Ready Reckoner for Externally Funded Projects as on June, 2022

Name of the Projects	Project Leader	Past work	Deliverables	Status	Date of start/ completion
Entomology					
1. Understanding the mechanism of resistance to sucking pest, *Helopeltis theivora* and development of microbe based bio-formulation against major tea pests.	Dr. Somnath Roy Dr. M. Sarmah	Deltamethrin Resistance was observed in field strains of *Helopeltis theivora* collected from eight tea growing sub districts of Doars, and Darjeeling and Jorhat. This was supported by biochemical resistance enzyme studies. The enzymes seemed to be associated with mechanism for creating pyrethroid resistance in *Helopeltis theivora*. RBD Field trials have been proved their efficiency in controlling both the pest under field condition in different agroclimatic region LC50 and LC95 determination ,ovicidal,	This project will generate resistance map and mechanism of resistance development (genetic and enzymatic level) of *Helopetis theivora*against different groups of insecticieds all over North East India. Identification of gene responsible for resistance in *Helopeltis theivora*. Screening of Actinobacterial metabolites against red spider mite, tea mosquito bug and tea looper Evaluation of efficacy of Actinobacterial metabolties at small scale field level	**October – December (Q4)** The project started in the month of December, 2019. Requisition of the Research Associate-I under the project. Conducted a meeting among collaborator (Boss institute, Kolkata & IASST, Guwahati) to discuss about the work plan. Collection and maintaining culture of Tea mosquito bug and Red spider mite in the laboratory. Standard curve for General esterase activity, CYP450 and protein Estimation for *Helopeltis theivora* was prepared. Standardising the Sodium Dodecyl Sulphate (SDS) Polyacrylamide Gel for *Helopeltis theivora*. **January- March 2020 (Q1)** Body lipid content of *Helopeltis theivora* collected from Tocklai Division was estimated by following	Duration: 03 years (30 September 2019) To 30 Sept.2022

		ovipositional deterent, antifeedant, repellant and growth inhibitory activity Multilocation field trials in randomized block design using different pesticides against different tea pest viz. tea mosquito bug, red spider mite ,thrips, jassids, looper, etc to generate data for CIB registration following standard protocol		the method of soxhlet 1879. Standardization of SDS- Page protocol is being working out specifically for *Helopeltis theivora*. Estimation of detoxifying enzyme- General esterase was done for *Helopeltis theivora* collected from Tocklai Division. **April-June 2020 (Q2)** The *Glutathione S-transferases* and General Esterase level is more in female than male tea mosquito bug, however no such significant variation was observed in case of Cytochromes *P450* activity. Total body lipid content of TMB collected from tocklai division was found to be 6.65 and 8.06% in male & female respectively showing a mean difference of 1.41%. Electrophoresis of *H. theivora* was carried out in 8% polyacrymide gels using equal amount of protein in Tris – glycine (pH 8.8) at 200 v for 1-2 h at 4 ^{o}C and stained at Commasie Briliant blue for protein bands. **July- Sept 2020 (Q3)** Collection of Tea mosquito bug, Tea looper and Red spider mite from Banaspati T.E, Cinamara T.E & Teok	

				T.E, and maintaining laborataory culture for performing resistance and bioassay study. Relative susceptibility (LC 50) for Thiamethoxam 25WG and Thiacloprid 21.7% SC against Tea mosquito bug after 24hrs of observation is found to be 125.26 ppm and 264.501 ppm respectively. Collection of leaf , root and soil samples of TV 1 standard, TV4, TV10, TV14, TV17, TV23, TV25, TV mother plant (seed bearing & vegetative clones), and also two of the non cultivable varities i.e Japonica and Rosifera from New Botanical Garden for project related work. Collection of 5 different strains of Actinobacterial isolates from Institute of Advanced Study in Science and Technology, Guwahati for screening pesticidal activity against Red spider mite, Tea looper and Tea mosquito bug. Studied the bioassay of one actinobacterial isolates (Strain ATE7) collected from Institute of Advanced Study in Science and Technology, Guwahati against tea red spider mite and tea mosquito bug. Preliminary results showing encouraging results against tea red spider mite compared to tea mosquito	

