00cd	8.00c	11.67d
	B3 - 10	31.04d	6.29a	5.67b	9.33b	14.33a
	B4 - 15	31.6cd	6.02ab	5.00cd	7.67d	10.67f
	B5 - 20	31.31cd	5.18c	4.67d	8.00c	11.00ef
A2 - Twice a week (2x / wk)	B1 - 0	32.62ab	5.29c	5.00cd	8.00c	11.00ef
	B2 - 5	31.00de	6.13a	5.67b	8.00c	12.00cd
	B3 - 10	30.82e	6.24a	6.33a	10.00a	14.67a
	B4 - 15	31.04d	5.69b	5.67b	8.33c	12.00cd
	B5 - 20	31.58cd	6.07a	5.33bc	8.33c	12.33c
A3 - Once a month (1x / mo)	B1 - 0	32.29b	5.27c	4.33d	7.67d	11.00ef
	B2 - 5	31.4cd	6.20a	4.67d	8.00c	11.67d
	B3 - 10	31.71c	6.24a	6.00ab	9.00b	13.67b
	B4 - 15	32.07bc	5.93ab	5.00cd	7.33d	10.67f
	B5 - 20	31.02d	6.13a	4.33d	7.67d	11.00ef
ANOVA (*Treatments*)		*	*	*	**	**
cv (%)		2.40	7.57	12.25	7.90	6.02

**Mean of the same letter/s within a column is not significantly different based on Tukey's Honestly Significant Difference (HSD) Test*

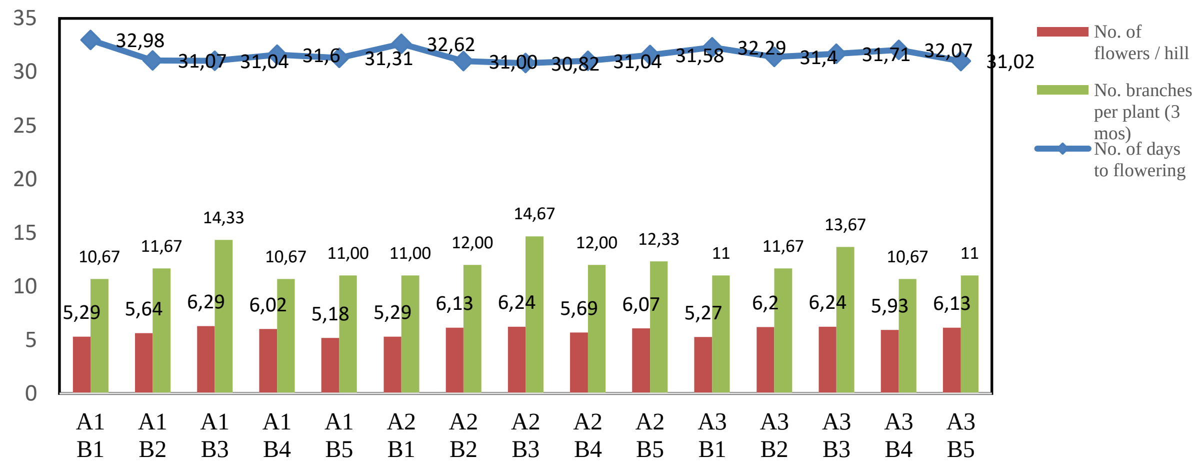

Figure 2 Number of days to flower, number of flowers per hill and number of branches per plant (3 mos after) of peanut (*Arachis hypogaea* L.) as affected by the different seaweed concentration and frequenc

The minimum number of branches per plant was observed in control plots or without application of FSE and in treatment combinations with once-a-week and once-a-month application and 15% and 20% concentration (A1B4 & A3B4) with 10.67, (A1B5 & A3B5) and 11.00 branches, respectively. The rest of the treatment combinations did not vary in the number of branches per plant ranging from 11 to 13.67 throughout the growing season (Table 3 & Figure 2).

Yield Parameters

a. Number of Pods per Plant

The yield of peanuts as influenced by different frequency applications and concentrations of FSE are presented in Table 4. Peanuts with FSE applied twice a week with 10% concentration (A2B3) produced the highest number of pods with 26.13, while plants with once-a-week application of FSE at 5% concentration (A1B2) had 25.3 pods but without significant differences with the once-a-month application of FSE at 20% concentration (A3B5) with 24.66. The lowest number of pods per plot were from control plots (A2B1) with 15.72 and 15.75, respectively. There was no variation in the number of pods among treatments with once-a-month application with 0 to 15% concentration ranging from 17.29 to 19.90 pods per plant (Table 4 & Figure 3).

