

ANNUAL REPORT 2015



BANGLADESH TEA RESEARCH INSTITUTE
SRIMANGAL-3210, MOULVIBAZAR
An organ of
BANGLADESH TEA BOARD
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Nasirabad, Chittagong

ANNUAL REPORT 2015

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DIRECTOR'S REPORT

STAFF

The report of the technical staff shows the position as on 31 December 2015

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

TECHNICAL DIVISIONS

1. DEPARTMENT OF CHEMISTRY

Chief Scientific Officer : **Vacant**

A. SOIL SCIENCE DIVISION

Principal Scientific Officer (In charge) : **Abdul Qayyum Khan**
B.Sc. (Hons), M.Sc. (DU)
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)

B. BIOCHEMISTRY DIVISION

Principal Scientific Officer : **Vacant**

Senior Scientific Officer : **Vacant**

Scientific Officer : **Vacant**

2. DEPARTMENT OF CROP PRODUCTION

Chief Scientific Officer : **S.M. Altaf Hossain**
B.Sc. (Hons), M.Sc. (RU)
M.Sc. (Reading, UK)

A. BOTANY DIVISION

Principal Scientific Officer : **Md. Ismail Hossain**
B.Sc.Ag.(Hons), M.S. (BAU)

Senior Scientific Officer : **Dr. Md. Abdul Aziz**
B.Sc. (Hons), M.Sc. (RU), Dipl. (China), Ph.D. (RU)

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

B. AGRONOMY DIVISION

Senior Scientific Officer : **Dr. Toufiq Ahmed**
B.Sc.Ag., M.S. (BAU), Ph.D. (Sri Lanka)

Senior Scientific Officer (Deputation) : **Mohammad Masud Rana**
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Farm Supervisor : **Vacant**

3. DEPARTMENT OF PEST MANAGEMENT

Chief Scientific Officer : **Dr. Mohammad Ali**
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PGD (India), Ph.D

A. ENTOMOLOGY DIVISION

Senior Scientific Officer : **Mohammad Shameem Al Mamun**
B.Sc.Ag. (Hons.), M.S. (BAU), PGD (India)

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

B. PLANT PATHOLOGY DIVISION

Senior Scientific Officer : **Mohammed Syeful Islam**
B.Sc.Ag., M.S. (BAU)

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

Scientific Officer : **Raihan Mujib Himel**
B.Sc.Ag. (Hons.), M.S. (BSMRAU)

TECHNOLOGY DIVISION

Scientific Officer : **Dulal Chandra Dey**
B.Sc. Engg. Mech. (BUET)

Senior Tea Maker : **Md. Amir Ali**
B.Sc. (RU)

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

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

STATISTICS & ECONOMICS DIVISION

Principal Scientific Officer : **Vacant**

Senior Scientific Officer : **Shefali Boonerjee**
B.Sc. (Hons), M.Sc. (RU)

BTRI SUB-STATION, FATIKCHARI, CHITTAGONG

Scientific Officer & Officer in-charge : **Md. Abul Kasem**
B.Sc. (Hons), M.Sc. (CU)

Senior Farm Assistant : **Ajit Chandra Choudhury**
B.A. (NU)

BTRI SUB-STATION, KALITI, KULAURA

Field Assistant : **Aminul Islam Mandal**
Dip.-in-Agric. (Sherpur)

BTRI REGIONAL STATION, PANCHAGARH

Senior Farm Assistant : **Md. Zayed Imam Siddique**
Dip.- in- Agric. (Rangpur)

BILASHCHERRA EXPERIMENTAL FARM

Assistant Farm Superintendent : **Mohammad Sayadul Huq**
M.Sc (NU)

Farm Supervisor : **Md. Hossain Mahamud**
Dip.- in- Agric. (Dhaka)

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

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

Field Assistant : **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, 2015.

During the year under report, a total of **63** experiments on different aspects of tea culture were in progress in different disciplines, research divisions during 2015. 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 3018 soil, fertilizer including lime samples were analyzed during 2015.

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 germplasm 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 2015. A total of 166120 fresh cuttings, 7692 rooted cuttings and 215 Kg. bi-clonal seeds were distributed to different tea estates in the year 2015. 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 161 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 2014 was published in June 2015 and Tea Journal of Bangladesh, Volume 43, 2014 was also published in July 2015.

ANNUAL COURSE / SEMINAR / WORKSHOP

The 50th 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 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 - 1305
Total issues - 1699

LIBRARY

BTRI Library contained 4,595 books and 9,047 Periodicals, Journals, Pamphlets and Circulars, Newsletter, Research highlights, etc.

(Dr. Mainuddin Ahmed)
Director

SOIL SCIENCE DIVISION

Abdul Qayyum Khan

Principal Scientific Officer (In-charge)

STAFF

Ms. Kanij Fatema Tuz Zohora, Scientific Officer transferred to Bangladesh Tea Board, Chittagong on 31 December 2015. 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 2015 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 levels in reducing the chemical fertilizer use at Bilashcherra Experimental Farm. Dolomitic lime and NPK were applied on the soil after a good shower, simultaneously organic manure (cow-dung) was 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 were recorded during the plucking season. The experiment was laid out in the year 2012 and will be continued up to 2016. There were eight treatments in a Randomized Block Design with three replications. The unit plot size was 14.90 m². The treatment combinations are presented below.

T ₁ = Control T ₂ = BTRI Recommended dose of chemical fertilizer T ₃ = Organic manure (2 ton/ha) T ₄ = Organic manure (6 ton/ha)	T ₅ = 85% of T ₂ + Organic manure (2 ton/ha) T ₆ = 85% of T ₂ + Organic manure (6 ton/ha) T ₇ = 70% of T ₂ + Organic manure (2 ton/ha) T ₈ = 70% of T ₂ + Organic manure (6 ton/ha)
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(Recommended Fertilizer dose: (N¹⁰⁰, P³⁵, K⁶⁰ kg/ha & Zn¹⁰ 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	SL	4.3	1.03	0.106	5.12	52.4	43.2	6.3
Critical value	SL - L	4.5-5.8	1.0	0.1	10	80	90	25

SL- Sandy Clay Loam, SL- Sandy Loam L- Loam

The results showed that, in every treatment increased yield was recorded over the control. The highest made tea yield (2055 kg/ha) was recorded in treatment T₆ 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 13.09% in case of treatment T₆. But the increase of yield due to different treatments was statistically insignificant.

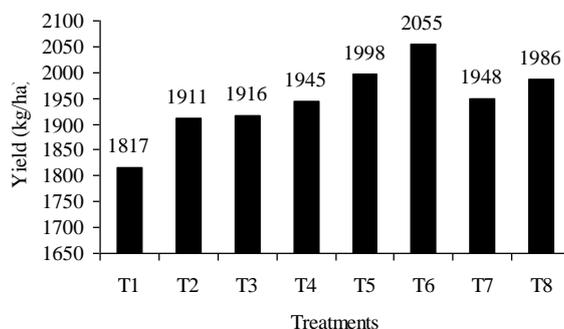


Fig 1: Effect of different treatments on the yield of tea (BEF, 2015)

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 and crop production. The experiment was conducted at two locations, one at BTRI Farm and the other at Srigobindpur T.E. Usual

cultural operations and pest control measures 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, 2015. Regular weekly harvesting data were recorded during the harvesting season. Each plot size was 35.60 m².

Treatment combinations are as follows:

T ₁ = Control (without fertilizer)	T ₅ = N ⁷⁰ + P ²⁰ + K ⁴⁵ (kg/ha)
T ₂ = N ⁴⁰ + P ⁵ + K ³⁰ (kg/ha)	T ₆ = N ⁸⁰ + P ²⁵ + K ⁵⁰ (kg/ha)
T ₃ = N ⁵⁰ + P ¹⁰ + K ³⁵ (kg/ha)	T ₇ = N ⁹⁰ + P ³⁰ + K ⁵⁵ (kg/ha)
T ₄ = N ⁶⁰ + P ¹⁵ + K ⁴⁰ (kg/ha)	

Zinc (10 kg/ha) was applied as blanket dose at the time of split fertilizer application. The results showed that, increase of yield was recorded in every treatment over the control. The highest made tea yield (2325 kg/ha) was recorded in treatment T₇ where N⁹⁰, P³⁰, K⁵⁵, and Zn¹⁰ kg/ha were applied. The rate of increase over the control was 15.16% in case of treatment T₇. Similar trend was observed in yield at both the locations. But the increase of yield due to different treatments was statistically insignificant.

Table 2. 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	4.5-5.8	1.0	0.1	10	80	90	25

SCL- Sandy Clay Loam, SL- Sandy Loam L- Loam

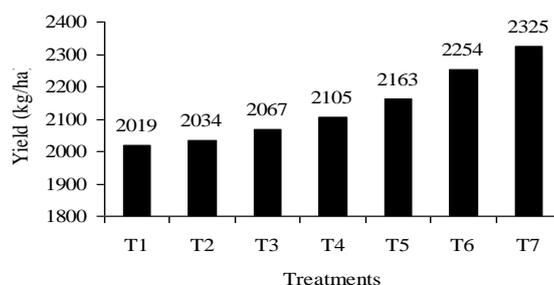


Fig 2: Effect of different fertilizer doses on the yield of tea (BTRI Farm, 2015)

The results showed that, in every treatment increased yield was recorded over the control. The highest made tea yield (3490 kg/ha) was recorded in the treatment T₇ where N⁹⁰, P³⁰, K⁵⁵, and Zn¹⁰ kg/ha were applied. The rate of increase over the control was 6.89% in case of treatment T₇. There was an increasing trend in yield with the increase of fertilizer dose. The increase of yield due to different treatments was statistically significant (F= 3.82) at 5% level.

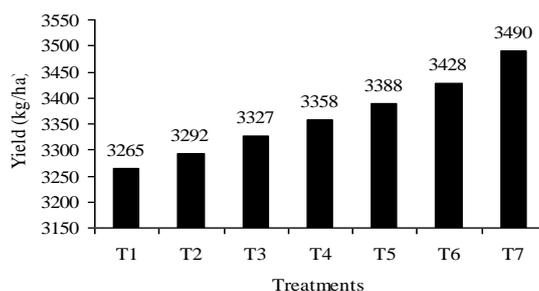


Fig 3: Effect of different fertilizer doses on the yield of tea (Srigobindpur T.E, 2015)

SS 3. Effect of single fertilizer dose on the yield of mature tea (2014-2015)

To estimate the effect of single fertilizer dose on the yield of mature tea, a field experiment was conducted at BTRI Farm. The experiment was laid out in a RBD having four treatments and three replications. 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, 2015. Each plot size was 30.00 m². Usual cultural operations and pest control measures were taken as and when needed. Regular weekly harvesting data were recorded during the harvesting season. Treatment combinations are as follows:

T₁ = Control T₂ = N¹³⁰ kg/ha
 T₃ = P³⁵ kg/ha T₄ = K⁹⁰ kg/ha

The results showed that, increase of yield was recorded in every treatment over the control. The highest yield (1959 kg/ha) was recorded in T₂ where 130 kg/ha nitrogen (N) was applied. The rate of increase was 3.98% over the control in case of treatment T₂. But the increase of yield due to different treatments was statistically insignificant.

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 A ₂ area	SCI	4.2	1.13	0.106	3.95	29.0	67.80	18.16
Critical value	SL - L	4.5-5.8	1.0	0.1	10	80	90	25

SCL- Sandy Clay Loam, SL- Sandy Loam L- Loam

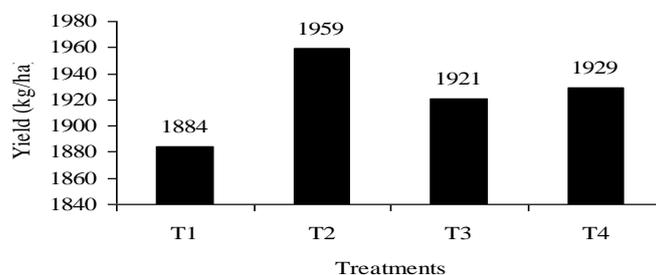


Fig 4: Effect of single fertilizer on the yield of tea during 2015

SS 4. Effect on growth and yield for rehabilitation of old tea soil before replanting

The details of this experiment were presented by the Agronomy Division as it is a collaborative research program of Agronomy and Soil Science Division.

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 2873 soil samples and 145 other samples from 87 tea estates were analyzed.

Table 5. Number of samples analyzed

Year	Soil	Fertilizer	Lime/Dolomite	Water	Compost	Total (others)	(Soil & others)
2015	2873	110	33	-	02	145	3018

Table 6. List of Tea Estates from where soil and other samples were received or collected and analyzed during the year 2015

Amo	Dantmara	Jhemai	Madhupur	Rungicherra
Amtali	Dilkhusha	Karimpur	Muraicherra	Rajghat
Ameenabad	Dinarpur	Kurma	Noyapara	Rema
Amrail	Deanston	Kapnapahar	Nahar	Rampore
Allynugger	Deundi	Khan	Nurjahan	Rasheedabad
Ayeshabagh	Dauracherra	Korotoah	Nalua	Srigobindpur
Balisera	Dildarpore	Kodala	Neptune	Shumshernugger
Burjan	Daragao	Lalchand	New Samanbagh	Sathgao
Bidyabheel	Etah	Lungla	Ootterbagh & Indanugger	Silloah
Brindaban	Ghazipore	Luskerpore	Oodalia	Saif
Baraooora	Hatimara	Luayuni- holicherra	Phulcherra	Sreemangal
Bahadurpur	Horincherra	Mazdehee	Phooltullah	Serajnagar
Chaklapunji	Hooglicherra	Mertinga	Patrakhola	Surma
Chandpore	Hajinagar	Mirzapore	Patharia	Udnacherra
Clevedon	Habibnagar	Mathiura	Phulbari	Zarreen
Chandbagh	Imam	Monipur	Pooteacherra	
Champarai	Jagcherra	Marina	Rajkie	
Chatlapore	Jagadishpur	Malnicherra	Ruthna	

Advisory correspondence

A total of 220 advisory letters to different tea estates on soil, fertilizers, dolomite, compost and other soil related aspects were sent during the year 2015.

Tours

During the year under report, officers of the division paid a total 52 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 organized by BTRI for the covenanted staff of tea estate during 2015. 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.

BOTANY DIVISION

Md. Ismail Hossain
Principal Scientific Officer

STAFF

Ms. Shefali Boonerjee, Scientific Officer was promoted to the post Senior Scientific Officer, Statistics and Economics Division on 23 June, 2015. The posts of two Scientific Officers and one Field Assistant were vacant. There was no other change in personnel position of the division during the period under report.

RESEARCH

Twenty two experiments in three programme areas namely– preliminary selection of vegetative clones, long term yield and quality trial of provisionally selected clones, tea breeding and field performances of BTRI released clones were carried out by the division. Results are briefly described below:

B1: PRELIMINARY SELECTION OF VEGETATIVE CLONES

B1-27: Selection of Vegetative Clones at Shumshernugger T. E., Main Div. Sec. No. 9 (1993-2017)

From the estate 22 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 2345 cuttings from 18 selected bushes from Shumshernugger T.E. were collected and put into the rooting trial.

B1-28: Selection of Vegetative Clones at Amo T. E., Section No. 8 (1993-2015)

Thirty one 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 5436 cuttings from 23 bushes of section no. 8 of Amo Tea Estate were collected and planted in the nursery.

