

ANNUAL REPORT 2021



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

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DIRECTOR'S REPORT STAFF

The report of the technical staff shows the position as on 31 December 2021

Director : Dr. Mohammad Ali
B.Sc. (Hons), M.Sc. (CU), M.Sc. (Newcastle, UK)
PGD (India), Ph.D

TECHNICAL DIVISIONS

1. DEPARTMENT OF CHEMISTRY

Chief Scientific Officer : Vacant

A. SOIL SCIENCE DIVISION

Principal Scientific Officer : Vacant
Senior Scientific Officer : Ashim Kumar Saha
B.Sc. (Hons), M.Sc (DU)
Senior Scientific Officer (Ph.D. Deputation) : Apu Biswas
B.Sc. (Hons), M.S. (DU), PGD (India)
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B.S. (Hons), M.S. (DU)
Scientific Officer : Farhana Jahan Chowdhury
B.S. (Hons), M.S. (CU)
Scientific Officer : Mr. Shuva Das
B.S.(Hons), M.S. (CU)

B. BIOCHEMISTRY DIVISION (Vacant)

Principal Scientific Officer : Vacant
(Dr. Mohammad Masud Rana, Senior Scientific Officer of Agronomy division was given the charge of the division as an additional duty)
Senior Scientific Officer : Vacant
Scientific Officer : Muhammad Abid Hasan Chowdhury
B.S. (Hons), M.S. (CU)

2. DEPARTMENT OF CROP PRODUCTION

Chief Scientific Officer : Dr. Md. Ismail Hossain
B.Sc .Ag.(Hons)
M.S in Crop Botany & Ph.D. (BAU)

A. BOTANY DIVISION

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Dipl. (China), Ph.D. (RU)
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Scientific Officer : Md. Riyadh Arefin
B.Sc.Ag. (Hons), M.S. (BSMRAU)
Scientific Officer : Md. Rayhan-Ur- Rahaman
B.Sc.Ag. (Hons.), M.S. (BSMRAU)
Scientific Officer : Selina Akther Lipa
B.S. (Hons), M.S. (CU)
Senior Farm Assistant : Md. Majibur Rahman
B.Sc. (CU), TPM (India)

B. AGRONOMY DIVISION

Principal Scientific Officer	:	Dr. Toufiq Ahmed B.Sc.Ag. (Hons) M.S. (BAU), Ph.D. (Sri Lanka)
Senior Scientific Officer	:	Dr. Mohammad Masud Rana B.Sc.Ag. (Hons) M.S. (BAU), Ph.D. (China)
Senior Scientific Officer	:	Vacant
Scientific Officer (Transferred to Bandarban CHT Project)	:	Md. Imran Hossen B.Sc.Ag. (Hons), M.S. (SAU)
Scientific Officer	:	Sultan Md. Monwarul Islam B.Sc.Ag. (Hons), M.S. (BAU)
Farm Supervisor	:	Roni Debnath M.Sc.Ag. (Hons), M.S. (SAU)
Farm Assistant	:	Md. Shamim Hossain Dip.-in-Agric. (ABKC)

3. DEPARTMENT OF PEST MANAGEMENT

Chief Scientific Officer	:	Vacant
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A. ENTOMOLOGY DIVISION

Principal Scientific Officer	:	Vacant
Scientific Officer (Ph.D. Deputation)	:	Shovon Kumar Paul B.Sc.Ag. (Hons.) (KU), M.S. (BSMRAU)
Scientific Officer	:	Md. Jahangir Alam B.Sc.Ag.(Hons), M.S. (BAU)
Senior Farm Assistant	:	Md. Abul Kalam Azad Dip.-in-Agric. (Dhaka)

B. PLANT PATHOLOGY DIVISION

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

TECHNOLOGY DIVISION

Senior Scientific Officer	:	Vacant
Scientific Officer (Deputation in Bandarban)	:	Dulal Chandra Dey B.Sc. Engg. Mech. (BUET)
Senior Tea Maker (Deputation in Bandarban)	:	Md. Amir Ali B.Sc. (RU)
Assistant Engineer (Civil)	:	Md. Naion Hossain B.Sc. Engg. Civil (DUET)

STATISTICS & ECONOMICS DIVISION

Principal Scientific Officer	:	Vacant
Senior Scientific Officer	:	Dr. Shefali Boonerjee B.Sc. (Hons), M.Sc. (RU) Ph.D. (DU)

BTRI SUB-STATION, FATIKCHARI, CHATTOGRAM

Scientific Officer & Officer in-charge	:	Md. Moshir Rahman Akonda B.Sc.Ag. (Hons), M.S. (BAU)
Senior Farm Assistant	:	Ajit Chandra Chowdhury B.A. (NU)

BTRI SUB-STATION, KALITI, KULAURA

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Dip.-in-Agric. (Sherpur)

BTRI REGIONAL STATION, PANCHAGARH

Senior Scientific Officer & Officer in-charge : Dr. Mohammad Shameem Al Mamun
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PGD (India), Ph.D (SUST)

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

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

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B.Sc.Ag. (Hons.), M.S. (BSMRAU)

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)

RESEARCH

This report reflects the research and other activities of the institute for the year 2021 starts from 1st January to 31rd December.

During the year under report, a total of 61 experiments on different aspects of tea culture were in progress in different disciplines research divisions. The main 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. Experiments on effect of vermicompost on soil properties, growth and yield of mature tea; status of micronutrients in tea soils and its effects on the growth and yield of young and mature tea, performance of bio-char as a soil amendment and its effect on tea soil properties was started during the reporting year. Research on present status of toxic heavy metals (Pb, Cd, Cr, Ni) in tea soils, green leaves & made tea and determination of critical values of nutrients in tea soil and plant leaf in Sylhet, Chattogram and Panchagarh region were also initiated during the reported year. 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 analyses. A total of 1666 advisory soil, paid soil, fertilizer, compost and others samples were analyzed during 2021.

Biochemistry division carried out researches on tea product diversification and standardization of green tea processing technique using a modern green tea processing unit under Bangladesh condition. Product diversification of tea holds immense possibilities for the future and is an important area of research. This type of research would contribute to the domestic economy by innovating new products as well as creating new employment opportunities. Green tea is being popular in our country for its known health benefits; and due to its increasing demands, new factories are being established day by day. Research on green tea processing technique would enable our domestic manufacturers to produce quality green tea. The experimental findings obtained so far were highlighted and discussed in the current report.

Plant improvement received top priority as usual amongst the research activities of Botany Division. Several new germplasms were collected and screened for desired characters under plant improvement research. Certain amount of test clones were under different stages of long term yield and quality trials. Hybridization between clones and agrotypes, collection and preservation of germplasms of tea from home and exotic sources were continued. Several tea tasting sessions were organised for the tea planters to improve the quality of tea.

Agronomy Division carried out research activities on various cultural practices e.g. Planting, pruning, tipping, plucking and related agro-techniques in tea field. Labour crisis is becoming a problem in many of the tea growing area of Bangladesh as well as in many of the tea estates. To cope up the upcoming problem of the tea industry, it may be needed to adopt with the mechanization of tea. Experiments on mechanization of tea was going on to adopt this technology.

The Research of Entomology Division includes cultural and mechanical control of insect pests, bio-control of insect pests, and screening of pesticides, host plant resistance and pesticide residue analysis in tea. This Division also rendered all sorts of advisory services to tea estates on problems arising out of pests of tea and analyzed soil and water for nematode count. This Entomology 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, culture & identification of major disease causing organisms of tea and ancillary crops, Screening of different fungicides & herbicides, Use of Plant Growth Promoting Rhizospheric (PGPR) Microbes in controlling different tea diseases, Identification of potential source of infection of tea disease for disease development were the new areas of research of the division.

Statistics and Economics division engaged on the economic efficiency of the test clones of BTRI and adoption of BTRI Innovated Technologies and its Extension to Bangladesh Tea Industry. The division also assisted 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 and Bilashcherra experimental farm was conducted by Technology Division.

The supply of improved planting materials in the form of fresh as well as rooted cuttings and biclonal seeds were continued from BTRI and sub-stations (including CHT project) during 2021. A total of 18,59,550 fresh cuttings, 17722 rooted cuttings and 762 kg bi-clonal seeds were distributed to different tea estates in the year 2021. 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, six tea tasting sessions and one tea tasting course (for army and navy officers) were conducted for the tea planters to improve further the manufacturing of quality tea from the tea factories.

VISITS

Scientific personnel of the institute and sub-stations paid a total of 217 experimental, advisory and official 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

'BTRI Annual Report 2020' and four circular were published in 2021.

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 staffs of different Tea Estates during the period under report.

LIBRARY

BTRI Library contained 4,936 books and 9,150 Journals, Annual Report, Pamphlets, Circulars, Newsletter, Proceedings and Research highlights, etc.



(Dr. Md. Ismail Hossain)
Director (In-charge), BTRI.

SOIL SCIENCE DIVISION

Ashim Kumar Saha
Senior Scientific Officer
STAFF

Mr. Shuva Das, Scientific Officer joined Bangladesh Tea Research Institute, Srimangal on 28 February 2021 and transferred to BTRI-Substation Fatikcherry, Chattogram on 10 November 2021. One (01) Principle scientific officer post was lying vacant during the period. There was no other change in the personnel position of the division during the period under report.

RESEARCH

A total of six experiments were conducted during the year 2021 by Soil Science Division. Progress of the experiments is given below.

SS 1: EVALUATION OF PHYSICAL PROPERTIES OF SOME SELECTED TEA SOILS OF BANGLADESH & THEIR INFLUENCE ON CHEMICAL PROPERTIES & YIELD OF TEA

The life cycle of tea plant is long, yields tend to decline after four or five decades and plant death or stunted growth is a common occurrence in above 40-yr-old tea fields. The decline in yield, as well as the increase in plant mortality or stunted growth under long-term tea cultivation, however, may also reflect degradation of soil health. So, this research will help to assess the long-term impact of growing tea on soil physical properties and how it correlates with crop yield.

Methodology:

This research will be conducted by selecting some tea gardens with old, mature and young tea plantation randomly. The following physical properties of soils of those selected gardens will be assessed by using standard methods:

- a) Texture
- b) Structure
- c) Bulk Density
- d) Particle Density
- e) Compaction
- f) Hydraulic Conductivity

Chemical properties will be determined also. All the data will be statistically analyzed by using standard statistical packages.

Location: BTRI, Bilashcherra Experimental Farm and different tea gardens of Bangladesh

Duration: 2017-2022

Progress, 2021:

60 soil samples were collected from 25 different Tea Estates of Bangladesh. Soil Texture, Structure, Soil Color, Soil Moisture percentage & Bulk density and some Chemical

Properties are determined, which is shown below. More soil samples from different tea estate will be collected to estimate the Physical Properties. Soil collection and Analysis is going on. This experiment will be continued 2022.

Valley wise Soil physical property:

Valley	Texture	Structure	Color	Moisture %	Bulk density gcm^{-3}	Particle density gcm^{-3}	Pore space %
Balisera	SCL	Sub Angular Blocky	Gray-Greenish Gray	12.58-22.73	1.66-1.89	2.28-2.46	18.86-32.52
Monu Doloï	SCL - Cl	Sub Angular Blocky - Angular Blocky	Pale green -Pinkish gray	12.36-16.00	1.65 -1.87	2.27-2.32	17.62-28.88
Lungla	SL – SCL - CL	Sub Angular Blocky - Granular	Pale Yellow - Pale red - Light Brown- Light reddish brown- Light Brownish Gray	2.44-21.93	1.50-1.89	2.30-2.64	19.57-43.18
Luskerpore	SCL - CL	Sub Angular Blocky - Angular Blocky	Greenish Gray - Dark Gray	5.23-12.00	1.45-2.20	2.35-2.50	12.00-40.82
Juri	SL – SCL - CL	Sub Angular Blocky-granular	Light Brown - Light Reddish brown - Pinkish gray - Grey	1.23-22.18	1.62 -2.08	2.35- 2.54	14.40-35.20
North Sylhet	S	Angular blocky	Light Brown-Gray	12.64	1.72	2.55	32.55
Chattogram	SCL - CL	Sub Angular Blocky	Light Brown-Gray- Light Olive Gray	12.64-15.22	1.72-1.74	2.50-2.58	31.20-32.56

From the result of soil physical property of different valley, it has been shown that the moisture % is low than ideal soil moisture % (25%) which is normally favorable for tea plantation. Bulk density, particle density status is also low so porosity % ranges below 50%.

Valley wise Soil Chemical property:

Valley	pH	O.C%	Total N%	Av. P ppm	Av. K ppm	Av. Ca ppm	Av. Mg ppm
Balisera	5.04 -5.40	0.95 -1.36	0.099 -0.139	12.07 -22.77	63.28 - 77.89	95.20 -105.62	20.69-32.41
Monu Doloï	4.5-4.8	1.11-1.25	0.108- 0.12	21.18 -22.36	42.87 -44.40	72.32 -225.62	34.42-43.25
Lungla	4.5-5.1	1.05 -1.67	0.105 -0.170	8.17-75.27	42.87 – 129.71	95.23 – 209.40	18.36 -43.36
Luskerpore	4.4-4.9	0.65 – 1.37	0.058 – 0.140	4.22 -10.15	56.88 -145.81	86.35 – 207.60	15.29 -32.65
Juri	4.5 -5.08	0.90 -1.75	0.093 -0.178	5.69 -92.36	56.32 -204.40	145.60 -358.20	22.36 – 71.04
North Sylhet	4.5 -4.9	1.03 – 1.28	0.105 -0.130	9.32 – 18.69	36.25 -56.68	98.02 -109.63	19.68 -29.23
Chattogram	4.5 -4.6	1.25 -1.41	0.078 - 0.141	8.68 -8.74	61.08 - 135.31	88.65 -105.98	23.25 -29.62

The soil analytical result and yield data will be statistically analyzed at the end of 2022. The experiment will be closed December, 2022

SS 2: STATUS OF MICRONUTRIENTS (B, Zn, Mn, Fe & Cu) IN SOME SELECTED TEA SOILS OF BANGLADESH.

Micronutrients are very important for plants to complete their life cycles but need only in a small amount. Micronutrients such as Fe, Mn, Cu, Zn etc function in the enzyme systems in tea plant. They also play an important role in chlorophyll production, oxidation- reduction system, co-enzymatic factor etc. which is ultimately influence on growth, yield and quality of tea. Though very small application of micronutrient may produce dramatic result but the effects of micronutrient deficiency may be severe in term of stunted growth, low yield, dieback and even plant death.

So, it is very important to know the status of micronutrients (B, Mo, Zn, Mn, Fe & Cu) in tea soils of Bangladesh which will helpful for the proper nutrient management.

Methodology: Soil samples were collected randomly from tea sections of BTRI and BEF and analyzed accordingly to estimate the status of micronutrients.

Duration: 2017-2022

Location: BTRI, BEF and different tea gardens of Sylhet, Chattogram and Panchagarh.

Progress: Micronutrient analysis of the collected 50 (fifty) soil samples of BTRI farm, Bilashcherra Experimental farm and Luskerpore Tea Estate has been done. Zinc, Iron, Manganese and copper analysis of the soil samples has been completed. Minimum content of Zn, Fe and Cu were 0.053, 0.14 and 0.015 ppm respectively. Among 50 soil samples Manganese content of 19 soil samples were in Below Detection Level (BDL). Maximum content of Zn, Fe, Mn and Cu were 1.64, 16.99, 6.54 and 0.47 ppm respectively. 651 soil samples from 47 tea estates has been collected and analysis is going on.

SS 3: PRESENT STATUS OF TOXIC HEAVY METALS (Pb, Cd, Hg, Cr) IN TEA SOILS, GREEN LEAVES AND MADE TEA IN BANGLADESH.

Tea is rich in many trace inorganic elements. In addition to many essential elements required for human health, some toxic elements may also be present in tea leaves. This could be due to polluted soil, application of pesticides, fertilizers of industrial activities. There is often little information available about the safety of tea leaves and finished products with respect to heavy metal contamination. Due to the significant amount of tea consumed, it is important to know the toxic metal contents.

Location: BTRI, Bilashcherra Experimental Farm and different tea gardens of Sylhet, Chattogram and Panchagarh.

Duration: 2018-2022

Progress:

46 soil, 18 green leaves and 07 made tea (black) Golden Broken Orange Pekoe (GBOP), Pekoe Fannings (PF), Churamoni Dust (CD) and Orthodox grade samples and 01 made tea (green) were collected from Korotoa tea estate and Kazi & Kazi tea estate of Panchagarh district. 42 soil, 18 green leaves and 03 made tea (black) Golden Broken Orange Pekoe (GBOP), Pekoe Fannings (PF) and Orange Fannings (OF) grade samples and 01 made tea (green) were collected from Bilashcherra Experimental Farm of Bangladesh Tea Research Institute (BTRI), Srimangal.

43 soil, 23 green leaves and 09 made tea (black) Golden Broken Orange Pekoe (GBOP), Pekoe Fannings (PF)/Orange Fannings (OF) and Churamoni Dust (CD)/Red Dust (RD) grade samples were collected from 03 tea gardens of Chattogram district. 61 soil, 53 green leaves and 15 made tea (black) samples such as Golden Broken Orange Pekoe (GBOP), Pekoe Fannings (PF) and Churamoni Dust (CD) grade samples were collected from 05 tea gardens of Moulvibazar district and 01 tea garden of Sylhet district. 03 made tea (green) samples such as Hyson, Young Hyson and Fine Young Hyson grade samples were collected from Jagcherra tea estate. The physical, chemical and biochemical analysis of the collected soil, leaf and made tea samples such as moisture, soil textural class, pH, organic carbon, total nitrogen, available phosphorus, exchangeable potassium, calcium, magnesium, sulphur, boron, iron, manganese, zinc, copper, lead, cadmium, chromium, nickel as well as protein content, total polyphenol, theaflavin, thearubigin and caffeine content of made tea has been completed.

Information on soil type, physiographic region and topography of the sampling locations as well as the history of fertilizers and pesticides application, yield of tea, age of tea plants, plant spacing etc. at each of the tea gardens of Panchagarh, Chattogram, Moulvibazar and Sylhet districts were recorded.

Laboratory analytical data of the collected soil, leaf and made tea samples as well as the environmental data were compiled and stored properly for further use.

SS 4: DETERMINATION OF CRITICAL VALUES OF NUTRIENTS IN TEA SOIL AND PLANT LEAF IN SYLHET, CHATTOGRAM AND PANCHAGARH REGION.

Critical values of nutrients in tea soil and plant leaf are very important for proper fertilizer management. Critical values of some nutrients in tea soils of Bangladesh were optimized earlier. But soil fertility status is changing day by day. So, now it's a crucial time to estimate critical values of essential elements in tea soil as well as tea plant leaves on the basis of present scenario of tea soils of Bangladesh.

Location: Different tea gardens of Sylhet, Chattogram and Panchagarh.

Duration: 2018-2023

Progress: Compilation of soil analytical data of different valley circles has been completed.

Critical limit Data (Valley-wise)

No.	Tea Growing Area	Texture	pH	Org. C%	Total N%	Av. P ppm	Av. K ppm	Av. Ca ppm	Av. Mg ppm
1.	Balisera Valley	SL-SCL	3.9-5.2	0.56-1.36	0.061-0.140	2.35-89.09	37.69-125.11	38.65-105.82	3.82-112.15
2.	Luskerpore Valley	SL-SCL	3.8-4.6	0.43-1.11	0.051-0.123	3.79-39.29	32.12-128.31	51.02-115.14	5.92-30.50
3.	Juri Valley	SL-SCL	4.0-5.1	0.50-1.27	0.055-0.131	5.64-45.84	22.43-204.40	60.32-182.22	4.59-24.81
4.	Monu Doloi Valley	SL-SCL	3.9-4.9	0.61-1.25	0.065-0.125	6.34-78.37	32.87-108.74	72.32-225.62	18.52-43.25
5.	North Sylhet Valley	SL-SCL	4.2-4.7	0.57-1.34	0.062-0.144	9.24-44.54	38.23-106.65	78.25-181.56	7.44-37.27
6.	Chittagong	SL-SCL	4.0-5.0	0.55-1.29	0.059-0.139	8.74-56.72	44.56-135.31	64.28-196.27	13.25-44.60
7.	Panchagarh	SL-SCL	4.7-6.2	1.49-2.09	0.120-0.211	12.74-68.55	27.95-88.28	110.25-285.36	30.57-88.78

Pot experiments will be conducted for further investigation.

SS 5: COMPARATIVE STUDY OF CONSERVATION AND CONVENTIONAL AGRICULTURE PRACTICE IN SMALL HOLDING TEA CULTIVATION IN RESPONSE TO CLIMATE CHANGE.

Introduction:

Conservation Agriculture (CA) comprises the practical application of three principles, namely: nor minimum mechanical soil disturbance, rational crop biomass soil cover and crop diversification, in conjunction with other complementary improved agricultural practices of integrated crop and production management. Numerous studies conducted across varied ecologies of South Asia have shown the potential benefits of Ca component technologies with respect to natural resource conservation, efficiency of use of external inputs, crop yield enhancement, soil health improvement, economic farm profitability and adaptation to climate change to address the food, energy and water nexus and meet sustainable development goals. The objective of this research is to efficient use of external and natural resources to reduce the mortality rate of new plantation in dry season and to minimize soil erosion with nutrient.

Methodology:

1. Land Preparation would be different in separate area *i.e.* follow Conservation agriculture management system and another would be Conventional agriculture management system.
2. Planting New two acres area in Bilashcherra Experimental Farm one will plant by Conservation agriculture management system and another would be Conventional agriculture Management System.
3. Comparative data Collection will start from 2nd year in the new planting area of two *i.e.* Mortality of sapling, Growth and yield of tea plant, soil properties, etc.

Duration: 5 years (2020-2025)

Progress 2021:

1. In conventional Method about 500 young teas were planted in Bilashcherra Experimental Farm. (Section: Near Coffee Tilah)
2. In conservation method Field was prepared. Plantation work is running.
3. Initial Soil Sample analysis was done:

Treatment	Sample No	Texture	pH	O.C	Total N%	Av.P ppm	Av.K ppm
Conventional Method	1	SCL	4.4	1.57	0.159	13.81	41.72
	2	SCL	4.5	1.90	0.192	10.16	117.09
Conservation Method	1	SCL	4.9	1.95	0.196	7.83	183.37
	2	SCL	4.8	1.83	0.185	85.69	158.67

SS 6: EFFECT OF DIFFERENT MULCHING MATERIALS ON SOIL PROPERTIES, EARTHWORM POPULATION AND GROWTH OF YOUNG TEA.

Objectives:

Mulching is an important cultural practice for soil-moisture conservation in tea lands. Different mulches have variable effects on soil physical and chemical properties and plant growth. The practice of mulching in tea plantations is commonly known as thatching. New clearings under young tea remain exposed to the vagaries of weather, until such time as the tea forms a canopy and provides an adequate soil cover. As a consequence, new clearings are vulnerable to erosion, soil-moisture evaporation, and effects brought on by the proliferation of weeds. In order to minimize these adverse effects, it is necessary to provide ground cover with dead or live mulches.

Location: Bilashcherra Experimental Farm and Luskerpore Tea Estate

Plot size: 1.50 m²

Number of plants per plot: 6 Nos

Duration: 2020-2022

Replication: 03

Design: RBD

Methodology:**Treatment**

T₁ = Control

T₂ = Boga Medula (5 cm layer) 3.75tons/ha

T₃ = water hyacinth 5cm layer.

T₄ = Guatemala Grass 2.5ton/ha

T₅ = Citronella Grass 2.5ton/ha

T₆ = Straw 20 tons/ha

T₇ = Banana Tree 20 tons/ha

T₈ = Pruning litter 10 ton/ha

T₉ = Weeds (5 cm layer) 20 tons/ha

<ul style="list-style-type: none"> ➤ Initial soil analysis ➤ Final soil analysis ➤ Yield data collection (Tipping) ➤ Growth data collection 	<ul style="list-style-type: none"> ➤ Earthworm count ➤ Laboratory Analysis (Soil Physical and Chemical) As well as some biological (if possible) ➤ Data Compilation and Statistical Analysis
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Progress, 2021:

Initial Soil Status of Bilashcherra Experimental Farm and Luskerpore Tea Estate (2020):

Progress, 2020:

Table 8. Initial Soil Status of the experimental field (Bilashcherra Experimental Farm)

Treatment	Soil Texture	Soil Structure	Color	Bulk Density gm/cm ³	Moisture %	pH	O.C	Total N%	Av. P ppm	Av. K ppm
T ₁	SCL	Sub angular blocky	Grey	1.88	28.75	4.6	0.71	0.074	6.33	48.97
T ₂	SCL					4.7	0.58	0.062	8.85	47.72
T ₃	SCL					4.7	0.99	0.103	22.63	90.32
T ₄	SCL					4.8	1.18	0.120	7.60	49.01
T ₅	SCL					4.8	1.37	0.140	16.28	38.32
T ₆	SCL					4.8	0.99	0.102	24.35	80.36
T ₇	SCL					4.9	1.11	0.115	14.92	93.45
T ₈	SCL					4.6	1.06	0.110	7.55	40.82
T ₉	SCL					5.0	1.24	0.128	6.82	102.85

Table 9. Initial Soil Status of the experimental field (Luskerpore Tea Estate)

Treatment	Soil Texture	Soil Structure	Color	Bulk Density gm/cm ³	Moisture %	pH	O.C	Total N%	Av. P ppm	Av. K ppm
T ₁	SCL	Sub angular blocky	Greenish Grey	1.70	7.15	4.1	1.04	0.108	2.73	32.53
T ₂	SCL					4.2	0.95	0.10	4.06	33.31
T ₃	SCL					4.2	0.90	0.095	5.13	49.65
T ₄	SCL					4.4	0.92	0.098	9.19	38.01
T ₅	SCL					4.1	0.95	0.10	5.43	47.83
T ₆	SCL					4.2	1.09	0.120	2.50	54.14
T ₇	SCL					4.4	1.10	0.114	5.18	31.21
T ₈	SCL					4.2	1.03	0.108	5.64	33.06
T ₉	SCL					4.3	0.90	0.098	15.51	39.09

After mulching application Soil Nutrient Status of BEF (Bilashcherra Experimental Farm) and Luskerpore Tea Estate (2021):

Physical property:

BEF						Luskerpore Tea Estate				
Treatment	Texture	Moisture %	Soil Structure	Color	Bulk Density gm/cm ³	Texture	Moisture %	Soil Structure	Color	Bulk Density gm/cm ³
T ₁	SCL	18.32	Granular	Grey	1.45	SCL	6.32	Granular	Greenish Grey	1.36
T ₂	SCL	21.18			1.36	SCL	12.07			1.30
T ₃	SCL	24.66			1.40	SCL	22.86			1.46
T ₄	SCL	20.14			1.52	SCL	6.96			1.50
T ₅	SCL	15.29			1.42	SCL	16.25			1.42
T ₆	SCL	23.36			1.32	SCL	12.00			1.30
T ₇	SCL	25.92			1.46	SCL	20.23			1.46
T ₈	SCL	20.08			1.50	SCL	10.58			1.44
T ₉	SCL	18.59			1.40	SCL	9.69			1.50

Chemical Property:

BEF								Luskerpore Tea Estate						
Treatment	pH	O.C	Total N%	Av.p ppm	Av.K ppm	Av.Ca ppm	Av.Mg ppm	pH	O.C	Total N%	Av.p ppm	Av.K ppm	Av.Ca ppm	Av.Mg ppm
T ₁	4.6	1.11	0.114	35.80	60.94	142.40	50.08	4.5	1.25	0.128	9.27	60.21	182.40	30.08
T ₂	4.9	1.32	0.135	24.15	63.52	123.60	41.58	4.8	1.30	0.135	18.33	75.54	153.60	21.58
T ₃	5.1	1.07	0.110	13.41	100.58	98.26	43.58	5.0	1.02	0.108	22.38	108.39	108.26	23.58
T ₄	4.8	1.15	0.118	13.91	114.40	130.26	69.78	5.0	1.38	0.145	19.77	90.86	130.26	19.78
T ₅	5.0	1.00	0.102	22.01	73.94	106.40	46.70	4.9	1.52	0.156	19.37	70.38	116.40	26.70
T ₆	5.0	1.41	0.144	18.41	133.18	93.60	32.20	4.8	1.68	0.170	20.46	860.16	98.60	22.20
T ₇	5.2	1.34	0.137	22.60	90.68	89.60	43.52	5.1	1.38	0.142	11.99	102.36	98.80	13.52
T ₈	5.2	1.05	0.108	24.40	69.56	86.60	28.54	5.0	1.22	0.126	15.98	59.55	96.60	28.54
T ₉	5.2	1.49	0.151	14.91	169.44	100.20	22.35	4.8	1.19	0.122	12.05	127.41	120.20	22.25

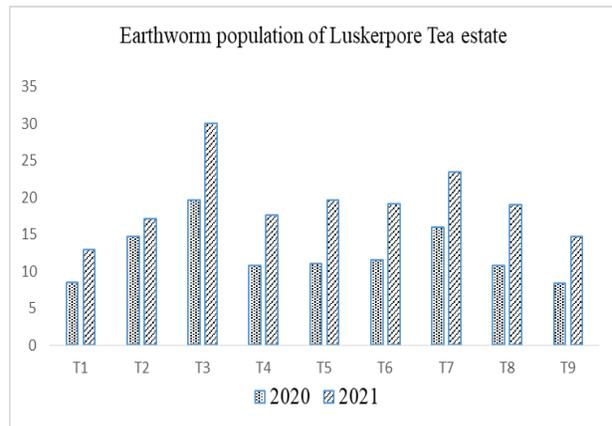
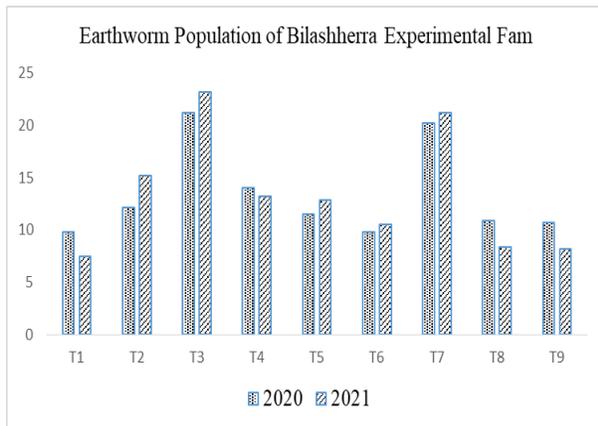
From the soil analysis report it has been shown that soil physical and chemical status has increased after mulching applications.