				bug. **Oct- Dec (Q4)** Collection soil samples of TV 1 standard, TV4, TV10, TV14, TV17, TV23, TV25, TV mother plant (seed bearing & vegetative clones), and also two of the non cultivable varities i.e Japonica and Rosifera from New Botanical Garden for soil analysis. Studied the bioassay of five actinobacterial isolates (Strain ATE7, ATE 26, SA1, T1LA2,KA12) collected from Institute of Advanced Study in Science and Technology, Guwahati against tea red spider mite , tea mosquito bug and tea looper. Preliminary results showing encouraging results against tea red spider mite compared to tea mosquito and looper. Antifeedant test was performed on 2nd instar larvae of *Hyposidra talac*, and adult tea mosquito bug using metabolites of five actinobacterial strains namely: ATE7, ATE 26, SA1, KA12 and T1LA3. Preliminery studies showed no any promising results as antifeedant. Collection of adult female *H.Theivora* from Nahoroni T.E, Sesa T.E and Kolony T.E for the study of detoxyifying enzymes.	

				Jan- March 2021 (Q1) Biochemical study performed for detoxifying enzyme activities estimation: General Esterase, Glutathion-S-transferase, Cytochrome P450 and total protein estimation for *H. theivora* population collected from Naharani T.E, Sesa T.E, Kolony T.E and Singri T.E. Screening bioefficacy of five actinobacterial isolates (Strain ATE7, ATE 26, SA1, T1LA2, KA12) to check the effectiveness after first trial against tea red spider mite, *Oligonychus coffeae.* Assessment of Lethal effects after 24 hours observation respectively of flupyradifuron(Sivanto),Deltamethrin 2.8 EC and Quinalphos 25 EC against *Helopeltis theivora* (adult stages). LC50 and LC95 of the same calculated using Finney's probit analysis method (Finney 1973) and expressed in parts per million. After 24hrs of observation is found to be 330.30 ppm, 0.27 ppm and 373.90 ppm respectively. Plot preparation to plant tea seedling for pot experiment.	

				April - June 2021 (Q2) Field collection of adult *Helopeltis theivora* from *Upper* Assam (Tinsukia Region) was done. Assessment of Lethal effects after 24 hours observation respectively of flupyradifurone (Sivanto), Deltamethrin 2.8 EC, Thiamethoxam 25 WG and Quinalphos 25 EC against *Helopeltis theivora* (adult stages). LC50 and LC95 of the same using Finney's probit analysis method (Finney 1973) and expressed in parts per million was calculated for Deamoolie T.E , Tinsukia. Comparing the LC_{50} values of five different insecticides for observing mortality against adults of *H.theivora* showed the least susceptibility to Deltamethrin (2955.34 ppm). The order of susceptibility was: Quinalphos > Thiametoxam > flupyradifurone > Deltamethrin. Biochemical essays performed to estimate of enzyme activity: General Esterase, Glutathion-S-transferase and Cytochrome P450 against adult females of *H. theivora* collected from Deamoolie T.E, Tinsukia. Tinsukia *H. theivora* population showed significantly higher general	

				esterase (3.05 fold) and GST (1.56 fold) activities than Jorhat population; however there was no significant difference in CYP450 activity Collection of ethyl acetate extracts of previously used actinobacterial strains from IASST, Guwahati for screening against major tea pest viz Tea looper(*Hyposidra talaca*), tea mosquito bug (*Helopeltis theivora*) and red spider mite (*Oligonychus coffeae*) Relative toxicity of LC50 values after 24 hrs observation was observed for ethyl extract of one actinobacterial metabolites (ATE 7) against red spider mite. Further repetitions required before any conclusion. **July - Setember 2021 (Q3)** Assessment of Lethal effects of three commonly used insecticides, viz., Deltamethrin 2.8 EC, Thiamethoxam 25 WG and Quinalphos 25 EC against adult female *Helopeltis theivora* collected from different tea geographical populations [South Bank of Assam (Sesa T.E , Powai T.E, Lepetkata T.E and Basmatia T.E), Eastern Dooars (Meenglass T.E., Damdim T.E., Rangamutee T.E.); Central Dooars Gandrapara T.E., Lakhipara T.E., Hope T.E., Jiti T.E.,	