The results of the study revealed peanut pod bearing was efficient in once and twice-a-week applications of FSE at 5% to 10% concentration. The findings of the study illustrate that it only requires a lower concentration of FSE to produce a higher number of pods, considering the ability of peanuts as a legume to form an association in the biological nitrogen fixation. The study by Gomonet and Cagasan (2020) revealed the average number of pods ranged from 18 to 37 per plant, which is comparable to the result of the study conducted. It is most likely the FSE contains growth hormone that influences the physiological processes of peanuts at lower concentrations. Seaweed extracts contain higher phosphorus and complement peanuts' ability for symbiotic N fixation with rhizobia (Smith et al., 1987). Rathore *et al.* (2008) reported that FSE contains enough phosphorus (of about 34 ppm) and a greater amount of Ca and Mg that affect the flowering and pod bearing of legumes. Moreover, the ability of peanuts to produce pods is directly affected by management practices and the micro climatic condition of the growing area.

b. Number of Seeds per Pod

The number of seeds per pod is shown in Table 4. The treatment combination of twice-a-week application FSE with 10% concentration (A2B3) got the highest number of seeds per pod with a mean of 2.30 but did not vary with other treatment combinations like twice-a-week application at 5% concentration (Table 4 & Figure 3). The lowest number of seeds per pod was from plants with once-a-month application at 20% FSE (A3B5) with a mean of 2.00 seeds per pod, which is similar to control plots (A1B1) or without FSE applied.

Table 4 The average number of pods per plant, number of seeds per pod, yield per plot (kg) and total yield tons per hectare of peanut (*Arachis hypogaea* L.) as affected by the different seaweed extract concentrations and frequency of application

Fermented Seaweed Extract (TREATMENTS)		**Number of Pods per plant***	**Number of Seeds per pod***	**Yield per plot (kg)***	**Total Yield (tons/ha)***
Frequency of Application (Factor A)	**Concentration (%) (Factor B)**				
A1 - Once a week (1x / wk)	B1 - 0	15.75c	2.02d	0.70d	1.13d
	B2 - 5	25.30a	2.23a	1.16a	2.31ab
	B3 - 10	16.08c	2.15bc	0.73cd	1.18d
	B4 - 15	18.20c	2.17b	0.82bcd	1.39d
	B5 - 20	21.23ab	2.15bc	0.96abc	1.83bc
A2 -Twice a week (2x / wk)	B1 - 0	15.72c	2.15bc	0.71d	1.20d
	B2 - 5	24.83ab	2.28a	1.21a	2.49a
	B3 - 10	26.13a	2.30a	1.12a	2.21ab
	B4 - 15	24.13ab	2.20ab	1.03ab	1.92ab
	B5 - 20	22.31ab	2.25a	0.95bc	1.78bc
A3 - Once a month (1x / mo)	B1 - 0	19.00c	2.18b	0.82bcd	1.48d
	B2 - 5	19.90bc	2.23a	0.86bcd	1.54cd
	B3 - 10	17.29c	2.22a	0.74cd	1.25d
	B4 - 15	19.39c	2.10c	0.84bcd	1.46d
	B5 - 20	24.66ab	2.00d	1.06ab	2.06abc
ANOVA (*Replication*)		*	*	*	*
cv (%)		30.85	4.40	32.06	43.79

**Mean of the same letter/s within a column is not significantly different based on Tukey's Honestly Significant Difference (HSD) Test*

The result of the study was greatly influenced by the frequent application of FSE and its concentration at 5% to 10%. There was inconsistency in the result like the treatment applied once a week but showed similar results in the amount of concentration applied for both twice-a-week and once-a-month applications. It is noteworthy to consider that the frequent application (twice a week) of FSE increased the seed per pod. The amino acids and other phytohormones are believed to have influenced the seed formation of peanuts. This conforms with the study of other researchers like Prasedya *et al.* (2022) but is much better than the study conducted by Gomonet and Cagasan (2020) in which the number of seeds per pod ranged from 1- 2 seeds only. This is quite lower than the result of the present study, which ranges from 2-3 seeds per pod. The FSE nutrient composition influenced the increase in the seed formation of a peanut since it contains sufficient phosphorus, very high calcium, and magnesium, including micronutrients like zinc and iron necessary for seed formation (Prasedya *et al.* 2022; Lalog, 2011; Mosaic Compan, 2013).

c. Yield per plot (kg) and Total Yield (ton/ha)

The yield of peanuts was affected by the frequency and concentration of FSE application (Table 4 & Figure 3). Plants applied twice a week with a 5% concentration of FSE (A2B2) produced heavier pods per plot with a mean of 1.21 kg, followed by plots with once-a-week application at a 5% concentration of FSE (A1B2) with 1.16 kg per plot. Twice spraying of FSE every week with 10% concentration (A2B3) resulted in 1.12 kg per plot, while once-a-month application with 20% concentration of FSE (A3B5) produced 1.06 kg per plot. The rest of the treatment combinations have no variation in the yield per plot (Table 4). The lowest yield per plot is from the control plots (A1B1) or without application of FSE with a mean of 0.70 kg per plot (Table 4 & Figure 3).

