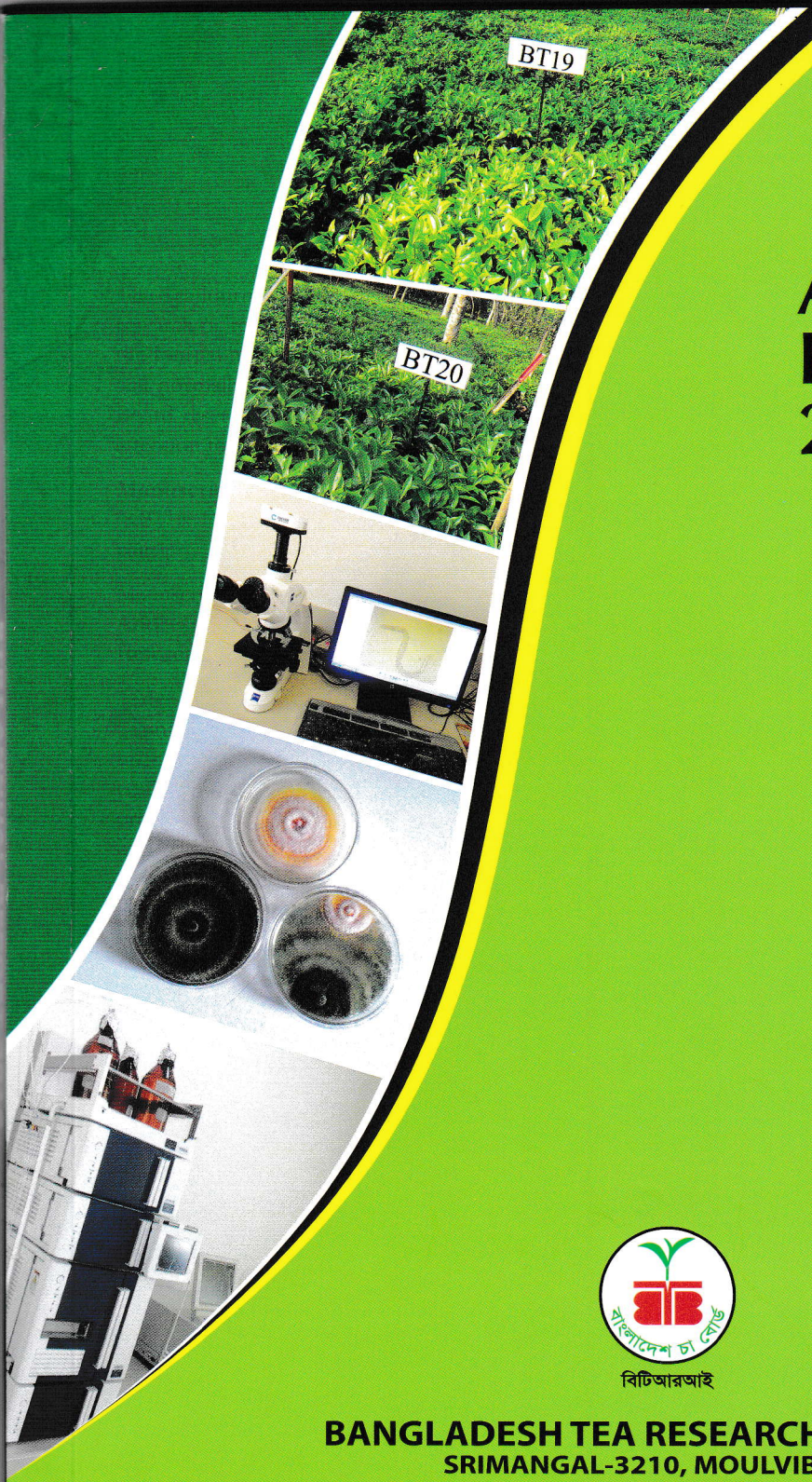

ANNUAL REPORT 2016

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BANGLADESH TEA RESEARCH INSTITUTE
SRIMANGAL-3210, MOULVIBAZAR
An organ of
BANGLADESH TEA BOARD
171-172, Baizid Bostami Road
Nasirabad, Chittagong
www.btri.gov.bd

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DIRECTOR'S REPORT

STAFF

The report of the technical staff shows the position as on 31 December 2016

Director Up to 30 11.2016 : **Dr. Mainuddin Ahmed**
M.Sc. (DU), B.Ed. (DU), M.Sc. (London)
DIC (London), Ph.D.

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1. DEPARTMENT OF CHEMISTRY

Chief Scientific Officer : **Vacant**

A. SOIL SCIENCE DIVISION

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M.Sc (Reading, UK)

Senior Scientific Officer : **Ashim Kumar Saha**
B.Sc. (Hons), M.Sc. (DU)

Scientific Officer : **Apu Biswas**
B.Sc. (Hons), M.S. (DU), PGD (India)

Scientific Officer : **Kanij Fatema Tuz Zohora**
B.Sc. (Hons), M.S. (CU)

Scientific Officer : **Naim Mustafa Ali**
B.S. (Hons), M.S. (DU)

B. BIOCHEMISTRY DIVISION

Scientific Officer : **Md. Arif Mahmud Howlader**
B.Sc. (Hons), M.S. (DU)

2. DEPARTMENT OF CROP PRODUCTION

Chief Scientific Officer & : **S.M. Altaf Hossain**
Director in-charge from 1.12.2016
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M.Sc. (Reading, UK)

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Scientific Officer : **Md. Riyadh Arefin**
B.S.Ag.(Hons), M.S. (BSMRAU)

Senior Farm Assistant : **Md. Majibur Rahman**
B.Sc. (CU)

B. AGRONOMY DIVISION

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Senior Scientific Officer (Deputation in Chaina) : **Mohammad Masud Rana**
B. Sc. Ag.(Hons), M.S. (BAU)

Scientific Officer : **Md. Arifur Rahman**
B.Sc.Ag.(Hons), M.S. (SAU)

Scientific Officer : **Md. Imran Hossen**
B.Sc.Ag.(Hons), M.S. (SAU)

3. DEPARTMENT OF PEST MANAGEMENT

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PGD (India), Ph.D

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Scientific Officer : **Shovon Kumar Paul**
B.Sc.Ag. (Hons.) (KU), M.S. (BSMRAU)

Scientific Officer : **Md. Jahangir Alam**
B.Sc.Ag.(Hons), M.S. (BAU)

B. PLANT PATHOLOGY DIVISION

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B.Sc.Ag., M.S. (BAU)

Scientific Officer : **Md. Moshiur Rahman Akonda**
B.Sc.Ag. (Hons), M.S. (BAU)

TECHNOLOGY DIVISION

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B.Sc. (RU)

Assistant Engineer (Civil) (PRL) : **Sadeque Ahmed**
Dip-in-Engg. Civil, (Dhaka)

Foreman : **Nazrul Islam Chaudhury**
Dip-in-Engg. Elect. (Sylhet)

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B.A. (NU)

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BTRI REGIONAL STATION, PANCHAGARH

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Dip.- in- Agric. (Rangpur)

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M.Sc (NU)

Farm Supervisor : **Roni Debnath**
B.Sc. Ag. (Hons.), M.S. (SAU, Sylhet))

Field Assistant : **Ajit Kumar Sarker**
Dip.- in- Agric. (Mymensingh)

Field Assistant : **Zobayer Ahamed**
Dip.- in- Agric. (Rangpur)

Field Assistant (Deputation in Bandarban) : **Md. Sabbir Mahedi Joy**
Dip.- in- Agric. (Rangpur)

LIBRARY & PUBLICATION

Librarian & Publication Officer : **Mohammad Kamal Uddin**
M. Sc. (RUD), M.S.S. (NU), LL.B (NU)
PGD in Lib. Sc. (Dhaka)

RESEARCH

The importance of research and technology transfer system has also increased many folds. The research activities are designed and carried out keeping in view of the need of the industry towards maximum yield as well as the quality tea. Like previous years all out efforts were made by the Institute to maintain standard of the work relating to research, advisory, training, workshops, seminars, tea tasting session etc. Similar service was also extended from the Fatikchari and Panchagarh sub-station.

This report of Bangladesh Tea Research Institute covers the period from January to December, 2016.

During the year under report, a total of 58 experiments on different aspects of tea culture were in progress in different disciplines, research divisions during 2016. The salient features are briefly enumerated below:

Soil Science Division carried out researches on two major fields in respect of fertilizer efficiency and improvement of soil properties. Effect of dolomitic lime on the yield of tea and soil properties has been undertaken. Experiments on fertilizer requirement of mature tea in the tea growing areas of Panchagar and Lalmonirhat Districts in the Northern Zone are being continued. The importance of organic fertilizers and its sources were also encompassed. Besides, the most useful advisory services on planting, replanting, manuring, soil rehabilitation, extension and other aspects of tea husbandry were rendered to the tea industry through soil analysis. A total of 3021 soil, fertilizer including lime samples were analyzed during 2016.

Research activities of the biochemistry division are concerned with the improvement of quality of tea particularly the bio-chemical aspects (such as TF, TR, HPS, CI, Caffeine, Antioxidants etc.). Also the division is rendering advisory service through the chemical analysis of made tea samples. A total of 5 experiments were performed and analyzed. Moisture analyzer and pH meter were calibrated and standardized four times respectively during this year.

Plant improvement received top priority as usual amongst the research activities of Botany Division. Several new test clones were under different stages of long term yield and quality trials. Hybridization between clones and agrotypes, collection and preservation of germplasms of tea from home and exotic sources were continued.

Agronomy Division carried out researches on various cultural practices i.e. planting, pruning, tipping, plucking and related agro-techniques as well as determining ideal plant population, shade spacing, etc. Besides, this year, new experiments on the effect of some common shade plants on tea soil, water and yield of tea and its management of shade canopy for sustainable tea production in Bangladesh have been initiated.

Research of Entomology Division include screening of host preference of pests, susceptibility of tea clones for nematodes, studies on indigenous plant extracts, searching and identification of bio-control agents, standardization of pesticides against *Helopeltis,* red spider mites, termites, nematodes, aphids & flush worms and determination of residue level of pesticides in made tea of different tea agro-types. The Division also rendered all sorts of advisory services to tea estates on problems arising out of pests of tea and analyzed soil, water and cowdung for nematode count. The division also engaged in analyzing made tea samples for the detection of pesticide residue received from different tea estates, companies and organizations.

Plant Pathology Division was mainly concerned with the isolation and culture of major disease causing organisms of tea and ancillary crops, screening of different fungicides and herbicides, bio-ecology of disease causing organisms and integrated management of diseases and weeds, assessment of arbuscular mycorrhizal (AM) fungi in tea and tea associated plants. Determination of critical period of weed competition in young tea and evaluation of biofungicidal activities of some plant extracts against different foliar diseases of tea were the new areas of research of the division.

Statistics and Economics division is working on the economics of tea cultivation and to study economic way of small holding tea cultivation in Bangladesh. The division also assists in designing experiments and related statistical analyses of data of other research divisions as and when required.

Normal manufacture of tea in the factory from the green leaves harvested from its Main station farm and Bilashcherra experimental farm and different experiments on the improvement of tea manufacturing technique were being conducted by Technology Division.

The supply of improved planting materials in the form of fresh as well as rooted cuttings and biclonal seeds was continued from BTRI and sub-stations during 2016. A total of 3,35,940 fresh cuttings, 4,400 rooted cuttings and 517 Kg. bi-clonal seeds were distributed to different tea estates in the year 2016. Technology disseminations through seminars, workshops and advisory visits were continued in the Main station and Sub-stations during the year.

TEA TASTING SESSIONS

As a regular annual feature and group exercise, two general tea tasting sessions were conducted for the tea planters to improve further the manufacturing of quality tea from the tea factories as a whole at BTRI Tea Tasting Room for Sylhet and one more in Chittagong Sub-station. In addition, Open Day Tea Tasting Sessions were also arranged in each of the four valley circle clubs.

VISITS

Scientific personnel of the institute and sub-stations paid a total of 61 experimental and advisory visits to different tea estates in order to solve various local problems connected with tea culture and experimental purposes during the period under report.

PUBLICATIONS

Annual Report 2015 was published in June 2016 and Circular no. 139 and Circular no. 140 was also published in October 2016.

ANNUAL COURSE / SEMINAR / WORKSHOP

The 51nd Annual course (6 day- duration) was held on 'Tea Culture' at the Institute for the covenanted staff of Tea Estates of greater Sylhet. Same courses were held at Chittagong and Panchagarh Sub-stations having two-day duration each. In these courses, Managers, Assistant Managers, Proprietors of different Tea Estates, Small tea growers, Scientific Officers of BTRI and Officers of PDU were participated.

MANAGEMENT TRAINING COURSE

Scientists of BTRI conducted a series of Management Training Modules on nursery, young and mature tea management, pruning, pest management, soil management, etc. organized by MTC of Bangladesh Tea Board for the management executives and staff of different Tea Estates during the period under report.

OFFICIAL CORRESPONDENCE

Total receipts - 1620
Total issues - 1652

LIBRARY

BTRI Library contained 4,616 books and 9,140 Periodicals, Journals, Pamphlets and Circulars, Newsletter, Research highlights, etc.

(Dr. Mohammad Ali)
Director, BTRI.

SOIL SCIENCE DIVISION

Abdul Qayyum Khan
Principal Scientific Officer (In- charge)

STAFF

Ms. Kanij Fatema Tuz Zohora, Scientific Officer transferred from Bangladesh Tea Board, Chittagong to Bangladesh Tea Research Institute, Srimangal on 10 July 2016. Mr. Naim Mustafa Ali joined as Scientific Officer on 28 February 2016. There was no other change in the personnel position of the division during the period under report

RESEARCH

A total of four experiments were conducted during the year 2016 by Soil Science Division. Progress of the experiments is given below:

SS 1: RESPONSE TO ORGANIC MANURE AND CHEMICAL FERTILIZER FOR MAXIMIZING YIELD OF TEA (2012-2016)

The long term (2012-2016) experiment has been undertaken to observe the performance of organic manure on different level in reducing the chemical fertilizer use at Bilashcherra Experimental Farm. Dolomitic lime and NPK were applied on the soil after a good shower i.e. when soil was moistened simultaneously organic manure (cow-dung) was also applied and mixed with the soil by light forking in two split doses. Usual cultural practices and pest control measures were taken as and when needed. Regular weekly plucking data was recorded during the plucking season. The experiment was laid out in the year 2012 and continued upto 2016. There were eight treatments in a Randomized Block Design with three replications. The unit plot size was 14.90 m^2 .The treatment combinations are presented below:

T_1= Control T_2= BTRI Recommended dose of chemical fertilizer T_3= Organic manure (2t/ha) T_4= Organic manure (6t/ha)	T_5= 85% of T_2 + Organic manure (2t/ha) T_6= 85% of T_2 + Organic manure (6t/ha) T_7= 70% of T_2 + Organic manure (2t/ha) T_8= 70% of T_2 + Organic manure (6t/ha)

(Recommended Fertilizer dose: (N^{100}, P^{30}, K^{60} kg/ha)

Table 1. Fertility status of the initial soil of the experimental field

Location	Texture	pH	O.C %	Total N %	Av. P ppm	Av. K ppm	Av. Ca ppm	Av. Mg ppm
BEF	SCl	4.3	1.03	0.106	5.12	52.4	43.2	6.3
Critical value	SL - L	4.5-5.5	1.0	0.1	10	80	90	25

SCL- Sandy Clay Loam, SL- Sandy Loam L- Loam, O.C- Organic Carbon

The result shows that, increased yield was recorded in every treatment over the control. The highest made tea yield (1684 kg/ha) was recorded in treatment T_6, where 85% of the recommended dose of chemical fertilizer and 6 t/ha organic manure were applied. The rate of increase over the control was 9.00% in case of treatment T_6. But the increase of yield due to different treatment was statistically insignificant.

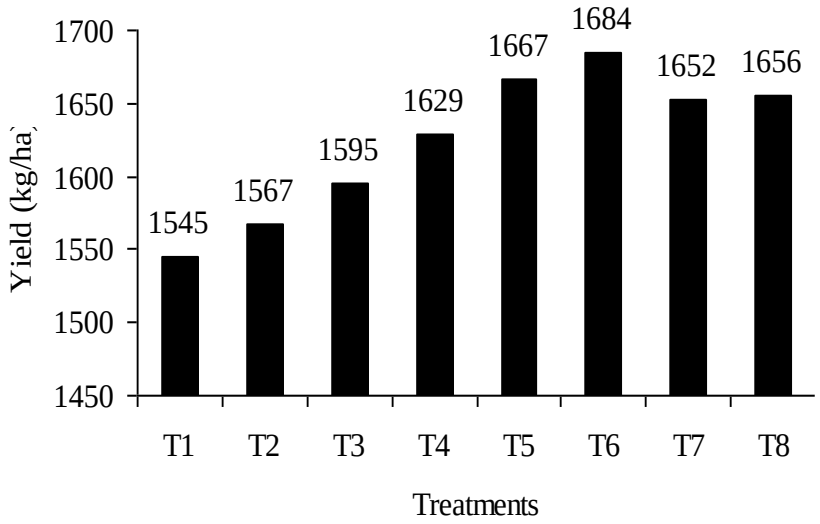


Fig 1. Effect of different treatments on the yield of tea (BEF, 2016)

Table 2. Soil analytical results at the end of the year 2016

Treatment	Texture	pH	O.C %	Total N %	Av. P ppm	Av. K ppm	Av. Ca ppm	Av. Mg ppm
T_1	SCl	4.2	0.98	0.099	10.88	50.97	58.41	8.25
T_2	SCl	4.3	1.01	0.102	21.41	51.57	66.78	10.96
T_3	SCl	4.3	1.25	0.127	21.63	51.79	68.25	11.62
T_4	SCl	4.4	1.32	0.135	22.59	59.00	73.90	15.20
T_5	SCl	4.6	1.29	0.131	31.22	77.83	81.52	16.46
T_6	SCl	4.7	1.40	0.142	34.54	112.33	82.97	18.85
T_7	SCl	4.5	1.22	0.125	28.07	63.37	77.80	15.92
T_8	SCl	4.6	1.26	0.129	29.51	74.25	80.95	16.27

Table1&2 shows analytical results of the soil samples which were collected from the experimental plots before setting up the experiment as well as after completion of the experiment. The soil texture was sandy clay loam which is heavier than sandy loam with highly acidic in nature. After completion of the experiment a slight changes of the nutrient content was found.

SS 2: STUDIES ON UPGRADING THE PRESENT FERTILIZER RECOMMENDATION (2012-2016)

A long term (2012-2016) experiment was initiated in 2012 to find out appropriate dose of chemical fertilizers for tea plantation with the change of soil environment on the basis of soil test based and crop production. The experiment was conducted at two locations, one at BTRI Farm and another at Srigobindpur T.E. Usual cultural operations and pest control measure were taken as and when needed. Fertilizer was applied in two split doses. The 1st dose was applied after a good shower of monsoon and the 2nd dose was applied in 1st week of August, 2016. There were seven treatments in a Randomized Block Design with three replications. Regular weekly harvesting data were recorded during the harvesting season. Each plot size was 35.60 m^2

Treatment combinations are as follows:

T_1= Control (without fertilizer) T_2= N^{40} + P^{5} + K^{60} (kg/ha) T_3= N^{50} + P^{10} + K^{70}(kg/ha) T_4= N^{60}+ P^{15} + K^{80}(kg/ha)	T_5= N^{70} + P^{20} + K^{90}(kg/ha) T_6= N^{80}+ P^{25} + K^{100} (kg/ha) T_7= N^{90} + P^{30} +K^{110} (kg/ha)

Table 3. Fertility status of the initial soil of the experimental field

Location	Texture	pH	O.C %	Total N %	Av. P ppm	Av. K ppm	Av. Ca ppm	Av. Mg ppm
BTRI Farm (PhD Plot)	Sl	4.1	1.09	0.11	3.33	25.0	46.6	7.5
Srigobindpur T.E	SCl	4.3	1.69	0.178	6.71	44.4	56.8	11.2
Critical value	SL - L	4.5-5.5	1.0	0.1	10	80	90	25

SCL- Sandy Clay Loam, SL- Sandy Loam, L- Loam, O.C- Organic Carbon

Table 4. Soil analytical results at the end of the year 2016 (BTRI Farm)

Treatment	Texture	pH	O.C %	Total N %	Av. P ppm	Av. K ppm	Av. Ca ppm	Av. Mg ppm
T_1	Sl	4.0	1.04	0.107	17.03	21.70	46.28	5.17
T_2	Sl	4.1	1.12	0.115	20.51	28.70	51.80	6.15
T_3	Sl	4.2	1.16	0.118	21.69	31.78	65.36	8.10
T_4	Sl	4.2	1.16	0.117	22.89	32.90	65.42	8.82
T_5	Sl	4.4	1.21	0.125	23.01	36.02	75.01	12.60
T_6	Sl	4.5	1.30	0.132	25.15	43.24	77.85	13.92
T_7	Sl	4.6	1.36	0.139	48.74	63.98	79.87	15.29

Table 5. Soil analytical results at the end of the year 2016 (Srigobindpur T.E)

Treatment	Texture	pH	O.C %	Total N %	Av. P ppm	Av. K ppm	Av. Ca ppm	Av. Mg ppm
T_1	SCl	4.1	1.60	0.158	32.57	54.62	50.89	5.98
T_2	SCl	4.1	1.76	0.179	41.69	59.02	52.84	6.90
T_3	SCl	4.2	1.78	0.180	44.28	83.04	64.50	7.75
T_4	SCl	4.3	1.80	0.179	46.26	89.24	66.59	10.15
T_5	SCl	4.5	1.82	0.180	46.56	111.54	75.90	12.97
T_6	SCl	4.5	1.87	0.185	50.09	115.80	76.51	13.06
T_7	SCl	4.6	1.97	0.192	54.96	116.38	81.52	17.01

Zinc (10kg/ha) was applied as blanket dose at the time of split fertilizer application. The result shows that, increase of yield was recorded in every treatment over the control. The highest made tea yield (1979 kg/ha) was recorded in treatment T_7 where N_{90}, P_{30}, K_{110}, and Zn_{10} were applied. The rate of increase over the control was 6.39% in case of treatment T_7. Similar trend was observed in yield of Srigobindpur tea estate. The increase of yield of different treatments was statistically significant (F=38.86) at 1% level.

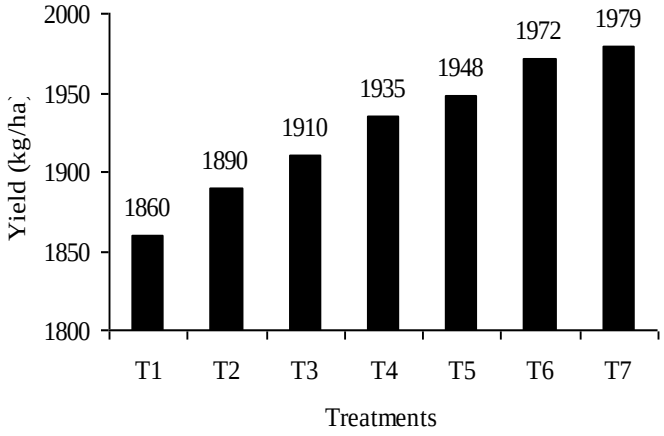


Fig 2. Effect of different fertilizer doses on the yield of tea (BTRI Farm, 2016)

The result shows that, in every treatment increased yield was recorded over the control. The highest made tea yield (1731 kg/ha) was recorded in the treatment T_7 where N_{90}, P_{30}, K_{110}, and $Zn_{10\ kg/ha}$ were applied. The rate of increase over the control was 8.73% in case of treatment T_7. There was trend to increase yield with the increase of fertilizer dose. The increase of yield due to different treatments was statistically significant (F=7.89) at 1% level.

