STUDY OF INORGANIC FERTILIZER EFFECTS ON MORPHOLOGICAL OF COCONUTS (*Cocus Nucifera L.)* AT DIFFERENT TROPICAL REGIONS IN PERAK

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ABSTRACT

The study was carried out to examine the effects of inorganic fertilizers on the measurable morphology characters of coconut planted at different tropical region in Perak at pre-matured stage. 48 Malayan Red Dwarf (MRD) at the age of nine-month-old were used and planted horizontally on raised sites at a spacing of 7.0 m between seedlings and 7.0 m between rows triangularly each experimental site. The fertilizer used is NPK 15:15:15 (Green) compound and the treatments are as T1 (Control), T2 (1.5 kg/plant/year), T3 (3.0 kg/plant/year) and T4 (4.5kg/plant/year). Details of the treatments are as T1 (Control), T2 (1.5 kg/plant/year of NPK Green), T3 (3.0 kg/plant/year of NPK Green), T4 (4.5kg/plant/year of NPK Green). The measurable characters of were collected like i.e., plants height (m), stems girth (cm), number of fronds, fronds length (m), chlorophyll content (SPAD Reading) and light intensity (µmol m−2 s−1). After the evaluation in the first yea, it shows that treatment of T2 (1.5 kg/ plant /year) available dosage rate for excellent growth performance. Followed to the second year, treatment T3 (3.0 kg /plant /year) increased the nutrient capabilities for plants uptake. Then, for third year, treatment T4 (4.5kg/plant/year) adopted the nutritional requirement of seedlings at field stage. The work indicated morphological diversity of seedlings at field stage to help the growers in choosing the optimum rate of fertilizer for their plantation in Perak, Malaysia.

Key words: Coconut, Field Stage, Inorganic Fertilizer, Morphology Characters

INTRODUCTION

Proper selection and planting of good quality of seed nuts must be done to ensure the productive of plantation (Magat, 1999). The palm shows an indeterminate growth pattern, producing one compound leaf and an inflorescence at each leaf axils at intervals varying from 25 to 30 days over six to seven decades, but it was depending on the environmental conditions and age of the palm (Liyanage, 1950). The basis for fertilizing crops is by understanding the amount of input materials which would be required to make up the difference between the nutrients needed by the crop and those supplied by the soil itself. This can be implying that crop performance will be improved, if we are in a position to estimate, firstly the amount of a particular nutrient required by the plant for unrestricted growth, and secondly the amount that is actually supplied by the soil medium. There is a need to organize the supply of nutrients to the crop through inorganic and renewable sources by integrated nutrient management (INM) (Anderson et al., 2002). Under such circumstances, an integrated approach is suggested through complementary use of inorganic and organic fertilizers to boost/sustain soil fertility and crop productivity (Lampe, 2000). Annually, the palm removes large quantities of nutrients from the soil (Nathanael, 1961; Von Uexhull, 1971). Balakrishna (1975) studied that all the inorganic and organic fertilizers mixture treatments have consistent and significant effects on the yield. Mravilla et al., (1978) noted that the non-responsiveness to fertilization of seedlings in the early nursery stages could be due to the already sufficient levels of nutrients available while they were still in the endosperm stage. Sumbak (1970) studied that more frequent or heavier N applications might be necessary for maximum growth. Menon & Pandalai (1960) mentioned from their studies that soaking of seed nuts in water for period up to 15 days resulted in quicker and better germination. Therefore, the main objective of this study were to examine the effects of inorganic fertilizers on the measurable morphology characters of coconut planted at different tropical region in Perak at pre-matured stage.

MATERIALS AND METHODS

Experiment sites: The experiment was conducted at two different experiment plots in tropical region in Perak which is located at Bagan Datuk (BD) in Mardi Bagan Datuk Research Station and Kuala Kangsar (KK) located in MARDI Kuala Kangsar Research Station. The site in BD was located at 3°53'36.0" N latitude and 100°51'24.0" E longitude. Experiment plot was characterized with an average of 1900 mm annual rainfall, 28ºC annual temperature and 88% relative humidity. The soil of BD was generally classified as loamy clay (riverine alluvial) with medium pH and low availability of N and K. While site in KK was located at 4°46'21.80" N latitude and 100°56'25.10" E longitude. Experiment site was characterized with more than 2216 mm annual rainfall, 27.5ºC annual temperature and 90% relative humidity. The soil of KK was generally classified as sandy loam (laterite) with medium pH and availability of N and K.