				Nagarakata T.E, Ambari T.E); Western Dooars (Sankos T.E., Kumargram T.E.); Terai (Simulbari T.E, Singaijhora T.E) and Darjeeling (Castleton T.E.) along with a laboratory susceptible strain after 24 hrs observation based on standard leaf-dipped method. Biochemical essays to estimate of enzyme activity: General Esterase, Glutathion-S-transferase and Cytochrome P450 against adult females of *H. theivora* collected from above mentioned gardens were performed. **October - December 2021 (Q4)** Laboratory screening of ethyl acetate extracts of actinobacterial strains ATE 26 and KA12 have been done and relative toxicity (LC50 values) for both the actinobacterial strains worked out against adult red spider mite, O. *coffeae*. Biochemical studies for detoxifying enzymes were done for General Esterase, Glutathion-S-transferase, Cytochrome P450 and total protein estimation for *H. theivora* population collected from Dooars and Darjeeling region. Assessment of LC_{50} and antifeedant activity of ethyl acetate extracts of 3 actinobacterial strains viz. ATE 26, T1LA3 and KA12 were done against	

				adult *Helopeltis theivora* collected from Jorhat area. Assessment of LC_{50} and antifeedant activity of ethyl acetate extracts of 4 actinobacterial strains viz. ATE 26, ATE 7, SA1 and KA12 were done against 2nd instar *Hyposidra talaca* larvae collected from Saraipani T.E, Titabor. **January – March 2022 (Q1)** Field visit to saraipani T.E, Borbheta T.E and Cinnamara T.E for collection of *O. coffeae* for experimental purpose. Laboratory screening of ethyl acetate extracts of actinobacterial strains ATE 7, SA1, and T1LA3 have been done and relative toxicity (LC50 values) for both the actinobacterial strains worked out against adult red spider mite, O. *coffeae*. Laboratory screening of ethyl acetate extracts of actinobacterial strains ATE 7 and SA1 have been done and relative toxicity (LC50 values) for both the actinobacterial strains worked out against adult Tea mosquito bug, *H. theivora*. Field visit to saraipani T.E for collection of looper, *H. talaca* for experimental purpose.	

				April- June 2022 (Q2) Visit to IASST, Guwahati for collection of 5 new actinobacterial strains viz. **PTS 94, BT12, ATE -5, ATE-21,** and **A13** (both in broth culture and ethylacetate form) for microbial bioassay against *Helopeltis theivora*, *Oligonychus coffeae,* and *Hyposidra talaca*. PTS 94, BT12, ATE-5, ATE-21, and A13 were tested for 24 hours, 48 hours, and 72 hours against O. coffeae and H. theivora to determine their efficacy after treatment. The lethal concentration of ethyl extracts by actinobacterial strain A13 against Oligonychus coffeae (adult stages) was determined. Field trip to Amgoorie T.E. to evaluate the lethal effects of three commonly used insecticides, namely Deltamethrin 2.8 EC, Thiamethoxam 25 WG, and Quinalphos 25 EC, on adult female Helopeltis theivora after 24 and 48 hours of observation using the standard leaf-dipped method.	
2. Development of bio-rational non-chemical based	Dr. Somnath Roy.	Different species of termites, both live-wood eating and scavenging	After successful completion of the research work, this project will generate sufficient	**October- December, 2019 (Q4)** The project has been initiated and Research Fellow selected via interview.	Duration: 3 years. 24th of October 2019