Tipping Data

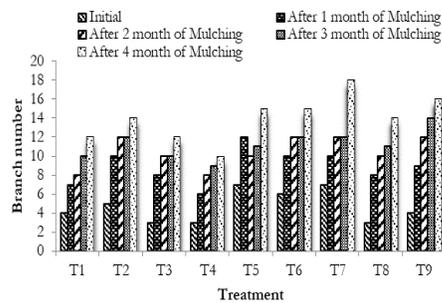
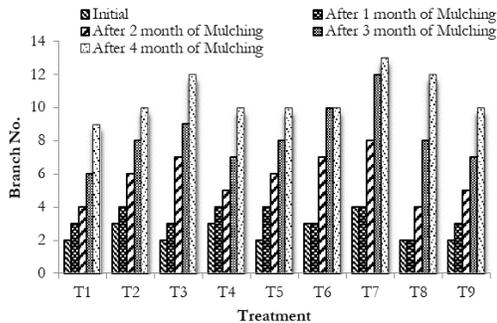
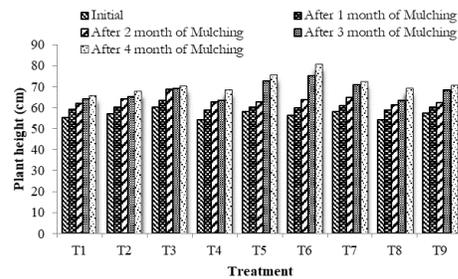
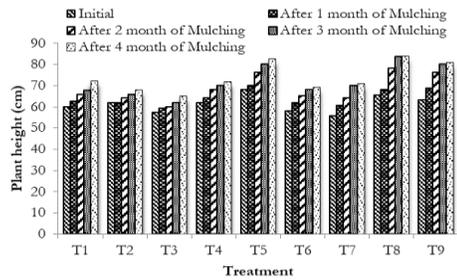
Treatment	Bilashcherra Experimental Farm Green leave weight			Luskerpore Tea Estate Green leave weight		
	Mean weight gm/plot	kg/plot	kg/ha	Mean weight gm/plot	kg/plot	kg/ha
T ₁	0.0217	0.0000217	0.14	0.0143	0.0000143	0.10
T ₂	0.0373	0.0000373	0.25	0.0293	0.0000293	0.20
T ₃	0.0633	0.0000633	0.42	0.0530	0.0000530	0.35

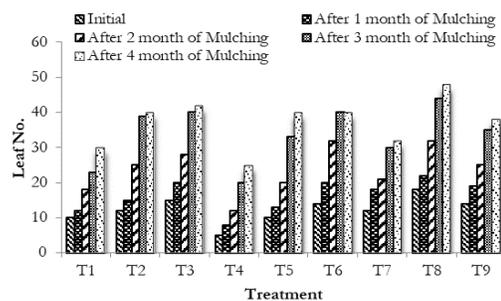
T ₄	0.0300	0.0000300	0.20	0.0400	0.0000400	0.27
T ₅	0.0403	0.0000403	0.27	0.0340	0.0000340	0.23
T ₆	0.0543	0.0000543	0.36	0.0337	0.0000337	0.22
T ₇	0.0707	0.0000707	0.47	0.0483	0.0000483	0.32
T ₈	0.0413	0.0000413	0.28	0.0190	0.0000190	0.13
T ₉	0.0583	0.0000583	0.39	0.0203	0.0000203	0.14

Earthworm population

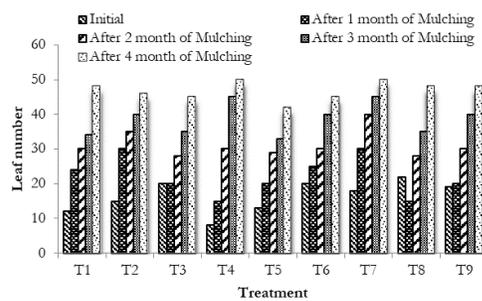


Growth data Analysis

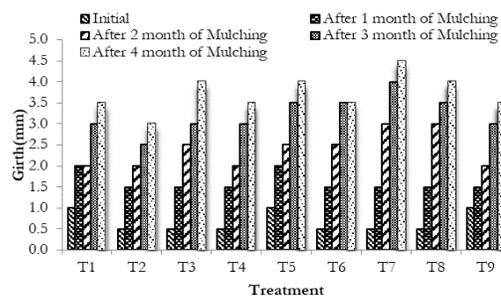




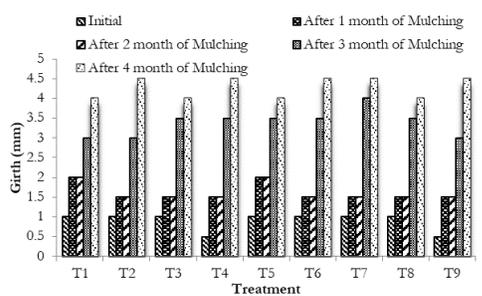
e



f



g



h

In the graph all the parameters of plant growth (such as Plant height, Branch number, Leaf Number and Girth) are gradually increased over initial growth. Tipping data, growth data and earthworm population's data will be statistically analyzed at the end of 2022. This experiment will be finished December, 2022.

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 1581 soil samples (297 advisory and 1284 paid) and 85 other samples from 74 tea estates were analyzed for different purposes, the breakup of which is presented in table 12.

Table 12. Number of samples analyzed

Year	Advisory Soil	Soil	Fertilizer	Lime/ Dolomite	Leaf	Water	Compost	Total (Fertilizers & others)	Total (Soils & others)
2021	297	1284	29	26	21	00	09	85	1666

Table 13. List of Tea Estates from where soil and other samples were received or collected and analyzed during the year 2021

Affifanagar	Green Leaf	Lallakhal	Pathariya
Ameenabad	Habibnagar	Langliyacherra	Patrakhola
Balibera	Hafiz	Lungla	Phulbari
Bidyabeel	Haldavalley	M R Khan	Phulcherra
Bilashcherra	Hooghicherra	Madabpore	Pooteacherra
Chandpore	Horrincherra	Madanmohanpur	Rajghat
Chaklapunji	Jafflong	Madhupur	Rema
Champarai	Jagadishpur	Marina	Rungicherra
Chandbagh	Jagcherra	Mathiura	Sabari
Chatlapore	Jhemai	Mertinga	Sagurnal
Clevedon	Junglebari	Mirzapore	Saif
Dakshingul & Laxmicherra	Kazi and Kazi	Monipur	Shumshernugger
Dauracherra	Kaiyacherra Dalu	Moomincherra	Silloah
Deundi	Kalikabari	Moulvi	Sreebari
Dildarpur	Kashipore	Nahar	Srigobindpur
Dinarpur	Khan	Nalua	Surma
Etah	Kodala	Neptune	Zareen
Fatehbagh	Kurma	New Samanbagh	
Ghazipore	Lalchand	Ootterbhag & Indanugger	

OTHER ACTIVITIES

Advisory correspondence

A total of 143 advisory letters to different tea estates on soil, fertilizers, dolomite, compost and other soil related aspects were sent during the year 2021.

Tours

During the year under report officers of the division paid a total 42 visits to different tea estates and other related places for experimental, advisory and official purposes.

Courses on tea culture

Comprehensive lectures on different aspects of soil management were presented by the scientific personnel of the division at the annual course and workshops organized by BTRI for the covenanted staff of tea estate during 2021. Scientists of this division also delivered lectures as resource speakers at the Management Training centre (MTC) for Post Graduate Diploma Course organized by Project Development Unit (PDU) of Bangladesh Tea Board.

BIOCHEMISTRY DIVISION

Dr. Mohammad Masud Rana
Senior Scientific Officer

STAFF

Mr. Muhammad Abid Hasan Chowdhury, Scientific Officer of Biochemistry division joined on 28.02.2021. Dr. Mohammad Masud Rana, Senior Scientific Officer of Agronomy division acted as the in-charge of the division as an additional duty. The posts of Principal Scientific Officer and Senior Scientific Officer of the division were lying vacant during the period under report.

RESEARCH

A total of three experiments were conducted during the year 2021 by Biochemistry division. Two were ongoing experiments and one was new and started during the period August-September 2020. The progress of the experiments are summarized below.

Experiment 1: Assessing biochemical and sensory changes of tea during standardization of a modern green tea production unit for manufacturing quality green tea (BTRI; Short term: 2020-2021)

A modern green tea factory has just launched at Bangladesh Tea Research Institute. The processing steps in this factory are Withering → Fixation → 1st Re-humidification → Rolling → Roll Drying (1st Drying) → 2nd Re-humidification → Final Drying. Variable temperatures and durations can be used in these steps. So, there is a great scope to standardize the processing technique using this green tea production unit. Therefore, the present study has been carried out to standardize the green tea processing technique using the modern green tea production unit for quality product.

Objectives of the study:

- To standardize the green tea production technique using the modern green tea production unit.
- To identify the major chemical constituents present in the final product.

Treatments:

Four sets of treatments were included in this study which are as follows-

a) Withering periods-

- W1 : 1 hour
- W2 : 2 hours
- W3 : 3 hours

b) Fixation temperatures (averages of three zones)-

F1 : 250 °C

F2 : 260 °C

F3 : 270 °C

c) Rolling periods-

R1 : 45 minutes

R2 : 50 minutes

R3 : 55 minutes

d) Roll drying (1st drying) temperatures (averages of three zones)-

D1 : 200 °C

D2 : 210 °C

D3 : 220 °C

e) Final drying temperatures-

D1 : 100 °C

D2 : 110 °C

D3 : 120 °C

Progress: During processing of green tea different treatments were employed one by one and the respective product green tea samples were collected and preserved in the refrigerator for further analysis. Chemical analysis of the samples were done in the biochemistry lab following standard protocols (according to ISO and others). Findings from the analysis results are summarized below.

Effects of different withering periods

It was observed that total polyphenols and caffeine contents were significantly highest when withering was done for one hour (Figure 1). When withering periods were extended, the total polyphenols and caffeine contents were gradually decreased significantly.

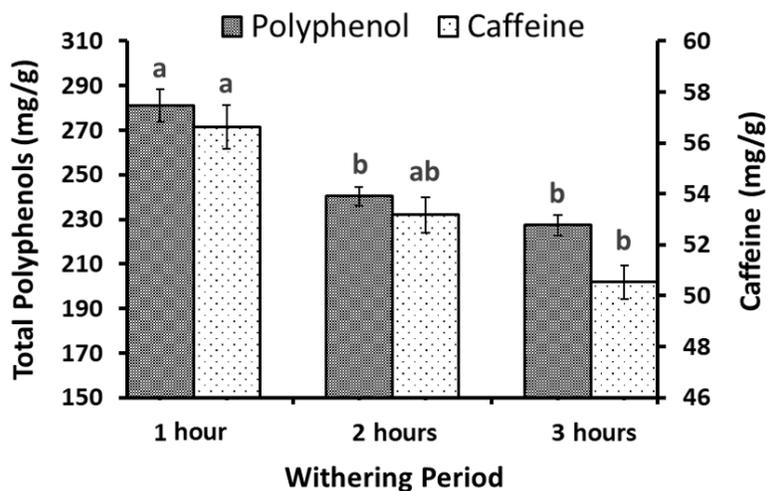


Figure 1. Effects of different withering periods on the total polyphenols and caffeine contents of the product green tea

Effects of different fixation temperatures

It was noticed that when the fixation temperatures were increased from 250 to 270 °C, the total polyphenols contents were increased gradually, though not significantly (Figure 2). Caffeine contents did not vary due to different fixation temperatures.

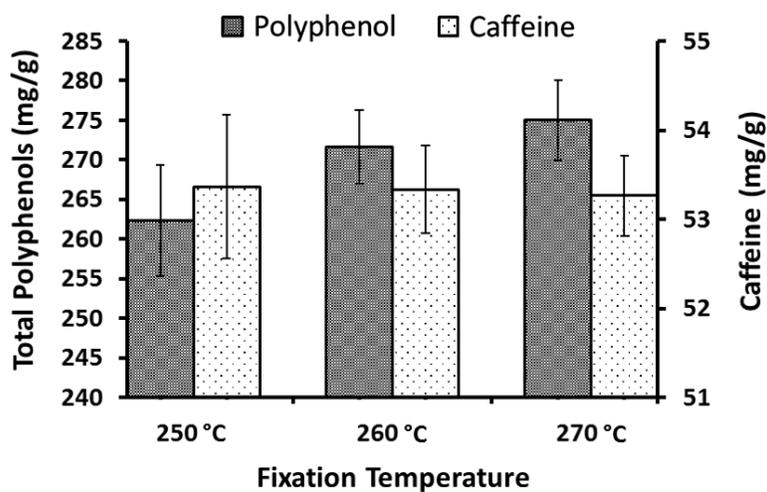


Figure 2. Effects of different fixation temperatures on the total polyphenols and caffeine contents of the product green tea

Effects of different rolling durations

The total polyphenols and caffeine contents were significantly increased when rolling durations were increased from 45 to 55 minutes (Figure 3). The highest total polyphenols and caffeine contents were noted with 55 minutes rolling, when other factors are constant. So, there is a further scope to try for a 60-65 minutes rolling duration to observe its effect on the green tea quality.

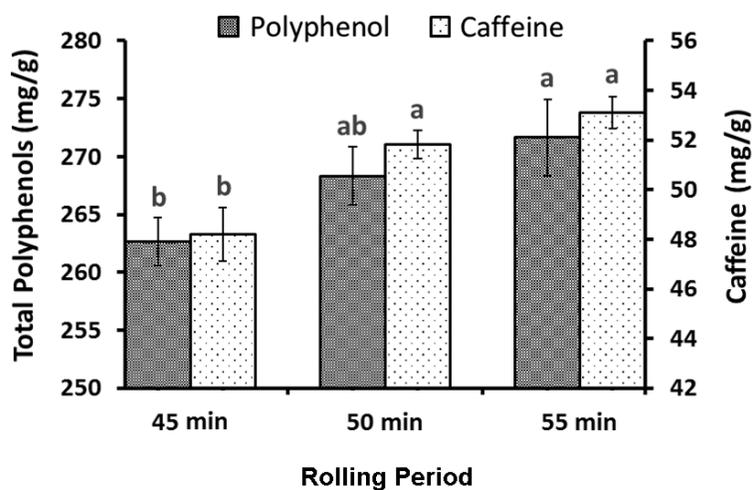


Figure 3. Effects of different rolling durations on the total polyphenols and caffeine contents of the product green tea

Effects of different roll drying (1st drying) temperatures

Roll drying (1st drying) temperature showed significant effect on green tea quality. It was observed that roll drying temperature is negatively correlated with the green tea quality. When the roll drying temperature increased from 200 to 220 °C, the total polyphenols and caffeine contents were decreased (Figure 4). Compared to 200 °C, the decrease was not significant at 210 °C but was significant at 220 °C. Therefore, it can be said that roll drying temperature should not exceed 210 °C.

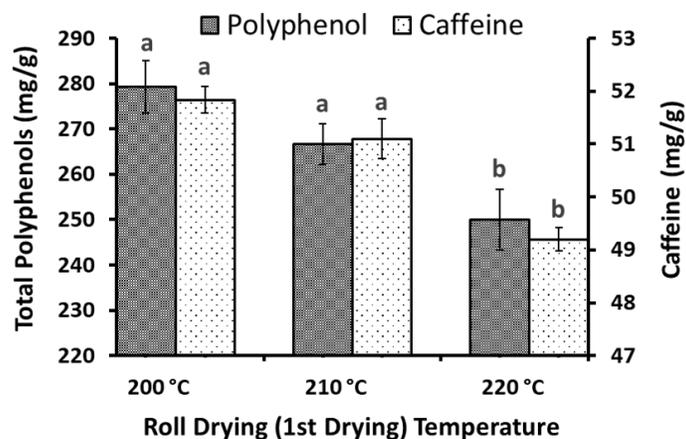


Figure 4. Effects of different roll drying (1st drying) temperatures on the total polyphenols and caffeine contents of the product green tea

Effects of different final drying temperatures

It was observed that when final drying temperature increased from 100 to 120 °C, the total polyphenols and caffeine contents were increased (Figure 5). The increase was significant for total polyphenols, but insignificant for caffeine. From the finding it can be said that irrespective to other factors, final drying temperature can be maintained at 120 °C for better quality green tea.

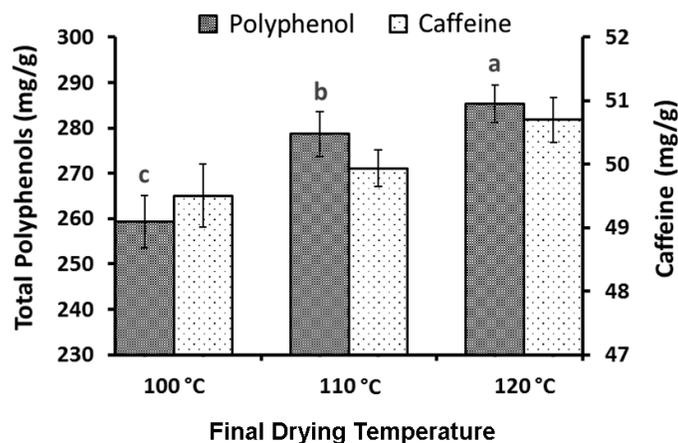


Figure 5. Effects of different final drying temperatures on the total polyphenols and caffeine contents of the product green tea

Experiment 2: Development of different value added products using the tea flavor (BTRI, Short term: 2020-2021)

Objectives of the study:

- To invent different diversified products using the tea flavor.
- Develop standard protocols for the production of diversified products.

Progress: For the study, first tea extracts were collected from the Black and Green teas. Then these extracts were used during the production process of different products to add value and also to develop new products. Black and Green tea powders and liquors were also directly used to develop new products. Green tea soap, green tea instant facial, tea flavored candy, tea flavored cookies, and green tea pickles has been developed so far (Figure 6). Research will be continued to improve the quality of the developed products and also to invent new products. The experiment is closed officially.



Green tea soap

Green tea instant facial
(Paste type)Green tea instant facial
(Powder type)

Tea flavored candy



Tea flavored cookies



Green tea pickles

Figure 6. Developed different diversified products using the tea and tea flavor

Experiment 3: Effect of storage time and packaging materials on the quality of black tea (BTRI, Short Term: 2021-2022)**Objectives of the study:**

- To determine how the flavor attributes of tea changes over time during storage.
- To identify the best packaging material for the storage of tea.
- To determine the shelf life of tea under a specific packaging material.

Treatments:

There are two sets of treatments in this study which are as follows-

a) Different packaging materials (7)-

- P1 : Polyethylene pack
- P2 : Foil pack
- P3 : Stand-up pouch
- P4 : Jute bag (with inner liner)
- P5 : WPP bag (with inner liner)
- P6 : Kraft paper bag (4 layered, with aluminum foil)
- P7 : Chest box (with aluminum foil)

b) Different storage periods (24)-

- S1 to S24 : From 1 to 24 months, respectively.

So, total number of tea samples will be analyzed = $7 \times 24 \times 3$ (replication) = 504

Data collection

Stored black tea samples within different packaging materials will be analyzed through chemical analysis every month up to 24 months of storage for the determination of caffeine, theaflavins, thearubigins, total colour, amino acids, lipid, chlorophyll, carotenoids etc. Related data will be collected and analyzed.

Progress: The study was proposed to begin in early 2021. However, the study could not be started in time as the HPLC machine required for chemical analysis of the tea samples could not be fixed in due time. However, for storing the tea samples as per treatment, the preparation work of the containers/bags/sacs was continued. At the end of the year of 2021, a total of 168 containers/bags/sacs were made with different types of packaging materials (Figure 7). After making the HPLC machine operational, the black tea samples will be stored in different containers as per the treatment. Thereafter, each month tea samples will be analyzed chemically to

determine the extent of deterioration of the quality within different types of packaging materials over time. The experiment will be continued.



Polyethylene Pack



Foil Pack



Stand-up Pouch



Jute Bag



WPP Bag



Kraft Paper bag



Chaste Box

Figure 7. Prepared containers/bags/sacs with different types of packaging material for storing black tea samples

BOTANY DIVISION
Dr. Md. Abdul Aziz
Principal Scientific Officer

STAFF

Mrs. Selina Akther Lipa joined as Scientific Officer on 28 February, 2021. The post of one Scientific Officer, one Senior Scientific Officer and one Field Assistant were vacant. There were no other changes in personnel position of the division during the period under report.

RESEARCH

Forty two experiments in four programme areas namely –

Prog. Area-1: Preliminary selection of vegetative clones,

Prog. Area-2: Long term yield and quality trial of provisionally selected clones,

Prog. Area-3: Tea breeding & establishment of germplasm bank and

Prog. Area-4: Short term/mid term experiments were carried out by the division.

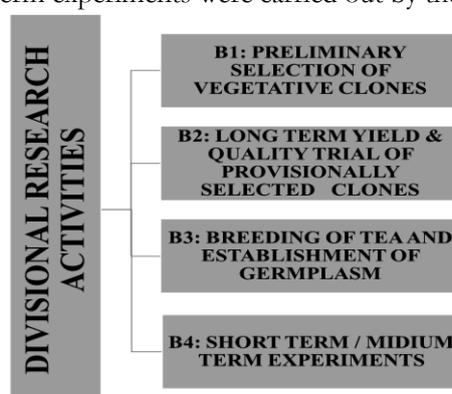


Fig 1. Divisional Activities of Botany Division (2021)

Results are briefly described below:

B1: PRELIMINARY SELECTION OF VEGETATIVE CLONES (NO. OF EXPERIMENTS-3)

B1-27-7: Selection of Vegetative Clones at Shumshernugger T. E., Section Main Div. Sec. No. 9 (1993-2022)

22 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 2436 cuttings from 16 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 (1993-2021)

Thirty-two 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 3169 cuttings from previously selected 23 bushes of section no. 1 of Amo Tea Estate were collected and planted in the nursery.

B1-31: Selection of Vegetative Clones at Baraoorah T. E., Section No. 8 (2007-2021)

13 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 1255 cuttings from 12 bushes of section no. 1 of Baraoorah Tea Estate were collected and planted in the nursery.

Progress:

- Preliminary selection of desirable mother bushes is continued at Shumshernugger, Amo and Baraoorah Tea Estates.

- A total of 32, 22 and 13 mother plants from variable seedling population of Amo, Shumshernugger and Baraoorah tea estates respectively have been selected.
- 08 plants are also selected from BTRI C2 area.
- Collection of cutting is going on from the selected plants for rooting trial in nursery in order to find out their rooting ability.

B2: LONG TERM YIELD & QUALITY TRIAL OF PROVISIONALLY SELECTED CLONES (NO. OF EXPERIMENTS-22)

B2-40: Yield and Quality Trial of Six Test clones – MZ/39, E/4, D/13, B2T1, BR2/97 and SDL/1 against Standard BT2 (BTRI, 2000-2022).

The plants of this trial were light skiffed at 80 cm in 2021. There were 22 plucking rounds in 2021. Recommended doses of fertilizer & usual cultural practices were applied. The yield data were analyzed and presented in Table-1.

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

Clone	MZ/39	E/4	D/13	B2T1	BR2/97	SDL/1	BT2
Treatment mean	Released as BT21	757.97	617.45	670	585.49	870.85	786.67

Treatment difference- Significant (LSD value at 5% level of significance= 42.92)

The analytical results reveal that yield difference was highly significant (at 5% level of significance) in 2021. Test clones SDL/1 and E/4 were significantly higher in terms of yield with the control BT2 while the test clone D/13, B2T1, BR2/97 and SDL/1 performed lower yield than the control. The cup quality of made tea for all the test clones were assessed organoleptically and average scores are presented in Table 2. The estimated made tea production in kg/ha is presented in Fig. 2.

