International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor (2018): 7.426

Effect of Compost and Vermicompost on Quality of Organic Tea (*Camellia sinensis*) Grown in Hills of Himachal Pradesh

Parmod Verma

Farm Manager (Tea), Department of Tea Husbandry and Technology, CSK Himachal Pradesh Krishi Vishvavidyalaya, District Kangra Palampur – 176 062 India

Abstract: ***A field experiment was conducted for the two consecutive to evaluate effect of organics (compost and vermicompost) from different bio resources under different treatments (T_0 to T_9) on quality of made tea . Results indicated that Polyphenol contents of made tea was significantly influenced by seasonal variation as well as by different organics application. Caffeine content of made tea, which is one of the important quality parameter also significantly influenced by seasonal variation as well as by different organics treatments, except in case of organic application of 1.50 t/ha under few treatments during all the seasons, except compost application. Organics at higher rates (3.00 t/ha and 4.50 t/ha) resulted in increase in thearubigin. Maximum total colour i.e. 0.35 per cent, 0.28 per cent & 0.31 per cent was observed with the application of tea skiff vermicompost at the rate of 4.50 t/ha during first, second and third season, respectively***

Keywords: compost, vermicompost, organics, polyphenol, caffeine

1. Introduction

Tea {*Camellia sinensis* (L) O. Kuntze}, one of the most popular beverages worldwide, is increasing in popularity because of its positive effect on human health. Tea is an important crop of most of the hilly region and as such prefers very acidic conditions. Tea is consumed by almost all age group of the population [10]. Tea is one of the commercial crops of India as well as Himachal Pradesh, but yield has been considered to be quite low as compared to other parts of world. However, immense possibilities are there for increasing the productivity of green as well as orthodox black tea through the adoption of various scientific techniques among which effect of liquid manures occupies an important aspect.

In Himachal Pradesh, India the China type tea (Kangra local jat) bushes grows on the gentle slopes of the outer Himalayas (Latitude: 32°07' 15.68"N , Longitude: 76°31' 47.26" E altitude 1290 m above mean sea level, soil pH 4.8-5.8) where the annual rain fall of 2500 mm with hot humid summer and cold winter. Owing to low temperatures during the winter months of the tea bushes experience complete dormancy for about 120-150 days and plucking is done from April to October.

Tea is a perennial plantation crop preferring acidic and sloppy lands under high rainfall conditions. Soil and associated micro-environmental parameters are well known factors that affect the growth of tea plants in terms of yield and seasonal cropping characteristics. Tea grows well along undulating slops of alluvial soil that are highly acidic in nature (pH 5-6) Tea plants required good moisture contents for growth. The competitive advantage can be achieved only by improving the productivity, quality (value addition) and curtailing the cost of production by using low input energy sources. In this context, the production of organic tea assumes a considerable significance. The produce should be free from pesticides residue so as to avoid carcinogenic effects on human health. Also the price of organic tea is 3-4 folds the conventional tea, thus making organic tea production more remunerative to the tea growers.

Tea cultivation of tea in Kangra Valley was initiated by growing of tea nursery raised at different locations. During 1849 planting material was brought from China by the Europeans and the first tea plantation was established at Holta (Palampur) during 1852. The produce of plantation fetched a premium price at auction centers during 1860 excellent quality of produce encouraged many other plantations were developed with the total area of 4180 hectares.

It was [15] reported that high values of tea could be correlated with high levels of theraflavins and adequate levels of thearubigins. By and large, theaflavins are considered to be an important parameter for determining the quality of made tea [11,19] the terms 'TF' and 'TR' started that TRs are as important to the flavor and quality of black tea as the TFs. TFs impart the mouth sensations of 'briskness', 'freshness', and 'aliveness' while TRs are responsible for 'body' and 'richness' of tea brew.