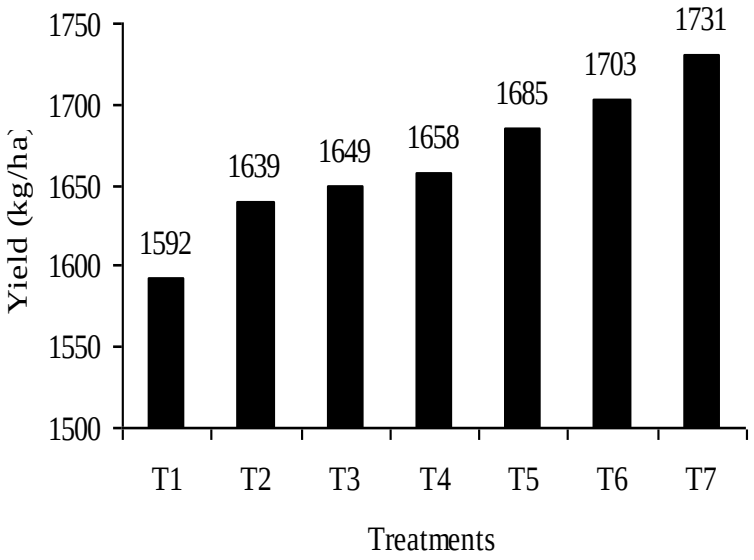


Fig 3. Effect of different fertilizer doses on the yield of tea (Srigobindpur T.E, 2016)

SS 3: RESPONSE OF DOLOMITE LIME AND ITS EFFECT ON THE CHANGES OF SOIL PROPERTIES AND YIELD OF MATURE TEA (2016-2019)

To estimate the effect of dolomite lime on the yield of mature tea, a field experiment was conducted at Srigobindpur Tea Estate. The experiment was laid out in a RBD having seven treatments and three replications. Dolomite was applied was applied after a good shower in 1st week of March, 2016. The experiment was laid out in the year 2016 and will be continued upto 2019. Each plot size was 14.00 m^2. Usual cultural operations and pest control measures were taken as and when needed. Regular weekly harvesting data were recorded during the cropping season. Treatment combinations are as follows:

T_1 = Control	T_5 = 2000 kg/ha dolomite
T_2 = 500 kg/ha dolomite	T_6 = 2500 kg/ha dolomite
T_3 = 1000 kg/ha dolomite	T_7 = 3000 kg/ha dolomite
T_4 = 1500 kg/ha dolomite	

In every experimental plot basal dose of chemical fertilizers (N_{220}, P_{40}, K_{105} & Zn_{10} kg/ha) were applied. Fertilizer was applied in two split doses. The 1st dose was applied after a good shower of monsoon and the 2nd dose was applied in 1st week of August, 2016.

Table 6. Fertility status of the initial soil of the experimental field

Location	Texture	pH	O.C %	Total N %	Av. P ppm	Av. K ppm	Av. Ca ppm	Av. Mg ppm
Srigobindpur T.E	SCl	4.75	1.08	0.125	7.95	51.26	78.61	19.20
Critical value	SL - L	4.5-5.5	1.0	0.1	10	80	90	25

SCL- Sandy Clay Loam, SL- Sandy Loam L- Loam, O.C-Organic Carbon

Table 7. Soil analytical results at the end of the year 2016

Treatment	Texture	pH	O.C %	Total N %	Av. P ppm	Av. K ppm	Av. Ca ppm	Av. Mg ppm
T_1	SCl	4.4	1.08	0.110	5.28	64.18	71.42	12.97
T_2	SCl	4.5	1.10	0.112	6.05	70.84	75.95	16.11
T_3	SCl	4.6	1.17	0.119	10.79	74.95	81.25	16.49
T_4	SCl	4.7	1.17	0.120	11.85	77.62	83.75	19.65
T_5	SCl	4.7	1.22	0.125	11.92	79.29	84.06	19.98
T_6	SCl	4.9	1.25	0.129	16.15	82.47	88.20	23.05
T_7	SCl	5.3	1.20	0.122	6.80	71.65	128.46	37.65

The result shows that, increase of yield was recorded in every treatment over the control. The highest made tea yield (1319 kg/ha) was recorded in treatment T_6 where 2500 kg/ha dolomite with basal doses of chemical fertilizers were applied. The rate of increase over the control was 7.94% in case of treatment T_6. But the increase of yield due to different treatment was statistically insignificant.

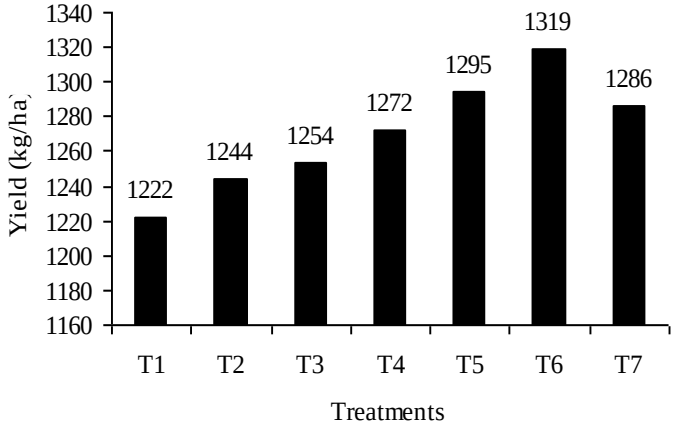


Fig 4. Effect of different dolomite lime doses on the yield of tea (Srigobindpur T.E, 2016)

SS 4: EFFECT OF VERMICOMPOST ON SOIL PROPERTIES, GROWTH AND YIELD OF YOUNG TEA (2016-2019)

The long term (2016-2019) experiment has been undertaken to observe the effect of vermicompost on soil properties, growth and yield of young tea at Bilashcherra Experimental Farm. Evaluation of the dose and efficiency of vermicompost on tea production as well as minimize the use of chemical fertilizer is the prime goal of this experiment. Dolomitic lime and NPK were applied on the soil after a good shower, simultaneously vermicompost was also applied and mixed with the soil by light forking. Usual cultural practices and pest control measures were taken as and when needed. Regular weekly plucking data were recorded during the plucking season. The experiment was laid out in the year 2016 and will be continued upto 2019. There are eight treatments in a Randomized Block Design with three replications. The unit plot size was 13.40 m^2 .The treatment combinations are presented below:

T_1 = Control	T_5 = Vermicompost (6.0 tons/ha)
T_2 = 100% Recommended fertilizer dose	T_6 = Vermicompost (1.5tons/ha) + 100% Recommended fertilizer dose
T_3 = 80% Recommended fertilizer dose	T_7 = Vermicompost (3.0tons/ha) + 80% Recommended fertilizer dose
T_4 = 60% Recommended fertilizer dose	T_8 = Vermicompost (6.0tons/ha) + 60% Recommended fertilizer dose

(Recommended Fertilizer dose: N^{100}, P^{30}, K^{60} kg/ha)

Table 8. Fertility status of the initial soil of the experimental field

Location	Texture	pH	O.C %	Total N %	Av. P ppm	Av. K ppm	Av. Ca ppm	Av. Mg ppm
BEF	SCl	4.5	1.01	0.120	5.49	48.31	49.26	9.52
Critical value	SL - L	4.5-5.5	1.0	0.1	10	80	90	25

SCL- Sandy Clay Loam, SL- Sandy Loam L- Loam, O.C-Organic Carbon

Table 9. Soil analytical results at the end of the year 2016

Treatment	Texture	pH	O.C %	Total N %	Av. P ppm	Av. K ppm	Av. Ca ppm	Av. Mg ppm
T_1	SCl	4.4	1.09	0.112	4.12	54.92	70.98	12.85
T_2	SCl	4.6	1.02	0.108	28.36	78.54	80.79	18.92
T_3	SCl	4.6	1.04	0.101	23.25	73.02	80.25	18.78
T_4	SCl	4.5	1.07	0.109	17.52	67.72	78.10	16.42
T_5	SCl	4.5	1.29	0.134	18.18	64.18	76.45	15.98
T_6	SCl	4.7	1.12	0.115	31.00	134.54	82.28	19.40
T_7	SCl	4.8	1.18	0.120	36.07	94.60	87.15	23.05
T_8	SCl	4.7	1.23	0.125	41.59	80.16	84.06	20.27

The result shows that, increase of yield was recorded in every treatment over the control. The highest made tea (1440 kg/ha) was recorded in treatment T_7 where 3.0 tons/ha vermicompost with 80% of the recommended doses of chemical fertilizers were applied (Fig. 5). The rate of increase over the control was 8.51% in case of treatment T_7. The increase of yield due to different treatment was statistically significant (F= 7.56) at 1% level.

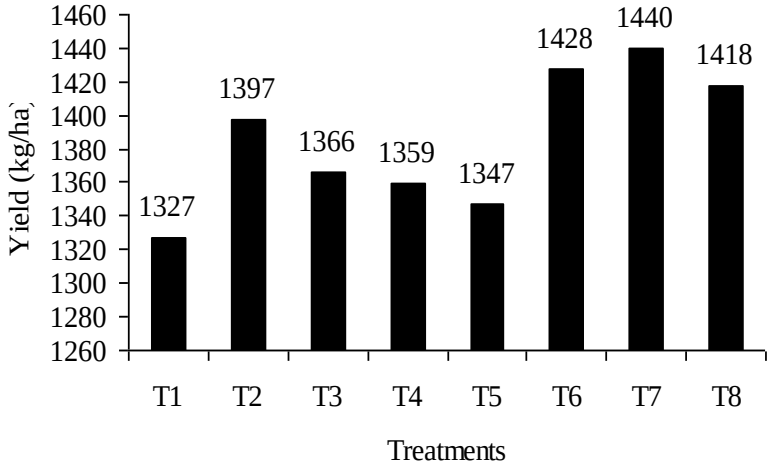


Fig 5. Effect of vermicompost on the yield of tea (BEF, 2016)

OTHER ACTIVITIES

Advisory services

The advisory work is comprised of analysis of soil, water, fertilizer, lime, compost etc. collected or received from different tea estates. Soil samples were analyzed to find out their suitability for proposed new extension, replanting, rehabilitation and also to diagnose the cause of poor growth or failure of existing tea, to recommend appropriate fertilizer requirement and to study the suitability of establishing seed or V.P nursery. During the year under report a total of 2871 soil samples and 150 other samples from 83 tea estates were analyzed for different purposes, the breakup of which is presented in table 10.

Table 10. Number of samples analyzed

Year	Soil	Fertilizer	Lime/Dolomite	Water	Compost	Total (others)	(Soil & others)
2016	2871	91	43	04	12	150	3021

Table 11. List of Tea Estates from where soil and other samples were received or collected and analyzed during the year 2016

Amo	Deundi	Kalikabari	Madhupur	Rampore
Amtali	Dauracherra	Khadim	New Dantmara	Rajghat
Ameenabad	Daragao	Kapnapahar	Noyapara	Sabazpur
Allynugger	Etah	Khan	Nurjahan	Srigobindpur
Baban	Fyzabad	Lallakhal	Nalua	Shumshernugger
Baromasia	Ghazipore	Lackatoorah	New Samanbagh	Sathgao
Bidyabheel	Goolni	Lalchand	Ootterbagh & Indanugger	Silloah
Brindaban	Hingajea	Lungla	Oodalea	Saif
Bahadurpur	Hossainabad	Luskerpore	Panchaboti	Surma
Chundeecherra	Horincherra	Luayuni-holicherra	Parkul	Udnacherra
Chaklapunji	Hooglicherra	Maajan	Phulcherra	Zarreen
Chandpore	Hajinagar	Mazdehee	Patrakhola	
Clevedon	Habibnagar	Mohammad nagar	Patharia	
Chandbagh	Jagcherra	Mirzapore	Phulbari	
Chatlapore	Jagadishpur	Modhuban	Rasidpur	
Dantmara	Jhemai	Monipur	Rajnagar	
Dinarpur	Karimpur	Marina	Rajkie	
Deanston	Korotoah	Malnicherra	Ruthna	

Advisory correspondence

A total of 223 advisory letters to different tea estates on soil, fertilizers, dolomite, compost and other soil related aspects were sent during the year.

Tours/ Visits

During the year under report officers of the division paid a total 54 visits to different tea estates and other related places for experimental, advisory and official purposes.

Courses on tea culture

Comprehensive lectures on different aspects of soil management were presented by the scientific personnel of the division at the annual course and workshops organized by BTRI for the covenanted staff of tea estate during 2016. Scientists of this division also delivered lectures as resource speakers at the Management Training centre (MTC) for Post Graduate Diploma Course organized by Project Development Unit (PDU) of Bangladesh Tea Board.

BIOCHEMISTRY DIVISION

Md. Arif Mahmud Howlader
Scientific Officer

STAFF

Mr. Md. Arif Mahmud Howlader joined as Scientific Officer on 2nd May, 2016. The posts of Principal Scientific Officer (PSO), Senior Scientific Officer (SSO), and Laboratory Helper (LH) were lying vacant during the period under report. There was no other change in the personnel position of the division during the year.

RESEARCH

Different experiments were carried out from May 02, 2016 to September 08, 2016 in Biochemistry division. Some experiments are in pipeline. All experimental progress of Biochemistry Division is summarized below:

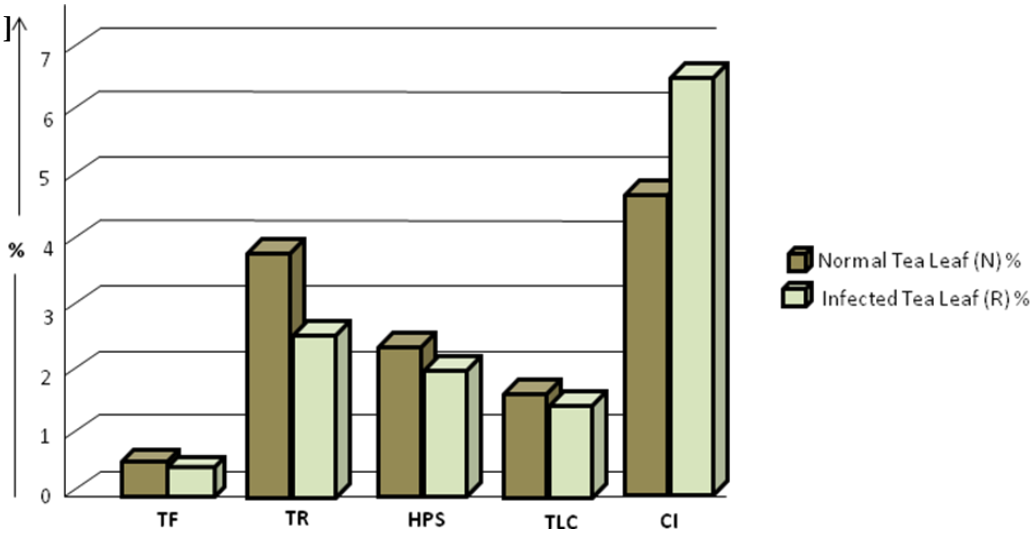
BIO 1: COMPARATIVE ANALYSIS OF NORMAL TEA LEAF WITH INFECTED TEA LEAF (RED RUST) FROM THE VIEW OF DIFFERENT BIOCHEMICAL PARAMETERS WITH COLLABORATION OF PLANT PATHOLOGY DIVISION

The following parameters have been tested and reports have been submitted to Plant Pathology division.

Biochemical Parameters:

a) Estimation of Caffeine
b) Estimation of theaflavin (TF), thearubigin (TR), highly polymerized substances (HPS), total liquor colour (TLC) and Color Index (CI)

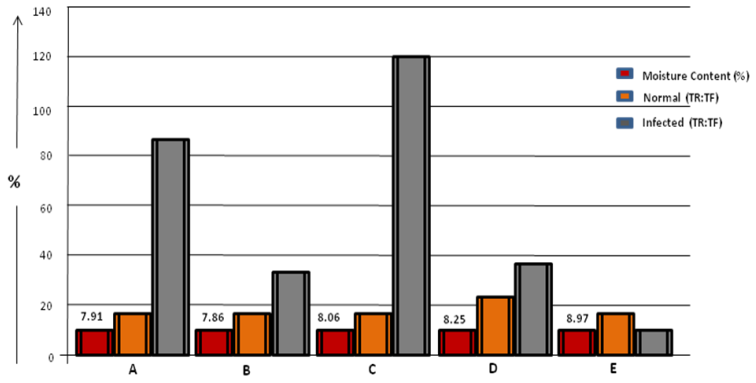
Result]



BIO 2: TO SEE BIOCHEMICAL STATUS OF DIFFERENT BRAND OF UNINFECTED MADE TEA COMPARING WITH INFECTED MADE TEA IN COLLABORATION OF PLANT PATHOLOGY DIVISION

Different biochemical status of uninfected five brands made tea were compared with infected (after growing of fungus or bacteria in the incubator) same five brands made tea. Reports have been provided to concern person of Plant Pathology division.

Result



Comparison of TR:TF with respect to Moisture content

BIO 3: ESTIMATION OF CHLOROPHYLL AND CAROTENOIDS IN NORMAL LEAF AND INFECTED LEAF (DARK GREEN)

Chlorophyll content of tea shoots was measured using the method suggested by Wellburn (1994) on 21st July,2016. A tea shoot was weighed in table top balance and grounded with a mortar and pestle with a sufficient quantity of prechilled methanol (100%). Finely ground sample was filtered and made up to 50ml in a standard volumetric measuring flask using methanol and further diluted five times with methanol. Absorbance of the diluted *methanolic extract was read at 470, 653 and 666 nm using UV-Visible spectrophotometer* against methanol as blank. Pigments, chlorophyll a, b and carotenoids were calculated using the following formulae and the chlorophyll and carotenoids values were expressed as milligram per gram (mg/g) fresh weight basis.

BIO 4: EXTRACTION AND CHARACTERIZATION OF POLYPHENOL OXIDASE (PPO) FROM TEA (CAMELLIA SINENSIS, FAMILY: THEACEAE) AND ITS ACTIVITY MEASUREMENT (BTRI 2016-2017)

Design of the experiment

The enzyme was extracted by homogenizing with 250 ml cold potassium phosphate buffer

Parameters	Normal Leaf (mg/g)	Infected Leaf (mg/g)
Chlorophyll a	4.42998	1.02488
Chlorophyll b	1.7955	0.31192
Carotenoids	1.019690757	0.510265969

(0.2 M, pH 7).The homogenate was filtered through cheese cloth and centrifuged at 5000 g for 10 minutes. Successively following the method of Mahmood, W.A. et al.; 2009, PPO was extracted.

PPO was extracted as active form. Now PPO is kept for activity assay and it will be inspected up to six months.

Result

Enzyme activity assay	Up to 50 Unit
Optimum temperature	10-30ºC
Optimum pH	5.8-7.9
Thermal stability	Under observation
Michaelis constant (km)	Under observation
Storage stability	Under observation

BIO 5: SHELF LIFE STUDY OF BAGGED AND LOOSE TEA LEAF OF DIFFERENT BRAND WITH RESPECT TO DIFFERENT STANDARD BIOCHEMICAL PARAMETERS (BTRI 2016-2017)

Design of the experiment

Five popular brand tea samples will be collected from market point at random and successively after one month interval up to one year, different biochemical parameters will be assayed according to AACC , 2000; Roberts and Smith, 1963; Ramaswamy, 1986 and Maidon *et al*., 2012 method. The following standard parameters will be tested:

S.l No.	Specifications	Std. Value
1.	Moisture Content	(3.0-5.0)%
2.	TF : TR	Max. 1: 10 to 1 : 12
3.	CI	(5-11) %

In Bangladesh, different brand of made tea, green tea, processed tea in the market. But we have no data related to shelf life or storage time or storage condition. Tea will eventually lose its flavor, but dry leaves will last a very long time. The shelf life of tea depends on a variety of factors, such as the best before date, the preparation method and how it was stored. Therefore biochemistry division has taken an attempt regarding this issue. It will be continued till September, 2017. Data of two months have been presented.

Sample ID	Moisture%	TF	TR	TR:TF	TLC	CI	Tome Intervals
SL-1	4.14	0.685767	6.384924	9.31	3.66	4.05	0 months
	4.25	0.694393	5.975634	8.60555	3.41	4.618637	2 months
SL-2	6.01	0.918669	5.880133	6.40017	4.22	6.787932	0 months
	6.51	0.867344	6.069771	6.99811	4.13	6.422296	2 months
SL-3	5.39	0.478743	6.084778	12.7099	3.24	3.890326	0 months
	5.61	0.465804	6.398567	13.73661	3.21	3.747787	2 months
SL-4		0.569316	8.281301	14.54605	4.03	3.028268	0 months
		0.534812	8.008441	14.97431	3.92	2.923227	2 months
SL-5	4.21	0.565003	6.930644	12.26656	4.51	3.86319	0 months
	4.45	0.530499	6.876072	12.96152	4.31	3.710337	2 months

Observation

These data show us that no samples are found to be in appropriate condition. TR:TF ratio, Color index and moisture content of most of the samples were out of specification.

BOTANY DIVISION

Md. Ismail Hossain
Principal Scientific Officer

STAFF

Mr. Md. Riyadh Arefin joined as Scientific Officer on 3 February, 2016. The post of one Scientific Officer and one Field Assistant were vacant. There were no other change in personnel position of the division during the period under report.

RESEARCH

Thirty two experiments in six programme areas namely–Preliminary selection of vegetative clones, Screening of drought tolerant variety of tea (*camellia sinensis*) at the nursery level and in the field condition, Long term yield and quality trial of provisionally selected clones, Breeding of tea, Survey and conservation of gene resources of tea in Bangladesh (BTRI, 1981), Developing a sustainable and cost effective protocol for manufacturing different kinds of tea rather than CTC tea and other experiments. Results are briefly discussed below:

B1: PRELIMINARY SELECTION OF VEGETATIVE CLONES

B1-27: Selection of Vegetative Clones at Shumshernugger T. E., Section Main Div. Sec. No. 9 (1993-2016)

From the estate 16 new bushes were selected during the period under report besides previous selections. Newly selected bushes were pruned in order to collect cuttings. A total of 2415 cuttings from 19 selected bushes of Shumshernugger T.E. were collected and put into the rooting trial.

B1-28: Selection of Vegetative Clones at Amo T. E., Section No. 8 (1993-2016)

Thirty three new bushes have been selected during the period under report. The selected bushes have been pruned for collecting cuttings for rooting trial. A total of 5526 cuttings from 35 bushes of section no. 1 of Amo Tea Estate were collected and planted in the nursery.

B1-31: Selection of Vegetative Clones at Baraoorah T. E., Section No. 8 (2007-2016)

Nineteen bushes have been selected during the period under report. The selected bushes have been pruned for collecting cuttings for rooting trial. A total of 2245 cuttings from 13 bushes of section no. 8 of Baraoorah Tea Estate were collected and planted in the nursery.

B2: SCREENING OF DROUGHT TOLERANT VARIETY OF TEA AT THE NURSERY LEVEL AND IN THE FIELD CONDITION

B2-1: (a) Screening of drought tolerant variety of tea at the nursery level

Cuttings are collected from Baraoorah (T1), Shumshernugger (T2) and Mirzapure T. E. (T3) from November'15 to October'2017. Overall performance (6 months) are given below:

Table 1. Rotting performance of different selected cuttings

Parameter	*T1*	*T2*	*T3*	*BT2*
Rotting Performance	*93%*	*91%*	*92%*	*90%*

B2-1: (b) Screening of drought tolerant variety of tea in the field condition upto 3 years of planting

Test clone collected from Shumshernugger, Mirzapure & Baraooarah T.E. (2014-2017). Average Depth of root (cm) of sorted rooted cutting in first 3 years is presented below:

Table 2. Average depth of root (cm) of sorted rooted cuttings

Parameter	T1	T2	T3	BT2
Depth of root at 1st year (cm)	26.67	26.16	26.64	25.91
Depth of root at 2nd year (cm)	30.10	29.18	30.20	28.58
Depth of root at 3rd year (cm)	31.24	30.86	31.19	30.86

B3: LONG TERM YIELD & QUALITY TRIAL OF PROVISIONALLY SELECTED CLONES

B2-35: Yield and Quality Trial of Test clones Selected from Shumshernugger and Amo T. Es., Test clones Sh/D/11/313, A/8/8, A/17/7 and A/22/39 against Control TV1 (BTRI, 1996-2016)

The plants of this trial were medium skiffed at 83 cm in 2016. There were 20 plucking rounds in 2016. The yield data were analyzed and presented in Table 3 and Fig. 1.

Table 3. Yield of green leaves (g/plant) in 2016

Clone	SH/D/11/313	A/8/8	A/17/7	A/22/39	TV1
Treatment mean	1134	1158	1163	1144	1023.4

Treatment difference- LSD at 5% = 110.6

The analytical results reveal that yield difference was highly significant (5% level of significance) in 2016. Test clones A/17/7, A/8/8, A/22/39 and SH/D/11/313 were comparable in terms of yield while control TV1 performed lower yield than the test clones. The estimated made tea production in kg/ha is presented in Fig.1. The cup qualities of all the test clones were assessed organoleptically and the average values of the scores are presented in Table 4.

