



Yield, Growth and Quality of Tea in Organic Cultivation under Palam Region of Himachal Pradesh

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ABSTRACT

Background: In Himachal Pradesh, parts of Kangra and Mandi districts in the state are known for unique colour and flavor tea production since British times and has been registered under the Geographical Indication (GI) of Goods (Registration and Protection) Act, 1999 but in recent years, chemical farming practice has brought drastic changes crop productivity and quality. Organic farming that believes in natural growth of crops without adding any chemical fertilizers or any other foreign elements can be suitable remediation measure. Tea grown with bio-organic fertilizers has superior colour and taste compared to tea treated with chemical fertilizers. Therefore, the present investigation has been carried out to evaluate productivity and quality of tea under organic cultivation.

Methods: Field experiment was conducted during pre-monsoon (summer), monsoon (kharif) and post monsoon (rabi) season of 2021-22 at Research farm of Department of Tea Husbandry and Technology CSK HPKV, Palampur (H.P.) to monitor the effect of organic nutrient inputs in Tea [*Camellia sinensis* (L.) O. Kuntze]. The experiment was laid out in Randomised Block Design (RBD) with three replications. The experiment comprised of 10 treatments with the organic treatment include application of different nitrogen sources, viz farmyard manure; vermicompost; jeevamrit and vermivash.

Result: The results revealed that higher yield, mean fresh shoot biomass (mg/shoot), mean dry shoot biomass (mg /shoot) was recorded with application of vermicompost @10t/ha+ jeevamrit @10%. The application of vermicompost @10 t/ha + vermivash @10% showed higher value of theaflavin and thearubigin content in all three seasons i.e., pre- monsoon, monsoon and post monsoon. Therefore, the applications of organic inputs showed significantly improved results in comparison to the control.

Key words: Jeevamrit, Theaflavin, Thearubigin, Vermicompost, Vermivash.

INTRODUCTION

Tea [*Camellia sinensis* (L.) O. Kuntze] belongs to family Theaceae is one of the world's oldest and most important beverages consumed worldwide (Jigisha *et al.* 2012). Tender shoots of tea consisting of two or three leaves and a bud are harvested periodically to produce either 'black' (withered and fermented) or 'green' (withered but unfermented) tea. Commercially tea is produced in more than 60 countries across the world. India is second largest producer of tea after China in the world having 1.4 million tonnes tea production from an area of 0.6 million hectare (Anonymous, 2020-21a). In India tea is cultivated in 15 states of which Himachal Pradesh, Assam, West Bengal and Kerala are the major tea growing states. The popularity of tea has been steadily growing due to its high content of beneficial antioxidants, amino acids and vitamins. As per a report by Expert Market Research firm, the Indian tea industry is expected to grow at a CAGR of 4.2% from 2021-26 and reach an approximate valuation of 1.40 million tons (Ganadinni, 2021). Tea industry of Himachal Pradesh is about 150 years old and its cultivation was started in 1849 (Verma and Gupta, 2015). Though Himachal Pradesh is not a major tea producing state, yet parts of Kangra and Mandi districts in the state are known for quality tea production since British times. Although the area under tea gardens in the state is quite low yet it is the major source of livelihood for many farm families. But due to some

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reasons, the area under tea as well as its production in the region has been declining for the last few decades. The tea produced in Kangra valley is known for its unique colour and flavor and in 2005 it has been registered under the Geographical Indication (GI) of Goods (Registration and Protection) Act, 1999. Total area under tea in Himachal Pradesh is 2310.714 ha with a tea production of 11.45 lakh kg (Anonymous, 2020-21b). In recent years, chemical farming practice has brought drastic changes in soil