B1-31: Selection of Vegetative Clones at Baraoorah T. E., Section No. 8 (2007-2015)

Twenty three bushes have been selected during the period under report. The selected bushes have been pruned for collecting cuttings for rooting trial. A total of 2345 cuttings from 19 bushes of section no. 8 of Baraoorah Tea Estate were collected and planted in the nursery.

B2: 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 BT1 (BTRI, 1996-2015)

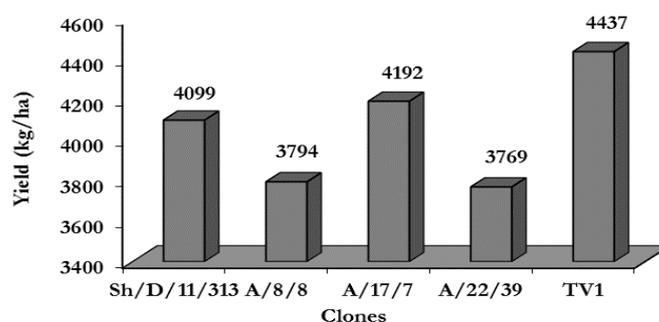
The plants of this trial were deep skiffed at 78 cm in 2015. There were 29 plucking rounds in 2015. The yield data were analyzed and found insignificant treatment difference which is presented in table 1 and made tea production in kg/ha is in fig. 1.

Table 1. Yield of green leaves (g/plant)

Clone	Year	Sh/D/11/313	A/8/8	A/17/7	A/22/39	TV1
Treatment mean	2015	1122.65	1039.29	1148.18	1032.38	1215.88

Treatment difference: Insignificant

The statistical analysis reveals that all the test clones are comparable in the case of yield with the control TV1. 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 2.

**Fig. 1.** Comparative yield of clones (made tea kg/ha)**Table 2.** 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	7.21	7.26	2.73	32.21	AA
A/8/8	7.47	7.51	7.22	7.30	2.77	32.27	AA
A/17/7	7.51	7.69	7.41	7.31	2.81	32.73	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

All the test clones are above average while the control TV1 is excellent in terms of cup quality.

B2-36: 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, 1996-2015)

The plants of this trial were deep skiffed at 78 cm in 2015. There were 29 plucking rounds in 2015. The yield data were analyzed and presented in table 3 and the estimated made tea production in kg/ha is in fig. 2.

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

Clone	Year	A/8/01	A/17/22	A/22/27	A/22/40	BT1
Treatment mean	2015	701.48	713.95	668.04	832.63	833.29

Treatment difference: LSD at 5% = 84.94

The analytical results reveal that yield difference was significant in 2015; test clone A/22/40 gave similar yield with the control BT1 while rest of the test clones yielded lower with 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 4.

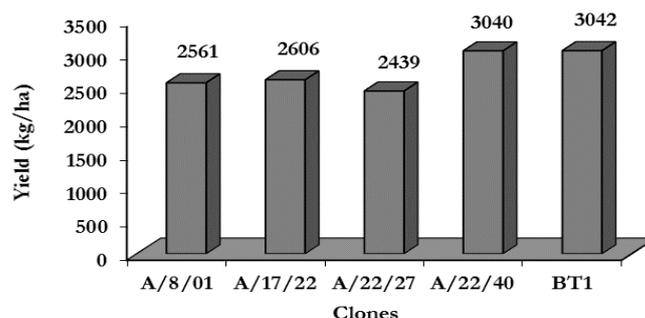


Fig. 2. Comparative yield of clones (made tea kg/ha)

Table 4. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
A/8/01	7.52	7.59	7.25	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	7.64	7.48	7.39	7.35	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

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 to the control.

B2-38: Yield and Quality Trial of Test clones Selected from Chandpore, Shumshernugger and Amo T. Es.; Test clones Cha/J1/10, Sh/B/6/59, Sh/B/6/62 and A/8/24 against Control BT2 (BTRI, 1997-2015)

The plants of this trial were deep skiffed at 73 cm in 2015. There were 27 plucking rounds in 2015. The yield data were analyzed and presented in table 5 and made tea production in kg/ha is presented in fig. 3.

Table 5. 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	2015	703.51	659.79	652.16	894.63	717.17

Treatment difference: LSD at 5% = 112.05

The analytical results reveal that yield difference was significant in 2015; test clone A/8/24 gave significantly higher yield over the control BT2 but the test clones Cha/J1/10, Sh/B/6/59 and Sh/B/6/62 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 6.

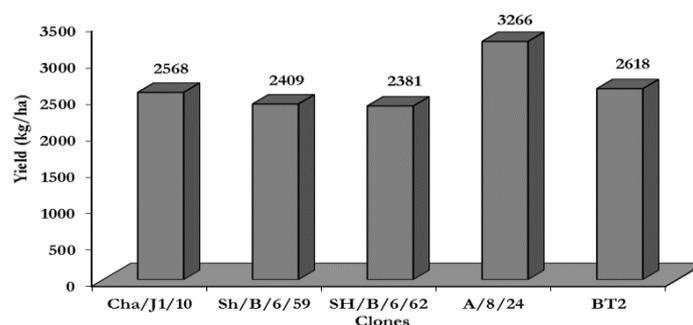


Fig. 3. Comparative yield of clones (made tea kg/ha)

Table 6. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
Cha/J1/10	7.67	7.32	7.37	7.39	2.80	32.45	AA
Sh/B/6/59	7.11	7.18	7.28	7.25	2.47	31.42	A
Sh/B/6/62	7.31	7.33	7.81	7.69	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

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.

B2-39: 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, 1998-2015)

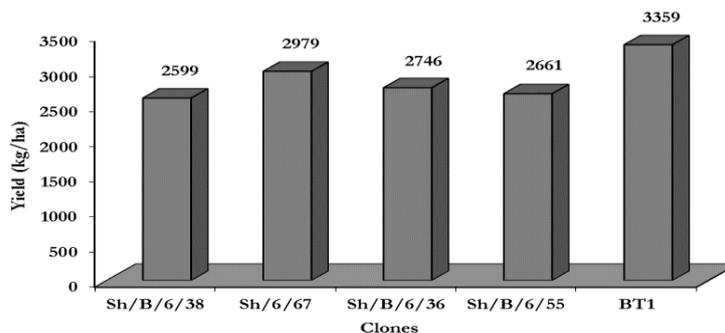
The plants of this trial were light skiffed at 81 cm in 2015. There were 25 plucking rounds in 2015. The yield data were analyzed and presented in table 7 and the estimated made tea production in kg/ha is in fig. 4.

Table 7. 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	2015	711.92	815.94	752.14	728.8	920.00

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 8.

**Fig. 4.** 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	
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

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.

B2-40: Yield and Quality Trial of Six Test clones – MZ/39, E/4, D/13, B2×T1, BR2/97 and SDL/1 against Standard BT2 (BTRI, 2000-2015)

The plants of this trial were medium skiffed at 79 cm in 2015. There were 33 plucking rounds in 2015. The yield data were analyzed and presented in table 9 and the estimated made tea production in kg/ha is in fig. 5.

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

Clone	Year	MZ/39	E/4	D/13	B2×T1	BR2/97	SDL/1	BT2
Treatment mean	2015	1267.5	969.64	805.45	1003.22	889.52	1173.35	1079.78

Treatment difference: LSD at 5% = 221.89

The analytical results reveal that yield difference was highly significant in 2015. 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 was assessed through organoleptic test and the average scores are presented in table 10.

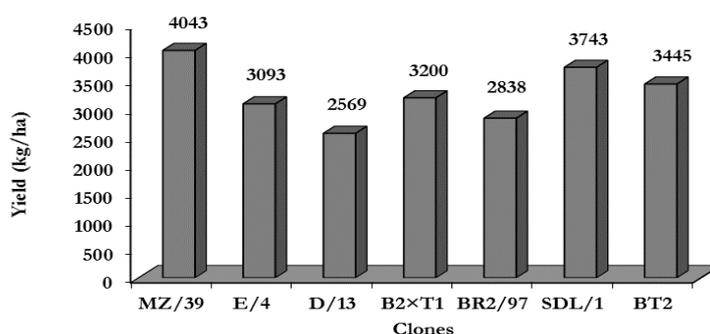


Fig. 5. Comparative yield of clones (made tea kg/ha)

Table 10. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
MZ/39	7.49	7.43	7.54	7.43	2.68	32.57	AA
E/4	7.51	7.69	7.43	7.37	2.61	32.61	AA
D/13	7.61	7.52	7.41	7.43	2.84	33.82	AA
B2×T1	7.28	7.39	7.30	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

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.

B2-41: 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, 2000-2015)

The plants of this trial were deep skiffed at 74 cm in 2015. There were 32 plucking rounds in 2015. The yield data were analyzed and presented in table 11 and made tea production in kg/ha is presented in fig. 6.

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

Clone	Year	A/8/37	A/8/55	A/8/62	A/8/66	BT2
Treatment mean	2015	1059.11	719.17	615.48	1224.44	984.76

Treatment difference: LSD at 5% = 116.33

The analytical results reveal that yield difference was significant in 2015; the yield potential of the test clone A/8/66 was higher than that of control BT2 while test clone A/8/37 yielded similar to the control. Remaining two test clones performed lower yield. The cup quality of made tea for all the test clones was assessed through organoleptic test. The average scores are presented in table 12.

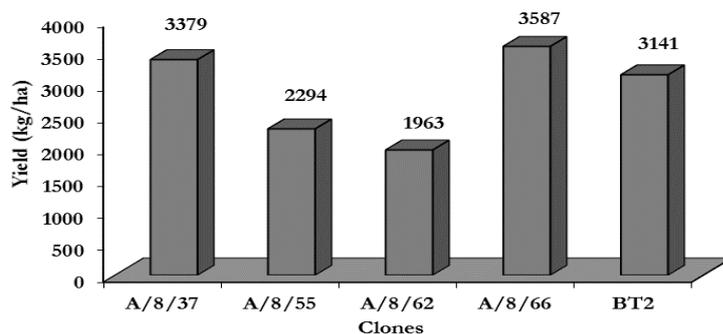


Fig. 6. Comparative yield of clones (made tea kg/ha)

Table 12. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
A/8/37	7.51	7.38	7.74	7.62	2.80	33.06	AA
A/8/55	7.33	7.36	7.29	7.31	2.25	31.54	A
A/8/62	7.39	7.55	7.68	7.41	2.82	32.65	AA
A/8/66	7.50	7.52	7.37	7.44	2.76	32.59	AA
BT2	7.56	7.76	7.38	7.38	2.67	32.45	AA

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.

B2-42: 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, 2001-2015)

The plants of this trial were light pruned at 61 cm in 2015. There were 32 plucking rounds in 2015. The yield data were analyzed and presented in table 13 and made tea production in kg/ha is in fig. 7

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

Clone	Year	A/17/16	Ph/9/1	Ph/9/9	Sh/B/6/46	BT1
Treatment mean	2015	854.54	589.62	835.45	784.74	776.17

Treatment difference: Insignificant

The analytical results reveal that yield difference was not significant in 2015; 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 14.

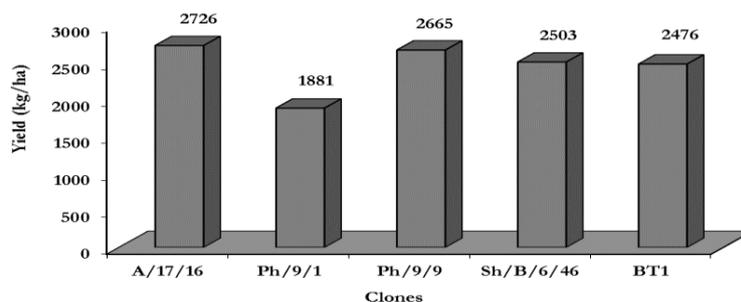


Fig. 7. Comparative yield of clones (made tea kg/ha)

Table 14. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
A/17/16	7.33	7.39	7.34	7.35	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	7.45	7.36	7.47	7.25	2.77	32.30	AA
BT1	7.39	7.60	7.75	7.32	2.87	32.93	AA

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.

B2-43: 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, 2001-2015)

The plants of this trial were light pruned at 59 cm in 2015. There were 33 plucking rounds in 2015. The yield data were analyzed and presented in table 15 and made tea production in kg/ha is in fig. 8.

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

Clone	Year	Ph/9/4	Ph/9/25	Ph/9/40	BS/67	BT5
Treatment mean	2015	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 in 2015; all the test clones excepting Ph/9/25 are comparable in terms of yield with the control. The yield performance of test clone Ph/9/25 was lower than the control BT5. The cup quality of made tea for all the test clones was assessed through organoleptic test. The average scores are presented in table 16.

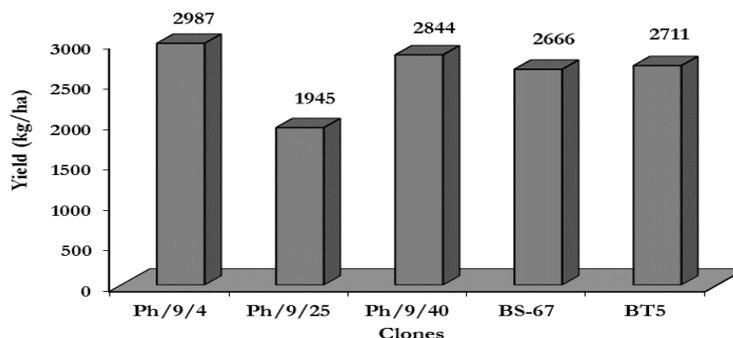


Fig. 8. Comparative yield of clones (made tea kg/ha)

Table 16. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
Ph/9/4	7.15	7.48	7.50	7.35	2.76	32.24	AA
Ph/9/25	7.28	7.56	7.35	7.51	2.46	32.16	AA
Ph/9/40	7.42	7.24	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

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.

B2-44: Yield and Quality Trial of Three Test clones Selected from Amo and Phulcherra T. Es.; Test clones– A/8/B1, Ph/9/B1, Ph/9/11 and against Standard BT1 (BTRI, 2003-2015)

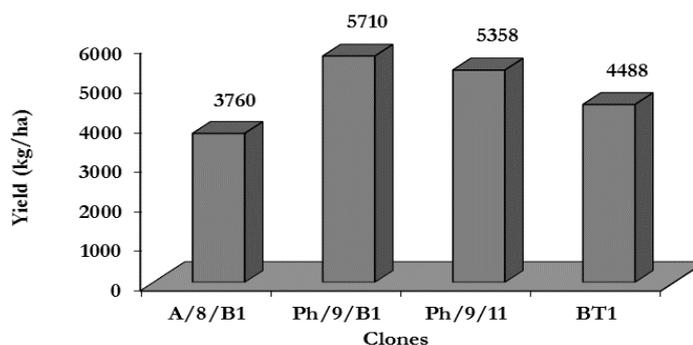
The plants of this trial were deep skiffed at 69 cm in 2015. There were 29 plucking rounds in 2015. The yield data were analyzed and presented in table 17 and made tea production in kg/ha is in fig. 9.

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

Clone	Year	A/8/B1	Ph/9/B1	Ph/9/11	BT1
Treatment mean	2015	1178.58	1790.00	1679.51	1406.91

Treatment difference: LSD at 5% = 240

The analytical results reveal that yield difference was significant in 2015. The yield potential of the test clones Ph/9/B1 and Ph/9/11 was higher than the control while A/8/B1 found to be similar to the control BT1. The cup quality of made tea for all the test clones was assessed through organoleptic test. The average scores are shown in table 18.