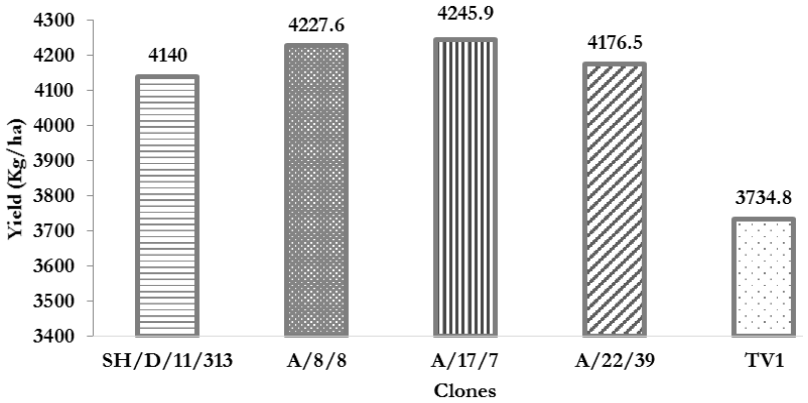


Fig. 1. Comparative yield of clones made tea (kg/ha)

Table 4. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
SH/D/11/313	7.35	7.66	7.22	7.28	2.73	32.24	AA
A/8/8	7.77	7.79	7.52	7.53	3.55	34.56	E
A/17/7	7.51	7.69	7.51	7.51	2.81	33.03	AA
A/22/39	7.43	7.52	7.34	7.41	2.75	32.45	AA
TV1	7.78	7.83	7.73	7.79	3.16	34.29	E

(A: Average, AA: Above Average, E: Excellent cup quality)

All the test clones were above average while the test clone A/8/8 and control TV1 were excellent in terms of cup quality. Consistent touch of sweet flavor was found in A/17/7. Test clones A/17/7 and A/8/8 were released as BT19 and BT20 respectively in 2016.

B3-36: Yield and Quality Trial of Test clones Selected from Amo T. E. Test clones A/8/01, A/17/22, A/22/27 and A/22/40 against Control BT1 (BTRI, 1996-2017)

The plants of this trial were medium skiffed at 83 cm in 2016. There were 20 plucking rounds in 2016. The yield data were analyzed and presented in Table 5.

Table 5. Yield of green leaves (g/plant)

Clone	Year	A/8/01	A/17/22	A/22/27	A/22/40	BT1
Treatment mean	2016	649.43	681.79	729.46	634.47	749.9

Treatment difference: Insignificant

The analytical results revealed that all test clones are comparable in terms of yield. The estimated made tea production in kg/ha is presented in Fig.2. The cup quality of made tea for all the test clones were assessed organoleptically and average scores are presented in Table 6.

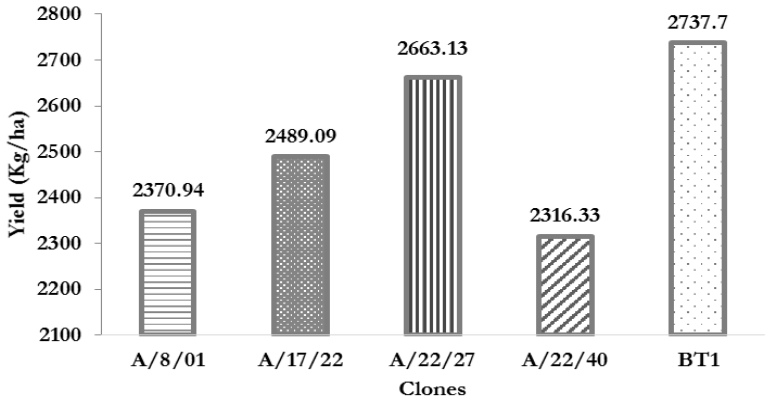


Fig. 2. Comparative yield of clones made tea (kg/ha)

Table 6. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
A/8/01	7.55	7.59	7.23	7.42	2.35	32.23	AA
A/17/22	7.24	7.23	7.14	7.24	2.49	31.34	A
A/22/27	7.65	7.50	7.39	7.32	2.20	32.49	AA
A/22/40	7.53	7.53	7.43	7.38	2.87	32.74	AA
BT1	7.53	7.71	7.46	7.41	2.91	33.12	AA

(A: Average, AA: Above Average, E: Excellent cup quality)

All the test clones excepting A/17/22 were comparable with the control BT1 in case of quality, Test clone A/17/22 was inferior in cup than that of control.

B3-38: Yield and Quality Trial of Test clones Selected from Chandpore, Shumshernugger and Amo T. Es.; Test clones C/J1/10, Sh/B/6/59, Sh/B/6/62 and A/8/24 against Control BT2 (BTRI, 2019)

The plants of this trial were deep skiffed at 76 cm in 2016. There were 27 plucking rounds in 2016. The yield data were analyzed and presented in Table-7.

Table 7. Yield of green leaves (g/plant)

Clone	Year	CHA/J1/10	Sh/B/6/59	Sh/B/6/62	A/8/24	BT2
Treatment mean	2016	1230.77	1161.3	1027.7	1397.27	1170

Treatment difference: Insignificant.

The analytical results revealed that all test clones are comparable in terms of yield. The estimated made tea production in kg/ha is presented in Fig.3. The cup quality of made tea for all the test clones were assessed organoleptically and average scores are presented in Table 8.

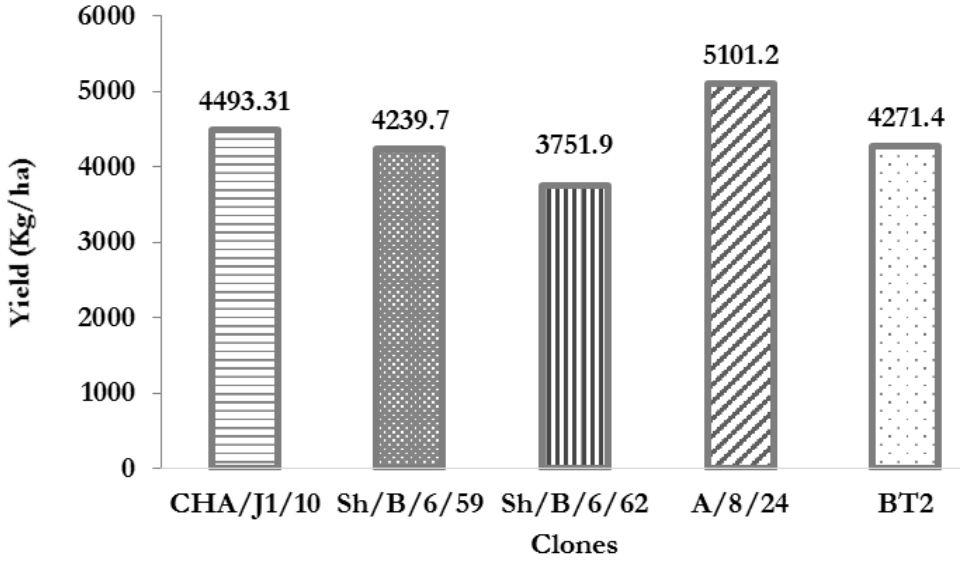


Fig. 3. Comparative yield of clones made tea (kg/ha)

Table 8. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
CHA/J1/10	7.68	7.34	7.38	7.40	2.84	32.45	AA
Sh/B/6/59	7.11	7.18	7.28	7.25	2.47	31.42	A
Sh/B/6/62	7.32	7.32	7.83	7.67	2.84	33.21	AA
A/8/24	7.41	7.34	7.48	7.39	2.68	32.29	AA
BT2	7.52	7.63	7.39	7.24	2.93	32.75	AA

(A: Average, AA: Above Average, E: Excellent cup quality)

All the test clones excepting Sh/B/6/59 have got comparable cup quality with test clone BT2 excepting the test clone's unique flavoury character. Test clone Sh/B/6/59 was inferior to the control BT1 in case of cup quality.

B3-39: Yield and Quality Trial of Four Test clones Selected from Shumshernugger T.E.; Test clones Sh/B/6/36, Sh/B/6/38, Sh/B/6/55 and Sh/B/6/67 against Standard BT1 (BTRI, 1998-2016)

The plants of this trial were light pruned at 66 cm in 2016. There were 19 plucking rounds in 2016. The yield data were analyzed and presented in Table 9 and the estimated made tea production in kg/ha in Fig. 4.

Table 9. Yield of green leaves (g/plant)

Clone	Year	Sh/B/6/36	Sh/B/6/38	Sh/B/6/55	Sh/B/6/67	BT1
Treatment mean	2016	568.1	627.4	566.67	614.47	380.1

Treatment difference- Insignificant.

The analytical results revealed that all test clones are comparable in terms of yield. The cup quality of made tea for all the test clones were assessed organoleptically and average scores are presented in Table 10.

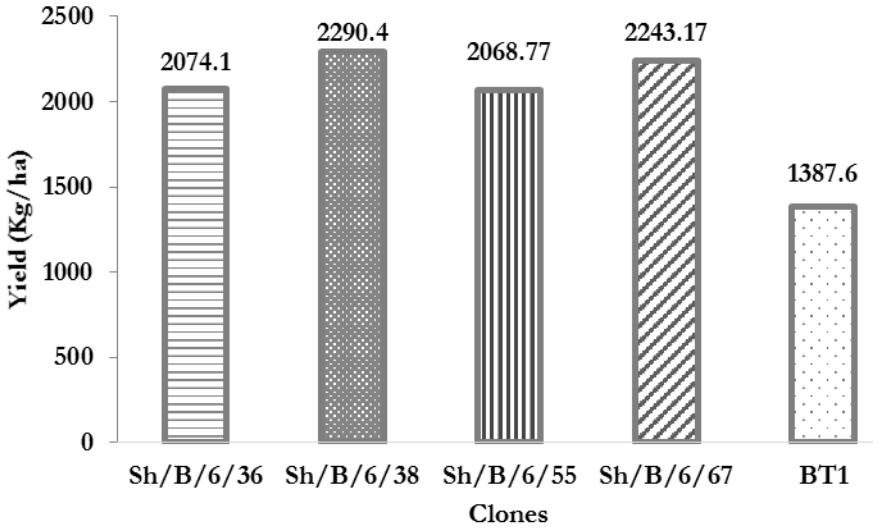


Fig. 4. Comparative yield of clones made tea (kg/ha)

Table 10. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
Sh/B/6/36	7.11	7.31	7.95	7.24	2.90	32.51	AA
Sh/B/6/38	7.36	7.41	7.57	7.35	2.76	32.45	AA
Sh/B/6/55	7.13	7.13	7.02	7.16	2.80	31.24	A
Sh/B/6/67	7.77	7.41	7.15	7.37	2.82	32.52	AA
BT1	7.26	7.41	7.54	7.34	2.96	32.51	AA

(A: Average, AA: Above Average, E: Excellent cup quality)

All the Test clones excepting Sh/B/6/55 were comparable in cup with the control BT1. Test clone Sh/B/6/55 was inferior to the control BT1 in the case of cup quality.

B3-40: Yield and Quality Trial of Six Test clones – MZ/39, E/4, D/13, B2T1, BR2/97 and SDL/1 against Standard BT2 (BTRI, 2000-2016)

The plants of this trial were medium skiffed at 78 cm in 2016. There were 22 plucking rounds in 2016. The yield data were analyzed and presented in Table 11.and the estimated made tea production in kg/ha in Fig.5.

Table 11. Yield of green leaves (g/plant)

Clone	Year	MZ/39	E/4	D/13	B2T1	BR2/97	SDL/1	BT2
Treatment mean	2016	1240.6	925.6	848.3	1048.9	875.9	903.0	1105.6

Treatment difference- LSD at 5% = 193.95

The analytical results reveal that yield difference was highly significant (at 5% level of significance) in 2016. Test clones MZ/39, SDL/1, B2×T1, E/4 and BR2/97 were comparable in terms of yield with the control BT2 while the test clone D/13 performed lower yield than the control. The cup quality of made tea for all the test clones were assessed through organoleptic test and the average scores are presented in Table 12.

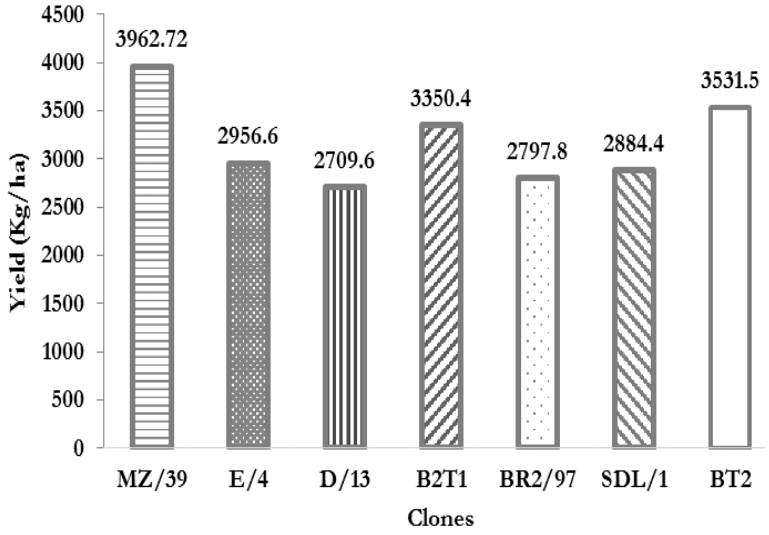


Fig. 5. Comparative yield of clones made tea (kg/ha)

Table 12. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
MZ/39	7.49	7.43	7.53	7.44	2.68	32.57	AA
E/4	7.50	7.69	7.44	7.37	2.61	32.61	AA
D/13	7.61	7.51	7.42	7.43	2.84	33.82	AA
B2T1	7.27	7.39	7.31	7.28	2.61	32.25	AA
BR2/97	7.61	7.38	7.44	7.42	2.74	32.60	AA
SDL/1	7.32	7.52	7.48	7.33	2.58	32.80	AA
BT2	7.41	7.49	7.45	7.33	2.67	32.25	AA

(A: Average, AA: Above Average, E: Excellent cup quality)

All the Test clones were comparable in cup with the control BT2. However, the unique flavoury character of BT2 was not considered in the case of assessing cup quality.

B3-41: Yield and Quality Trial of Four Test clones Selected from Amo T. E.; Test clones – A/8/37, A/8/55, A/8/62 and A/8/66 against Standard BT2 (BTRI, 2000-2016)

The plants of this trial were medium skiffed at 78 cm in 2016. There were 22 plucking rounds in 2016. The yield data were analyzed and presented in Table 13 and made tea production in kg/ha is presented in Fig. 6.

Table 13. Yield of green leaves (g/plant)

Clone	Year	A/8/37	A/8/55	A/8/62	A/8/66	BT2
Treatment mean	2016	1075.5	820.7	654.9	1013.4	1018.1

Treatment difference- Insignificant.

The analytical results revealed that all test clones are comparable in terms of yield. The cup quality of made tea for all the test clones were assessed organoleptically and average scores are presented in Table 14.

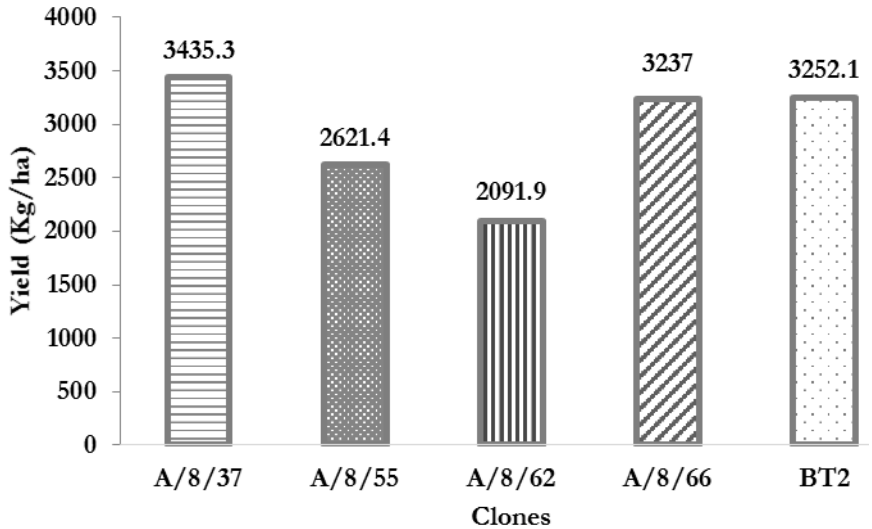


Fig. 6. Comparative yield of clones made tea (kg/ha)

Table 14. Quality scores

Clone	Infusion	Liquor colour	Brisknes s	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
A/8/37	7.52	7.38	7.74	7.62	2.79	33.06	AA
A/8/55	7.32	7.37	7.29	7.31	2.25	31.54	A
A/8/62	7.40	7.55	7.68	7.41	2.81	32.65	AA
A/8/66	7.50	7.53	7.37	7.43	2.76	32.59	AA
BT2	7.56	7.76	7.38	7.38	2.67	32.45	AA

(A: Average, AA: Above Average, E: Excellent cup quality)

All the test clones excepting A/8/55 were comparable in terms of cup quality. The test clone A/8/55 was found inferior to the control. The flavoury character of BT2 was not considered in the case of assessing cup quality.

B3-42: Yield and Quality Trial of Four Test clones Selected from Phulcherra, Amo and Shumshernugger T. Es.; Test clones – A/17/16, Ph/9/1, Ph/9/9 and Sh/B/6/46 against Standard BT1 (BTRI, 2001-2016)

The plants of this trial were deep skiffed at 73 cm in 2016. There were 21 plucking rounds in 2016. The yield data were analyzed and presented in Table 15 and made tea production in kg/ha in Fig. 7.

Table 15. Yield of green leaves (g/plant)

Clone	Year	A/17/16	Ph/9/1	Ph/9/9	Sh/B/6/46	BT1
Treatment mean	2016	854.54	589.62	835.45	784.74	776.17

Treatment difference- Insignificant

The analytical results reveal that yield difference was not significant in 2016; all the test clones were comparable in terms of yield with the control BT1. The cup qualities of made tea for all the test clones were assessed organoleptically and the average scores are shown in Table 16.

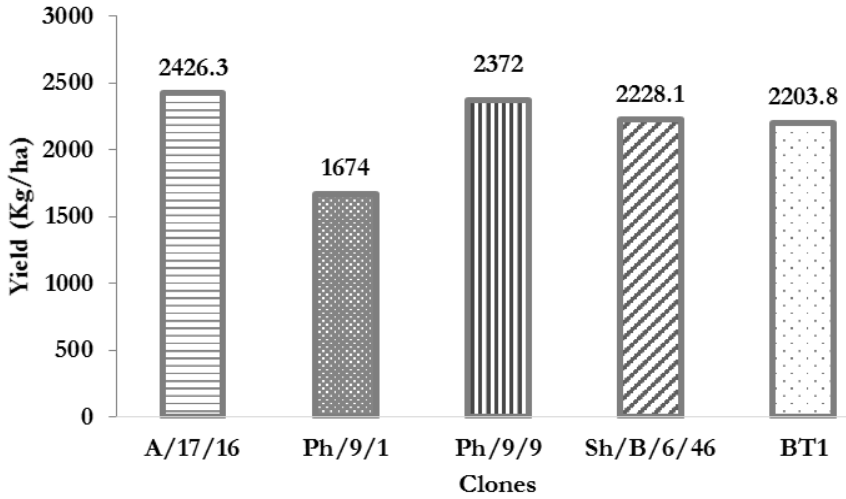


Fig. 7. Comparative yield of clones made tea (kg/ha)

Table 16. Quality scores

Clone	Infusion	Liquor colour	Brisk-ness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
A/17/16	7.34	7.39	7.34	7.34	2.90	32.31	AA
Ph/9/1	7.32	7.29	7.28	7.22	2.53	31.64	A
Ph/9/9	7.42	7.55	7.60	7.30	2.57	32.40	AA
Sh/B/6/46	7.44	7.36	7.47	7.26	2.77	32.30	AA
BT1	7.38	7.60	7.75	7.33	2.87	32.93	AA

(A: Average, AA: Above Average, E: Excellent cup quality)

All the test clones excepting Ph/9/1 were comparable in cup with the control. The Test clone Ph/9/1 was found inferior to the control BT1.

B3-43: Yield and Quality Trial of Four Test clones Selected from Phulcherra and Hybrid Progeny; Test clones– Ph/9/4, Ph/9/25, Ph/9/40 and BS/67 against Standard BT5 (BTRI, 2001-2016)

The plants of this trial were deep skiffed at 73 cm in 2016. There were 21 plucking rounds in 2016. The yield data were analyzed and presented in Table 17 and made tea production in kg/ha in Fig. 8.

Table 17. Yield of green leaves (g/plant)

Clone	Year	Ph/9/4	Ph/9/25	Ph/9/40	BS/67	BT5
Treatment mean	2016	936.5	609.63	891.53	835.66	849.91

Treatment difference- LSD at 5% = 156.86

The statistical results reveal that yield difference was significant (at 5% level of significance) in 2016; all the test clones excepting Ph/9/4 are comparable in terms of yield with the control. The yield performance of test clone Ph/9/4 was higher than the control BT5.The cup quality of made tea for all the test clones were assessed through organoleptic test. The average scores are presented in Table 18.

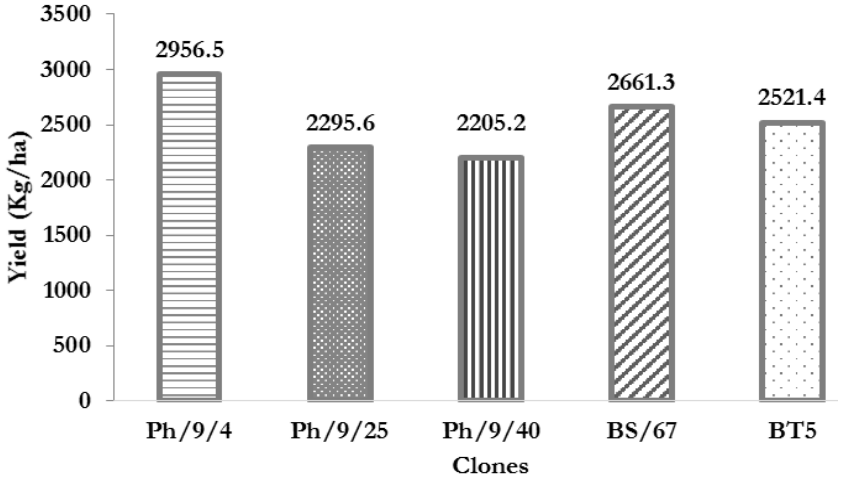


Fig. 8. Comparative yield of clones made tea (kg/ha)

Table 18. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
Ph/9/4	7.14	7.48	7.50	7.36	2.76	32.24	AA
Ph/9/25	7.28	7.55	7.35	7.52	2.46	32.16	AA
Ph/9/40	7.43	7.23	7.20	7.16	2.68	31.70	A
BS/67	7.51	7.60	7.53	7.51	2.80	32.95	AA
BT5	7.61	7.36	7.53	7.46	2.65	32.83	AA

(A: Average, AA: Above Average, E: Excellent cup quality)

All the test clones were comparable in terms of cup quality with the control BT5 excepting Ph/9/40 which was inferior to the control.

B3-44: Yield and Quality Trial of Three Test clones Selected from Amo and Phulcherra T. Es.; Test clones– A/8B/1, Ph/9B/1, Ph/9/11 and against Standard BT1 (BTRI, 2003-2016)

The plants of this trial were light skiffed at 76 cm in 2016. There were 19 plucking rounds in 2016. The yield data were analyzed and presented in Table 19 and made tea production in kg/ha in Fig. 9.

Table 19. Yield of green leaves (g/plant)

Clone	Year	A/8B/1	Ph/9B/1	Ph/9/11	BT1
Treatment mean	2016	1178.58	1790.00	1679.51	1406.91

Treatment difference: LSD at 5% = 240

The analytical results reveal that yield difference was significant (at 5% level of significance) in 2016. The yield potential of the test clones Ph/9/B1 and Ph/9/11 were higher than the control. The cup quality of made tea for all the test clones was assessed through organoleptic test. The average scores are shown in Table 20.

