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Effect of Amended Soil with Oil Palm Empty Fruit Bunch Compost on the pH of Soil and the Growth of Choy Sam (*Brassica chinensis var parachinensis*)

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Abstract: There are several types of fertilizers that are commonly used in the agriculture sector either organic or chemical fertilizer. The application of organic fertilizer is a common practice used in the agriculture sector. Today, the application of inorganic fertilizer is widely used in large scale sector. The continuous application of this type of fertilizer contributes greatly to soil degradation. Hence, a study was conducted to determine the effect of amended soil with oil palm empty fruit bunch (EFB) compost and fish meal on the growth of Choy Sam (*Brassica chinensis var parachinensis*). This experiment was conducted at the shaded and closed area to prevent and minimize the factors that can affect the results. The experiment also was conducted by using Completely Randomized Block Design (CRBD) with three treatments replicated for three times. The treatments were treatment 1: combination NPK fertilizer and EFB compost, treatment 2: fish meal and EFB compost and Treatment 3: 100% EFB compost. The soil pH and soil moisture was determined before and after treatments. The growth performance was determined by the plant height, leaf area and biomass. The three treatments had not changed the pH condition after a crop of Choi. However, the combination of NPK fertilizers and EFB compost showed the best growth performance.

Key words: Inorganic fertilizer, NPK fertilizer, organic fertilizer, empty fruit bunch compost, fish meal, plant height, leaf area, biomass

INTRODUCTION

Chinese flowering cabbage or also known as Choy Sam (*Brassica chinensis var parachinensis*) is originated in the Mediterranean Region and widely distributed throughout the tropics. Choy Sam vegetables is a short term crops and are ready to be harvested at 30 days after sowing. The characteristics of the plant are simple taproot, flat stems with green basal leaves and bright yellow flowers. This plant cannot withstand towards the excessive rainfall and poor soil drainage conditions. The recommended pH for its growth is 6-6.8. It has high demand of nutrients and continuously planting in the same location will yield poorly.

There are several types of fertilizers that are commonly used in the agriculture sector which are organic and inorganic or chemical fertilizer. Band *et al*. (2007) reported the demand for the crop has increased significantly, leading to the extensive use of inorganic or chemical fertilizers without any consideration for soil health and quality which are a critical factors for realizing sustainable yield. The continuous application of this type of fertilizer contributes greatly to soil degradation. The application of organic fertilizer is an increasing practice used in the agriculture sector due to the increase in environmental awareness and threats posed by pesticide use (Somasundram *et al*., 2016). This trend has opened the opportunity for the development of organic based fertilizers.

Oil palm empty fruit bunch (EFB) is the waste product from the oil palm processing industry. EFB is considered suitable for the production of good quality compost which can improve soil pH as well as improving soil drainage (Good and Beatty, 2011; Mohammadi *et al*., 2012; Kavitha *et al*., 2013). However, EFB compost mixed with topsoil was not sufficient to produce good yield and need the supply of nitrogenous source. Fish remains are traditionally used as fertilizer, given their wealth of nutritive elements: principally nitrogen, phosphorus and their rapid decomposition and utilized to provide the plant with the nutrient needed for better growth (Radziemska *et al*., 2018). This study was conducted to determine the pH of amended soil with oil palm EFB compost supplemented with fish meal. The growth response of Choy Sam was also investigated.

MATERIALS AND METHODS

Experimental site and design: The experiment was conducted at the farm unit, Universiti Teknologi MARA,

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Samarahan Campus. Kota Samarahan, Sarawak, Malaysia. The experiment was set up using Completely Randomized Block Design (CRBD) with three treatment replicated three times.

Raw materials preparation: The growth media was prepared by mixing EFB compost with topsoil at the ratio of 1:2 filled in a polybag of 30 cm diameter and 30 cm height. The treatment was the application of combination NPK fertilizer or fish meal. The control treatment was only the application of EFB. The Choi Sam was pre-germinated before transplanted to the polybags assigned to different treatments. For the NPK treatment, the fertilizer was applied 2 weeks after the transplanting of a week old seedling with 20 g per plant. For the fish meal treatment, 0.6898 kg of fish offal were blended and mixed with the soil and left for a week before transplanting the seedlings.