**Fig. 9.** 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	
A/8/B1	7.11	7.72	7.36	7.14	2.29	31.62	A
Ph/9/B1	7.29	7.39	7.41	7.45	2.84	32.98	AA
Ph/9/11	7.72	7.39	7.12	7.31	2.89	32.43	AA
BT1	7.72	7.63	7.68	7.40	2.85	33.28	AA

All the Test clones were comparable in terms of cup quality with the control BT1 excepting A/8/B1 which performed average cup quality with the control.

B2-45: 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, 2005-2015)

The plants of this trial were light pruned at 57 cm in 2015. There were 25 plucking rounds in 2015. The yield data were analyzed and presented in table 19 and made tea production in kg/ha is in fig. 10.

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

Clone	Year	Ph/9/68A	Sh/D/11/18	A/8/61	SC/12/28	BT2
Treatment mean	2015	765.25	688.1	1013.38	749.55	614.35

Treatment difference: Insignificant

The analytical results reveal that yield difference was not significant in 2015; 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 20.

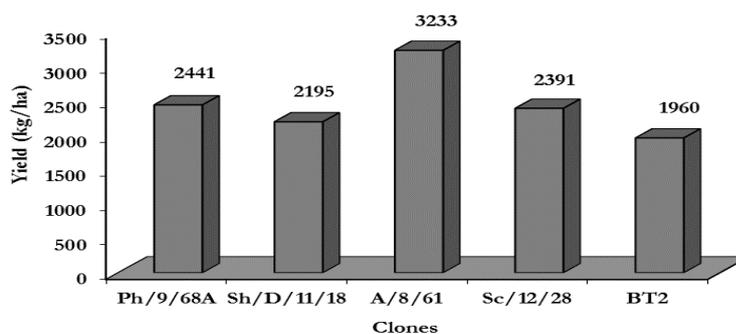


Fig. 10. Comparative yield of clones (made tea kg/ha)

Table 20. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
A/8/61	7.31	7.33	7.52	7.39	2.86	32.41	AA
Ph/9/68A	7.45	7.39	7.60	7.27	2.58	32.55	AA
Sh/D/11/18	7.20	7.39	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	7.20	7.45	7.66	7.72	2.70	33.08	AA

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.

B2-46: 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, 2005-2015)

The plants of this trial were light pruned at 57 cm in 2015. There were 24 plucking rounds in the reporting year. The yield data were analyzed and presented in table 21 and made tea production in kg/ha is in fig. 11.

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

Clone	Year	D1/18	D/6	D/10	D/12	BT5
Treatment mean	2015	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 22.

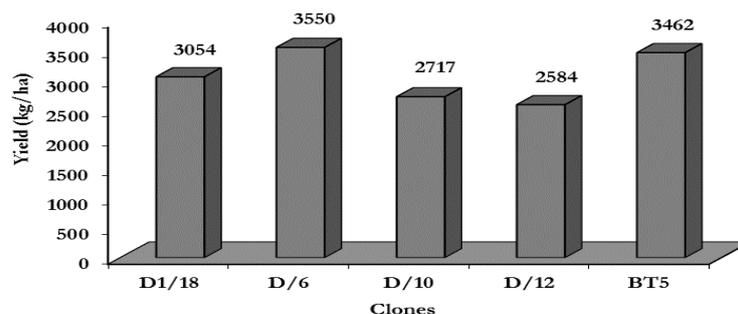


Fig. 11. Comparative yield of clones (made tea kg/ha)

Table 22. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
	7.71	7.39	7.62	7.55	2.79	33.06	AA
	7.55	7.34	7.65	7.77	2.82	33.13	AA
	7.15	7.55	7.34	7.66	2.65	32.35	AA
	7.22	7.17	7.29	7.27	2.30	31.25	A
BT5	7.16	7.25	7.63	7.43	2.78	32.25	AA

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

B2-47: 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 skiffed at 79 cm in 2015. There were 25 plucking rounds in 2015. The yield data were analyzed and presented in table 23 and made tea production in kg/ha is in fig. 12.

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

Clone	Year	Ph/9/92	BS/3	Ph/9/108	G/61/8	BT15
Treatment mean	2015	872.12	783.04	843.23	855.26	842.42

Treatment difference: Insignificant

The analytical results reveal that yield difference was not significant in 2015; the performances of all the test clones were similar with 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 24.

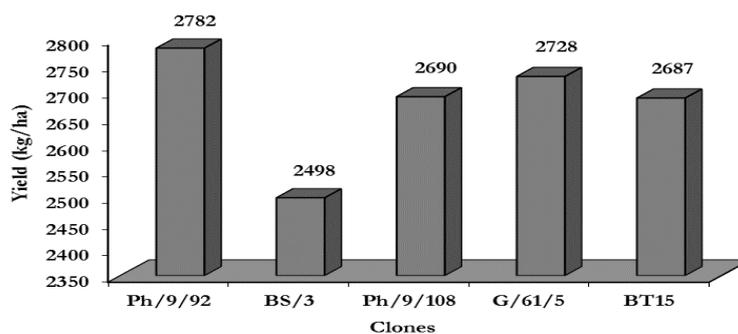


Fig. 12. Comparative yield of clones (made tea kg/ha)

Table 24. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
2	7.61	7.29	7.51	7.37	2.75	32.53	AA
	7.22	7.38	7.18	7.09	2.27	31.14	A
08	7.45	7.61	7.31	7.47	2.76	32.60	AA
	7.41	7.58	7.66	7.68	2.85	33.18	AA
	7.83	7.77	7.83	7.70	3.48	34.61	E

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.

B2-48: 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 and A/11/38 against Standard BT2 (BTRI, 2009-2019)

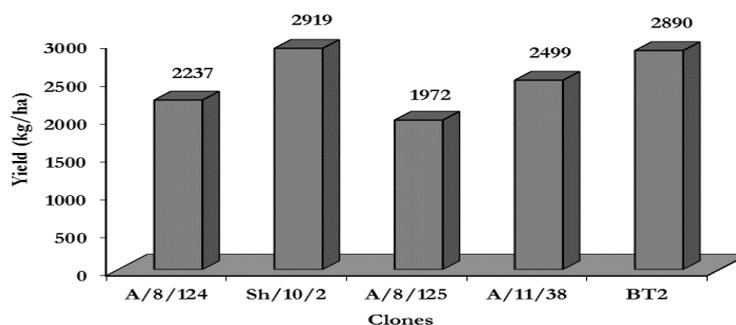
The plants of this trial were light skiffed at 70 cm in 2015. There were 24 plucking rounds in 2015. The yield data were analyzed and presented in table 25 and made tea production in kg/ha is in fig. 13.

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

Clone	Year	A/8/124	Sh/10/2	A/8/125	A/11/38	BT2
Treatment mean	2015	701.21	914.91	618.26	783.34	905.86

Treatment difference: Insignificant

The analytical results reveal that yield difference was insignificant in 2015; all the test clones gave similar yield with the control BT2. The cup quality of made tea for all the test clones were assessed through organoleptic test. The average scores are shown in table 26.

**Fig. 13.** 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	
4	7.41	7.52	7.36	7.43	2.85	32.57	AA
2	7.35	7.61	7.73	7.34	2.78	32.82	AA
5	7.56	7.58	7.79	7.32	2.78	33.03	AA
8	7.51	7.16	7.24	7.53	2.84	32.29	AA
	7.51	7.65	7.41	7.65	2.74	32.96	AA

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.

B2-49: Yield and Quality Trial of Four Test clones Selected from Shumshernugger T.E. (Sh/10/5 and Sh/D/13/4) and Amo T. E. (A/8/128 and BS/91/6) against Standard BT2 (BTRI, 2011-2019)

The plants were skiffed at 70 cm in 2015 and tipping was done at 75 cm. There were 20 plucking round during the cropping period. The yield data were analyzed and presented in table 27 and made tea production in kg/ha is in fig. 14.

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

Clone	Year	Sh/D/13/4	BS/91/6	Sh/10/5	A/8/128	BT2
Treatment mean	2015	662.94	513.07	502.73	605.18	612.39

Treatment difference: Insignificant

The analytical results reveal that yield difference was not significant in 2015; all the test clones gave similar yield with the control BT2. The cup quality of made tea for every clone was assessed through organoleptic test. The average scores are shown in table 28.

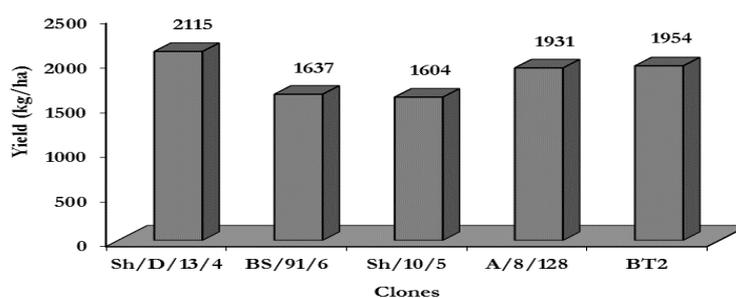


Fig. 14. Comparative yield of clones (made tea kg/ha)

Table 28. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
3/4	7.31	7.34	7.32	7.86	2.67	32.50	AA
6	7.31	7.40	7.35	7.30	2.76	32.18	AA
5	7.44	7.68	7.51	7.31	2.73	32.67	AA
8	7.41	7.40	7.32	7.19	2.76	32.08	AA
	7.46	7.32	7.32	7.44	2.79	32.31	AA

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

B2-50: Yield and Quality Trial of Four Test Clones Selected from Shumshernugger T.E. (Sh/9/65 and Sh/9/71) and Amo T. E. (A/8/233 and B/8/93) against Standard BT2 (BTRI, 2014-2022)

The experiment was initiated in May 2013 at BTRI farm under Latin Square Design with 105cm x 60cm spacing. Normal cultural practices were followed. The plants were skiffed at 50 cm in November, 2015 and tipping was done at 55 cm.

There were 20 plucking round during the cropping period. The yield data were analyzed and presented in table 29 and made tea production in kg/ha is in fig. 15.

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

Clone	Year	Sh/9/65	B/8/93	Sh/9/71	A/8/233	BT2
Treatment mean	2015	293.03	254.1	279.8	281.35	228.81

Treatment difference: Insignificant

The analytical results reveal that yield difference was not significant in 2015; 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.

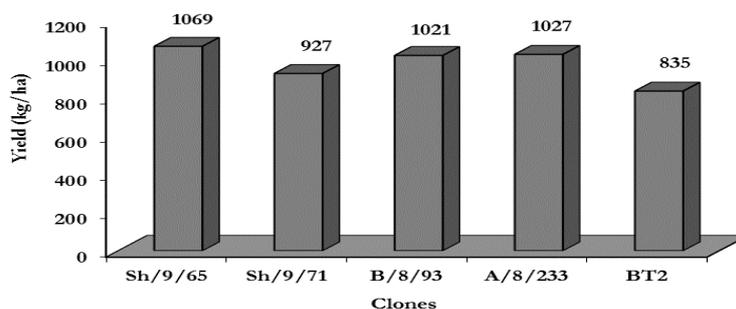


Fig. 15. Comparative yield of clones (made tea kg/ha)

Table 30. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
5	7.34	7.37	7.35	7.89	2.70	32.65	AA
1	7.33	7.42	7.37	7.32	2.78	32.20	AA
	7.45	7.69	7.52	7.32	2.74	32.72	AA
3	7.43	7.43	7.35	7.22	2.79	32.23	AA
	7.48	7.34	7.34	7.46	2.81	32.41	AA

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: BREEDING OF TEA

B3-1.1: 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 2015:

BT2 × TV23, TV23 × BT2, BT8 × TV23, TV23 × BT8, BT17 × BT2, BT2 × BT17,

BT4 × TV23, TV23 × BT4, BT6 × TV23, TV23 × BT6, BT1 × BT2, TV18 × 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.

B3-1.5: 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).

B3-1.8: Comparative Yield and Quality Trial of BTRI Released Biclonal Stock BTS1, Biclonal Stock T18×B3, Allynugger Polyclonal Stock (ANPS), Phulbari General Seed Stock (PBS) and Clone BT1 (BTRI, 1999-2015)

The plants of this trial were light skiffed at 81 cm in 2015. There were 33 plucking rounds in 2015. The yield data were analyzed and presented in table 31 and made tea production in kg/ha is in fig. 16.

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

Clone	Year	BT1	BTS1	PBS	ANPS	T18×B3
Treatment mean	2015	1048.48	941.56	862.1	965.99	984.92

Treatment difference: 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 32.

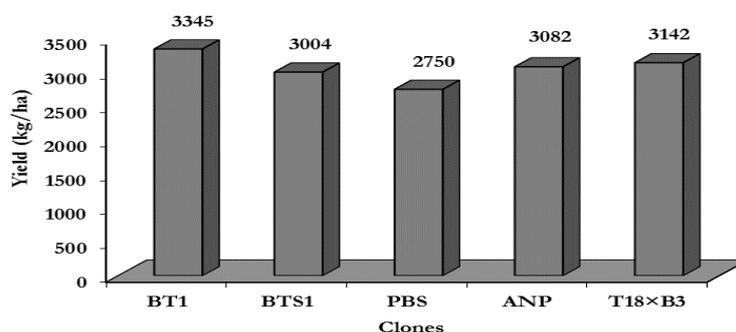


Fig. 16. Comparative yield of clones (made tea kg/ha)

Table 32. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
	7.39	7.60	7.33	7.63	2.78	32.73	AA
	7.43	7.52	7.66	7.34	2.87	32.82	AA
	7.13	7.18	7.25	7.33	2.89	31.78	A
	7.51	7.58	7.26	7.42	2.84	32.61	AA
	7.61	7.64	7.56	7.54	2.83	33.22	AA

All biclonal seed stocks excepting PBS are comparable with the control BT1 in terms of quality. Biclone PBS was inferior in cup to the control.

B3-1.9: Comparative Trial of Four Biclinal Seed Stocks (BTS1, BTS3, TV18×BT3 and TS463) and Three Parental Clones (BT1, TV1 and TV19) (2002-2015)

The plants of this trial were light skiffed at 79 cm in 2015. There were 30 plucking rounds in 2015. The yield data were analyzed and presented in table 33 and made tea production in kg/ha is in fig. 17.

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

Clone	Year	BTS1	BTS3	TV18×BT3	TS463	BT1	TV1	TV19
Treatment mean	2015	1562.54	1602.88	1565.72	1555.76	1461.42	1460.0	1764.92

Treatment difference: Insignificant

The statistical results reveal that there was no significant yield difference between the seedling jats. All the biclonal progenies 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 34.

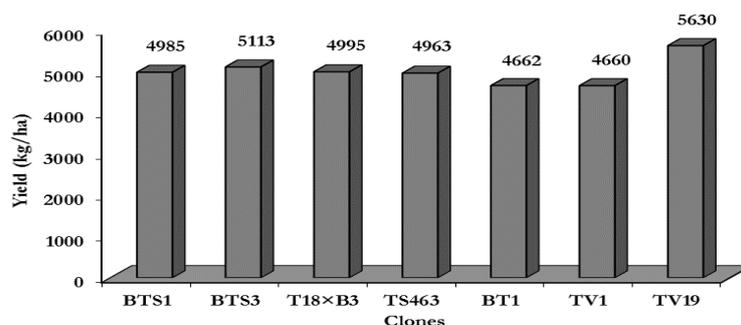


Fig. 17. Comparative yield of clones (made tea kg/ha)

Table 34. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
	7.32	7.61	7.49	7.61	2.93	32.96	AA
	7.34	7.15	7.12	7.51	2.69	31.81	A
BT3	7.41	7.36	7.15	7.56	2.73	32.22	AA
	7.59	7.36	7.42	7.32	2.76	32.45	AA
	7.28	7.34	7.33	7.44	2.78	32.17	AA
	7.54	7.34	7.56	7.64	2.90	32.98	AA
	7.41	7.34	7.53	7.49	2.81	32.58	AA

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

B3-8: 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.

