International Journal of Sciences: Basic and Applied Research (IJSBAR)

ISSN 2307-4531
(Print & Online)

http://gssrr.org/index.php?journal=JournalOfBasicAndApplied

Effect of Organic Fertilizer on the Growth of Tea ((*Camellia sinensis* L.)

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Abstract

This study was conducted at National Tea and High value crops Research Institute, Shinkiari, Mansehra during 2014- 2015. The objective of the experiment was to evaluate the response of different doses of organic fertilizers to the growth of newly planted tea (*Camellia sinensis* L., variety, Turkish). Different doses of Hyosung applied as kg/acre were T_0= Control, T_1 = (400), T_2 = (500), T_3 = (600), T_4 = (700) and T_5 = (800). The data recorded during growth season during 2014 and 2015. Highest plant height (50 & 52 cm), Number of leaves per plant (39.67, 17.75) and Number of branches/plant (7.67, 6.29) were recorded in T_4 respectively followed by T_5 while maximum leaf area was recorded in T_4 (48 cm^2) during 2014 and T_3 (47.87cm^2) during 2015 respectively. Soil samples were collected at 0-20 cm and 21-40 cm depth and analyzed for physico-chemical characteristics. It is revealed that soil was sandy loam in texture with soil pH 6.25 and 2.90% organic matter and was supportive for the good growth of tea crop. A gradual increase in the organic matter content was observed with the increase of fertilizer dose. Soil pH was slightly decreased by the application of organic fertilizer which is a good sign to increase the growth of tea crop.

Key words: Hyosung; Plant height; organic matter; soil texture; sandy loam.

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1. Introduction

Tea (*Camellia sinensis* L.) is an important commercial crop in many subtropical and tropical areas of the world. Tea, owing to its favorable effects on human health, currently enjoys a great popularity among other beverages worldwide [19]. The authors in [24] reported that it is an economically important, high-value plantation crop. It belongs to family *theaceae*. There are 82 species of genus camellia originated to south-east India. From the main centers of cultivation in south-east Asia, tea has been introduced into many other areas of the world and now grown in condition which range from Mediterranean-type climate to hot, humid tropics. It is reported by authors in [33] that tea plantation can be grown as far as North Georgia (42^0N latitude) to as far as south Brazil (30^0S latitude). The authors in [30] noted that tea is a perennial plant, which repeatedly pruned at different intervals (3-6 years). It is confirmed that tea shoots are plucked at regular intervals (6-25 days) which remove various quantity of different elements from the plant-soil system. Certain major nutrients have to be supplemented through fertilizer application.

Tea plant need large amount of micro and macro nutrients for its growth. The deficiency of these nutrients could adversely affect the yield and quality. These nutrients are critical and their deficiency and inadequate supply would eventually lead to poor seedlings establishment and performance. In fact tea plant need large amount of N, P, K and Mg for its growth. It was reported by authors in [29, 31] that tea cannot be produced optimally without fertilizer application and external nutrient addition as reported by authors in [18, 4]. Tea production is commercially being done by nutrients supply through inorganic fertilizer at rates between 150 kg-300kg N/ha for black tea (fermented tea). It is confirmed by the authors in [17] that use of fertilizer helps in production and it is somewhat quick method for achieving maximum yields. It is also confirmed by authors in [6] that tea yield increases sharply with increased levels of N and K to a certain point. Tea being a leaf crop, in the flush shoot the nitrogen content is the highest followed by potassium (K), calcium (Ca), phosphorus (P), sulfur (S), magnesium (Mg) and zinc (Zn). Nitrogen (N) is an important constituent of plants parts and plays a vital role in the physiology of the tea plant. It is estimated by authors in [30] that harvestable crop contains 3.5-5% N on dry matter basis. The authors in [2] confirmed that significant effect of N and Zn was observed on plant height of maize. The authors in [10] observed that although applications of N can increase tea yields, the quality of the manufactured product is suppressed by large N rates. Potassium and magnesium are required in large quantities and they are both involved in almost all biological reactions. Potassium is the second major nutrient for tea after N and makes up 1.5-2% of the dry matter in tea leaves [30, 32]. It is reported by authors in [8] that response of potassium occur only whenever pH is lower than 5.2. The quality of made tea depends on organic and inorganic composition of harvested shoots, which are changed into the substances, these are responsible for taste, flavor and color of made tea. In this regard, balanced nutrition of tea is of particular importance to secure good harvested fresh leaves as a prerequisite for tea of superior quality [32]. Some authors in [15] reported that agro-chemicals are unable to sustain production increases and cannot restore soil fertility, solutions must be found to recover the soil's original characteristics (as in the forest), i.e., its biological, physical and chemical properties, before it becomes degraded. Heavy application of inorganic fertilizers leads to deterioration of soil cation exchange capacity (CEC) and clay contents of the soil, high concentration of Al and silicate in drainage water in addition to air pollution through nitrous gas emission, excessive leaching leads to underground water pollution. Also due to high cost of inorganic fertilizers and the poor resources, farmers cannot afford such types of