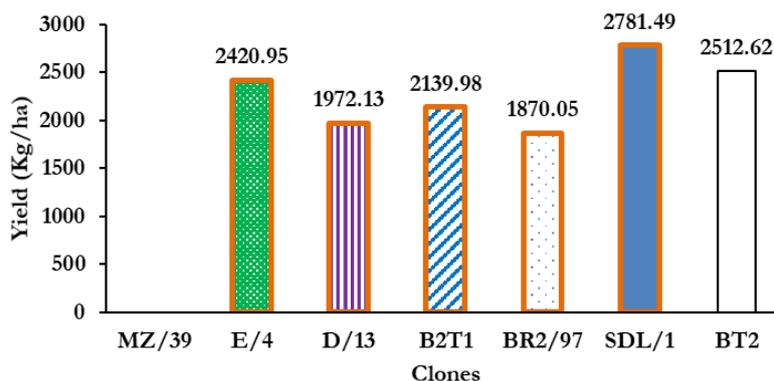


Fig. 2. Comparative yield of clones made tea (kg/ha)

Table 2. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
MZ/39	7.46	7.42	7.61	7.51	2.86	32.86	AA
E/4	7.61	7.58	7.42	7.38	2.79	32.78	AA
D/13	7.46	7.51	7.47	7.45	2.73	32.62	AA
B2T1	7.41	7.37	7.45	7.41	2.79	32.43	AA
BR2/97	7.53	7.44	7.42	7.54	2.78	32.71	AA
SDL/1	7.36	7.47	7.51	7.62	2.78	32.74	AA
BT2	7.47	7.65	7.51	7.43	2.61	32.67	AA

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

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

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, 2000-2022).

The plants of this trial were light skiffed at 81 cm in 2021. There were 19 plucking rounds in 2021. Recommended doses of fertilizer & usual cultural practices were applied. The yield data were analyzed and presented in Table-3.

Table 3. Yield of green leaves

Clone	A/8/37	A/8/55	A/8/62	A/8/66	BT2
Treatment mean	658.71	726.89	660.46	695.13	844.79

Treatment difference- Insignificant

The analytical results reveal that yield difference was insignificant during the cropping year. The analytical results revealed that all test clones gave lower yield than control 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 4.

Table 04. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
A/8/37	7.38	7.53	7.52	7.31	2.78	32.52	AA
A/8/55	7.27	7.41	7.51	7.41	2.69	32.29	AA
A/8/62	7.33	7.38	7.56	7.37	2.79	32.43	AA
A/8/66	7.55	7.54	7.44	7.56	2.82	32.91	AA
BT2	7.53	7.48	7.59	7.65	2.73	32.98	AA

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

All the test clones were comparable in terms of cup quality. The flavoury character of BT2 was not considered in the case of assessing cup quality. The estimated made tea production in kg/ha is presented in Fig. 3.

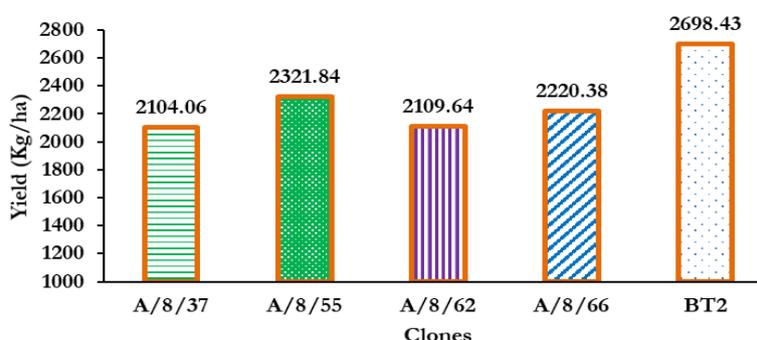


Fig. 3. Comparative yield of clones made tea (kg/ha)

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, 2001-2022).

The plants of this trial were medium skiffed at 81 cm in 2021. There were 19 plucking rounds in 2021. Recommended doses of fertilizer & usual cultural practices were applied. The yield data were analyzed and presented in Table-5

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

Clone	A/17/16	Ph/9/1	Ph/9/9	Sh/B/6/46	BT1
Treatment mean	715.619	610.304	636.2198	725.1893	639.7436

Level of significance: Insignificant.

The analytical results revealed that all test clones except Ph/9/1 and Ph/9/9 are comparable in terms of yield. The estimated made tea production in kg/ha is presented in Fig. 4. The cup quality of made tea for all the test clones were assessed organoleptically and average scores are presented in Table 6.

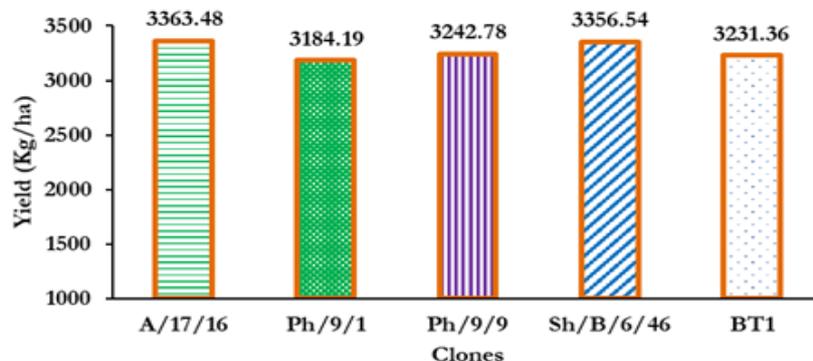


Fig. 4. Comparative yield of clones made tea (kg/ha)

Table 6. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
A/17/16	7.51	7.35	7.41	7.46	2.75	32.48	AA
Ph/9/1	7.35	7.43	7.37	7.46	2.68	32.29	AA
Ph/9/9	7.47	7.49	7.56	7.42	2.72	32.66	AA
Sh/B/6/46	7.49	7.41	7.44	7.46	2.67	32.47	AA
BT1	7.33	7.35	7.49	7.42	2.74	32.33	AA

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

All the test clones were comparable in cup with the control.

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, 2001-2022).

The plants of this trial were medium skiffed at 81 cm in 2021. There were 19 plucking rounds in 2021. Recommended doses of fertilizer & usual cultural practices were applied. The yield data were analyzed and presented in Table-7. The estimated made tea production in kg/ha is presented in Fig. 5.

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

Clone	Ph/9/4	Ph/9/25	Ph/9/40	BS/67	BT5
Treatment mean	629.52	698.14	623.611	679.86	526.05

Treatment difference- Insignificant.

The statistical results reveal that yield difference was insignificant in 2021. The yield performance of test clone Ph/9/4, Ph/9/25, Ph/9/40 and BS/67 were higher than the control BT5. The cup quality of made tea for all the test clones were assessed organoleptically and average scores are presented in Table 8.

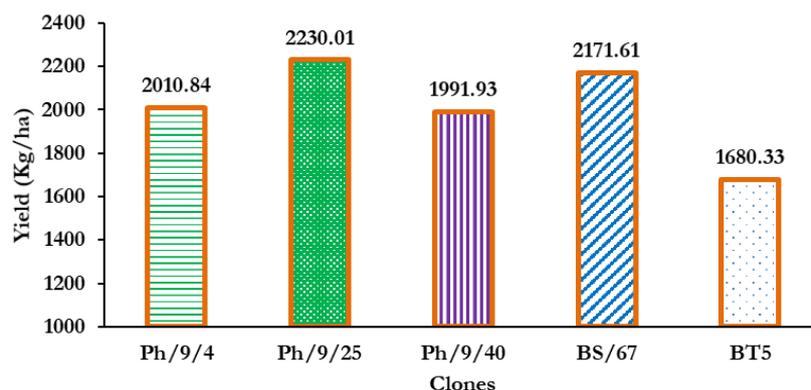


Fig. 5. Comparative yield of clones made tea (kg/ha)

Table 8. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
Ph/9/4	7.37	7.52	7.43	7.47	2.68	32.47	AA
Ph/9/25	7.33	7.35	7.43	7.51	2.67	32.29	AA
Ph/9/40	7.32	7.34	7.36	7.43	2.71	32.16	AA
BS/67	7.52	7.55	7.56	7.47	2.65	32.75	AA
BT5	7.48	7.52	7.54	7.44	2.75	32.73	AA

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

All the test clones were comparable in terms of cup quality with the control BT5.

B2-44: Yield and Quality Trial of Three Test clones Selected from Amo and Phulcherra T. Es.; Test clones– A/8B/1, Ph/9B/1, Ph/9/11 and against Standard BT1 (BTRI, 2003-2022).

The plants of this trial were light pruned at 64 cm in 2021. There were 22 plucking rounds in 2021. Recommended doses of fertilizer & usual cultural practices were applied. The yield data were analyzed and presented in Table-9.

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

Clone	A/8B/1	Ph/9B/1	Ph/9/11	BT1
Treatment mean	941.96	1035.82	913.54	884.84

Treatment difference- Significant (LSD value at 5% level of significance= 98.11)

The analytical results revealed that all test clones are significantly produce higher yield against control. The estimated made tea production in kg/ha is presented in Fig. 6. The cup quality of made tea for all the test clones were assessed organoleptically and average scores are presented in Table 10.

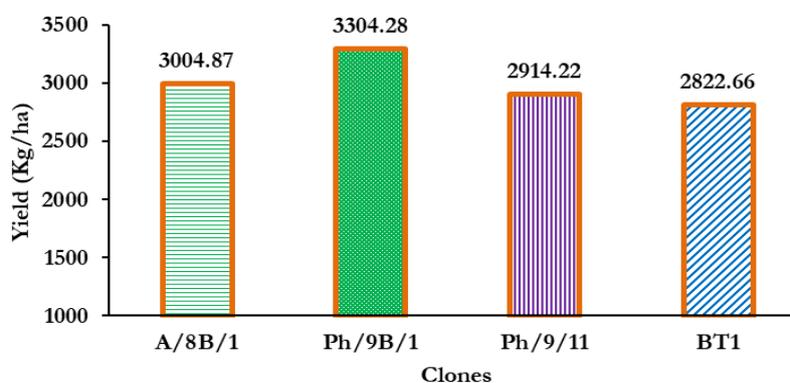


Fig. 6. Comparative yield of clones made tea (kg/ha)

Table 10. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
A/8B/1	7.43	7.63	7.43	7.45	2.61	32.55	AA
Ph/9B/1	7.42	7.43	7.51	7.54	2.83	32.73	AA
Ph/9/11	7.58	7.52	7.45	7.34	2.78	32.67	AA
BT1	7.56	7.63	7.41	7.38	2.81	32.79	AA

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

All the Test clones were comparable in terms of cup quality with the control BT1.

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, 2005-2022).

The plants of this trial were medium skiffed at 77 cm in 2021. There were 28 plucking rounds in the reporting year. Recommended doses of fertilizer & usual cultural practices were applied. The yield data were analyzed and presented in Table-11.

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

Clone	D1/18	D/6	D/10	D/12	BT5
Treatment mean	1363.08	1354.09	1238.56	1327.02	1152.71

Treatment difference- Significant (LSD value at 5% level of significance=134.84)

The statistical results reveal that yield difference was significant (at 5% level of significance) in 2021. The yield performance of all test clones were higher than the control BT5. The estimated made tea production in kg/ha is presented in Fig. 7.

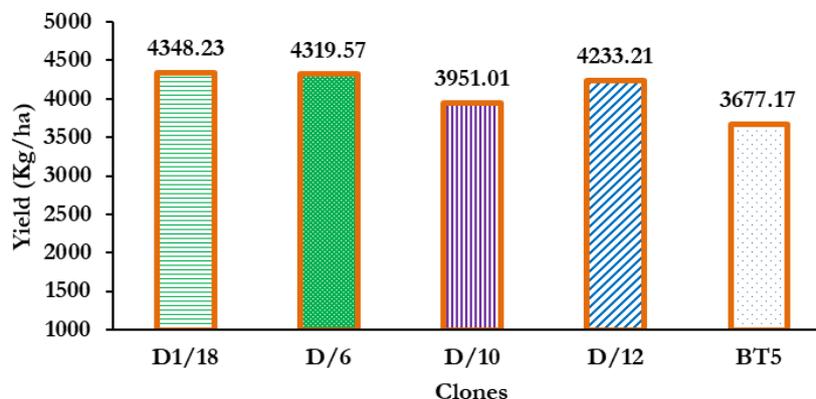


Fig. 7. Comparative yield of clones made tea (kg/ha)

The cup quality of made tea for all the test clones were assessed organoleptically and average scores are presented in Table 12.

Table 12. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
D1/18	7.64	7.47	7.54	7.43	2.85	32.93	AA
D/6	7.47	7.53	7.54	7.75	2.89	33.18	AA
D/10	7.22	7.52	7.43	7.53	2.96	32.66	AA
D/12	7.41	7.67	7.48	7.38	2.77	32.71	AA
BT5	7.31	7.72	7.36	7.59	2.91	32.89	AA

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

Test clones were comparable with the control BT5.

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, 2006-2023).

The plants of this trial were deep skiffed at 71 cm in 2021. There were 26 plucking rounds in 2021. Recommended doses of fertilizer & usual cultural practices were applied. The yield data were analyzed and presented in Table-13.

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

Clone	Ph/9/92	BS/3	Ph/9/108	G/61/8	BT15
Treatment mean	1100.74	1093.76	1019.34	1047.88	938.84

Treatment difference- Significant (LSD value at 5% level of significance= 58.66)

The statistical results reveal that yield difference was significant (at 5% level of significance) in 2021. The yield performances of all the test clones were higher than the control BT15. The estimated made tea production in kg/ha is presented in Fig. 8. The cup quality of made tea for all the test clones were assessed organoleptically and average scores are presented in Table 14.

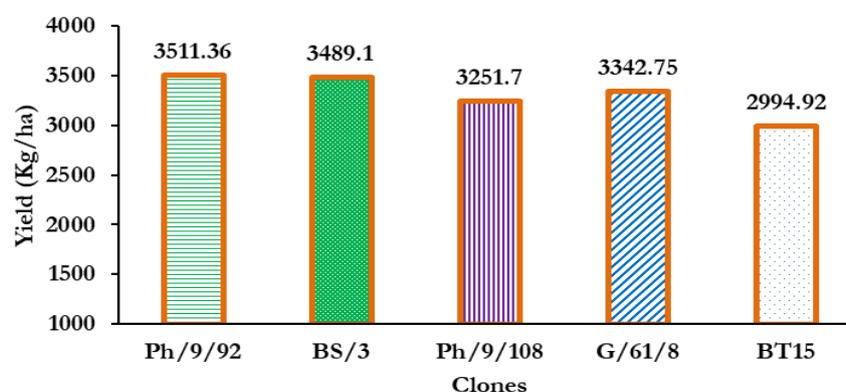


Fig. 8. Comparative yield of clones made tea (kg/ha)

Table 14. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
Ph/9/92	7.57	7.44	7.68	7.52	2.83	33.04	AA
BS/3	7.33	7.52	7.19	7.35	2.68	32.07	AA
Ph/9/108	7.52	7.73	7.45	7.63	2.86	33.19	AA
G/61/5	7.55	7.54	7.65	7.85	2.84	33.43	AA
BT15	7.73	7.83	7.81	7.33	3.54	34.24	E

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

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

B2-48: Yield and Quality Trial of Four Test clones Selected from Shumshernugger and Amo T. E; Test clones – A/8/124, Sh/10/2, A/8/125 and A/11/38 against Standard BT2 (BTRI, 2009-2026).

The plants of this trial were light skiffed at 74 cm in 2021. There were 31 plucking rounds in the reporting year. Recommended doses of fertilizer & usual cultural practices were applied. The yield data were analyzed and presented in Table-15.

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

Clone	A/8/124	Sh/10/2	A/8/125	A/11/38	BT2
Treatment mean	1453.69	1369.96	1476.87	1371.09	1057.98

Treatment difference- Significant (LSD value at 5% level of significance= 85.64)

The statistical results reveal that yield difference was significant (at 5% level of significance) in 2021. The yield performance of all test clones were higher than the control BT2. The estimated made tea production in kg/ha is presented in Fig. 9. The cup quality of made tea for all the test clones were assessed organoleptically and average scores are presented in Table 16.

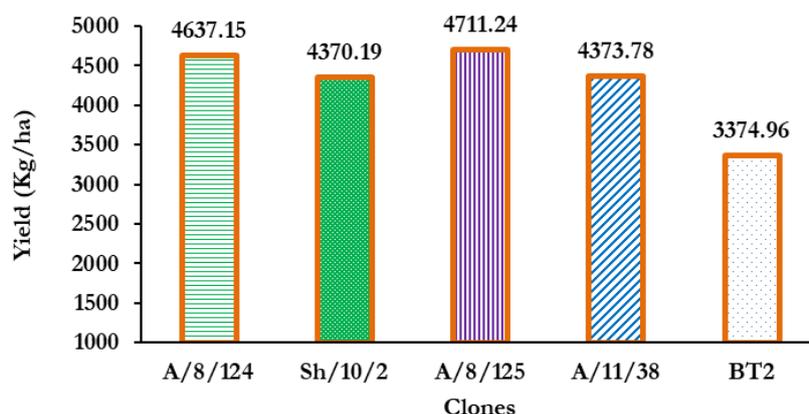


Fig. 9. Comparative yield of clones made tea (kg/ha)

Table 16. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
A/8/124	7.51	7.53	7.44	7.41	2.85	32.74	AA
Sh/10/2	7.42	7.41	7.58	7.41	2.82	32.64	AA
A/8/125	7.77	7.54	7.71	7.54	2.65	33.21	AA
A/11/38	7.38	7.54	7.32	7.54	2.85	32.63	AA
BT2	7.58	7.59	7.43	7.62	2.69	32.91	AA

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

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

B2-49: Yield and Quality Trial of Four Test clones Selected from Shumshernugger T.E. (Sh/10/5, Sh/D/13/4 and Amo T. E.; Test clones – A/8/128, BS/91/6, against Standard BT2 (BTRI, 2011-2028).

The plants were light skiffed at 74 cm in 2021 and there were 31 plucking round during the cropping period. Recommended doses of fertilizer & usual cultural practices were applied. The yield data were analyzed and presented in Table-17.

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

Clone	Sh/D/13/4	BS/91/6	Sh/10/5	A/8/128	BT2
Treatment mean	1384.24	1349.8	1201.47	1203.06	1048.46

Treatment difference- Significant (LSD value at 5% level of significance= 201.63)

The analytical results revealed that all test clones are comparable in terms of yield. The estimated made tea production in kg/ha is presented in Fig. 10. The cup quality of made tea for all the test clones were assessed organoleptically and average scores are presented in Table 18.

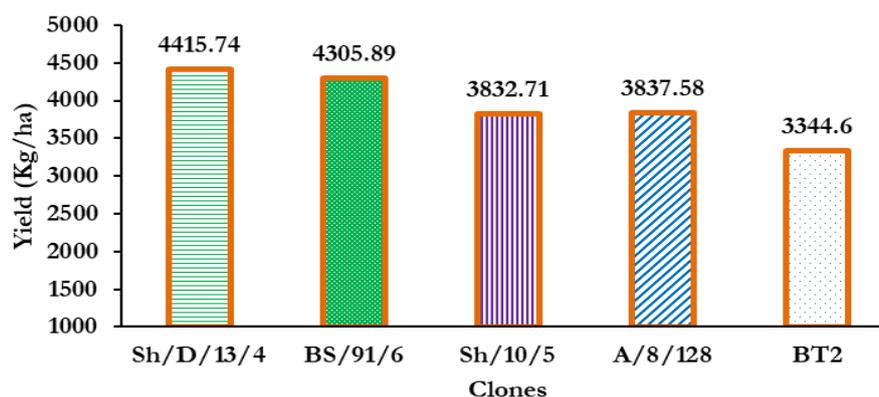


Fig. 10. Comparative yield of clones made tea (kg/ha)

Table 18. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
Sh/D/13/4	7.51	7.27	7.53	7.39	2.84	32.54	AA
BS/91/6	7.52	7.39	7.31	7.47	2.82	32.51	AA
Sh/10/5	7.42	7.64	7.43	7.51	2.78	32.78	AA
A/8/128	7.54	7.51	7.43	7.53	2.71	32.72	AA
BT2	7.37	7.53	7.39	7.43	2.86	32.58	AA

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

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

B2-50: Yield and Quality Trial of Three Test Clones Selected from Baraoorah T.E. and Shumshernugger T.E.; Test Clones – B/8/79, Sh/9/43 and B/8/93 against Standard BT2 and BT17 (BTRI, 2014-2032).

The plants were medium light pruned at 53 cm in 2021 and there were 28 plucking rounds during the cropping period. Recommended doses of fertilizer & usual cultural practices were applied. The yield data were analyzed and presented in Table 19.

Table 19. Yield of green leaves

Clone	BT17	B/8/79	Sh/9/43	B/8/93	BT2
Treatment mean	725.31	876.81	878.72	932.79	756.6

Treatment difference- Significant (LSD value at 5% level of significance= 73.48)

The analytical results revealed that all the test clones gave significantly higher yield than the control. The estimated made tea production in kg/ha is presented in Fig. 11. The cup quality of made tea for all the test clones were assessed organoleptically and average scores are presented in Table 20.

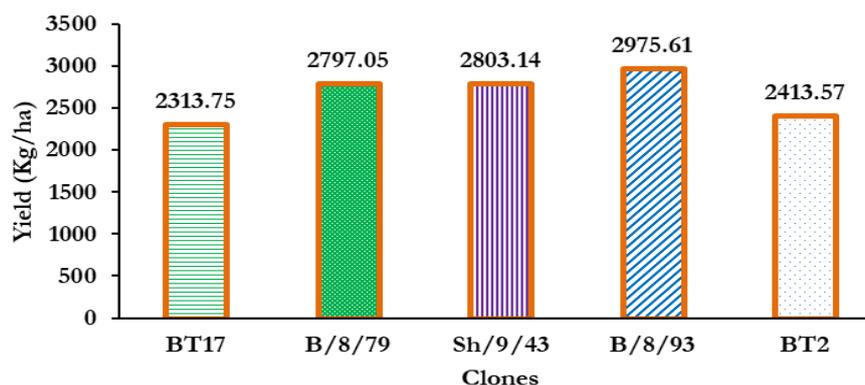


Fig. 11. Comparative yield of clones made tea (kg/ha)

Table 20. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
BT17	7.27	7.43	7.46	7.43	2.72	32.31	AA
B/8/79	7.42	7.23	7.52	7.41	2.83	32.41	AA
Sh/9/43	7.49	7.34	7.63	7.29	2.62	32.37	AA
B/8/93	7.58	7.53	7.27	7.41	2.35	32.14	AA
BT2	7.57	7.52	7.17	7.52	2.68	32.46	AA

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

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

B2-51: Yield and Quality Trial of Two Test Clones Selected from Amo T.E., and Shumshernugger T.E.; Test Clones – A/8/194 and Sh/9/65 against Standard BT2, BT17 and BTS1. (BTRI, 2015-2032).

The plants were light pruned at 55 cm in 2021 and there were 26 plucking round during the cropping period. Recommended doses of fertilizer & usual cultural practices were applied. The yield data were analyzed and presented in Table 21.

Table 21. Yield of green leaves

Clone	BTS1	A/8/194	Sh/9/65	BT17	BT2
Treatment mean	578.76	814.26	800.21	677.83	723.86

Treatment difference- Significant (LSD value at 5% level of significance= 38.82)

The analytical results revealed that all the test clones gave higher yield than the control. The estimated made tea production in kg/ha is presented in Fig. 12. The cup quality of made tea for all the test clones were assessed organoleptically and average scores are presented in Table 22.

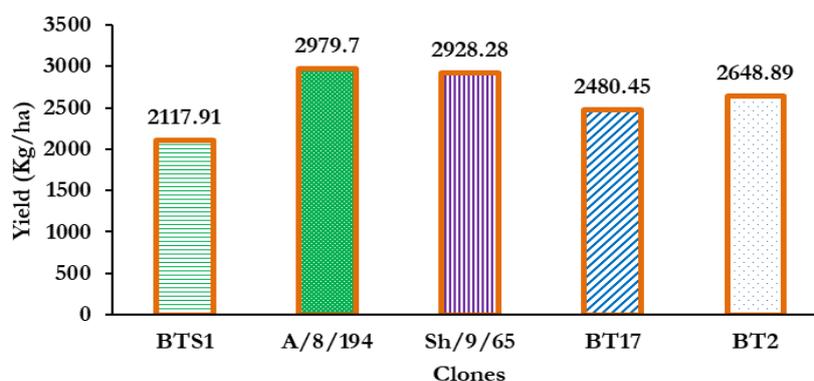


Fig. 12. Comparative yield of clones made tea (kg/ha)

Table 22. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
BTS1	7.27	7.43	7.46	7.41	2.72	32.29	AA
A/8/194	7.43	7.23	7.52	7.45	2.78	32.41	AA
Sh/9/65	7.49	7.37	7.65	7.27	2.59	32.37	AA
BT17	7.31	7.33	7.44	7.44	2.64	32.16	AA
BT2	7.43	7.64	7.39	7.37	2.84	32.67	AA

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

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

B2-52: Yield and Quality Trial of Four Test Clones Selected from Amo T.E., Baraoorah T.E., and Shumshernugger T.E.; Test Clones–B/8/97, B/8/101, Sh/9/71 and A/8/217 against Standard BT2 (BTRI, 2017-2034).

The trial was initiated in May 2017 at BTRI farm under Latin Square Design with 105cm x 60cm spacing. The plants were FFP-2 pruned at 45 cm in 2021. Recommended doses of fertilizer & usual cultural practices were applied. The yield data were analyzed and presented in Table 23. The analytical results revealed that all the test clones gave significantly higher yield than the control.

Table 23. Yield of green leaves

Clone	B/8/97	Sh/9/71	A/8/217	B/8/101	BT2
Treatment mean	302.59	284.81	311.34	255.53	207.82

Treatment difference- Insignificant

The estimated made tea production in kg/ha is presented in Fig. 13. The cup quality of made tea for all the test clones were assessed organoleptically and average scores are presented in Table 24.