Tours

During 2015 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:

Year	Experimental	Advisory	Others	Total
2015	32	2	-	34

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 49th Annual Courses arranged at BTRI for the covenanted staff of Tea Estates. 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 also 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 organized in 2015 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 35. Tea Tasting Sessions during 2015

Open day/Valley Tea Tasting Sessions	Date	Venue	No. of Estate participated	No. of participants
1. BTRI	06.06.15	BTRI	67	85
2. BTRI Sub-station Oodaleah	13.06.15	BTRI Sub-station Oodaleah	10	30
3. Juri Valley	08.08.15	Juri Valley Club	19	29
4. North Sylhet Valley	22.08.15	Khadim Tea Factory	9	16
5. Luskerpore Valley	05.09.15	Luskerpore Valley Club	14	19
6. Lungla Valley	12.09.15	Chandbag Tea Factory	17	28
7. Monu-Doloi Valley	19.09.15	Monu-Doloi Valley Club	14	25

AGRONOMY DIVISION

S.M. Altaf Hossain
Chief Scientific Officer
Department of Crop Production
&
Dr. Toufiq Ahmed
Senior Scientific Officer
Agronomy Division

STAFF

Mr. Masud Rana is on study leave to do his PhD in China. The posts of Principal Scientific Officer, two Scientific Officers, Farm Supervisor and Field Assistant were lying vacant during the reporting year. There was no other change in the staff position of the division.

RESEARCH

The division carried out two long-term and three short-term experiments during the reporting year under two research program namely- Standardization of cultural practices and Development of soil fertility. Results on the basis of collected data are briefly discussed below:

Experiment 1: Effect of different pruning cycles on the yield of different mature clonal tea (BTRI Farm, Long term: 2010-2023)

Treatments:

T₁ : LP -DS-MS

T₂ : LP -DS-MS-LS

T₃ : LP -LS-DS-MS

T₄ : LP -LS-DS-MS-DS-LS

T₅ : 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 analytical result of yield data in 2015 it is observed that there was significant interaction between pruning system and clone (Fig. 1). The highest yield (4,425 kg/ha) observed in the treatment combination of T₄ X BT13 and the lowest was in T₃ X BT12 (2,484 kg/ha). For overall analysis, it was seen that the lowest yield in 2015 was in T₃ and the highest yield in T₄ which was similar with T₅ (Table 1) and it indicates that longer pruning cycles have tendency to produce higher yield of tea. The experiment is being continued and has to wait until the field experiment is over to make the final comments.

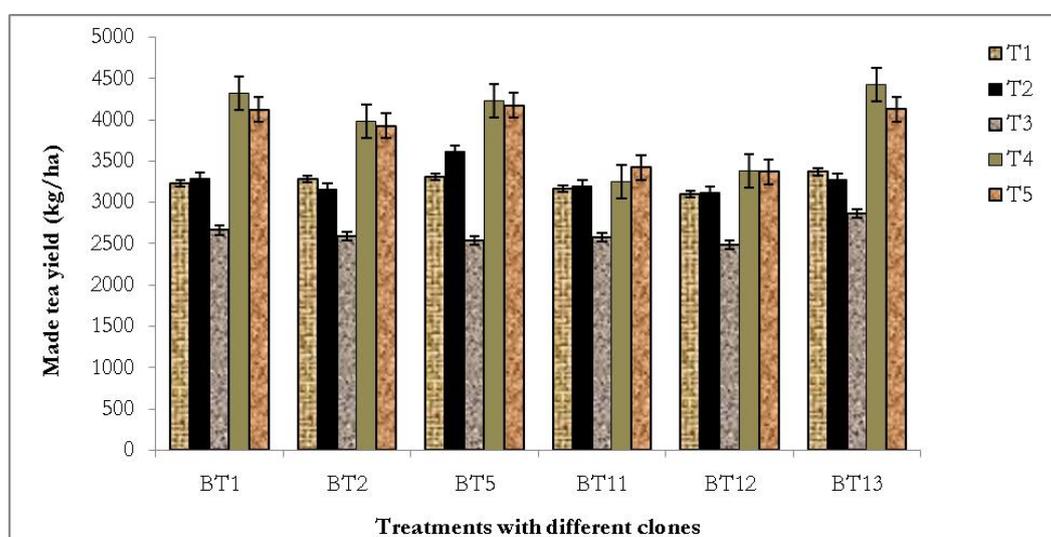


Figure 1. Variation of made tea yield in 2015

Table 1. Made tea yield (kg/ha) of different treatments in 2015

Treatments	Yield (kg/ha)
T ₁ (LP-DS-MS)	3239b
T ₂ (LP-DS-MS-LS)	3275b
T ₃ (LP-LS-DS-MS)	2617c
T ₄ (LP-LS-DS-MS-DS-LS)	3929a
T ₅ (LP-DS-MS-LS- DS-MS-LS)	3855a
LSD (0.05)	355
CV (%)	9.0

Experiment 2: Management of shade plant canopy for maximizing tea production in Bangladesh (BTRI Farm, Long term: 2011-2017)

Treatments:

T₁: Control (normal practice – pruning is not done)

T₂: Pruning at 2 meter height

T₃: Pruning at 2 and 3 meter height (in the consecutive years)

T₄: Pruning at 2, 3 and 4 meter height (in the consecutive years)

T₅: Pruning at 2, 3, 4 and 5 meter height (in the consecutive years)

The experiment was laid out at the BTRI Farm with *Albizia odoratissima* shade tree. Treatments based on pruning operations of shade tree are completed and from 2016 data will be recorded particularly the harvested leaf yield. For overall analysis based on the canopy coverage data of shade tree in the year 2015, shade tree canopy was found significant at 5% level of probability. The highest spreading was in T₅ and the lowest was in T₁ (Table 2).

Table 2. Treatment wise canopy measurement/spreading (m²) of shade tree in 2015.

Treatments	Spreading of shade tree canopy (m ²)
T ₁ (Common practice)	5.2c
T ₂ (Pruned at 2m height after one year of planting)	9.0b
T ₃ (Successively pruned at 2m and 3m height after 1 st and 2 nd year of planting)	9.3ab
T ₄ (Successively pruned at 2m, 3m and 4m height after 1 st , 2 nd and 3 rd year of planting)	9.3ab
T ₅ (Successively pruned at 2m, 3m, 4m and 5m height after 1 st , 2 nd , 3 rd and 4 th year of planting)	9.4a
LSD (0.05)	0.35
CV (%)	3.0

Experiment 3: Effect of different doses of chemical fertilizers and organic manures in pit for the establishment of clonal tea (BTRI Farm, Short term: 2014-2016)

Treatments:

T₁: No fertilizer and manure is applied in pit

T₂: 1 kg decomposed cow dung was applied

T₃: 2 kg decomposed cow dung was applied

T₄: ½ kg decomposed oil cake was applied

T₅: 30 g TSP + 15 g MOP was applied

T₆: 1 kg decomposed cow dung + ½ kg decomposed oil cake was applied

T₇: 1.5 kg decomposed cow dung + 30 g TSP + 15 g MOP was applied

Having seven treatments, the experiment was laid out as RCBD at the BTRI Farm. Other cultural operations related to plantation and maintenance were followed by the BTRI guide lines. After about a year of plantation during the centre out, different growth related parameters were collected from each and every treatment e.g. no. of leaves, fresh weight of roots, fresh weight of above ground part, base diameter of the tea plant etc. The experiment will be continued to get some other yield related parameters.

Experiment 4: Effect of different time of pruning on yield and crop distribution of mature clonal tea (BEF, Bilashcherra, Short term: 2015-2017)

Treatments:

T₁: Pruning in mid of October

T₂: Pruning in mid of November

T₃: Pruning in mid of December (Control – Normal practice)

T₄: Pruning in mid of January

T₅: Pruning in mid of February

T₆: Pruning in mid of March

The experiment was laid out at the Bilashcherra Experimental Farm with randomized complete block design (RCBD). Pruning operation was completed according to the schedule of treatments. In 2015, 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 2). However, the experiment should be continued another two years to finalize the result.

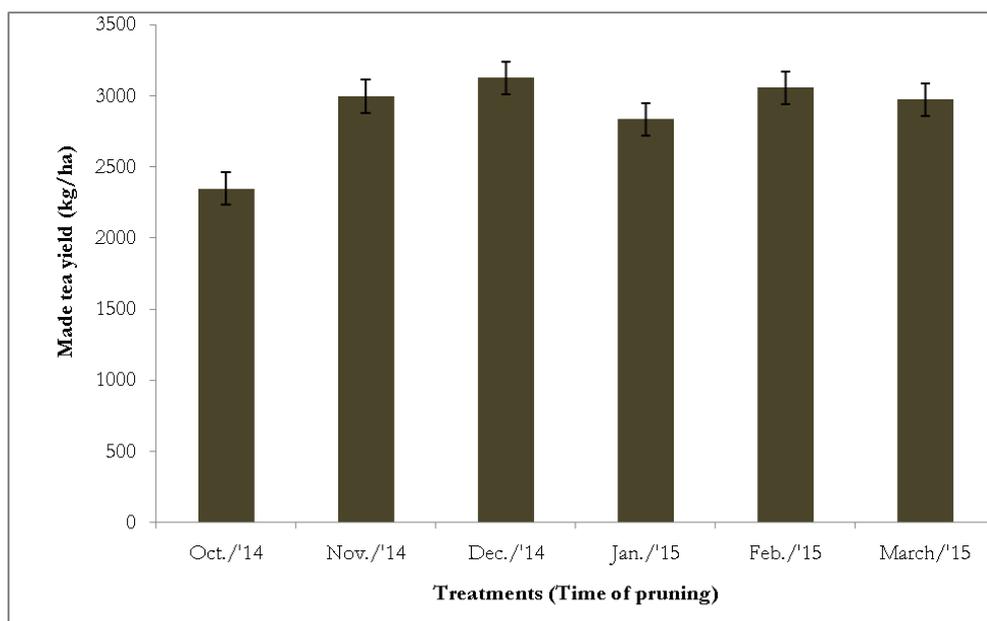


Figure 2. Variation of made tea yield due to the variation of pruning time

Experiment 5: Effect of a plant growth regulator (BIOKAD) on growth and yield of mature clonal tea (BTRI Farm, Short term: 2015-2016)

Treatments:

T₁: Control

T₂: BIOKAD is applied @ 200 ml/ha

T₃: BIOKAD is applied @ 300 ml/ha (recommended rate of UPASI)

T₄: BIOKAD is 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. Data of harvested green leaf of every week was recorded from each plot throughout the plucking season in 2015. After analysis of harvested leaf yield, it was observed that there was no significant difference among treatments (Figure 3). The experiment will be continued another year to finalize the result.

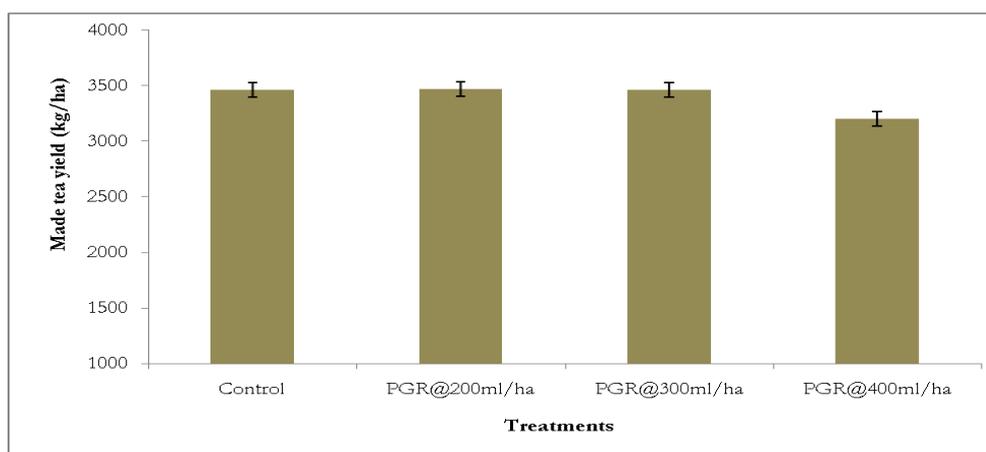


Figure 3. Variation of made tea yield due to treatments

Research Publications

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

01. Ahmed, T., De Costa, W.A.J.M. and Wijeratne, M.A. 2014. Effects of different rates of GA₃ on shoot growth dynamics and yield of mature clonal tea. *Tea J. Bangladesh*. 43: 1-9.
02. Hossain, S.M.A. 2014. Pruning, tipping and plucking for enhancing of tea production. *In: Proceedings of the workshop on Tea Production Technology Updated*. Bangladesh Tea Research Institute, Srimangal, Moulvibazar. Pp. 11-24.

Visit

Researchers of the division paid 50 visits to different Tea Estates for experimental, advisory services and other official purposes during the reporting year. Numbers of visits for the reporting year 2015 are 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	Nos. of other official tours
2015	22	25	3

Workshop / Seminar

Scientific personnel of Agronomy division arranged 18 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 50th BTRI annual course.

BTRI Main Farm

Md. Majibur Rahaman (Senior Farm Assistant, Botany division) was acting as the Farm Supervisor in-charge of BTRI Farm and Md. Hossain Mahmud (Farm Supervisor) attached in Agronomy Division was transferred from BTRI to the Tea Extension Project of Hilly area, Bandarban. 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
2015	1,66,120	7,692

Green leaf production and earning from other farm products:

Reporting year	Green leaf production in kg	Earning from other farm products in tk
2015	84,938	55,085/-

Table4. Meteorological Data for the year 2015

Month	No. rainy days	Rainfall (mm)	Evaporation (mm)	Temperature (°C)		Dew point (°C)	Sunshine hrs.	R.H. (%)
				Max.	Min.			
January	1	0.5	84.6	26.2	11.6	13.7	5.6	70.1
February	2	0.48	92.9	28.5	11.8	13.0	6.3	62.2
March	1	0.26	160.2	32.0	15.4	15.2	8.0	57.6
April	18	385	124.6	31.6	20.8	21.3	5.3	72.1
May	19	561	142.3	32.9	23.2	23.7	6.2	77.3
June	21	230	120.2	32.7	25.3	25.0	3.9	79.4
July	26	579	103.0	32.4	25.3	25.1	2.9	81.4
August	24	421	97.9	32.7	25.5	25.4	3.1	82.0
September	16	164	104.3	33.1	24.8	25.2	5.4	79.4
October	10	104	108.1	32.4	22.1	23.4	6.3	78.8
November	1	21	81.7	30.4	16.3	18.4	7.7	73.4
December	2	2	55.8	26.1	11.4	14.4	4.4	73.8
Average	11.8	205.7	106.3	30.9	19.5	20.3	5.4	73.9

ENTOMOLOGY DIVISION
Mohammad Shameem Al Mamun
Senior Scientific Officer

STAFF

The posts of Principal Scientific Officer, Scientific Officer and Senior Farm Assistant were lying vacant during the period under report.