ecology, crop productivity and quality, in tea farming system. Over the decades conventional tea cultivation practice using chemical fertilizers and pesticides has jeopardized the yield and reduced product quality. To combat such adverse consequences and regain of lost resources is to initiate appropriate remediation measures along with soil enrichment strategies with suitable renewable soil nutrients. Organic farming that believes in natural growth of crops without adding any chemical fertilizers and pesticides or any other foreign elements can be suitable remediation measure (Kumar *et al.*, 2015). It has become the quintessential solution for reverting the cycle of depletion propelled by chemical farming practices. Researchers have also found that tea grown with bio-organic fertilizers has superior colour and taste compared to tea treated with chemical fertilizers (Lin *et al.* 2019; Zhang *et al.* 2012). These days there is also a steady growing demand for tea free from chemical inputs in the international market which impinges on the export price. In terms of organic black tea, India leads the world and the entire production is exported to the United Kingdom, Germany, United States of America, Japan and Australia. The important organic amendments are crop residues; vermicompost, farm yard manure, green manure *etc.* and use of these inputs are increasingly becoming important aspects of environmentally sound sustainable agriculture (Dutta *et al.*, 2021; Hindoriya *et al.*, 2019). Recently, organic farming practices for tea have been gaining popularity, as compared to conventional farming (Supriya *et al.*, 2023), due to their effect on sustainability in tea production and improved product quality (Barbora, 1995). In Himachal Pradesh research work on systematic field experiments on supply of nutrients through organic sources, particularly on the use of vermicompost, vermiwash and *jeevamrit* in tea crop and their recommended dose is lacking. Keeping in view the above-mentioned facts the present investigation with the objective to evaluate yield, growth and quality of tea in organic cultivation under Palam region of Himachal Pradesh.

MATERIALS AND METHODS

Site details

The experiment was conducted during pre-monsoon (summer), monsoon (*kharif*) and post monsoon (*rabi*) season of 2021-22 at Research farm of Department of Tea Husbandry and Technology, Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishwavidyalaya Palampur (India). The experimental site is situated at an elevation of 1291 m above the mean sea level with latitude 32°61' N and longitude 76°31' E in the lap of Palam valley of Himachal Pradesh. Agro-climatically, this experimental site represents sub-humid temperate and mid hill zone of Himachal Pradesh, characterized by cool winters from November to February and moderate summers from March to June. During the experimental period total rainfall received was 2332.6 mm. Out of which 411.8 mm *i.e.*, 17% was received during pre-

monsoon season of tea (May - June), 1369.8 mm *i.e.*, 58% during monsoon season of tea (July-August) and 551mm *i.e.*, 23% during post monsoon season of tea (September to October). During the experimental period the weekly mean maximum temperature varied from 22.1°C to 31.1°C and mean minimum temperature ranged from 9.3°C to 20.8°C. The average relative humidity remained between 48-97.6% during the experimental period. The mean sunshine hours for the experimental period remained between 1.3-9.6 hours.

Treatment details

The experiment was carried out in a randomized block design with 10 different treatments and 3 replications. The experiment comprised of 10 treatments with control (T_1), FYM @ 20 t/ha (T_2), vermicompost @ 10 t/ha (T_3), Split doses of FYM @ 10 t/ha + 10 t/ha (T_4), Split doses of vermicompost @ 5t/ha + 5 t/ha (T_5), FYMp nbki @ 20 t/ha + Jeevamrit @ 10% (T_6), Vermicompost @ 10t/ha + Jeevamrit @ 10% (T_7), FYM @ 20t/ha + vermiwash @ 10% (T_8), Vermicompost 10t/ha + vermiwash @ 10% (T_9) and Jeevamrit @ 10% (T_{10}).

Crop studies

Fresh yield (kg/ha)

The two leaf and one bud from each plot were plucked manually. The total fresh weight of the pluck from each plot was taken. The green leaf yield obtained from each plot was converted to kg/ha. The cumulative green leaf yield was the sum total of all the pluckings taken during three seasons.

Mean fresh and dry shoot biomass (mg/shoot)

Five plants from each plot were selected randomly and ten shoots per plant were tagged. Total 50 shoots per plot were plucked for shoot biomass and the fresh weight of the 50 shoots was measured and then average weight per shoot was calculated. For dry weight per shoot, fresh shoots were sun dried for 2 days and then oven dried for 48 hrs at 60°C and final dry weight/shoot was calculated by taking average weight.

