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Effect of Organic and Inorganic Fertilizers on Growth and Development of Young Tea Plants (*Camellia sinensis* (L.) O. Kuntze) Inter-Planted in Arecanut Garden

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ABSTRACT

An experiment entitled that Effect of organic and inorganic fertilizers on growth and development of young tea plants (Camellia sinensis (L.) o. kuntze) inter-planted in arecanut garden, it was conducted at Instructional plots of the Department of Plantation Crops and Processing, UBKV, Pundibari, West Bengal during March, 2016 to May, 2017.The performance of growth parameters with application of manures and fertilizers among the treatments. The experiment was conducted with five treatments (T_1: Control), (T_2: FYM @2.0kg+1/2RDF),(T_3:Vermicompost@1.0kg+1/2RDF),(T_4:FYM@2.0kg+RDF)and(T_5:Vermico mpost@1.0kg+RDF) with four replications and laid out in Randomized Block Design (RBD), growth parameters were recorded from 30 to 360 days after planting. Experimental results varied significantly with application of manures and fertilizers inter planted in arecanut garden among the treatments from 60 to 360 days after planting. The treatment T_5: VC+RDF has given best results regarding the growth parameters like minimum number of days taken to reach pluckable height of 55 cm, maximum number of leaves (75.5/ plant), number of branches (15.55/plant), plant girth (29.43 mm) at collar region, leaf area (37.60 cm^2) and plant spreading (1475.26 cm^2) followed by T_4: FYM+RDF and T_3: VC+1/2 RDF whereas the minimum results was recorded by T_1: control.

Key words: *Areca nut, FYM, Tea and Vermicompost.*

INTRODUCTION

Tea plants are commercially grown throughout the world, generally, the bush grows into a small tree with a cone shaped canopy and height of the tea plants varies from two to nine meters. Under commercial growing condition its growth is modified by pruning to keep the bushes pluckable and to stimulate vegetative growth. In the tropical belt it is usual to grow tea on slopes of mountains and high plateaus at altitudes varying from about 700 m to 2400 m above mean sea level. In temperate zone low hills of less than 700 m elevations are generally chosen for its cultivation.

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The optimum temperature for its growth lies between 21 °C to 30"C. Temperature above 30°C and below 13°C are harmful for tea bush. Rainfall in tea growing areas of the world varies from less than 1000 mm to 6000 mm in a year. Tea requires deep, fairly porous soil with good drainage system. The soil may be coarse sandy loam. Tea prefers acidic soil with pH ranging from 4.5 to 5.5. Plants develop more vigorously slightly shady places.

Fertilizer is one of the major agro-inputs contributing to the cost of production and productivity in tea plantation, for proper maintenance of the health of tea bushes and to obtain high yield a well-balanced fertilization is necessary throughout the year. Nitrogen, phosphorous and potassium are three major nutrients required for the cultivation and should be used in proper proportion. For maintaining the soil health integration of various factors like physical, chemical and biological properties of soil, climate, addition of organic matters, water, shade and weed management are vital for achieving maximum return from the investment and productivity of the soil. Fertilizers available in India do not replace trace mineral elements in the soil which become gradually depleted by crops removal and cannot maintain desirable soil physical properties such as water holding capacity and congenial conditions for microbial activity[8], to ensure soil productivity, plants must have an adequate and balanced supply of nutrients that can be realized through integrated nutrient management where both natural and man-made sources of plant nutrients are used[3]. Chemical fertilizers stimulate the availability of nutrients in organic manures[8]. Chen *et al.*[2], indicated that supplementing composted livestock manure and nutrient rich trees/shrubs and legumes with added inorganic fertilizers makes the compost in to a more complete nutrient source for strongly acidic soils.

Therefore, the use of integrated nutrient management is very important and best approach to maintain and improve soil fertility[9], thereby to increase crop productivity in an efficient and environmentally benign manner, without sacrificing soil productivity of future generations. This study was conducted with the objective of Effect of organic and inorganic fertilizers on growth and development of young (juvenile) tea (camellia sinensis (L.) o. kuntze) inter-planted in arecanut garden.