RESEARCH

Ten experiments under six programme areas were carried out during the year of 2015. The experiments were: *In vitro* and *in vivo* screening of tea clones at nursery level for nematode susceptibility; Susceptibility of red spider mite to different agro types and clones; Evaluation of some indigenous plant extracts against *Helopeltis*, red spider mites & nematodes; Studies on physiological and biochemical changes in tea leaves due to pest infestation; Searching and identification of bio-control agents for the control of pests in tea; Predation capacity of *Oxyopes* spider and *Stethorus* beetle against red spider mite of tea; Bioefficacy of Entomopathogenic fungi against major pests of tea; Screening of pesticides against termites, *Helopeltis*, red spider mites and nematodes; Determination of judicious use of pesticides for a model tea estate; Determination of pesticide residue in made tea of different tea agro-types. Details of the experiments together with their findings are furnished below:

ENT 1. ENTOMOLOGICAL RESEARCH ON CLONAL VARIETIES OF TEA

ENT 1.1. *In vitro* and *in vivo* screening of tea clones at nursery level for nematode susceptibility (2008-2015)

An experiment was conducted at BTRI nursery to identify the resistance/susceptibility of a particular clone to nematode during 2008-2015. The experiment was laid out in paired plot design with three replications. Pathogenic nematode was cultured in primary bed as well as for polytube filling by adding half rotten cowdung. Pathogen free primary bed as well as polytube filling soil was also prepared by adding Furadan 5G. Screening of eighteen BTRI released clones (BT₁-BT₁₈) and three test clones (A/8/8, A/17/7 & A/22/40) were planted in the primary bed. Seedlings were transplanted from primary bed to secondary bed in polybags accordingly. Nematode population/10g of soil in each clone was counted at monthly interval. Mortality of the clones due to nematodes attack was also observed. The clones were categorized according to nematode susceptibility index by Boerma and Hussey (1992) with some modification as (i) Relatively resistance: 0.10-0.30%, (ii) Less susceptible: 0.31-0.50%, (iii) Moderately susceptible: 0.51-0.60% and (iv) Highly susceptible: ≥0.61% (Table 1). Results revealed that the BT₃, BT₁₃, BT₁₆, BT₁₇ and test clone A/17/7 were found relatively resistant while BT₆, BT₇, BT₈, BT₁₀ and test clone A/8/8 were less susceptible, BT₄, BT₅, BT₉, BT₁₂, BT₁₈ and test clone A/22/40 were moderately susceptible and BT₁, BT₂, BT₁₁, BT₁₄ and BT₁₅ were highly susceptible (Fig. 1).

Table. 1. Susceptibility index of BTRI and test clones against nematodes

Name of clones	No. of nematode population/10g soil	Mortality of clones (%)	Susceptibility index (%)
BT ₁	25.35	17.02	0.676ab
BT ₂	22.32	15.24	0.683a
BT ₃	30.14	5.32	0.176h
BT ₄	36.27	19.56	0.543d
BT ₅	14.33	8.66	0.600bcd
BT ₆	12.78	4.68	0.366ef
BT ₇	27.54	11.81	0.433e
BT ₈	29.32	10.67	0.356ef
BT ₉	26.35	14.56	0.546d
BT ₁₀	23.55	7.51	0.316fg
BT ₁₁	19.66	12.72	0.650abc
BT ₁₂	15.66	8.57	0.550d
BT ₁₃	11.54	3.33	0.293fg
BT ₁₄	19.52	13.69	0.703a
BT ₁₅	21.13	13.33	0.633abc
BT ₁₆	10.0	2.66	0.270g
BT ₁₇	12.16	3.00	0.253g

BT ₁₈	16.24	9.64	0.590cd
Λ/8/8	20.12	10.46	0.397ef
Λ/17/7	26.35	4.15	0.206gh
Λ/22/40	31.24	18.57	0.594cd

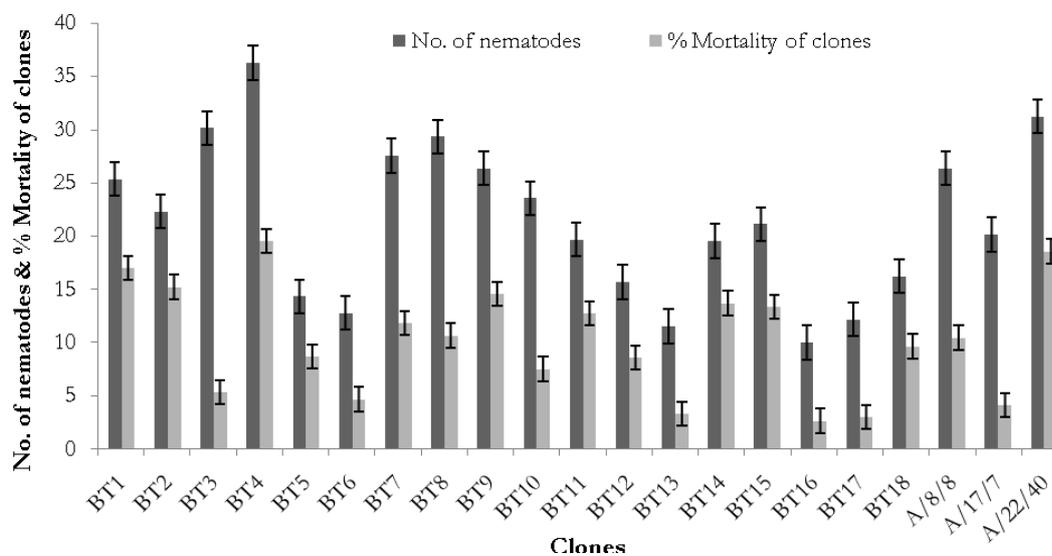


Fig. 1. Mortality percentage due to nematode infestation in tea seedlings at nursery

ENT 1.2. Susceptibility of red spider mite to different agro types and clones (2013-2015)

An experiment was carried out on the susceptibility of different tea agrotypes and clones to red spider mite infestation at the clonal block of BTRI Main Farm during 2013-2015. Susceptibility to red spider mites of different tea agrotypes such as China, Assam, Burma, Monipuri, Hybrids and tea clones namely, BT1, BT2, BT3, BT4, BT5, BT6, BT7, BT8, BT9, BT10, BT11, BT12, BT13, BT14, BT15, BT16, BT17, BT18, TV1 & Seedlings were evaluated. From the clonal block of BTRI, the mite population was estimated every month by sampling randomly 10 mature leaves per plot and transporting to the laboratory in poly bags where mites were then extracted from the leaves using a mite brushing machine (Model–Leedom Engineering, USA) and the number of mites was counted under the stereomicroscope.

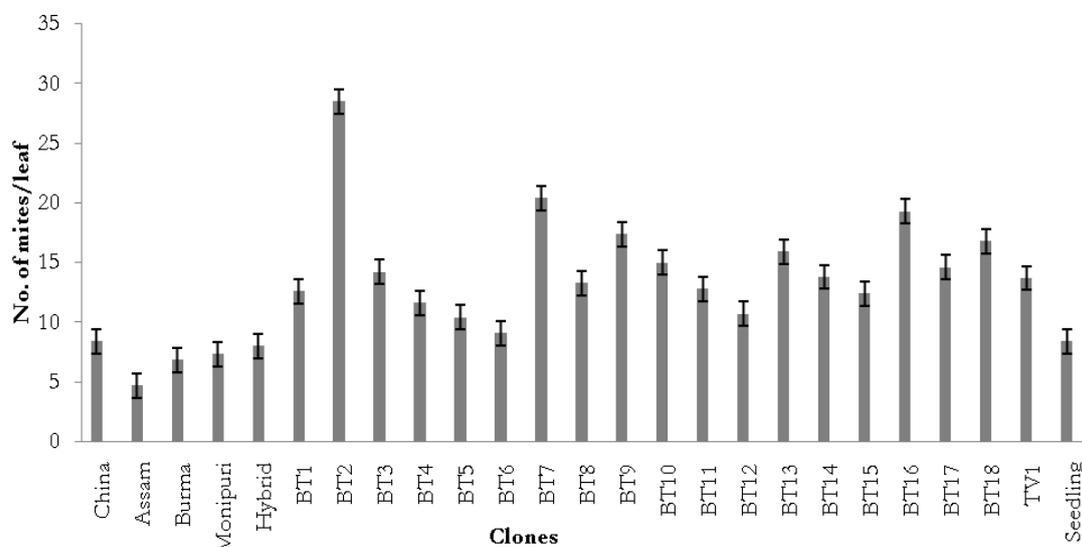


Fig. 2. Susceptibility of different tea agrotypes and clones to red spider mites

Result revealed that China agrotypes and BT2, BT7, BT9 & BT16 clones were found to be more susceptible to the attack of red spider mite (Fig. 2). The significant variability in damage may perhaps be attributed to physical or biological attributes of the agrotypes and clones.

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)

Laboratory and field screening of some plant extracts against *Helopeltis* (2008-2015)

An experiment was conducted to determine the toxic effect of some indigenous plant extracts against *Helopeltis* in tea under both laboratory and field condition. Six plant extracts of Bur weed (*Xanthium strumarium*), Datura (*Datura metel*), Katamehedi (*Duranta erecta*), Lantana (*Lantana camara*), Mahogani (*Swietenia mahagoni*) and Neem (*Azadirachta indica*) have already been evaluated and detailed results were published in Annual Report 2008-2014 as well as Tea J. Bangladesh, 2013, 43: 10-20. In this year, some new plants such as Bhat (*Clerodendron infortunatum*), Shetwadron (*Leucas aspera*), Dholkalmi (*Ipomoea fistulosa*) and Bashok (*Adhatoda vasica*) were evaluated. 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 2-4 and Figure 3-4).

Table 2. Plants evaluated for insecticidal activities against *Helopeltis*

Common name	Scientific name	Family	Plant parts used
Bhat	<i>Clerodendron infortunatum</i>	Verbenaceae	Leaves
Shetwadron	<i>Leucas aspera</i>	Lamiaceae	Whole plant
Dholkalmi	<i>Ipomoea fistulosa</i>	Convolvulaceae	Leaves

Bashok	<i>Adhatoda vasica</i>	Acanthaceae	Leaves
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Average mortality percentage of *Helopeltis* at 24, 48 and 72 hours after treatment indicated that Bashok extract possessed the highest (69.01%) toxic effect whereas Shetwadron extract possessed the lowest (44.56%) toxic effect under laboratory condition. The maximum average mortality (57.90%) 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.

Table 3. Mean mortality percentage of tea mosquito bug, *H. theivora* treated with different plant extracts under laboratory condition (Interaction of plant extracts and time)

Name of the plant	Dose (%)	Mortality rate (%)			Mean (%)
		24HAT	48HAT	72HAT	
Bhat	5.0	44.25	46.52	41.36	44.04f
	7.5	53.28	48.35	50.26	50.63d
	10.0	61.35	55.64	59.48	58.82c
Shetwadron	5.0	42.54	38.26	41.52	40.77g
	7.5	46.25	39.23	46.27	43.92f
	10.0	51.12	47.26	48.55	48.98d
Dholkalmi	5.0	35.29	40.53	42.27	39.36g
	7.5	38.35	47.41	52.51	46.09e
	10.0	45.33	50.62	51.36	49.10d
Bashok	5.0	65.57	60.55	54.65	60.26c
	7.5	71.74	65.58	69.35	68.89b
	10.0	80.32	77.42	75.92	77.89a
\bar{Sx}		0.130			0.1150
Probability level		NS			0.001

HAT= Hours after treatment; NS = Not Significant

Within column values followed by different letter(s) are significantly different by DMRT

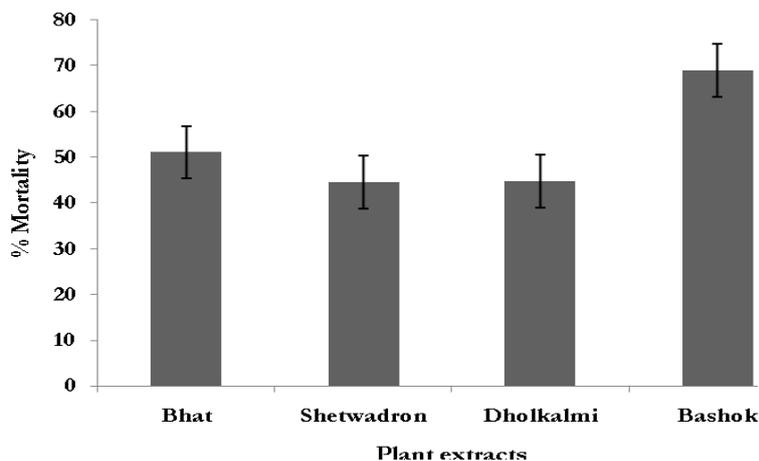


Fig. 3. Percent mortality of *Helopeltis* using plant extracts in topical application method

Field evaluation of plant extracts recorded to be 46.68-57.98% and 50.49-65.30% infestation reduction of *Helopeltis* at 7.5% and 10% concentration respectively. The highest infestation reduction (55.73%) was found in Bashok treated plot and that of the lowest (45.61%) was found in Dholkalmi treated plot. The order of the toxicity of plant extracts were Bashok>Shetwadron>Bhat>Dholkalmi against *Helopeltis*.

Table 4. Field evaluation of different plant extracts against *Helopeltis*

Treatments	Dose (%)	Pre treatment (% shoot infestation)	Post treatment observations (% reduction of infestation over control)				
			1 st spray		2 nd spray		Mean (%)
			7 days	14 days	21 days	28 days	
Bhat	5.0	33	45.23	39.45	47.18	35.53	41.85d
	7.5	36	51.56	48.45	53.52	39.48	48.25c
	10.0	41	60.12	58.28	62.58	50.78	57.94b

Shetwadron	5.0	30	41.06	34.44	45.81	38.32	39.91d
	7.5	29	55.35	47.51	53.25	45.19	50.33c
	10.0	32	62.56	55.47	59.65	53.84	57.88b
Dholkalmi	5.0	35	45.52	35.17	46.35	31.64	39.67d
	7.5	39	54.28	44.68	49.37	38.39	46.68cd
	10.0	44	58.73	46.82	51.03	45.33	50.49c
Bashok	5.0	37	49.29	41.45	45.33	39.59	43.92cd
	7.5	43	62.82	58.58	60.78	49.74	57.98b
	10.0	38	70.75	62.19	68.59	59.65	65.30a
Control	-	30	37	44	48	55	-
CV%	-	-	7.45	8.32	6.51	9.23	-

Mean of four observations

Within column values followed by different letter(s) are significantly different by DMRT

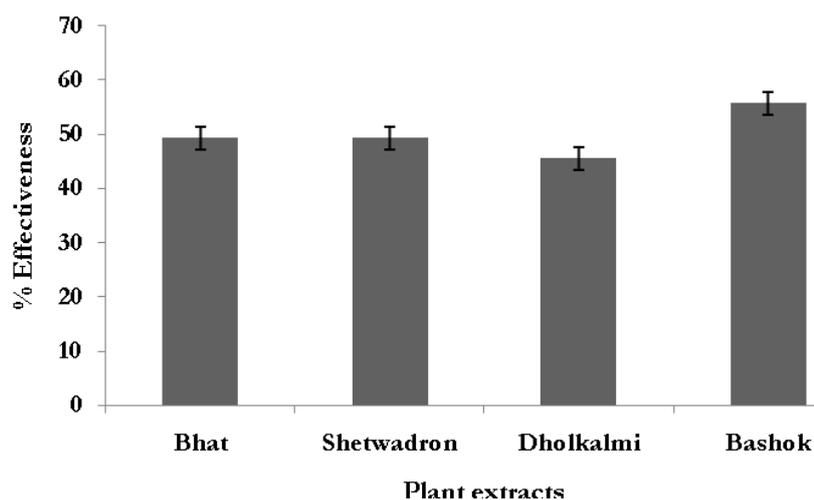


Fig. 4. Effect of plant extracts on *Helopeltis* in field condition

Laboratory and field screening of some plant extracts against red spider mite (2008-2015)

An experiment was conducted to determine the toxic effect of some indigenous plant extracts against red spider mite in tea under both laboratory and field condition. Plant extracts of Bishkatali (*Polygonum hydro piper*), Bur weed (*Xanthium strumarium*), Datura (*Datura metel*), Lantana (*Lantana camara*), Mahogani (*Svetenia mahagoni*) and Neem (*Azadirachta indica*) have already been evaluated and detailed results were published in Annual Report 2008-2014. In this year, some new plants such as Bhat (*Clerodendron infortunatum*), Shetwadron (*Leucas aspera*), Dholkalmi (*Ipomoea fistulosa*) and Bashok (*Adhatoda vasica*) were evaluated. 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 5-6 and Figure 5-6).

