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Original article

Growth and dry matter yield of tea (*Camellia sinensis* [L] Kuntze) under varied light intensity and organic amendment in Owena, Southwest Nigeria

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Abstract
The need to meet the increasing demand for tea in Nigeria has led to the expansion of its production frontier from the Mambilla highland to the lowland areas where tea production is majorly affected by high light intensity and poor soil fertility. Due to inadequate information on the response of tea cultivar C143 to organic fertilizers (OF) under different light intensity (LI), the growth and dry matter yield of tea to varied light intensities and different organic fertilizers was evaluated in Owena Station of Cocoa Research Institute of Nigeria (CRIN) from 2016 to 2017. The response of tea plants to two OF types [Cocoa Pod Husk (CPH) and Poultry Manure (PM)], with each applied at three rates as 0-F1(control), 150-F2 and 300-F3 kg Nha^{-1}, was evaluated on the field under three LI which were achieved using palm fronds as sheds in layers and coded Palm Frond Layers (PFL) to achieve the desired light intensity as: L_1= [(2PFL-45% LI (4.57x10^{4}lux)]; L_2=[(1PFL-65% LI (6.75x10^{4}lux)] and L_3=100% LI (1.04x10^{5}lux). The experiment was laid out in completely randomized design in four replicates. Data on Leaf Area (LA, cm^2), number of branches (NB) and Dry Matter (DM, g) were obtained and analyzed with ANOVA at $\alpha_{0.05}$. The L_1 was superior to other LI levels by increasing the LA, NB and DM by 61.6%, 33.33% and 47.9%, respectively. Application of F2-CPH enhanced the highest DM-128.99 g, as F1 caused the lowest-46.10 g. The highest LA (9615.75 cm^2) and NB (41.75) was obtained with tea plants fertilized using F2-CPH under L1, while the lowest was recorded in the control plants under L3. In conclusion, Light intensity at 4.57x10^{4}lux achieved with 2 layers of palm fronds enhanced the growth and dry matter yield of C143 tea fertilized using cocoa pod husk at 150 kg Nha^{-1}.

Keywords: Dry matter yield, Growth, Light intensity, Organic fertilizers, Palm fronds layers

Introduction

Tea plant (*Camellia sinensis* (L.) Kuntze) is an evergreen beverage crop in the family Theaceae that is cultivated in over 50 countries (FAO, 2014). Apart from the nutritional and health benefits derivable from the consumption of tea beverage (Pen Medicine, 2023), the relevance of tea to the economy of tea producing countries like China, India, Kenya and Tanzania cannot be underestimated. China stands out as the world largest producer of tea, producing 3.2 million metric tonnes in 2022; while Kenya is Africa largest and the world third largest producer of tea, with 432,400 metric tonnes of tea produced in 2018 (Shahbandeh, 2020; Ridder, 2024). Production of tea in Nigeria is on marginal scale because cultivation in commercial quantity is found only on Mambilla highlands with cool climate, suitable light intensity and slightly acidic soil (Famaye *et al*., 2006; Ipinmoroti, 2006). However, limited land availability for tea cultivation on Mambilla highlands has necessitated the need to explore the lowland areas and more importantly, Southern Nigeria for tea cultivation. However, the warm temperature of Southern Nigeria occasioned by high light intensity, with inherent poor soil fertility are detrimental to optimal tea growth and sustainable production. It has been documented that light intensity and soil fertility constitute major abiotic factors influencing tea growth in Nigeria and other tea producing regions of the world (Esan *et al*., 1996; Omolaja *et al*., 2008).