The catechins[19] that take part in enzymic oxidation during the fermentation in the presence of polyphenol oxadase resulted in the formation of black tea pigments viz., TF, TR etc. TF is responsible for briskness and brightness while TR is responsible for colour and strength of liquor. The enzyme polyphenol oxidase is actively involved in biochemical changes when the leaf temperature is maintained below 35°C. After the fermentation, to have maximum TF in made tea, the enzyme should be deactivated during initial stage of drying. The TF level dropped when the fresh leaf was subjected to high temperature in made tea from good leaf. Therefore, proper handling of green leaf is necessary to exploit the quality of tea.

At present total area under tea plantation is 2312 ha out of which 1200ha is being well maintain by progressive growers, whereas, 1100 hectares is in neglected state.

Compost and vermicompost are commonly used organic manures in organic farming. Composting is the biological process of decomposing of organic constituent of bio-waste material under controlled condition. During composting process, organic residue of plant and animal origin are converted into organic manure that is rich in plant nutrients and can be observed directly by plants. Rate of decomposition and mineralization of organic residue vary among species having different plant chemistry.

The role of earth worms in the soil formation and soil fertility is well documented and [1,6,9]. An approach toward good soil management, with an emphasis on the role of soil inhabitants like earthworms in soil fertility, is very important in maintaining balance in an ecosystem. There are evidence to show that vermicompost improve the physical, chemical and biological properties of soil [8] and have a favorable influence on growth of the plants in many crops [2,13].

2. Material and methods

The field experiment was conducted at the Tea Experimental Farm of the Department of Tea Husbandry and Technology, CSK Himachal Pradesh Krishivishvavidyalaya, Palampur, situated at an elevation of 1291 m above the mean sea level with latitude 32°6' N and 76°3´E receiving an annual rain fall of 2016 mm.

The experiment was laid out in Randomized Block Design (RBD) with (1+9) treatment combinations at three levels (1.5, 3.0, and 4.5 t/ha) of organics (Compost and Vermicompost) from three sources (tea skiff, Albizzia and weed waste) each, replicated thrice and one control.

The biomaterial (tea skiff litter, weed flora and shade tree litter) was collected and compost prepared as per the method described by [17]. Tea skiff litter, weed flora and shade tree litter were collected and vermicompost was prepared by the method [3] *Eiseniafoetida*, *Eudriluseuginia* and locally available spp. of earthworms were used for converting biomaterial into vermicompost

Tea shoots consisting of two leaves and bud were collected at different plucking seasons i.e. summer (April-June), monsoon (July-August) and back end seasons (September-October). Orthodox black tea samples were manufactured in a miniature manufacturing unit [20]. Qualitative analysis for Theaflavin (%TF), Thearubigin (%TR), Total Colour (%TC) and Brightness (%B) were carried out as [16]. The statistical analysis of the data was done by the procedure suggested [4}.

Treatments	Vermicompost level (VC)	Compost level (C)
T_0	Control (No use of organics)	Control (No use of organics)
T_1	Tea skiff vermicompost @ 1.5 t/ha	Tea skiff compost @ 1.5 t/ha
T_2	Tea skiff vermicompost @ 3.0 t/ha	Tea skiff compost @ 3.0 t/ha
T_3	Tea skiff vermicompost @ 4.5 t/ha	Tea skiff compost @ 4.5 t/ha
T_4	*Albizzia* litter vermicompost @1.5 t/ha	*Albizzia* compost @ 1.5 t/ha
T_5	*Albizzia* litter vermicompost @3.0 t/ha	*Albizzia* compost @ 3.0 t/ha
T_6	*Albizzia* litter vermicompost @4.5 t/ha	*Albizzia* compost @ 4.5 t/ha
T_7	Weed flora vermicompost @ 1.5 t/ha	Weed flora compost @1.5 t/ha
T_8	Weed flora vermicompost @ 3.0 t/ha	Weed flora compost @3.0 t/ha
T_9	Weed flora vermicompost @ 4.5 t/ha	Weed flora compost @4.5 t/ha

3. Results and Discussion

Polyphenol contents of made tea

Polyphenol contents of made tea was significantly influenced by seasonal variation as well as by different organics application during all the seasons, except compost application during season-1 (Table -1). The maximum polyphenol content was observed (20.57%, 16.77% & 18.50% during first, second and third season, respectively) with the application of tea skiff vermicompost at the rate of 4.50 t/ha (T_3), which showed an increase of 20.71 per cent, 12.23 per cent & 22.25 per cent over the control. Treatment T_3 also proved to be superior under compost application.