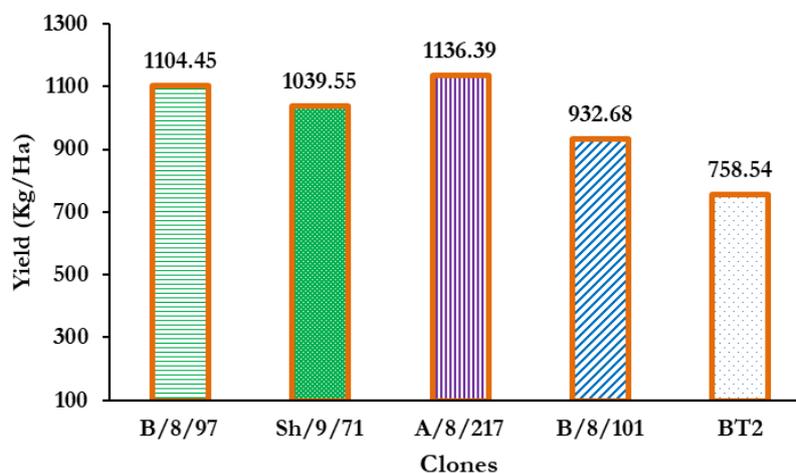


Fig. 13. Comparative yield of clones made tea (kg/ha)

Table 24. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
B/8/97	7.21	7.63	7.32	7.16	3.13	32.45	AA
Sh/9/71	7.23	7.33	7.45	7.31	2.84	32.16	AA
A/8/217	7.32	7.46	7.41	7.32	2.52	32.03	AA
B/8/101	7.33	7.59	7.53	7.41	2.89	32.75	AA
BT2	7.25	7.71	7.55	7.32	3.21	33.04	AA

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

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

B2-53: Yield and Quality Trial of Four Test Clones Selected from Amo T.E., Baraoorah T.E., and Shumshernugger T.E.; Test Clones–B/8/131, B/8/144, Sh/9/85 and A/8/254 against Standard BT2 (BTRI, 2017-2034).

The trial was initiated in May 2017 at BTRI farm under Latin Square Design with 105cm x 60cm spacing. The plants were skiffed pruned at 45 cm in 2021. Recommended doses of fertilizer & usual cultural practices were applied. The yield data were analyzed and presented in Table 25. The analytical results revealed that all the test clones gave significantly higher yield than the control.

Table 25. Yield of green leaves

Clone	B/8/131	B/8/144	Sh/9/85	A/8/254	BT2
Treatment mean	261.45	233.52	197.61	265.72	195.46

Treatment difference- Significant (LSD at 5%=13.08)

The estimated made tea production in kg/ha is presented in Fig. 14. The cup quality of made tea for all the test clones were assessed organoleptically and average scores are presented in Table 26.

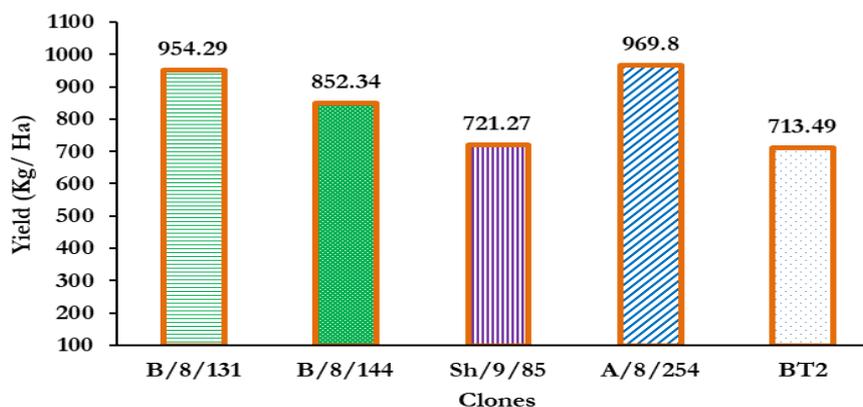


Fig. 14. Comparative yield of clones made tea (kg/ha)

Table 26. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
B/8/131	7.34	7.76	7.33	7.41	2.95	32.79	AA
B/8/144	7.25	7.78	7.44	7.51	2.85	32.83	AA
Sh/9/85	7.27	7.53	7.61	7.43	2.93	32.77	AA
A/8/254	7.31	7.47	7.31	7.25	2.98	32.32	AA
BT2	7.37	7.59	7.38	7.72	2.96	33.02	AA

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

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

B2-54: Yield and Quality Trial of Four Test Clones Selected from Rajghat T.E. (Biddyabil Division), Amrail T.E., and Madhabpur T.E.; Test Clones–P/RJG/8/80, P/AML/14/98, P/RJG/11/106 and P/MDP/13/70 against Standard BT2 (BTRI, 2019-2036).

A long-term experiment was initiated at Bilashcherra Farm in 2019 under Latin Square Design with 105cm x 60cm spacing of plants. Normal cultural practices and timely operations were carried out. Growth of the plants was satisfactory. The experimental plants were FFP-1 pruned at 40 cm. This experiment was initiated under NATP-2 sub project titled as “**Germplasm conservation and farm productivity enhancement through the interaction of shade trees and tea based Agroforestry system to mitigate the climate change**”.

The yield data were analyzed and presented in Table 27. The analytical results revealed that all the test clones gave significantly higher yield than the control.

Table 27. Yield of green leaves

Clone	P/RJG/8/80	P/AML/14/98	P/RJG/11/106	P/MDP/13/70	BT2
Treatment mean	263.63	282.84	258.59	294.16	249.82

Treatment difference- Significant (LSD at 5%=10.57)

The estimated made tea production in kg/ha is presented in Fig. 15. The cup quality of made tea for all the test clones were assessed organoleptically and average scores are presented in Table 28.

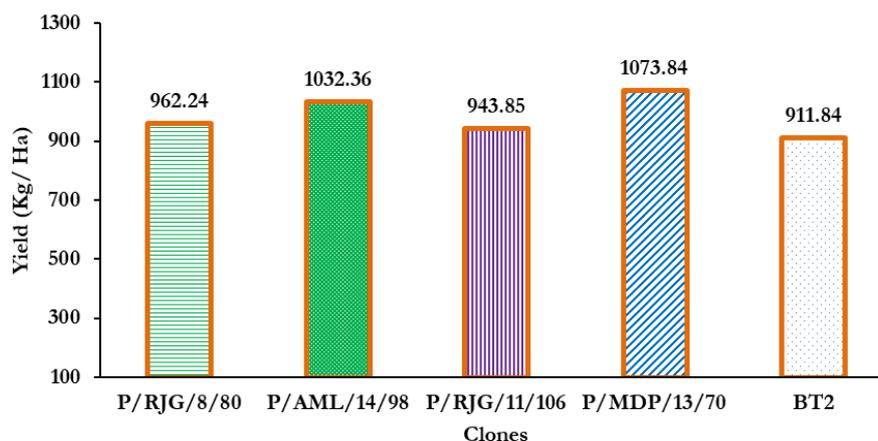


Fig. 15. Comparative yield of clones made tea (kg/ha)

Table 28. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
P/RJG/8/80	7.43	7.35	7.27	7.35	2.85	32.25	AA
P/AML/14/98	7.35	7.51	7.41	7.61	2.88	32.76	AA
P/RJG/11/106	7.34	7.44	7.56	7.35	2.98	32.67	AA
P/MDP/13/70	7.38	7.52	7.33	7.46	2.85	32.54	AA
BT2	7.34	7.61	7.65	7.38	3.09	33.07	AA

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

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

B2-55: Yield and Quality Trial of Four Test Clones Selected from Rajghat T.E. (Biddyabil Division), Kurmah T.E., and Champarai T.E.; Test Clones– P/RJG/6/57, P/KRM/11/46, P/RJG/6/48 and P/CHM/18/79 against Standard BT2 (BTRI, 2019-2032).

A long term experiment was initiated at Bilashcherra Farm in 2019 under Latin Square Design with 105cm x 60cm spacing of plants. The experimental plants were FFP-1 pruned at 40 cm. This experiment was initiated under NATP-2 sub project titled as “**Germplasm conservation and farm productivity enhancement through the interaction of shade trees and tea based Agroforestry system to mitigate the climate change**”.

The yield data were analyzed and presented in Table 29. The analytical results revealed that all the test clones gave significantly higher yield than the control.

Table 29. Yield of green leaves

Clone	P/RJG/6/57	P/KRM/11/46	P/RJG/6/48	P/CHM/18/79	BT2
Treatment mean	276.74	245.43	287.54	246.82	239.65

Treatment difference- Significant (LSD at 5%=15.95)

The estimated made tea production in kg/ha is presented in Fig. 16. The cup quality of made tea for all the test clones were assessed organoleptically and average scores are presented in Table 30.

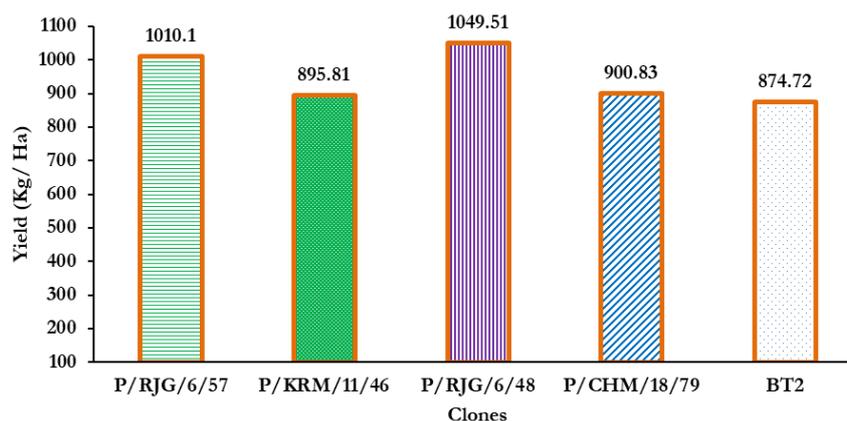


Fig. 16. Comparative yield of clones made tea (kg/ha)

Table 30. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
P/RJG/6/57	7.37	7.53	7.49	7.57	3.11	33.07	AA
P/KRM/11/46	7.48	7.36	7.28	7.47	3.22	32.81	AA
P/RJG/6/48	7.52	7.41	7.23	7.41	2.97	32.54	AA
P/CHM/18/79	7.45	7.54	7.42	7.29	3.15	32.85	AA
BT2	7.35	7.57	7.55	7.42	3.12	33.01	AA

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

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

B2-56: Long term Yield and Quality Trial of Four Test Clones (Multi-location trail) at Amo Tea Estate against Standard BT2 (2019-2032).

The experimental plants were FFP-1 pruned at 40 cm. The yield data were analyzed and presented in Table 31. The analytical results revealed that all the test clones gave significantly higher yield than the control.

Table 31. Yield of green leaves

Clone	A/8/217	A/8/194	Sh/9/65	B/8/93	BT2
Treatment mean	381.56	398.91	372.82	389.25	369.95

Treatment difference- Insignificant

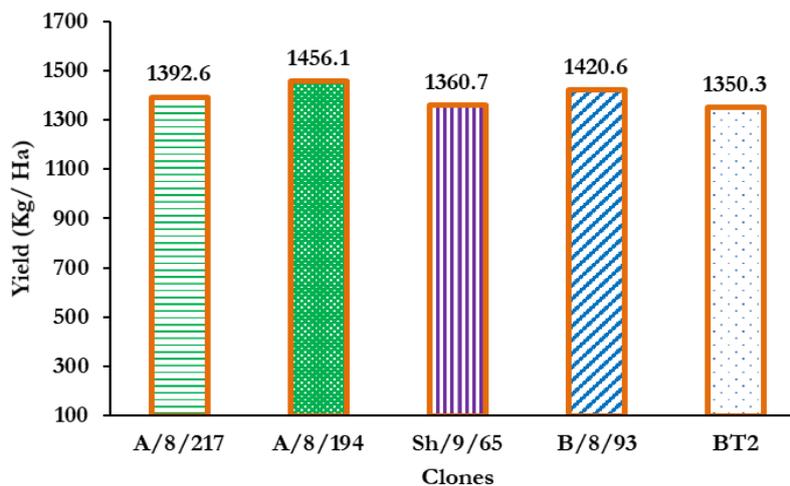


Fig. 17. Comparative yield of clones made tea (kg/ha)

The estimated made tea production in kg/ha is presented in Fig. 17. The cup quality of made tea for all the test clones were assessed organoleptically and average scores are presented in Table 32.

Table 32. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
A/8/217	7.36	7.51	7.39	7.26	3.14	32.66	AA
A/8/194	7.26	7.38	7.33	7.55	2.89	32.41	AA
Sh/9/65	7.29	7.38	7.41	7.35	3.11	32.54	AA
B/8/93	7.33	7.25	7.44	7.31	3.13	32.46	AA
BT2	7.46	7.22	7.44	7.51	2.99	32.62	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

B2-57: Long term Yield and Quality Trial of Four Test Clones (Multi-location trail) at Hafiz Tea Estate against Standard BT2 (2019-2032).

The experimental plants were FFP-1 pruned at 40 cm. The yield data were analyzed and presented in Table 33. The analytical results revealed that all the test clones gave significantly higher yield than the control.

Table 33. Yield of green leaves

Clone	B/8/97	Sh/9/71	B/8/79	Sh/9/43	BT2
Treatment mean	271.53	251.38	256.95	261.58	258.18

Treatment difference- Insignificant

The estimated made tea production in kg/ha is presented in Fig. 18. The cup quality of made tea for all the test clones were assessed organoleptically and average scores are presented in Table 34.

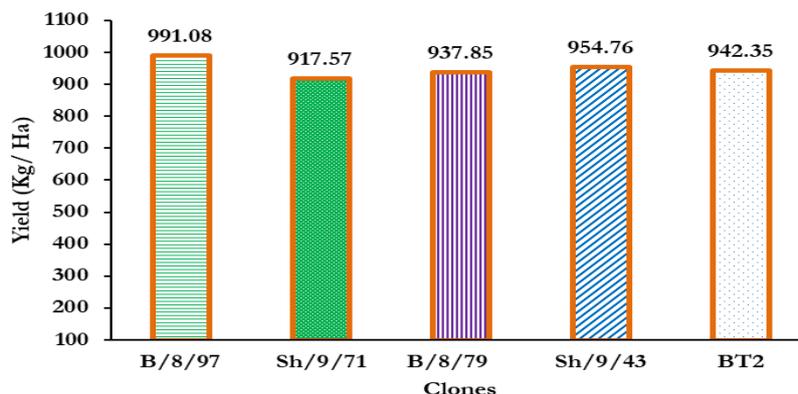


Fig. 18. Comparative yield of clones made tea (kg/ha)

Table 34. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
B/8/97	7.33	7.59	7.55	7.26	3.14	32.87	AA
Sh/9/71	7.25	7.44	7.32	7.31	2.96	32.28	AA
B/8/79	7.35	7.51	7.25	7.34	3.12	32.57	AA
Sh/9/43	7.31	7.54	7.83	7.22	2.91	32.81	AA
BT2	7.45	7.55	7.53	7.27	3.22	33.02	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

B2-58: Yield and Quality Trial of Four Test Clones Selected from Chandbagh T. E. , Teliapara T.E., (Satchori Division), Kapnapahar T. E., Madhabpur T. E.; Test Clones– P/CHB/18/67, P/TLP/5/58, P/KPR/56 and P/MDP/12/41 against Standard BT20 (BTRI, 2019-2032).

A long term experiment was initiated at BTRI Farm in 2019 under Randomized Complete Block Design with 100cm x 60 cm spacing of plants. This experiment was initiated under NATP-2 sub project titled as **“Germplasm conservation and farm productivity enhancement through the interaction of shade trees and tea based Agroforestry system to mitigate the climate change”**. The experimental plants were FFP-1 pruned at 40 cm. The yield data were analyzed and presented in Table 35. The analytical results revealed that all the test clones gave significantly higher yield than the control.

Table 35. Yield of green leaves

Clone	P/CHB/18/67	P/TLP/5/58	P/KPR/56	P/MDP/12/41	BT20
Treatment mean	221.45	251.68	248.84	254.71	219.27

Treatment difference- Insignificant

The cup quality of made tea for all the test clones were assessed organoleptically and average scores are presented in Table 36.

Table 36. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
P/CHB/18/67	7.33	7.12	7.35	7.26	3.22	32.28	AA
P/TLP/5/58	7.35	7.25	7.22	7.39	3.21	32.42	AA
P/KPR/56	7.23	7.33	7.55	7.33	3.23	32.67	AA
P/MDP/12/41	7.24	7.36	7.65	7.38	3.25	32.88	AA
BT20	7.34	7.36	7.62	7.43	4.28	34.03	E

B2-59: Yield and Quality Trial of Four Test Clones Selected from Monipore T. E., Amrail T. E., Rajghat T.E. (Biddyabil Division); Test Clones– P/MPR/16a/99, P/AML/12/20, P/MPR/16a/78 and P/RJG/6/19 against Standard BT15 (BTRI, 2019-2032).

A long term experiment was initiated at BTRI Farm in 2019 under Randomized Complete Block Design with 100 cm x 60cm spacing of plants. This experiment was initiated under NATP-2 sub project titled as **“Germplasm conservation and farm productivity enhancement through the interaction of shade trees and tea based Agroforestry system to mitigate the climate change”**. The experimental plants were FFP-1 pruned at 40 cm.

The yield data were analyzed and presented in Table 37. The analytical results revealed that all the test clones gave significantly higher yield than the control.

Table 37. Yield of green leaves

Clone	P/MPR/16a/99	P/AML/12/20	P/MPR/16a/78	P/RJG/6/19	BT15
Treatment mean	178.53	166.95	175.99	196.25	171.33

Treatment difference- Insignificant

The cup quality of made tea for all the test clones were assessed organoleptically and average scores are presented in Table 38.

Table 38. Quality scores

Clone	Infusion	Liquor colour	Briskness	Strength	Creaming down	Total	Remarks
	10	10	10	10	10	50	
P/MPR/16a/99	7.21	7.64	7.31	7.15	3.2	32.51	AA
P/AML/12/20	7.32	7.37	7.32	7.33	2.83	32.17	AA
P/MPR/16a/78	7.32	7.43	7.42	7.31	2.56	32.04	AA
P/RJG/6/19	7.35	7.61	7.52	7.41	2.86	32.75	AA
BT15	7.27	7.71	7.54	7.33	4.26	34.11	E

B2-60: Yield and Quality Trial of Three Test Clones Selected from Bethelpara para and Lairunpi para from Ruma Upazila of Bandarban District; Test Clones– P/RU/LAI/13, P/RU/BTL/49 and P/RU/LAI/53 against Standard BT19 (BTRI, 2020-2033).

A long term experiment was initiated at BTRI Farm in 2020 under Randomized Complete Block Design with 100 cm x 60 cm spacing of plants. This experiment was initiated under NATP-2 sub project titled as **“Germplasm conservation and farm productivity enhancement through the interaction of shade trees and tea based Agroforestry system to mitigate the climate change”**.

B2-61: Yield and Quality Trial of four Test Clones; Test Clones– P1, P2, P3 and P4 against Standard BT2 (BTRI, 2021-2033).

A long term experiment was initiated at BTRI Farm in 2020 under Randomized Complete Block Design with 100 cm x 60 cm spacing of plants. This experiment was initiated under NATP-2 sub project titled as

“Germplasm conservation and farm productivity enhancement through the interaction of shade trees and tea based Agroforestry system to mitigate the climate change”.

B2-62: Yield and Quality Trial of Three Test Clones; Test Clones– A1, A2 and A3 against Standard BT13 (BTRI, 2021-2033).

A long term experiment was initiated at BTRI Farm in 2020 under Randomized Complete Block Design with 100 cm x 60 cm spacing of plants. This experiment was initiated under NATP-2 sub project titled as “Germplasm conservation and farm productivity enhancement through the interaction of shade trees and tea based Agroforestry system to mitigate the climate change”.

B3: BREEDING OF TEA (NO. OF EXPERIMENTS-8)

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 parents was done in 2020:

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.

Crossing compatibilities and germination:

Table 39: Crossing compatibilities and germination

Crossing combination		No. of pollinations	No. of fruit set	Fruit setting (%)	No. seeds germinated	Germination (%)
Receiver	Donor					
TV18	x BT3	64	47	73.43	27	57.44
BT4	x TV1	58	49	84.48	34	69.38
TV26	x BT6	59	44	74.57	34	83.67
TV19	x BT3	62	50	80.64	45	80.76
BT2	x TV9	45	33	73.33	18	78.72
TV19	x TV1	47	21	44.68	13	77.27
BT2	x BT17	55	48	87.27	31	76.27
BT10	x TV26	33	18	54.54	11	75.67
TV26	x BT10	38	22	57.89	12	72.97
BT12	x TV26	47	37	78.72	28	67.85
TV1	x BT2	68	51	75.00	46	66.66
TV1	x TV19	38	24	63.15	16	64.58
BT4	x TV26	53	39	73.58	24	64.58
TR1	x BT2	62	46	74.19	29	63.04
TV1	x BT4	42	28	66.66	19	61.9
BT2	x TR1	36	19	52.77	11	61.53
BT6	x TV26	38	16	42.10	8	61.11
TV23	x BT2	73	59	80.82	45	57.89
TV26	x BT12	59	48	81.35	31	55.26
BT2	x TV23	63	52	82.53	46	88.46
TV19	x BT2	57	37	64.91	27	54.54
TV9	x BT2	29	11	37.93	5	50
BT2	x TV19	52	38	73.07	21	48.27
TV26	x BT4	50	29	58.00	14	45.45

Highest Percentages of fruit setting was found in BT2 X BT17 (87.27%) and Highest Percentages of germination was found in BT2 X TV23 (88.46%).

B3-1.3: Establishment of polyclonal seedbaries according to the proposed model by the Institute and observation on the open pollinated progenies.

Saplings of BT1, BT2, BT3, B207/39, BS1/3, BS1/4 and TV1 were raised in Botany nursery. Due to insufficient demand of polyclonal seedbaries by the tea estates, no polyclonal seedbarie was established in 2021.

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 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.

B3-8: Survey and Conservation of Gene Resources of Tea in Bangladesh (BTRI, 1981-)

Plants having fourteen special attributes like leaf color and size, seed bearing habit, disease pest tolerant, plant types etc. were collected from the different tea estates. Planting materials were raised in the nursery and afterwards planted in the field to observe the response of these diverse agrotypes and finally conserved in BTRI Tea germplasm center. Proper care and attention were given to this experiment.

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.

B3-11: Detailed survey and assessment of tea seed baries in Bangladesh (1985-).

a. Survey and isolation of mother bush of breeding value in Parkul Tea Estate Seed Barie (2019-2022).

In 2021, seven mother bushes having breeding value were selected. Cuttings and seeds were collected. These were kept under observation.

b. Survey and isolation of mother bush of breeding value in Monipore Tea Estate Seed Barie (2019-2022).

In 2021, five mother bushes having breeding value were selected. Cuttings and seeds were collected. These were kept under observation.

c. Survey and isolation of mother bush of breeding value in Merina Tea Estate Seed Barie (2019-2022).

In 2021, three mother bushes having breeding value were selected. Cuttings and seeds were collected. These were kept under observation.

B3-12: Morphological characterization of BTRI released clones, some test clones and wild genotypes.

A total of 25 accessions (20 BTRI released clones, 4 test clones and 1 wild genotype) were planted in the nursery to observe their rooting performance and to evaluate their rooting character. Details data will be published after completion of the experiment.

B4: SHORT TERM/MID TERM EXPERIMENTS (NO. OF EXPERIMENTS-9)

B4-10: Effect of drought on morpho-physiological and water relations traits in tea clones at nursery level (2019-).

Striking Percentage of rooted cuttings, Chlorophyll Stability Index (CSI), Relative Leaf Water Content (RWC) and water relation parameters, Proline content, Poly-phenol content, Vertical Depth of Root,

Root Shoot Ratio, Total primary and secondary root length were assessed to screen drought hardy/ drought tolerant plant in nursery condition.

B4-11: Effect of drought on morpho-physiological and water relations traits in tea clones at field level.

Chlorophyll Stability Index (CSI), Relative Leaf Water Content (RWC), Proline content, Poly-phenol content, Rate of Photosynthesis, Transpiration loss, Water Use Efficiency, Leaf Water Potential, Vertical Depth of Root, Root Shoot Ratio, Total primary and secondary root length, Total dry matter production, 100 Shoot weight, Number of branching, Pruning Recovery, number of bullation, number of serration, Number of Pubescence and Wight of pruning litter/ bush at FFP-1 & FFP-2, Average Leaf area were assessed to screen drought hardy/ drought tolerant plant in field condition.

B4-12: Sustainable protocol development of artisan tea and different kinds of value added tea.

The protocol of manufacturing and processing of Jasmine Flavored Tea and Rose Flavored Tea were optimized and standardized. Details data will be published after completion of the experiment.

B4-13: Amendment of existing of tea plantation area and standardization of new extension plantation area by using BTRI released clones for manufacturing better cup quality tea in Northern region of Bangladesh. (2022-)

This experiment will be started very soon.

B4-14. Impact of Biokad and micronutrients on productivity and sustainable tea farming (2021-).

Research activities will be continued to 2022 and detailed data will be published after completion of the experiment.

B4-15. Fabrication and characterization of polymer matrix composite based on tea waste and different polymer (2021-).

Research activities will be continued to 2022 and detailed data will be published after completion of the experiment.

B4-16. Estimation of simple equation for measuring Leaf Area of BTRI released individual clones and biclones (2021-).

Research activities will be continued to 2022 and detailed data will be published after completion of the experiment.

B4-17. Effect of number of tea leaf pubescence and rate of fermentation on made tea quality of BTRI released clones & biclones (2021-).

Research activities will be continued to 2022 and detailed data will be published after completion of the experiment.

B4-18: Impact of blending on commercial tea cultivar on black tea quality along with price. (2021-)

This experiment will be started very soon.

Summary of activities of Botany Division-2021

1. No. of Experimental, Advisory and Official Visit: 25
2. Correspondence: 93
3. Tea Tasting Course/ Session: 07

Date	Type	Venue	Participants/ Number of Tea Estate
19.09.21- 30.09.21	Army & Navy Tea Tasting	BTRI	Participants: 12
26.09.21	Monu-Doloi Valley Tea Tasting Session	BTRI Tea Tasting Room	Number of Tea Estate: 19
26.09.21	Juri Valley Tea Tasting Session	BTRI Tea Tasting Room	Number of Tea Estate: 11
27.09.21	Luskerpore Valley Tea Tasting Session	BTRI Tea Tasting Room	Number of Tea Estate: 20
27.09.21	Lungla Valley Tea Tasting Session	BTRI Tea Tasting Room	Number of Tea Estate: 15
28.09.21	Balishira Valley Tea Tasting Session	BTRI Tea Tasting Room	Number of Tea Estate: 15
28.09.21	North Sylhet Valley Tea Tasting Session	BTRI Tea Tasting Room	Number of Tea Estate: 11

4. Received Tea Sample Tasting: 1566
5. Quantity of planting material supplied:

Rooted cutting (nos.)	Seasonal Bi-clonal seeds (kg)
2717	722

AGRONOMY DIVISION

Dr. Toufiq Ahmed
Principal Scientific Officer

RESEARCH

A total of 09 experiments were approved in the last Research Sub Committee (RSC) meeting for the year 2021 under two research program areas such as (i) standardization of cultural practices and (ii) development of soil fertility. Among the 09 experiments, 07 were conducted in 2021 and rest 02 could not be started due to some unavoidable circumstances. Results of the experiments are briefly discussed below-

Experiment 1: Development of a new pruning cycle for higher sustainable tea yield in the context of present climate change (BTRI Farm; Long term: 2010-2023).