Preparation of standard black tea infusion

Nine grams of black tea were infused in 375 ml boiling distilled water in a vacuum flask for 10 minutes using a mechanical shaker. The liquor was then filtered through a cotton wool plug and allowed to cool to room temperature.

Spectrophotometric measurements of black tea pigments

- Twenty mL of the cool, well-shaken and filtered standard tea infusion was mixed with 20 mL isobutyl methyl ketone (IBMK) and gently shaken to avoid formation of an emulsion. The layers were allowed to separate and the aqueous layer was collected in to a small flask.
- 4 mL portion of the IBMK layer was taken and made to 25 mL with methanol in a volumetric flask (solution A).
- 2 mL portion of the aqueous layer was diluted to 10 mL with distilled water and then to 25 mL with methanol (Solution B).
- 10 mL of the remaining initial IBMK layer was taken in a separate flask and mixed with 10 mL of 2.5% aqueous

sodium hydrogen carbonate. The mixture was vigorously shaken before the layers were allowed to separate and the aqueous layer discarded.

- A 4 mL portion of the washed IBMK layer was made to 25 mL with methanol (Solution C), 2 ml of saturated oxalic acid and 6 ml Shaker of water were added to a 2 ml portion of the aqueous layer left from the first extraction with IBMK and diluted to 25 ml with methanol (Solution D).

The absorbance for solutions A, B, C and D at 380 nm and 460 nm was obtained using spectrophotometer with methanol and distilled water as the blanks.

Calculation of black tea pigments

Following equations were used for estimate percentage of theaflavins and thearubigins in black tea liquor.

E_A , E_B , E_C and E_D - Spectrophotometer reading at 380 nm.

E_{A1} , E_{B2} , E_{C3} and E_{D4} - Spectrophotometer reading at 460 nm.

At 380 nm

Theaflavin % = $2.25 \times E_C$

Thearubigin % = $1.77 \times E_D + (E_A - E_C) \times 7.06$

The total liquor color was calculated as follows:

At 460 nm

Total liquor color = $6.25 \times (E_{A1} + 2E_{B2})$

The liquor brightness was estimated as follows:

At 460 nm

Brightness % = $100 \times E_{C3} / (E_{A1} + 2E_{B2})$

The liquid characteristics of made tea such as theaflavins (% TF), total color (%) and brightness (%) were analyzed by the method suggested by Ullah (1972).

Statistical analysis of data

The data collected during field experiment was analyzed using analysis of variance (ANOVA) as described by Gomez and Gomez, (1984) in MS EXCEL. Statistical significance of the experimental data was determined at 5% level of significance by using "F test" and wherever F value was

found significant, critical difference ($p=0.05$) value was calculated.

RESULTS AND DISCUSSION

Fresh yield

The data pertaining to fresh yield of tea leaf, as influenced by different components of organic farming were statistically analyzed and have been presented in Fig 1. Organic treatments significantly influenced the fresh yield of tea plucked in 15 days interval. Irrespective of different treatments, fresh yield of tea was also influenced by seasonal effect. The monsoon season had the highest fresh yield followed by the pre- and post-monsoon seasons. In pre monsoon season among all the treatments, higher fresh yield was recorded with application of vermicompost @10 t/ha+ jeevamrit @10% though this treatment was statistically at par with treatment having vermicompost @ 10 t/ha + vermiwash @10%, vermicompost (5 t/ha + 5 t/ha), FYM @ 20t/ha+ jeevamrit @ 10%, vermicompost @10 t/ha. But in monsoon season higher fresh yield was recorded with treatment having vermicompost @10 t/ha+ jeevamrit @10% which was at par with all other treatments except jeevamrit@10% and no use of any organic nutrient source. Similar trend was followed in post monsoon season also. As the yield of crop is manifestation of yield attributing characters, the higher fresh yield of tea under treatment having vermicompost @10 t/ha+ jeevamrit @10% might be due to fulfilment of nutritional requirement of tea, the better availability of nutrients throughout the year that ultimately improved growth and yield attributing characters (to more number of actively growing shoots per square meter, improved leaf growth and higher shoot biomass per square meter) of tea, which resulted in higher fresh yield. These results are in close conformity with Negi and Bist, (2017), Li *et al.* (2018) and Ji *et al.* (2018).