The growth and development of tea plants is influenced greatly by light intensity. It influences physiological processes like biosynthesis of phenolics and flavonoids, photosynthesis, respiration, transpiration, translocation of photoassimilate and development (Graham, 1998; Jannedra *et al*., 2007; Too *et al*., 2015; Zhang *et al*., 2023). However, Rajkumar *et al.* (1999) observed that sub and supra optimal levels of Photosynthetic Active Radiation (PAR) inhibited photosynthesis significantly. Hence, high light intensity with accompanying warm ambient temperature retards growth of tea. Adeosun *et al*., (2019) opined that tea grown in pots without shade suffered significant growth retardation, early senescence and leaf defoliation at Ibadan, Nigeria.

One other constraint to tea production in Nigeria is poor soil fertility, as most soils in many tea producing areas of the world are deficient in essential plant nutrients with resultant low tea production. Limited supply of plant nutrients was the major factor restricting tea productivity as well as synthesis and accumulation of its quality components (Ruan, 2007). In Nigeria, poor tea seedling establishment, poor yield, depressed growth of the apical meristem with leaves appearing dark green, thick, leathery, misshapen and crinkled have been linked to poor soil fertility on the Mambilla Plateau (Ipinmoroti, 2006). The soils of Southwestern Nigeria have been reported declining in plant nutrients due to continuous cropping without fertilizer usage (Ande *et al*., 2017). It becomes apparent that application of fertilizers to tea farms is inevitable (Ipinmoroti *et al*., 2008). However, application of fertilizer among Nigerian farmers especially tree crop farmers is at marginal rate, as only 8.8% of farmers in some parts of Southwest Nigeria applied fertilizers on their farms (Adebiyi *et al*., 2011), due to inaccessibility, high cost and untimely availability (Agbede and Kalu, 1995). Besides, the continuous and uncontrolled use of inorganic fertilizers have deleterious effects on the soils, crops and the underground waters; hence the need for affordable and environmental friendly alternative means of soil amendment, which has been found in organic fertilizers, as they enhance the physical and chemical conditions of the soil, facilitate nutrient uptake by plants and improve water holding capacity of soils (Lal, 1986; Akinbola *et al*., 2004), while they release plant nutrients gradually to meet the need of tea plants (Ipinmoroti, 2013).

Possible interaction of light intensity and plant nutrient has been reported to play significant roles in the availability of essential plant nutrients for tea growth. Mohotti and Lawlor (2002) have shown that photo-inhibition of tea is minimized by abundant nitrogen supply. Besides, availability of essential plant nutrients is equally influenced by level of available soil water because excessive soil water loss occasioned by high light intensity increases solute concentration which makes it difficult for plant root to absorb the water. Fatubarin, (2003) had earlier postulated that essential plant nutrient must be in relative dilute solution for easy absorption by plant roots. This field trial was carried out to evaluate the influence of varied light intensity and different levels of organic fertilizers on the growth and dry matter yield of tea plants in Owena, Southwest Nigeria.

Materials and Methods

The field trial was carried out in Cocoa Research Institute of Nigeria (CRIN) Station, Owena, Ondo State, Southwestern Nigeria. Owena is located on Latitude 07° N and longitude 05° 7'E in the humid tropical rain forest zone of Nigeria. It experiences two seasons: the rainy season which runs from early March to early November is characterized by heavy rainfall, humid atmosphere and cloudy sky; and the dry season which runs from late November to early March, is characterized by scanty rainfall, dry atmosphere and intense sun heat.

The trial was a 3 × 5 factorial comprising 3 levels of light intensities [45% light (4.57×10^4lux), 65% light ($6.75\text{x}10^4$lux) and 100% light ($1.04\text{x}10^5$lux)] and five rates of organic fertilizer treatments: two levels each of Poultry Manure (PM) and Cocoa Pod Husk (CPH): 150 kg Nha^{-1} (PM_{150}) and 300 kg Nha^{-1} (PM_{300}); 150 kg Nha^{-1} (CPH_{150}) and 300 kg Nha^{-1} (CPH_{300}) and zero fertilizer as control for a total of 15 treatment combinations in four replications, which were laid out in randomized complete block design in split plots arrangement with light intensities and organic fertilizer rates as main and sub-plots, respectively. The land was cleared of all vegetation manually and the plot laid out into four blocks, each comprising 3 main plots and 5 sub-plots per main plot. Each main plot was 8 m long and 3 m wide, while the sub-plots were 2 m long and 1.2 m wide.