Among the tested plants, Bhat extract showed the highest (64.10%) toxic effect whereas Dholkalmi showed the lowest (47.92%) toxic effect against red spider mite under laboratory condition.

Table 5. Mean mortality percentage of red spider mite treated with different plant extracts under laboratory condition (Interaction of plant extracts and time)

Name of the plant	Dose (%)	Mortality rate (%)			Mean (%)
		24HAT	48HAT	72HAT	
Bhat	5.0	45.24	52.36	44.91	47.50fg
	7.5	69.72	65.17	61.62	65.50d
	10.0	80.31	79.31	78.31	79.31a
Shetwadron	5.0	46.93	42.38	40.38	43.23gh
	7.5	60.62	58.62	62.07	60.44e
	10.0	75.21	68.21	74.21	72.54b
Dholkalmi	5.0	35.92	33.69	32.14	33.92i
	7.5	46.83	44.83	48.28	46.65g
	10.0	65.52	60.52	63.52	63.19de
Bashok	5.0	38.03	44.03	42.93	41.66h
	7.5	52.28	47.28	50.72	50.09f
	10.0	73.41	65.86	68.31	69.19c
\bar{Sx}		0.1521			0.0619
Probability level		NS			0.001

HAT= Hours after treatment; NS = Not Significant

Within column values followed by different letter(s) are significantly different by DMRT

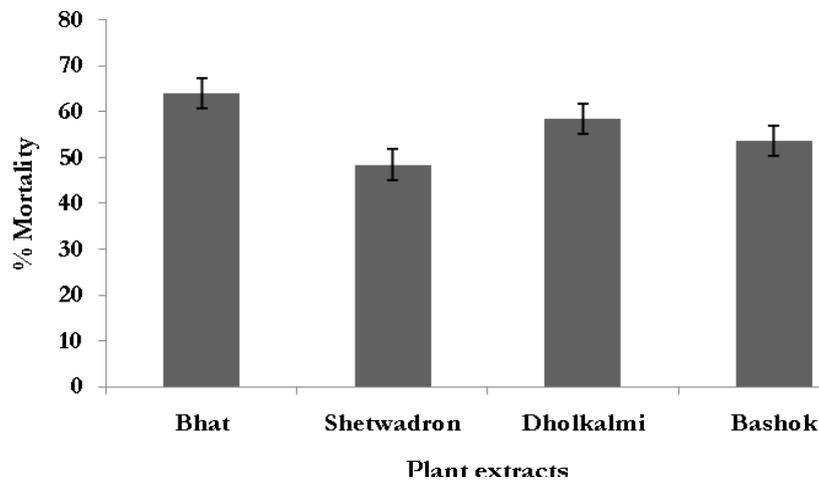


Fig. 5. Percent mortality of red spider mite using plant extracts under laboratory condition

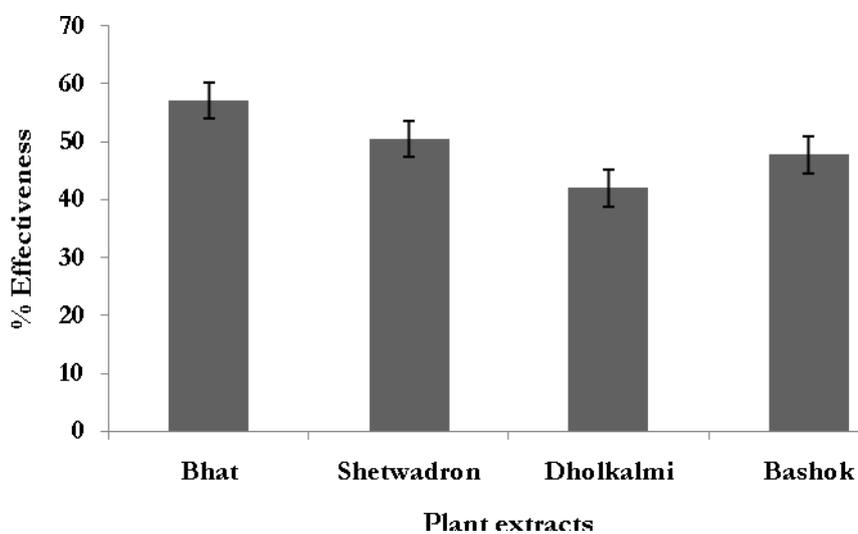
Field evaluation of plant extracts recorded to be 38.51-59.52% and 57.35-70.58% population reduction of red spider mite at 7.5% and 10% concentration respectively. The highest population reduction (57.18%) was found in Bhat treated plot and that of the lowest (42.02%) was found in Dholkalmi treated plot. The order of the toxicity of plant extracts were Bhat>Shetwadron>Bashok>Dholkalmi against red spider mite infesting tea.

Table 6. Field evaluation of different plant extracts against red spider mite in tea

Treatments	Dose (%)	Pre-treatment (no. of population)	Post-treatment observations (% reduction of population over control)				
			1 st spray		2 nd spray		Mean (%)
			7 days	14 days	21 days	28 days	
Bhat	5.0	254	48.46	38.17	44.04	35.04	41.43g
	7.5	260	62.36	56.94	64.61	54.18	59.52c
	10.0	250	71.23	69.27	73.37	68.46	70.58a
Shetwadron	5.0	265	46.27	39.23	36.53	31.72	38.44h
	7.5	248	48.08	46.31	54.57	52.51	50.37e
	10.0	262	65.74	59.36	63.86	61.04	62.50b
Dholkalmi	5.0	269	33.72	28.71	31.01	27.38	30.21i
	7.5	245	43.48	36.83	40.39	33.35	38.51h
	10.0	266	59.64	53.65	60.18	55.91	57.35d
Bashok	5.0	270	39.47	34.13	40.73	36.94	37.82h
	7.5	268	48.18	41.26	50.01	39.17	44.66f
	10.0	247	64.11	59.95	65.07	54.36	60.87bc
Control	-	244	249	255	257	262	-
CV%	-	-	10.32	14.52	11.41	13.42	-

Mean of four observations

Within column values followed by different letter(s) are significantly different by DMRT

**Fig. 6.** Effect of plant extracts on red spider mite in field condition

ENT 3. PEST INFESTATION AND QUALITY OF TEA

ENT 3. Studies on physiological and biochemical changes in tea leaves due to pest infestation (2013-2015)

An experiment was conducted to find out the biochemical changes in tea leaves and made tea due to *Helopeltis*, red spider mite and thrips pest infestation at Bangladesh Tea Research Institute, Srimangal 2013-2015. Result revealed that the fresh tea leaves contain more chlorophyll a, chlorophyll b and carotenoids than pest infested leaves. Result revealed that biochemical components such as Chlorophyll a and b, carotenoids, polyphenol, catechin, reducing sugar were very much reduced when the shoots were severely infested thrips compared to other pests (Table 7). Black tea prepared from pest infested shoots contained significantly lower amount of TF and TR ratio, HPS, TLC, colour index, caffeine and lipid than that of normal (fresh) tea (Table 8).

Table 7. Effect of pest infestation on the physio-biochemical components in green leaves of tea

Categories	Chlorophyll a (mg/g)	Chlorophyll b (mg/g)	Carotenoids (mg/g)	Polyphenol (ppm)	Catechin (ppm)	Reducing sugar (ppm)
Fresh leaves	2.76	1.26	1.32	76.26	21.40	55.33
Mite infested leaves	2.34	1.19	0.67	46.26	19.20	53.28
<i>Helopeltis</i> infested leaves	2.17	1.13	0.41	45.66	15.45	44.41
Thrips infested leaves	2.10	1.13	0.50	35.38	10.75	34.26

Table 8. Influence of pest infestation on the quality parameters in made tea

Grade	TF %	TR %	TF:TR	HPS %	TLC %	Colour index	Lipid %	Caffeine (ppm)	Total ash %	Moisture %	Dry matter %	Water extract %
Fresh leaves	0.53	5.313	10.05	9.81	4.25	3.50	4.37	62.03	5.42	3.27	96.73	36.72
Mite	0.52	5.780	11.29	8.73	4.17	3.58	4.30	53.35	5.61	3.30	96.74	31.47
<i>Helopeltis</i>	0.49	7.400	15.51	6.86	2.38	3.44	3.39	52.41	5.28	2.70	97.30	25.62
Thrips	0.43	7.000	16.45	6.16	2.20	3.27	3.38	51.44	6.68	3.15	96.84	18.46

ENT 4. BIO-CONTROL OF PESTS

ENT 4.1. Searching and identification of bio-control agents for the control of pests of tea (2011-2015)

An investigation was carried out at Bangladesh Tea Research Institute (BTRI) Main Farm during 2011-2015 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 twice 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, of which most of the species were found to be intimately associated with tea pests or occurred as their hosts. Among the natural enemies, Coccinellid was dominant. No new species was identified other than the previous year. Monitoring, searching and collection are being continued.

ENT 4.2. Predation capacity of *Oxyopes* spider and *Stethorus* beetle against pests of tea (2015)

An experiment was conducted to determine the predation capacity of *Oxyopes* spider and *Stethorus* beetle against red spider mite, *Oligonychus coffeae* infesting tea under laboratory condition at Bangladesh Tea Research Institute during March-December 2015. Data were collected at 24, 48, 72 hours after treatment. The study showed significantly different preying activity of predators on egg, larva, nymph and adult of red spider mite. *Stethorus* larva consumed the maximum number of egg, larva and adult of RSM in the laboratory condition (Table 9).

Table 9. Consumption of different stages of red spider mite, *Oligonychus coffeae* by the *Oxyopes* and *Stethorus* at 24, 48, 72 HAT in the laboratory condition

Stages of Predators	Percent consumed of different stages of red spider mites by the predators*											
	24 HAT				48 HAT				72 HAT			
	Egg	Larva	Nymph	Adult	Egg	Larva	Nymph	Adult	Egg	Larva	Nymph	Adult
T ₁ - <i>Oxyopes</i> spider (Nymph)	37.32	34.68	27.62	20.24	42.42	37.20	32.08	26.14	45.62	41.84	36.16	32.06

T ₂ - <i>Oxyopes</i> spider (Adult)	42.0 8	41.7 4	38.2 7	36.0 6	45.0 6	43.2 5	41.0 8	38.2 6	47.1 0	45.3 4	44.2 8	40.2 3
T ₃ - <i>Stethorus</i> beetle (Larva)	46.0 2	43.4 2	41.0 8	39.2 4	48.4 6	46.2 0	43.8 6	41.3 8	50.0 0	48.2 8	46.3 4	43.5 6
T ₄ - <i>Stethorus</i> beetle (Adult)	43.5 4	40.8 4	38.3 0	37.2 8	46.8 2	44.3 6	40.5 8	38.6 4	48.2 6	45.3 0	42.2 2	41.2 6

*Mean of three observations (50 adults/observation)

HAT= Hours after treatment

ENT 4.3. Bioefficacy of Entomopathogenic fungi against major pests of tea (2013-2015)

Some potential entomopathogens against red spider mites in tea

An experiment was carried out to evaluate the bioefficacy of some microbial pesticides *Beauveria bassiana*, *Metarhizium anisopliae*, *Streptomyces avermitilis*, *Paecilomyces fumosoroseus*, *Verticillium lecanii*, and *Pseudomonas fluorescens* @ 5.0 g/L, 5.0 g/L, 2.0 ml/L, 5.0 g/L, 5.0 g/L, 4.0 g/L concentration against red spider mite *Oligonychus coffeae* Nietner (Tetranychidae: Acarina) infesting tea under both in the Entomology Laboratory and Main Farm of Bangladesh Tea Research Institute (BTRI), Srimangal, Moulvibazar during 2013-2015. Results indicated that all the biopesticides showed the toxic effect on red spider mite in tea and significantly reduced mite population both in laboratory and field condition. In laboratory condition, among the biopesticides, the highest mortality of red spider mites was observed in *Verticillium lecanii* followed by *Streptomyces avermitilis* and *Paecilomyces fumosoroseus*. The order of toxicity of the tested biopesticides on adult red spider mite was *V. lecanii*>*S. avermitilis*>*P. fumosoroseus*>*P. fluorescens*>*M. anisopliae*>*B. bassiana* both *in vitro* and *in vivo*. Application of the tested biopesticides did not affect the non-target organisms such as *Stethorus gilvifrons* and *Oxyopes* sp.

Bacillus thuringiensis against looper caterpillar in tea

An experiment was carried out to determine the bioefficacy of *Bacillus thuringiensis* against looper caterpillar infesting tea at Entomology Laboratory and Bilashcherra Experimental Farm of BTRI during 2013-2015. The satisfactory result was obtained for the control of looper control in both laboratory and field conditions (Fig. 7).

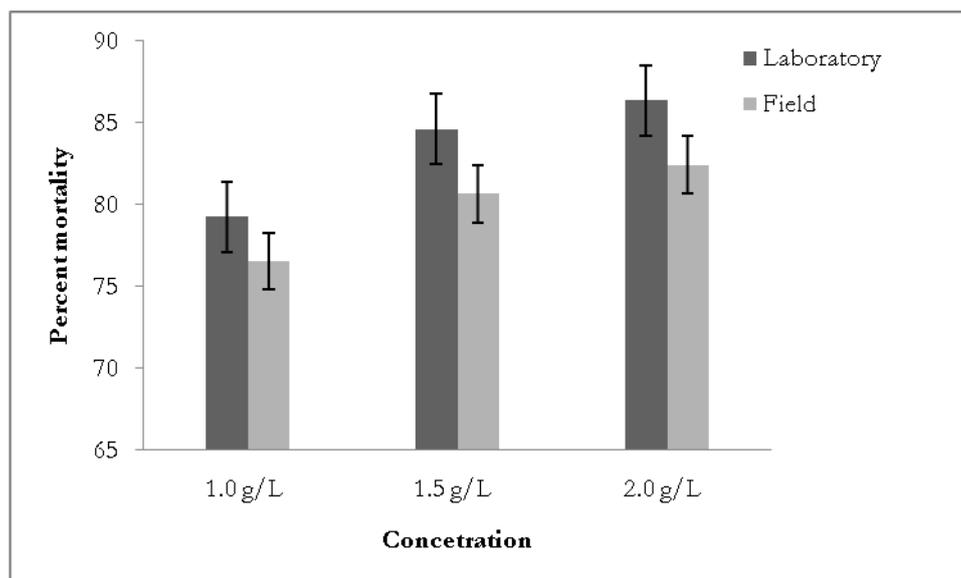


Fig. 7. Performance of *Bacillus thuringiensis* against looper caterpillar in tea in lab. & field level

ENT 5. SCREENING OF PESTICIDES

ENT 5.1. Screening of pesticides against *Helopeltis*, Red spider mites, Termites, Nematodes, Aphids and Flushworm in tea (2010-2015)

Eighty one (81) pesticides under different groups were tested against *Helopeltis*, Red spider mite, Nematodes, Termites, Aphids and Flushworm in the field and the report was sent to plant protection wing for their standardization during 2015. The experiment was conducted at Baraora 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 respectively in tea. 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 tested chemicals were found 'good' i.e. >80% effectiveness against the mentioned pests of tea. Trial reports were sent to PTASC for standardization.