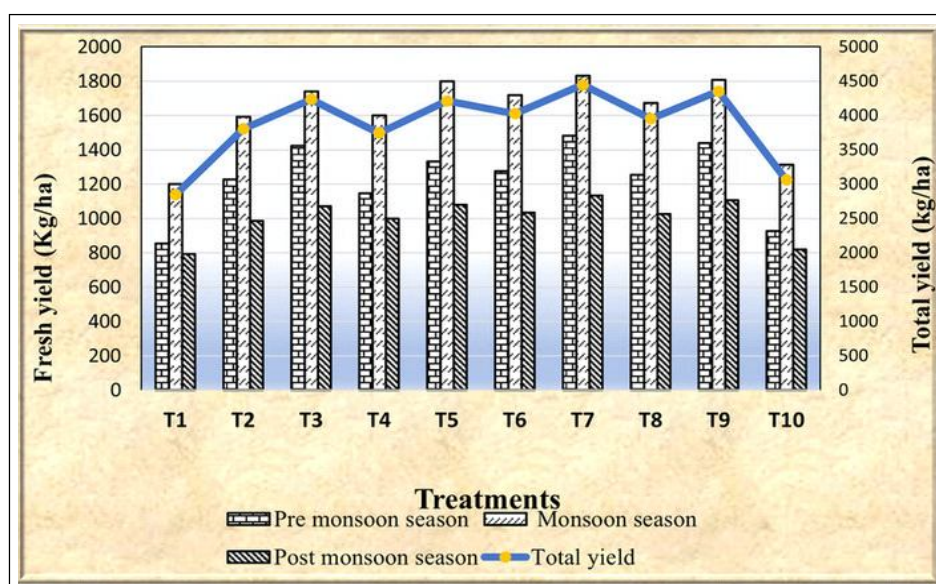


Fig 1: Effect of different organic nutrient sources on fresh yield.

Mean fresh shoot biomass (mg/shoot)

The effect of organic nutrient sources on fresh shoot biomass (mg/shoot) was found to be significant in all the three seasons (Table 1). In pre-monsoon season among all the treatments, higher value of fresh shoot biomass was observed with the application of vermicompost @ 10t/ha+ *jeevamrit* @10% which was at par with treatment having vermicompost @ 10t/ha + vermiwash @10%. These treatments were found significantly superior over rest of the treatments. In monsoon season maximum fresh shoot biomass (mg/shoot) was recorded than in pre-monsoon and post monsoon season. Similar trend was also followed in post monsoon season. In rainy season also significantly higher fresh shoot biomass was recorded with application of vermicompost @10 t/ha + *jeevamrit* @10% which was statistically at par with treatments having vermicompost @10 t/ha + vermiwash@10%, FYM @20 t/ ha + *jeevamrit* @10% and FYM @ 20 t/ ha + vermiwash @10%.

The highest fresh shoot biomass under treatment having vermicompost @10t/ha + *jeevamrit* @10% might be due to sufficient availability of essential nutrients and plant growth promoting substances, results in improved cell division and elongation of leaves which ultimately favours the better shoot growth. These results are in close conformity with Negi and Bisht, (2017).