Treatments: 05

- 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.

Progress: The plants were pruned according to the schedule of treatments. Yield data were collected as green leaf from the plots. From the analysis result of yield data obtained in 2021, it was observed that significantly highest yield was obtained in the treatment T₅ and that was followed by T₁, T₄, and T₂; and the lowest yield was obtained in T₃ (Table 1). Statistically, the highest yield from T₅ is comparable with the yield from T₄ and T₁. The lowest yield in T₃ is also comparable with all the treatments except T₅. These differences in yields were due to the differences in the given pruning operations. The interaction effect between the clone and treatment was not significant (Figure 1). From overall analysis (2010-2021) it is observed that longer pruning cycles are providing higher yield of tea (Figure 2). It is noted that the 7-years long pruning cycle (T₅) gave 19.70% more yield compared to the existing BTRI recommended 4-years pruning cycle (T₂). The experiment will be continued till 2023. Final comments will be made thereafter.

Table 1. Made tea yield (kg/ha) of different treatments in 2021

Treatments	Yield (kg/ha)
T ₁ (LP-DS-MS)	4628 ab (DS)
T ₂ (LP-DS-MS-LS)	4231 b (MS)
T ₃ (LP-LS-DS-MS)	4185 b (DS)
T ₄ (LP-LS-DS-MS-DS-LS)	4384 ab (DS)
T ₅ (LP-DS-MS-LS-DS-MS-LS)	4851 a (LS)
LSD (0.01)	496.3
CV (%)	12.46

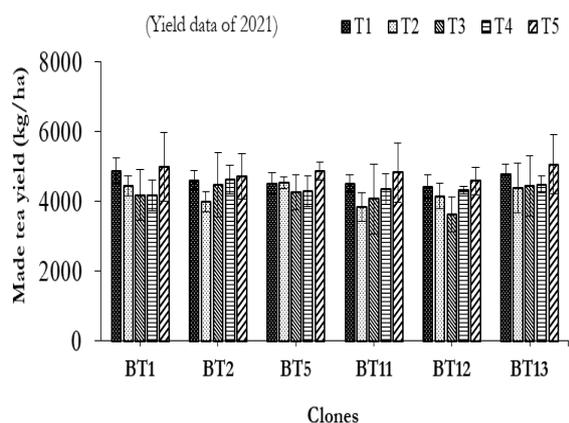


Figure 1. Interaction effect of different clones with different treatments in 2021.

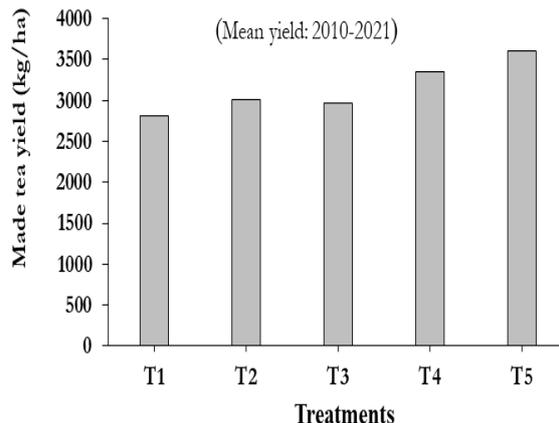


Figure 2. Average yield of made tea (kg/ ha) in different treatments from 2010-2021.

Experiment 2: Effects of different types of composts on growth and development of clonal tea (BTRI Main Farm, Duration: 2017-2022).

Treatments: 04

- T₁ : Applied 2 kg vermi-compost per pit during the plantation
- T₂ : Applied 2 kg farm-yard compost per pit during the plantation
- T₃ : Applied 2 kg decomposed water hyacinth per pit during the plantation
- T₄ : Applied 2 kg decomposed cowdung per pit during the plantation (Control)

The experiment was set as a Randomized Complete Block Design (RCBD) with 04 replications. Year 2021 was the 4th year of young tea plants and pruning height of these plants were 18 inches from the ground. Data were collected on the harvested green leaf yield from each plot and number of branches per plant. For the interpretation of results, green leaf yield of each plot was converted as made tea yield (kg/ha).

Progress:

After analyzing the yield data of 2021, it was observed that yield was not significantly different for treatments at $p=0.05$. Among the treatments, maximum yield was observed in T₄ (1145 kg/ha) which was statistically similar with others (Figure 3). Number of branches was also found higher in T₄.

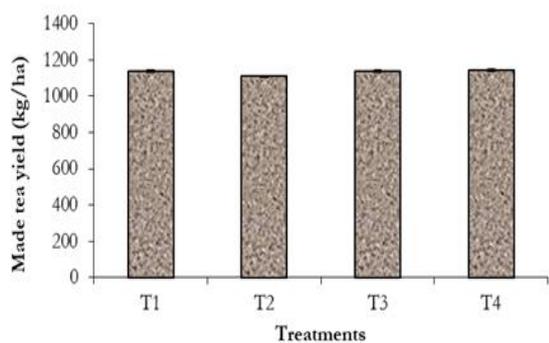


Figure 3. Variation of made tea yield due to treatments

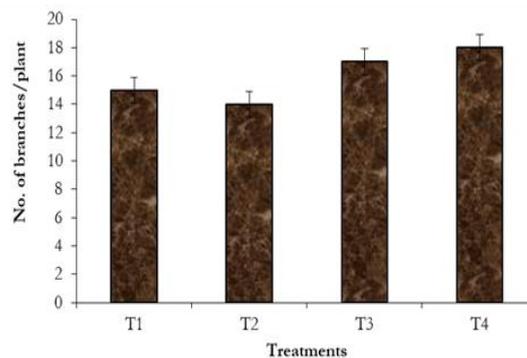


Figure 4. Number of branches in different treatments

Experiment 3: Mechanization in pruning and its impact on the yield of tea (BTRI Main Farm; Duration: 2019-2022)

Objectives:

- To check the impact of pruning mechanization on the yield of tea.
- To find out the best pruning policy using pruning/trimming machines.

Treatments: Different pruning policies using the machine and traditional pruning knife (Figure 5) were the different treatments of the experiment. The traditional method of pruning using pruning knife was the control treatment. Three pruning policies were tested on four different types of pruning operations (LP, DSK, MSK and LSK).

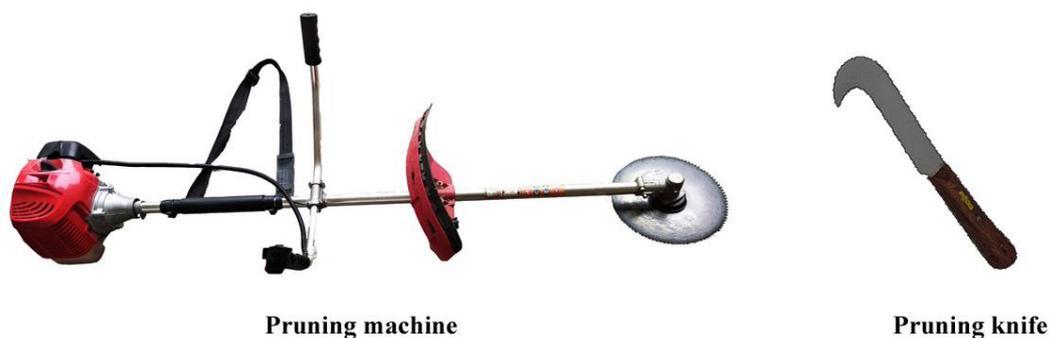


Figure 5. Photos of the pruning machine and the traditional pruning knife

a) Different pruning policies-

- T₁ : Manual pruning using traditional pruning knife (Control)
- T₂ : Machine pruning only
- T₃ : Machine pruning followed by manual repairing

b) On different types of pruning-

- Light Pruning (LP)
- Medium Skiff (MSK)
- Deep Skiff (DSK)
- Light Skiff (LSK)

Data collection method:

Different pruning policies were being implemented in the field on different types of pruning. The following data were collected during the experimentation-

- Number of pruned bushes/hour
- Input (labour, fuel etc) requirement for different pruning policies
- Yield data

Progress: The experiment was initiated at BTRI main farm on December 2019. A mature tea field of BT2 was used for the experiment. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications and total number of plots under the experiment is 36. According to the treatments, all the pruning operations were completed in between December 2020 to February 2021. Data were collected for comparing the efficiency between machine and manual pruning (Table 2 and Table 3). Yield data were also collected to evaluate the yield variations due to different pruning policies employed, which is shown in the Figure 6. From the result it was noticed that there was no significant

difference in yield between traditional manual pruning and machine pruning. In machine pruning, yield slightly decreased in case of LSK pruning; but for all other pruning types (LP, DSK and MSK), the yield either increased or remained almost equal compared to traditional pruning. According to pruning types, fuel consumption of the machine varied from 0.27 to 0.37 liter/hour. Per hectare fuel consumption was highest for LP (59.26 liter/hectare) and lowest for LSK (33.33 liter/hectare). Compared to traditional manual pruning, machine pruning helped to complete the task 3.15-5.01 times quicker. The experiment will be continued.

Table 2. Comparison of efficiency between machine pruning and manual pruning

Pruning Type	Machine Pruning*		Manual Pruning (On the basis of tasks**)		Ratio (Machine: Manual) (on the basis of required time/ha)
	No. of bushes pruned per hour	Time required to prune one hectare area (Hours)	No. of bushes pruned per hour	Time required to prune one hectare area (Hours)	
LP	55	207	15	1038	1 : 5.01
DSK	113	106	31	498	1 : 4.70
MSK	113	98	44	356	1 : 3.63
LSK	118	99	50	312	1 : 3.15

** Two people was involved for each machine for taking rest and to do the work alternatively.

** Considering, manual pruning task LP-120 plants, DSK-250 plants, MSK-350 plants, and LSK-400 plants per man-days; 8 working hours per man-days; 15576 plants per hectare.

Table 3. Fuel consumption in machine pruning (continuous run)

Pruning Type	Fuel consumption per hectare (Octane in liter)	Fuel consumption per hour (Octane in liter)
LP	59.26	0.27
DSK	35.19	0.34
MSK	37.04	0.37
LSK	33.33	0.34

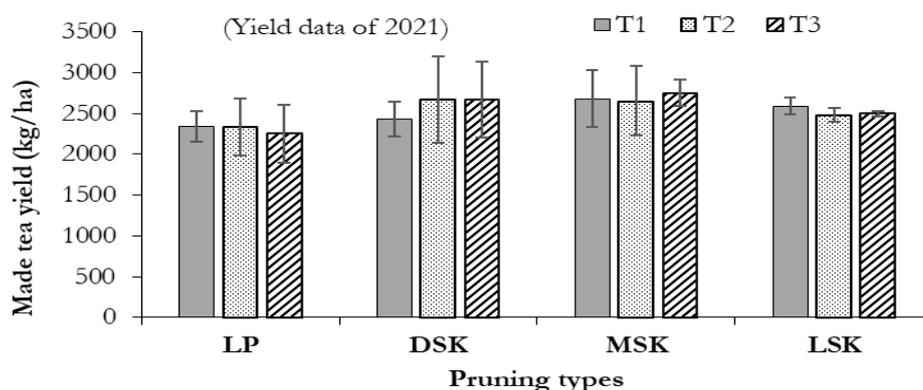


Figure 6. Yield of tea under different treatments on various pruning types in 2021.

Experiment 4: Implementation of grafting technique to produce composite tea plant in the nursery for increasing yield and drought resistance capacity of the plant (V.P Nursery, BTRI Main Farm, Duration: 2020-2022)

Objectives: To develop drought resistant tea plants as well as to increase the yield.

Treatments: 04 (Four)

T₁ : BT2

T₂ : BT12

T₃ : BT15

T₄ : BT17

Scions were collected from BTRI released high yielding clonal tea plants as fresh cuttings and used as treatments. Bi-clonal seedling tea plants were used as 'root stocks' for all the treatments. Randomized block design is followed having four replications. In each replication there were 50 seedlings for this study.

Results:

After analyzing the collected data of 2021, it was observed that sprouting percentage was not significantly different for treatments. Similarly, it was observed that the success of grafting after four months was not significantly different for treatments (Table 4).

Table 4. Sprouting (%) in treatments at the beginning and success (%) observed after four months

Treatments	Sprouting percentage (Mean)	Success percentage (Mean) after 4 months
T ₁ = BT2	90.80	87.60
T ₂ = BT12	96.40	87.20
T ₃ = BT15	87.60	80.80
T ₄ = BT17	94.40	89.60
Mean	92.30	86.30
CV (%)	18	20
LSD (p=0.05)	21.84	23.96

Data was also collected on emerged shoot length for each grafted plants. After analysis of data, it was observed that shoot extension rate (mm/month) was significantly different for treatments. Maximum shoot extension was observed in T₁ (9.20 mm) and the lowest was in T₂ (5.0 mm), showed in the Figure 7.

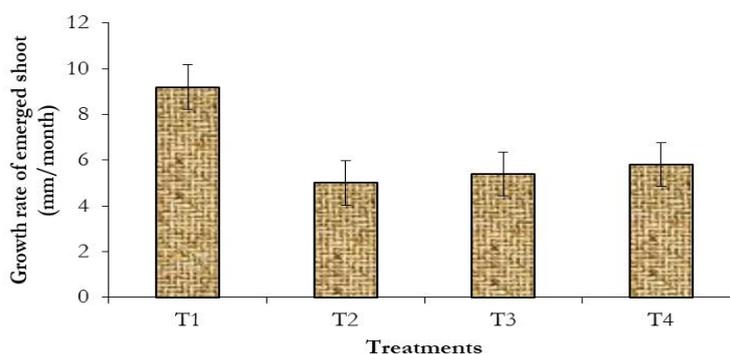


Figure 7. Variation of shoot extension rate due to treatments

Observations/ Comments: The experiment will be continued till December 2022. During this period, data will be collected regularly on different parameters. After completion of the experiment, final results will be presented in detail. Produced composite tea plants will be planted in the main field.

Experiment 5: Effect of different irrigation techniques to irrigate young tea, planted at the hot slope in tillah area (Newly plantation area of Bilashcherra Experimental Farm, BTRI, Duration: 2021-2024).

Justification: In Bangladesh, due to unevenness of seasonal rainfall often causes seasonal drought during the month of November – March. Beside this, the soil of tea gardens particularly in tillah area is thin, poor in water retention, and strong in permeability and therefore the young tea, planted in tillah area severely suffer from drought.

In order to solve the problem, several economic and water-saving irrigation techniques are used in tea gardens and sprinkler irrigation technique is widely used among them. Sprinkler irrigation system is more costly, hard to manage and time consuming.

Therefore, in the present experiment has been carried out to find the effective and economic irrigation system to irrigate young tea, especially young tea planted at the hot slope in tillah area.

Objective (s):

1. To observe the efficacy of different irrigation techniques over the control in southern part of tillah area; and
2. To find out the most effective and economic irrigation techniques for hot slope of tillah area.

Treatments: 05 (five)

- T₁ : No irrigation (Control)
- T₂ : Sprinkler irrigation: 2 hours at 15 days interval
- T₃ : Sprinkler irrigation: 2 hours at 10 days interval
- T₄ : Drip irrigation: 2 hours at 15 days interval and
- T₅ : Drip irrigation: 2 hours at 10 days interval

The experiment was laid out in a Randomized Complete Block Design (RCBD) with 03 replications. Data will be collected on casualty percentage, growth parameters (Number of branches, diameter of branches and bush formation quality), yield etc. Expenditure of different treatments will also be calculated.

Progress: According to the experimental design, the experiment was initiated. Irrigation is going on according to different treatments. At the end of dry period, data on mortality and other physiological parameters will be recorded.

Experiment 6: Effect of a plant growth regulator (FLORA – Nitrobenzene) on growth and yield of mature clonal tea (BTRI Main Farm, Duration: 2021-2022)

Objective (s): To find out the effect of FLORA on growth and yield of tea in Bangladesh.

Treatments: 09 (Nine)

T₁ : Control

T₂ : 2.0 ml Flora/ L H₂O after every plucking round

T₃ : 2.0 ml Flora/ L H₂O after every two plucking round

T₄ : 2.0 ml Flora/ L H₂O after every three plucking round

T₅ : 2.0 ml Flora/ L H₂O after every four plucking round i.e. applied at monthly interval

T₆ : 3.0 ml Flora/ L H₂O after every plucking round

T₇ : 3.0 ml Flora/ L H₂O after every two plucking round

T₈ : 3.0 ml Flora/ L H₂O after every three plucking round and

T₉ : 3.0 ml Flora/ L H₂O after every four plucking round i.e. applied at monthly interval

The experiment was laid out in a completely randomized design with 04 replications. All together there were 36 plots in the experiment and each plot was with 48 mature tea bushes (BT2 clone). The experimental field was under light pruning (LP) operation. Required data (Yield and active shoot percentage) were collected regularly from the experiment during the period 2021.

Results:

After analyzing the collected data of 2021, it was observed that yield was not significantly different for treatments at $p=0.05$. But the yield data showed a positive trend on application of Flora. All treatments of this experiment gave higher yield than the control - T₁, showed in Figure 8. Maximum yield observed in T₆ (3368 kg/ha) which was 379 kg higher than the control - T₁ (2989 kg/ha).

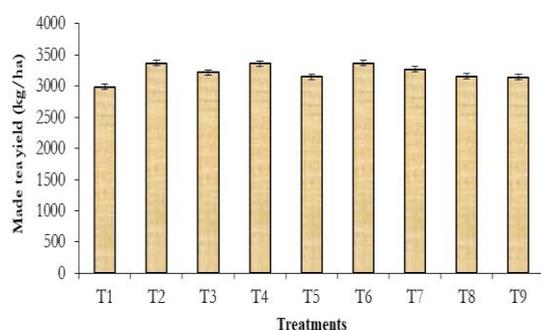


Figure 8. Variation of made tea yield due to treatments

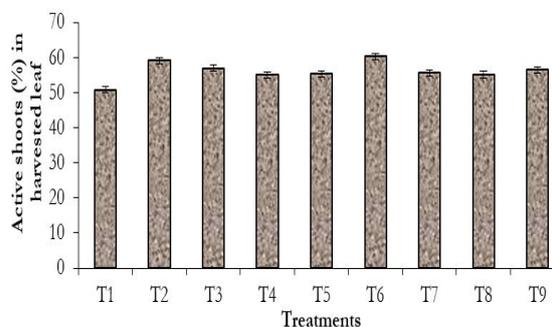


Figure 9. Variation of active shoots in the harvested leaf due to treatments

After analyzing the data on active shoot percentage, it was observed that active shoot percentages in the harvested green leaves were not significantly different for treatments. However, average maximum percentage of active shoots was observed in T₆ (60%) and the lowest was in T₁ (51%), presented in the Figure 9.

Experiment 7: Effect of different plucking rounds on yield and quality of tea at Northern Tea growing area of Bangladesh (Northern Tea Growing Area, Panchagarh, Duration: 2021-2024).

Justification: Recently, Northern Bangladesh is being considered as one of the major tea growing areas for its higher yield and production. It is noticed that the quality of harvested green leaf in this area is not up to the mark and so the quality of made tea is also below the standard. This may be due to longer plucking round; and the growers are practicing it to get maximum green leaves at a time. Most of the growers are harvesting their green leaves by knives or by a plucking machine keeping the plucking round 30-45 days. As a result, most of the harvested green leaves are coarse leaves and total numbers of plucking rounds in a year are only 6 to 8.

Hence, this experiment will be carried out to find out the best plucking system for northern Bangladesh which will ensure the quality and quantity of made tea.

Treatments: 10 (Ten)

T₁ : Manual plucking at 7 days interval (Control)

T₂ : Manual plucking at 15 days interval

T₃ : Manual plucking at 30 days interval

T₄ : Manual plucking at 45 days interval

T₅ : Knife plucking at 15 days interval

T₆ : Knife plucking at 30 days interval

T₇ : Knife plucking at 45 days interval

T₈ : Machine plucking at 15 days interval

T₉ : Machine plucking at 30 days interval and

T₁₀: Machine plucking at 45 days interval.

The experiment will be laid out in a Randomized Complete Block Design (RCBD) with 03 replications. Data on harvested leaf yield will be collected and quality of harvested leaf will be evaluated regularly. Moreover, number of plucking rounds will be counted in a year under each treatment.

Progress: There was a plan to start the experiment in 2021 but due to COVID-19 pandemic, it was not possible to initiate it in due time. Hence, it will be initiated by May 2022.

Experiment 8: Effect of First Frame Formation Pruning of winter planted tea at different times after planting on its growth and survivality (Luskorpore Tea Estate, Luskorpore valley, Habigonj, Duration: 2020-2024).

Objective (s): To identify the appropriate time for first frame formation pruning of young tea and to minimize the time for young tea maintenance period.

Treatments: 7 (Seven)

T₁ : First Frame Formation Pruning in August, 2021

T₂ : First Frame Formation Pruning in September, 2021

T₃ : First Frame Formation Pruning in October, 2021

T₄ : First Frame Formation Pruning in November, 2021

T₅ : First Frame Formation Pruning in December, 2021

T₆ : First Frame Formation Pruning in January, 2022

T₇ : First Frame Formation Pruning in February, 2022

The experiment was laid out in a Randomized Complete Block Design (RCBD) with 03 replications. Data on striking rate (Mortality percentage), growth parameters (Number of branches, base diameter and bush formation quality) and yield will be collected.

Progress: According to the experimental design and operational time frame, the decentering work for all the treatments were completed. Then First Frame Formation Pruning was completed for the treatments T₁ – T₅ in 2021; and the pruning for T₆ and T₇ will be carried out in time in 2022. Corresponding data will be collected and interpreted thereafter.

Experiment 9: Development of a standard young tea pruning schedule for Northern Tea Growing areas of Bangladesh (Northern Tea Growing Area, Panchagarh, Duration: 2021-2027).

Justification: Top-soil of northern Bangladesh is very fertile and so the growth and development of tea plants are faster than the other major tea growing areas of the country. Generally it takes 4 - 5 years to bring young tea into bearing in the established tea growing areas. However, in the Northern part of Bangladesh this duration found much lower due to rich soil and favorable climatic condition. Hence, it is necessary to find out the best pruning schedule for bringing young tea into bearing especially for this part of Bangladesh. The findings of this experiment will help to fix a standard young tea pruning schedule for the Northern tea growing areas of Bangladesh.

Treatments: 04 (four)

Operations	Treatment 1	Treatment 2	Treatment 3	Treatment 4
Decentering/ Breaking at 6-9 inch height	Within 3 months after planting	Within 6 months after planting	BTRI Recommended practice (Control)	Local Practice
Pruning: FFP1 at 14-16 inch height	Within a year after plantation	At the beginning of second year		
Skiff at 20 inch height	At the beginning of second year	At the end of second year		
Pruning: FFP2 at 18-20 inch height	At the end of second year	At the beginning of third year		
Skiff at 28 inch height	At the beginning of third year	At the end of third year		
First Light Pruning (LP) at 20-22 inch height	At the end of third year	At the beginning of fourth year		

The experiment will be laid out in a Randomized Complete Block Design (RCBD) with 03 replications. Data on green leaf yield and other related parameters e.g. number of branch, branching behavior, base diameter etc will be collected regularly. The experiment will be established in a new plantation area. Other intercultural operations and managements like tipping, fertilization and irrigation will be carried out according to BTRI recommendations.

Progress: There was a plan to start the experiment in 2021 but due to COVID-19 pandemic, it was not possible to initiate it in due time. Hence, it will be initiated by May 2022.

OTHER ACTIVITIES

Visits:

Apart from divisional research activities and experimental visits, scientists of the division kept themselves busy to enrich the tea industry through different activities. During the reporting year 2021, researchers of Agronomy division delivered lectures in MTC of PDU, visited different Tea Estates to render advisory services and some other places to accomplish the official tasks which are summarized in Table 5.

Table 5. Number of visit paid by the scientific personnel of the division during the reporting year

Reporting year	No. of advisory visits	No. of other official visits	Delivered lectures at MTC, PDU (Hours)
2021	15	3	30 Hours

Workshop/ Seminar

Researchers of Agronomy division accomplished 4 workshops in different tea estates to disseminate updated technologies among tea growers and planters on pruning, tipping, plucking, drainage, drought management etc.

BTRI Main Farm

Mr. Roni Debnath is the Farm Supervisor of BTRI Main Farm. The institute is spread over an area of 34.90 hectare and breakup of the land is as follows:

Under tea

1. Young clonal tea	: 0.33 ha
2. Mature clonal tea	: 4.64 "
3. Mature seedling tea	: 4.15 "
4. Mother bush, seed bari etc.	: 1.48 "
5. Tea nursery	: 0.62 "

Total : 11.22 ha

Other crops

1) Rehabilitation crops	: 0.16 ha
2) Nursery	: 1.09 "
3) Mixed forest, Orchard, Lemon, Guava etc.	: 5.21 "

Total : 6.46 ha

Other uses

Office, Laboratory, Guest house, Mosque, School, Factory, Club house, labour line, roads etc.	: 17.22 ha
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Grand total : 34.90 ha

Improved planting materials supplied

Year of supply	No. of fresh cuttings	No. of rooted cuttings
2021	518500	15005

Green leaf production and earning from other farm products

Reporting year	Green leaf production in kg	Earning from other farm products in Taka
2021	90867.00	30030.00

Green Leaf Supplied in kg

Reporting year	Central Factory BTRI	Mini Factory BTRI	Green Tea Factory	Total Green Leaf Production
2021	90283.00	-	584.00	90867.00

Independence and Victory Day

National Independence Day and Victory Day were celebrated with due solemnity during the reporting year following the guidelines circulated by the Government due to COVID-19 pandemic.

ENTOMOLOGY DIVISION

Md. Jahangir Alam
Scientific Officer

STAFF

Dr. Mohammad Shameem Al Mamun, Senior Scientific Officer was transferred to BTRI Substation, Panchagarh on 8th March 2017. Mr. Shovon Kumar Paul, Scientific Officer is now in deputation at Malaysia for PhD purpose. The post of Principal Scientific Officer was lying vacant during the period under report. There was no other change in personnel position of the division.

RESEARCH

Four experiments under four programme areas were carried out during the year of 2021. The experiments were - Biopesticides as promising alternatives to chemical pesticides for sustainable management of tea insect pests; Ethoprophos: An alternative chemical options for nematode control in tea; Survey and monitoring of new insect pests in tea due to change in climate: Causes and Remedies; Screening of pesticides against *Helopeltis*, Red spider mite, Termites, Nematodes and Thrips in tea; Details of the experiments together with their findings are furnished below:

ENT 1. BIO-CONTROL OF PESTS

ENT 1.1. Biopesticides as promising alternatives to chemical pesticides for sustainable management of tea insect pests (2019-2024)

Comparative efficacy of microbials and synthetic chemicals for sustainable management of Looper caterpillar

Progress: An experiment was carried out to evaluate the potentiality of three bio-pesticides: botanicals (*Celastrus angulatus*) & microbials (*Bacillus thuringiensis*, *Beauveria bassiana*) and one chemical (Emamectin benzoate) against looper caterpillar infesting tea in laboratory and field condition at Entomology Division and BEF experimental farm, respectively. The Looper caterpillar was collected from different sections of BTRI and BEF farm and reared in the Entomology Laboratory, BTRI, at 27-30°C temperature and 70-80% relative humidity on a tea clone. The looper pests were reared on tea leaves in rectangular jars (9.5 cm x 7.5 cm x 20 cm).