MATERIAL AND METHODS

The experiment was carried out in the instruction cum research plots of the Department of Plantation Crops and Processing, Faculty of Horticulture, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India, work was done during June 2016 to May 2017, with the following treatments T_1(Control), T_2(FYM@ 2.0kg+1/2 RDF), T_3(VC@ 1.0kg+1/2RDF), T_4(FYM@2.0kg+RDF), T_5(VC@1.0kg+RDF), planting material used for the experiment of tea was biclonal seed stock of TS-462, taken from the Departmental nursery and interplanted in arecanut garden with spacing of 110 cm X 60 cm (single hedge), maintaining a distance of 60 cm from the base of the arecanut palm. The arecanut variety used for the study was Mohitnagar. Source of nutrients for the experiment was organic matter as farm yard manure (FYM@2.0 kg/plot) and vermicompost (VC @1kg/plot); nitrogen as urea, phosphorus as single super phosphare (SSP) and potash as muriate of potash (MOP) and recommended dose of fertilizers for tea [Young tea mixture (NPK:10: 5: 10) @ 200 kg/ha/year], as per recommendation of Tea Research Association (TRA), in case of arecanut recommended dose of fertilizers i.e., NPK @ 100:40:140 g/palm/year was given. The experiment was laid out in Randomized Complete Block Design (RCBD) with five treatments (T_1 to T_5) and four replications (R_1 to R_4), Spacing of areca nut was followed 2.70 m X 2.70 m, age of areca nut palms 11years old when tea was interplanted in arecanut garden. Observations were recorded like days taken to reach pluckble height of 55 cm, number of leaves, number of branches, plant girth at collar region (mm), leaf area (cm^2) and plant spreading (cm^2).

RESULTS AND DISCUSSION

3.1. Days taken to reach pluckable height of 55 cm after centering or thumb breaking

Observations recorded on days taken to reach pluckable height of 55 cm after centering or thumb breaking at 20cm from ground level have been presented in Table 3.1. It is clear from Table 3.1 that days taken to reach pluckable height of 55 cm varied significantly among the treatments. The minimum number of days (98.00) taken to reach pluckable height was observed in $T_{5:\ VC}$+RDF followed by (108.00) days in T_4: FYM+RDF and (115.50) days in T_3: VC+1/2RD, whereas, maximum number of (125.50) days taken to reach pluckable height of 55 cm was observed in T_1: control. According to Debere *et al*., plant height in tea was significantly affected by application of inorganic source of nitrogen and organic source of phosphorus. These results were confirmed with Sarwar *et al*.[15], they reported that plant height was increased with application of different nitrogenous fertilizers on tea plants. Ipinmoroti *et al*.[7], also reported that enhanced plant growth and leaf quality of tea fertilized with organic and inorganic based fertilization in Nigeria. Plant height in okra was significantly influenced with application of inorganic NPK fertilizers and oregano minerals[12].

Table 3.1. Days taken to reach 55 cm pluckable height after thumb breaking or centering

Treatments	Days taken to reach 55 cm pluckable height
T_1-Control	125.50
T_2-FYM+1/2 RDF	120.50
T_3-VC+1/2 RDF	115.50
T_4-FYM+RDF	108.00
T_5-VC+RDF	98.00
SE(m) (±)	**3.56**
C.D at (0.05)	**10.98**

3.2. Number of leaves per plant

Number of leaves were not statistically significant difference among the treatments on 30 days after planting from table 3.2. In T_5: VC+RDF that maximum number of (75.5) leaves were recorded, followed by T_4: FYM+RDF (68.90) leaves and T_3: VC+1/2 RDF (66.65), whereas minimum number of (58.05) leaves were recorded in T_1: control on 360 days after planting. Number of leaves were observed that significantly varied among the treatments from 60 to 360 days after planting. Maximum increment was observed on numbers of leaves from 300to 360 DAP, however, less increment was observed during the winter months from 210 to 270 days after planting. Similar findings were observed by Owuor[13], that the commercial portion of tea crop consists of leaves and therefore highly responsive to application of nitrogenous fertilizers. Which was in conformity with the observations by Nixwell[11]. that number of leaves were significantly affected with application of N, P and K fertilizers on tea plants. Astri *et al*.[1], also recorded that number of leaves in coffee significantly affected with application of 25% of inorganic fertilizers and 75% of organic fertilizers compared to controlled plot.