Planting materials: 48 Malayan Red Dwarf (MRD) at the age of nine-month old were used and planted horizontally on raised sites at a spacing of 7.0 m between seedlings and 7.0 m between rows triangularly each experimental sites. All the planting materials planted at the same time.

Fertilizer treatments application: The experiment was carried out for three years since November 2017 until November 2020. The fertilizer used is NPK Green compound. The details of the treatments are as T1 (Control), T2 (1.5 kg/plant/year), T3 (3.0 kg/plant/year) and T4 (4.5kg/plant/year). The fertilizer treatments divided into three parts equally and were applied at 3th, 6th and 9th month after seedlings planted each year.

Data collections: The measurable characters of coconuts were collected like i.e., plants height (m), stems girth (cm), number of fronds, fronds length (m), chlorophyll content (SPAD Reading) and light intensity (μmol m−2 s−1).

Experimental design: The experiment was laid down in a complete randomized design with four treatments and three replications. The data were subjected to statistical analysis following Steel et al., (1997).

RESULTS AND DISCUSSION

Plants height performance of coconut: The data on growth parameters of plant height at different tropical region in Perak are given table 1. For the first year, the plants height at BD experimental sites was significantly high in treatment T2 with 3.98 + 0.39, whereas treatment T1 was minimum height was recorded 2.95+0.78. Subjected to the parameter of plant height in KK was significantly high in treatment T2 with 2.55 + 0.61 and unfortunately treatment T1 was minimum height was recorded 1.96 + 0.97. For second year, at BD area observed that the plants height was dramatically increased compared to previous year. It was significantly high in Treatment T3 with 4.67 + 0.37, followed by treatment T1 was minimum height recorded with 3.28 + 1.58. For the plant height in KK experimental sites at same year al so show the increasing of plant height than previous years which was significantly high in treatment T3 with 2.88 + 0.49, whereas treatment T1 was minimum height was recorded 2.03 + 1.15. The current recommended rate of application of 3 kg per palm appears on average to be too high to maximize profit and greater than that necessary for maximum coconut production per hectare (De Silva and Tisdel, 1981). For third year of evaluation, at BD sites shows that the plants height was significantly high in treatment T4 with 4.87 + 0.18, but unlikely treatment T1 was minimum height with 3.88 + 0.53. For the plant height in KK experimental sites at year 3 of evaluation, it was clearly that treatment T4 with 3.94 + 0.50 was the highest recorded, while treatment T1 was the lowest height parameter recorded with 3.12 + 0.84. The levels of fertilizers did not have much effect on the growth characters of adult palms as reported by Reddy et al. (2002).

Stem girth characters of coconuts: The results presented in table 2 revealed the parameters of stem girth for 3 years of evaluation. At experimental site of BD, for the first year of evaluation, the stem girth was significantly high in treatment T2 with 27.30 + 2.09, followed by treatment T4 with lowest record at 21.72 + 5.15. At site of KK, the stem girth was clearly high in treatment T2 with 14.33 + 5.70, but treatment T1 was lowest with 11.13 + 5.05. For the evaluation of second year, for BD sites, the stem girth was tremendous high in treatment T3 with 32.83+4.21, followed by T2 with 30.00¬+1.98, whereas treatment T1 was lowest recorded with 20.58 + 9.58 cm. While at KK sites, the stem girth was magnificently high in treatment T4 with 17.42 + 10.76, followed by T3 with 16.42 ¬+ 1.34, but treatment T1 was lowest recorded with 12.63 + 7.04 cm.

For third year of evaluation, BD site shows the stem girth was concretely high in treatment T4 with 33.92 + 4.57, whereas treatment T1 as control plots clearly lowest recorded with 23.83 + 11.14. At site of KK, the stem girth was high in treatment T4 with 18.75 + 5.76, followed by T2 with 18.54¬+4.71 which closely with T1, whereas as predicted that treatment T1 gave the lowest recorded with 13.25+4.25. Liyanage & Abeywardena, (1957) clearly mentioned from their finding that the seedling vigor was highly correlated with adult palm characters such as early flowering, nut yield and copra production. Jithya (2010) summarised that the fertilizer application is mainly based on chemical fertilizers which are costly and exerts negative impacts on soil health. Due to the fact that the nutrient demand during the production stage is a requirement for stem growth and fruit production only, higher fertilizer doses are recommended for the formation and initial production stage, where there is also root growth and leaf recycling is not taken into account, than for the production stage (adult plant).