Mean dry shoot biomass (mg /shoot)

The data embodied in Table 1 revealed that the effect of organic nutrient sources on dry shoot biomass (mg/shoot)

was found to be significant in all the three seasons. Among all the treatments, the treatment comprising vermicompost @10t/ha+ *jeevamrit* @10% recorded maximum dry shoot biomass in pre-monsoon season which was statistically at par with vermicompost @10 t/ha + vermiwash @10%. Significantly higher dry biomass was recorded with application of vermicompost @10 t/ha+ *jeevamrit* @10% in monsoon season which was statistically at par with treatments having vermicompost @10 t/ha+ vermiwash @10%, FYM @ 20 t/ha+ *jeevamrit*@10% and FYM @ 20 t/ ha + vermiwash @10%. Similar trend was also followed in post monsoon season. Dry shoot biomass was higher in treatment vermicompost @ 10 t/ha + *jeevamrit* @10% due to increased microbial activity which might have resulted into steady supply of nutrients, which ultimately increased the dry shoot biomass. These results are in close conformity with Negi and Bisht, (2017).

Theaflavin content (%)

A clear observation of the data in Table 2 indicated that theaflavin content was higher in pre-monsoon season followed by post monsoon and lower value was recorded in monsoon season. High degree of withering and favourable temperature (30°C) during processing results in higher theaflavin content in pre-monsoon season. The lowest value of theaflavin content was recorded in monsoon season due to high rainfall, relative humidity and prolonged withering have been reported to decrease the theaflavin content. Similar results were found by Sud and Baru, (2000). The

Table 1: Effect of different organic nutrient sources on mean fresh shoot biomass.

T no.	Treatments	Fresh shoot biomass (mg/shoot)			Dry shoot biomass (mg/shoot)		
		Pre-monsoon season	Monsoon season	Post monsoon season	Pre-monsoon season	Monsoon season	Post monsoon season
T ₁	Control	152.1	187.3	149.5	44.0	45.0	40.0
T ₂	FYM @ 20 t/ha	185.3	206.5	167.7	54.0	53.0	49.0
T ₃	Vermicompost @ 10 t/ ha	202.3	234.4	196.5	55.0	54.0	51.0
T ₄	FYM @ 10 t/ha (early season) + @ 10 t/ha (monsoon season)	171.3	211.5	173.7	49.0	49.7	45.0
T ₅	Vermicompost @ 5 t/ha (early season) + @ 5 t/ha (monsoon season)	177.5	236.5	198.8	51.0	51.0	47.0
T ₆	T ₂ + <i>Jeevamrit</i> @ 10% within 2 days after plucking	200.1	225.7	187.9	58.0	57.0	54.0
T ₇	T ₃ + <i>Jeevamrit</i> @ 10% within 2 days after plucking	217.4	251.7	212.8	63.0	60.0	58.0
T ₈	T ₂ + Vermiwash @ 10% within 2 days after plucking	191.5	220.5	181.7	58.0	56.0	53.0
T ₉	T ₃ + Vermiwash @ 10% within 2 days after plucking	207.4	241.7	203.8	60.0	58.0	55.0
T ₁₀	<i>Jeevamrit</i> @ 10% within 2 days after plucking	160.3	194.5	155.7	46.0	47.0	42.0
	SEm±	5.1	6.1	4.7	1.6	1.6	1.2
	CD (P= 0.05)	15.0	17.9	13.8	4.8	4.6	3.6

application of vermicompost @10 t/ha + vermiwash @10% showed higher value of theaflavin content in pre- monsoon, monsoon and post monsoon *i.e.*, 1.59, 1.4 and 1.48%, respectively, which was statistically at par with treatments having vermicompost @ 10 t/ha + *jeevamrit* @10%, FYM @ 20t/ha + vermiwash @10%, FYM @ 20 t/ha + *jeevamrit* @10% and vermicompost @10 t/ha. Lowest value of theaflavin content was recorded in absolute control. Higher theaflavin content under treatment having vermicompost @10 t/ha + vermiwash @10% might be due to gradual release of nutrients and the rise in organic acids which causes a decrease in the pH of the leaf to make it more acidic. The polyphenol oxidase enzyme becomes more active when the pH of leaves decreases, which is beneficial for theaflavin production from catechins. Similar results were recorded by Verma (2019) and Gulati *et al.* (1996).