Five composite soil samples were collected at 0-30 cm across the entire site and thoroughly mixed, dried, sieved with a 2 mm sieve for routine analysis. Soil pH (1:1 soil/water) was determined with pH meter, while organic matter was determined by Wet Oxidation method (Walkey and Black, 1934). Soil available P was extracted by the Bray PI and measured by the Murphy blue colouration and determined on a Spectronic 20 at 882µm (Murphy and Riley, 1962). Soil exchangeable K, Ca and Mg were extracted with I.0M NH4OAC. The K, was determined using flame photometer, while Ca and Mg were determined by atomic absorption spectrophotometer. The total N was by Microkjedahl methods (AOAC, 1990).

The different light intensities were achieved by the construction of light sheds with bamboo poles and different layers of palm fronds (2 palm frond layers = 45% light intensity, 1 palm frond layer = 65% light intensity), while 100% light intensity had no shed cover. The light intensity was measured using Lux meter model LX1010BS. Thus, each block of the experimental plot contained 2 sheds with each shed measuring 8 m long, 3 m wide and 2 m high.

Healthy potted tea clones (C143 cultivar) were obtained from CRIN Substation, Kusuku-Mambilla, Taraba State, Nigeria, while two organic manures: cured Poultry Manure (PM) and milled Cocoa Pod Husk (CPH) were used. The PM was collected at Ajanla farms Nigeria Limited located along Ibadan-Ijebu-Ode road, Ibadan; and the CPH was collected from the Fermentary Unit of CRIN, Ibadan. The CPH were sun-dried for two weeks, and milled into granules. The organic materials were assayed in the laboratory for their nutrient contents following standard procedures (AOAC, 1990).

The tea clones were transplanted at planting distance of 100 cm × 60 cm, and in each sub-plot, a row of four stands of tea plants was transplanted. There were five subplots in each main plot, each receiving one organic fertilizer treatment two Months after transplanting (MAT). Fertilizer treatments were applied at 0.5 kg and 1.0 kg of poultry manure (PM) per stand to supply 150 kg Nha^{-1} (PM_{150}) and 300 kg Nha^{-1} (PM_{300}), respectively, while it was 0.6 kg and 1.2 kg of CPH per stand to supply 150 kg Nha^{-1} (CPH_{150}) and 300 kg Nha^{-1} (CPH_{300}), respectively.

At three MAT, two tea plants per treatment per replicate were randomly tagged for data collection on leaf area, number of branches and plant height on monthly basis. At 15 MAT, the tagged plants were uprooted and partitioned into root, stem and leaves; oven dried at 70 ^{o}C for 48 hours to constant weight and weighed with digital scale (Ipinmoroti, 2006). Data obtained were analyzed with Analysis of Variance (ANOVA) and the significant mean differences separated with Tukey's Honest Significant Difference (HSD) test (p=0.05).

Results and Discussion

The site soil physical and chemical properties (Table 1) showed that sand, silt and clay contents were 120.00, 822.00 and 58.00 gKg^{-1}, respectively, with sand-loam texture. Hence, they could enhance better drainage and prevent water logging which is detrimental to tea growth, since tea thrives well on well drained soils (Famaye *et al.,* 2006). The slightly acidic pH of the soil implies that it was suitable for tea production (Egbe *et al.*, 1989). The soil is higher in P content (10.40 mg/Kg) compared to the critical level for other tree crops (Egbe *et al*., 1989). The poor level of K, Ca and Mg could be ameliorated by the application of organic manure to the soil. The N content (1.56 g kg^{-1}) was above the critical soil value of 1.0 g/Kg (0.10%) for soils suitable for tea production in Nigeria (Egbe *et al*., 1989).