Table 1: Inorganic fertilizer effect to the plant height of coconut at 1st, 2nd and 3rd year.

Plant height (m)	(1st Year)		(2nd Year)		(3rd Year)	
Sites/ Treatments	BD	KK	BD	KK	BD	KK
T1	2.95 ± 0.78 c	1.96 ± 0.97 c	3.28 ± 1.58 b	2.03 ± 1.15 b	3.88 ± 0.53 b	3.12 ± 0.84 b
T2	3.98 ± 0.39 a	2.55 ± 0.61 a	4.23 ± 0.15 a	2.73 ± 0.64 a	4.32 ± 0.33 b	3.16 ± 0.62 b
T3	3.35 ± 0.36 b	2.17 ± 0.47 b	4.67 ± 0.37 a	2.88 ± 0.49 a	4.82 ± 0.24 a	3.61 ± 0.91 b
T4	3.34 ± 0.62 b	2.15 ± 0.65 b	3.42 ± 0.95 b	2.21 ± 1.08 b	4.87 ± 0.18 a	3.94 ± 0.50 a

Mean value with the same letter for each treatment are not significantly different at $P < 0.05$.

Table 2: Inorganic fertilizer effect to the stem girth of coconut at 1st, 2nd and 3rd year

Stem girth (cm)	(1st Year)		(2nd Year)		(3rd Year)	
Sites/ Treatments	BD	KK	BD	KK	BD	KK
T1	24.64 ± 5.77 b	11.13 ± 5.05 c	20.58 ± 9.58 c	12.63 ± 7.04 c	23.83 ± 11.14 c	13.25 ± 4.25 c
T2	27.30 ± 2.09 a	14.33 ± 5.70 a	30.00 ± 1.89 a	15.17 ± 9.21 b	31.42 ± 2.62 b	18.54 ± 4.71 a
T3	24.75 ± 4.23 b	11.75 ± 3.38 c	32.82 ± 4.21 a	16.42 ± 1.34 b	32.67 ± 2.76 a	17.58 ± 4.75 b
T4	21.71 ± 5.15 c	13.17 ± 5.87 b	24.42 ± 5.62 b	17.42 ± 10.76 a	33.92 ± 4.57 a	18.75 ± 5.67 a

Mean value with the same letter for each treatment are not significantly different at $P < 0.05$.

Number of fronds of coconuts: Figure 1 shows the parameter number of fronds for 3 years of evaluation at different environmental site. At BD plot experiment, at the first year shows the maximum number of the fronds significantly recorded in T2 with 15.67 ± 2.80, followed by T1with 15.58 ± 4.28 and minimum frond numbers was recorded in T4 with 13.67 ± 2.50. For the second year of evaluation, the number of fronds was clearly highest recorded in T3 with 21.33±1.80, followed by T2 with 20.83±1.67. Unfortunately, there is a minimum frond numbers were recorded in T1with 14.17 ± 7.22. In examination of third year, the number of fronds in BD sites was highest in T4 with 22.67 ± 0.47 and there is a minimum frond numbers were recorded in T1 with only 18.50 ± 1.85,

For KK sites, at early evaluation of year 1, the maximum number of the fronds was recorded in T2 with 8.83 ± 1.94, followed by minimum frond numbers are at treatment T1 with 7.00 ± 2.55. In second year growing stages, the maximum number of fronds was recorded in T3 with 9.25 ± 0.89, followed by T4 with 9.00 ± 3.52 and T1with 7.00 ± 2.94 are the minimum fronds numbers. At third year of evaluation, the maximum number of fronds is at T2 with 14.92 ± 3.61, followed by T4 with 13.75 ± 2.17 and T3 was the lowest fronds numbers with 13.50 ± 2.50. The optimum dose lies within these two combinations. Thus one could expect the optimum rate to produce good vegetative growth during the juvenile stage as well (Loganathan and Balakrishnamurti, 1975).