3.3. Number of branches per plant

Observations recorded on number of branches per plant from 30 to 360 days after planting at 30 days interval have been presented in Table 3.3. Number of branches were not statistically significant difference among the treatments on 30 days after planting whereas numbers of branches were observed vary significantly among the treatments 60 to 360 days after planting. Maximum number of (15.55) branches per plant were observed in T_5: VC+RDF, followed by (14.60) branches in T_4: FYM+RDF while minimum number of (13.50)

branches were observed in T_1: control on 360 DAP. Generally, it was observed that the number of branches developed per plant increased in all the treatments with advancement of age. Maximum increment was observed on numbers of branches from 300 to 360 DAP. Similar observations were recorded by Debere *et al*., that numbers of branches per plant in tea was significantly affected by application of inorganic source of nitrogen and organic source of phosphorus. Which was in conformity with the observations by Hajra[4]. tea being a leaf crop, nitrogen is probably the key element among the various essential elements in plant nutrition. Therefore, nitrogen was considerable importance in the vegetative growth of tea plant. Ullah *et al*.[16], also recorded that application of organic and inorganic fertilizers had great influence on vegetative growth of crop.

3.4. Plant girth at collar region

Plant girth at collar region was not statistically varied among the treatments on 30 days after planting from table 3.4. Maximum plant girth at collar region (29.43 mm) was observed in T_5: VC+RDF followed by T_4: FYM+RDF (29.18 mm) and T_3: VC+1/2RDF (27.50 mm) whereas the minimum plant girth was recorded in T_1: control (26.30 mm) on 360 days after planting. Plant girth at collar region was recorded significant deference among the treatments from 60 to 360 days after planting. Similar findings were recorded by Nixwell[11], that plant girth was significantly affected with application of NPK fertilizers on tea plants. Ipinmoroti *et al.*[6], reported that use of both organic and inorganic fertilizer materials improved tea growth performance indicating that the soil requires the application of fertilizer before meaningful tea cropping could be carried out. Similar observations were also recorded by Ilupeju *et al*.[5], that significant variability of girth in tomato with application of 25% NPK fertilizers combined with 75% tithonia compost.

3.5. Leaf area

Observations recorded on leaf area from 30 to 360 days after planting at 30 days interval have been presented in Table 3.5. There was no significant difference among the treatments on 30 days after planting in case leaf area varied significantly among the treatments from 60 to 360 days after planting. On 360 days after planting, maximum leaf area (37.60 cm^2) was recorded in T_5: VC+RDF followed by T_4: FYM+RDF (37.30 cm^2) and T_3: VC+1/2 RDF (36.85 cm^2) respectively, whereas minimum leaf area (35.85 cm^2) was recorded in T_1: control plots. Similar observations recorded by Sarwar *et al*.[15], that leaf area was increased with application of different nitrogenous fertilizers on tea plants. Astri *et al.*[1], also recorded that leaf area was statistically significant difference with application of 25% inorganic fertilizers with 75% organic manures in coffee.

3.6. Plant spreading

From table 3.6 plant spreading was not statistically significant differences among the treatments on 30 days after planting. Constantly increased the plant spreading from 60 to 180 days after planting while less increment in plant spreading was observed during the winter months from 210 to 270 days after planting. The plant spreading was significant difference among the treatments from 60 to 360 days after planting. Maximum plant spreading (1475.26 cm^2) was observed by T_5: VC+RDF followed by T_4: FYM+RDF (1437.54 cm^2) and T_3: VC+1/2 RDF (1384.43 cm^2) whereas the minimum plant spreading was recorded by $T_{1:}$ control (1277.33 cm^2) on 360 days after planting. Plant spreading was increased in all treatments with advancement of age. Sarwar *et al*.[15], also observed that plant spreading was significantly affected with application of different nitrogenous fertilizers on tea plants. Munnu singh *et al*.[10], also recorded that plant spreading in coriander showed that significant difference with application of vermicompost (7.5 t/ha) with 25% recommended dose of NPK (25:12.5:12.5kg/ ha).