Control of *Helopeltis* in tea

Evaluation of the performance of the pesticides, viz. SP Ten 10EC, Cyclone 3WDG, Dimithrin plus 3WDG, Star plus 25WDG, Corus 40WDG, Bond 007 6WDG, Gugle 55EC, Team plus 400WDG, Marithrin 10EC, Peskil Gold 20EC, Sera 48SC, Guarantee 24.7SC, Marlo 2.5EC, Platina 3WDG, Channel 3WDG, Carbel 85WP, Filter 2.5EC, D-thion 57EC, Lufa 55EC, Kit Viper 15%WP, Sniper 10SC against *Helopeltis* in tea.

Control of red spider mite in tea

Evaluation of the performance of the pesticides, viz. Muktavit plus 80WG, Meghmani 80WG, Privavite 80WG, Abtin 1.8EC, Wintin 1.8EC, Concord 1.8EC, Cought 40WG, Mirror 40WG, N-Chomok 3WDG, Rain 6WDG, Insert 6WDG, Burntec 1.8EC, Acetin 4EC, Reximite 57EC, Balaka 5WDG, Hobamectin 5SG, Sulfovit 80DF, Tonic 6WDG, Cosul 80WDG, Imagine 100EC, Pilu 6WG, Kartin 6WDG, Bestin 1.8EC, Killer 1.8EC, Mikovit 80DF, Mkzoate 5SG, Hasal 80DF, Gherao 1.8EC, Dumet 10EC, Rimzim 5EC, Panchatara 5SG, Hexymite 10%EC, against Red spider mite in tea

Control of Termites in tea

Evaluation of effectiveness of the insecticides viz. Ranesa 70WDG, Bismark plus 20SP, Biplan Super 55EC, Hossafos 48EC, Agent 505EC, KBS Joy 55EC, Racer 20SL, Hossachlopid 20SL, Larceta 20SP and Forstrike Xtra 55EC against Termites in Tea

Control of Nematodes in tea

Evaluation of effectiveness of nematicides viz. Caliver 3GR and Apache 5G against Nematodes in tea.

Control of Aphid in tea

Evaluation of effectiveness of insecticides viz. Kent 95SP, Gitoxazole 11%SC, Amatozole 11%SP, Ultra plus 10EC, Betathrin plus 3WDG, Xylem 70WDG, Magot 3WDG, Rider Plus Extra 95SP, Baitap Plus Extra 95SP, Ecotap Plus Extra 95SP, Demand 95SP, D-Lam 5EC, Very Fast 5EC, Halo 2.5EC and Faron 5EC against Aphids in tea.

Control of Flushworm in Tea

Evaluation of effectiveness of Orozon 60EC against Flushworm in tea.

ENT 5.12 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. This experiment will be continued.

Table 10. 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	<i>Helopeltis</i>	6	2036.28	37.38
	Red spider mite	5		
	Thrips	2		
	Termite	1		
General plot	<i>Helopeltis</i>	10	2100.64	41.72
	Red spider mite	8		
	Leaf roller	2		
	Thrips	3		
	Termite	1		
Control plot	<i>Helopeltis</i>	-	1482.24	-
	Red spider mite	-		
	Aphids	-		
	Termite	-		
	Thrips	-		

ENT 6. PESTICIDE RESIDUE ANALYSIS

ENT 6.1. Determination of pesticide residue in made tea of different tea agro-types (2011-2015)

An experiment was conducted to determine the pesticide residue in made tea of different tea agro-types such as assam, china, clones, seedling etc at BTRI main farm. Pluckable shoots were collected from selected plots of different tea agro-types at 0th, 7th & 14th day's interval after the application of pesticides and manufactured accordingly. Then the residue level was determined with GC (Gas Chromatography) in the Pesticide Residue Analytical Laboratory. Result revealed that made tea prepared from assam variety contains 1.86 mg/kg cypermethrin after 7 days of plucking where as china variety contains 1.05 mg/kg cypermethrin which was far below the MRL (20 mg/kg) fixed by EPA, Japan, Codex/WHO.

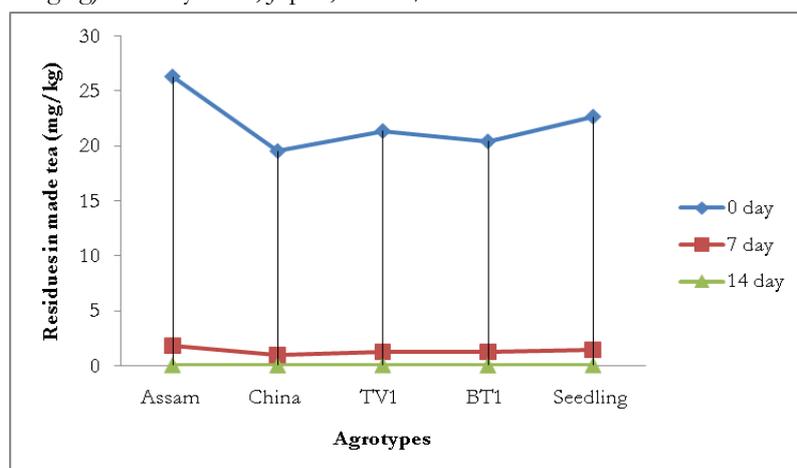


Fig. 8. Dissipation rate of cypermethrin residue in made tea manufactured from different agrotypes

PLANT PATHOLOGY DIVISION

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

STAFF

The posts of Principal Scientific Officer and one Field Assistant were lying vacant during the period under report. There was no other change in personnel position of the division during the period under report.

RESEARCH

Seven experiments were conducted during the year 2015 under three research areas.

PP 3: DISEASE MANAGEMENT

PP 3.5: Evaluation of antifungal activities of some plant extracts against different foliar disease of Tea (2011- 2015)

Leaf extracts of five indigenous plants viz. Arjun (*Terminalia arjuna*), Bashok (*Adhatoda vasica*), Neem (*Azadirachta indica*), Bishkatalia (*Polygonum barbatum*) and Lemon grass (*Cymbopogon citratus*) had been applied @ 2% to the Dieback infected tea shoots of mother bushes caused by *Colletotrichum gloeosporioides* at nucleus clone plot (NCP). As a result, minimum disease development was found in Bashok treated shoots at both 7 days (4.38%) and 15 days (5.77%). Untreated control clearly showed maximum development of disease which was nearly similar to other treatments except Bashok. Bashok could inhibit more than 80% growth of the pathogen in laboratory condition. So the antifungal activity of the leaf extract of Bashok indicates that it can be used as a natural fungicide in controlling *Colletotrichum gloeosporioides*, the causal agent of Dieback disease of tea. The results are shown in table 1&2.

Table 1. Effect of leaf extracts of different indigenous plants tested @ 2% on the development of Dieback of tea (*C. gloeosporioides*) at field condition

Treatments	Lesion size (cm) (Average of five replications)					PDI	
	Initial	7 DAS	% Development	15 DAS	% Development	Initial	15 DAS
Control	5.73	8.17	42.47 a	10.47	82.72 a	36	64
Arjun	4.25	5.47	28.43 b	6.53	53.53 b	56	64
Bashok	5.24	5.47	4.38 c	5.77	10.11 c	52	56
Neem	5.16	6.77	30.98 ab	8.43	63.23 b	36	48
Bishkatali	5.27	7.43	40.77 ab	9.43	64.57 b	48	64
Lemon grass	6.23	8.13	30.49 ab	9.43	51.35 b	48	64

NCP= Nucleus Clone Plot, DAS= Days After Spraying, PDI= Percent Disease Index

Table 2. Effect of leaf extracts of different indigenous plants tested @ 2% on the growth of *C. gloeosporioides* under laboratory condition

Treatments	Mycelial growth of <i>C. gloeosporioides</i> (cm) (Average of three replications)	% growth inhibition
Control	9.00	00.00 e
Arjun	3.88	56.88 d
Bashok	1.20	86.66 a
Neem	3.00	66.66 b
Bishkatali	3.57	60.33 c
Lemon grass	3.75	58.33 d

PP 3.3: Screening of new fungicides and herbicides against different diseases and weeds in tea. Short term: BTRI/BEF/T.Es.

A total of seventy one fungicides of different groups were received from different pesticide companies through PTASC to test their efficacy against diseases in tea. All the supplied fungicides were tested against Red rust, Die back, Black rot, Branch canker diseases both in laboratory and field condition. Efficacy of fungicides was compared with standardized fungicides. Tested fungicides were found >80% effective. Reports were sent to PTASC for further necessary action.

A total of eighty three herbicides (pre & post) of different groups were received from different pesticide companies through PTASC to test their efficacy against weeds in tea. All the supplied herbicides were tested against mixed weeds (monocot & dicot) in tea. Efficacy of the herbicides was compared with standardized one. Reports were sent to PTASC for further necessary action.

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

Two sets of experiments were carried out at plant pathology laboratory, Bangladesh Tea Research Institute (BTRI) to find out the quality deteriorating fungi inhabited in finished tea. The samples were collected from tea processing factories, different companies concerned in blending and packaging tea, and small tea stalls in the market. About 18 samples of black tea, organic tea and green tea were tested. Initial moisture content of black tea and organic tea was measured using a digital moisture meter at biotechnology laboratory. In a set of experiment, sterilized cotton ball was placed in a sterilized petridish containing test sample. Sterilized water was poured in the cotton ball so that the ball contained maximum water. The whole operation was done in a Laminer Air Flow Cabinet to avoid contamination. In another trial, petridishes containing test samples were kept in open environment for natural absorption of atmospheric moisture.

Three species of fungi namely *Aspergillus* spp., *Penicillium* spp. and *Rhizopus* spp. were found growing fast in the samples of tea collected from factories at different moisture level. Sample collected from open oxidation chamber allowed only a slow growing fungus *Colletotrichum* spp. to grow.

In open environment, *Aspergillus* spp. was found in the black tea sample containing 11.89% moisture after 20 days of plating. The initial moisture of that sample was measured as 4.9%. The *Aspergillus* spp was also recorded after 42 days in the sample collected from drier mouth which contained 2.5% initial moisture.

Observation:

Table 3. Microbial presence at different moisture level in factory Samples (CTC tea) collected before packaging (observation: 7 days after plating)

% moisture	<i>Aspergillus</i> spp.	<i>Penicillium</i> spp.	<i>Rhizopus</i> spp.	<i>Colletotrichum</i> spp.
2.5	A	A	A	A
3.2	P	A	A	A
5.7	P	A	A	A
6.7	P	P	A	A
7.1	P	A	A	A
9.5	P	P	A	A
10	P	A	P	A
68 (OOC)	A	A	A	P

P=Present, A= Absent, OOC= Open Oxidation Chamber

Table 4. Microbial presence in Samples (CTC tea) collected from Tea estates after packaging (observation: 7 days after plating)

Sample No.	Company Name/Type	% moisture	Name of fungi
1	Mazdehee TE	4.1	<i>Aspergillus niger</i>
2	Acme blending	3.4	Not found
3	Ceylon tea	3.2	Not found
4	Silloah TE	4.6	<i>Aspergillus niger</i>

Table 5. Microbial presence in Samples (CTC tea) collected from market (observation: 5 days after plating)

Sample No.	Company	Sample forms	% moisture	Name of fungi
1	Mirzapore Tea	Small tea bag	4.5	<i>A. niger</i> & <i>A. flavus</i>
2	Unknown	Open source CTC	5.2	<i>A. flavus</i> & <i>A. niger</i>

Table 6. Microbial presence in organic and green tea samples (observation: 7 days after plating)

Sample No.	Types	Name of Tea Estate	Name of fungi
1	CTC organic tea	Kazi & Kazi	<i>A. niger</i>
2	Green tea without CaCO ₃	Jaghcherra	<i>A. flavus</i>
3	Green tea with CaCO ₃	Jaghcherra	<i>A. niger</i>

Table 7. 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	<i>A. flavus</i> & <i>A. niger</i>
2	2.5 (Drier mouth)	8.3	42	<i>Aspergillus</i> spp.

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

Chlorophyll-a, Chlorophyll-b and Carotenoids content of fresh leaves and Red rust infected tea leaves were determined. The contents of Chlorophyll-a, Chlorophyll-b and Carotenoids were 4.05mg, 1.76mg, and 0.93mg per g in fresh leaves and 2.21mg, 1.01mg, 0.59 mg per g in infected leaves. The Chlorophyll-a, Chlorophyll-b and Carotenoids were reduced to 45.43%, 42.61% and 36.56% respectively due to disease infection (Table 8).

Table 8: 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	4.05	1.76	0.93
Infected leaves	2.21	1.01	0.59
% Reduced	45.43	42.61	36.56

The percentage of theaflavin (TF), thearubigin (TR), highly polymerized substances (HPS), total liquor color (TLC) and color index (CI) content of fresh leaves and Red rust infected tea leaves were determined. The contents of TF, TR, HPS, TLC and CI were 0.69%, 6.38%, 10.55%, 3.66%, 4.05 in fresh leaves and 0.92%, 5.73%, 7.08%, 2.83%, 7.20% in infected leaves. The TF:TR ratio in infected leaves was calculated 1:6 but in fresh leaves it was 1:10 (Table 9). From the result it was seen that there was significant reduction in quality of tea due to Red rust disease infection.

Table 9: TF, TR, HPS and color changes in fresh and red rust infected tea leaves

	TF%	TR%	HPS%	TLC%	Color Index
Fresh Leaves	0.69	6.38	10.55	3.66	4.05
Infected leaves	0.92	5.73	7.08	2.83	7.20
% Reduced	(-) 25	10.18	32.90	22.67	(-) 43.75

PP 4: WEEDS MANAGEMENT

PP 4.5: Determination of critical period of weed competition in young tea (BEF: 2011-2015)

The maximum numbers of weeds were found in the plots (T₁₀) which were kept weed free for 75 days (15th July- 30th September) and then were declined due to environmental condition. Weed height was also found higher in T₁₀ which is statistically similar to T₁₁- T₁₅. In case of canopy size of tea plants, maximum and statistically identical size were found in T₁, T₂ and T₈- T₁₅. Considering the number of weeds, height of weeds and canopy size of tea plants, the interrupt point was found in T₁₀. So, it can be concluded that a 90 days span of controlling the weed (1st July-30 September) will check the weeds to reach the maximum growth to allow the young tea plants to increase the canopy size properly (Table 10).