Determination of soil moisture and soil pH: The soil moisture data was collected at the first week of the soil media preparation and at the last day of the harvesting activities. A 100 g of soil sample wet weight was weighed using digital scale from all treatments placed inside an envelope and placed into the drying oven at 80°C for 3 days. The soil samples were weighted again to obtain its dried weight. The soil moisture was calculated based on this equation:

$$\text{Soil moisture (\%)} = \frac{\text{Loss in weight}}{\text{Over dry weight of soil}} \times 100$$

The pH of the soil media of each treatment was determined using a pH meter before transplanting and after harvesting.

Plant height and number of leaves: The growth performance was determined by the plant height measured weekly for 5 weeks. The plant heights were measured using measuring tape. Rope was also used to measured plant that did not have straight stem and after that rope was placed on measuring tape to obtain the measurement of the height. The measurement was taken from the base of the plant above the soil surface to the upper part at the terminal shoot tip. The measurement unit used was in centimetre.

Leaf area: The leaf area from all the leaves of the terminal shoot and the middle canopy of each plant were determined after harvesting using Autodesk AutoCAD Software methodology developed by Affif (2015). All the leaves were placed on A4 paper and each leaf's shape was traced because delay resulted in shrinkage of the leaves and the original shape of leaves. Every drawing of the leaves of each plant was then scanned by using scanner. All scanned leaves were labelled carefully and saved in JPEG images placed in computer's folder. The JPEG images were uploaded to the AutoCAD Software where areas of leaves were determined.

Plant biomass: The plant biomass was carried out after harvesting. All parts of plants were collected and carefully rid of soil and kept in plastic bags. Plants were labelled carefully and weighing scale was used to measure biomass. The data included the total plant weight, shoot weight and root weight, root length and stem diameter, were also collected after harvesting. Only the wet weight was recorded.

Stem diameter: The diameter of the stem were measured midway between the bottom and the terminal shoot of the plant by using the digital callipers. The unit of measurement used is in millimetre (mm).

Root length: The harvested roots was measured with the measuring tape from the base of the stem to the root tip of the plant.

Data analysis: Analysis of Variance (ANOVA) and Tukey Multiple of Comparison of Means were conducted using IBM SPSS Statistic Data Editor Version 24.

RESULTS AND DISCUSSION

Soil moisture and pH: The results were observed and discussed. Table 1 shows the Analysis of Variances (ANOVA) of means of soil moisture and pH of the treatments at $\alpha = 0.05$.

Initial soil moisture content was not significantly different among the treatments. However, after harvesting, the soil moisture content was significantly different among the treatments and this was attributed to the 10% difference in the EFB treatment. This also affected the soil moisture contents before and after observation.

The initial pH was shown to be favourable as the recommended pH for Choi Sam growth was 6.0-6.8. The initial pH before harvesting showed NPK treatment was significantly different from the other two treatments. The pH after harvesting did not showed significant differences. All pH was reduced after harvesting with NPK by a difference of 0.15, fish meal by 0.29 and EFB by 0.64 which did not indicate significant differences. The pH after growing a crop of Choi Sam from NPK and EFB alone fell below the recommended pH for Choi Sam growth. According to Rosenani Abu Bakar *et al*., the application of EFB resulted in increased of soil pH of the top soil and sub-soils when compared to chemical fertilizers (Table 1).

Table 1: The mean pH and soil moisture of soil media before and after planting at ANOVA $\alpha = 0.05$, common letters showing no significant difference based on tukey multiple comparison of means

	Soil moisture				pH			
	Before		After		Before		After	
Treatment	Percentage	SD	Percentage	SD	Percentage	SD	Percentage	SD
NPK	35.78	5.333	38.67 a	6.265	6.11 a	0.147	5.97	0.122
Fish meal	35.78	2.863	41.00 a	5.809	6.47 b	0.075	6.19	0.889
Control	39.00	2.549	29.22 b	9.039	6.41 b	0.241	5.76	0.258

ANOVA at $\alpha = 0.05$; 0.219 (Not significant); 0.004 (Significant); 0.000 (Significant); 0.294 (Not significant); ANOVA ($\alpha = 0.05$); 0.204 (Not significant)

Table 2: ANOVA for plant height and number of leaves where $\alpha = 0.05$

	Plant height		No of leaves	
Weeks	ANOVA	Significant*	ANOVA	Significant*
1	0.549	NS	0.144	NS
2	0.363	NS	0.013	S
3	0.055	NS	0.012	S
4	0.014	S	0.024	S
5	0.003	S	0.000	S