Poultry manure was higher in all the macro and micro nutrients than cocoa pod husk (CPH) (Table 2). This is consistent with the findings of Ipinmoroti (2006). Hence, higher quantity of CPH would be needed to supply the same quantity of N by poultry manure. The higher Ca and Mg contents in PM could be due to possible addition of bone meal in poultry feeds. The lower nutrient content of cocoa pod husk was a further indication that most cocoa farmers do not apply fertilizers on their farms (Adebiyi *et al*., 2011).

Light intensities and organic manure significantly enhanced leaf area of the tea plants (Table 3). The 65 and 45% LI enhanced the highest leaf area at 3 – 6 and 9 – 12 MAT, respectively. Generally, tea plants under 45 – 65% LI were significantly (p=0.05) better than those under 100% LI in leaf area. This indicates that tea plants needs some amounts of shades and reduced ambient temperature to perform well in the lowland areas of Nigeria. This is in support of reports by Obatolu and Ipinmoroti (2000) when plantain shades were used to enhance growth performance of tea in Ibadan, Nigeria. Similarly, tea plants that received CPH_{150} produced the highest leaf area consistently between 6 – 12 MAT. Although CPH_{150} was not significantly (p>0.05) better than other organic manure rates, it was significantly (p=0.05) superior to the control. On treatment interactions, tea plants that received CPH_{150} with 45% LI produced significantly higher leaf area than those under other treatment interactions especially from 6 – 12 MAT, while the tea plants under 100% LI, with or without fertilizer, produced the lowest leaf area.
The number of branches were significantly (P=0.05) increased by light intensities and organic manure treatments compared to the control (Table 4). The 45 and 65% LI enhanced higher number of branches compared to 100% LI across the sampling periods. However, tea grown under 45% LI produced the highest number of branches (23.40), while the least number of branches of (15.61) was obtained under 100% LI at 12 MAT. The fertilized tea plants produced higher number of branches compared to the unfertilized ones, with the tea plants that received CPH_{150} producing the highest number of branches (23.46) which was significantly (P=0.05) higher than that of PM_{300}, CPH_{300} and control with values of 18.77, 16.67 and 10.21, respectively. Generally, light intensity and fertilizer interactions showed that tea plants that received CPH_{150} at 45% LI produced the highest number of branches (41.75) at 12 MAT; while both fertilized and unfertilized tea under 100% LI produced the least number of branches.

Table 1: Pre-cropping soil particle size and chemical properties

Soil properties	Values
pH (H_2O) 1:1	6.2
Exchangeable cations	
($cmolkg^{-1}$soil)	
Na^+	0.33
K^+	0.29
Ca^{2+}	0.17
Mg^{2+}	0.13
OM (%)	29.14
Total N (gkg^{-1})	15.6
Average P ($mgkg^{-1}$)	10.4
Exchangeable micronutrients ($cmolkg^{-1}$soil)	
Mn^{2+}	0.11
Al^+	0.11
H^+	0.1
CEC	1.01
ECEC me/100g	0.68
%base saturation	90.14
Particle size analyses (gkg^{-1})	
Sand	120
Silt	822
Clay	58
Textural class	Sand-loam

Plants under reduced light intensities of 45 – 65% grew taller significantly (P=0.05) compared to those grown under 100% light, while the tallest plants were observed under 45% at 9 – 12 MAT (Table 5). The organic fertilizer rates did not significantly (p>0.05) enhance the plant height; although CPH_{150} caused the tallest height at 12 MAT. Similarly, light intensities and fertilizer rates interactions did not produce significant difference on tea plant height (Table 5). The mean dry matter accumulation in the tea plants in response to light intensity and organic manure treatments was significantly (P=0.05) different (Table 6). The dry matter produced with

45% LI was higher than the dry matter under other light intensities, resulting to root, stem and leaf dry matter increase of 32.5%, 35.4% and 47.5%, respectively compared to the 65% LI; and by 42.8%, 50.3% and 45%, respectively, compared to100% LI. Teas with CPH_{150} treatment were superior to those with other rates, while control tea plants accumulated the least dry matter. Interaction of 45% LI with CPH_{150} enhanced the highest TDM of 216.59 g as against 34.19 g by the control with 100% LI.