fertilizer so this is need to look for alternative resource, that are cheap, readily available and affordable i.e FYM, compost, EM etc. The inorganic fertilizers are usually not available and are always rather expensive for the low-income, small-scale farmers. It was reported by the authors in [21, 27] that application of organic fertilizers is one of important practical measures to improve soil fertility. In addition to providing necessary nutrients for crops and improving soil physico-chemical properties, organic fertilizer is able to enhance soil microbial activity of soil, such as improving activity of soil enzymes and increasing soil microbial biomass. Organic fertilizers have traditionally been used in agricultural areas, especially in view of their benefits for the soil biological and chemical properties [20]. It is worth remembering that the addition of organic residues is fundamental for carbon (C) recycling in the soil and can improve its physical quality [9]. Organic manures can be used as an alternative for the inorganic fertilizers. They release nutrients rather slowly and steadily over a longer period and also improve the soil fertility status by activating the soil microbial biomass [3, 7]. For decades researchers have noted in [16] the benefits of manure additions to soil, from renovating eroded sites to improving soil physical properties and fertility following centuries of manuring. Manure addition to sandy soil improves water holding capacity and improves structure [14, 11, and 22]. Other researchers in [5] indicated that manure additions can tolerance to corn rootworm, possibly by maintaining higher soil nutrient levels. The objective of organic tea cultivation is to have an eco-friendly plantation aimed at the conservation of ecology and natural habitat without polluting soil, air and water and yet maintaining sustainable tea production. Here, tea is producing the absence of synthesized chemicals like pesticides, fungicides, herbicides, growth regulators and concentrated fertilizers. Naturally occurring mined products and bulky concentrated organic manures are used for nutrition and maintenance of soil fertility. Pests and diseases are controlled by the use of resistant cultivars, regulation of micro-climate and biological control agents etc. During the transition from chemical based agriculture to organic farming, decline in productivity has been noticed. However, it has been reported that establishment of organic tea right from planting gave more desirable results in terms of productivity and net return. The objectives of this study was to assess the effect of organic fertilizers on tea (*Camellia sinensis* L) plants growth to promote the application of organic fertilizer and decrease the use of chemical fertilizer to face the soil deterioration and preserve the natural resource.

2. Materials and Methods

This study was conducted at National Tea and High Value Crops Research Institute, Shinkiari, Mansehra during 2014-15. Objective of the experiment was to find out the organic fertilizer effect on tea growth of one year age and on soil characteristics.

2.1 Layout

The experiment was laid out in Randomized Complete Block Design with three replications and six treatments.

2.2 Sampling method

Before start of experiment, soil samples were collected from field and soil pH, Organic matter and soil texture was determined in Soil Science Laboratory of NTHRI. Soil was sandy loam in texture with pH 6.25 and 2.90 %

organic matter.

2.3 Source of organic fertilizer

Organic fertilizer used was Hyosung having 4-4.5% N, 3-3.5% P_2O_5, 2-2.5% K_2O, 50-60% organic matter. Different doses of organic fertilizer used kg/acre were T_0= control, T_1= 400, T_2= 500, T_3= 600, T_4= 700, T_5= 800.

2.4 Parameters recorded

Different parameters recorded were plant height, No. of leaves /plant, No. of branches and leaf area. The data obtained were subjected to statistical analysis and treatment differences were determined using LSD.

3. Results and Discussion

3.1 Organic Matter

It is observed from the data that organic matter was increased with the increase of fertilizer dose (Table I). However, it was observed from the data recorded during 2014, 2015 that maximum organic matter (%) after harvest was found in T_5 (9.36, 9.47) respectively followed by T_4 (9.30, 8.54) while minimum organic matter after harvest was observed in T_1 (3.11, 4.03). The authors in [12] also reported that application of organic manure adds various macro and micro nutrients to the soil and contributes to improve the soil fertility status.

3.2 Soil pH

Tea cannot be grown in the soil having pH values higher than 6.5. Ideal soil pH range for the growth of tea is 4.5-5.5(25) while marginal pH range is 5.5 -6.5. Soil samples collected after harvest from the depth of 0-20 and 21-40 cm during 2014 & 2015 indicated that all doses of fertilizer mixture lowered the soil pH. However, lowest soil pH was observed in T_4 (4.87 & 4.65) during 2014 & 2015 followed by F_5 (4.96 & 4.99). Same results were reported by authors in [13].