Table 3.2. Number of leaves per plant on days after planting

Number of leaves per plant												
Treatments	**30 DAP June'16**	**60 DAP July'16**	**90 DAP August'16**	**120 DAP Sept'16**	**150 DAP Oct'16**	**180 DAP Nov'16**	**210 DAP Dec'16**	**240 DAP Jan'17**	**270 DAP Feb'17**	**300 DAP Mrch'17**	**330 DAP April'17**	**360 DAP May'17**
T_1-Control	15.35	15.95	17.30	19.20	22.55	23.03	24.05	25.33	26.80	37.53	49.45	58.05
T_2-FYM+1/2 RDF	17.80	18.70	20.25	22.00	24.65	26.10	26.95	27.60	29.85	39.90	52.05	60.98
T_3-VC+1/2 RDF	19.10	20.15	22.25	24.85	27.45	31.40	32.50	33.70	35.45	45.60	57.45	66.65
T_4-FYM+RDF	19.70	21.10	23.50	26.23	29.10	32.05	33.20	34.58	36.60	47.35	59.15	68.90
T_5-VC+RDF	19.80	23.55	26.00	29.55	32.90	35.35	36.60	38.04	39.40	50.95	63.45	75.75
SEm(±)	**0.86**	**1.15**	**1.13**	**1.23**	**1.43**	**1.45**	**1.50**	**1.54**	**1.72**	**1.67**	**1.56**	**1.47**
C.D at (0.05)	**NS**	**3.55**	**3.49**	**3.78**	**4.41**	**4.47**	**4.63**	**4.74**	**5.30**	**5.14**	**4.82**	**4.53**

DAP: Days after planting, RDF: Recommended dose of fertilizers, (FYM: Farm yard manure, VC: Vermicompost).

Table 3.3. Number of branches per plant on days after planting

Number of branches per plant												
Treatments	**30 DAP June'16**	**60 DAP July'16**	**90 DAP August'16**	**120 DAP Sept'16**	**150 DAP Oct'16**	**180 DAP Nov'16**	**210 DAP Dec'16**	**240 DAP Jan'17**	**270 DAP Feb'17**	**300 DAP Mrch'17**	**330 DAP April'17**	**360 DAP May'17**
T_1-Control	2.75	3.10	4.45	6.50	7.50	7.85	8.00	8.25	9.10	10.30	11.65	13.50
T_2-FYM+1/2 RDF	3.15	4.50	4.90	6.85	7.85	8.20	8.65	9.10	9.53	10.68	11.98	13.85
T_3-VC+1/2 RDF	3.20	4.60	5.15	7.05	8.10	8.55	8.85	9.25	9.85	11.05	12.25	14.15
T_4-FYM+RDF	3.30	4.75	5.35	7.20	8.35	8.70	9.05	9.50	10.25	11.45	12.65	14.60
T_5-VC+RDF	3.75	5.35	6.10	7.35	8.90	9.10	9.60	10.05	10.88	12.08	13.28	15.55
SEm(±)	**0.19**	**0.23**	**0.28**	**0.18**	**0.27**	**0.15**	**0.18**	**0.20**	**0.17**	**0.16**	**0.16**	**0.26**
C.D at (0.05)	**NS**	**0.70**	**0.86**	**0.56**	**0.83**	**0.47**	**0.56**	**0.61**	**0.52**	**0.51**	**0.49**	**0.79**

DAP: Days after planting, RDF: Recommended dose of fertilizers, (FYM: Farm yard manure, VC: Vermicompost).

Table 3.4. Plant girth at collar region on days after planting (mm)

Plant girth at collar region(mm)												
Treatments	**30 DAP June'16**	**60 DAP July'16**	**90 DAP August'16**	**120 DAP Sept'16**	**150 DAP Oct'16**	**180 DAP Nov'16**	**210 DAP Dec'16**	**240 DAP Jan'17**	**270 DAP Feb'17**	**300 DAP Mrch'17**	**330 DAP April'17**	**360 DAP May'17**
T_1-Control	17.01	18.04	18.95	20.03	21.09	21.62	22.14	22.64	23.13	24.23	25.28	26.30
T_2-FYM+1/2RDF	18.22	19.25	20.13	21.16	22.20	22.69	23.20	23.68	24.18	25.26	26.20	27.13
T_3-VC+1/2 RDF	18.85	19.91	20.85	21.65	22.68	23.20	23.68	24.10	24.60	25.70	26.50	27.50
T_4-FYM+RDF	19.12	21.05	22.08	23.13	24.18	24.68	25.15	25.65	26.15	27.25	28.20	29.18
T_5-VC+RDF	19.71	21.60	22.59	23.60	24.61	25.08	25.54	26.05	26.53	27.63	28.53	29.43
SEm(±)	**0.60**	**0.60**	**0.59**	**0.60**	**0.60**	**0.60**	**0.61**	**0.61**	**0.60**	**0.60**	**0.62**	**0.65**
C.D at (0.05)	**NS**	**1.86**	**1.81**	**1.86**	**1.85**	**1.86**	**1.88**	**1.87**	**1.85**	**1.85**	**1.93**	**1.99**

DAP: Days after planting, RDF: Recommended dose of fertilizers, (FYM: Farm yard manure, VC: Vermicomposting).