Length of fronds of coconuts: Figure 2 shows the data on growth parameters of fronds length. For the site of BD, at first of examinations, significantly shows that the maximum of fronds length was observed in T2 with 4.17 ± 0.34, followed by minimum fronds length was recorded in T4 with 3.12 ± 0.82. For second year, the maximum length of the fronds shows at treatment T3 with 3.32 ± 0.51, followed by T2 with 3.25 ± 0.34 and the minimum fronds length were recorded in T1 with 2.70 ± 1.26. At the third year of evaluation, T4 with 3.58 ± 0.45 tremendously gave the best results, but unfortunately the treatment of T1 gave minimum fronds length recorded with 3.22 ± 0.36.

Moved to KK sites, at early of growing stage, the maximum of fronds length was observed in T2 with 2.78 ± 0.52, followed by T4 with 2.35 ± 0.72 and the shortest fronds length was recorded in T1with 1.93 ± 0.92. For the next year of performance, the maximum of fronds length was observed in T3 with 3.18 ± 0.53, followed by control plots of T1 with lowest record of fronds length with 2.31 ± 1.04. The third year of performance, it was observed that T2 with 2.35 ± 0.51 gave the best results compared to T3 with 2.06 ± 0.37 which clearly shows the lowest numbers. It was observed that inorganic fertilizers improved the growth parameters of coconut seedlings. It can be concluded that the seedling vigor was highly correlated with adult palm characters such as early flowering, nut yield and copra production. Marimuthu & Natarajan (2005) observed that to get more quality seedlings, the seed nuts are to be cured for one month in open shade followed by sand curing for 2 or 3 months.

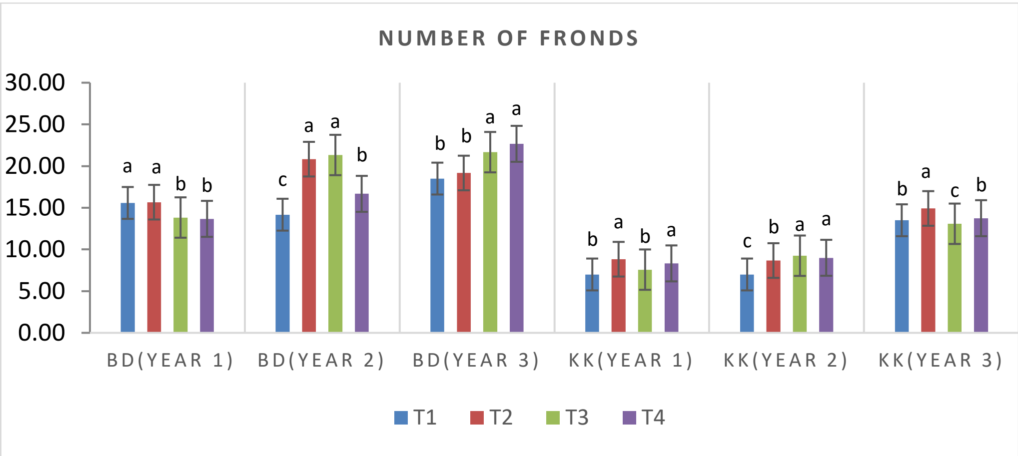

Figure1: Inorganic fertilizer effect to the number of fronds of coconut at 1st, 2nd and 3rd year. Bar with the same letter for each treatment are not significantly different at P < 0.05.