IPM package for live wood eating tea termite, a devastating pest of tea plantation in North East India.		were recorded from tea in North-East India. Live wood eating termites (*Microcerotermes* sp and *Microtermes* sp.) are more dangerous for north-east Indian tea plantations. Termites are responsible for major damage to young and mature teas plants especially in Cachar and North Bank areas of Assam, Tripura and Terai region in North Bengal. Das (1962) reported that at least 15 per cent of the total crop is annually lost due to the attack of termites. Many termite species caused considerable damage to tea bushes and shade trees. Throughout the world, lot of research is being carried out on biological alternatives for termite control, albeit primary on dry wood feeding termites in domestic and	knowledge on the present status of live wood eating termite in different parts of tea plantations of northeast India mainly North Bank of the Brahmaputra, Cachar and Tripura tea plantation. Region specific bio intensive non-chemical based IPM package recommendations will be made available to the tea planters for the best possible practices for management of live wood eating termite. This may ensure low-cost, eco-compatible, pest management package.	Survey was initiated in North Bank and south bank tea gardens. Collection of termites from Sessa Tea Estate (North Bank) and Dessoi Tea Estate (South Bank). Preparation of questionnaires for termite and distributing in tea gardens. Standardizing and maintaining culture of termite in the laboratory. **January- March 2020 (Q1)** Survey, collection and estimation of level of infestation of live wood eating termite were carried out in seven tea estates viz. Sessa T.E., Lukwa TE, Khona TE, Nambornadi T.E., Amgoorie T.E., Dessoie T.E and Gorunga T.E. Further, soil samples were also collected from each tea estate for microbial analysis. DNA extraction and isolation method from head and thorax region of termite has been standardized. Screening of fungus from mound soil of termite collected from Nambur nodi TE has been done **April-June 2020 (Q2)** Isolation of fungus in PDA media from soil samples collected from termite infested sections of Hathikuli T.E.	to 24th of October 2022

		commercial settings. Biological alternative to termite control primarily includes use of botanical control (bioactive constituents) and biological control (use of bacterial, fungal toxins, bacterial symbiont and entomopathogenic nematodes). Beside these components, considerable success in termite control also has been achieved using baits. However, in India, predominant research on biological control of termites is focused so far on assessment of plant products. There are several reports of damage to tea by the termite from Sri Lanka (Ranaweera, 1962; Sivapalan and Senaratne, 1977; Sivapalan et al., 1977) and Indonesia (Damiri, 2014). These are scavenging termites which have occasionally		Standardization of Cytochrome oxidase 1 and cytochrome oxidase 2 primer for DNA extracted from termites of Borbhetta T.E. Organic carbon and hot water extractable carbon estimation method is being standardized using Hathikuli T.E soil samples. **July- Sept 2020 (Q3)** DNA extraction and PCR amplification with COII (cytochrome oxidase II) primer of termite from Hathikuli T.E was done and the gel cut has been sent for sequencing. Survey of termites infestation in Teok T.E. was done. Termites species collected from Hathikuli & Teok T.Es of Assam and Bhatpara and Ramjhora tea estate of Dooars to be sent to ZSI for identification. One set of molecular and morphological identification of live wood eating termite was completed. Soil collection from Teok T.E was done for soil analysis and screening of fungus. Isolation of *Termitomyces* fungi from fungus comb of termites is being done in	

		been found to cause damage to the tender roots of tea and are thus sometimes grouped with live wood termites (Cranham, 1966). There are few species of live wood termites which cause direct damage to tea, viz. *Microcerotermes beesoni* Snyder, *Microtermes obesi* Holmgren, *Postelectrotermis militaris* Desneux, *Neotermis greeni* Desneux and *Glyptotermes dilatatus* Bugnion and Popoff. The live-wood termites chronic problem in North bank of the Brahmaputra River and Barak valley Assam and Tripura tea plantations, which spreading to south bank of Assam and North Bengal region. In India, there are several species of		PDA media. **October- December 2020 (Q4)** Survey, collection and estimation of level of infestation of live wood eating termite in tea estates of North Bank region of Assam viz. Nahorani T.E, Sessa T.E, Kolony T.E, Singri T.E and Dalowjan T.E in South Bank. Fungus comb spotted in Teok T.E, Section 12 was directly placed in PDA (Potato Dextrose Agar) media to screen and isolate fungus which exhibit mutualism with termites. DNA isolation of Bhatpara T.E and Teok T.E termite is done and after PCR amplification is to be sent for sequencing for molecular identification. Total organic carbon, dissolved carbon, total nitrogen, potassium and phosphorus of soil samples collected from termite infested section 7B of Bhatpara T.E (North Bengal) has been carried out. **January – March 2021 (Q1)** Infestation survey, collection and estimation of level of infestation of live wood eating termite in four tea estates of Tripura viz. Brahmakunda T.E, Narendrapur T.E, Mohanpur T.E, Simnacherra T.E and three tea estates of	