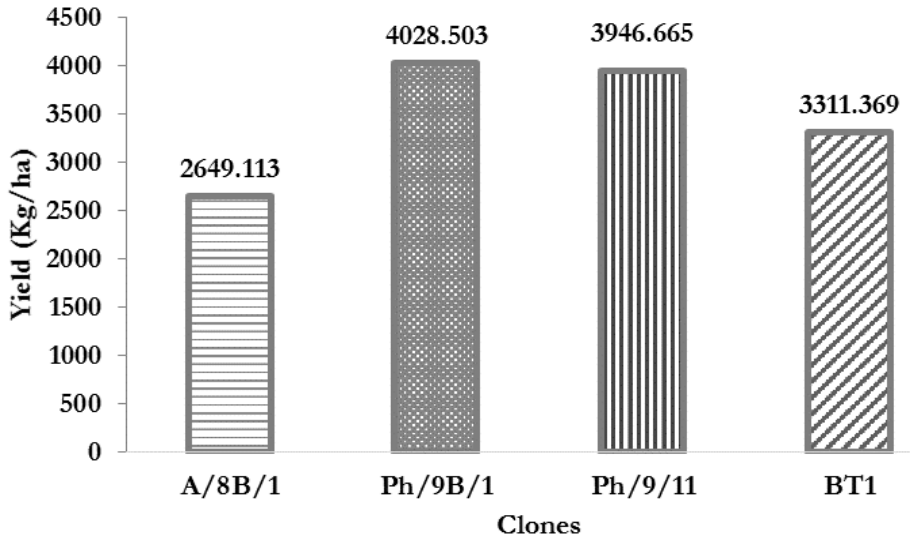


Fig. 9. Comparative yield of clones made tea (kg/ha)

Table 20. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
A/8B/1	7.10	7.72	7.36	7.15	2.29	31.62	A
Ph/9B/1	7.30	7.38	7.41	7.45	2.84	32.98	AA
Ph/9/11	7.73	7.38	7.12	7.31	2.89	32.43	AA
BT1	7.72	7.63	7.68	7.40	2.85	33.28	AA

(A: Average, AA: Above Average, E: Excellent cup quality)

All the Test clones were comparable in terms of cup quality with the control BT1 excepting A/8B/1 which performed average cup quality with the control.

B3-45: Yield and Quality Trial of Three Test clones Selected from Amo, Phulcherra and Shumshernugger T. Es.; Test clones- A/8/61, Ph/9/68A, Sh/D/11/18 (retrial from Expt. B2-26) and One Introduced Clone SC/12/28 against Standard BT2 (BTRI, 2005-2016)

The plants of this trial were deep skiffed at 68 cm in 2016. There were 21 plucking rounds in 2016. The yield data were analyzed and presented in Table 21 and made tea production in kg/ha in Fig. 10.

Table 21. Yield of green leaves (g/plant)

Clone	Year	Ph/9/68A	Sh/D/11/18	A/8/61	SC/12/28	BT2
Treatment mean	2016	765.25	688.1	1013.38	749.55	614.35

Treatment difference: Insignificant

The analytical results reveal that yield difference was not significant in 2016; all test clones were comparable with the control BT2. The cup quality of made tea for all the test clones was assessed through organoleptic test. The average scores are shown in Table 22.

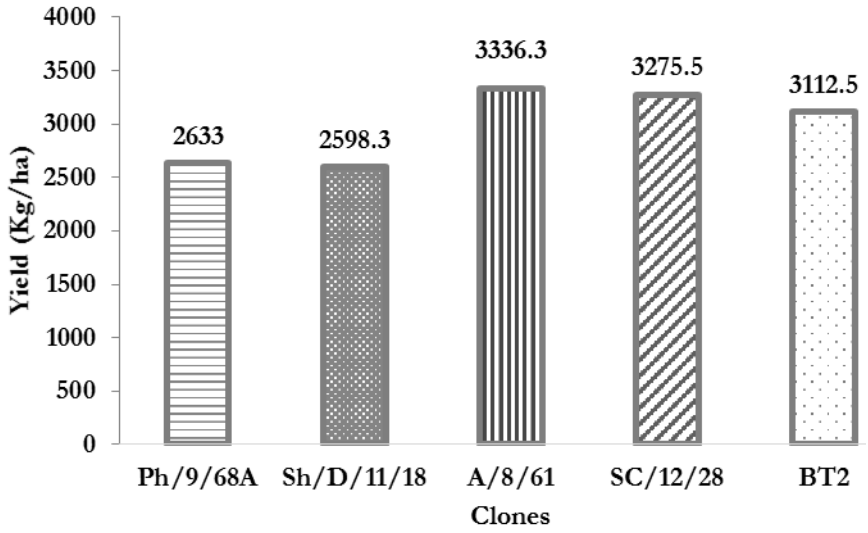


Fig. 10. Comparative yield of clones made tea (kg/ha)

Table 22. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
A/8/61	7.32	7.32	7.52	7.39	2.86	32.41	AA
Ph/9/68A	7.46	7.39	7.60	7.28	2.58	32.55	AA
Sh/D/11/18	7.21	7.38	7.66	7.28	2.82	32.35	AA
SC/12/28	7.20	7.21	7.36	7.50	3.01	32.28	AA
BT2	7.2	7.45	7.66	7.72	2.70	33.08	AA

(A: Average, AA: Above Average, E: Excellent cup quality)

All the test clones were comparable in terms of cup quality. However, the flavoury character of BT2 was not considered in the case of assessing cup quality.

B3-46: Yield and Quality Trial of Four Test clones Selected from BTRI Farm (Dulia Section); Test clones – D1/18, D/6, D/10 and D/12 against Standard BT5 (BTRI, 2005-2016)

The plants of this trial were deep skiffed at 68 cm in 2016. There were 18 plucking rounds in the reporting year. The yield data were analyzed and presented in Table 23 and made tea production in kg/ha in Fig. 11.

Table 23. Yield of green leaves (g/plant)

Clone	Year	D1/18	D/6	D/10	D/12	BT5
Treatment mean	2016	957.36	1112.78	851.78	809.94	1085.14

Treatment difference: Insignificant

The analytical results reveal that all the test clones are comparable in respect of yield with the control BT5. The cup quality of made tea for all the test clones was assessed through organoleptic test. The average scores are shown in Table 24.

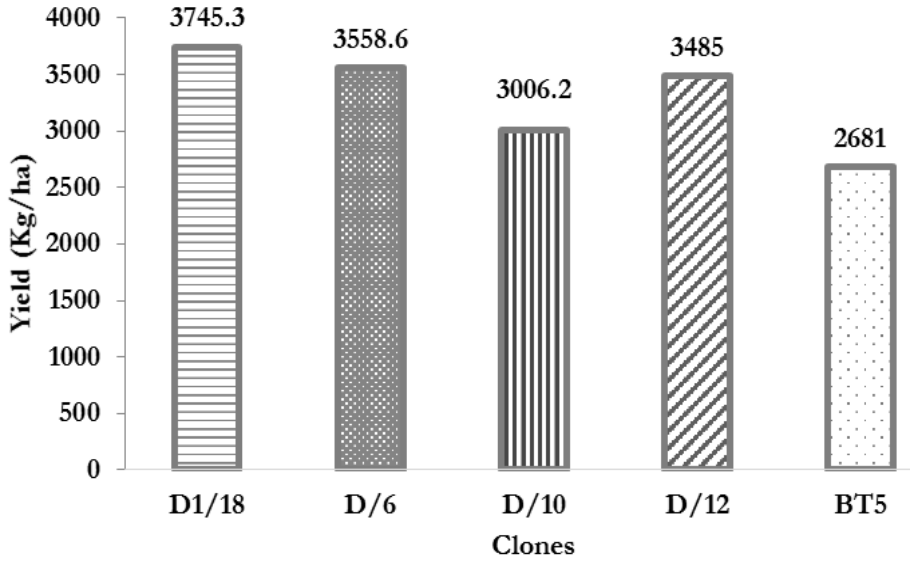


Fig. 11. Comparative yield of clones made tea (kg/ha)

Table 24. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
D1/18	7.70	7.40	7.62	7.55	2.79	33.06	AA
D/6	7.54	7.34	7.65	7.78	2.82	33.13	AA
D/10	7.14	7.55	7.34	7.67	2.65	32.35	AA
D/12	7.23	7.16	7.29	7.27	2.30	31.25	A
BT5	7.16	7.25	7.63	7.43	2.78	32.25	AA

(A: Average, AA: Above Average, E: Excellent cup quality)

Test clones excepting D/12 are comparable with the control while D/12 is inferior to the control.

B3-47: Yield and Quality Trial of Four Test clones Selected from Phulcherra T. E. and BTRI Germplasm Bank; Test clones-Ph/9/92, BS/3, Ph/9/108 and G/61/8 against Standard BT15 (BTRI, 2006-2016)

The plants of this trial were light pruned at 60 cm in 2016. There were 19 plucking rounds in 2016. The yield data were analyzed and presented in Table 25 and made tea production in kg/ha in Fig. 12.

Table 25. Yield of green leaves (g/plant)

Clone	Year	Ph/9/92	BS/3	Ph/9/108	G/61/8	BT15
Treatment mean	2016	872.12	783.04	843.23	855.26	842.42

Treatment difference: LSD at 5% = 316.89

The statistical results reveal that yield difference was significant (at 5% level of significance) in 2016; all the test clones excepting Ph/9/92 are comparable in terms of yield with the control. The yield performance of test clone Ph/9/92 was higher than the control BT15. The cup quality of made tea for all the Test clones was assessed through organoleptic test. The average scores are shown in Table 26.

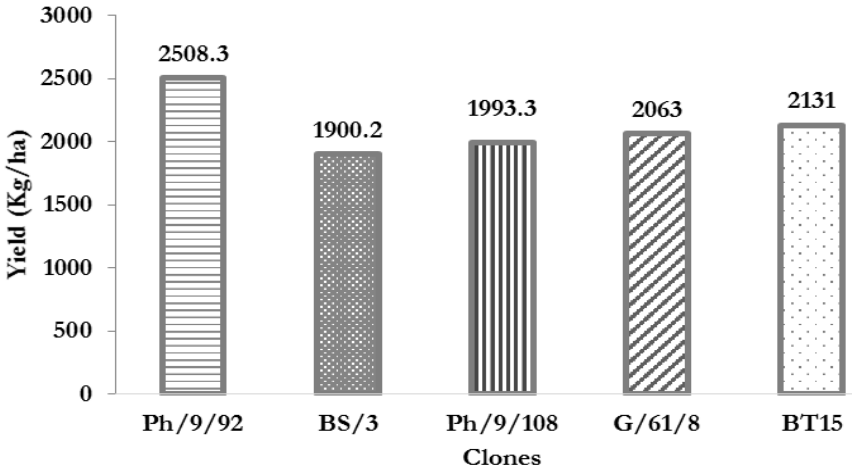


Fig. 12. Comparative yield of clones made tea (kg/ha)

Table 26. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
Ph/9/92	7.60	7.29	7.52	7.37	2.75	32.53	AA
BS/3	7.20	7.38	7.19	7.10	2.27	31.14	A
Ph/9/108	7.45	7.61	7.31	7.47	2.76	32.60	AA
G/61/5	7.41	7.58	7.66	7.68	2.85	33.18	AA
BT15	7.83	7.77	7.83	7.70	3.48	34.61	E

(A: Average, AA: Above Average, E: Excellent cup quality)

The test clones Ph/9/92, Ph/9/108 and G/61/5 gave above average cup quality while the control BT15 gave excellent cup quality. The test clone BS/3 gave average cup quality with the control.

B3-48: Yield and Quality Trial of Four Test clones Selected from Shumshernugger and Amo T. Es. Test clones – A/8/124, Sh/10/2, A/8/125 A/11/38 against Standard BT2 (BTRI, 2009-2019)

The plants of this trial were light pruned at 45 cm in 2016. There were 16 plucking rounds in 2016. The yield data were analyzed and presented in Table 27 and made tea production in kg/ha in Fig. 13.

Table 27. Yield of green leaves (g/plant)

Clone	Year	A/8/124	Sh/10/2	A/8/125	A/11/38	BT2
Treatment mean	2016	701.21	914.91	618.26	783.34	905.86

Treatment difference: 2016- Insignificant

The analytical results reveal that yield difference was insignificant in 2016; all the test clones gave similar yield with the control BT2. The cup quality of made tea for all the test clones was assessed through organoleptic test. The average scores are shown in Table 28.

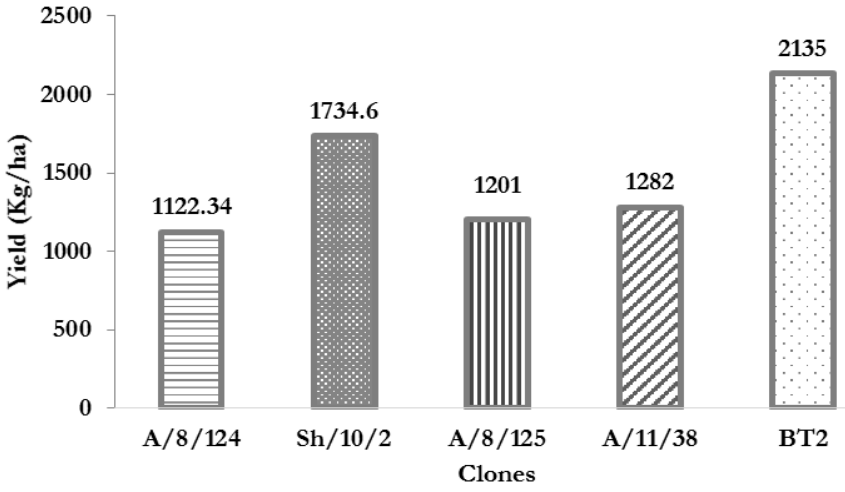


Fig. 13. Comparative yield of clones made tea (kg/ha)

Table 28. Quality scores

Clone	Infusion	Liquor colour	Brisknes s	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
A/8/124	7.42	7.51	7.36	7.43	2.85	32.57	AA
Sh/10/2	7.34	7.62	7.73	7.34	2.78	32.82	AA
A/8/125	7.56	7.58	7.79	7.32	2.78	33.03	AA
A/11/38	7.51	7.16	7.24	7.53	2.84	32.29	AA
BT2	7.51	7.65	7.41	7.65	2.74	32.96	AA

(A: Average, AA: Above Average, E: Excellent cup quality)

All the test clones were similar to the control BT2 in respect of cup quality. However, the flavoury character of BT2 was not considered in the case of assessing cup quality.

B3-49: Yield and Quality Trial of Four Test clones Selected from Shumshernugger T.E. (Sh/10/5, Sh/D/13/4and Amo T. Es. Test clones – A/8/128, BS/91/6, against Standard BT2 (BTRI, 2011-2019)

The plants were light pruned at 45 in 2016 and tipping was done at 45 cm. There were 16 plucking rounds during the cropping period. The yield data were analyzed and presented in Table 29 and made tea production in kg/ha. in Fig.14.

Table 29. Yield of green leaves (g/plant)

Clone	Year	Sh/D/13/4	BS/91/6	Sh/10/5	A/8/128	BT2
Treatment mean	2016	662.94	513.07	502.73	605.18	612.39

Treatment difference- Insignificant

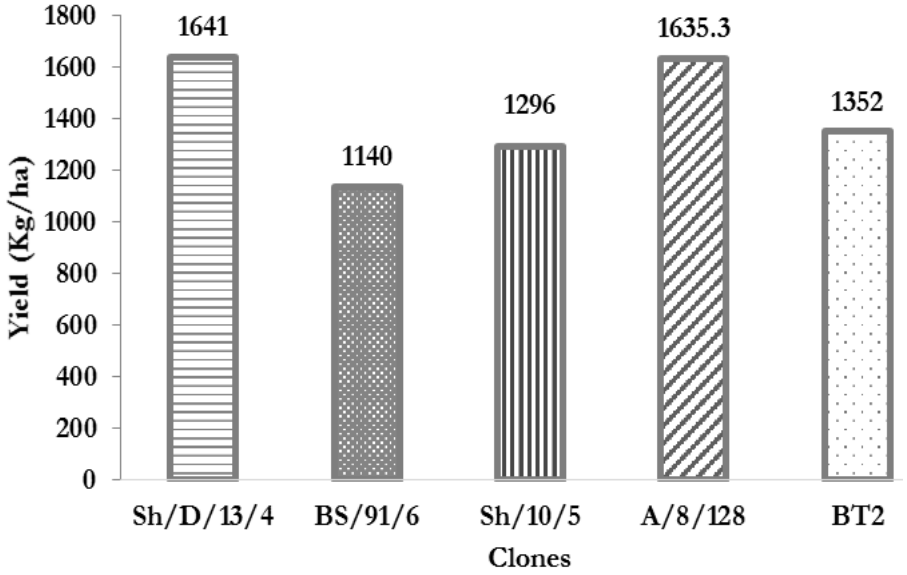


Fig. 14. Comparative yield of clones made tea (kg/ha)

The analytical results reveal that yield difference was not significant in 2016; all the test clones gave similar yield with the control BT2. The cup quality of made tea for all the

test clones was assessed through organoleptic test. The average scores are shown in Table 30.

Table 30. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
Sh/D/13/4	7.30	7.34	7.33	7.86	2.67	32.50	AA
BS/91/6	7.32	7.40	7.34	7.30	2.76	32.18	AA
Sh/10/5	7.45	7.70	7.50	7.31	2.73	32.67	AA
A/8/128	7.41	7.40	7.32	7.19	2.76	32.08	AA
BT2	7.46	7.32	7.32	7.44	2.79	32.31	AA

(A: Average, AA: Above Average, E: Excellent cup quality)

All the test clones were similar to the control BT2 in respect of cup quality. However, the flavoury character of BT2 was not considered in the case of assessing cup quality.

B3-50: Yield and Quality Trial of Four Test Clones Selected from Baraoorah T.E., Shumshernugger T.E. and Amo T. Es. Test Clones – B/8/79, Sh/9/43 and A/8/194 against Standard BT2 and BT17 (BTRI, 2014-2032)

The experiment was initiated in May 2014 at BTRI farm under Latin Sqaure Design with 105cm x 60cm spacing normal cultural practices were followed. The plants were pruned at 45 cm in November, 2016 and tipping was done at 71 cm.

There were 15 plucking rounds during the cropping period. The yield data were analyzed and presented in Table 31 and Fig. 15.

Table 31. Yield of green leaves (g/plant)

Clone	Year	BT17	B/8/79	Sh/9/43	A/8/194	BT2
Treatment mean	2016	161.47	209.29	185.34	160.52	205.6

Treatment difference- Insignificant

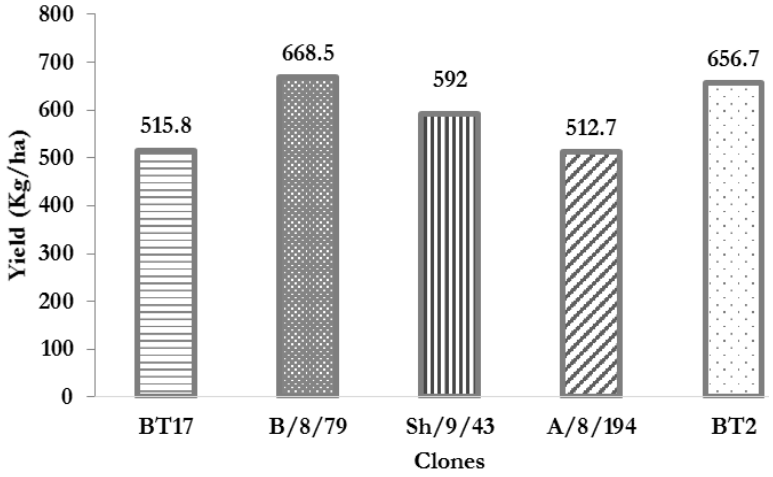


Fig. 15. Comparative yield of clones made tea (kg/ha)

The analytical results reveal that yield difference was insignificant in 2016; all the test clones gave similar yield with the control.

B3-51: Yield and Quality Trial of Two Test Clones Selected from Baraoorah T.E., and Shumshernugger T.E. Test Clones – B/8/79 and Sh/9/71 against Standard BT2, BT17 and BTS1 (BTRI, 2015-2032)

The experiment was initiated in May 2015 at BTRI farm under Latin Sqaure Design with 105cm x 60cm spacing normal cultural practices were followed. The plants were breaking/de-centered at 15-22 cm in November, 2016 and tipping was done at 50 cm.

There were 11 plucking rounds during the cropping period in 2016. The yield data were analyzed and presented in Table 32 and Fig. 16.

Table 32. Yield of green leaves (g/plant)

Clone	Year	BTS1	B/8/79	Sh/9/71	BT17	BT2
Treatment mean	2016	48.4	55.5	59.72	41.59	49.74

Treatment difference- Insignificant

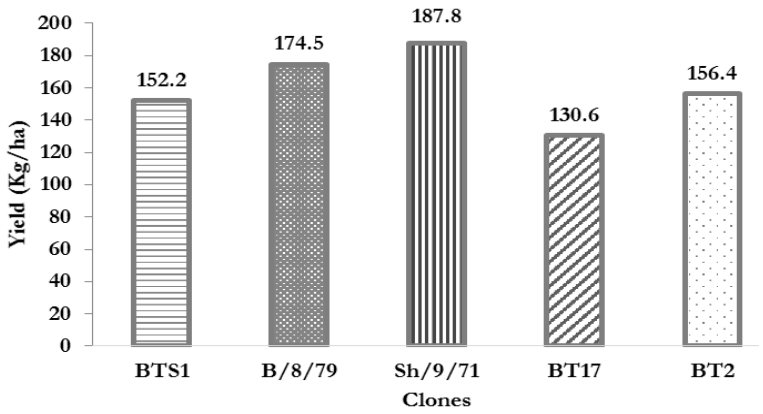


Fig. 16. Comparative yield of clones made tea (kg/ha)

The analytical results reveal that yield difference was insignificant in 2016; all the test clones gave similar yield with the control.

B3-52: Yield and Quality Trial of Two Test Clones Selected from Baraoorah T.E., and Shumshernugger T.E. Test Clones – B/8/66 and Sh/8/61, against Standard BT2, BT17 and BTS1 (BTRI, 2014-2031)

The experiment was initiated in May 2015 at BTRI farm under Latin Sqaure Design with 105cm x 60cm spacing normal cultural practices were followed. The plants were breaking/de-centered at 15-22 cm in November, 2015 and tipping was done at 50 cm.

There were 11 plucking rounds during the cropping period in 2016. The yield data were analyzed and presented in Table 33 and Fig. 17.

Table 33. Yield of green leaves (g/plant)

Clone	Year	BT17	B/8/66	BTS1	A/8/194	BT2
Treatment mean	2016	47.4	54.5	48.4	53.5	49.74

Treatment difference- Insignificant

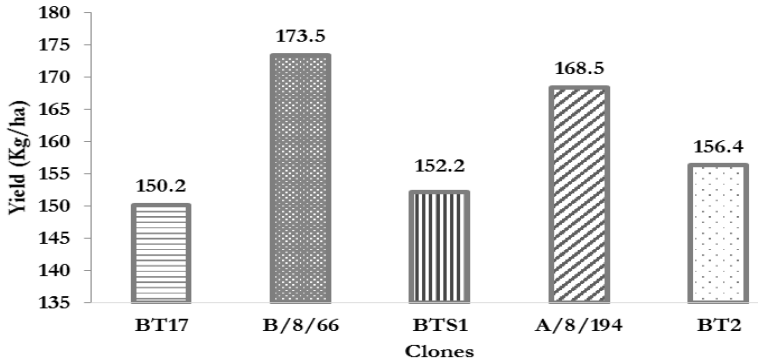


Fig. 17. Comparative yield of clones made tea (kg/ha)

The analytical results reveal that yield difference was insignificant in 2016; all the test clones gave similar yield with the control.

B3-53: Yield and Quality Trial of Four Test Clones Selected from Baraoorah, Shumshernugger and Mirzapure T.E. (T1, T2, T3 and T4 against Standard BT2 (BTRI Fatikchori Sub-Station, 2016-ongoing)

The experiment was initiated in February 2017 at BTRI Fatickcharri Sub-Station under Latin Square Design with 105cm x 60cm spacing.

B4: BREEDING OF TEA (NO. OF EXPERIMENTS-5)

B4-1.1: Controlled Pollination between Selected Clones/Agrotypes and Selection of Generative Clones for the Establishment of Clonal Seed Reserve (1964-)

Hybridization between the following clone pairs were done in order to identify new biclonal combinations (for hybrid seed production) as well as to select vegetative clones from the progenies.