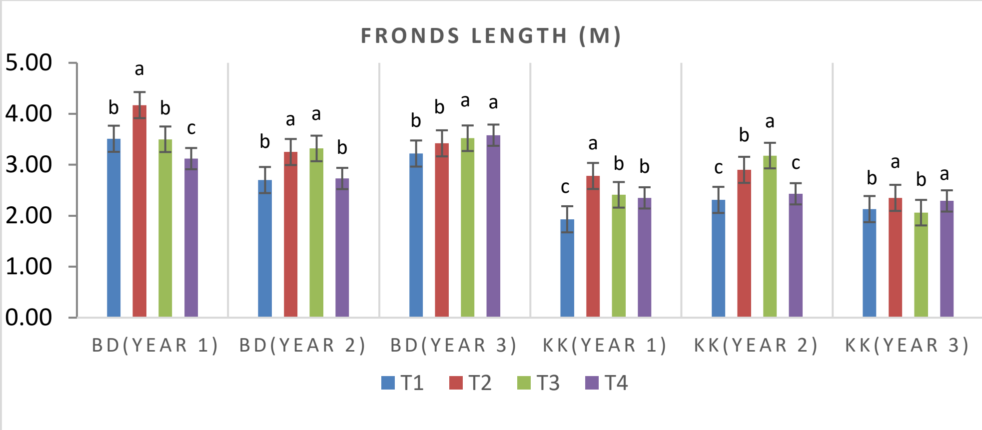

Figure 2: Inorganic fertilizer effect to the fronds length of coconut at 1st, 2nd and 3rd year. Bar with the same letter for each treatment are not significantly different at P < 0.05

Chlorophyll content and light intensity: Table 3 presented the effect of inorganic fertilizer rate on the chlorophyll content and light intensity for 1st, 2nd and 3rd year under agro climatic condition of BD and KK. In the first year of evaluation, the chlorophyll reading in BD was highest in T4 with 55.77 + 6.07, but treatment T1 was lowest record with 50.58 + 7.16. The maximum intensity of light of plant canopy in first year at BD experimental site year was significantly recorded in T4 with 218.50 + 43.89, whereas minimum intensity of light was in T2 with 149.83 + 27.62. In the experimental site of KK, at first year of evaluation, the chlorophyll reading in BD was clearly highest in T2 with 41.06 + 2.23, followed by treatment T1 was lowest record with 27.80 + 10.28. The highest light intensity of plant canopy in first at KK experimental site was in T3 with 135.92 + 29.72, followed by T4 with 122.83 + 22.05 whereas minimum intensity of light was in T1 with 111.25 + 27.29.
For the second year of evaluation, the chlorophyll content at BD was highest in T3 with 54.19 + 2.63 respectively, and then followed by T2 with 47.83 + 8.58, whereas T1 was the minimum record with 30.68 + 15.63. The maximum intensity of light of plant canopy at BD experimental site year was recorded in T3 with 169.33 + 20.08, followed by T4 with 157.33 + 35.58 whereas lowest intensity of light was in T1 with 76.17 + 35.93. At site of KK, the chlorophyll content was highest in T3 with 43.94 + 3.65, followed by T4, but T1 was lowest record with 27.00 + 16.78. The light intensity at KK experimental sites recorded that highest was in in T4 with 198.00 + 12.26, followed by T1, whereas lowest intensity of light was in T3 with 152.75 + 17.90 respectively.

For the third year of evaluation, the chlorophyll content at BD was highest in T4 with 56.90 + 2.61, followed by T2 with 54.93 + 3.71, but treatment T1 was lowest record with 38.78 + 9.49. The maximum intensity of light of plant canopy at BD experimental site year was recorded in T2 with 161.00 + 37.73, followed by T3 with 147.17 + 39.75 whereas minimum intensity of light was in T1 with 113.75 + 29.93. In the experimental site of KK, the chlorophyll reading in BD was slightly high in T4 with 54.35 + 8.60, followed by T3 with 42.43 + 7.40, and treatment T1 was lowest record with 38.25 + 0.95. The highest light intensity of plant canopy at KK experimental site was recorded in T3 with 163.25 + 41.88, followed by T4 with 137.50 + 5.85 whereas minimum intensity of light was in T1 with 124.00 + 7.00. SPAD reading has positive linear response to palm shading which meant that a reduced canopy might result in a reduced SPAD reading. Light intensity has linear negative respond to palm shading which meant that a reduced canopy permits more light intensity received in the area. More light received might promotes higher rate of photosynthesis for the new planted seedlings. Enhanced nutrient release at the highest level of NPK and its subsequent absorption by the palm ultimately resulted in higher NPK in the index leaf, which may help in better photosynthesis and leads to better palm productivity (Mohandas, 2012).