A critical examination of data presented in table showed that application of different organics at the rate of 3.00 and 4.50 t/ha resulted in significant increase in polyphenol contents over application of organics at a rate 1.50 t/ha, whereas non-significant difference was observed between these two treatments. As regard to individual effect of different organics, vermicompost from all three resources resulted in superior effect in respect of compost from corresponding resource.

Improvement in polyphenol content might be due to increase of available nutrients in soil through organic manure mineralization, which leads to more uptakes and ultimately the plant health improvement. So, better physiochemical status of tea shoot may be probable reason for higher polyphenol contents over the control.

Caffeine contents of made tea

Caffeine content of made tea, which is one of the important quality parameter also significantly influenced by seasonal variation as well as by different organics treatments, except in case of organic application of 1.50 t/ha under few treatments.

As indicated in Table -1, maximum caffeine content i.e. 4.62 per cent, 3.51 per cent and 3.94 per cent was recorded with tea skiff vermicompost at the rate of 4.50 t/ha (T_3) during first, second and third season, respectively, which was 34.47 per cent, 19.55 per cent & 21.75 per cent higher over the

control treatment during the first, second and third season respectively. Among the different types of organics, vermicompost from all three resources was dominant in caffeine content in respect to compost from these resources.

Decomposition of organic manure releases certain acids which increase the available nitrogen in soil along with phosphorous and potassium and ultimately the nitrogen uptake increased. Secondary metabolism in plant system also resulted in better growth with higher caffeine content

Among the different type of organics, vermicompost from all three resources was dominant in caffeine content in respect to compost from these resources due to higher available nitrogen in the soil.

Theaflavin (%TF) of made tea

Different organic treatments significantly influenced the thearubigin contents during all three seasons of tea crop (Table -2) except T_4, T_5 and T_7 during Season-1 and T_7 of Season-3 under compost and all treatments of vermicompost during Season-3. Maximum thearubigin content to the tune of 7.49 per cent, 6.89 per cent & 6.76 per cent was recorded in treatment T_3 (vermicompost), which resulted in an increase of 42.15 per cent, 58.32 per cent & 39.86 per cent over control during, first, second and third season, respectively..

A critical examination of data showed that application of different organics at higher rates (3.00 t/ha and 4.50 t/ha) resulted in increase in thearubigin contents over 1.50 t/ha, whereas the increase was non-significant with each other.

Increase in theflavins may be due to gradual release of nutrients during all the growing seasons which resulted in quality improvement in corresponding season over the control.

As regard of two types of organic manure, vermicompost treatments resulted in higher theaflavin content in comparison to corresponding compost application. This is due to the fact that vermicompost enhances the available nutrients during decomposition and possesses certain phyto-hormones responsible for better plant growth and quality improvement. Theaflavin content was greatly influenced by the seasonal variation. Season-I was most prominent in theaflavin content followed by Season-3 and lowest theaflavin content was reported during Season-2, similar finding has been reported [5].

Thearubigin (%TR) of made tea

Different organic treatments significantly influenced the thearubigin contents during all the three seasons of tea crop except T_4, T_5 and T_7 during Season-1 and T_7 of Season-3 under compost and all treatments of vermicompost during Season-3. Improvement in the thearubigin contents of tea liquor may be due to better growth of plant and accumulation of secondary metabolites in tea shoots. It was reported that variation in climatic parameters greatly influenced the thearubigin content in made tea. The results are in close conformity with [18]. Non-significant effect of all treatments of vermicompost during season-3 may be due to higher available nutrients in soil under all treatments and climatic conditions which improved the thearubigin level over the corresponding treatment during season-2. The cumulative effect of climate and available nutrient may result in a non-significant increase over the control.