Hybridization between the following parents was done in 2016:

BT2 X TV23, TV23 X BT2, BT8X TV23, TV23 X BT8, BT17 X BT2, BT2 X BT17, BT4 X TV23, TV23 X BT4, BT6 X TV23, TV23 X BT6, BT1 X BT2, TV18 X BT2.
The plants raised from earlier crosses are being preserved in Germplasm Bank. Yield, quality and other performance criteria of the progeny are being recorded.

B4-1.5: Establishment of a Biclonal Seedbarie with Clones TV18 and BT3.

Seedlings from the stock are being observed in the trial plots. Seeds are being collected and distributed to the Tea Estates. Seedbarie (B3-1.5) comprising TV18 and BT3 have been kept under observation. Comparative yield and quality potential of the hybrid progeny (TV18 and BT3) are being assessed against other standard biclonal seeds (B3-1.8 & B3-1.9).

B4-1.8: Comparative Yield and Quality Trial of BTRI Released Biclonal Stock BTS1, Biclonal Stock T18B3, Allynugger Polyclonal Stock (ANPS), Phulbari General Seed Stock (PBS) and Clone BT1 (BTRI, 1999-2016)

The plants of this trial were light pruned at 61 cm in 2016. There were 16 plucking rounds in 2016. The yield data were analyzed and presented in Table-34 and made tea production in kg/ha in Fig. 18.

Table 34. Yield of green leaves (g/plant)

Clone	Year	BT1	BTS1	PBS	ANPS	T18B3
Treatment mean	2016	1048.48	941.56	862.1	965.99	984.92

Treatment difference: 2016- Insignificant

The analytical results reveal that there was no significant yield difference between the biclonal seed stocks. All the biclonal stocks were comparable with the control BT1. The cup quality of made tea for all the treatments was assessed through organoleptic test. The average scores are shown in Table 35.

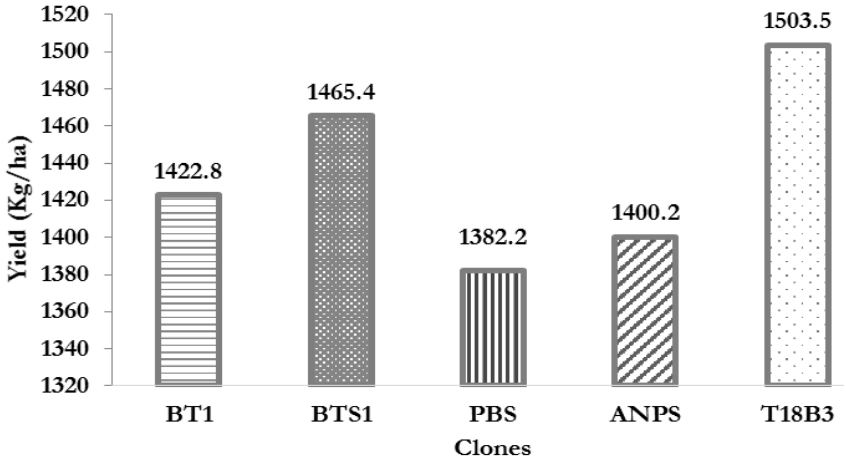


Fig. 18. Comparative yield of clones made tea (kg/ha)

Table 35. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
BT1	7.38	7.60	7.34	7.63	2.78	32.73	AA
BTS1	7.44	7.50	7.66	7.34	2.87	32.82	AA
PBS	7.14	7.18	7.26	7.33	2.89	31.78	A
ANPS	7.51	7.58	7.26	7.42	2.84	32.61	AA
T18B3	7.61	7.64	7.56	7.54	2.83	33.22	AA

(A: Average, AA: Above Average, E: Excellent cup quality)

The biclonal BTS1 and T18B3 are comparable in cup with the control clone BT1 while PBS was inferior to the control.

B3-1.9: Comparative Trial of 4 Biclonal Seed Stocks (BTS1, BTS3, TV18 × BT3 & TS463) and 3 Parental Clones (BT1, TV1 & TV19) (2002-2016)

The plants of this trial were light skiffed at 61 cm in 2016. There were 18 plucking rounds in 2016. The yield data were analyzed and presented in Table-36 and made tea production in kg/ha in Fig.19.

Table 36. Yield of green leaves (g/plant)

Clone	Year	BTS1	BTS3	TV18 × BT3	TS463	BT1	TV1	TV19
Treatment mean	2016	1562.54	1602.88	1565.72	1555.76	1461.42	1460.0	1764.92

Treatment difference: LSD at 5% = 214.65917

The statistical results reveal that there was significant yield difference (at 5% level of significance) between the seedling jats. All the biclonal progenies except TV19, BTS3 and TV18 × BT3 were comparable with the parent-lines. The cup quality of made tea for all the treatments was assessed through organoleptic test. The average scores are shown in Table 37.

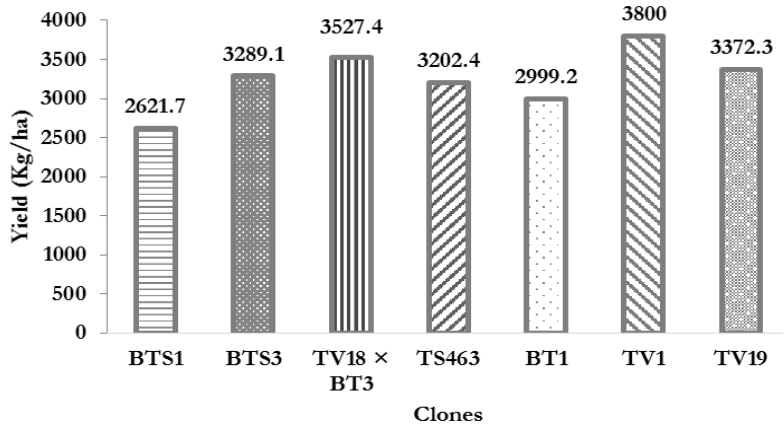


Fig. 19. Comparative yield of clones made tea (kg/ha)

Table 37. Quality scores

Clone	Infusion	Liquor colour	Brisknes s	Strength	Creamin g down	Total	Remarks
	10	10	10	10	10	50	
BTS1	7.31	7.62	7.49	7.61	2.93	32.96	AA
BTS3	7.34	7.15	7.12	7.51	2.69	31.81	A
TV18 × BT3	7.42	7.35	7.15	7.56	2.73	32.22	AA
TS463	7.59	7.36	7.42	7.32	2.76	32.45	AA
BT1	7.27	7.34	7.34	7.44	2.78	32.17	AA
TV1	7.54	7.34	7.56	7.64	2.90	32.98	AA
TV19	7.41	7.34	7.53	7.49	2.81	32.58	AA

(A: Average, AA: Above Average, E: Excellent cup quality)

In all the treatments excepting BTS3 the cup qualities were "Above Average" while BTS3 was just "Average".

B5: SURVEY AND CONSERVATION OF GENE RESOURCES OF TEA IN BANGLADESH (BTRI, 1981)

B5-8: Survey and Conservation of Gene Resources of Tea in Bangladesh (BTRI, 1981-)

A total of 516 tea germplasm has been maintained (*ex-situ* conservation) in the Germplasm Bank in order to use in future for varietal improvement.

B6: DEVELOPING A SUSTAINABLE AND COST EFFECTIVE PROTOCOL FOR MANUFACTURING DIFFERENT KINDS OF TEA RATHER THAN CTC TEA AND OTHER EXPERIMENTS

B6.1. Developing a sustainable and cost effective protocol for manufacturing health benefitted green tea and its derivatives (value added green tea)

This experiment started from August 2016. Data will be complied and analyzed after the completion of the experiment.

B5.2. Study on seasonal effect and different clonal effect on recovery percentages of green tea

This experiment started from August 2016. Data will be complied and analyzed after the completion of the experiment.

B5.3. Effect of different types of mulching materials on morpho-physiological characteristics of tea

This experiment will be conducted very soon.

4.2. Morphological characterization of BTRI released clones, some test clones and wild genotypes

This experiment will be conducted very soon.

OTHER ACTIVITIES

Tours/Visits

During 2016 Principal Scientific Officer, Senior Scientific Officer, Scientific Officer and Senior Farm Assistant of the division paid visits to different Tea Estates and other related places for the experimental, advisory and official purposes, which are summarized below:

Table 38. Tours/visits to different Tea Estates and other related places in 2016

Year	Experimental	Advisory	Others	Total
2016	26	11	-	37

Courses on Tea Culture

Principal Scientific Officer, Senior Scientific Officer, Scientific Officer and Senior Farm Assistant of the Division gave comprehensive lectures and practical demonstration on the method of tea improvement, clonal identification, establishment of biclonal seedbaries and NCP, tea tasting, nursery management, etc. at the 52h Annual Courses

arranged at BTRI for the covenanted staff of Tea Estates and 7 day course on "Tea Tasting and Quality Control" for the officers of Bangladesh Army. Principal Scientific Officer also gave lectures on tea improvement and nursery management in the Annual Courses held at Fatickcharri and at Panchagarh Sub-stations. He delivered lectures as resource speaker at the Management Training Center (MTC) for the Post-Graduate Diploma course and Tea Production Courses organized by Project Development Unit (PDU) of Bangladesh Tea Board.

Tea Tasting Sessions

There were seven tea tasting sessions and three group tea tasting sessions organized in 2016 under the supervision of the Division. Representatives from tea broking houses and tea planters from different Tea Estates participated in the sessions. Summary of the tea tasting sessions are tabulated below:

Table 39. Open day/Valley Tea Tasting Sessions in 2016

Open day/Valley Tea Tasting Sessions	Date	Venue	No. of Estates	No. of participants
1. BTRI	30.07.16	BTRI	81	111
2. BTRI Sub-station Oodaleah	12.11.16	BTRI Sub-station Oodaleah	20	125
3. Monu-Doloi Valley	16.07.16	Monu-Doloi Valley Club	15	21
4. Juri	23.07.16	Juri Valley Club	16	23
5. Luskerpore Valley	13.08.16	Loskerpore Valley Club	14	26
6. Lungla Valley	29.09.16	Chandbag Tea Factory	15	22
7. North Sylhet Valley	30.10.16	Khadim Tea Factory	12	20

Table 40. Group Tea Tasting Sessions in 2016

Group Tea Tasting Sessions	Date	Venue	No. of Estates	No. of participants
1. Group Tea Tasting Sessions-01	03.09.16	BTRI Mini Factory	08	11
2. Group Tea Tasting Sessions-02	15.10.16	BTRI Mini Factory	07	09
3. Group Tea Tasting Sessions-03	19.11.16	BTRI Mini Factory	07	10

AGRONOMY DIVISION

Dr. Toufiq Ahmed
Senior Scientific Officer
Agronomy Division

STAFF

During the reporting year, Mr. Masud Rana (Senior Scientific Officer) was on study leave to do his PhD in China. Mr. Arifur Rahman and Mr. Imran Hossen joined as Scientific Officer on 17th February 2016 and 14th March 2016, respectively. The posts of Principal Scientific Officer, Farm Supervisor and Field Assistant were vacant. There was no other change in personnel position of the division.

RESEARCH

Agronomy Division carried out six experiments under two research program namely- Standardization of cultural practices and Development of soil fertility. Results of six experiments on the basis of collected data are briefly discussed below:

AG 1: EFFECT OF DIFFERENT PRUNING CYCLES ON THE YIELD OF DIFFERENT MATURE CLONAL TEA (BTRI Farm, long term: 2010-2023)

Treatments:

T_1 : LP-DS-MS

T_2 : LP-DS-MS-LS

T_3 : LP-LS -DS -MS

T_4 : LP-LS -DS -MS-DS-LS

T_5 : LP-DS-MS-LS -DS-MS-LS

Planting materials:

The clones BT1, BT2, BT5, BT11, BT12 and BT13 were used in the experiment. The experiment was laid out in a Split Plot Design with three replications and total number of plots under the experiment is 90.

The plants were pruned according to the schedule of treatments. Yield data were collected at weekly interval. From the analysis result of yield data 2016, it is observed that there was significant interaction ($p=0.04$) between pruning system and clone (Fig. 1). The highest yield (4,827 kg/ha) observed in the treatment combination of T_5 X BT5 and the lowest was in T_2 X BT11 (2,650 kg/ha). For over all analysis it is observed that in 2016, longer pruning cycles providing higher yield of tea which is supported by the previous years (Table 1). The experiment will be continued and we have to wait until the field experiment is over to make final comments.

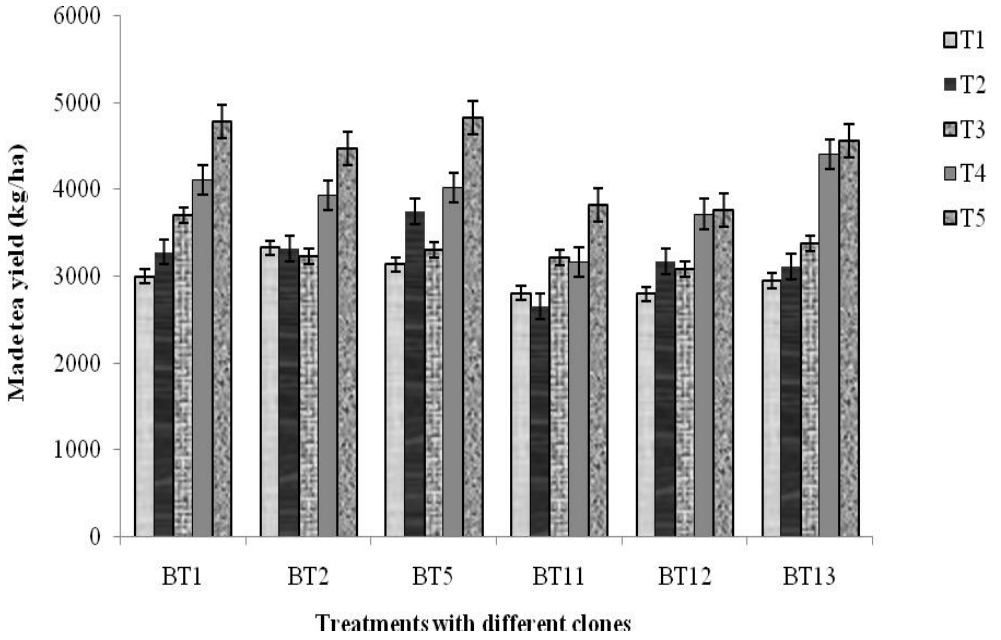


Fig.1. Variation of made tea yield in 2016

Table 1. Made tea yield (kg/ha) of different treatments in 2016

Treatments	Yield (kg/ha)
T_1 (LP-DS-MS)	3002 c
T_2 (LP-DS-MS-LS)	3212 c
T_3 (LP-LS-DS-MS)	3316 c
T_4 (LP-LS-DS-MS-DS-LS)	3891 b
T_5 (LP-DS-MS-LS- DS-MS-LS)	4370 a
LSD (0.05)	415
CV (%)	10

AG 2: MANAGEMENT OF SHADE PLANT CANOPY FOR MAXIMIZING TEA PRODUCTION IN BANGLADESH (BTRI Farm, long term: 2011-2017)

Treatments:

T_1: Control (normal practice – pruning is not done)

T_2: Pruning at 2 meter height

T_3: Pruning at 2 and 3 meter height (in the consecutive years)

T_4: Pruning at 2, 3 and 4 meter height (in the consecutive years)

T_5: Pruning at 2, 3, 4 and 5 meter height (in the consecutive years)

The experiment is laid out with *Albizzia odoratissima* shade tree. Increment of canopy coverage in the pruned shade plants is encouraging. For overall analysis, based on the canopy coverage data of shade tree in the year 2015 spreading of canopy was highly significant for treatments. Maximum spreading of shade tree canopy was observed in the treatment of T_5 (pruning at 2, 3, 4 and 5 meter height in the consecutive years) which was similar with T_4 (pruning at 2, 3 and 4 meter height in the consecutive years) but different with others. The experiment was continued in 2016 to know its effect on tea yield. After analysis of collected data, it is observed that there is significant effect of treatments on harvested leaf yield. Maximum yield (2949 kg/ha) was observed in T_5 which was identical with T_4 and different with others (Fig. 2).

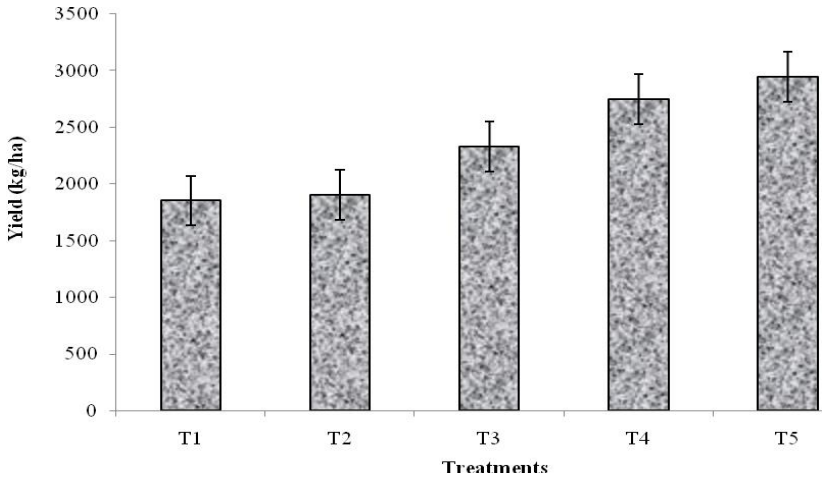


Fig.2. Variation of made tea yield due to treatments

AG 3: EFFECT OF DIFFERENT DOSAGES OF CHEMICAL FERTILIZERS AND ORGANIC MANURES IN PIT ON THE ESTABLISHMENT OF CLONAL TEA (BTRI Farm, long term: 2014-2019)

Treatments:

T_1: No fertilizer and manure is applied in pit

T_2: 1 kg decomposed cow dung was applied

T_3: 2 kg decomposed cow dung was applied

T_4: ½ kg decomposed oil cake was applied

T_5: 30 g TSP + 15 g MOP was applied

T_6: 1 kg decomposed cow dung + ½ kg decomposed oil cake was applied

T_7: 1.5 kg decomposed cow dung + 30 g TSP + 15 g MOP was applied

During the time of plantation, manures and fertilizer were applied in the pit according to the treatments. Normal practices for intercultural operations were followed by BTRI recommendation. Different morphological characters of tea plants in each treatment were studied during de-centering i.e. 1 year later after plantation (in 2015). Similarly in 2016, at the time of 1st frame formation pruning different morphological parameters were recorded and analyzed. Number of branches were significantly different for treatments. Greater number of branches observed in a plant of T_7 (1.5 kg decomposed cow dung + 30 gm TSP + 15 gm MOP is used) which was similar with T_3 (2 kg decomposed cow dung is used) and T_6 (1 kg decomposed cow dung + ½ kg oil-cake is used) but significantly different with others and the lowest number of leaves observed in T_1 (control), presented in Fig. 3. For the fresh weight of plant, maximum weight observed in T_7 and the minimum was in T_1. The experiment will be continued to know the impact of treatments up to the bush formation.

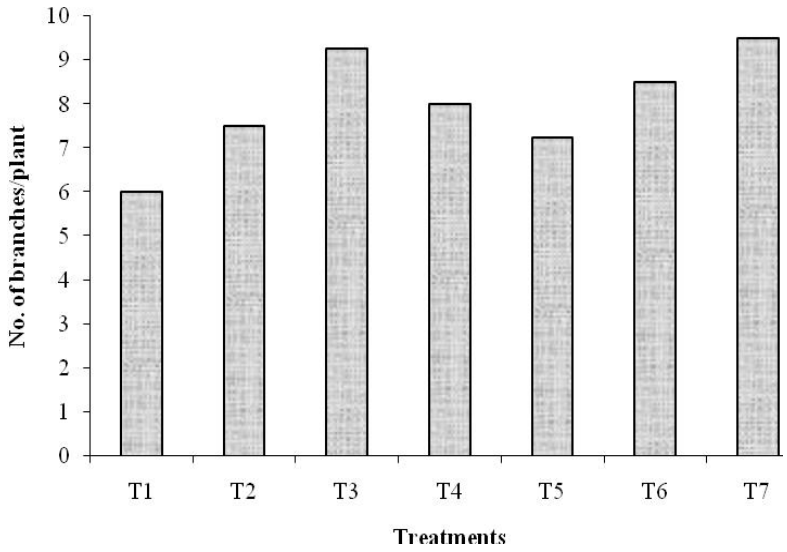


Fig.3. Variation of branch number during the 2nd year pruning (FFP1)

AG 4: EFFECT OF DIFFERENT TIME OF PRUNING ON YIELD AND CROP DISTRIBUTION OF MATURE CLONAL TEA (BILASHCHERRA Ex. Field, short term: 2015-2017)

Treatments:

T_1: Pruning in mid of October
T_2: Pruning in mid of November
T_3: Pruning in mid of December (Control – Normal practice)
T_4: Pruning in mid of January
T_5: Pruning in mid of February
T_6: Pruning in mid of March

The experiment was laid out at the Bilascherra Experimental Farm with randomized complete block design (RCBD). Pruning operation was completed according to the schedule of treatments. Like the previous year, in 2016 weekly harvested leaf yield was collected from each treatment and analyzed the data at the end of cropping year. It was observed that the yield was not significantly different for treatments (Figure 4). In 2016, maximum yield was observed in the treatment of November pruning but in 2015 it was in December pruning. The experiment should be continued another one/two years to finalize the result.

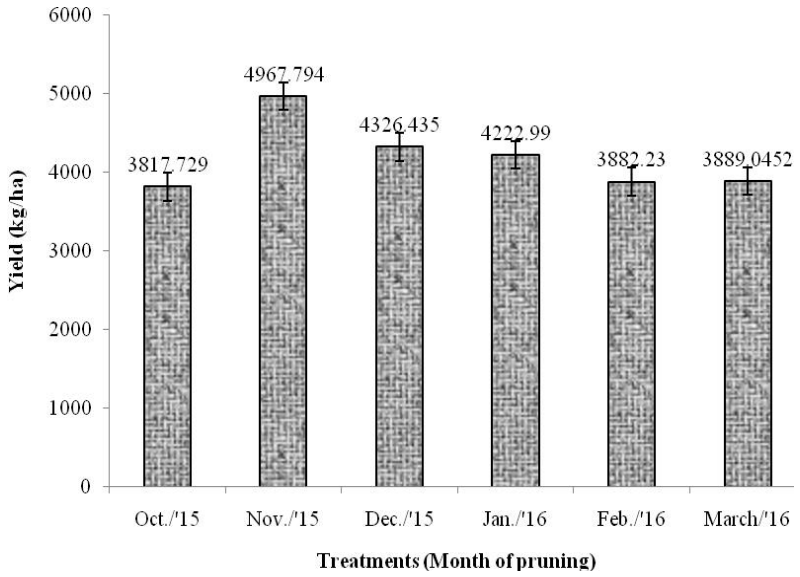


Fig.4. Variation of made tea yield due to the variation of pruning time

AG 5: EFFECT OF A PLANT GROWTH REGULATOR (BIOKAD) ON GROWTH AND YIELD OF MATURE CLONAL TEA (BTRI Farm, short term: 2015-2016, completed)

Treatments:

T_1: Control
T_2: BIOKAD applied @ 200 ml/ha
T_3: BIOKAD applied @ 300 ml/ha (recommended rate of UPASI)
T_4: BIOKAD applied @ 400 ml/ha

The experiment was laid out as randomized complete block design at the BTRI Farm. The plant growth regulator (BIOKAD) was applied according to the treatments once in a month. Like 2015, data of harvested green leaf of every week recorded from each plot throughout the plucking season in 2016. After analysis of harvested leaf yield, it was observed that there was no significant difference among treatments (Figure 5).