3.3 Plant height

The data recorded during 2014 & 2015 (Table-I, II) indicated that plant height was significantly affected by various doses of organic fertilizer. Highest plant height was observed in T_4 (52 & 50 cm) respectively. T_1 produced minimum plant height (39, 34.67 cm) during 2014 & 2015 respectively. The authors in [28] also noted greater plant height, number of branches and number of leaves per plant in Chilli with the application of farmyard manure along with NPK. Same results were observed earlier where maximum plant height was obtained in T_2 when organic fertilizer was applied with NPK.

3.4 No of leaves

The data recorded during 2014 & 2015 (Table-1, II) indicated that number of leaves was significantly affected

by the application of organic manure. Maximum number of leaves were found in T_4 (17.75, 39.67) respectively during 2014 & 2015 while minimum no of leaves were found in case of T_0 (11.46, 29.33).

These results are in line with the findings of the authors in [13] who observed maximum number of leaves by the application of $Al_2(SO_4)$ @ 600 g m^{-3} (10.37) followed by that of FYM @ 7 kg m^{-3} (8.75) and showed 107.5% and 61.5 % increase over control, respectively.

3.5 No of branches

Organic manure also significantly increased number of branches per plant. It is revealed from the data recorded during 2014 & 2015 that maximum number of branches found in T_4 (6.29& 7.67) while minimum number of branches observed in case of T_0 (3.63& 3.33) respectively.

3.6 Leaf area

Leaf area was also significantly affected by various doses of organic manure. Maximum leaf area was recorded in T_3 (47.87 cm^2) during 2014 while the maximum leaf area found in T_4 (48 cm) during 2015 Minimum leaf area was observed in case of T_0 (37.17 cm^2), (37.22 cm^2) during 2014 & 2015respectively. However, all the other treatments were at par with each other.

Table 1: % decrease of Soil pH and % increase of organic matter before & after harvest

Treat-ments	Soil depth (cm)	Soil pH (BH) (2014)	Soil pH (AH) (2014)	Soil pH (BH) (2015)	Soil pH (AH) (2015)	%Organic matter (BH) (2014)	%Organic matter (AH) (2014)	% Organic matter (BH) (2015)	% Organic matter (AH) (2015)
T_0	00-20	6.73	6.71	6.34	6.58	3.52	3.56	5.43	5.52
	21-40	6.63	6.44	6.47	6.51	2.90	3.11	5.64	5.61
T_1	00-20	6.52	5.89	5.42	5.12	4.05	4.23	5.87	4.66
	21-40	6.66	4.99	5.87	5.41	8.44	9.30	8.54	8.54
T_2	00-20	6.63	5.11	5.96	5.23	7.99	8.32	8.01	8.01
	21-40	6.54	5.43	5.85	5.04	5.32	5.36	6.34	6.34
T_3	00-20	6.62	5.52	5.67	5.11	6.87	7.44	5.03	5.03
	21-40	6.77	5.88	5.89	5.43	6.52	6.73	5.44	5.44
T_4	21-40	6.50	5.36	5.50	5.07	4.00	4.56	5.68	5.68
	21-40	6.49	4.87	5.49	4.65	6.52	8.32	8.45	8.45
T_5	00-20	6.67	4.96	5.47	5.00	8.23	9.36	9.47	9.47
	21-40	6.53	4.97	5.54	4.99	8.21	9.33	8.99	8.99

Table 2: Effect of organic fertilizer on tea growth (2014)

Treatment	Plant height (cm)	No of leaves	No of branches	Leaf area (cm^2)
T_0	34.67c	29.33c	3.33d	32c
T_1	43.67b	30.33c	4.00cd	37bc
T_2	47.00ab	32.33bc	5.00bc	38b
T_3	47.33ab	32.66bc	5.33bc	38b
T_4	50.00a	39.67a	7.67a	48a
T_5	47.00ab	35.00b	6.33ab	46a
LSD	5.23	4.57	1.40	

Table 3: Effect of organic fertilizer on tea growth (2015)

Treatment	Plant height (cm)	No of leaves	No of branches	Leaf area (cm^2)
T_0	39.00d	11.46b	3.63c	37.17b
T_1	43.33c	14.83ab	4.47bc	44.43ab
T_2	48.67ab	14.66ab	4.89b	45.37ab
T_3	48.33b	14.83ab	5.05b	47.87a
T_4	52.00a	17.75a	6.29a	45.94ab
T_5	50.33ab	16.08ab	4.37bc	45.68ab
LSD	3.53	4.67	1.05	10.65