In terms of peanut yield per hectare, the highest yield was recorded from plants applied with FSE twice a week at 5% concentration (A2B2) with a mean of 2.49 tons per hectare. However, it did not differ much with those plants applied once a week at 5% concentration (A1B2) with 2.31 tons/ha. Whereas peanuts sprayed twice a week at 10% concentration (A2B3) produced 2.21 tons/ha while those applied once a month at 20% concentration (A3B5) got a lower yield of 2.06 tons/ha (Table 4 & Figure 3). However, the result of this study reveals the obtained yield of peanuts is much higher than the reported average yield in the country of about 800 to 1,000 kg per hectare based on the report of Billen *et al.* (2015) as cited by Gomonet and Cagasan (2020). It can be attributed to the positive effect of using a twice-a-week application with a 5% concentration of FSE to stimulate pod formation, enhance the quality and quantity of pods, and thus increase harvest in tons per hectare. Based on the study of Prasedya *et al.* (2022), fermented brown seaweed positively contains nutrients N, K, Ca, Mg, and B, which make it a potent fertilizer. The result implies that FSE contains plant nutrient amendments with sufficient amounts of macro- and micronutrients that will increase crop yield (Rathore *et al.* 2008; Lalog 2011).

Cost and Return Analysis

Table 5 shows the cost and return analysis using the return-on-investment (ROI) computation of FSE in peanut production with different frequency applications and concentrations. Plants applied once a week with a 5% concentration of FSE (A1B2) have the highest return on investment (ROI) of 176.46%. However, it did not differ significantly with peanuts applied twice a week with a 5% concentration of FSE (A2B2) at 170.15% returns. The lowest ROI was found in peanuts applied twice a week with a 20% FSE concentration of 74.79%. The rest of the treatment combinations have ROI ranging from 80% to 156% (Table 5 and Figure 4). Variation in ROI results was due to the differences in yield and cost of production, specifically the cost of fermented seaweed extract at different concentrations. The study shows that using FSE for peanut production can give better economic returns for the local farmers and can benefit by recycling those wastes into organic fertilizers, thereby reducing the cost of farm inputs. This can save farmers from total dependence on the use of synthetic chemical fertilizers.

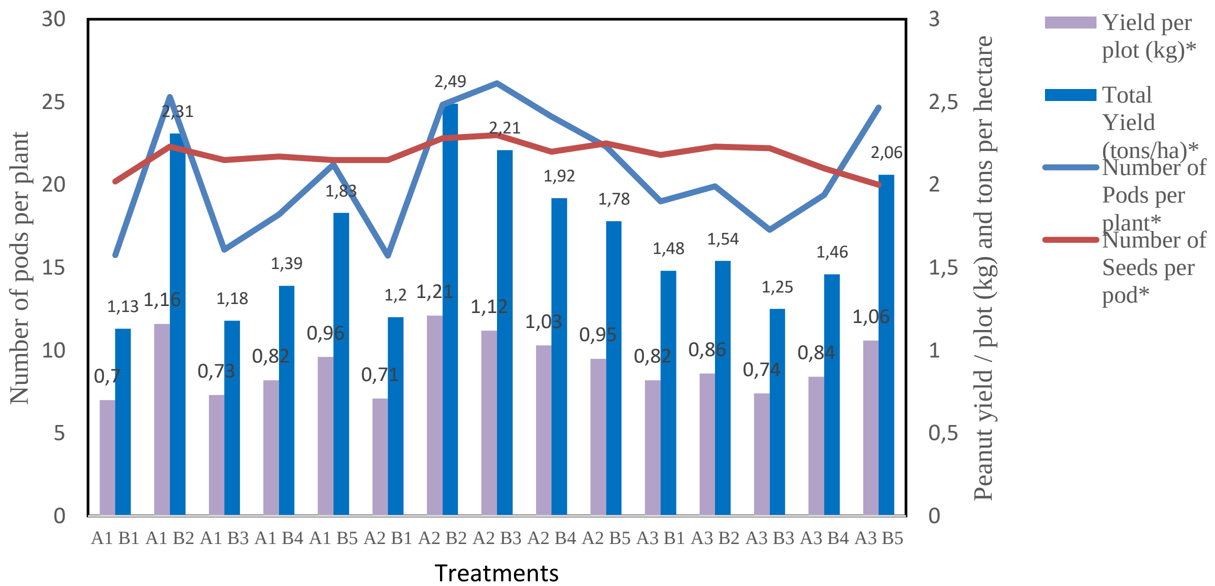

Figure 3 Number of pods per plant, number of seeds per pod, yield per plot (kg) and total yield tons per hectare of peanut (*Arachis hypogaea* L.) as affected by the different seaweed extract concentrations and