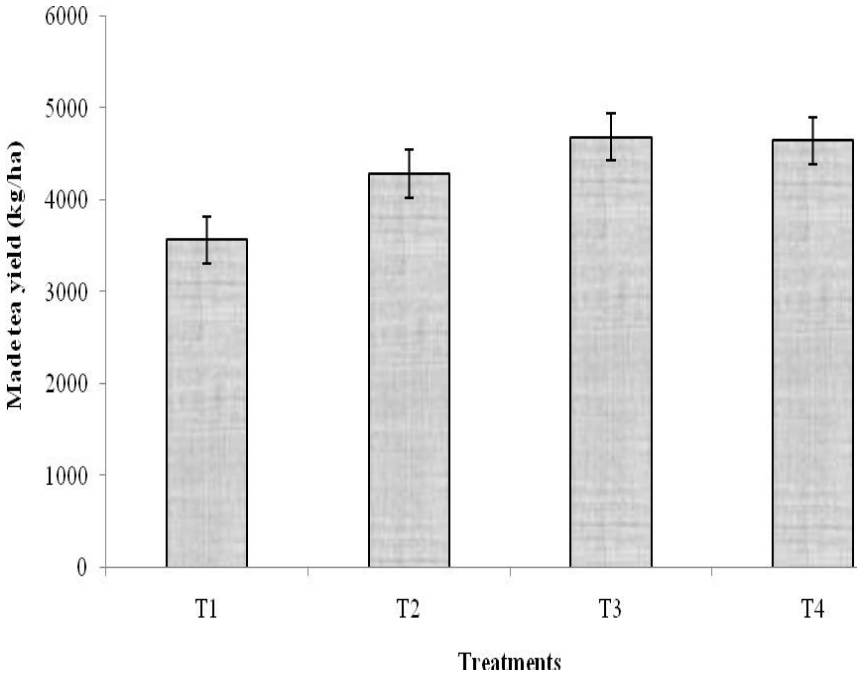


Fig.5. Variation of made tea yield due to treatments

AG 6: EFFECT OF A PLANT GROWTH REGULATOR (FLORA) ON GROWTH AND YIELD OF MATURE CLONAL TEA (BTRI Farm, short term: 2016-2017)

Treatments:

T_1: Control

T_2: Flora applied @ 0.4 L/ha

T_3: Flora applied @ 0.8 L/ha (recommended dosage)

T_4: Flora applied @ 1.2 L/ha

The experiment was laid out as randomized complete block design at the BTRI Farm. The plant growth regulator (Flora) was applied according to the treatments once in a month. Data of harvested green leaf of every week recorded from each plot throughout the plucking season. After analysis of harvested leaf yield, it was observed that there was no significant difference among treatments (Fig. 6). The experiment will be continued for another year more.

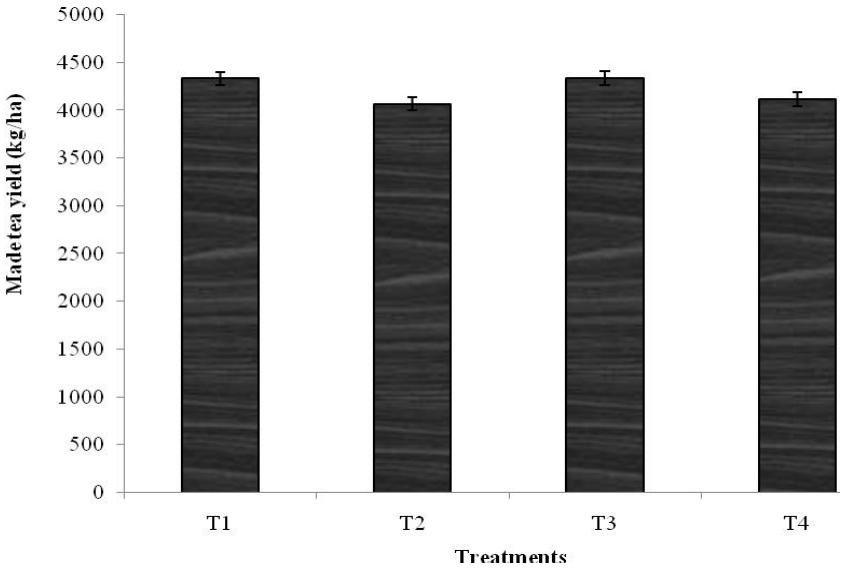


Fig.6. Variation of made tea yield due to treatments

OTHER ACTIVITIES

Research Publication

Based on the previous data of completed experiments, researchers of the division published a scientific paper during the reporting year-

01. I. Ahmed, A. Hossain, Rowshon Ara, M.D. Ziaul Hoque, Md. Liton Miah and T. Ahmed. 2015. Effect of Rainfall on Yield and Crop Distribution of Tea. *Journal of Global Biosciences*. 4(5): 2304-2315.

Tours/Visits

Researchers of the division paid 202 visits to different Tea Estates for experimental, advisory services and other official purposes during the reporting year. Number of visits for the reporting year 2016 presented in the table below:

Table 3. No. of visit paid by the scientific personnel of the division during the reporting year

Reporting year	No. of experimental visits	No. of advisory visits	No. of other official tours
2016	166	29	7

Workshops / Seminars

Scientific personnel of Agronomy division arranged 33 workshops in different tea estates and BTRI to disseminate updated technologies among planters on plantation, pruning, tipping, plucking, drought management in tea etc.

Annual Course

Scientific personnel of the division delivered lectures on tea culture in the 51th BTRI annual course.

BTRI Main Farm

Md. Majibur Rahaman (Senior Field Assistant, Botany division) was acting as the Farm supervisor in-charge of BTRI Farm. The institute is spread over an area of 34.90 hectare and breakup of the land is as follows:

Under tea	
1) Young clonal tea	: 0.33 ha
2) Mature clonal tea	: 4.64 "
3) Mature seedling tea	: 4.15 "
4) Mother bush, seed bari etc.	: 1.48 "
5) Tea nursery	: 0.62 "
Total	: 11.22 ha
Other crops	
1) Rehabilitation crops	: 0.16 ha
2) Nursery	: 1.09 "
3) Mixed forest, Orchard, Lemon, Guava etc.	: 5.21 "
Total	: 6.46 ha
Other uses	
Office, Laboratory, Guest house, Mosque, School, Factory, Club house, labour line, roads etc.	: 17.22 ha
Grand total	**: 34.90 ha**

Improved planting materials supplied:

Year of supply	No. of fresh cuttings	No. of rooted cuttings
2016	3,35,940	4,200

Green leaf production and earning from other farm products:

Reporting year	Green leaf production in kg	Earning from other farm products in tk
2016	83,556	2,680/-

Independence and Victory Day

Independence and Victory day were observed with due solemnity during the reporting year.

Meteorological data for the year 2016

Month	No. rainy days	Rainfall (mm)	Evaporation (mm)	Temperature (°C)		Dew point (°C)	Sunshine hrs.	R.H. (%)
				Max.	Min.			
January	1	2	59.3	24.9	9.9	13.1	4.4	72.4
February	6	131	86.8	29.5	15.5	16.0	5.6	65.7
March	4	94	111	32.0	18.9	19.2	6.7	67.2
April	16	303	172	33.5	23.2	23.7	6.7	72.6
May	23	475	147.3	32.4	23	23.5	5.6	77.2
June	21	387	143.3	33.3	25.3	25.2	4.9	79.1
July	27	186	128	32.8	24.9	25.2	4.0	79.9
August	18	307	163.2	34.0	25.9	25.5	6.0	76.7
September	18	177	114.3	33.3	25.3	25.5	4.8	81.7
October	13	227	108.6	32.8	23.4	24.5	6.2	80.2
November	3	228	85.4	29.5	17.1	19.1	7.4	76.0
December	0	0	85.2	28.6	12.9	16.0	7.3	72.5
Total/Average	150 (Total)	2517 (Total)	1404.4 (Total)	31.4	20.4	21.4	5.8	75.1

ENTOMOLOGY DIVISION

Mohammad Shameem Al Mamun
Senior Scientific Officer

STAFF

Mr. Md. Jahangir Alam joined as Scientific Officer on 2nd May 2016. The posts of Principal Scientific Officer and Senior Farm Assistant were lying vacant during the period under report. There was no other change in personnel position of the division.

RESEARCH

Ten experiments under six programme areas were carried out during the year of 2016. The experiments were - Evaluation of sex pheromone trap and sticky traps against *Helopletis* & Thrips; Effect of some organic amendments for the control of plant parasitic nematodes in tea; Evaluation of some indigenous plant extracts against *Helopeltis*, red spider mites & nematodes;; Searching and identification of bio-control agents for the control of pests in tea; Predation capacity of spider fauna against insect pests of tea; Antagonistic potential of entomopathogens on plant parasitic nematodes in tea; Screening of pesticides against termites, *Helopeltis*, red spider mites and nematodes; Determination of judicious use of pesticides for a model tea estate; Effect of nematicides on soil micro-organism in tea; Dissipation pattern of some commonly used pesticides in tea from bush to mug. Details of the experiments together with their findings are furnished below:

ENT 1: ENTOMOLOGICAL RESEARCH ON CLONAL VARIETIES OF TEA

ENT 1.1. Evaluation of sex pheromone trap and sticky traps against *Helopletis* & Thrips (2016-2017)

An experiment was conducted to evaluate blue sticky traps against Thrips at BTRI main farm. The experiment was laid out in Randomized Complete Block Design. Sex pheromone lure and blue, white & yellow sticky trap has been collected from Ispahani Agro Biotech Ltd. Blue Sticky traps has been set up in 10 m distance from each of traps in the mature section of A2, BTRI main farm. A control plot has also been taken 100 m away from sticky trap plots. Traps were fixed at a height of 5" (inch) above from the bush canopy of tea. A total of six traps were set up in the experimental plot. Data on no. of Thrips & other insects catched in those traps are being collected. Data are being collected at weekly interval.

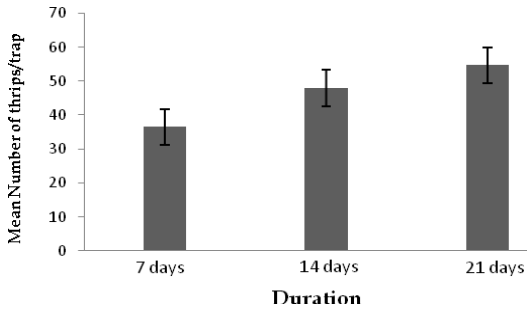


Fig. 1. Performance of blue sticky traps against Thrips in tea field

Result revealed that blue sticky traps captured greater number of thrips, *S. dorsalis* at different intervals. Number of capturing was significantly increased with the increasing of time. The maximum number of Thrips was captured at 21 days (Fig. 1). So, it is clearly indicated that, Capturation of Thrips depends on time. But the traps also captured non-target insects such as Lepidopteron insects (Butterfly and Moth), Hymenopterans' (Braconid, wasp), Dipterans' and Ordinate's (Dragon fly and Damsel fly) insect species available in tea ecosystem.

ENT 1.2. Effect of some organic amendments for the control of plant parasitic nematodes in tea (2016-2017)

The experiment was conducted at Nematology Field laboratory of BTRI with eight different organic materials such as mustard oil cake, sesame oil cake, rice husk, wheat bran, blackgram bran, poultry litter, vermicompost, tea waste compost has been selected for the study. The experiment was laid out in Complete Randomized Design with four replications. Those materials has been mixed with 5 kg sandy loam soil @ 100 g of each organic material and kept in plastic pot with a diameter of 22 cm. The pot has been kept for 2 weeks and watered regularly for decomposition of organic materials. Five (05) months old tea seedling has been planted in those pots after 2 weeks. A pot without organic material has been considered as control. Before application of organic materials, no. of nematodes has been counted. Data are being collected on nematode population at monthly interval. Results revealed that nematode population was lower in vermicompost treated pot (5.0 nematodes/10g soil) compared to control (23.0 nematodes/10g soil) (Fig. 2).

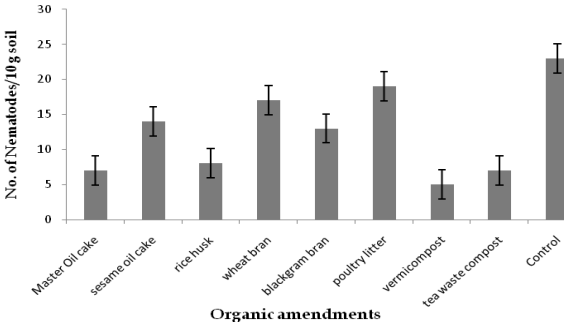


Fig. 2. Effect of some organic amendments on plant parasitic nematodes in tea

ENT 2: STUDIES ON INDIGENOUS PLANT EXTRACTS

ENT 2.1. Evaluation of some indigenous plant extracts against *Helopeltis*, Red spider mites & nematodes in tea (2008-2015)

Screening of some plant extracts against Helopeltis

An experiment was conducted to evaluate the toxicity of some indigenous plants viz., Akonda *(Calotropis procera),* Castor bean (*Ricinus communis*), Garlic, (*Allium sativum),* Nishinda (*Vitex negundo*) and Tobacco (*Nicotiana tabacum*) against tea mosquito bug under both laboratory and field conditions (Table 1). The extracts were prepared with water. The concentrations of the extracts were 5.0, 7.5 and 10% (w/v). The plant preparations were applied to *Helopeltis* by topical application method under laboratory condition. Data were

collected at 24HAT, 48HAT and 72HAT. Mortality percentages were corrected by Abbot's Formula. In field condition, the above mentioned plant extracts were sprayed with three different concentrations. Two rounds of foliar spray were given at 15 days interval and post treatment observations were taken in four consecutive weeks. Effectiveness of the plant extracts were calculated by using Henderson and Tilton's Formula. All the plant extracts showed toxic effect on *Helopeltis* under both laboratory and field condition.

Table 1. Plants evaluated for insecticidal activities against *Helopeltis*

Common name	Scientific name	Family	Plant parts used
Akonda	*Calotropis procera*	Apocynaceae	Leaves, flowers
Castor bean	*Ricinus communis*	Euphorbiaceae	Seeds
Garlic	*Allium sativum*	Amaryllidaceae	Cloves
Nishinda	*Vitex negundo*	Lamiaceae	Leaves
Tobacco	*Nicotiana tabacum*	Solanaceae	Leaves

Average mortality percentage of *Helopeltis* at 24, 48 and 72 hours after treatment indicated that Garlic extract possessed the highest (77.56%) toxic effect whereas Akonda extract possessed the lowest (54.54%) toxic effect under laboratory condition (Table. 2). Laboratory evaluation of plant extracts recorded to be 55.88-77.73% and 56.45-79.46% mortality of *Helopeltis* at 7.5% and 10% concentration respectively. The maximum average mortality (67.79%) was observed at the highest concentration (10%) of plant extract and the mortality percentage was directly proportional to the level of concentration of plant extract. The order of the toxicity of plant extracts were Garlic>Tobacco>Castor bean>Nishinda>Akonda against *Helopeltis*.

Table 2. Mean mortality percentage of tea mosquito bug, *H. theivora* treated with different plant extracts under laboratory condition

Name of the plant	Dose (%)	Mortality rate (%)			Mean (%)
		24HAT	48HAT	72HAT	
Akonda	5.0	50.44	53.78	49.67	51.30j
	7.5	56.28	57.64	53.71	55.88h
	10.0	58.07	55.64	55.64	56.45h
Castor bean	5.0	65.57	60.55	54.65	60.26g
	7.5	65.45	67.87	66.14	66.49f
	10.0	71.74	65.58	69.35	68.89e
Garlic	5.0	75.64	73.58	77.29	75.50c
	7.5	77.47	79.56	76.16	77.73b
	10.0	80.57	78.35	79.47	79.46a
Nishinda	5.0	51.42	55.89	54.07	53.79i
	7.5	55.21	57.48	58.41	57.03h
	10.0	59.72	57.19	60.46	59.12gh
Tobacco	5.0	69.54	65.58	69.35	68.16e
	7.5	71.35	68.23	71.28	70.29d
	10.0	76.49	73.19	75.43	75.04c
Probability level		NS			0.01

Mean of three observations; HAT= Hours after treatment ; NS = Not Significant; Within column values followed by different letter(s) are significantly different by DMRT

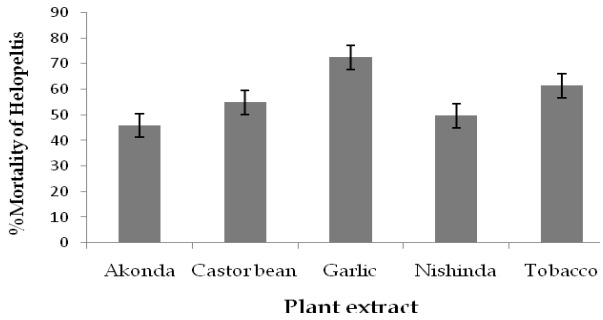


Fig. 3. Effect of plant extracts on *Helopeltis* in field condition

The highest infestation reduction (72.53%) was found in Garlic treated plot and that of the lowest (45.87%) was found in Akonda treated plot (Fig. 3). The order of the toxicity of plant extracts were Garlic>Tobacco>Castor bean>Nishinda>Akonda against *Helopeltis*.

Screening of some plant extracts against red spider mites

An experiment was conducted to evaluate the toxicity of five indigenous plants Akonda *(Calotropis procera),* Castor bean (*Ricinus communis*), Garlic, (*Alium sativum),* Nishinda (*Vitex negundo*) and Tobacco (*Nicotiana tabacum*) against red spider mite in tea under both laboratory and field conditions. The concentrations of the extracts were 5.0, 7.5 and 10% (w/v) in water. The plant preparations were applied to red spider mite by spraying method. Data were collected at 24HAT, 48HAT and 72HAT at laboratory condition. Mortality percentages were corrected by Abbot's Formula. In field condition, the above mentioned plant extracts were sprayed with three different concentrations. Two rounds of foliar spray were given at 15 days interval and post treatment observations were taken in four consecutive weeks. Effectiveness of the plant extracts were calculated by using Henderson and Tilton's Formula. All the plant extracts showed toxic effect on red spider mite under both laboratory and field condition.

Table 3. Mean mortality percentage of red spider mite treated with different plant extracts under laboratory condition

Name of the plant	Dose (%)	Mortality rate (%)			Mean (%)
		24HAT	48HAT	72HAT	
Akonda	5.0	54.29	57.43	51.96	54.56i
	7.5	57.84	55.36	56.82	56.67h
	10.0	58.07	60.27	56.85	58.40g
Castor bean	5.0	66.95	60.55	54.65	60.72f
	7.5	68.38	67.87	68.17	68.14e
	10.0	71.74	65.58	69.35	68.89e
Garlic	5.0	73.05	71.59	74.52	73.05d
	7.5	77.47	79.56	76.16	77.73c
	10.0	79.85	75.64	74.16	76.55c
Nishinda	5.0	75.59	78.46	79.12	77.72c
	7.5	80.19	82.46	77.35	80.00b
	10.0	83.74	85.67	86.85	85.42a
Tobacco	5.0	70.45	73.59	75.28	73.11d
	7.5	76.89	79.46	74.18	76.84c
	10.0	78.25	75.28	80.42	77.98c
Probability level		NS			0.01

Mean of three observations; HAT= Hours after treatment ; NS = Not Significant; Within column values followed by different letter(s) are significantly different by DMRT

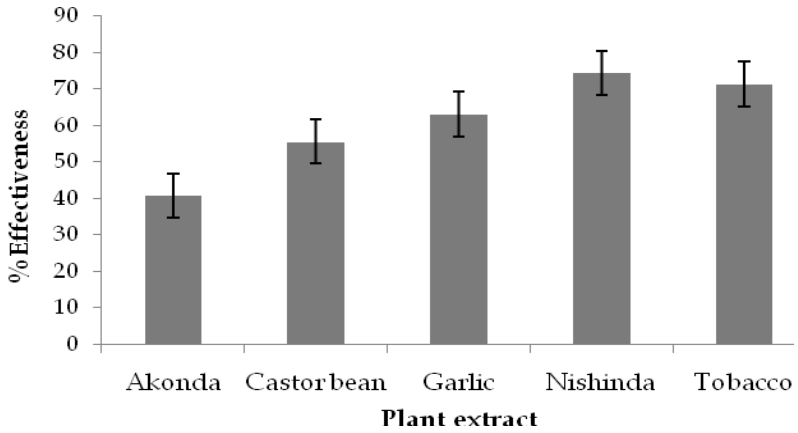


Fig. 4. Effect of plant extracts on Red spider mite in field condition

Among the tested plants, Nishinda extract showed the highest (81.05%) toxic effect whereas Akonda showed the lowest (56.54%) toxic effect against red spider mite under laboratory condition (Table 3). Laboratory evaluation of plant extracts recorded to be 56.67-80.00% and 58.40-85.42% mortality of *Helopeltis* at 7.5% and 10% concentration respectively. The order of the toxicity of plant extracts were Nishinda>Tobacco>Garlic>Castor bean>Akonda against *Helopeltis*.

The highest population reduction (74.56%) was found in Nishinda treated plot and that of the lowest (40.86%) was found in Akonda treated plot (Fig. 4). The order of the toxicity of plant extracts were Nishinda>Tobacco>Garlic>Castor bean>Akonda against red spider mite infesting tea.

Screening of some plant cakes against nematodes

A study was undertaken to evaluate the performances of some plant cakes i.e. Basok (*Adhatoda vasica*), Bhat (*Clerodendron infortunatum*), Akonda *(Calotropis procera),* Castor bean (*Ricinus communis*), Datura (*Datura metel*), Lantana (*Lantana camara*), Nishinda (*Vitex negundo*) and Tobacco (*Nicotiana tabacum*) against nematodes infesting tea at BTRI (Table 4).

Table 4. Plants evaluated for nematicidal activities against nematodes

Common Name	Scientific Name	Family	Plant Part Used
Basok	*Adhatoda vasica*	Acanthaceae	Leaves
Bhat	*Clerodendron infortunatum*	Verbenaceae	Leaves
Akonda	*Calotropis procera*	Asclepiadaceae	Leaves, flowers
Castor bean	*Ricinus communis*	Euphorbiaceae	Seeds
Datura	*Datura metel*	Solanaceae	Leaves, fruits
Lantana	*Lantana camara*	Verbenaceae	Leaves
Nishinda	*Vitex negundo*	Lamiaceae	Leaves
Tobacco	*Nicotiana tabacum*	Solanaceae	Leaves

Preparation of plant cake

Fresh leaves, succulent stems, seeds of Basok (*Adhatoda vasica*), Bhat (*Clerodendron infortunatum*), Akonda *(Calotropis procera),* Castor bean (*Ricinus communis*), Datura (*Datura metel*), Lantana (*Lantana camara*), Nishinda (*Vitex negundo*) were collected locally from nearby tea estates and BTRI main farm and Tobacco (*Nicotiana tabacum*) leaves was collected from local market of Srimangal, Moulvibazar. Each plant material was dried under shade and powdered by using electric grinder and pass through a 20 mesh sieve and kept in a 1 kg capacity polypropylene bag. 500 g of each powdered plant material were dissolved in 1lit distilled water and kept it for 24 hrs. After 24hrs the water soaked powder was dried in sunlight for 1 hr to make cake form.

Pot experiment

The experiment was carried out in pot under Completely Randomized Design (CRD) with four replications at the Nematology Field Laboratory of BTRI. Soils were collected from nematode cultured plots of Entomology Division. 5 kg of such soil was taken into 22cm dia plastic pot. Thereafter the tested plant cakes @ 100g/pot were mixed thoroughly with soils. Five months old tea seedling was planted in each pot. All pots were kept moist by sprinkling tap water as when required. Untreated pot was considered as Control. Pretreatment was done by counting nematodes before application.

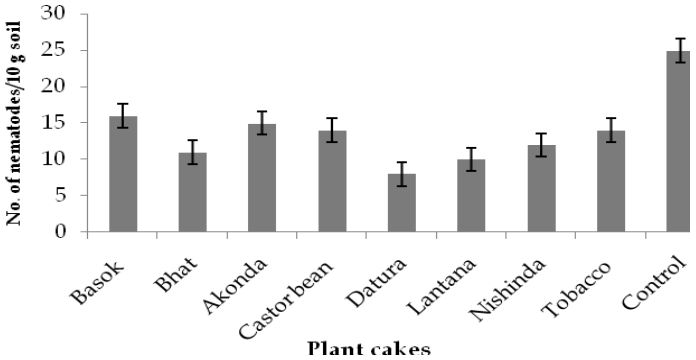


Fig. 5. Efficacy of some indigenous plant cakes on plant parasitic nematodes in tea

Result revealed that all the treatments had showed the toxic effect on nematodes and significantly reduced nematode population from the soil. Among the plant cakes, Datura cake showed the highest mortality of nematodes in the treated soil. The cakes of Lantana and Bhat also reduced the nematode population significantly (Fig. 5).