The dosage of *Celastrus angulatus* @ 1.5, 2.5 & 3.5 ml/L, *Bacillus thuringiensis* @ 1.0, 1.5 & 2.0g/L and *Beauveria bassiana* @ 3.0, 5.0 & 7.0 g/L concentrations, respectively are considered as treatments. The treatments were applied to reared larva (2nd & 3rd instar) both at lab and field condition. Data were collected at 24 HAT, 48HAT, 72HAT.

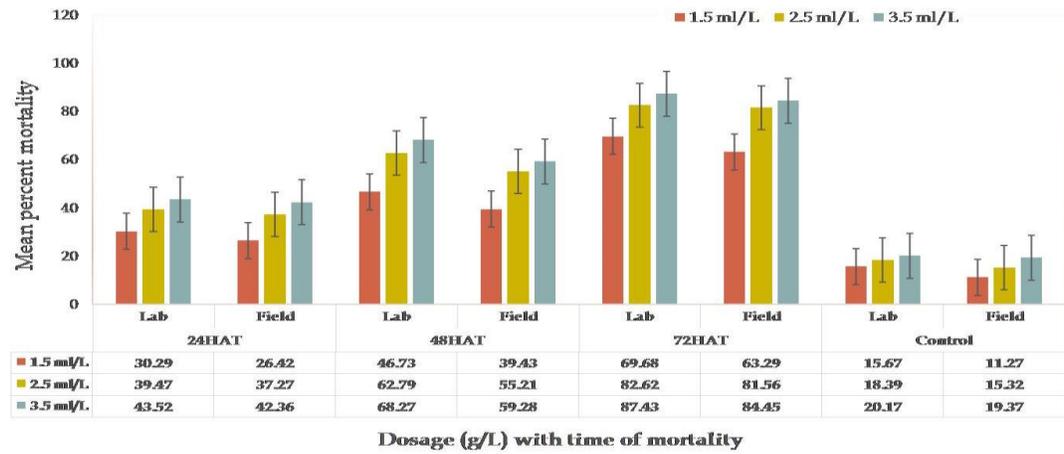


Fig. 1. Percent mortality of looper caterpillar using *Celastrus angulatus*

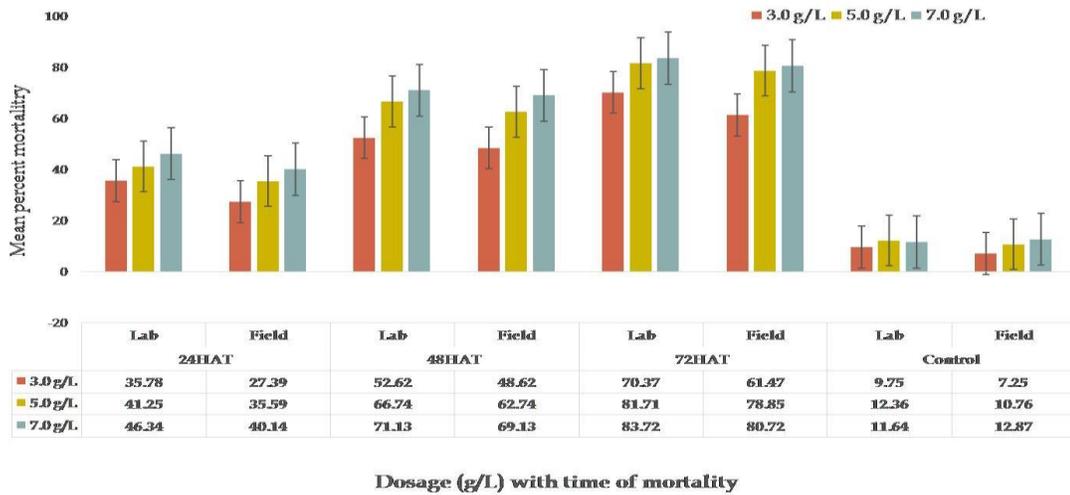


Fig. 2. Percent mortality of looper caterpillar using *Beauveria bassiana*

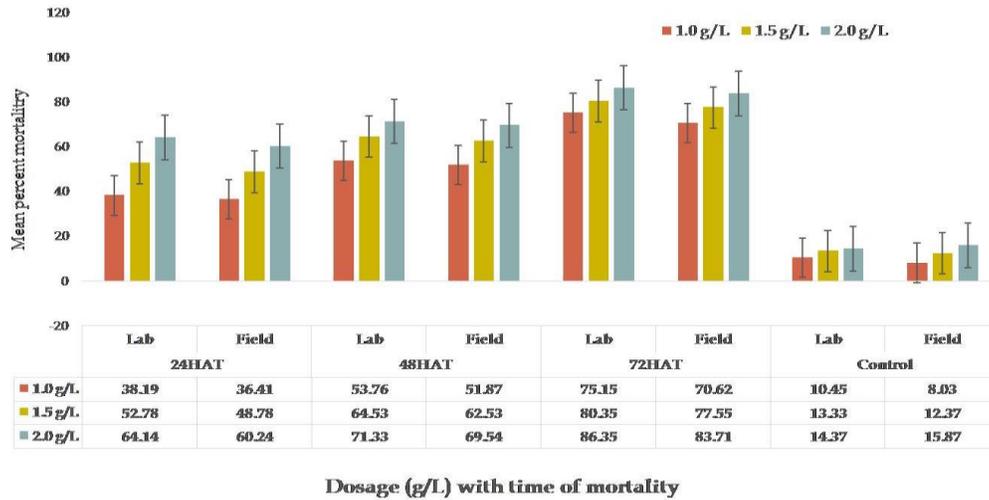


Fig. 3. Percent mortality of looper caterpillar using *Bacillus thuringiensis*

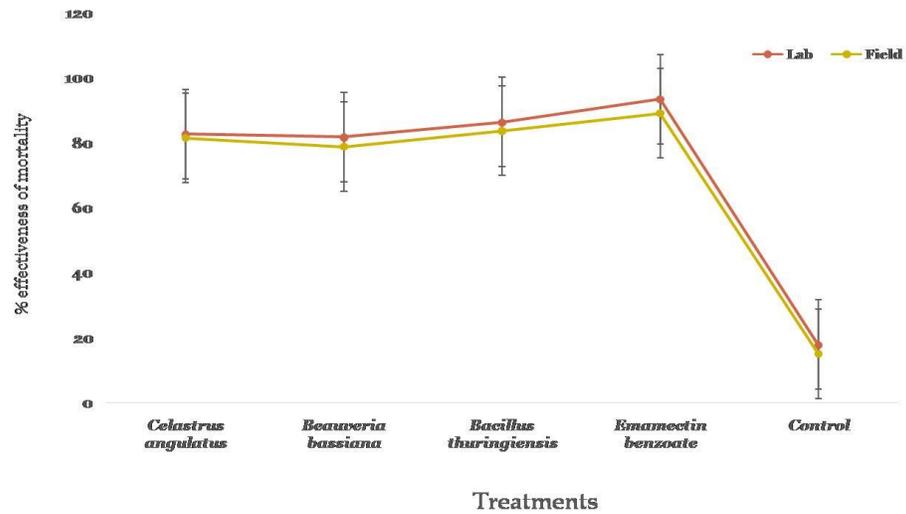


Fig. 4. Comparative effectiveness of tested pesticides

In laboratory condition, the highest mortality (86.35, 82.62 & 81.71%) was found using *Bacillus thuringiensis* (2.0 g/L), *Celastrus angulatus* (2.5 ml/L) & *Beauveria bassiana* (5 g/L) at 72 HAT whereas the mortality down both at 83.71, 81.56 & 78.85% in the field (Fig: 1, 2 & 3). On the other hand, chemical control of looper caterpillar showed average 93.43 to 89.12% mortality over control both in lab and field condition (Fig: 4). Though chemical options is better comparing with others in terms of mortality, bio control is most effective and safe for both target mortality and environment.

ENT 2. Chemical Control

ENT 2.1. Ethoprophos: An alternative chemical option for nematode control in tea (2020-2022)

Progress: An experiment was conducted to evaluate the toxicity of newer nematicides of EC formulation ethoprophos 20% @ 0.5, 0.75 & 1.0 ml/L against plant parasitic nematode in tea. The experiment was conducted at Nematology laboratory and V.P nursery, BTRI. It was laid out in Complete Randomized Design with three replications. The experiment was carried out in three different methods viz, Pot experiment, primary bed experiment & secondary experiment. Pre-treatment observations on the presence of nematodes were made. Second and third round applications were done at 60th days and 120th days respectively. Post treatment observations were recorded at 15 days intervals and thus a total of twelve observations were recorded. Extraction was done by "Bayerman Funnel Method". Data from the trial have been analyzed by using Henderson & Tilton formula.

Pot experiment: In this method, the plastic pot (22 cm dia.) with 5 kg soil was cultured with organic matter or cow-dung and then seedlings were planted in individual pot. Different concentrations of treatments (ethoprophos 20% @ 0.5, 0.75 & 1.0 ml/L) with standard (Carbofuran 5% @ 165 g/m³ soil) were applied directly to soil. The soil was then collected and analyzed to find out the nematode population in 10 g soil.

Primary bed experiment: Before and after implantation of vegetative propagation/cutting in primary bed, 0-9 & 9-18 inch soil were collected and analyzed in the laboratory to find out the nematode population.

Secondary bed experiments: Soil sample for V.P (Vegetative propagation) nursery polytube was collected and mixed with organic matter or cow-dung for culturing nematode population. The polytube with cutting was filled with processed soil sample. Nematode population was analyzed from polytube soil samples at monthly interval.

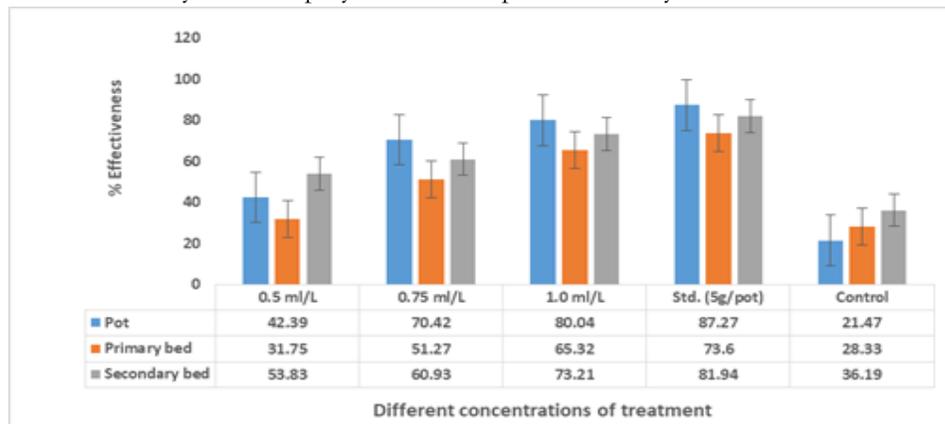


Fig. 5. Mean Percent reduction of plant parasitic nematode

Result revealed that significant reduction of nematode populations 80.04% @ 1.0 ml/L found in pot experiment, whereas commonly used granular formulation of nematicides (Carbofuran 5%) showed 87.27% reduction over control. Both the treatments showed significant reduction against plant parasitic nematode population.

ENT 3. SURVEY AND MONITORING OF PESTS

ENT 3.1. Survey and monitoring of new insect pests in tea due to change in climate: Causes and Remedies (2021-2023)

Progress: Monitoring directly and/or collecting data from affected zone/T.E. randomly identified from sampled area (100 tea bush in a plot). Frequent data collection from same area year the round has conducted to find out the seasonal abundances and nature of damage. Monthly data collection has been continued.

Findings: The occurrence of this pest has been first identified in 2019 at Monipur T.E. Recently, 20 tea garden (Monipur T.E., Moomincherra T.E., Amtoli T.E., Dinarpore T.E., Sathgaon T.E., Clonal T.E., Saif T.E., Madhupur T.E., Rajnagar T.E., Pathokhola T.E., Mathiura T.E., Jerin T.E., Bilashcherra Farm) have reported the spot occurrences of this herbivorous pest.

Pest: Green/Golden weevil

Nature of damage: It is an herbivorous pest causing sporadic and irregular damage making an irregular hole in maintenance (mostly) leaves.

Seasonal abundance: End of May-July and September (Approx.)



Fig. 6. Weevil pest and its leaf defoliation

ENT 4. SCREENING OF PESTICIDES

ENT 4.1. Screening of pesticides against *Helopeltis*, Red spider mites, Termites, Nematodes Aphids and Thrips in tea (2020-2021)

Progress: During 2021, Thirty four (34) insecticides under different groups were tested against *Helopeltis* (10), Red spider mite (14) & Termite (5), Thrips (1), Looper caterpillar (3) &

Nematode (1) in the field and the reports were sent to plant protection wing for their standardization (Fig. 6 & 7). The result revealed that all the tested pesticides was found satisfactory (>80% effectiveness).

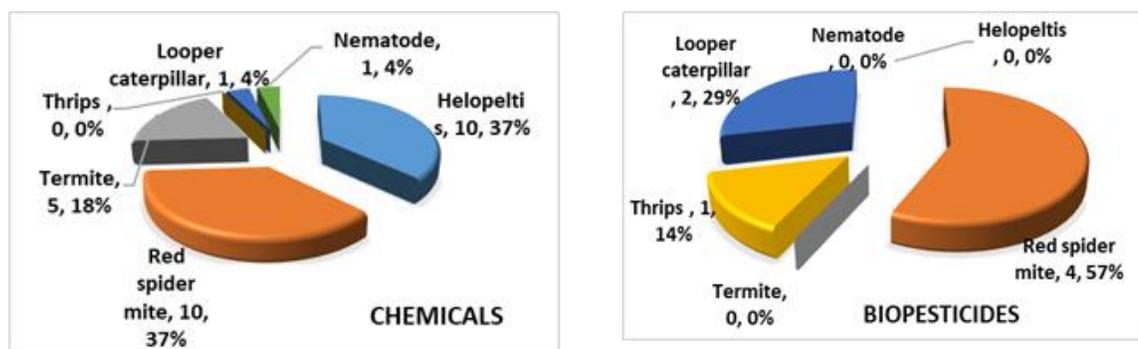


Fig. 7. Number & Percent of insecticides (chemicals & biopesticides) trial against *Helopeltis*, Red spider mite, Termite, Thrips, Looper caterpillar and Nematode

OTHER ACTIVITIES

Advisory and Experimental visits

A total of Eighteen (18) advisory visits were paid to different tea estates to identify and render advice on specific pest problems and Twelve (12) advisory letters issued to different tea estates in respect of identification of various pests, their control measures and report on nematode analysis during the reporting year.

Analysis

Thirty nine (39) soil samples were analyzed in the Laboratory for nematode count and reported to different tea estates.

Tours/Visits

Two (02) official visits were paid by the Scientist of the division to different organizations/T.E. for Official purposes.

Courses on tea culture

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

Workshop/Seminar

A total of three (03) workshops were conducted at different tea estates under different valley circles on tea pest management during 2021.

PLANT PATHOLOGY DIVISION**Mohammed Syeful Islam**

Senior Scientific Officer

Plant Pathology Division

(1) STAFF

The post of one Principle Scientific Officer and one Field Assistant of the division were remained vacant. There were no other changes in the staff position of this division during this period.

(2) RESEARCH

Five experiments (ongoing 3 and new 2) were approved to conduct during 2021. Among these three experiments were carried out under the research program of disease management and other two were under weed management. However the progresses of the experiments are as follows:

(1) Title: Effect of Leaf Reduction in MSK and LSK sections on the severity of Red rust & Black rot diseases and yield of tea.**Objective:**

1. To find out the best cultural practices for controlling Red rust and Black rot diseases by reducing very old leaves during LSK and MSK pruning operation.

Progress:

- Old leaves reduction from tea bushes of MSK and LSK pruned sections has a great positive effect on the reducing the severity of Red rust (Leaf rust) & Black rot diseases and increasing the yield of made tea (kg/ ha).
- Reduction of disease severity over the control was found by 42.30- 60.00% for Red rust (Leaf rust) and 27.63- 51.37% for Black rot with leaf removal within 10- 15 inch (25.40- 38.10 cm) as well as increasing 18.87- 22.00% yield without using any chemical.
- Only chemical can reduce the disease severity by 60.98% for Red rust and 51.93% for Black rot as well as increasing 2% yield.
- In case of both activities disease severity over the control was found by 81.21% for Red rust (Leaf rust) and 93.18% for Black rot with leaf removal within 10- 15 inch (25.40- 38.10 cm) as well as increasing 28% yield.

Recommendation:

Old leaves attached with tea bushes of MSK and LSK pruned sections within 10- 15 inches (25.40- 38.10 cm) from the soil level are recommended to remove.

Table 1: Disease severity of Red rust & Black rot diseases and yield of made tea (kg/ ha) against different treatments (2020)

Treatment	Percent Disease Index (PDI)				Yield of made tea (kg ha ⁻¹)	% Increased over the control
	Red rust		Black rot			
	PDI	% Reduction	PDI	% Reduction		
T ₁ = Control	52.00 a	00	41.00 a	00	1,788.00 c	00
T ₂ = 5 inches (12.70 cm)	38.67 b	25.63%	35.33 b	13.83%	1,896.00 b	6.04
T ₃ = 10 inches (25.40 cm)	30.00 c	42.30%	29.67 c	27.63%	2,125.50 a	18.87
T ₄ = 15 inches (38.10 cm)	26.67 cd	48.71%	26.33 cd	35.78%	2,168.70 a	21.29
T ₅ = 20 inches (50.80 cm)	22.67 d	56.40%	18.86 d	54.00%	2,142.60 a	19.83

Table 2: Disease severity of Red rust & Black rot diseases and yield of made tea (kg/ ha) against different treatments (2021)

Treatment	Percent Disease Index (PDI)				Yield of made tea (kg ha ⁻¹)	% Increased over the control
	Red rust		Black rot			
	PDI	% Reduction	PDI	% Reduction		
T ₁ = Control	63.33 a	00	48.66 a	00	1804.30 c	00
T ₂ = 5 inches (12.70 cm)	41.33 b	34.73	37.33 b	23.28	1900.11 b	5.31
T ₃ = 10 inches (25.40 cm)	28.67 c	54.78	29.33 c	39.72	2185.70 a	21.13
T ₄ = 15 inches (38.10 cm)	25.33 cd	60.00	23.66 d	51.37	2201.30 a	22.00
T ₅ = 20 inches (50.80 cm)	23.33 d	63.16	20.66 d	57.54	2193.00 a	21.54
CV	3.95		3.57		0.88	
LSD (P= 0.05)	4.047		3.21		22.408	

Table 3: Effect of leaf reduction level on the severity of Red rust & Black rot diseases and yield of made tea (kg/ha)

Treatment	Percent Disease Index (PDI)				Yield of made tea (kg ha ⁻¹)	% Increased over the control
	Red rust		Black rot			
	PDI	% Reduction	PDI	% Reduction		
T ₁ = Control	51.25 a	00	44.83 a	00	1796.20 o	00
T ₂ = 5 inches (12.70 cm)	38.16 b	25.54	36.33 b	18.96	1898.10 l	5.67
T ₃ = 10 inches (25.40 cm)	29.42 c	42.59	29.50 c	34.19	2155.60 i	20.00
T ₄ = 15 inches (38.10 cm)	25.49 d	50.26	24.98 d	44.27	2185.00 g	21.64
T ₅ = 20 inches (50.80 cm)	21.38 e	58.28	19.76 f	55.92	2167.80 h	20.68
T ₆ = Copper-oxichloride 50 WP	20.40 ef	60.20	29.51 c	33.84	1822.70 n	1.48

T ₇ = Carbendazim 50 WP	20.00 f	60.98	21.44 e	51.93	1840.00 m	2.44
T ₈ = T ₂ + Copper-oxichloride 50 WP	17.61 g	65.64	19.55 f	56.17	2018.20 k	12.37
T ₉ = T ₂ + Carbendazim 50 WP	19.41 f	62.13	11.06 i	75.20	2138.00 j	19.04
T ₁₀ = T ₃ + Copper-oxichloride 50 WP	13.55 i	73.56	17.47 g	60.83	2206.40 f	22.85
T ₁₁ = T ₃ + Carbendazim 50 WP	16.00 h	68.78	9.14 j	79.51	2246.20 e	25.06
T ₁₂ = T ₄ + + Copper-oxichloride 50 WP	11.58 j	77.40	13.40 h	69.96	2296.10 d	27.84
T ₁₃ = T ₄ + Carbendazim 50 WP	11.63 j	77.311	3.90 k	91.25	2310.00 a	28.61
T ₁₄ = T ₅ + + Copper-oxichloride 50 WP	11.38 j	77.79	11.63 i	73.92	2298.30 c	27.96
T ₁₅ = T ₅ + Carbendazim 50 WP	9.63 k	81.21	3.04 l	93.18	2302.20 b	28.18
CV	2.02		1.27		1.02	

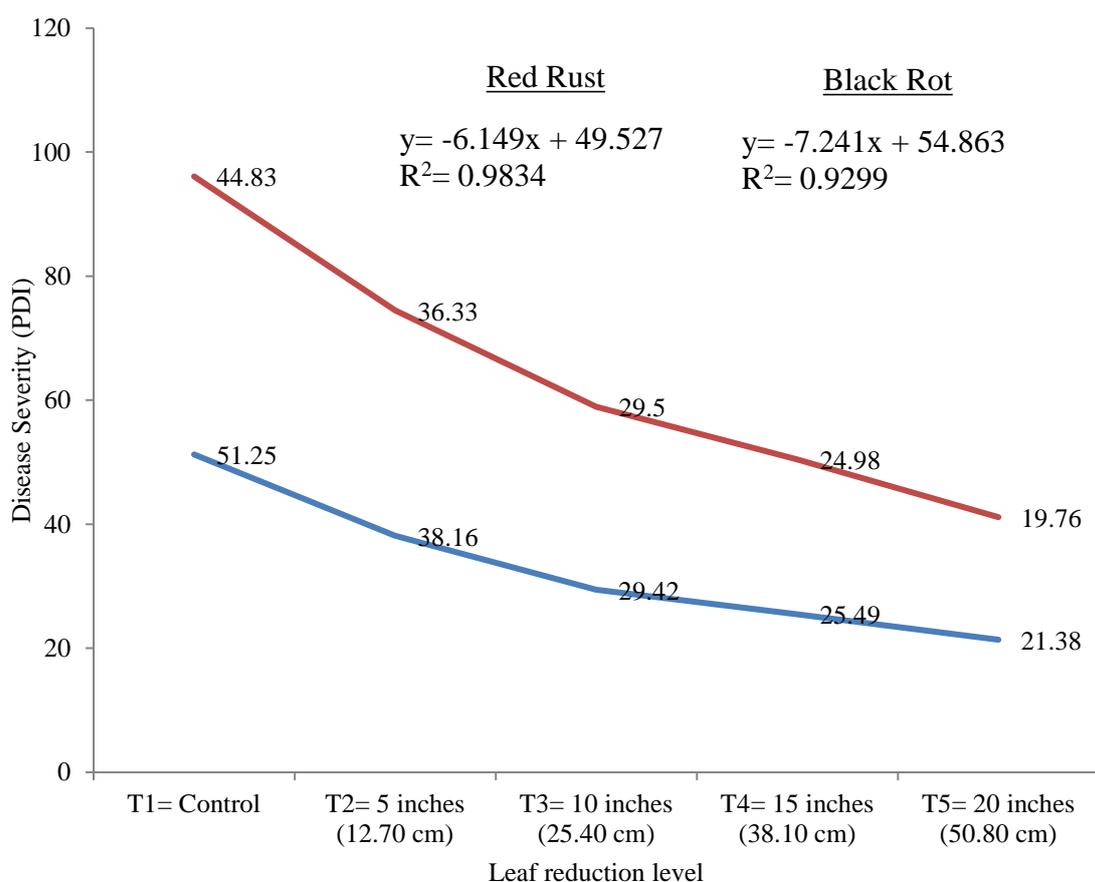


Fig.1: Regression between disease severity and level of leaf reduction from soil

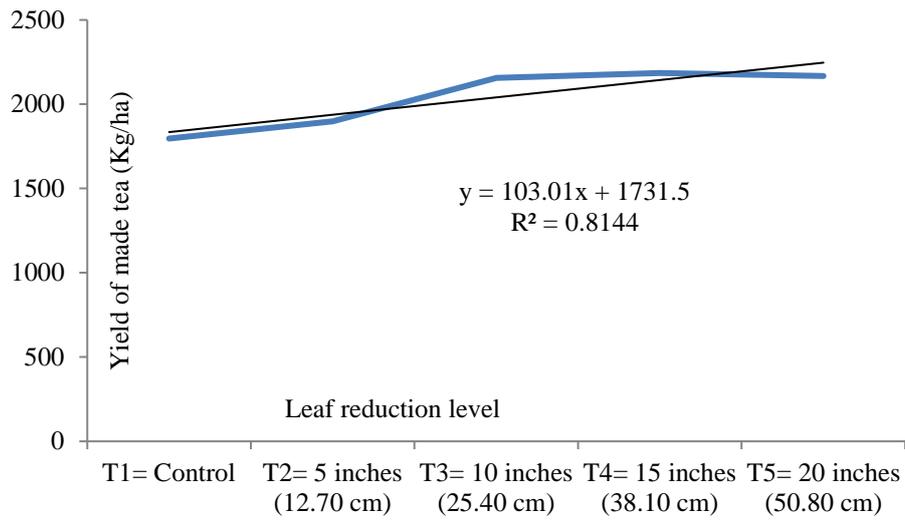


Fig.2: Regression between yield of made tea and level of leaf reduction from soil