Table 5 Cost and return analysis using return on investment (ROI) computation on peanut production with different frequencies and concentrations of FSE, MSU- Sulu

Fermented Seaweed Extract (TREATMENTS)		Total Sales PhP	Total Cost PhP	ROI (%)	
Frequency of Application (Factor A)	**Concentration (%) (Factor B)**				
A1 - Once a week (1x / wk)	B1 - 0	111	113.54	97.76	cd
	B2 - 5	226.83	128.55	176.46	a
	B3 - 10	115.75	143.55	80.63	d
	B4 - 15	136.33	158.55	85.99	d
	B5 - 20	179.17	173.55	103.24	cd
A2 - Twice a week (2x / wk)	B1 - 0	117.5	113.55	103.48	cd
	B2 - 5	244.25	143.55	170.15	a
	B3 - 10	216.33	173.55	124.65	c
	B4 - 15	188.17	203.55	92.44	d
	B5 - 20	174.67	233.55	74.79	e
A3 - Once a month (1x / mo)	B1 - 0	145.33	113.55	127.99	b
	B2 - 5	150.83	117.3	128.59	bc
	B3 - 10	122.83	121.05	101.47	cd
	B4 - 15	142.92	124.8	114.52	c
	B5 - 20	201.75	128.55	156.94	ab
ANOVA (*Replication*)		**	-	**	
CV (%)		43.79	-	42.35	

**Mean of the same letter/s within a column is not significantly different based on Tukey's Honestly Significant Difference (HSD) Test*

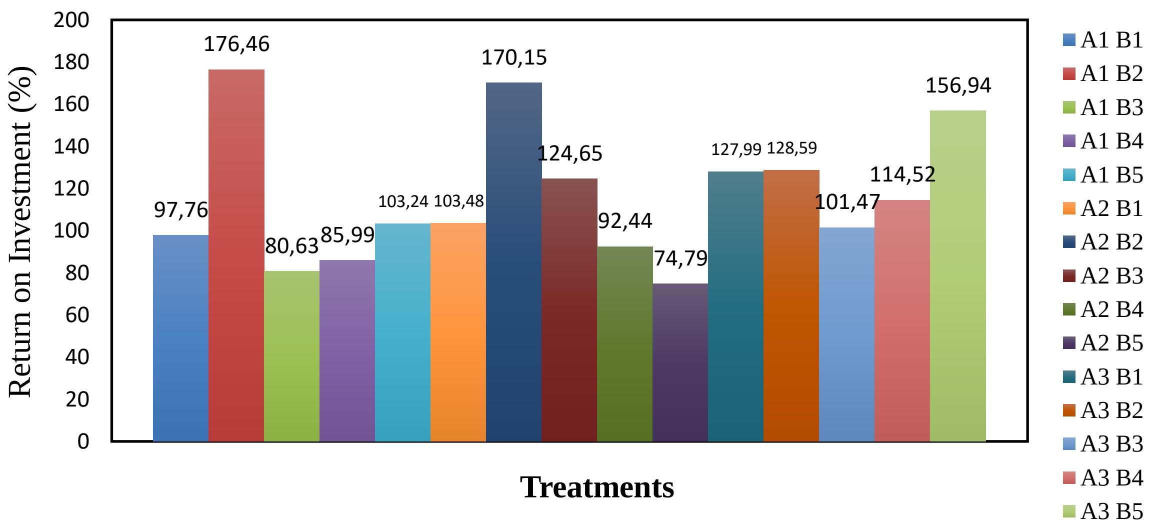

Figure 4 Cost and return analysis in peanut production applied with different frequency and concentration of fermented seaweed extract in MSU- Sulu, BARMM, Philippines

CONCLUSIONS

The results of the study indicate that fermented seaweed extract (FSE) at various frequencies and concentrations significantly affects the growth and yield response of peanuts due to nutrient components of FSE with sufficient amounts of both macro- and micronutrients and phytohormones present. The application of fermented seaweed extract once and twice a week at 5% and 10% concentrations as liquid fertilizer was found best for peanut production by having a greater number of pods and consequently higher yield. In terms of return on investment, a once-a-week application with 5% seaweed extract concentration gave the highest profit due to lower costs of expenses and less labor incurred during peanut production. It is necessary to conduct further study on the effect of long-term application and higher concentration of fermented seaweed extract as foliar fertilizer on peanut production. Given the effects of FSE, it is necessary to determine the beneficial microorganisms (effective microorganisms) present in the fermented seaweed extract as potential microorganisms in the manufacture of bio-fertilizer. Further study can be conducted to determine the influence of FSE at higher concentrations or greater than 20% on peanut and other commodities like cereals (rice and corn) and vegetable production.

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