Thearubigin content (%)

A glance of the data pertaining to thearubigin content (TR) in Table 2 revealed that organic nutrient inputs significantly influenced the thearubigin content of tea plucked in 15 days interval. Irrespective of different treatments, TR content of tea was also influenced by seasonal effect. Thearubigin content was higher in pre-monsoon season followed by post monsoon and lower value was recorded in monsoon season. The application of vermicompost @10 t/ha + vermiwash @10% showed higher value of thearubigin content in pre monsoon, rainy and post monsoon *i.e.*, 8.84%,

7.64% and 8.39%, respectively, which was statistically at par with all treatments except *jeevamrit*@10% and absolute control. Higher thearubigin content under treatment having vermicompost @10 t/ha + vermiwash @10% was due to gradual release of nutrients and organic acids. When macerated tea leaf was fermented at lower pH the resultant black tea contains increased level of theaflavin and important quality markers in black tea. During the processing of tea, it is believed that theaflavins partially change into thearubigins. Similar results were recorded by Verma (2019), Sud and Baru, (2000) and Gulati *et al.* (1996).

Total colour (%)

A perusal of the data pertaining to total colour in Table 3 revealed that organic nutrient inputs significantly influenced the total colour of black tea. Irrespective of different treatments, total colour of tea was also influenced by seasonal effect. Total colour was higher in pre-monsoon season followed by post monsoon and lower value was recorded in monsoon season. Significantly higher value of total colour was recorded with the application of vermicompost @10 t/ha + vermiwash @10% in pre-monsoon, monsoon and post monsoon *i.e.*, 2.5, 2.39 and 2.59 %, respectively, which behaved statistically similar with treatment having vermicompost @ 10 t/ha + *jeevamrit* @10%, FYM @ 20 t/ha + vermiwash @10%, FYM @ 20 t/ha + *jeevamrit* @10% and vermicompost @ (5 t/ha + 5 t/ha) vermicompost @10 t/ha. The lower value was recorded in absolute control. Higher total colour was recorded under

Table 2: Effect of different organic nutrient sources on theaflavin (%) and thearubigin (%) content in tea.

T. N.	Treatments	Theaflavin (%)			Thearubigin (%)		
		Pre monsoon season	Monsoon season	Post monsoon season	Pre monsoon season	Monsoon season	Post monsoon season
T ₁	Control	1.19	1.00	1.08	6.8	5.09	6.29
T ₂	FYM @ 20 t/ha	1.43	1.24	1.32	8.57	7.37	8.12
T ₃	Vermicompost @ 10 t/ ha	1.49	1.30	1.38	8.60	7.40	8.15
T ₄	FYM @ 10 t/ha (pre monsoon season) + @ 10 t/ha (monsoon season)	1.39	1.20	1.28	8.46	7.26	8.01
T ₅	Vermicompost @ 5 t/ha (pre monsoon season) + @ 5 t/ha (monsoon season)	1.41	1.28	1.30	8.50	7.30	8.05
T ₆	T ₂ + <i>Jeevamrit</i> @ 10% within 2 days after plucking	1.51	1.32	1.40	8.63	7.43	8.18
T ₇	T ₃ + <i>Jeevamrit</i> @ 10% within 2 days after plucking	1.58	1.39	1.47	8.71	7.51	8.26
T ₈	T ₂ + Vermiwash @ 10% within 2 days after plucking	1.52	1.33	1.41	8.67	7.47	8.22
T ₉	T ₃ + Vermiwash @ 10% within 2 days after plucking	1.59	1.40	1.48	8.84	7.64	8.39
T ₁₀	<i>Jeevamrit</i> @ 10% within 2 days after plucking	1.30	1.04	1.11	7.87	6.67	7.42
	SEm±	0.04	0.03	0.03	0.20	0.16	0.19
	CD(P= 0.05)	0.11	0.10	0.11	0.63	0.51	0.61

Table 3: Effect of different organic nutrient sources on total color (%) and brightness (%) of tea.