Total colour (%TC) of made tea

A deep insight in to the data presented in Table -3 indicates that different organics treatment levels influenced the total colour of tea liquor during all growing seasons of tea crop. It was observed that the increase was non-significant at the level of 1.50 t/ha of all types of organics. During the second season, all the treatments of vermicompost and compost reported to be non-significant for total colour over the control. Maximum total colour i.e. 0.35 per cent, 0.28 per cent & 0.31 per cent was observed with the application of tea skiff vermicompost at the rate of 4.50 t/ha during first, second and third season, respectively, similar seasonal trend was reported [18].

Per cent brightness (%B) of made tea

It is evident from Table -3 that per cent brightness of tea liquor significantly increased due to different treatments of organics during all the seasons of crop over the control. Maximum brightness content (17.61 per cent, 13.28 per cent & 16.42 per cent) was noticed with the application of tea skiff vermicompost at the rate of 4.50 t/ha during first, second and third seasons of tea crop, respectively, which showed an increase of 70.39 per cent, 88.86 per cent & 61.01 per cent over the control during first, second and third season, respectively. Similar trend was observed for compost treatments i.e. tea skiff compost (T_3) showed maximum brightness of tea liquor in comparison to other compost applications. The per cent increase of brightness content was higher for all treatments under vermicompost than the respective compost applications, thus, showing importance of vermicompost in enhancing quality of tea liquor as compared to compost.

4. Conclusion

All quality parameter of tea liquor greatly influenced by seasonal variation. Seasonal variation could be reduced by application of organic manure as gradual release of nutrients from organic manure result in upgradation of tea quality during rainy season. Organic manure at one end improve the quality of tea liquorwhile on other side also contribute in sustainability of agro-ecological system.

5. Acknowledgment

Author is highly thankful to his PhD guide and co-guide for their valuable guidance to carry out the research work, the funding from Tea Board of India and CSKHPKV is acknowledged herewith to for their assistance to carry out the work.

References

[1] Edwards, C.A., Bohlen, P.J., Linden, D.R. and Subber, S. 1995. Earthworms in agroecosystems. Pp: 185-213. In: *Earthworm Ecology and Biogeography in North*

America. (Ed) Hendrix, P.F. Lewis Publisher, Boca Raton, FL.

[2] Garg, K. and Bhardwaj, N. 2000. Effect of vermicompost of Parthenium on two cultivars of wheat. *Indian J. Ecol*. **27**: 177-180.

[3] Ghosh Hajara, N. 1994. Vermiculture and vermicasting in tea cultivation. *Assam Review & Tea News*, **83:** 9-12

[4] Gomez K.A., Gomez, A.A., 1987. *Statistical Procedure for Agricultural Research*. Second edition, John Wiley and Sons, New York.

[5] Gulati, A. and Ravindernath, S.D. (1996). Seasonal variations in quality of Kangra tea (*Camellia Sinensis* (L) O. Kuntze) in Himachal Pradesh. *Journal of the Science of Food and Agriculture*, **71**: 231-236.

[6] Ismail, S.A. 1997. *Vermicology:The Biology of Earthworms*. 92 pp. orient Longman Press, Hydrabad.

[7] Ismail, S.A. 2005. The Earthworm Book. 101pp. other India Press, Apusa, Goa.

[8] Kale, R.D. 1998. *Earthworm Cinderella of Organic Farming*. 88 pp. Prism Book Pvt. Ltd, Bangalore., India.

[9] Lalitha, R., Fathima, K. and Ismail, S.A. 2000. Impact of biopesticides and microbial fertilizers on productivity and growth of *Abelmoschusesculentus*Vasundhara. *The Earth***1 & 2** : 4-9

[10] Mann, A.R.S. and Balachandran, R. 1996. Tea- A refreshing beverage. *Indian Food Industry*, **15**: 22-29

[11] Ramamoorthy, G. and Venkateswarn, G. 2003. Efect of Temperature on Tea Quality in CTC tea manufacture. *Planters' Chronicle*, **98**: 57-60.