		termites that cause damage to tea plants, out of which *Microcerotermes beesoni* Snyder (live wood eating), *M. obesi* Holmgern (live wood eating) and *Odontotermes feae* Wasman (scavenging) have been identified and confirmed by the Zoological Survey of India, Kolkata from the Barak valley, Assam (Singha et al., 2011). In Barak Valley, southwest facing slopes are most affected possibly due to poor soil moisture and shade (Choudhury et al., 2005). A comparative study on degree of infestation of live wood eating and scavenging termites was done taking 10000 tea bushes in each case (Choudhury et al., 2005). In both the cases		Assam viz. Lepetkata T.E, Romai T.E and Oating T.E. Model plot layout and spraying was done in Namburnadi T.E (Assam), Bhatpara T.E (North Bengal) and Brahmakunda T.E (Tripura) following RBD method. Five treatments viz. Thiomethoxam, Entomopathogenic nematode (EPN), Metarhizium anisoplae, Thiomethoxam and Entomopathogenic nematode, Thiomethoxam and Metarhizium anisoplae were sprayed. Total organic carbon, dissolved carbon, total nitrogen, potassium and phosphorus of soil samples collected from termite infested section 12 of Teok T.E (Assam) has been completed. Soldier caste of termite from three tea estates of North Bank (Assam) sent to ZSI has been identified. Live wood eating termite*Ancistrotermes pakistanicus* and *Microtermes obesi* has been morphologically identified. **April- June 2021 (Q2)** Live wood eating termite infestation survey in tea estates of Terai region (North Bengal) viz. Satish Chandra T.E., Vijaynagar T.E., Ord T.E., Belgachi T.E., Matigara T.E., Nischintapur T.E. and Dirai, Kenduguri T.E of Assam was done. Soil has been collected from tea	

		preliminary surveys were done to assess the severity of infestation and population intensity at specific termite infested sites, in tea estates that were representative of that area. Variations of clonal susceptibility were also studied using 12 tea varieties viz. TV1, TV14, TV16, TV17, TV18, TV19, TV20, TV22, TV23, TV24, TV25 and TV26 (Choudhury et al., 2005). Among chemical pesticides, endosulphan, chloropyriphos and phorate were equitoxic (Choudhury et al., 2005). There has been heavy usage of organosynthetic pesticides since 1950s against termites, leading to rapid conversion of innocuous species into pests, development of resistance, and undesirable pesticide		estates infested with live wood eating termite. Soil chemical analysis (total organic carbon, dissolved organic carbon, available nitrogen, exchangeable potash, available phosphate) of termite infested and non-infested soil of tea estates of Assam viz. Teok T.E, Dolowjan T.E, Nahorani T.E, Sessa T.E., Singri T.E has been completed. DNA extraction, PCR amplification and sequencing data for 15 fungal isolates were obtained. Molecular identification of 11 isolates from mound soil and 4 isolates from control soil were completed. The identified fungi from mound soils were *Penicillium simplicissimum*, *Flavodon flavus*, *Penicillium ochrochloron*, *Mucor irregularis*, *Cunninghamella bainieri*, *Trichoderma harzianum*, *Gongronella butleri*, *Phanerochaete sp*; whereas from control soil *Aspergillus aculeatus*, *Humicola fuscoatra*, and *Aspergillus fumigatus* were identified. Preliminary studies on termite gut symbiotic bacteria confirmed the presence of cellulolytic bacteria. **July - Setember 2021 (Q3)** Live woodeating termite survey in Tripura region viz. Durgasbari T.E,	