CONCLUSIONS

Study indicated that the growth of coconut seedlings at pre-matured stage are likely dependable to the nutrition of inorganic fertilizer in the field after 3 years of examination. For the first year of evaluation, it found that treatment of T2 (1.5 kg/plant/year) available dosage rate for excellent growth performance of coconut seedlings planted in the fields. Followed to the second year of evaluation, the distribution T3 (3.0 kg/plant/year) will increase the nutrient capabilities contents for plants uptake. An evaluation for the third year of growing term of coconuts needed for T4 (4.5kg/plant/year) in order to adopted the nutritional requirement of seedlings at field stage. Coconut is highly exhaustive palm and it is difficult to meet the demand of plant through fertilisers alone. Hence, to reduce the cost on inorganic fertilisers and to sustain yields, locally available organic resources and bio-fertilisers are recommended (Parwaiz et al., 2014). It seems likely that inorganic manure would enhance the uptake of N, P and K and improved the fertility status of the soil. With regard to N and K, for every incremental addition of each nutrient, there was a corresponding increase in nut yield, whereas in case of P, the increase in nut yield was observed only up to 250 g / palm / year (Mohandas, 2012). The treatments applied being a very simple and easy to be adapted and recommended to growers for raise the coconut plants. Due to the fast growth of the dwarf coconut, the N, P, and K doses recommended from the second year on are superior to the doses recommended by Rosa Jr (2000), Sobral (1998) and Madeira et al, (1998). The study also has the limitation due to the information of the single nutrient study for in field stages of coconuts especially in Malaysia are limited. It was unclear whereas that the different sources of inorganic materials can be stabilised with different environment of planted area. Also there is less comparison study for the uses of inorganic fertilizer for coconut seedlings performance at different varieties i.e. inbred and hybrids. Thus, more research is needed to explore of these areas. The practice if adopted can cope-up the nutritional requirement of seedlings at field stage and considerably reduce the cost of production of field maintenance and can produce well healthy plants for plantation.

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Table 3: The Effect of inorganic fertilizer rate on the chlorophyll contents and light intensity for 1st, 2nd and 3rd year.

	(1st Year)				(2nd Year)				(3rd Year)			
Sites	**BD**		**KK**		**BD**		**KK**		**BD**		**KK**	
Parameters /Treatments	Chlorophyll (SPAD Reading)	Light intensity (µmol m^{-2} s^{-1})	Chlorophyll (SPAD Reading)	Light intensity (µmol m^{-2} s^{-1})	Chlorophyll (SPAD Reading)	Light intensity (µmol m^{-2} s^{-1})	Chlorophyll (SPAD Reading)	Light intensity (µmol m^{-2} s^{-1})	Chlorophyll (SPAD Reading)	Light intensity (µmol m^{-2} s^{-1})	Chlorophyll (SPAD Reading)	Light intensity (µmol m^{-2} s^{-1})
T1	50.58 ± 7.16 b	215.83 ± 61.67 a	27.80 ± 10.28 b	111.25 ± 27.29 c	30.68 ± 15.63 c	76.17 ± 35.93 c	27.00 ± 16.78 c	179.75 ± 54.09 b	38.78 ± 9.49 c	113.75 ± 29.93 c	38.25 ± 0.95 c	124.00 ± 7.00 c
T2	52.22 ± 4.62 b	149.83 ± 27.62 b	41.06 ± 2.23 a	113.17 ± 9.84 c	47.83 ± 8.58 b	132.33 ± 32.70 b	42.64 ± 7.04 b	154.58 ± 49.02 c	49.25 ± 9.56 b	161.00 ± 37.73 a	40.86 ± 6.00 b	134.83 ± 19.61 b
T3	47.52 ± 10.89 c	163.83 ± 31.23 b	40.08 ± 7.13 a	135.92 ± 29.72 a	54.19 ± 2.63 a	169.33 ± 20.08 a	43.94 ± 3.65 a	152.75 ± 17.90 c	54.93 ± 3.71 a	147.17 ± 39.75 b	42.43 ± 7.40 b	163.25 ± 41.88 a
T4	55.77 ± 5.07 a	218.50 ± 43.89 a	40.05 ± 12.82 a	122.83 ± 22.05 b	46.40 ± 8.07 b	157.33 ± 35.58 b	43.72 ± 10.22 a	198.00 ± 12.26 a	56.90 ± 2.51 a	134.43 ± 42.99 b	54.35 ± 8.60 a	137.50 ± 5.85 b

Mean value with the same letter for each treatment are not significantly different at $P < 0.05$.