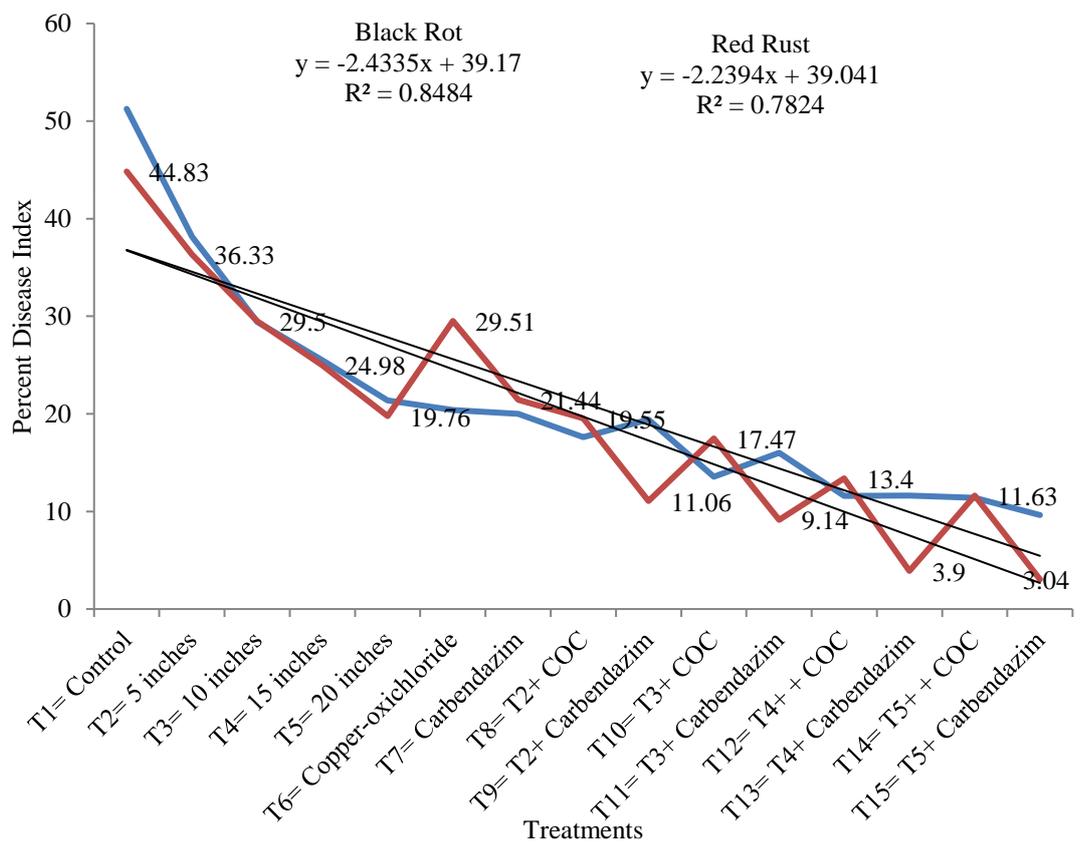


Fig.3: Regression between disease severity and level of leaf reduction & chemicals treatments

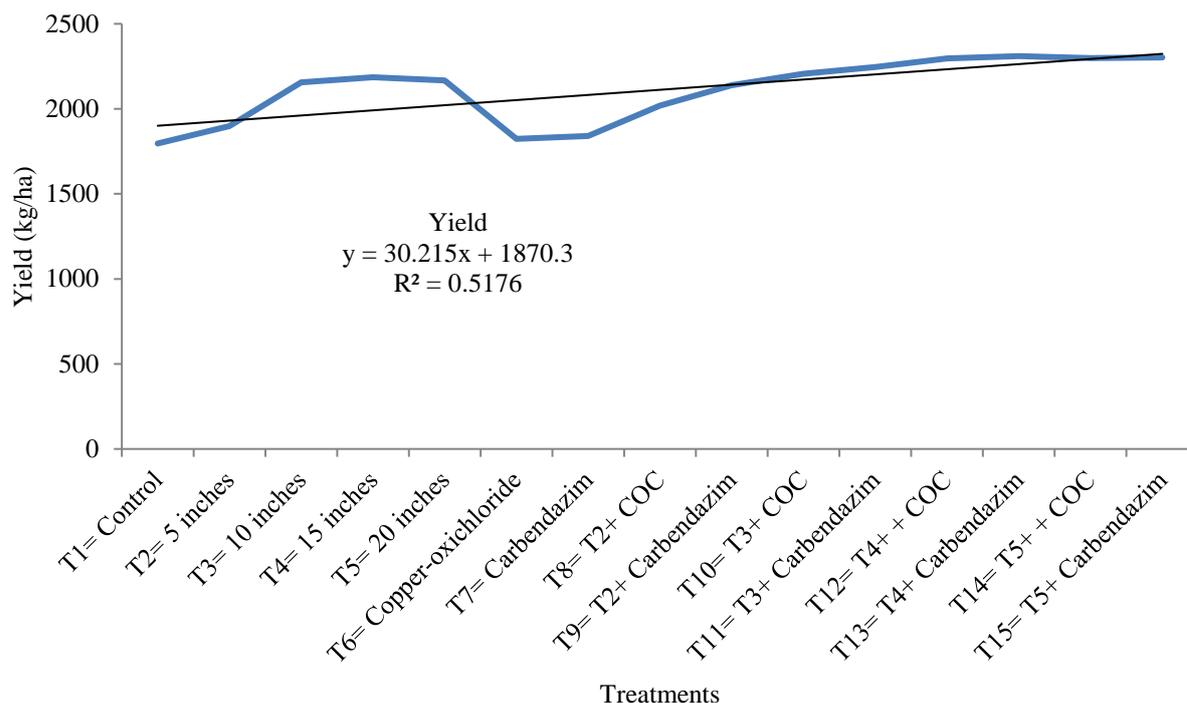


Fig.4: Regression between yields of made tea and level of leaf reduction & chemicals treatments

Title: Studies on Integration and Economics of Nitrogen fertilizer and Integrated Weed Management in young mature tea.

Objective:

1. To optimize of N fertilizer rate for young tea in different growth stages of weeds.
2. To find out the effect of different N rates on tea- weed competition.
3. To determine the economical weed control method in young tea.

Progress:

The experiment was completed in December 2021. Results and recommendations are as follows:

Results:

- Maximum weed density (per sq. feet) 120.86 was found $F_3 \times W_1$ combination that is statistically similar to $F_2 \times W_1$ and $F_1 \times W_1$. The second highest weed density was found in $F_3 \times W_2$ and $F_2 \times W_2$ but these are more or less similar to all of the rest combinations.
- Maximum weed height 37.16 cm was found $F_3 \times W_1$ combination. The second highest and identical weed height was found in $F_2 \times W_1$ and $F_1 \times W_1$. The lowest and more or less identical response in weed height was found in all of the rest combinations.
- The highest plant height 83.50 cm was found $F_3 \times W_4$ combination that is statistically more or less similar to $F_2 \times W_4$, $F_1 \times W_4$, $F_3 \times W_3$, $F_1 \times W_3$, $F_2 \times W_3$, $F_3 \times W_2$, $F_3 \times W_1$ and $F_2 \times W_2$ combinations. The lowest and identical response in plant height was recorded in $F_1 \times W_1$, $F_2 \times W_1$ and $F_1 \times W_2$ combinations.

- The response of different doses of fertilizers and weedicidal control of weeds in combinations there was no significant effect on number of shoots. All combinations showed statistically more or less similar.
- The highest yield tea 2196.60 kg/ha was found $F_3 \times W_4$ combination that is statistically similar to $F_2 \times W_4$ and $F_1 \times W_4$ followed by $F_3 \times W_3$ and $F_2 \times W_3$. The lowest and different responses in yield of made tea were found with control and hand weeding of weedicidal treatments.

Recommendations

- F_2 (Recommended doses of Urea: 330 kg, TSP: 110 kg MOP: 200 kg/ha) with one round application of Glyphosate weedicide and mechanical hand weeding is recommended for controlling weed density and weed height. This also helps to increase plant height, pluckable shoots and yield of made tea.

Other features:

- Higher doses of NPK fertilizer do not contribute in yield increase significantly. On the contrary it influences to increase weed density and weed height.

Table 1: Showing the interaction effects of fertilization and weed management on the weeds, tea bushes and yield of made tea (kg/ha) in 2020.

Treatments		Parameters				
Main treatment (Fertilizer)	2nd Treatment (Weed control)	Weed density ft^{-1} (929cm^{-1})	Weed height (cm)	Plant height (cm)	No. of shoot	Yield of made tea (kg/ ha)
F_1 = Urea: 250 kg, TSP: 92 kg MOP: 123 kg	W_1 = Control	119.40 a	37.00 a	80.40 d	16.00 a	1853.97 d
	W_2 = H.W	22.60 b	21.80 b	84.40 abcd	19.00 a	1934.07 c
	W_3 = Paraquat	13.40 cd	12.40 cde	87.80 abcd	16.60 a	2136.04 b
	W_4 = Glyphosate	8.00 d	8.60 de	91.00 ab	16.60 a	2171.33 a
F_2 = Urea: 330 kg, TSP: 110 kg MOP: 200 kg	W_1 = Control	114.80 a	24.20 b	80.40 d	16.60 a	1861.13 d
	W_2 = H.W	19.90 b	23.80 b	85.20 abcd	17.00 a	1943.87 c
	W_3 = Paraquat	13.20 cd	13.40 cd	81.80 cd	15.40 a	2157.61 a
	W_4 = Glyphosate	12.20 cd	7.00 e	93.00 a	17.20 a	2172.99 a
F_3 = Urea: 370 kg, TSP: 123 kg MOP: 250 kg	W_1 = Control	118.80 a	14.60 c	88.00 abcd	17.20 a	1858.58 d
	W_2 = H.W	23.20 b	25.80 b	83.40 abcd	15.80 a	1948.38 c
	W_3 = Paraquat	18.60 bc	14.00 cd	89.60 abc	16.60 a	2159.17 a
	W_4 = Glyphosate	6.20 d	7.60 e	92.00 ab	17.40 a	2174.86 a

Table 2: Showing the interaction effects of fertilization and weed management on the weeds, tea bushes and yield of made tea (kg/ha) in 2021.

Treatments		Parameters				
Main treatment (Fertilizer)	2nd Treatment (Weed control)	Weed density ft ⁻¹ (929cm ⁻¹)	Weed height (cm)	Plant height (cm)	No. of shoot	Yield of made tea (kg/ ha)
F ₁ = Urea: 250 kg, TSP: 92 kg MOP: 123 kg	W ₁ = Control	119.33 a	27.66 b	66.33 c	16.33 c	1891.00 d
	W ₂ = H.W	50.67 b	22.66 c	67.33 c	16.66 bc	1972.70 c
	W ₃ = Paraquat	14.67 cde	11.66 fg	68.67 bc	17.33 abc	2178.70 b
	W ₄ = Glyphosate	11.33 def	6.33 h	71.33 ab	17.33 abc	2214.70 a
F ₂ = Urea: 330 kg, TSP: 110 kg MOP: 200 kg	W ₁ = Control	120.67 a	31.67 b	67.33 c	16.66 bc	1898.30 d
	W ₂ = H.W	52.67 b	16.66 de	67.66 c	17.33 abc	1982.70 c
	W ₃ = Paraquat	15.33 cd	12.66 efg	68.67 bc	17.66 abc	2200.70 a
	W ₄ = Glyphosate	10.67 ef	7.33 h	72.66 a	18.33 ab	2216.40 a
F ₃ = Urea: 370 kg, TSP: 123 kg MOP: 250 kg	W ₁ = Control	122.33 a	37.33 a	68.33 bc	17.33 abc	1895.7 d
	W ₂ = H.W	55.33 b	19.33 cd	68.67 bc	17.66 abc	1987.30 c
	W ₃ = Paraquat	19.33 c	14.00 ef	69.33 bc	18.33 ab	2202.30 a
	W ₄ = Glyphosate	9.33 f	8.66 gh	74.00 a	18.66 a	2218.30 a

Table 3: Showing the interaction effects of fertilization and weed management on the weeds, tea bushes and yield of made tea (kg/ha).

Treatments		Parameters				
Main treatment (Fertilizer)	2nd Treatment (Weed control)	Weed density ft ⁻¹ (929cm ⁻¹)	Weed height (cm)	Plant height (cm)	No. of shoot	Yield of made tea (kg/ ha)
F ₁ = Urea: 250 kg, TSP: 92 kg MOP: 123 kg	W ₁ = Control	117.06 a	25.93 bc	73.36 c	15.86 c	1872.50 h
	W ₂ = H.W	35.08 bc	23.23 cd	74.56 c	16.33 c	1953.40 f
	W ₃ = Paraquat	13.93 d	12.03 ef	78.33 b	16.75 bc	2157.40 c
	W ₄ = Glyphosate	11.76 d	6.66 g	81.16 a	16.75 bc	2193.00 a
F ₂ = Urea: 330 kg, TSP: 110 kg MOP: 200 kg	W ₁ = Control	119.73 a	28.73 b	73.86 c	16.23 c	1879.70 g
	W ₂ = H.W	37.63 b	15.63 e	75.53 b	16.43 c	1963.30 e
	W ₃ = Paraquat	14.36 d	13.03 e	78.23 b	17.43 ab	2179.20 b
	W ₄ = Glyphosate	9.33 d	7.46 g	82.33 a	17.86 a	2194.70 a
F ₃ = Urea: 370 kg, TSP: 123 kg MOP: 250 kg	W ₁ = Control	120.86 a	37.16 a	76.36 b	16.42 c	1877.10 g
	W ₂ = H.W	41.93 b	20.56 d	76.93 b	17.33 ab	1967.80 d
	W ₃ = Paraquat	18.96 cd	14.00 e	79.46 ab	17.76 a	2180.70 b
	W ₄ = Glyphosate	7.76 d	8.63 fg	83.50 a	18.43 a	2196.60 a
LSD		19.43	3.46	4.13	0.58	4.72

(3) Title: Screening of BTRI clones against different diseases of Tea (2021-2025)**Objective:**

1. To find out the tolerance level of BTRI released tea clones against some major diseases of tea in Bangladesh.

Progress:

Table 1: Percent disease index of different diseases against different clones (BT1- BT12)

Disease	Percent disease index											
	BT 1	BT 2	BT 3	BT 4	BT 5	BT 6	BT 7	BT 8	BT 9	BT 10	BT 11	BT 12
Red rust	26.00 c	24.00 c	28.00 d	30.00 c	54.00 a	28.00 d	38.00 b	30.00 c	30.00 d	40.00 c	40.00 a	24.00 c
Leaf Rust	36.00 a	58.00 a	34.00 b	34.00 b	44.00 b	48.00 a	48.00 a	40.00 a	46.00 a	48.00 a	34.00 b	48.00 a
Black rot	24.00 d	22.00 d	26.00 e	30.00 c	24.00 d	44.00 b	32.00 c	32.00 b	32.00 c	42.00 b	24.00 c	24.00 c
Horse hair blight	36.00 a	22.00 d	36.00 a	34.00 b	38.00 c	48.00 a	48.00 b	30.00 c	30.00 d	30.00 d	20.00 d	24.00 c
Grey brown blight	24.00 d	30.00 b	30.00 c	20.00 d	22.00 de	38.00 c	30.00 d	32.00 b	36.00 b	24.00 e	36.00 b	34.00 b
Branch canker	32.00 b	30.00 b	24.00 f	40.00 a	20.00 e	26.00 d	26.00 e	22.00 d	24.00 e	24.00 e	16.00 e	18.00 d
Lsd (0.05)	0.74	1.84	0.94	0.94	2.20	2.68	0.99	1.60	0.99	0.99	2.79	0.93

Table 1 (con.): Percent disease index of different diseases against different clones (BT 13- BTS1)

Disease	Percent disease index									
	BT 13	BT 14	BT 15	BT 16	BT 17	BT 18	BT 19	BT 20	BT 21	BTS1
Red rust	28.00 c	24.00 b	26.00 b	32.00 c	24.00 c	34.00 c	40.00 b	28.00 a	26.00 c	32.00 c
Leaf Rust	34.00 b	38.00 a	32.00 a	36.00 b	40.00 a	44.00 a	44.00 a	26.00 ab	28.00 b	20.00 e
Black rot	26.00 d	26.00 b	26.00 b	50.00 a	26.00 d	22.00 d	24.00 d	22.00 cd	22.00 d	44.00 b
Horse hair blight	24.00 e	18.00 c	14.00 d	22.00 d	20.00 d	22.00 d	14.00 e	20.00 d	18.00 e	50.00 e
Grey brown blight	38.00 a	38.00 a	32.00 a	32.00 c	34.00 b	38.00 b	30.00 c	24.00 bc	32.00 a	28.00 d
Branch canker	20.00 f	16.00 c	24.00 c	16.00 e	16.00 e	16.00 e	24.00 d	22.00 cd	22.00 d	26.00 d
Lsd (0.05)	0.93	2.55	0.93	0.93	0.99	0.99	0.99	2.37	1.62	3.38

From Table 1, comparing all the clone it is revealed that in case of Red rust disease, BT 5 is susceptible to Red rust; BT 7, BT 10, BT 11 & BT 19 are moderately susceptible. BT 4, BT 6, BT 8, BT 9, BT 13, BT 16, BT 18 & BTS1 are moderately tolerant while BT 1, BT 2, BT 3, BT 12, BT 14, BT 15, BT 17, BT 20 & BT 21 show tolerance to red rust disease.

In case of Leaf rust disease, BT 2 is susceptible to leaf rust; BT 5, BT 6, BT 7, BT 8, BT 9, BT 10, BT 12, BT 17, BT 18 & BT 19 are moderately susceptible. BT 1, BT 4, BT 11, BT 13, BT 14, BT 15 & BT 16 are moderately tolerant while BTS1, BT 20 & BT 21 show tolerance to red rust disease.

In case of Black rot disease, BT 16 is susceptible to black rot; BT 5, BT 6, BT 10 & BTS1 are moderately susceptible. BT 4, BT 7, BT 8 & BT 9 are moderately tolerant while BT1, BT 2, BT 3, BT 11, BT 12, BT 13, BT 14, BT 15, BT 17, BT 18, BT 19, BT 20 & BT 21 show tolerance to black rot disease.

In case of Horse Hair Blight disease, BT 6 & BTS1 is susceptible to Horse Hair Blight; BT 1, BT 3, BT 4, BT 5, BT 8, BT 9, BT 10 are moderately susceptible. BT 2, BT 11, BT 12, BT 13, BT 16, BT 17, BT 18 & BT 20 are moderately tolerant while BT 14, BT 15, BT 19 & BT 21 show tolerance to Horse Hair Blight disease.

In case of Grey Brown Blight disease, BT 6, BT 8, BT 9, BT 11, BT 12, BT 13, BT 14, BT 15, BT 16, BT 17, BT 18 & BT21 is susceptible to Grey Brown Blight; BT 2, BT 3, BT 7, BT 19, & BTS1 are moderately susceptible. BT 1, BT 4, BT 5, BT 10 & BT 20 show tolerance to moderate tolerance to Grey Brown Blight disease.

In case of Branch canker, BT 1, BT 2 & BT 4 is susceptible to Branch canker; BT 3, BT 6, BT 7, BT 8, BT 9, BT 10, BT 15, BT 19, BT 20, BT 21 & BTS1 are moderately susceptible. BT 5, BT 11, BT 12, BT 13, BT 14, BT 16, BT 17 & BT 18 show tolerance to moderate tolerance to Branch canker disease. The experiment will be continued to the next year.

(4) Title: Effect of different group of herbicides on tea soil environment.

Objective:

1. To reveal the impact of different herbicides used in tea cultivation on tea soil environment

Progress:

Presence of Mycoflora:

Mycoflora found in tea soil at different interval after application of different group of herbicides

Phytotoxic Effect:

For determining retention level of herbicide in soil, soil solution was prepared from treated plot after 07 & 14 days of herbicide application. No phytotoxic effect (Yellowing of Leaf, leaf curling, leaf burn) was found in tea foliage. Further experiment will be carried to the next year to draw a concrete conclusion.

Table 2: Presence of soil microorganism after different days of intervals of herbicides application

Treatment	7 DAS	14 DAS	21 DAS	28 DAS
T ₁ = Paraquat	<i>Aspergillus sp</i> , <i>Rhizopus sp</i> ,	<i>Aspergillus sp</i> , <i>Rhizopus sp</i> , <i>Penicillium sp</i>	<i>Aspergillus sp</i> , <i>Rhizophus sp</i> , <i>Penicillium sp</i> , <i>Trichoderma sp</i>	<i>Aspergillus sp</i> , <i>Rhizophus sp</i> , <i>Penicillium sp</i> , <i>Trichoderma sp</i>
T ₂ = 2,4-D	<i>Aspergillus sp</i>	<i>Aspergillus sp</i> , <i>Penicillium sp</i>	<i>Aspergillus sp</i> , <i>Rhizopus sp</i> , <i>Penicillium sp</i>	<i>Aspergillus sp</i> , <i>Rhizopus sp</i> , <i>Penicillium sp</i> ,
T ₃ = Glufosinate ammonium	<i>Aspergillus sp</i> , <i>Penicillium sp</i>	<i>Aspergillus sp</i> , <i>Rhizopus sp</i> , <i>Penicillium sp</i>	<i>Aspergillus sp</i> , <i>Rhizophus sp</i> , <i>Fusarium sp</i> , <i>Trichoderma sp`</i>	<i>Aspergillus sp</i> , <i>Rhizophus sp</i> , <i>Fusarium sp</i> , <i>Trichoderma sp</i>
T ₄ = Diquat	<i>Aspergillus sp</i> , <i>Penicillium sp</i>	<i>Aspergillus sp</i> , <i>Rhizopus sp</i> , <i>Penicillium sp</i>	<i>Aspergillus sp</i> , <i>Rhizophus sp</i> , <i>Penicillium sp</i> ,	<i>Aspergillus sp</i> , <i>Rhizophus sp</i> , <i>Penicillium sp</i> , <i>Rhizoctonia sp</i>
T ₅ = Glyphosate	<i>Aspergillus sp</i> , <i>Rhizopus sp</i>	<i>Aspergillus sp</i> , <i>Rhizopus sp</i> , <i>Penicillium sp</i>	<i>Aspergillus sp</i> , <i>Rhizophus sp</i> , <i>Penicillium sp</i> , <i>Trichoderma sp</i> , <i>Fusarium sp</i>	<i>Aspergillus sp</i> , <i>Rhizophus sp</i> , <i>Penicillium sp</i> , <i>Trichoderma sp</i> ,
Control	<i>Aspergillus sp</i> , <i>Rhizopus sp</i> , <i>Penicillium sp</i>	<i>Aspergillus sp</i> , <i>Rhizopus sp</i> , <i>Penicillium sp</i> , <i>Trichoderma sp</i>	<i>Aspergillus sp</i> , <i>Rhizophus sp</i> , <i>Penicillium sp</i> , <i>Trichoderma sp</i> , <i>Fusarium sp</i>	<i>Aspergillus sp</i> , <i>Rhizophus sp</i> , <i>Penicillium sp</i> , <i>Trichoderma sp</i> , <i>Fusarium sp</i>

* DAS = Days after spray

(5) Title: Screening of new fungicides and herbicides against different diseases and weeds in tea.

Progress

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

(3) OTHER ACTIVITIES

A total of Eighteen (18) advisory visits were paid to different tea estates to identify and render advice on specific disease and weeds problem and Nineteen (19) correspondences issued to different tea estates in respect of identification of various diseases and their control measures during the reporting year. Twenty four (24) experimental visits were made with particular preference to experimental data collection in tea estates.

A total of four (04) official visits were paid by the scientists of the division to different organizations for official purposes.

The scientific personnel of the division delivered lectures on tea disease and weeds management at annual courses held at BTRI main station, Srimangal.

Three (03) workshops were carried out during the reporting year. Twenty two (22) hours lecture was paid to MTC module on tea disease and weed management. There are two scientific research articles were published during the reporting year. There are twenty nine different groups of fungicides and herbicides were standardized also in same year.

STATISTICS & ECONOMICS DIVISION

Dr. Shefali Boonerjee

Senior Scientific Officer

STAFF

Dr. Shefali Boonerjee, Senior Scientific Officer joined on 23rd June 2015 in this Division. The post of Principal Scientific Officer (PSO) was lying vacant during the period under report. Md. Shahadot Hossen has joined as Statistical Assistant on 28th February 2021. There was no other change in personnel position of the division.

RESEARCH

There were two experiments running in this division regarding economic efficiency of tea production and evaluation of technologies. The present situation of these experiments is summarized below.

SE 1: Economic efficiency of tea production

SE1.1 Economic efficiency of the test clones of BTRI.

This experiment has undertaken to evaluate the economic efficiency of the test clones from which commercial clone (s) will be released. The economic performance is needed to be understood before commercial release of a clone. The test clones are examined in the experimental plots for 10 to 12 years to study the different performances of yield, quality, stress tolerance etc. Along with these attributes the economic performance is also needed to be understood before commercial release of the elite clones. The Study of economic performance in the controlled condition of the experimental plots for 10-12 years is enough to estimate the profitable efficiency of these clones in future. With the view of importance, the experiment has been started at November 2018. Initially 2 experimental plots of BTRI farm have been selected for data collections which are named as Bot-40 and Bot-43. The data from both the plots regarding green leaf production, expenditure of worker's wages and other cultural operations are being collecting. The secondary data collection of production and approximate expenditure of last 10 years is also going on.

Objectives

- Study the economic efficiency of the test clones in respect of yield.
- Find out the economic efficient test clone(s) comparing internal rate of return.
- Use of economic performance as a parameter for suitable selection of significant clone(s).

Progress: Data from both the plots regarding green leaf production, expenditure of worker's wages and other cultural operations has been collected and tabulated. The secondary data collection of production and approximate expenditure of last 10

years is also going on. For the year 2021 the collected data were summarized and presented in the Table 1, 2, 3 & 4.

Table1. The expenditure of labor wages and different cultural practices in experiment B2-43

Cultural Operation	No of application	Worker used (No.)	Material cost (Taka)	Total Cost (Taka)	Production (kg)
Plucking	19 (round)	22	-	2640.0	179600 (Green leaf)
Insecticide	5 (time)	1.00	120	240	
Fungicide & weedicide	2 (time)	0.5	40	100	
Pruning	2 (days)	2	-	240	
Other works	8 (days)	2.6	-	288	

Table2. The expenditure of labor wages and different cultural practices in experiment B2-40

Cultural Operation	No of application	Worker use (No.)	Material cost (Taka)	Total Cost (Taka)	Production (kg)
Plucking	17 (round)	19.8	-	2376.0	332450 (Green leaf)
Insecticide	5 (time)	1.00	140	260	
Fungicide & weedicide	2 (time)	0.5	50	110	
Pruning	2 (days)	2	-	240	
Other works	10 (days)	2.2	-	264	

Table 3. Test clone wise production and comparative cost of different cultural practices in experiment B2-40 (2021).

Clone/Test clones	Production (kg)	Cost of cultural operation (Tk.)					Total cost
		Plucking	Fungicide & weedicide	Insecticide	pruning	Other works	
T1 (MJ 39)	-	-	15.71	37.14	34.28	37.71	124.84
T2 (E/4)	55700	396.00	15.71	37.14	34.28	37.71	520.46
T3 (D/13)	46500	396.00	15.71	37.14	34.28	37.71	520.46
T4 (B2T1)	60900	396.00	15.71	37.14	34.28	37.71	520.46
T5 (BR/97)	48350	396.00	15.71	37.14	34.28	37.71	520.46
T6 (SDL/1)	51400	396.00	15.71	37.14	34.28	37.71	520.46
T7 (BT2)	69600	396.00	15.71	37.14	34.28	37.71	520.46

Table 4. Test clone wise production and comparative cost of different cultural practices in experiment B2-43 (2021).