The outstanding growth of tea under 45% light showed that moderate light intensity is fundamental to tea optimal performance in the study location, especially in the dry season when sunlight was brightest and ambient temperature was highest with little or no precipitation to ameliorate the harsh weather. The 45% LI must have precipitated optimal condition for photosynthesis by the tea plants by way of regulating their leaf and canopy temperature (Jannedra *et al*., 2007). The unhindered photosynthesis must have led to expanded leaf area which enhanced the growth of other plant parts. This corroborates reports by Wijeratne *et al.* (2008) and Hajiboland *et al*. (2011) that growth of tea was enhanced under intermediate light intensities.

Table 2: Chemical properties of fertilizer materials used in the experiment

Properties	CPH	PM
%K	0.73	1.37
%Ca	0.24	2.86
%Mg	0.25	0.26
%OM	41.15	68.34
%N	1.4	1.96
%P	0.41	0.99
Mn ($mgkg^{-1}$)	32.3	33.15
pH	7.2	8.3
C:N	10.44	9.56
Iron ($mgkg^{-1}$)	169.57	128.6
Zinc ($mgkg^{-1}$)	15.2	15.7
Copper ($mgkg^{-1}$)	4.3	6.1

CPH: Cocoa pod husk; PM: Poultry manure

Table 3: Effects of light intensities and organic fertilizers on leaf area (cm^2) of tea plants

Treatments		Months after transplanting			
		3	6	9	12
Light intensities (%)					
45		728.81a	1532.81a	2544.62a	4999.74a
65		886.25a	1657.26a	2301.77a	3977.58a
100		535.22a	745.19b	824.19b	1917.55b
Fertilizers (kg Nha^{-1})					
CPH_{150}		650.04a	1740.93a	2510.68a	4836.98a
CPH_{300}		684.73a	1268.68c	1822.93ab	3125.16ab
PM_{150}		636.22a	1009.78de	1861.40ab	3010.97ab
PM_{300}		682.98a	1420.54b	1734.69ab	2706.61ab
Control		444.12b	615.81e	1045.54b	1834.24b
Light intensity (%) x	Fertilizer (Kg Nha^{-1})				
45	CPH_{150}	850.99a	2712.67a	4342.08a	9615.75a
	CPH_{300}	575.53b	1440.51c	2091.77cd	4257.62c
	PM_{150}	787.45a	1184.04cd	3231.48b	4363.76c
	PM_{300}	867.42a	1134.44d	1699.15cd	2461.79d
	Control	472.49b	626.72e	1284.44d	1484.69e
65	CPH_{150}	546.20c	1749.47b	2456.79ab	2429.07d
	CPH_{300}	1107.81a	1642.99b	2357.46abc	3397.68bc
	PM_{150}	543.92c	872.71c	1643.02bcd	3348.39b
	PM_{300}	757.44b	2492.52a	2837.91a	4163.22a
	Control	437.30c	685.23c	1049.43d	2833.04cd
100	CPH_{150}	552.93a	760.63a	733.18a	2466.12a
	CPH_{300}	370.86b	722.54a	1019.55a	1720.19b
	PM_{150}	577.30a	972.59a	709.70a	1320.77b
	PM_{300}	424.09b	634.66a	667.00a	1494.83b
	Control	557.22a	535.47a	802.77a	1185.00b

Means followed by the same letters along a column in each treatment are not significantly different by HSD (P=0.05).