		residues in tea (Pandey et al., 2013). Additionally, it has been observed that worker caste of termites is more exposed to the pesticide residues and organic matter of tea plantations (Biswa and Mukhopadhyay, 2013). A comparative study of detoxifying enzymes General Esterases (GE) and Glutathione S-Transferase (GST) between worker and soldier castes of *Odontotermes obesus*, showed a 3.46 and 2.45 folds' higher expression of GE and GST, respectively, in worker termites compared to that of the soldiers (Biswa and Mukhopadhyay, 2013).		Harishnagar T.E, Kamalasagar T.E and Binodini. T.E. Second round treatment for termite control using treatments (Five treatments viz. Thiomethoxam, Entomopathogenic nematode (EPN), *Metarhizium anisoplae*, Thiomethoxam and Entomopathogenic nematode, Thiomethoxam and *Metarhizium anisoplae* were sprayed) was done in Namburnadi T.E (Assam), Bhatpara T.E (North Bengal) and Brahmakunda T.E (Tripura) DNA extraction of 8 termite specimens and PCR amplification using COII (cytochrome oxidase II) forward and reverse primer was done. The gelcut has been sent for sequencing for the purpose of molecular identification of termites collected from various tea estates of Assam Two fungus isolated from fungus comb of termites (obtained from Teok T.E, Sec-12) have been identified as *Trichoderma erinaceum* and *Penicillium glaucoroseum* **October - December 2021 (Q4)** Chemical analysis of termite infested and non-infested soil collected from four tea estates located in Tripura *viz*. Durgabari T.E, Harishnagar T.E, Kamalasagar T.E, Binodini T.E have been completed.	

				PCR amplification using COII (cytochrome oxidase II) forward and reverse primer of eight termites (collected from tea estates of northeast India) DNA samples. The PCR product was run in 1% agarose gel and the gel cut was sent for sequencing for the purpose of molecular identification. Soldiers of termite collected from tea estates of Tripura viz. Durgabari T.E, Harishnagar T.E, Kamalasagar T.E, Binodini T.E. were separated and have been sent to ZSI (Zoological Survey of India) for morphological identification. The images of soldiers and workers were taken under the microscope. **January – March 2022 (Q1)** Live wood eating termite infestation survey was done in Assam (Harchurah T.E) and Silchar (Koomber T.E, Coombergram T.E, Silcoorie T.E, Iringmara T.E, Borokai T.E). Bait trap was standardized for detection of termite. Multilocation bat trial is in progress. Multilocation field trial using entomopathogenic nematode (EPN), *Metarhizium anisopliae* and ITK has been initiated in Durgabari T.E (Tripura); Koomber and Coombergram T.E	

				(Silchar) and in Dejoo T.E (Assam). To detect and prevent termite infestation in new plantation area, field trial using different concentrations of entomopathogenic nematode (EPN), *Metarhizium anisopliae* and thiamethoxam is in progress in Aamgoorie T.E (Assam). **April – June 2022 (Q2)** Field visit and termite collection from Hathikuli T.E. and Namburnadi T.E. Termite infestation count after the first round of treatment application has been completed in Dejoo T.E (Assam) and Durgabari T.E (Tripura). The second round of termite treatment application, which includes different ITKs, commercially available entomopathogenic nematode (EPN), and commercially available entomopathogenic fungus such as *Metarhizium sp*.along with the tocklai strain, was done in Dejoo T.E and Durgabari T.E. Gut bacteria have been isolated from termites collected from Hathikuli T.E. and Namburnadi T.E. Different strains of bacteria were grown as pure cultures in nutrient agar media. Most of the bacterial	