[12] Reddy, M.V., 1988. The effect of casts of *Pheretimaalexandri* on the growth of *Vincarosea* and *Oryzasativa*. Pp. 241-248. In: earthworms in environmental and waste management. (Eds.) Edwards, C.A. and E.F. Neuhauser, S P B Bakker, The Netherlands.

[13] Roberts, E.A.H. and Smith, R. F. 1961. Spectrophotometric measurements of theaflavins and thearubinigs in black tea liquor in assessment of quality in tea. Analyst (London), **86:** 94-98

[14] Robrets, E.A.H. 1958. The chemistry and tea manufacture. *Journal of the Science of Food and Agriculture*, **9:** 381-387.

[15] Ullah, M.R. 1972. A simplifier Spectrophotometeric method for measuring theaflavins and thearubigins in black tea liquors. *Curr. Sci*. **41**: 422-23.

[16] Verma, D.P. and Venkatesan, S. 2001. *Organic manure in tea. Planter's Chronicle March*, pp. 111-119.

[17] Verma, Parmod, Kaul Harpreet, Sharma, K.L. and Sharma, D.K. 2008. Influence off seasonal and factor blending on caffeine and Polyphenol contents of orthodox black and green tea of North- West Himalayan region of India. *Journal of plantation crops*, **(36) 3**: 475-479

[18] Wickremasinghe, R. L. and Perera, K.P.W.C. 1973. Factore affecting quality, strength and colour of black tea liquors. *Journal of the National Science Council of Sri Lanka*,**1:** 111-121.

[19] Wood, D.J. Bhatia, I.S., Chakrabarty, S., Dev Choudhary, M.N., Dev, S.B. Roberts, E.A S. and Ullah, M.R. 1964. The chemical basis of quality of tea 1. Analysis of freshly plucked shoots. *J. Sci. Food Agriculture*. **15:** 14-18.

Table 1: Effect of vermicompost and compost on polyphenol and caffeine contents of made tea of young plantation

Treatments	Polyphenols (%)						Caffeine (%)					
	Vermicompost			**Compost**			**Vermicompost**			**Compost**		
	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
T_0	16.36	14.90	15.13	16.36	14.90	15.13	3.43	2.93	3.23	3.43	2.93	3.23
T_1	18.17 (11.04)	15.57 (4.47)	16.76 (10.75)	18.47 (12.90)	15.81 (6.09)	16.73 (10.53)	3.73 (8.74)	3.26 (11.02)	3.56 (10.00)	3.79 (10.49)	3.19 (8.75)	3.43 (5.98)
T_2	19.17 (17.16)	16.17 (8.50)	17.8 (17.62)	18.66 (14.06)	15.86 (6.42)	17.58 (16.19)	4.22 (23.01)	3.34 (13.86)	3.51 (8.66)	4.09 (19.03)	3.29 (12.27)	3.55 (9.79)
T_3	20.57 (25.71)	16.77 (12.53)	18.50 (22.25)	19.64 (20.03)	16.35 (9.73)	18.10 (19.60)	4.62 (34.47)	3.51 (19.55)	3.94 (21.75)	4.28 (24.56)	3.34 (13.98)	3.64 (12.68)
T_4	17.80 (8.80)	15.57 (4.47)	16.56 (9.43)	17.53 (7.13)	15.33 (2.91)	16.57 (9.47)	3.53 (2.91)	3.11 (6.02)	3.50 (8.14)	3.55 (3.40)	3.03 (3.41))	3.43 (6.08)
T_5	18.25 (11.55)	16.32 (9.55)	16.56 (9.45)	17.92 (9.52)	15.41 (3.40)	16.93 (11.89)	3.67 (6.80)	3.17 (7.95)	3.58 (10.62)	3.63 (5.83)	3.14 (7.05)	3.48 (7.63)
T_6	18.33 (12.02)	16.30 (9.40)	16.82 (11.12)	18.67 (14.10)	16.17 (8.50)	17.62 (16.41)	3.89 (13.30)	3.35 (14.20)	3.66 (13.09)	3.79 (10.49)	3.39 (15.68)	3.53 (9.18)
T_7	18.03 (10.23)	16.00 (7.38)	16.40 (8.37)	17.68 (8.09)	15.40 (3.36)	16.47 (8.81)	3.87 (12.62)	3.15 (7.27)	3.36 (3.92)	3.95 (15.15)	3.12 (6.25)	3.43 (5.98)
T_8	19.08 (16.65)	16.25 (9.08)	18.02 (19.05)	18.66 (14.08)	15.70 (5.37)	17.72 (17.07)	4.24 (23.50)	3.33 (13.41)	3.57 (10.52)	4.03 (17.48)	3.27 (11.36)	3.46 (7.01)
T_9	20.43 (24.90)	16.57 (11.19)	18.45 (21.92)	20.23 (23.63)	16.20 (8.72)	18.4 (21.70)	4.30 (25.24)	3.48 (18.52)	3.80 (17.42)	4.24 (23.40)	3.45 (17.50)	3.55 (9.69)
CD(5%)	1.43	1.01	0.93	1.42	NS	0.40	0.14	0.20	0.49	0.16	0.14	