CPH_{150} = 150 kg Nha^{-1} Cocoa Pod Husk; CPH_{300} = 300 kg Nha^{-1} Cocoa Pod Husk; PM_{150} = 150 kg Nha^{-1} Poultry manure; PM_{300} = 300 kg Nha^{-1} Poultry manure

Table 4: Effects of light intensities and organic fertilizers on number of branches of tea plants

Treatments		Months after transplanting			
		3	6	9	12
Light intensities (%)					
45		5.29a	8.40a	15.60ab	23.40a
65		6.44a	10.33a	19.51a	21.75ab
100		6.54a	7.81a	12.27b	15.61b
Fertilizers (kg Nha^{-1})					
CPH_{150}		6.21a	11.88a	18.94a	23.46a
CPH_{300}		8.29a	8.00bc	12.94ab	18.77bc
PM_{150}		5.75ab	8.83ab	14.90ab	21.08ab
PM_{300}		5.29ab	8.58ab	16.00ab	16.67b
Control		2.17c	4.21c	9.67b	10.21d
Light intensity (%) x	Fertilizer (Kg Nha^{-1})				
45	CPH_{150}	7.75a	14.50a	23.56a	41.75a
	CPH_{300}	6.25b	8.75bc	11.88c	18.88d
	PM_{150}	5.00c	7.88cd	15.75b	24.50c
	PM_{300}	4.50c	6.75d	13.13bc	15.25d
	Control	1.38d	2.88e	7.50d	10.50e
65	CPH_{150}	5.38b	13.25a	19.94ab	14.75c
	CPH_{300}	10.25a	8.13c	20.00ab	23.88a
	PM_{150}	4.88b	9.13c	18.00ab	24.50a
	PM_{300}	4.38b	10.63b	23.50a	19.75b
	Control	1.50c	4.63d	7.13c	10.38d
100	CPH_{150}	5.50c	7.88bc	13.31b	13.88a
	CPH_{300}	8.38a	7.13cd	6.94c	13.56a
	PM_{150}	7.38a	9.50a	10.94b	14.25a
	PM_{300}	7.00b	8.38abc	11.38b	15.00a
	Control	3.63d	5.13d	14.38a	9.75b

Means followed by the same letters along a column in each treatment are not significantly different by HSD (P=0.05).
CPH_{150} = 150 kg Nha^{-1} Cocoa Pod Husk; CPH_{300} = 300 kg Nha^{-1} Cocoa Pod Husk; PM_{150} = 150 kg Nha^{-1} Poultry manure; PM_{300} = 300 kg Nha^{-1} Poultry manure.

Table 5: Effects of light intensities and organic fertilizers on height (cm) of tea plants

Treatments		Months after transplanting			
		3	6	9	12
Light intensities (%)					
45		41.02a	50.35a	58.49a	80.33a
65		39.89a	53.75a	56.26a	72.59a
100		40.66a	45.82a	39.77b	50.11b
*Fertilizers (kg Nha^{-1})					
CPH_{150}		41.77	54	52.88	75.3
CPH_{300}		33.46	48.08	49.22	70.4
PM_{150}		41.5	43.75	46.58	61..87
PM_{300}		40.15	50.83	45.59	48.67
Control		37.59	48.25	55.94	55.97
*Light intensities (%) × Fertilizers (kg Nha^{-1})					
45	CPH_{150}	49.13	61.13	71.16	108.94
	CPH_{300}	29.21	42.9	47.88	77.63

	PM_{150}	44.63	41.18	54.59	81.61
	PM_{300}	37.81	51.58	51.38	58.3
	Control	31.5	44.95	60.45	49
65	CPH_{150}	35.9	55.93	53.33	65.88
	CPH_{300}	44.41	69.48	68.79	88.06
	PM_{150}	37.96	42.69	48.83	63
	PM_{300}	42.38	48.31	51.74	50.35
	Control	34.3	50.38	56.08	64.88
100	CPH_{150}	40.28	44.94	34.14	51.09
	CPH_{300}	26.75	31.88	31.02	45.5
	PM_{150}	41.9	47.38	36.32	41
	PM_{300}	40.25	52.61	33.66	37.38
	Control	46.98	49.43	51.31	54.04