Table 3.5. Leaf area on days after planting (cm2)

Leaf area(cm^2)												
Treatments	**30 DAP June'16**	**60 DAP July'16**	**90 DAP August'16**	**120 DAP Sept'16**	**150 DAP Oct'16**	**180 DAP Nov'16**	**210 DAP Dec'16**	**240 DAP Jan'17**	**270 DAP Feb'17**	**300 DAP Mrch'17**	**330 DAP April'17**	**360 DAP May'17**
T_1-Control	24.95	25.65	27.10	29.10	29.75	30.00	30.00	30.45	30.80	31.80	33.93	35.85
T_2-FYM+1/2 RDF	25.40	26.15	27.70	29.80	30.30	30.55	30.60	30.95	31.55	32.55	34.33	36.35
T_3-VC+1/2 RDF	25.90	26.50	28.10	30.40	30.95	31.15	31.20	31.60	32.23	33.23	34.85	36.85
T_4-FYM+RDF	26.35	27.10	28.90	31.35	31.75	31.95	31.95	32.15	32.60	33.60	35.13	37.30
T_5-VC+RDF	26.40	28.00	29.75	31.60	32.20	32.35	32.35	32.65	33.00	34.00	35.68	37.60
SEm(±)	**0.23**	**0.27**	**0.27**	**0.24**	**0.25**	**0.24**	**0.24**	**0.23**	**0.20**	**0.17**	**0.19**	**0.15**
C.D at (0.05)	**NS**	**0.83**	**0.83**	**0.74**	**0.76**	**0.74**	**0.74**	**0.70**	**0.62**	**0.52**	**0.59**	**0.46**

DAP: Days after planting, RDF: Recommended dose of fertilizers, (FYM: Farm yard manure, VC: Vermicompost).

Table 3.6. Plant spreading on days after planting (cm^2)

plant spreading(cm^2)												
Treatments	**30 DAP June'16**	**60 DAP July'16**	**90 DAP August'16**	**120 DAP Sept'16**	**150 DAP Oct'16**	**180 DAP Nov'16**	**210 DAP Dec'16**	**240 DAP Jan'17**	**270 DAP Feb'17**	**300 DAP Mrch'17**	**330 DAP April'17**	**360 DAP May'17**
T_1-Control	149.75	291.75	442.75	593.75	695.75	726.75	758.25	790.50	822.50	973.75	1125.00	1277.75
T_2-FYM+1/2RDF	229.25	384.25	535.25	685.75	787.00	818.00	849.75	881.75	914.25	1065.25	1217.75	1369.75
T_3-VC+1/2 RDF	242.75	396.25	549.00	700.00	801.75	833.25	864.50	896.25	928.25	1079.50	1232.00	1384.75
T_4-FYM+RDF	302.00	451.75	602.50	754.50	856.00	887.75	918.75	950.00	981.75	1133.00	1284.75	1437.00
T_5-VC+RDF	305.25	488.25	639.00	790.00	892.00	923.25	954.75	986.25	1019.00	1170.00	1321.75	1475.25
SEm(±)	**5.11**	**8.63**	**8.77**	**8.76**	**8.69**	**8.61**	**8.59**	**8.39**	**8.40**	**8.48**	**8.68**	**8.74**
C.D at (0.05)	**NS**	**26.58**	**27.01**	**27.00**	**26.77**	**26.52**	**26.46**	**25.85**	**25.89**	**26.12**	**26.75**	**26.95**

DAP: Days after planting, RDF: Recommended dose of fertilizers, (FYM: Farm yard manure, VC: Vermicompost)

CONCLUSION

From this experiment concluded that, there was no statistically significant difference among the treatments on 30 days after planting. However, experiment results were varied significant difference with application of manures and fertilizers inter planted in arecanut garden among the treatments from 60 to 360 days after planting, comprising with treatment T_5: VC+RDF gave best results of growth parameters like minimum number of days taken (98.00) reach to pluckable height 55 cm. Maximum number of leaves (75.5/plant), number of branches (15.55/plant), plant girth (29.43 mm) at collar region, leaf area (37.60 cm^2) and plant spreading(1475.26 cm^2) followed by T_4: FYM+RDF and T_3:VC+1/2 RDF whereas minimum results were recorded by T_1: control .

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