S_1, $S_2$and S_3= Season-1, Season-2, and Season-3
values in parenthesis is percentage change over control

Table 2: Effect of vermicompost and compost on theaflavins and thearubigins contents off made tea of young plantation

Treatments	Theaflavins (%)						Thearubigins(%)					
	Vermicompost			Compost			Vermicompost			Compost		
	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
T_0	0.82	0.78	0.98	0.82	0.78	0.98	5.27	4.33	4.83	5.27	4.33	4.83
T_1	1.41 (71.26)	1.18 (51.50)	1.53 (56.46)	1.36 (65.9)	0.86 (10.73)	1.49 (52.38)	5.95 (12.97)	5.27 (21.73)	5.50 (13.86)	6.33 (20.20)	6.00 (38.75)	5.83 (20.69)
T_2	1.57 (91.09)	1.25 (60.94)	1.76 (79.59)	1.47 (78.14)	0.95 (22.75)	1.72 (75.85)	7.12 (35.19)	6.65 (53.78)	6.63 (37.18)	6.17 (17.09)	6.30 (45.61)	5.88 (21.59)
T_3	1.56 (89.47)	1.40 (80.26)	1.84 (87.76)	1.53 (86.23)	1.05 (34.76)	1.78 (81.63)	7.49 (42.15)	6.85 (58.32)	6.76 (39.86)	7.01 (33.02)	6.13 (41.57)	6.47 (33.95)
T_4	1.18 (42.91)	1.47 (89.27)	1.26 (28.57)	1.16 (41.30)	0.90 (15.58)	1.18 (20.75)	5.59 (6.14)	4.70 (8.64)	5.48 (13.45)	5.72 (8.61)	4.90 (13.17)	5.32 (10.00)
T_5	1.23 (48.99)	1.30 (66.95)	1.36 (38.44)	1.21 (47.37)	0.93 (19.31)	1.27 (29.25)	5.77 (9.62)	5.47 (26.35)	5.93 (22.76)	5.83 (10.70)	4.99 (15.41)	5.40 (11.72)
T_6	1.29 (56.28)	1.05 (34.76)	1.54 (57.48)	1.26 (53.44)	0.98 (26.61)	1.41 (43.88)	6.40 (21.58)	5.62 (29.82)	6.17 (27.72)	6.16 (16.90)	5.45 (25.96)	5.92 (22.48)
T_7	1.28 (55.47)	0.97 (24.46)	1.52 (55.10)	1.36 (65.59)	1.05 (34.76)	1.35 (37.76)	5.82 (10.44)	5.62 (29.89)	6.21 (28.48)	5.78 (9.79)	5.19 (19.95)	5.52 (14.14)
T_8	1.35 (64.37)	0.88 (12.88)	1.70 (73.81)	1.31 (58.70)	1.15 (48.07)	1.53 (55.78)	6.51 (23.67)	5.88 (35.98)	6.32 (30.830	6.12 (16.14)	5.49 (26.81)	5.98 (23.79)
T_9	1.44 (75.30)	1.00 (28.76)	1.76 (79.93)	1.38 (68.02)	1.18 (52.36)	1.68 (71.77)	6.97 (32.28)	6.10 (40.91)	6.46 (33.59)	6.76 (28.35)	6.13 (41.68)	6.28 (30.00)
CD (5%)	0.03	0.03	0.02	0.02	0.03	0.05	0.23	0.63	NS	0.62	0.41	0.40