Table 10: Effect of different intervals of weed control

Treatments	Number of weeds	Height (cm)	Canopy size (inch)
1= Weed free (1 st March- 30 th September, 210 days)	1.80 l	6.80 j	66.46 a
2= Weed free (15 th March- 30 th September, 195 days)	27.60 k	9.00 i	66.22 a
3= Weed free (1 st April- 30 th September, 180 days)	43.20 j	13.80 h	55.10 c
4= Weed free (15 th April- 30 th September, 165 days)	53.80 i	19.60 g	57.78 c
5= Weed free (1 st May- 30 th September, 150 days)	64.00 h	25.52 f	61.30 b
5= Weed free (15 th May- 30 th September, 135 days)	68.40 g	28.02 e	61.52 b
7= Weed free (1 st June- 30 th September, 120 days)	77.80 f	31.66 d	63.76 ab
3= Weed free (15 th June- 30 th September, 105 days)	87.60 d	34.64 c	65.42 a
9= Weed free (1 st July- 30 th September, 90 days)	96.40 b	38.34 b	65.44 a
10= Weed free (15 th July- 30 th September, 75 days)	114.40 a	42.68 a	66.68 a
11= Weed free (1 st August- 30 th September, 60 days)	98.60 b	43.18 a	66.32 a
12= Weed free (15 th August- 30 th September, 45 days)	90.80 c	43.24 a	66.20 a
13= Weed free (1 st Sept.- 30 th September, 30 days)	83.80 e	43.34 a	66.52 a
14= Weed free (15 th Sept.- 30 th September, 15 days)	70.40 g	43.18 a	66.60 a
15= Weed free upto 0 day (control)	54.20 i	42.56 a	66.48 a

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

An experiment was carried out with at BTRI Farm with 10 treatments following RCBD. The treatments T₀ = Control, T₁ = Paraquat 20 SL @ 2.8 L, T₂ = Glyphosate 41 SL @ 3.5L, T₃ = BecAno 500 SC @ 150 ml/ha, T₄ = Paraquat 20% + BecAno 500 SC, T₅ = Glyphosate 41 SL + BecAno 500 SC, T₆ = BecAno 500 SC after 1 month interval application of Paraquat 20% SL, T₇ = BecAno 500 SC after 1 month interval application of Glyphosate 41 SL, T₈ = Paraquat 20% SL after 1 month interval application of BecAno 500 SC, T₉ = Glyphosate 41 SL after 1 month interval application of BecAno 500 SC were applied on plots containing sufficient soil moisture mixed in 400 L/ha of water. Data were collected in terms of percent weed germination (monocot and dicot) at monthly interval. The germination of both monocot and dicot weed species were found to be started after 45 and 90 days of application in T₁ and T₂ plots respectively. In treatment T₃, 90% weed control was observed and weed free condition prevailed up to 180 days. Among all the treatments, T₄ and T₅ provided satisfactory results where weed control was 95% and weed free condition remained up to 180 days and 215 days respectively. The experiment will be continued.

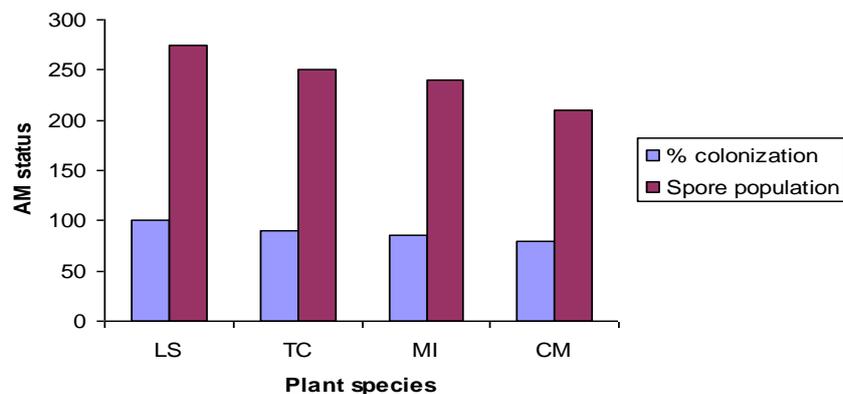
Table 11: Effect of different herbicides on weed control

Treatments	Dose (ha ⁻¹)	Weed control (%)	Days to weed free condition
T ₀	Control	-	0 h
T ₁	Paraquat 20SL	2.8 L	95 a
T ₂	Glyphosate 41 SL	3.5 L	90 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	95 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	90 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. 2cm layer of crude AM fungi inoculum was made on 10sqm 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 interval and mycorrhizal spores in soils and colonization in roots were estimated. The result revealed that all the tested plants and soil are significantly ($P= 0.01$) mycorrhizal. 100% root colonization was recorded in *Lucas aspera* followed by *Tephrosia candida* (90%) and *Mimosa invisa* (85%). Same trend was also recorded in the rhizosphere soil considering spore population (figure 1). A positive correlation ($r = 0.99$) was observed between root colonization and AM spore population of test plants (figure 2). So, the high levels of AM colonization and spore population clearly indicated the potentiality of the plants and suitability for inoculum production particularly *Lucas aspera*.



LS= *Lucas aspera*, TC= *Tephrosia candida*, MI= *Mimosa invisa* and CM= *Calapogonium mucunoides*
Figure 1. Percentage of root colonization and spore population of AM fungi

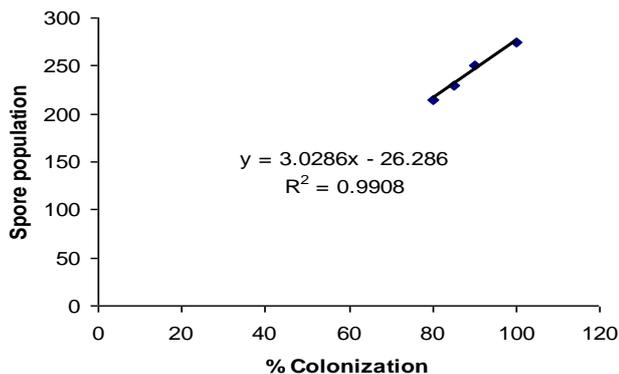


Figure 2: Correlation between % colonization and spore population of AM fungi

Advisory/ Workshop to tea estates

Scientists of this division paid a total of 7 advisory visits to different tea estates to solve plant pathogenic problems and weed infestation in tea. Accordingly 11 advisory letters were issued by this division. Two workshops on tea disease and weed management were conducted by the division during the period under report.

Official visits/ Tours

A total of 15 official visits/tours were paid by the scientists of this division to different organizations for official purposes.

Annual Courses and Post Graduate Diploma Course, MTC, PDU

The scientists of this division delivered lectures on tea diseases and weeds management at BTRI main station, Fatickcherri and Panchagarh substations in Annual courses and Post Graduate Diploma Courses, MTC, PDU. They gave comprehensive lectures and practical field demonstrations regarding tea diseases and weeds infestation.

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 taken for 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 supervision 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 was conducted to evaluate the overall feature of implementation and efficiency of the BTRI technologies to the tea estates. BTRI has innovated a number of technologies since last 55 years and made a great impact on tea improvement providing these technologies. Bangladesh tea has increased its productivity remarkably from the last few decades but it is still now 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, Srilanka etc. The important reason of such low production is assumed due to improper utilization of scientific technologies like inferior planting material, lack of authentic control measures of pest and disease management, absence of proper agronomic practices, soil fertility and pH control etc. BTRI has so far released 18 outstanding clones and many other successful technologies which are effectively being 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 be 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 technologies.

There are 167 tea estates in Bangladesh including North Bengal. To collect the information about the adoption of BTRI innovated technologies a well designed questionnaire has send to almost all the estates. The data collection questionnaire has been sent to different tea estate and the returned information are now tabulating for analysis.

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 2014-1015 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 were also sent to BCS office, Dhaka.

TECHNOLOGY DIVISION

Dulal Chandra Dey

Scientific Officer

STAFF

There was no 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.

- During excess humidity, application of heat improves quality.
- At low humidity application of heat decreases quality.
- Broken percentage is high at without heat and dust percentage is high with heat.

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

RH (%)		Infused leaf	Color	Strength	Briskness	Total	Average
65	Without heat	7.00	7.50	6.50	7.50	28.50	7.13
	With heat	6.50	6.00	6.50	6.00	25.00	6.25
70	Without heat	6.50	7.00	7.50	6.50	27.50	6.88
	With heat	6.00	6.50	7.00	6.00	25.50	6.38
75	Without heat	7.00	6.50	7.00	6.50	27.00	6.75
	With heat	6.50	6.00	6.50	6.00	25.00	6.25
80	Without heat	6.50	7.00	6.00	6.50	26.00	6.50
	With heat	7.00	6.50	7.00	7.50	28.00	7.00
90	Without heat	6.00	6.50	6.00	6.00	24.50	6.13
	With heat	6.50	7.00	6.50	7.00	28.00	7.00
95	Without heat	7.00	6.00	6.50	6.00	25.50	6.38
	With heat	7.50	7.00	7.50	7.00	29.00	7.25

Table 2. Grade percentage

Without heat	With heat
53% Broken	49% Broken
21% Fanning	20% Fanning
13% Dust	19% Dust
13% Over	12% Over

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

- Highest quality of made tea from one bud and one leaf.
- 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	Briskness	Total	Average
1	One bud & one leaf	7.00	7.50	6.50	7.50	28.00	27.33
		6.50	7.00	7.00	6.50	27.00	
		7.50	6.50	6.00	7.00	27.00	
	One bud &	6.50	6.00	6.50	6.00	25.00	24.67

2	two leaves	6.00	6.50	6.00	6.50	25.00	
		6.00	6.00	6.00	6.00	24.00	
3	One bud & three leaves	5.00	6.00	5.50	5.00	21.50	21.17
		5.50	5.00	5.00	5.00	20.50	
		5.00	5.50	5.50	5.50	21.50	

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 Temperature	Infused leaf	Color	Strength	Briskness	Total	Average
1	42° c	6.00	7.00	7.50	7.50	28.00	7.00
	44° c	6.50	6.00	6.50	7.00	26.00	6.50
	46° c	5.50	6.50	6.00	5.50	23.50	5.88
2	43° c	7.00	6.50	7.00	6.50	27.00	6.75
	45° c	6.50	6.00	5.50	6.00	24.00	6.00
	46° c	5.50	5.00	6.00	6.50	23.00	5.75
3	44° c	7.00	6.50	7.00	6.50	27.00	6.75
	46° c	6.00	6.50	5.50	6.00	24.00	6.00
	48° c	5.50	5.00	5.50	5.00	21.00	5.25

Factory

Repairing along with maintenance of factory machineries had been done as a regular practice. Re-sharpening of CTC rollers had been completed maintaining proper standard. Maintenance of power house and different kinds of vehicles were done properly time to time.

BILASHCHERRA EXPERIMENTAL FARM
BTRI, SREEMANGAL

STAFF

Mr. Md. Hossain Mahammud, Farm Supervisor joined on 23 April 2015 to this Farm. Later he was transferred to BTB, Chittagong on 24 July in the same year. There was no other change in the staff position during the reporting year.

FARM

Land Distribution

Sl. No.	Description	Area (ha)
	Under Tea	107.63
	I. Plucking Area	
	1. Immature Tea (under 5 years)	5.27
	2. Tea bushes 5 to 10 years	2.38
(a)	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
	Under Subsidiary Crops	19.76
(b)	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	71.37
Total Area of the Farm		228.36

Crop Production

Description	Quantity
a. Green Leaf	7,27,307 (kg)
b. Made Tea	1,64,808 (kg)
c. Average Production	1638 (kg/ha)

Green leaf Production of the Farm in the Year 2015

Name of the Month	Month-wise crop production in 2015 (kg)
January	-
February	-
March	970
April	42,375
May	35,555
June	1,16,071
July	1,22,508
August	95,770
September	1,18,933
October	65,607
November	1,06,992
December	22,526
Total	7,27,307 kg

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)
215	60	155	23,250.00	30,000.00

Extension and Development

0.10 ha of land was newly planted in 2015. It has a nursery with the average capacity of 65,000 plants. Water supply, labor houses, roads and bridges were regularly maintained. Three (03) hectares of new land was brought under tea cultivation in section no. 11 during the year under report. Forty seven thousand tea saplings were infilled in different sections in the year 2015. 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

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

PRODUCTION

41,512 kgs green leaves were produced during the year 2015. 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)			
2015	Fresh Cuttings	5	1594840	-	-	1594840
	Rooted Cuttings	-	-	10000	-	10000
	Biclonal Seed	5	198	-	-	198

Besides the above mentioned items, jackfruits were sold at worth of 7000/=Tk during the year.

Infilling programme

About 22,152 nos. tea plants were infilled during the reporting year.

Development

One (01) new kancha labour house was built along with infrastructural development of four (04) others during the year.

Seminar and workshop

Workshops of two days duration such as pruning, plucking, insects and diseases management etc. were organized time to time at the sub-station for the tea planters of Chittagong Valley. Tea Tasting Programme was arranged during the year 2015 in the presence of the proprietors and management staff of Chittagong Circle.

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 sub-station and their children on both the occasions.

**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 2015 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)
2015	28,471	7,14,622.10	61,000	18,300.00

**REGIONAL STATION
PANCHAGARH**

STAFF

Mr. Md. Helal Hossain, Office Assistant cum Computer Operator was transferred to BTRI, Srimangal on 1 December 2015. There was no other change in the personnel position of the Sub-station during the reporting year.

PRODUCTION

50,060 nos. of BT2 @ Tk. 5.0; 3000 nos. of TV26 @ Tk. 1.5. The total cuttings supplied to tea estates were 53,060.

Other activities of the divisions during 2015

Sl.	Item	Soil Science	Botany	Agronomy	Entomology	Plant Pathology	St. & Eco.
01	No. of experiments	04	23	05	10	07	03
02	No. of experimental visits	43	13	52	15	52	-
03	No. of advisory visits	09	03	25	24	07	-
04	No. of advisory correspondence	220	05	17	23	11	-
05	No. of official visits	-	-	03	05	15	-
06	No. of soil, fertilizer & dolomite samples analyzed	3018	-	-	02	-	-
07	No. of nursery soil, water & cowdung samples analyzed for nematodes	-	-	-	71	-	-
08	No. of pesticide residue analysis (commercial)	-	-	-	07	-	-
09	No. of pesticide residue analysis (Experimental)	-	-	-	08	-	-
10	Physical test of pesticides in Lab.	-	-	-	09	-	-
11	No. of pesticides tested in tea fields	-	-	-	81	154	-
12	No. of circulars/pamphlets/leaflets issued to T. E.	-	-	-	-	-	-
13	No. of workshop/seminar conducted	02	-	17	09	02	-
14	MTC module conducted (Hours/year)	21	-	16	07	-	-
15	Attended national seminar, conference, symposium & workshop	-	02	01	03	-	-
16	Attended international seminar, conference & symposium	-	-	-	-	-	-
17	Attended Training/Course	-	-	-	01	-	-
18	No. of research paper published	01	-	02	05	01	-
19	No. of Fresh cutting supplied	-	-	166120	-	-	-
20	No. of Rotted cutting supplied	-	3280	7692	-	-	-
21	Biclonal seed supply to T. E.	-	215 Kg	-	-	-	-
22	Tea tasting	-	07	-	-	-	-