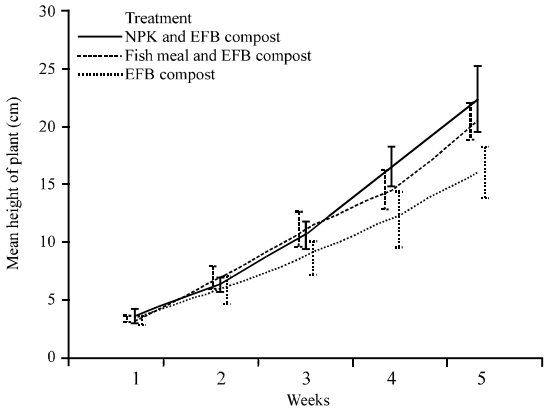

Fig. 1: The mean height of plant and the number of leaves of Choy Sam from treatments: 1) NPK fertilizer; 2) Fish meal and 3) control for the 5 weeks period of growth (Error bars: +/-2 SE)

Plant height and number of leaves: Table 2 shows the ANOVA for plant height and number of leaves. Figure 1 shows the growth pattern of the Choy Sam plants over a 5 weeks period of growth and in week 1 until week 3, the highest mean plant height was observed in the fish meal treatment but after week 3, the growth in the NPK overtook the fish meal treatment. However, there was no significant difference between the NPK and fish meal treatments. Growth in EFB compost was consistently lagging significantly throughout the growth period as ANOVA showed p-value of 0.014 and 0.003, respectively.

Figure 2 shows the number of leaves over the 5 weeks growth period. In week 1, the number of leaves was similar among the treatments. At week 2 and 3, fish meal recorded the highest number of leaves followed by NPK except at week 4 but there were no significant

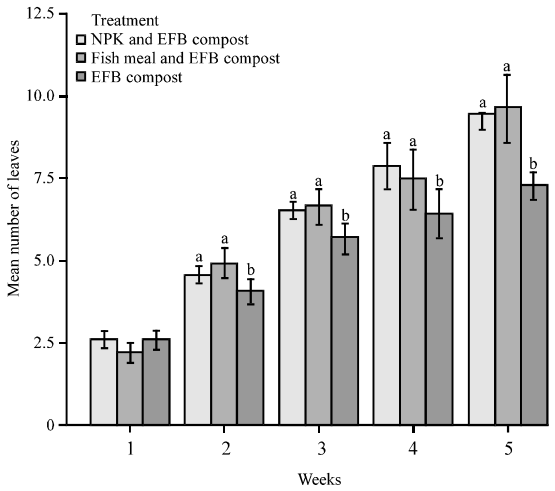

Fig. 2: The mean number of leaves of Choy Sam from treatments: 1) NPK fertilizer; 2) Fish meal and 3) Control for the 5 weeks period of growth (Error bars: +/-2 SE)

differences among the treatments. The number of leaves in EFB compost was significantly less than NPK and fish meal throughout the growth period of 5 weeks.

Based on Table 2, there was significant difference from week 2 onwards as ANOVA showed p-value of 0.013, 0.012, 0.024 and 0.000, respectively. This was similarly observed by Omotosu *et al.* that NPK can increase the growth and yield performance of okra. According to Okonwu and Mensah, the application of NPK fertilizer can increase the number of leaves of pumpkin. Thus, it indicated that fish meal had high nitrogen content.

Leaf area: Figure 3 shows the mean leaf area of plant (cm^2) from treatments: NPK, fish meal and control (EFB compost only). The highest total leaf area of 316.67 cm^2 was obtained from NPK treatment followed by fish meal with leaf area of 287.98 cm^2 and EFB compost with leaf area 104.10 cm^2. There were no significant difference between NPK and fish meal treatments. However, both were significantly different from EFB compost. It clearly indicated that there was not sufficient N for the leaf growth in EFB compost without supplementing other N

Table 3: The mean and ANOVA of biomass by total plant weight, root length and stem diameter of Choi Sam where $\alpha = 0.05$; common letters indicating no significant differences based on tukey multiple comparisons of means