S_1, $S_2$and **S_3** = Season-1, Season-2, and Season-3
values in parenthesis is percentage change over control

Table 3: Effect of vermicompost and compost on total colour andbrightness of made tea of young plantation

Treatments	Total colour						Brightness					
	Vermicompost			Compost			Vermicompost			Compost		
	S1	**S2**	**S3**	**S1**	**S2**	**S3**	**S1**	**S2**	**S3**	**S1**	**S2**	**S3**
T_0	0.19	0.16	0.17	0.19	0.16	0.17	10.33	7.03	10.20	10.33	7.03	10.20
T_1	0.25 (29.31)	0.21 (26.53)	0.25 (44.23)	0.24 (24.14)	0.19 (18.37)	0.21 (19.23)	12.22 (18.23)	8.74 (24.22)	11.35 (11.27)	12.08 (16.94)	8.33 (18.48)	11.08 (8.66)
T_2	0.32 (65.52)	0.23 (40.82)	0.27 (55.77)	0.30 (55.17)	0.22 (36.73)	0.26 (51.92)	14.71 (42.35)	12.59 (79.00)	13.16 (28.99)	13.84 (33.97)	12.44 (76.92)	13.50 (32.35)
T_3	0.35 (81.03)	0.28 (71.43)	0.31 (78.85)	0.33 (70.69)	0.26 (61.22)	0.27 (57.69)	17.61 (70.39)	13.28 (88.86)	16.42 (61.01)	16.74 (62.03)	12.49 (77.54)	15.64 (53.33)
T_4	0.23 (18.97)	0.20 (24.49)	0.21 (19.23)	0.22 (13.79)	0.18 (8.16)	0.24 (38.46)	11.70 (13.23)	8.47 (20.38)	11.90 (16.63)	11.35 (9.84)	8.37 (18.96)	11.40 (11.76)
T_5	0.29 (50.00)	0.23 (38.78)	0.24 (38.46)	0.27 (41.38)	0.18 (10.20)	0.22 (28.85)	13.31 (28.84)	11.27 (60.24)	12.85 (25.95)	13.38 (29.52)	10.04 (42.80)	12.37 (21.31)
T_6	0.33 (70.69)	0.25 (53.06)	0.26 (51.92)	0.29 (48.28)	0.24 (46.94)	0.26 (50.00)	14.44 (39.77)	10.90 (54.98)	13.76 (34.93)	14.35 (38.87)	10.92 (55.21)	14.03 (37.58)
T_7	0.31 (58.62)	0.19 (14.29)	0.22 (28.85)	0.23 (17.24)	0.19 (18.37)	0.20 (13.46)	12.28 (18.84)	8.45 (20.09)	12.34 (20.95)	12.37 (19.68)	8.32 (18.25)	11.22 (10.03)
T_8	0.33 (68.97)	0.23 (38.78)	0.26 (48.08)	0.30 (56.90)	0.21 (30.61)	0.24 (40.38)	14.00 (35.48)	11.60 (64.98)	12.36 (21.18)	14.85 (43.71)	12.06 (71.47)	12.82 (25.65)
T_9	0.34 (75.86)	0.28 (71.43)	0.30 (71.15)	0.32 (65.52)	0.25 (55.10)	0.28 (63.46)	16.67 (61.35)	12.35 (75.59)	15.73 (54.25)	16.00 (54.84)	12.98 (84.50)	14.66 (43.73)
CD(5%)	0.07	NS	0.09	0.02	NS	0.08	0.38	0.89	0.34	0.94	0.48	0.17

S_1, $S_2$and **S_3** = Season-1, Season-2, and Season-3
values in parenthesis is percentage change over control