				isolates are found to be gramme negative. Isolation of fungus from fungus combs of termites collected from tea estates of Assam is in progress. To obtain pure cultures for identification, sub-culturing is used. Enzymes (General Esterase, Glutathione S- transferase, Cytochrome P450) and total protein estimation have been initiated for tea termites collected from conventional tea estates	
3. Isolation, identification and synthesis of pheromones of major looper pest of tea *Hyposidra talaca* Walker for the development of pheromone based management strategy**.** [Funding Agency: DBT]	Dr. Azizur Rahman	Before this no work has been done at Tocklai on the pheromone of looper	We wish to exploit the sexual communication system of this insect by means of identifying, formulating and utilizing their sex pheromone for monitoring, mating disruption and masss trapping of adult insects (moths). This project will cover different approaches that include electrophysiological, behavioural bioassays, molecular identification of sex pheromone compounds. Further we will systhesize the identified compound synthetically and development of pheromone trap for the selected insect pest. Subsequently, standardization of	**July – September (Q3)** The project started in the month of August, 2021. Requisition of the Research Fellow – 2 & Project Assistant - 1 under the project. Field collection and maintaining culture of tea looper pest in the laboratory. 100 male and 90 female pupa of looper sent to National Chemical Laboratory, Pune (CSIR- NCL). **October – December (Q4)** Field collection and maintaining culture of tea looper pest in the laboratory. 200 male and 200 female pupa of looper	Project Duration: Upto 31st March, 2024

			the dose by field evaluation wiil be done to acertain the effectiveness of the synthetic pheromone under field condition. As a deliverable, and eco-friendly, sustainable, effective and economically viavble pheromone lure in a suitable trap will be designed as an important tool of IPM for managing this destructive defoliating pest of tea.	sent to National Chemical Laboratory, Pune (CSIR- NCL). Pheromone isolated from pheromone gland of adult moth in Laboratory. **January-March, 2022 (Q1)** Field collection and maintenance of culture of tea looper (*Hyposidra talaca)* pest in the laboratory. 50 male and 50 female pupa of looper sent to National Chemiical Laboratory, Pune (CSIR- NCL). Visited CSIR-NCL Pune for experimental purpose. Carried live Insect Pupa to CSIR-NCL for extraction and detection of pheromone. Dissected pheromone gland of Looper (*Hyposidra talaca*) and extracted pheromone at Entomology laboratory, CSIR-NCL Pune. Learned and performed EAG and GC-EAD at CSIR-NCL Entomology department. Disinfaction of insect culture lab by Sodium Hypochlorite solution.	

				April-June,2022(Q2) 40 male and 60 female pupa of looper (*Hyposidra talaca*) sent to National Chemical Laboratory, Pune (CSIR-NCL). Field collection and maintaining culture of tea looper pest in the laboratory.	
Soils					
4. Impact of IFFCO Liquid Nano Urea on yield and quality of tea in North East India (New experiment)	Dr. H. Malakar, Dr. J. Dutta, Dr. P Pramanik, Dr. Tanmoy karak and others		1. To evaluate the efficacy of IFFCO Liquid Nano Urea on growth, yield and quality of tea. 2. To find out the effective dose and frequency of application of IFFCO Liquid Nano Urea for tea in North East India. 3. To evaluate the impact of frequency of the foliar applications on phytotoxicity and related issues.	The field experiments have been intiated in Borbhetta Experimental tea estates, TTRI, Jorhat, Assam and Looksun Tea estate at Nagrakata, West Bengal in collaboration with IFFCO. The experiments consist of fifteen treatments under randomized block design (RBD) with three replications. The field layout has been done at Borbhetta Experimental tea estates and Nagrakata. The first round of foliar treatments of nano urea has been imposed in March, 2022. This experiment is also being conducted in commercial gardens of different regions of North Estern India. The following commercial gardens are selected. Layout and treatment imposed have been done in few estaes and rest of	**March, 2022 to February, 2023**