ENT 3: BIO-CONTROL OF PESTS

ENT 3.1. Searching and identification of bio-control agents for the control of pests of tea (2011-2016)

An investigation was carried out at BTRI main farm to document the arthropod natural enemies in the tea ecosystem. Frequent visits were made to search bio-control agents in the field. The survey was conducted two times in a month. A good number of natural enemies

such as spiders, preying mantids, beetles, and some other insects were collected from the field and enlisted in this communication, which was presented in the previous year. Among the natural enemies, Coleoptera: Coccinellidae was dominant. From the study it is also revealed that three species of lady bird beetle viz. *Stethorus gilviforns*, *Micraspis discolor, Verania vincta* and three species of spiders e.g. lynx spider (*Oxyopes* sp.), web making spider (*Pholcus* sp.) and jumping spider (*Phidippus* sp.) were more prevalent. *Stethorus gilviforns* and *Oxyopes* sp. were found more number than others. No new species was found during 2016.

ENT 3.2. Predation capacity of spider fauna against insect pests of tea (2015-2016)

An experiment was conducted to determine the predation capacity of lynx spider (*Oxyopes* sp.), web making spider (*Pholcus* sp.) and jumping spider (*Phidippus* sp.) against red spider mite in tea. The study showed significantly different preying activity of three potential spiders on egg, larva, nymph and adult of red spider mite, *O. coffeae*. There were significant correlations between the prey consumption by the grub and adults of *Oxyopes* spider and *Stethorus* beetle against red spider mite infesting tea (Fig. 6).

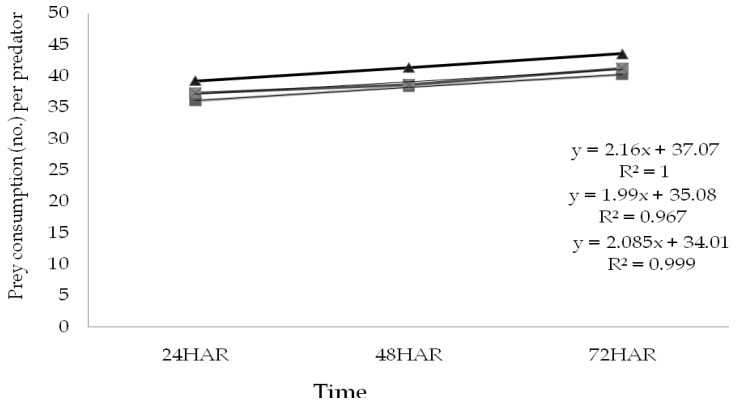


Fig. 6. Relationship between the prey consumption by three predaceous spiders against RSM in tea

ENT 3.3. Antagonistic potential of entomopathogens on plant parasitic nematodes in tea (2016-2017)

Six commercial microbial pesticides (entomopathogens) i.e. *Beauveria bassiana, Metarhizium anisopliae, Paecilomyces lilacinus,Pseudomonas fluorescens,Trichoderma viridae and Verticillium lecanii* were collected from different companies. The entomopathogens @ 10 g were mixed well decomposed cowdung and kept it for 7 days for increasing microbial action. Then 4 kg sandy loam soil was mixed with 1 kg cowdung containing entomopathogens and kept it in a plastic pot of 22 cm dia. Untreated pots were also prepared as control. Tea seedling will be planted in each pot. Five months old tea seedling was planted in those pots and the pot was arranged in CRD with 4 replications. Other agronomical practices were done as and when necessary. Data on nematode population were collected at monthly interval. Soil samples were collected with the help of an auger from the pot at the depth of 0-9". Results revealed that *Pseudomonas fluorescens* reduced nematode population significantly compared to control (Fig. 7).

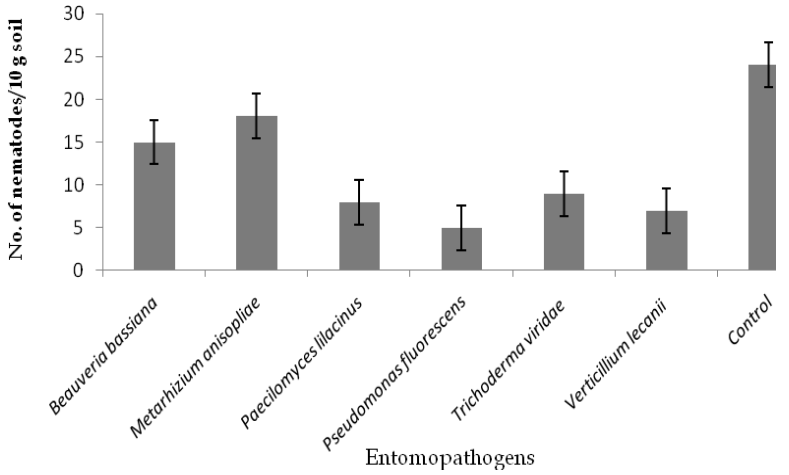


Fig. 7. Effect of some entomopathogens on plant parasitic nematodes in tea

ENT 4: SCREENING OF PESTICIDES

ENT 4.1. Screening of pesticides against *Helopeltis*, Red spider mites, Termites, Nematodes Aphids and Thrips in tea (2016-2017)

During 2016, One hundred and two (102) pesticides under different groups were tested against *Helopeltis*, Red spider mite, Nematodes, Termites, Aphids and Thrips in the field and the report was sent to plant protection wing for their standardization. The experiment was conducted at Baraoora T.E. and BTRI Main Farm at CRD & RCBD with three replications. Data on percent infestation were collected at weekly, fortnightly and monthly intervals for *Helopeltis*, Red spider mites, Flushworm, Termites, Nematodes in tea, respectively. A total of twelve data were recorded. Abbott's formula, Henderson and Tilton formula, Lubischeb analytical method, Baermann funnel method etc. were applied for determining the effectiveness of the tested pesticides. The result revealed that all the tested pesticides was found satisfactory (>80% effectiveness). The experiment will be continued for other chemicals are in progress.

ENT 4.2. Determination of judicious use of pesticides for a model tea estate (2014-2018)

An experiment was initiated at BTRI to determine the judicious use of pesticides for a model tea estate. Standard plots were compared to the general practiced plots. Pesticide spray was given in standard plots by monitoring the insect pest infestation as well as observing the Economic Threshold Level (ETL) of different insects. The weight of green leaves of each plot was taken in every plucking interval and insect pest infestation was also observed. It was found that the amount of spray volume was lower in standard plots compared to general practiced plots (Table 5). This experiment will be continued in BTRI and will also be set up in Bilashcherra Experimental Farm in this year to confirm the significant yield difference between the standard and general practiced plots.

Table 5. Determination of judicious use of pesticides for a model tea estate

Plots	Insect infestation	No. of spray	Average yield (Kg/ha)	Increase of yield over control (%)
Standard plot	*Helopeltis*	6	2089.34	39.92
	Red spider mite	6		
	Thrips	2		
	Termite	1		
General plot	*Helopeltis*	11	2155.56	44.36
	Red spider mite	10		
	Leaf roller	2		
	Thrips	3		
	Termite	1		
Control plot	*Helopeltis*	-	1493.29	-
	Red spider mite	-		
	Aphids	-		
	Termite	-		
	Thrips	-		

ENT 4.3. Effect of nematicides on soil micro-organism in tea (2016-2017)

The experiment was carried out at Bangladesh Tea Research Institute (BTRI) with five chemical nematicides under RCBD with three replications from July 2016. The nematicides like (i) Furadan 5G (Carbofuran) @ 165 g/m^3, (ii) Regent 3GR (Fipronil) @ 165 g/m^3, (iii) Ferterra 0.4G (Rynaxypyr) 70 g/m^3, (iv) Diaton 10G (Diazinon) @ 165 g/m^3 and (v) Rugby 10G (Cadusafos) @ 300 g/m^3 has been applied in the plots measuring 3 ft x 3 ft. An untreated plot has been taken as control. Soil samples will be collected using a soil sampling auger at a depth of 20 cm at 10, 30, 60 days interval from the application of the said nematicides. Soil samples were analyzed for both physico-chemical properties and microorganisms of soil. Soil physico-chemical properties like texture, pH, organic matter (%), total nitrogen (%), available phosphorus, potassium, calcium, magnesium in ppm of the experimental plot were determined at the Soil Science laboratory of BTRI. Result revealed that the physico-chemical properties of soil were slightly changed in nematicides treated plot than control plot (Table. 6). However, no significance difference or definite relationship was found. Results also revealed that Rugby 10G reduced nematode population (6.0 nematodes/10 g soil) compared to control (Fig. 8).

Table 6. Values of soil physico-chemical properties in different treatments

Parameters	**Values**					
	Furadan 5G	Regent 3GR	Ferterra 0.4G	Diaton 10G	Rugby 10G	Control
pH	4.4±0.012	4.3±0.023	4.5±0.018	4.6±0.024	4.5±0.019	4.4±0.016
Organic carbon (%)	0.71±0.035	0.89±0.045	0.90±0.027	1.05±0.038	0.89±0.040	0.74±0.030
Total nitrogen (%)	0.08±0.002	0.09±0.004	1.0±0.001	0.11±0.003	0.09±0.005	0.08±0.002
Phosphorus (ppm)	9.13±0.014	12.04±0.020	11.70±0.017	12.57±0.016	12.54±0.015	11.07±0.013
Potassium (ppm)	27.6±0.003	25.4±0.005	30.0±0.004	36.6±0.003	40.0±0.002	30.3±0.004
Calcium (ppm)	66.9±0.010	53.9±0.011	76.6±0.011	78.9±0.012	80.7±0.013	60.9±0.010
Magnesium (ppm)	9.0±0.001	7.6±0.003	11.3±0.002	13.3±0.001	16.6±0.003	10.0±0.002

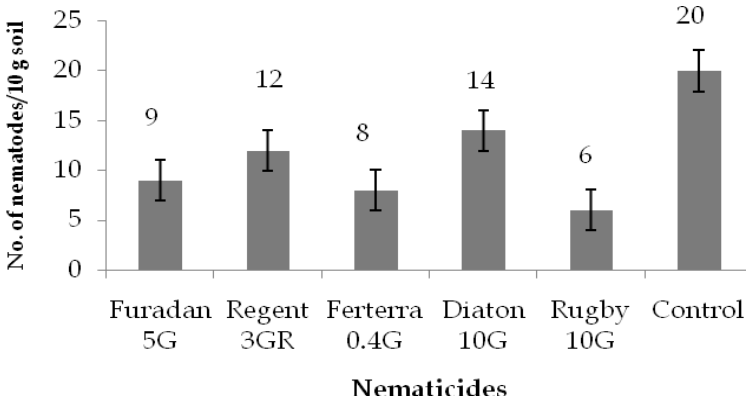


Fig. 8. Effect of nematicides on soil microorganisms in tea

Microfloral analysis was carried out at Plant Pathology laboratory of BTRI. For microfloral analysis, serial dilution agar plating technique was adopted. Growth of microorganisms was observed after 4-7 days. Four types of fungi, *Aspergillus* sp., *Rhizoctonia* sp., *Fusarium* sp. and *Trichoderma* sp. were found in control plot. No fungal growth was observed in Rugby 10G treated plots during the study period. In Diaton 10G treated plot, all of the above fungi were grown. *Aspergillus* sp. and *Trichoderma* sp. were grown in 60 days after application of Ferterra 0.4G treated plot. *Aspergillus* sp., *Fusarium* sp. and *Trichoderma* sp. were grown in 60 days after application of Furadan 5G. On the other hand, *Aspergillus* sp., *Fusarium* sp. and *Trichoderma* sp. were developed within 30 days after application of Regent 3GR and *Rhizoctonia* sp. was grown within 60 days in same nematicides. Rugby 10G is more toxic to soil microflora compared to other nematicides. The order of toxicity of the nematicides on soil microflora was: Rugby 10G>Ferterra 0.4G>Furadan 5G>Regent 3GR>Diaton 10G (Table. 7).

Table 7. Growth of different microflora against selected nematicides application in tea soil

Treatments	Growth of soil microflora (DAA)											
	***Aspergillus* sp.**			***Rhizoctonia* sp.**			***Fusarium* sp.**			***Trichoderma* sp.**		
	10	**30**	**60**	**10**	**30**	**60**	**10**	**30**	**60**	**10**	**30**	**60**
Furadan 5G	-	-	+	-	-	-	-	-	+	-	-	+
Regent 3GR	-	+	+	-	-	+	-	+	+	-	+	+
Ferterra 0.4G	-	-	+	-	-	-	-	-	-	-	-	+
Diaton 10G	-	+	+	-	+	+	-	+	+	-	+	+
Rugby 10G	-	-	-	-	-	-	-	-	-	-	-	-
Control	+	+	+	+	+	+	+	+	+	+	+	+

DAA- Days after application of nematicides
+ Fungal growth positive, - No growth of fungus

ENT 5: PESTICIDE RESIDUE ANALYSIS

ENT 5.1. Dissipation pattern of some commonly used pesticides in tea from bush to mug (2016-2018)

An experiment was initiated to know the dissipation pattern of pesticides from bush to mug at BTRI main farm. This experiment was discontinued due to technical problem in

instrument. In the year of 2017, the commonly used pesticides in tea i.e. Ripcord 10EC (Cypermethrin) and Omite 57EC (Propergite) will be applied in experimental plots following BTRI recommended dose and their dissipation pattern will be determined in each and every steps from plucking to tea infusion. The residue analysis will be done according to the methods developed by Ahmed & Sarker (2002) at Central Science Laboratory (CSL) in U.K. (Method reference: PGD-95/01-07). The determination of residue will be done by Electron Captured Detector (ECD) and Flame Thermoionic Detector (FTD) using Gas Chromatograph (Shimadzu 14-B) with DB-5 Capillary Column.

OTHER ACTIVITIES

Advisory and Experimental visits

A total of Twenty eight (28) advisory visits were paid to different tea estates to identify and render advice on specific pest problems and Thirty (30) advisory letters issued to different tea estates in respect of identification of various pests and their control measures during the reporting year. Twelve (12) experimental visits were made with particular reference to experimental data collection in tea estates.

Analysis

A total of One hundred thirty four (134) soil and water samples were analyzed in the Laboratory for nematode count and reported to different tea estates. A total of 102 pesticides including insecticides, miticides, nematicides and termiticides were received from plant protection wing, Department of Agricultural Extension, Dhaka for field trial and reports were sent to plant protection wing for standardizations during the year 2016. One (01) pesticide for physical analysis was also done in the laboratory of the division.

Tours/Visits

A total of Eleven (11) official visits were paid by the Scientists of the division to different organizations for Official purposes.

Courses on tea culture

The Scientific personnel of the division delivered lectures on tea pest management at Annual Courses held at BTRI Main Station, Srimangal; BTRI Sub-Station, Fatikchari, Chittagong and BTRI Sub-Station, Panchagarh as well as in Post graduation diploma course, MTC, BTB. The resource persons gave comprehensive lectures and practical demonstration on tea pest spectrum, their control options, pesticides and its residue in made tea and spraying techniques.

Workshop/Seminar

A total of Seventeen (17) workshops were conducted at different tea estates under different valley circles on tea pest management during 2016.

PLANT PATHOLOGY DIVISION

Dr. Mohammad Ali
Chief Scientific Officer
Department of Pest Management
&
Mohammed Syeful Islam
Senior Scientific Officer
Plant Pathology Division

STAFF

Mr. Mohammed Syeful Islam, Senior Scientific Officer left for China on 25 April 2016 to attend a training course entitled "2016 Seminar on Pollution free Tea Production Technology for Developing Countries". He returned and joined the division on 22 June 2016 after successfully completion of the training course. Mr. Raihan Mujib Himel, Scientific Officer was transferred to BTRI substation, Fatickcherri, Chittagong on 1st August, 2016. The posts of one Principal Scientific Officer and one Field Assistant were remained vacant. There was no other change in the staff position of this division.

RESEARCH

The division carried out seven experiments during the year 2016 under three research areas. Results are briefly discussed below:

PP 3: DISEASE MANAGEMENT

PP 3.6: Study of microbial effects on made tea quality (BTRI: 2015- 2017)

Nine black tea and one Darjeeling green tea (mini pack) samples were collected from the market for microbial loads. The initial moisture content for each black tea sample was more than 7.8%, and 5.48% in Darjeeling green tea. In controlled condition, *Aspergillus niger* and *Penicillium* spp. were found in all the samples (table 1). In open environment, *Aspergillus* spp. was recorded in the black tea sample contained 11.89% moisture reaching from 4.9% after 20 days of plating. The *Aspergillus* spp was also recorded in drier mouth sample that contained 2.5% initial moisture reached to 8.3% after 42 days of plating (table 2). Theaflavins (TF), Thearubigins (TR), Total Liquor Color (TLC), Highly Polymerized Substances (HPS) and Color Index (CI) of five black tea samples were measured in both pre- and post-fugal growth stage (table 3).

Table 1. Microbial contamination with black tea and Darjeeling green tea samples at different moisture level

Sample no.	Company/ Brand	% moisture	Name of fungi
1	Meghna Tea Co. Ltd. (Strong tea)	7.91	*Aspergillus niger, Penicillium* spp.
2	Danish Tea	7.86	*A. niger, A. flavus, Penicillium* spp.
3	IspahaniMirzapore	8.06	*A. niger, Penicillium* spp.
4	Star ship (Special tea)	8.25	*A.niger, A. flavus, Penicillium* spp.
5	Seylon tea (Gold)	8.97	*A. niger, Penicillium* spp.
6	Sylhet Gold tea	9.12	*A. niger, Penicillium* spp.
7	Pusti tea (Tender sample)	7.95	*A. niger, A. flavus, Penicillium* spp.
8	Pusti tea (Market sample)	8.56	*A. niger, A. flavus, Penicillium* spp.
9	Darjeeling green tea	5.48	*A. niger, Penicillium* spp.
10	Drier mouth sample (BTRI) as standard	2.5	Not found

Table 2. Moisture absorption and fungal growth on black tea in open environment

Sample no.	Initial moisture (%)	Final moisture (%)	Days required to fungal growth	Name of fungi
1	4.9	11.89	20	*A. flavus* & *A. niger*
2	2.5 (DM)	8.3	42	*Aspergillus* spp.

Table 3 Biochemical parameters for black tea samples at pre- and post-fungal growth stage

Sample no.	Pre-fungal growth stage					Post-fungal growth stage				
	TF	TR	TLC	HPS	CI	TF	TR	TLC	HPS	CI
1	0.250	3.111	1.74	3.015	4.084	0.017	1.514	4.92	1.514	0.118
2	0.267	2.933	1.94	4.038	3.836	0.026	0.805	5.02	0.805	0.163
3	0.311	3.752	1.67	3.956	4.029	0.009	1.037	3.55	1.037	0.064
4	0.155	3.465	1.70	7.299	1.442	0.026	0.860	3.84	0.860	0.259
5	0.259	3.533	2.76	7.845	2.274	0.036	1.300	4.35	0.505	0.596

Note: TF, TR, TLC HPS are expressed in percentage.

PP 3.7: Effects of diseases on the change of tea quality (BTRI: 2015-2017)

There is a significant reduction in quality of tea in terms of Chlorophyll-a, Chlorophyll-b and Carotenoids by 76.98, 82.78 and 50%, respectively in red rust infected tea by *Cephaleuros parasiticus* (table 4).

Table 4. Chlorophylls and Carotenoids contents in fresh and red rust infected tea leaves

	Chlorophyll-a (mg/g)	Chlorophyll-b (mg/g)	Carotenoids (mg/g)
Fresh leaves	4.43	1.80	1.02
Infected leaves	1.02	0.31	0.51
% Reduced	76.98	82.78	50

In infected tea leaves, a reduced per cent of Thearubigin (TR), highly polymerized substances (HPS) and total liquor color (TLC) were observed by 34.35, 18.52 and 3.417%, respectively. No change was found in case of Theaflavin (TF) in both fresh and infected leaves but Color Index (CI) was found to be increased in infected leaves by 35.32% (table 5). Caffeine Content was decreased by 15.97% and P^H value was found almost same for fresh and infected leaves (table 6). The experiment will be continued.

Table 5. TF, TR, HPS levels and color changes in fresh and red rust infected tea leaves

	TF%	TR%	HPS%	TLC%	Color Index
Fresh Leaves	0.29	3.90	2.43	1.76	4.70
Infected leaves	0.29	2.56	1.98	1.70	6.36
% Reduced	00	34.35	18.52	3.41	(-) 35.32

Table 6: Caffeine level in fresh and red rust infected tea leaves

	Amount of Caffeine (mg/ L) at specific absorbance		P^H of brewed tea		Color of brewed tea	
	Absorbance at 260 nm	Amount of Caffeine	Before boiling	After boiling	Before boiling	After boiling
Fresh Leaves	1.81	47.45	4.84	4.81	Reddish	Light red brownish
Infected leaves	1.52	39.87	4.93	4.80	Yellowish	Deep red brownish
% Reduced	-	15.97	-	-	-	-

PP 3.8: Management of soil borne diseases in tea with Plant Growth Promoting (PGP) microbes (BTRI/ BEF: 2016- 2020)

There are four microbes like *Bacillus, Pseudomonas, Streptomyces, Trichoderma* are recorded. During 1st year in nursery, the polybags used for transferring tea rooted cuttings were inoculated with the four isolated microbial strains and one collected bio-fertilizer by mixing with 50 g of decomposed cowdung. The responses to these microbes in context of the

number of leaves, height of plants and girth of stems were recorded after 9 months. In 2nd year the microbes will be screened out against some disease causing pathogens. These

microbes and one collected biofertilizer enhance plant growth identically (P= 0.05) in nursery regarding increasing number of leaves, plant height and stem girth (table 7). The experiment will be continued.

Table 7. Showing the plant growth parameter against different growth promoting microbes in nursery

Treatments	No of leaves	Height of plant (cm)	Girth of stem (mm)
Control	16.67 b	46.67 b	1.53 b
Bacillus	19.67 a	54.80 a	1.87 a
Pseudomonas	19.67 a	55.37 a	1.80 a
Streptomyces	20.33 a	55.43 a	1.93 a
Trichoderma	19.67 a	55.37 a	1.63 b
Biofertilizer	19.33 a	54.90 a	1.53 b

PP 3.9: Studies on the overwintering process of the pathogen and capability of transmission for infecting Black rot disease (BTRI/ BEF: 2016- 2017)

The highest number of viable and vigorous pathogenic propagules (> 20%) was found in plant debris in all diluted concentrations followed by pruning liters and surface soils (Table1). Only cleaning the plant debris can reduce 22.50% disease severity over the control whereas pruning litres and soil fragments showed similar disease severity (table 8). From the result, it can be concluded that the pathogen can able to survive vigorously with plant debris in dormant period followed by pruning litres and soil fragments.

Subsequently, after pruning operations in infected plantation cleaning of pruning litres, cleaning of infected plant debris & soil drenching 2- 3 times application of a systemic fungicides like Carbendazim 50 WP @ 750gm/ ha mixed in 1000 L of water in May to July at 15 days interval gave highest production of tea and low disease severity as well (table 9). The experiment will be continued.

Table 8. Presence of *Corticiumtheae* in different sources of infection during dormant period

Sources of infection	Direct method	Dilution method		
		10^{-3}	10^{-4}	10^{-5}
Pruning liters	+ + +	+ + +	+ + +	+ +
Plant debris	+ + +	+ + +	+ + +	+ + +
Soil	+ +	+ +	+ +	+ +

Table 9. Effect of different groups of fungicides on the severity of Black rot disease and yield of tea

Treatments	Made tea (Kg/ha)	Disease Severity (PDI)	% changes in severity
T_1= Control (No cleaning & sanitation)	1437.37 j	7.60 a	00
T_2= Cleaning of only pruning litres	1705.09 h	6.69 b	11.97
T_3= Cleaning of only infected plant debris	1719.19 g	5.89 c	22.50
T_4= Only soil drenching	1633.71 i	6.90 b	9.21
T_5= Cleaning of pruning litres + Cleaning of infected plant debris + soil drenching	1757.24 c	4.47 d	41.18
T_6= Cleaning of only pruning litres + soil drenching	1729.93 e	4.33 d	43.02
T_7= Cleaning of only infected plant debris + soil drenching	1725.09 f	5.41 c	28.81
T_8= Cleaning of pruning litres + Cleaning of infected plant debris	1742.29 d	4.29 d	43.55
T_9= Cleaning of pruning litres + Cleaning of infected plant debris + soil drenching + Carbendazim	1806.94 a	3.55 e	53.28
T_{10}= Cleaning of pruning litres + Cleaning of infected plant debris + Carbendazim	1778.75 b	4.10 de	46.05

PP 3.3: Screening of new fungicides and herbicides against different diseases and weeds in tea (BTRI/ BEF/ TE (s): Short term)

A total of fifty seven fungicides and fifty eight herbicides were tested against respective pests. Tested chemicals were found > 80% effective against the respective pests. Reports were sent to PTASC for further necessary action.