T. N.	Treatments details	Total colour (%)			Brightness (%)		
		Pre-monsoon season	Monsoon season	Post monsoon season	Pre-monsoon season	Monsoon season	Post monsoon season
T ₁	Control	1.83	1.20	1.49	10.73	7.73	9.73
T ₂	FYM @ 20 t/ha	2.30	2.22	2.43	13.23	10.23	12.73
T ₃	Vermicompost @ 10 t/ha	2.36	2.25	2.49	15.12	11.72	14.22
T ₄	FYM @ 10 t/ha (pre-monsoon season) + @ 10 t/ha (monsoon season)	2.31	2.21	2.39	14.51	11.51	14.01
T ₅	Vermicompost @ 5 t/ha (pre-monsoon season) + @ 5 t/ha (monsoon season)	2.40	2.30	2.41	14.72	12.12	14.62
T ₆	T ₂ + <i>Jeevamrit</i> @ 10% within 2 days after plucking	2.41	2.32	2.51	15.34	12.34	14.84
T ₇	T ₃ + <i>Jeevamrit</i> @ 10% within 2 days after plucking	2.48	2.38	2.58	15.99	12.99	15.49
T ₈	T ₂ + Vermiwash @ 10% within 2 days after plucking	2.43	2.34	2.52	15.86	12.83	15.36
T ₉	T ₃ + Vermiwash @ 10% within 2 days after plucking	2.50	2.39	2.59	16.88	13.88	16.38
T ₁₀	<i>Jeevamrit</i> @ 10% within 2 days after plucking	1.90	1.82	2.09	11.81	8.81	10.81
	SEM±	0.05	0.05	0.05	0.31	0.23	0.27
	CD (P= 0.05)	0.17	0.15	0.17	1.00	0.72	0.87

treatment having vermicompost @10 t/ha + vermiwash @10% might be due to presence of higher thearubigins in made tea. Similar results were recorded by Verma (2019), Sud and Baru, (2000) and Gulati *et al.* (1996).

Brightness (%)

A glance of the data pertaining to brightness in Table 3 revealed that organic nutrient inputs significantly influenced the brightness of tea. Irrespective of different treatments, brightness of tea was also influenced by seasonal effect and processing of tea. Brightness was higher in pre-monsoon season followed by post monsoon and lower value was recorded in monsoon season. High degree of withering during hot and dry seasons leading to the development of greater theaflavin content which ultimately responsible for brightness of black tea. The application of vermicompost @10 t/ha + vermiwash @10% showed higher value of brightness in pre-monsoon, rainy and post monsoon *i.e.*, 16.88, 13.88 and 16.38 %, respectively, which was statistically similar with vermicompost @10 t/ha + *jeevamrit* @10%. Lowest brightness was recorded with no use of any organic nutrient source. As the brightness of made black tea is manifestation of quality attributing chemicals such as theaflavin (mostly) and thearubigin. Higher brightness under treatment having vermicompost @10 t/ha + vermiwash @10% might be due to increase in theaflavin content in black tea from organic nutrient sources, gradual release of nutrients in soil and the rise in organic acids in tea leaf. Similar results were recorded by Verma (2019), Sud and Baru, (2000) and Gulati *et al.* (1996).

CONCLUSION

It is evident from the present study that the mean fresh shoot biomass (mg/shoot), mean dry shoot biomass (mg / shoot) was recorded with application of vermicompost @10t/ha + *jeevamrit* @10%. The application of vermicompost @10 t/ha + vermiwash @10% showed higher value of theaflavin and thearubigin content in pre-monsoon, monsoon and post monsoon. Therefore, the applications of organic inputs showed improved results yield and quality and can be recommend to the commercial tea farmers in the Palam valley of Himachal Pradesh.

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Conflict of interest

All authors declared that there is no conflict of interest.

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