Clones/Test clones	Production (kg)	Cost of cultural operation (Tk.)					Total cost
		Plucking	Fungicide & weedicide	Insecticide	pruning	Other works	
T1 (PH 9/4)	39450	528.00	20.00	48.00	48.00	57.60	701.6
T2 (PH9/25)	29350	528.00	20.00	48.00	48.00	57.60	701.6
T3 (PH9/40)	39150	528.00	20.00	48.00	48.00	57.60	701.6
T4 (BS-67)	39400	528.00	20.00	48.00	48.00	57.60	701.6
T5 (BT 5)	32250	528.00	20.00	48.00	48.00	57.60	701.6

The experiment plots are same in size and the conditions are controlled. The expenditure divided equally into the plots of corresponding test clones.

Table 5. Estimation of benefit cost ratio (BCR) of experiment B2-40

Clones/Test clones	Green Leaf Production	Made Tea Production	Cost per kg	Total cost	Total Benefit	BCR
T1	-	-				
T2	55700	12811	189.68	2429990.48	2461761.7	1.013
T3	46500	10695		2028627.6	2055151.2	1.013
T4	60900	14007		2362700.76	2691585.12	1.139
T5	48350	11120		2109241.6	2136915.28	1.013
T6	51400	11822		2242396.96	2271715.52	1.013
T7	69600	16008		2716237.44	3076097.2	1.132

Table 6. Estimation of benefit cost ratio (BCR) of experiment B2-43

Clones/Test clones	Green Leaf Production	Made Tea Production	Cost per kg	Total cost	Total Benefit	BCR
T1 (PH 9/4)	39450	9073.5	189.68	1721061.48	1743563.8	1.013
T2 (PH9/25)	29350	6750.5		1280434.84	1297176.2	1.013
T3 (PH9/40)	39150	9004.5		1707973.56	1730304.7	1.013
T4 (BS-67)	39400	9062		1718880.16	1741354	1.013
T5 (BT 5)	32250	7417.5		1406951.4	1425346.8	1.013

SE 2: Evaluation of technologies.

SE 2.1 Adoption of BTRI matured technologies and its extension to Bangladesh Tea Industry.

The study conducted to examine the overall feature of implementation and its efficiency of the BTRI technologies to the tea estates. BTRI has developed a number of technologies and made a great impact on the tea industry providing these technologies. Bangladesh tea has increased its productivity remarkably from the last few decades. One of the reasons behind

such improvement is the utilization of scientific technologies like superior planting materials, authentic control measures of pest and disease management, proper agronomic practices, increase of soil fertility and pH control etc. BTRI has so far released 23 outstanding clones and many other successful technologies which are effectively been used in the tea industry. But there is no information about the percentage of application of the technologies and its efficiency in implementation. So, the current data regarding the disseminated technologies to the estate required to up-to-date. This database will be helpful to find out the adoption efficiency in the field and to find out the limitations of dissemination of the BTRI technologies.

In the present experiment, the adoption percentages of both BT and TV clones in the tea estates of different valleys are explored. The collected data of total 144 gardens were summarized according to valley wise and management wise adoption of clone plantation. From the result it was observed that about 41.64% land of total tea area of the 7 valleys is occupied by clonal plantation with the average production of 1607.48 kg/ha. The use of BT and TV clones were 45.05% and 40.20% with the average production of 1591 and 1667 kg/ha respectively. Among the valleys, the highest BTRI released clones were adopted by Chittagong valley which is 74.62% of their clone area. After then the higher percentage of BT clones were planted in Luskerpur valley (68.31%) followed by North Sylhet (51.79%), Lungla (51.28 %), Monu-Doloi (48.78 %) and Juri (47.69%) valley of their clone area respectively. The Balisera valley has the lowest (35.63%) clone area of which only 21.82% is occupied by BT clones. In case of different managements, it was observed that about 60% to 65% of clone area of NTC, New Sylhet TE Ltd. and Deundi Tea Co. Ltd. was planted with BT clones. The Duncun Brothers (BD) Ltd. and Finlay were also used BT clones which were 30.22% and 8.35% of their total clone areas (Table 5). Beside BT clones, the clone areas were planted by TV clones along with some other introduced or garden clones. The data on using of cultural practices like pruning cycle, plant to plant spacing, pests and disease control measures were also collected in the same time through the questionnaire from the estates and the results are under analyzing. From the study plantation areas planted with different BT clones in different tea estates was also revealed (Fig 1). Among the 144, about 54 gardens could not mention the specific name and area coverage of the BT clones available in their clone areas. Among the tea estates that have specifically mentioned the name of BT clones, 90 and 49 tea estates were found to have BT2 clones (100%) and BT1 clone (54%) respectively. BT5 (21%), BT6 (21%) and BT4 (20%) followed by BT3 (12%), BT8 (6.6%), BT11 (4.4%) and BT18 (4%) were observed to be planted in different tea gardens. Other BT clones (1-3%) were also found to be planted in the clone areas of different tea gardens (Fig. 1). Most of the tea estates have different BT clones as mother bush in their nucleus clone plot (NCP) besides the plantation areas.

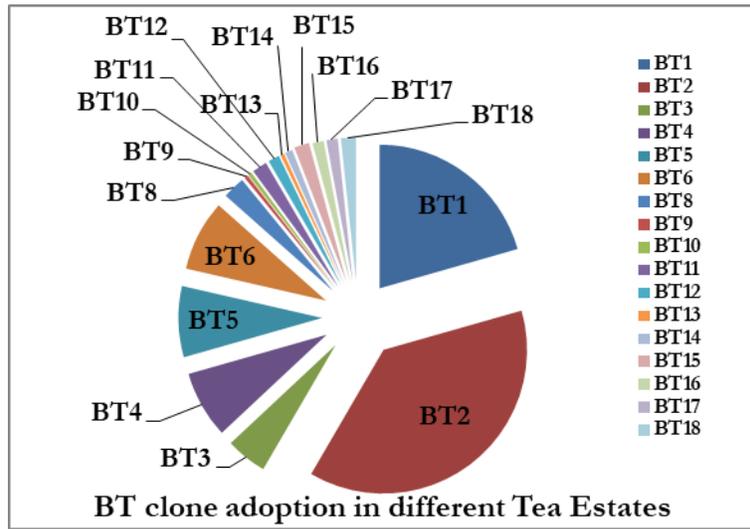


Figure 1: Different BT clones in different tea estates.

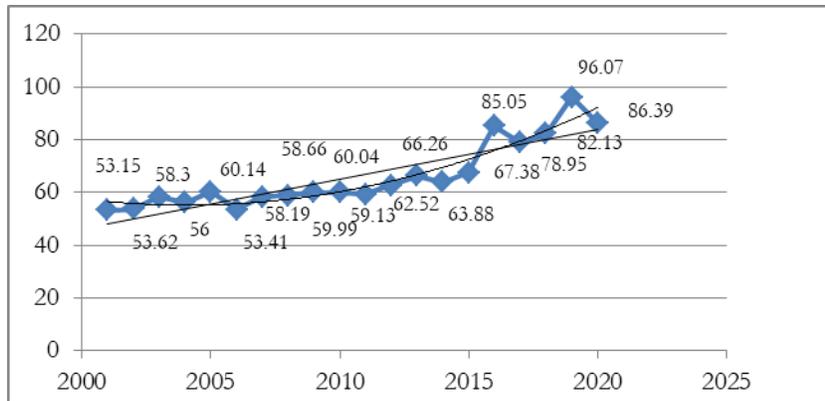
STATISTICS

1. Estimation of Annual Crop for 2021:

Annual crop forecasting (2021) using time series data (last 20 years) was done.

Methodology

- Correlation analysis for assessing the relationship of forecasted year and other observed last year’s production
- Regression analysis for dependency analysis and forecast crop production
- Trend analysis of time series data
- Linear, Polynomial and Exponential Growth Model



Graph 1: Yield trend in correlation regression analysis using last 20 years data for forecasting the tea crop of 2021.

Table 7. Correlation regression analysis using last 20 years data for forecasting the tea crop of 2021

Sl.	Year	Production (Mkg)	linear (0.62)	Polynomial (.7557)	exponential (.673)
1	2001	53.15	51.4615	56.5187	52.2412
2	2002	53.62	52.731	55.7654	53.2859
3	2003	58.3	54.0005	55.3011	54.3515
4	2004	56.00	55.27	55.1258	55.4383
5	2005	60.14	56.5395	55.2395	56.5469
6	2006	53.41	57.809	55.6422	57.6777
7	2007	58.19	59.0785	56.3339	58.8311
8	2008	58.66	60.348	57.3146	60.0076
9	2009	59.99	61.6175	58.5843	61.2076
10	2010	60.04	62.887	60.143	62.4316
11	2011	59.13	64.1565	61.9907	63.6801
12	2012	62.52	65.426	64.1274	64.9535
13	2013	66.26	66.6955	66.5531	66.2524
14	2014	63.88	67.965	69.2678	67.5772
15	2015	67.38	69.2345	72.2715	68.9286
16	2016	85.05	70.504	75.5642	70.3070
17	2017	78.95	71.7735	79.1459	71.7130
18	2018	82.13	73.043	83.0166	73.1470
19	2019	96.07	74.3125	91.8763	74.6097
20	2020	86.39	75.582	91.625	76.1017
21	2021	?	76.8515	96.3627	77.6236
SD		12.63562887	7.87704035	13.27483057	7.8683
Mean		65.963	63.522	65.835	63.464

Three observations were found in linear (76.8515), Exponential (77.6236) and Polynomial (96.3627) model for the estimation of annual crop of 2021. In Polynomial model the estimated data was found more relevant to last 20 years examined production data along with the closer SD value of time series data. So, the estimated crop for 2021 will may be 96.3627 million kg. (NB. The analysis was done depending only on the yield parameter of the last 20 years. The climatic factors (e. g. rainfall parameters, temperature, RH, day length, wind velocity etc.) along with the pest and disease infestations are directly influence the yield of crop as well as the projection.

Conclusion: Correlation analysis using time series data showed estimated production of 96.3627 M.kg teas for the year 2021. If any difference will come in actual production it would be due to the influences of environmental and other related factors over the production of crop in 2021.

2. Estimation of Cost of Production (COP) for the crop of BTRI farms (BEF, BTRI and Kality) in 2021: The cultivation cost and the factory cost of 2021 of BTRI farms has determined. The summary of the estimation has given below.

Table8. Production and per kg cost of green leaves and made tea produced in BTRI Farms in 2021

Item	BEF	BTRI	Kality	Total
Produced Green Leave (Kg)	808835	90867	43220	942922
Produced made Tea (Kg)	186032.05	20899.41	9940.6	216872.1 (23% Recovery)
Field Cost/Kg (Tk)	30.71	39.64	34.20	34.85 (Avg.)
Others Cost/Kg (Tk)	1.63	-	3.85	
Factory Cost/Kg (Tk)				35.75
Cost of made tea/ Kg (Tk) [GL Cost * 4.5 + F Cost + Others Cost]	175.58	199.96	193.5	189.68 (Avg.)

Total field cost (Tk.) = 26161428 + **3315899** + 1641603 = 31118930 (BEF +BTRI + Kality)

Total factory cost (Tk.) = 10697373.00

Total Cost + Factor Cost (Tk.) = 41816303

Total return (Tk.) = 43900297.12 (Selling price of total made tea @192.16 Tk.)
{Made tea: 228457kg}

Total Income (Tk.) = 43900297.12 – 41816303 = 2083994.12

BCR (%) = Total Return/Total Cost X100

= 43900297.12/41816303

= 1.05

(Benefit Cost Ratio is greater than 1, i.e. 105%, shows the profitable condition of the farms.)

Table 9. Tea Production, Internal Consumption, Export and Import of Bangladesh

Year	Production (Mkg)	Internal Consumption (Mkg)	Export (Mkg)	Import (Mkg)
2001	53.15	36.95	12.92	-
2002	53.62	41.50	13.65	-
2003	58.30	37.44	12.18	-
2004	56.00	43.33	13.11	-
2005	60.14	43.30	9.01	-
2006	53.41	40.51	4.79	-
2007	58.19	46.27	10.56	-
2008	58.66	52.12	8.39	-
2009	59.99	53.74	3.15	4.5
2010	60.04	57.63	0.91	6.0
2011	59.13	58.50	1.47	7.0
2012	62.52	61.19	1.50	8.5
2013	66.26	64.00	0.54	11.6
2014	63.88	67.17	2.66	6.9
2015	67.38	77.57	0.54	10.68
2016	85.05	81.64	0.62	8.83
2017	78.95	85.93	2.56	6.29
2018	82.134	90.45	0.643	7.45
2019	96.07	95.20	0.60	2.73
2020	86.394	100.20	2.17	0.68
2021	96.506	95.24	0.68	0.74

Source: BTB

Table 10. Month wise tea production (Mkg) of last five years in Bangladesh

Month	Production (Mkg)				
	2017	2018	2019	2020	2021
January	0.157	0.331	0.495	0.175	0.268
February	0.016	0.038	0.114	0.026	0.019
March	1.152	1.556	1.917	1.625	1.681
April	4.382	3.505	6.110	2.365	3.932
May	5.934	6.334	7.645	8.655	6.151
June	8.584	7.634	11.667	8.963	13.354
July	11.206	10.985	11.104	12.178	12.338
August	10.648	12.477	13.505	11.321	14.387
September	9.784	12.008	13.382	12.144	12.607
October	11.464	11.863	13.407	11.486	14.578
November	9.075	9.147	10.300	10.495	10.241
December	6.547	6.256	6.423	6.961	6.932
Total	78.95	82.134	96.069	86.394	96.506

Source: BTB Monthly Bulletin

Meteorological Data for the year 2021

Month	No. of rainy days	Rainfall (mm)	Evaporation (mm)	Temperature (oc)		Dew point (oc)	Sunshine hrs	R.H (%)
				Max.	Min.			
January	01	03	77.9	24.23	10.05	12.88	5.63	68.24
February	00	00	94.1	29.38	11.19	12.82	7.33	60.1
March	04	109	146.4	33.47	18.08	16.78	7.94	57.86
April	04	39	174.5	35.14	21.44	20.66	8.68	60.93
May	15	236	168.2	34.4	23.93	23.22	6.56	70.8
June	22	171	129.1	32.99	25.43	24.93	4.27	78.68
July	22	295	130.1	32.47	26.25	25.66	3.6	80.81
August	25	408	111.8	32.9	25.42	25.77	3.64	82.5
September	13	176	131.1	34.33	25.29	25.51	6.41	78.08
October	09	166	118.2	33.46	23.95	24.64	7.17	78.88
November	02	02	87.9	30.22	16.04	18.1	7.75	72.93
December	05	66	87.7	26	12.83	15.05	6.13	72.69
Total/ Average	122 (Total)	1691 (Total)	1457 (Total)	31.58	19.20	20.50	6.26	71.87

OTHER ACTIVITIES

Annual Returns of BTB and BCS

The annual returns of BTRI farm including Bilashcherra experimental farm and sub stations on land use, tea seeds, plants and tea waste and also on employment and employment cost (BTB return Form No. 1 & 3) were prepared for the period of 2021 and sent to BTB. The annual statistical return of manpower and labor welfare and on tea garden land (BCS form No. 2 & 3) of BTRI farms including sub stations for 2021 had also sent to BCS office, Dhaka.

Courses on tea culture

The Scientific personnel of the division delivered lectures on tea Statistics and Economics at 56th Annual Course of BTRI held at BTRI Main Station, Sreemangal.

Advisory visits

In 2021, a total of six (6) conjoined (with other divisions) advisory visits were paid by the scientific personnel of the department to different tea estates and rendered advice as per the estate's requirements. Six (6) advisory correspond letters were issued according to the visit.

BILASHCHERRA EXPERIMENTAL FARM

BTRI, SREEMANGAL

In Charge: Md. Rayhan-Ur- Rahaman, Scientific Officer, Botany Division

STAFF

There was no other change in the staff position during the 2021.

FARM**Table 1.** Land Distribution

Sl. No.	Description	Area (ha)	
	Tea cultivated area	128.33	
	I. Plucking Area		
	1. Immature Tea (under 5 years)	16.29	
	2. Tea bushes 6 to 10 years	08.02	121.33
(a)	3. Tea bushes 11 to 40 years	32.56	
	4. Tea bushes 41 to 60 years	64.46	
	II. Seed Bari	6.00	
	II. Seed Nursery	0.50	
	III. Clone Nursery	0.50	
	Under Subsidiary Crops	32.17	
(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	25.30	
(d)	Cultivable, Fallow and Waste Land	42.56	
	Total Area of the Farm	228.36	

Table 2. Crop Production 2021

Black Tea		Green Tea		Total	Total Made	Tea	Average Production
Green Leaf (kg)	Made Tea (kg)	Green Leaf (kg)	Made Tea (kg)	Green Leaf (kg)	Tea (Black Tea+ Green Tea)	cultivated area (Excluding immature tea area)	(Excluding immature tea area)
808835	195990	3095	653	811930	196643	112.04	1755.11

Table 3. Green leaf Production of the Farm in the Year 2021

Name of the Month	Month-wise crop production in 2021 (kg)		
	Green Leaf for Black Tea	Green Leaf for Green Tea	Grand Total
January	0	0	0
February	0	0	0
March	982	0	982
April	26078	0	26078
May	45422	116	45538
June	158081	629	158710
July	125367	0	125367
August	150074	293	150367
September	108312	627	108939
October	109852	664	110516
November	64951	385	65336
December	19716	380	20096
Total	808835	3095	811930

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

Bi-Clonal Seed production(kg)	Institutional use (kg)	Sales of Bi-Clonal Seed (kg)	Sale amount (Tk)	Sales of Different Fruit (Tk)
722 kg	All seeds were sent to BTRI		-	-

Extension and Development

It has a nursery with the average capacity of 100000 plants. Water supply, labor houses, roads and bridges were regularly maintained. 7875 tea saplings were infilled in section no 5 and 1000 tea saplings were infilled in section no 12 in the year 2021 and . 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 Fatickchari Sub-station
Chattogram**

Personnel

Mr. Md. Moshiur Rahman Akonda (Scientific Officer, Plant Pathology Division) performed his duties as Officer-In-Charge during the reporting year. Mr. Shuva Das (Soil Science) transferred from BTRI, Srimangal to BTRI Sub-station, Fatickchari on 10 November, 2021. However, Mr. Ajit Chandra Chowdhury (Senior Farm Assistant) and Mr. Md. Kamal Hossen (Upper Divisional Assistant) carried out their responsibilities as in before, consecutively.

Production of green leaves

During the year, about 56,980 Kg of green leaves were plucked from the existing tea plantation and sold to Kaiyacherra Dolu Tea Estate @ Tk. 34 per Kg.

Distribution of improved planting materials

About 12, 91,050 no. of fresh cuttings were collected from the mother bush area and 40 Kg of bi-clonal tea seeds were harvested from the Seed-bari of the sub-station. The materials were distributed to the different tea gardens, small tea growers and Chattogram Hill Tract project (CHT), Bandarban.

Infilling Program

About 21,130 tea saplings were planted to fill the vacancies in the existing young tea plantation during the reporting year.

KALITI SUB-STATION

Kulaura, Moulvibazar

STAFF

During the reporting year 2021, there was no change in personnel position of the sub-station.

PRODUCTION

Year	Production of green leaf (kg)	Fresh cutting supplied to different Tea Estates (No.)	Tea plants raised in the nursery (No.)
2021	43,220*	50,000	5,000**

*Produced green leaves were sent to BTRI Black Tea Factory for manufacturing.

**Plants raised in the nursery mainly used for infilling in vacancies of the sub-station.

BTRI SUB-STATION
Bandarban
Suman Sikder
Senior Planning Officer & Project Director

Senior Tea Maker Mr.Md. Amir Ali, B.Sc. (RU), Bangladesh Tea Research Institute Joined BTRI SUB-Station Bandarban on 2019. There were no other changes in the personnel position of the Sub-station during the reporting year.

Extension Progress

There was a total no. of small grower under registration 372, No. of small grower under tea cultivation 125, total land under tea cultivation 614 Acre in the year 2021. Provided technical support all over the year to small holding tea growers. Co-ordinated sales of green leaves all over the year.

Works under the Project

1. Given newly registration small tea grower 237 N0s.
2. Tea sapling raised 11.80 lac.
3. Land lease for tea sapling production 2.63 Acre.
4. Training of different topics such as tea plantation, land preparation, pruning, plucking, disease and pest management, Total no. of farmer 1325 under 53 batches.
5. Necessary repairing of the office building has been done in the reporting year.
6. Proper maintenance of mother bush plot around the year.
7. Made tea processed from factory 6780 kg in 2021.

BTRI SUB STATION, PANCHAGARH**Dr. Mohammad Shameem Al Mamun**

Senior Scientific Officer (Entomology)

&

Officer in-charge

STAFF

Mr. Md. Zayed Imam Siddiqi, Senior Farm Assistant transferred from Nilphamari and joined on 23 August 2021 at BTRI Sub Station, Panchagarh. Mr. Md. Jahurul Islam, Driver transferred from BTB Head Office, Chattagram and joined on 07 March 2021 at BTRI Sub Station, Panchagarh. Mr. Md. Jahurul Islam, Driver transferred from BTRI Sub Station, Panchagarh to BTB Liaison Office, Dhaka on 06 October 2021. Mr. Asaduzzaman, Driver transferred from BTB Liaison Office, Dhaka and joined on 14 October 2021 at BTRI Sub Station, Panchagarh. There was no other change in the personnel position of the BTRI Sub Station, Panchagarh during the period under report.

Statistical Information

A total of 30 tea gardens (9 registered and 21 unregistered) and 8,067 small holding tea gardens in the plains of North Bengal (Panchagarh, Thakurgaon, Lalmonirhat, Dinajpur and Nilphamari) produced a total of 14.54 million kg of made tea in 2021. In other words, 15 percent tea has been added to the national production from the tea plantations in the northern plains and ranked 2nd in respect of region wise production. In 2021, tea has been cultivated on a total of 11,433.94 acres of land in five districts of Northern Bangladesh. A total of 7,35,68,009 kg of green tea leaves have been produced from these tea gardens, from which 14.54 million kg of made tea has been produced in 22 running tea factories of Panchagarh, Thakurgaon and Lalmonirhat which is the highest record of tea industry in North Bengal. In 2020, the area under tea cultivation in North Bengal was 10,170.57 acres and the amount of tea production was 10.30 million kg. Compared to the previous year, the cultivation of tea area has increased by 1,263.37 acres (12.42%) and 42.30 lakh kg (41.02%) more tea has been produced in 2021. A total of 41 tea factories have been approved from Bangladesh Tea Board in Panchagarh, Thakurgaon and Lalmonirhat districts up to December 2021.

Development Project

A development project entitled “Extension of Small Holding Tea Cultivation in Northern Bangladesh” under Bangladesh Tea Board, Ministry of Commerce funded by Bangladesh Tea Board Own Fund as Overseas Development Assistance (ODA) and European Commission (EC) Revolving Fund was successfully implemented at BTB Regional Station, Panchagarh during 1 September 2015 - 30 June 2021. The total budget allocation of the project was 740.00 lakh taka. The objective of the project is to extend tea cultivation in 500 hectares of land (300 ha. in Panchagarh, 150 ha. in Thakurgaon, 25 ha. in Dinajpur & 25 ha.

in Nilfamari) by organizing and motivating the farmers in the project areas and to supply the planting materials (Fresh cuttings) & 10 lakh tea saplings of appropriate clone/variety at the cheapest rate to the tea growers of that locality each year. The project has been successfully completed on 30 June 2021. A total of 570.65 hectare of lands was extended under tea cultivation and 1,321 small tea growers were registered under this project. About 10.15 lakh tea saplings were raised in the nursery and 9.10 lakh tea saplings have been distributed to the registered small grower at the subsidized rate @ Tk. 2.00/Saplings. A total of 500 pruning knives and spray machines were distributed at free of cost to the registered marginal tea farmers in the project. The financial and physical progress of the project is 80.04% and 86.26%, respectively.

Advisory visit

A total of 82 advisory visits were paid to different tea gardens and small tea growers' gardens in northern Bangladesh under BTRI, PDU, Northern Project and rendered advice on tea cultivation in scientific way during 2021. Twenty one (21) samples of tea plants/plant parts were received from different small tea growers' garden in respect of identification of various pests, diseases, other nutrient deficiencies, and suggested their remedies during the reporting year.

Official visit

A total of twelve (12) official visits were paid to different organizations including Rangpur, Naogoan, BARC, Dhaka; BTRI/PDU, Srimanagal, and Ministry of Commerce, Dhaka during 2021.

Training/Workshop

A total of Ten (10) training workshop were conducted by BTRI and PDU for small tea growers in Panchagarh, Thakurgaon, Nilfamari & Dinajpur on different aspects of tea culture under the umbrella of "Camellia Khola Akash School" during 2021. Besides, Twenty three (23) training/seminar/rally/motivation workshops were conducted for small tea growers at different upazillas under Northern Bangladesh Project during 2021.

Miscellaneous

"Clonal demonstration plots of improved varieties of tea" was established and inaugurated at BTRI Sub Station, Panchagarh by the Honorable Chairman, Bangladesh Tea Board Major General Md. Ashraful Islam, ndc, psc on 18 October 2021.

Major General Md. Ashraful Islam, ndc, psc, Chairman, Bangladesh Tea Board visited BTB Regional Station, Small scale tea gardens, Bought leaf tea factory and attended in a meeting of exchange of views with stakeholders of tea industry of Panchagarh on 18 October 2021.

Other activities of the divisions during 2021

Sl.	Item	Soil Science	Botany	Agronomy	Entomology	Plant Pathology	St. & Eco.	Bio-Chemistry
01	No. of experiments	06	42	07	04	05	2	03
02	No. of experimental, advisory and official visits	38	25	46	51	46	10	1
03	No. of advisory correspondence	143	93	13	12	19	6	1
04	No. of soil, fertilizer & dolomite samples analyzed	1666			-			
05	No. of nursery soil, water & cowdung samples analyzed for nematodes	-	-	-	39	-	-	-
06	No. of pesticide residue analysis (commercial)	-	-	-	-	-	-	-
07	No. of pesticide residue analysis (Experimental)	-	-	-	-	-	-	-
08	Physical test of pesticides in Lab.	-	-	-	09	6	-	-
09	No. of pesticides/ Weedicides tested in tea fields	-	-	-	35	29	-	-
10	No. of circulars/pamphlets/leaflets issued to T. E.	-	02	-	01	01	-	-
11	No. of workshop/seminar conducted	04	5	4	03	03	-	-
12	MTC module conducted (Hours/year)	06	16	30	-	22	-	-
13	Attended national seminar, conference, symposium & workshop		-	-	-	-	-	-
14	Attended international seminar, conference & symposium	-	-	-	-	-	1	-
15	Attended Training/Course			-	01	-	2	-
16	No. of research paper published		1	1	01	02	1	-
17	No. of Fresh cutting supplied	-	-	518500	-	-	-	-
18	No. of Rotted cutting supplied	-	2717	15005	-	-	-	-
19	Biclinal seed supply to T. E.	-	722	-	-	-	-	-
20	Tea tasting session/ course	-	07	-	-	-	-	-
21	Received Tea Sample Tasting	-	1566	-	-	-	-	-
22	Biochemical analysis of tea sample							63