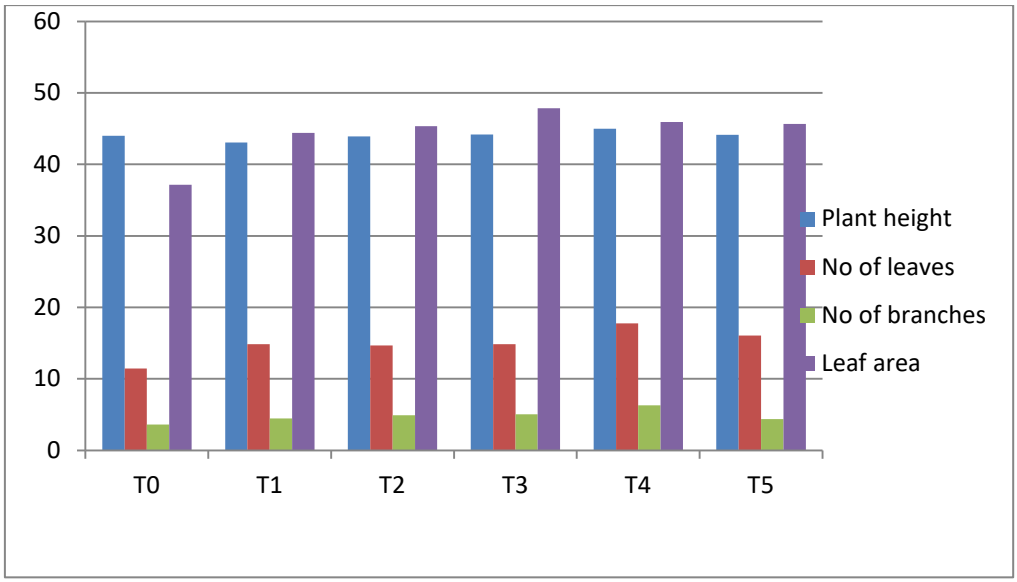

Figure 1: Response of organic fertilizer to tea growth during 2014 (Graphic presentation)

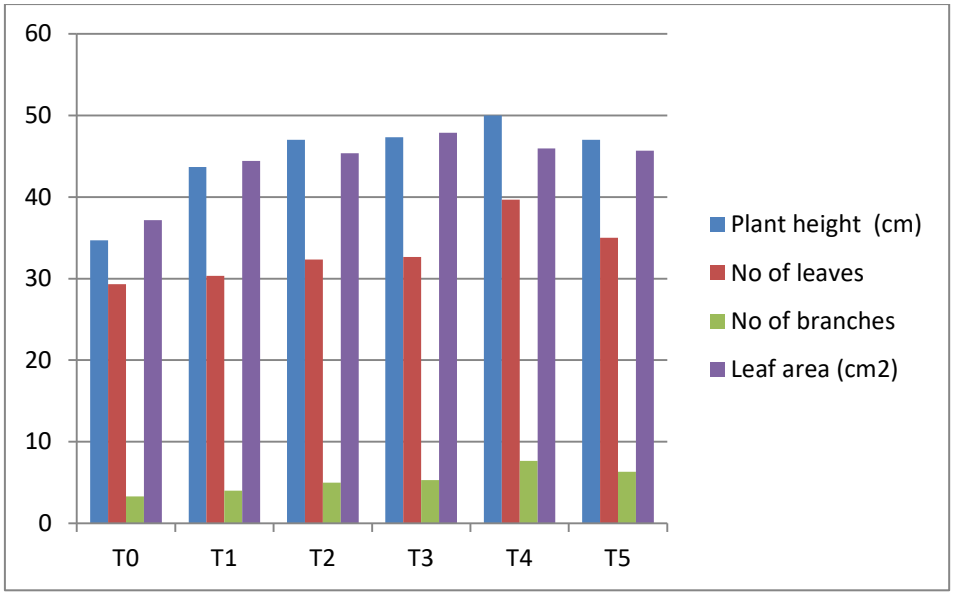

Figure 2: Response of organic fertilizer to tea growth during 2015 (Graphic presentation)

4. Conclusion

It is concluded from the study that organic fertilizer in the form of Hyosung performed the best and lowered the soil pH which is required for the growth of tea. Plant height, number of leaves and number of branches, organic matter were enhanced due to application of maximum dose of organic fertilizer. Since the chemical fertilizers deteriorate the physical properties of soil and organic fertilizer improve physical properties and fertility status of the soil, improves water holding capacity and structure of the sandy soil, the chemical fertilizer may be replaced with organic fertilizer.

Experiments should be continued to evaluate the beneficial effect of organic fertilizer on the growth of tea and fertility status of the soil to have an eco-friendly plantation and conservation of ecology and natural habitat without polluting soil, air and water and yet maintaining sustainable tea production. .

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