PP 4: WEEDS MANAGEMENT

PP 4.6: Weed management in tea with BecAno 500 SC (BTRI/ BEF/ TEs: 2014-2018)

An experiment was carried out at BTRI Farm with 10 treatments following RCBD. The treatments T_0 = Control, T_1 = Paraquat 20 SL @ 2.8 L, T_2= Glyphosate 41 SL @ 3.5L, T_3= BecAno 500 SC @ 150 ml/ha, T_4= Paraquat 20% +BecAno 500 SC, T_5= Glyphosate 41 SL+ BecAno 500 SC, T_6= First application Paraquat 20% SL and 30 days later BecAno 500 SC, T_7= First application Glyphosate 41 SL and 30 days later BecAno 500 SC, T_8= First application BecAno 500 SC and 30 days later Paraquat 20% SL, T_9= First application BecAno 500 SC and 30 days later Glyphosate 41 SL. The treatments were applied in the

plots containing sufficient moisture. Data are being collected in terms of per cent weed germination (monocot and dicot) at monthly interval. Till the month of June no weed germination was observed in the plots treated by T_5= Glyphosate 41 SL+ BecAno 500 SC (table 10). The experiment will be continued.

Table 10. Effect of different herbicides on weed control

Treatments		Dose ha^{-1} diluted in 400 L water	Weed control (%)
T_o	Control	-	0 b
T_1	Paraquat 20SL	2.8 L	95 a
T_2	Glyphosate 41 SL	3.5 L	95 a
T_3	BecAno 500 SC	150 ml	90 a
T_4	T_1+ T_3	2.8 L + 150 ml	95 a
T_5	T_2+ T_3	3.5 L + 150 ml	100 a
T_6	T_1 then T_3	2.8 L then 150 ml	90 a
T_7	T_2 then T_3	3.5 L then 150 ml	95 a
T_8	T_3 then T_1	150 ml then 2.8 L	90 a
T_9	T_3 then T_2	150 ml then 3.5 L	90 a

PP 5: ARBUSCULAR MYCORRHIZAL FUNGI IN TEA

PP 5.3: Inoculum Production of AM Fungi for Tea Cultivation (BTRI: 2015-2018)

Four mycorrhizal plants like *Lucas aspera*, *Tephrosia candida, Mimosa invisa* and *Calapogonium mucunoides* were selected for inoculum production. 2 cm layer of crude AM fungi inoculum was made on 10 m^2 plot containing spores, sporocarps, hypha and infected roots. Thereafter, the above selected plants were grown on the AM fungi incorporated plot separately. The plants were harvested after six months and mycorrhizal spores in soils and colonization in roots were estimated. The result showed that AM fungi produced about 473 spores per 10g soil and induced 100% root colonization in *Lucas aspera* followed by others plant species.

OTHER ACTIVITIES

Advisory and Experimental visits

A total of twenty one (21) advisory visits were paid to different tea estates to identify and render advice on specific disease and weeds problem and thirty (30) correspondence issued to different tea estates in respect of identification of various diseases and their control measures during the reporting year. Forty one (41) experimental visits were made with particular reference to experimental data collection in tea estates.

Official visits/tours

A total of nine (09) official visits were paid by the Scientists of the division to different organizations for official purposes.

Courses on tea culture

The Scientific personnel of the division delivered lectures on tea diseases and weeds management at annual courses held at BTRI main station, Srimangal; BTRI Sub-station, Fatikchari, Chittagong and Panchagarh. They also delivered eight (08) hours comprehensive lectures in Post Graduation Diploma Course, MTC, BTB.

Workshop/Seminar

A total of eight (8) workshops were conducted at different tea estates under different valley circles on tea diseases and weeds management during the year.

STATISTICS & ECONOMICS DIVISION

Shefali Boonerjee
Senior Scientific Officer

STAFF

Mrs. Shefali Boonerjee, Senior Scientific Officer joined on 23rd June 2015 in this Division. The posts of Principal Scientific Officer (PSO), and Statistical Assistant were lying vacant during the period under report. There was no other change in personnel position of the division.

RESEARCH

There were three experiments running in this division namely -Economic Efficiency of tea production, Evaluation of technology and Economic Efficiency of tea factories. The experiments were discontinued since last 3 years due to absence of researchers. Necessary attempts are being done for the rearranging and conducting these experiments. The present situation of these experiments is summarized below:

SE 1: ECONOMIC EFFICIENCY OF TEA PRODUCTION

SE 1.1. Economics of optimum fertilizer dose for some selective clones at BTRI farm.
The experiment is now under supervission for rearranging and analysing the data.

SE 2: EVALUATION OF TECHNOLOGIES

SE 2.1. Adoption of BTRI Innovated Technologies and its Extension to Bangladesh Tea Industry.

The study conducted to examine the overall feature of implementation and its efficiency of the BTRI technologies to the tea estates. BTRI has innovated a number of technologies since last 60 years and made a great impact on tea improvement providing those technologies. Bangladesh tea has increased its productivity remarkably from the last few decades but it is still behind in terms of yield and quality than the other leading tea growing countries in the world. The yield trend is less than that of other tea producing countries like India, Kenya, Sri Lanka etc. The important reason of such low production is assumed due to improper utilization of scientific technologies like inferior planting materials, lack of authentic control measures of pest and disease management, absence of proper agronomic practices, soil fertility and pH condition etc. BTRI has so far released 20 outstanding clones and many other successful technologies which are effectively been used in the tea industry. But there is no information about the percentage of application of the technologies and its efficiency in implementation. So the current data regarding the disseminated technologies to the estate required to up-to-date. This database will be helpful to find out the adoption efficiency in the field and to find out the limitations of dissemination of the BTRI innovated technologies.

In the present experiment, the adoption percentages of both BT and TV clones in the tea estates of different valleys are tried to explore. The calculated data on clonal plantation areas of the tea estates are presented in the Table 1. During this study, it was recorded that, among the 162, a total of 87 tea states were responded initially. They have sent their

information through the questionnaire. These data were tabulated by arranging them according to valley wise and ownership/company wise. It was observed that from Balisera valley highest 18 gardens (62.06%) have sent the filled-up questionnaire out of 29 gardens. Among the rest 6 Valleys 7 of Monu-Doli out of 14, 15 of Lungla and Juri out of 29, 14 of Luskerpur out of 19, 7 of North Sylhet out of 17 and 11 of Chittagong out of 22 Tea Estates have sent their information till to date. The necessary information of 57 gardens was collected from the monitoring reports of Project Development Unit (PDU), BTB. The collected data of total 144 gardens were partially summarized according to valley wise adoption of clonal plantation. About 41.64% land of total tea area of the 7 valleys is occupied by clonal plantation with the average production of 1607.48 kg/ha. The use of BT and TV clones are 45.05% and 40.20% with the average production of 1590.97 and 1667.42 kg/ha respectively. Among the valleys, highest clonal plantation was found in Chittagong valley (60.18%) followed by Luskerpur (48.17%), Juri (44.86%), Monu-Doloi (41.24%), Lungla (40.81%), Balisera (35.63%) and North Sylhet (24.29%). Highest (74.62%) BT clones are adopted by Chittagong valley and the lowest (21.82%) by Balisera valley.

Table 1. Valley wise clone plantation in the different tea estate

Valley	Total tea area (ha)	Total seedling area (ha) & % of total area	Total cone area (ha) &% of total area	% of BT clones planted	% of TV clone planted	Av. yield of BT area (kg/ha)	Av. yield of TV area (kg/ha)
Balisera	14537.91	8200.66 (56.41)	5179.3 (35.63)	21.82	78.39	1801.5	1836.37
Monu-Doloi	7410.07	3852.64 (51.99)	3055.71 (41.24)	48.78	46.26	1706.75	2403.00
Lungla	8025.3	4482.29 (55.85)	3274.86 (40.81)	51.28	44.77	1592.78	1715.83
Juri	7634.26	3701.86 (48.49)	3424.56 (44.86)	47.69	50.57	1765.67	1582.5
Luskerpur	8348.23	4332.49 (51.90)	4021.51 (48.17)	68.31	31.10	1591.2	1527.2
North Sylhet	4632.51	3485.06 (73.98)	1125.42 (24.29)	51.79	48.20	994.2	960.6
Chittagong	5326.97	2327.93 (43.70)	3205.99 (60.18)	74.62	28.35	1684.67	1646.43
Total	55915.25	30382.93 (54.34)	23287.35 (41.64)	45.05 (Av.)	40.20 (Av.)	1590.97	1667.42

OTHER ACTIVITIES

Annual Returns of BTB and BCS

Annual returns of BTRI farms including Bilashcherra Experimental farm on land use, tea seeds, plants and tea waste (BTB return No. 2) and also on employment and employment cost (BTB return No. 4) were prepared for the period of 2015-1016 and sent to BTB. Annual statistical return of manpower and labor welfare (BCS form No. 2) and on tea garden land (BCS return No. 3) of BTRI farms for 2014-2015 also had sent to BCS office, Dhaka.

Annual Courses

The Senior Scientific Officer delivered lectures on "Tea statistics and Economics" in the 51nd Annual course on Tea Culture organized by BTRI for the covenanted staff of tea estates of greater Sylhet held at the institute during 2016.

TECHNOLOGY DIVISION

Dulal Chandra Dey
Scientific Officer

STAFF

Mr. Dulal Chandra Dey, Scientific Officer (Technology Divission) was Transferred to BTRI Up-Kendra, Sualok, Bandarban. Mr. Shafikul Islam, Factory Assistant joined at BTRI Technology Divission on 09/10/2016. There was no other change in the division during the period under report.

RESEARCH

Three experiments were carried out by this division during the period under report. The progress of these experiments is summarized below.

TT1.1: **WITHERING**

T 1-11: Effect of heat in the withering trough on the quality of tea

a. During excess humidity, application of heat improves quality.
b. At low humidity application of heat decrease quality.
c. Broken percentage is high at without heat and dust percentage is high with heat.

Table 1. Scoring of tea quality parameter with and without heat

RH (%)		Infused leaf	Color	Strength	Briskness	Total	Average
70	Without heat	6.50	7.50	6.50	7.50	28.00	7.00
	With heat	7.00	6.50	7.00	6.50	27.00	6.75
75	Without heat	6.00	6.50	6.50	6.00	25.00	6.25
	With heat	6.50	7.00	6.50	6.00	26.00	6.50
80	Without heat	6.00	6.50	5.50	6.00	24.00	6.00
	With heat	6.50	7.50	6.50	6.50	27.00	6.75
90	Without heat	6.00	6.50	5.50	6.00	24.00	6.00
	With heat	7.50	6.50	7.00	7.00	28.00	7.00
95	With heat	5.50	6.00	5.50	5.50	22.50	5.63
	With heat	6.00	6.50	7.50	7.00	27.00	6.75

Table 2. Grade percentage

Without heat	With heat
52% Broken	50% Broken
22% Fanning	21% Fanning
12% Dust	17% Dust
14% Over	12% Over

T 1-12: Study the effect of different physical leaf composition on the tea quality and its grade percentage

a. Highest quality of made tea from one bud and one leaf.

b. Lowest quality of made tea from one bud and three leaves.

Table 3. Scoring of tea quality parameter with leaf composition

Sl. No.	Leaf	Infused leaf	Color	Strength	Brisknes s	Total	Average
1	One bud & one leaf	6.50	7.50	6.50	7.50	28.00	27.83
		7.00	7.00	6.50	7.50	28.00	
		6.50	6.50	7.50.	7.00	27.50	
2	One bud & two leaves	6.50	6.00	6.50	6.50	25.50	25.83
		7.00	6.50	6.00	6.00	25.50	
		6.00	7.50	6.00	7.50	26.50	
3	One bud & three leaves	5.50	6.00	6.50	5.50	23.50	23.67
		6.00	5.50	5.50	6.00	23.00	
		5.50	6.00	6.00	6.50	24.00	

T1-13: Determination of made Tea quality at different temperature of CTC Rollers

a. Highest quality of made tea from lowest temperature of CTC roller.

b. Lowest quality of made tea from highest- temperature of CTC roller.

Table 4. Scoring of tea quality parameter with different temperature of CTC roller

Sl. No.	Average Temperatu re	Infused leaf	Color	Strength	Briskness	Total	Average
1	41° c	7.00	7.50	7.00	6.00	27.50	6.88
	43° c	6.50	6.00	6.50	6.50	25.50	6.37
	46° c	6.00	5.50	6.50	5.50	23.50	5.88
2	42° c	6.50	7.50	6.50	7.00	27.50	6.88
	45° c	6.50	7.00	6.00	6.50	26.50	6.50
	47° c	6.00	6.50	5.50	5.50	25.50	5.88
3	43° c	7.50	6.00	7.00	7.50	28.00	7.00
	46° c	6.00	6.00	6.00	6.50	24.50	6.13
	47° c	5.50	5.00	6.00	5.50	22.00	5.50

Factory

Maintenance and repair works of the factory machinery were done as usual. Re- sharpening of CTC rollers was done at workshop with high degree of standard. Maintenance of power house and different kind of vehicles were done as usual.

OTHER ACTIVITIES

Advisory and Experimental visits

A total of four (04) advisory visits were paid to different tea estates.

Official visits/tours

A total of three (03) official visits were paid by the Scientists of the division to different organizations for official purposes.

Courses on tea culture

The Scientific personnel of the division delivered lectures on tea processing and manufacturing at annual courses held at BTRI for the covenanted staff of tea estates, Scientists and Officers of BTRI and PDU during 2016. Scientists of this division also delivered lectures as resource speakers at the Management Training centre (MTC) for Post Graduate Diploma Course organized by Project Development Unit (PDU) of Bangladesh Tea Board.

BILASHCHERRA EXPERIMENTAL FARM
BTRI, SREEMANGAL

STAFF

Mr. Md. Sabbir Mahedi Joy, Field Assistant was transferred to Bandarban Sub Station on 08 August 2016. Mr. Md. Rajib Ahamed joined as Field & Store Assistant, Mr. Rony Debnath joined as Farm Supervisor and Mr. Md. Shohidul Islam Sheikh joined as Tillah Clark at Bilashcherra Experimental Farm on 09 October 11 August and 07 March 2016 respectively. There was no other change in the staff position during the reporting year.

FARM

Table 1. Land Distribution

Sl. No.	Description	Area (ha)	
(a)	Under Tea	109.13	
	I. Plucking Area		
	1. Immature Tea (under 5 years)	5.77	
	2. Tea bushes 5 to 10 years	3.38	102.13
	3. Tea bushes 11 to 40 years	32.88	
	4. Tea bushes 41 to 60 years	60.10	
	II. Seed Bari	6.00	
	II. Seed Nursery	0.50	
	III. Clone Nursery	0.50	
(b)	Under Subsidiary Crops	19.76	
	I. Fruit Tree	5.15	
	II. Soft and Hard Wood Timber Garden	10.56	
	III. Agar	4.05	
(c)	Office/Bungalow/Godown, Staff Quarter, Labour Line, School, Hospital, Graveyard, Masjid/Mandir/Church and Roads	29.60	
(d)	Cultivable, Fellow and Waste Land	69.87	
Total Area of the Farm		**228.36**	

Table 2. Crop Production

Description	Quantity
a. Green Leaf	9,56,272 (kg)
b. Made Tea	2,15,161 (kg)
c. Average Production	2,235 (kg/ha)

Table 3. Green leaf Production of the Farm in the Year 2016

Month	Month-wise crop production (kg)
January	-
February	-
March	28,573
April	57,491
May	25,805
June	1,88,262
July	29,412
August	1,72,197
September	1,70,473
October	1,26,474
November	1,14,543
December	43,078
Total	**9,56,272 kg**

Table 4. Production of Improved Bi-clonal Seed, Planting Materials and Sales of Farm Products

Bi-Clonal Seed production (kg)	Institutional use (kg)	Sales of Bi-Clonal Seed (kg)	Sale amount (Tk)	Sales of Different Fruit (Tk)
589	30	559	83,850.00	25,000.00

Extension and Development

1.50 ha of land was newly planted in 2016. It has a nursery with the average capacity of 40,000 plants. Water supply, labor houses, roads and bridges were regularly maintained. Four thousand tea saplings were infilled in different sections in the year 2016. Experiments of different divisions had been facilitated at the period.

Miscellaneous

The Victory Day as well as the Independence Day were celebrated with due solemnity during the year. Prizes for sports and sweets were distributed among the labors of the farm and their children on both the occasions. Blankets were distributed among the labors as incentive of the year.

BTRI SUB-STATIONS

Fatickcherri, Chittagong

STAFF

Mr. Md. Abul Kashem, Scientific Officer (Botany Division) was transferred to Northern project area, Bangladesh Tea Board, Nilphamari and Mr. Raihan Mujib Himel, Scientific Officer (Plant Pathology Division) took over the charge of Officer-in-charge of the sub-station on 1 August, 2016. There was no other change in the personnel position of the sub-station during the period under report.

PRODUCTION

74,280 kgs green leaves were produced during the year 2016. Harvested green leaves were sent to Oodaleah Tea Estate for manufacturing.

Distribution of improved planting materials

Year	Items	Tea Estate		CHT Project	Banshkhali	Total (No./kg)
		No.	Quantity (No./kg)			
2016	Fresh Cuttings	8	19,51,800	1,00,000	-	20,51,800
	Rooted Cuttings	1	150	-	-	150
	Biclonal Seed	8	495	-	-	495

Besides the above mentioned items, jackfruits were sold at worth of 4,000/=Tk during the year.

Infilling and Extension programme

About 15,657 nos. tea plants were in filled during the reporting year.

Development

One (01) new kancha labor house was built during the year.

Seminars and Workshops

A course of two days on tea culture and workshops on different topics such as pruning, plucking, diseases and pest management etc. were organized time to time at the sub-station for the tea planters of Chittagong Valley.

Miscellaneous

The Independence Day as well as the Victory Day were celebrated with due solemnity during the reported year. On both the occasions sweets and prizes for sports were distributed among the labors and their children of the sub-station.

KALITI SUB-STATION
Klaura, Moulvibazar

STAFF

There was no change in the personnel position of the Sub-station during the reporting year.

PRODUCTION

Green leaves produced during 2016 and total numbers of fresh cuttings distributed to different tea estates are given below:

Year	Production of green leaf (Kg)	Sale price (Tk)	Fresh cutting supplied (nos.)	Sale price (Tk)
2016	39586	10,35,173.90	87000	26,100

REGIONAL STATION
Panchagarh

STAFF

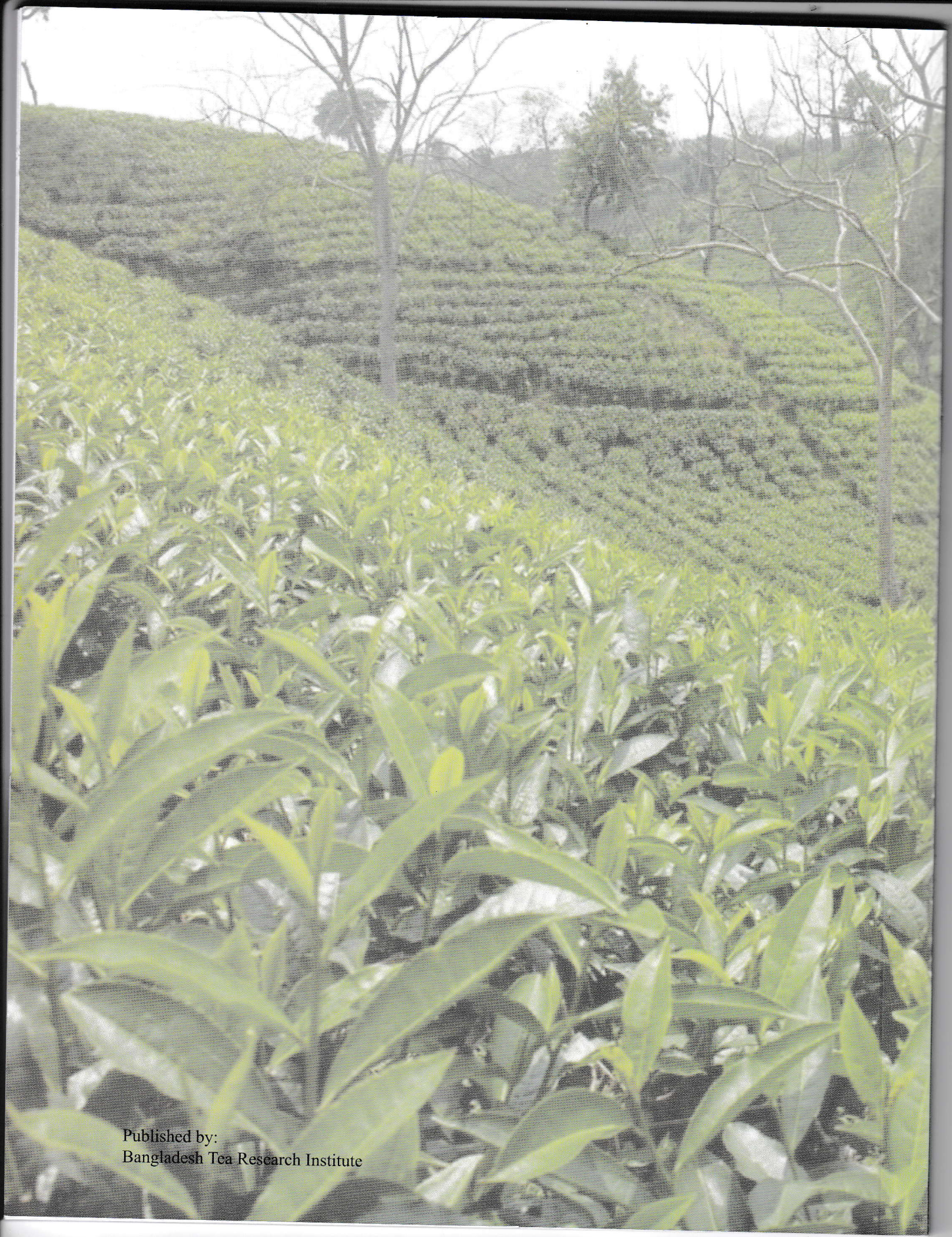
There was no other change in the personnel position of the regional station during the reporting year.

PRODUCTION

32, 500 nos. of BT2 @ Tk. 4.5; 2,500 nos. of TV23 @ Tk. 5 and 6,000 of TV26 @ Tk. 4.5. The total cuttings supplied to tea estates were 18,400 nos. @ of Tk. 2.5. Total earn of 2,31,750 taka.

Other activities of the divisions during 2016

Sl.	Item	Soil Science	Bio chemistry	Botany	Agronomy	Entomology	Plant Pathology	Stat. & Eco.	Technol ogy
01	No. of experiments	04	05	31	06	10	07	03	03
02	No. of experimental visits	40	-	26	166	12	41	-	-
03	No. of advisory visits	21	-	08	29	28	21	-	04
04	No. of advisory correspondence	223	-	11	22	30	30	-	-
05	No. of official visits	04	-	10	07	11	07	-	03
06	No. of soil, fertilizer & dolomite samples analyzed	3021	-	-	-	-	-	-	-
07	No. of nursery soil, water & cowdung samples analyzed for nematodes	-	-	-	-	134	-	-	-
08	No. of pesticide residue analysis (commercial)	-	-	-	-	02	-	-	-
09	No. of pesticide residue analysis (Experimental)	-	-	-	-	06	-	-	-
10	Physical test of pesticides in Lab.	-	-	-		01	-	-	-
11	No. of pesticides tested in tea fields	-	-	-	-	102	115	-	-
12	No. of circulars/pamphlets/leaflets issued to T. E.	-	-	-	-	-	-	-	-
13	No. of workshop/seminar conducted	-	-	02	32	17	08	-	-
14	MTC module conducted (Hours/year)	40	-	06	36	30	16	-	20
15	Attended national seminar, conference, symposium & workshop	-	-	01	01	05	02	-	-
16	Attended international seminar, conference & symposium	-	-	-	-	-	-	-	-
17	Attended Training/Course	-	01	-	-	01	-	-	-
18	No. of research paper published	-		-	01	04	03	-	-
19	No. of Fresh cutting supplied	-		-	3,35,940	-	-	-	-
20	No. of Rotted cutting supplied	-		200	4,200	-	-	-	-
21	Biclonal seed supply to T. E.	-		517 Kg	-	-	-	-	-
22	Tea tasting	-		10	-	-	-	-	-



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