Treatment	Total plant weight (g)	Shoot weight (g)	Root weight (g)	Shoot: root ratio	Stem diameter (mm)	Root length (cm)
NPK						
Mean	141.4778[a]	135.9111[a]	5.5667[a]	24.1994[a]	10.4156[a]	22.5667[a]
SD	57.57460	55.90884	1.91898	4.78858	1.91276	4.63276
Fish meal						
Mean	124.9111[b]	119.3667[b]	5.5444[a]	23.3735[a]	11.0711[a]	17.2778[b]
SD	51.10845	48.77548	2.86012	6.02324	1.88620	4.17815
EFB compost						
Mean	21.6889[c]	19.9444[c]	1.7444[b]	14.2849[b]	5.5956[b]	21.0556[a]
SD	10.70297	9.57041	1.29722	5.46151	1.11738	6.77036
ANOVA	0.000	0.000	0.001	0.001	0.000	0.115
Significant*	S	S	S	S	S	NS

*Significant (S) if $\alpha<0.05$ and Not Significant (NS) if $\alpha>0.05$; [a-c]Significant values

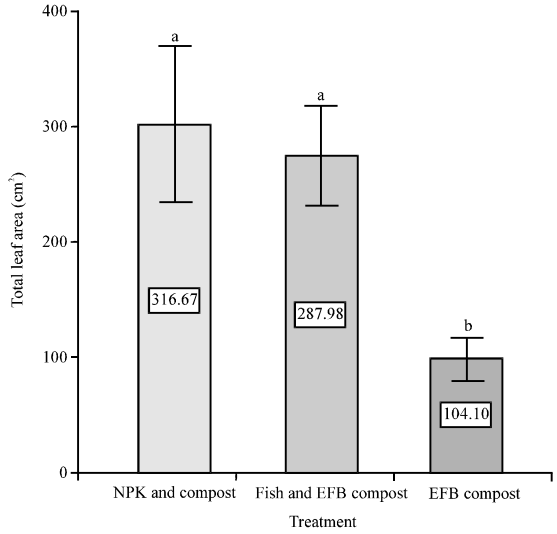

Fig. 3: The mean leaf area of plant (cm^2) from treatments: NPK, fish meal and control (EFB compost only); ANOVA at $\alpha = 0.05$, common letters showing no significant difference based on tukey multiple comparison of means (Error bars: +/-2 SE)

sources. The N sources from fish meal were sufficient and thus can be a good supplement for cultivating organic vegetable. This is also supported by Radziemska *et al.* (2018) that soil fertilization from fish waste caused an increase in leaf yield. The application of NPK fertilizer can increase leaf area (Omotoso and Shittu 2007; Okonwu and Mensah, 2012).

Plant biomass, stem diameter and root length: Table 3 shows the mean and ANOVA of each treatment on the yield pattern including total plant weight, shoot weight, root weight, shoot: root ratio, stem diameter and root length. The NPK has the highest total plant weight with the mean of 141.48 g followed by fish meal with the mean of 124.91 g. There was no significant difference between the two treatments. The control recorded the lowest mean weight with only 21.69 g, significantly difference from the other treatments as ANOVA showed p-value 0.000. The shoot: root ratio also showed a decreasing trend from NPK, fish meal and control in that order. According to Andrews (1993), the shoot: root ratio would decrease when growth was limited by nitrogen supply. Despite having a low root weight, the control had comparable root length of 21.06 cm to NPK treatment recorded at 22.57 cm. Fish meal treatment had the lowest mean of 17.28 cm. The highest stem diameter of 11.071 mm was obtained from fish meal treatment followed by NPK with 10.42 mm and EFB compost with 5.60 mm. There was no significant difference between NPK and fish meal treatments but both were significantly different from control compost indicated by ANOVA with the p-value of 0.000. All significant differences in means were determined by Tukey Multiple Comparisons of Means. Maria *et al.* stated that fish meal rapidly decomposed allowing organic substances to broken down faster. According to Radziemska *et al.* (2018), the application of fish waste can increase in yield as it increased the contents of several nutrients such as nitrogen, phosphorus and potassium important for growth of the plants. Thus, fish meal attributed the comparable growth to NPK fertilizer.

CONCLUSION

The treatments of NPK, fish meal and EFB compost had not changed the pH condition after a crop of Choi Sam. The soil moisture contents were not affected by NPK and fish meal treatments except the EFB compost alone. There is clear evidence NPK fertilizer had produced the best growth and yield of Choi Sam. However, fish meal also produced comparable growth and yield. Amendment with EFB compost alone was not sufficient to provide the nutrients required for better growth and yield performance. The application of organic or inorganic fertilizer is still required in amended soil with EFB to support the growth of the plants. Fish meal can be used as an alternative to inorganic fertilizer which can result in deterioration of soil quality in the long term. It is also preferable as the produce can be claimed as organic vegetable.

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