Means followed by the same letters along a column in each treatment are not significantly different by HSD (P=0.05).
CPH_{150} = 150 kg Nha^{-1} Cocoa Pod Husk; CPH_{300} = 300 kg Nha^{-1} Cocoa Pod Husk; PM_{150} = 150 kg Nha^{-1} Poultry manure; PM_{300} = 300 kg Nha^{-1} Poultry manure; *****: means are not significantly different by HSD (P=0.05)

Table 6: Effects of light intensities and organic fertilizers on dry matter accumulation of tea plants at 15 MAT

Treatments		Dry matter (g $plant^{-1}$)			
		Root	Stem	Leaf	Total
Light intensities (%)					
45		29.42a	53.15a	27.74a	110.31a
65		19.89b	34.34b	14.56b	57.41b
100		16.84b	26.42b	14.16b	57.41b
Fertilizers (kg Nha^{-1})					
CPH_{150}		34.97a	65.54a	28.48a	128.99a
CPH_{300}		25.70ab	41.58b	22.82ab	89.57ab
PM_{150}		22.91bc	39.80b	21.30ab	84.01bc
PM_{300}		14.80bc	21.28b	12.79b	48.88bc
Control		12.40c	21.66b	12.03b	46.10c
Light intensities (%) × Fertilizers (kg Nha^{-1})					
45	CPH_{150}	53.16a	112.86a	50.58a	216.59a
	CPH_{300}	30.36bc	41.63bc	27.14d	99.12bc
	PM_{150}	37.47ab	60.74b	32.63c	130.84b
	PM_{300}	14.24cd	26.12c	16.74e	57.10cd
	Control	11.87d	24.43c	11.63e	47.92d
65	CPH_{150}	26.16a	49.78a	20.29a	96.22a
	CPH_{300}	23.13ab	43.82a	19.77a	86.72a
	PM_{150}	19.28b	31.16b	16.42a	66.87a
	PM_{300}	18.48bc	19.20c	10.32b	47.99a
	Control	12.42c	27.75bc	16.02a	56.19a
100	CPH_{150}	25.59a	33.98ab	14.59bc	74.15ab
	CPH_{300}	22.02a	39.29a	21.56a	82.86a
	PM_{150}	11.96b	27.50bc	14.85b	54.31bc
	PM_{300}	11.69b	18.53cd	11.33b	41.56c
	Control	12.92b	12.82d	8.45c	34.19c

Means followed by the same letters along a column in each treatment are not significantly different by HSD (P=0.05).
CPH_{150} = 150 kg Nha^{-1} Cocoa Pod Husk; CPH_{300} = 300 kg Nha^{-1} Cocoa Pod Husk; PM_{150} = 150 kg Nha^{-1} Poultry manure; PM_{300} = 300 kg Nha^{-1} Poultry manure.

Conclusion and Recommendation

Growing tea plants treated with cocoa pod husk and poultry manure at the rates of 150 and 300 kg Nha^{-1} under light intensities of 45, 65 and 100% at Owena produced outstanding results over the control - without fertilizer application. These showed the effectiveness of fertilizer application on tea production in the study area. Application of organic fertilizers under 100% light intensity did not enhance the growth and dry matter of the tea plants but their growth and dry matter yield were highly enhanced when grown under 45 – 65% light intensity with CPH and PM based fertilizers. However, the optimal performance of C143 tea plants was achieved when fertilized with 150 kg Nha^{-1} under 45% light intensity using either of the fertilizer sources. It then follows that C143 tea can be grown successfully at Owena with 150 kg Nha^{-1} under 45% light intensity using either poultry manure or cocoa pod husks as nutrient sources.

Conflict of Interest: We declare that we have no conflict of interest in this research report.

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