				the gardens will be done shortly. Jorhat – Numaligarh Tea Estate, Borbam Tea Estate and Amgoorie Tea Estate Cachar- Rosekandy Tea Estate and Narsingpore Tea Estate North Bank- Bateli Tea Estate and Hurchura Tea Estate. Upper Assam- Sessa Tea Estate Terai- Hunsqua Tea Estate, Ord Terai Tea Estate and Simulbari Tea Estate. **April-June 2022 (Q-2)** The foliar sprays of IFFCO nano urea and first split of fertilizer were imposed as per scheduled and yield data was recorded at Borbhetta tea estates, TTRI, Jorhat, Assam and Looksun Tea estate at Nagrakata, West Bengal and similar observation also taken by the commercial gardens where experiment is in progress. Pre-treatment soil samples were collected from Borbhetta T.E. for generation of soil data and analysis under progress.	
Agronomy					
5. To evaluate the effect of poly halite on yield and quality of tea in North East India	Dr.S.P. Baruah		Polyhalite, a new mineral fertilizer (Polysulphate™), mined in the UK from deep underground. It contains four important plant nutrients: S (SO_3, 48%), K (K_2O, 14%), Mg (MgO, 6%), and Ca (CaO, 17%). After evaluation it may be an important source of potash fertilizer and also can be used in organic tea production.	**April-June (Q2)** In evaluation of Poly halite Virtual launching of the IPI sponsored project done. Plots demarcated and weekly crop yield prior to treatment application being done. **July- September (Q3)** Treatment applications in two splits completed. Pre and post application soil	Duration: 04 years

				and leaf samples collected for analysis and sent to the Soils and Biochemistry department. Weekly crop yield along with fineness count recorded. Made tea samples were sent to tea tasting for evaluation. **October- December (Q4)** Weekly crop yield along with fineness count recorded. Soil and leaf samples collected for analysis and analytical work is in progress. Made tea samples were prepared for quality evaluation. **January- March, 2022 (Q1)** Soil and leaf samples collected for analysis and analytical work is in progress. Plucking started and the weekly crop yield record taken since mid March. Yield analysis of the 1st year showed increase in yield in one of the treatments where polyhalite was applied. However, the treatment difference was not found to be significant. **April- June, 2022 (Q2)** Weekly crop yield along with fineness count recorded. Soil and leaf samples collected for analysis and analytical work is in progress. Made tea samples	

				were prepared for quality evaluation. The first split of treatment application done in the month of May. Status year for the 1st year prepared and sent to the sponsoring agency.	
Tea Processing & Manufacturing Advisory					
6. Development of portable spectroscopes and its application for estimation of quality compounds in tea **(New Proposal)**	Dr. A. K. Hazarika	Inspite of the present market decline, 'quality tea' continues to be a commodity which is intently sought after. Tea has fallen behind to meet the standards of a classic 21st century food products. One of the identified areas which would close this gap for Indian tea is implementation of quality assurance by means of stringent process control measures applied within the production process. Instrumentations for accurate and easy measurement of major quality bio-markers during tea processing would help ensure that desired conditions are maintained to produce tea of unsurpassed and consistent quality. This	1. Low-cost & portable NIR spectroscope for rapid measurement of some major quality bio-markers in tea (viz. catechins and theaflavin). 2. Could be profitably deployed at various stages of tea processing, enabling improved product consistency despite variability in raw material, and overall enable enhanced end product quality. 3. Customized systems having good market demand as rapid quality inspection tools.	**January-March 2021(Q1):** 1. 1st tranche of fund for quarter no. 1 was released. 2. Recruitment of JRFs for TTRI & Jadavpur University, Kolkata (Collaborating institution) completed. 3. Procurement of capital, consumable & contingency items are in progress. 4. Design & development of prototype NIR Spectrometer initiated. 5. Biochemical and Organoleptic analyses of tea samples in progress for drawing correlation with spectroscopic data. **April-June 2022(Q2):** A total of 80 black tea samples were prepared. Biochemical and Organoleptic analyses of the samples were completed. Samples were sent to Jadavpur University for spectroscopic analysis. Another set of samples were sent to NIT, Patna for electronic toungue studies.	Date of start: 20.12.2021 Likely date of completion: 19.06.2023 **Total approved budget: Rs. 49.547 lakhs)**

		project aims to develop methodologies for application of portable near-infrared (NIR) spectroscopes for rapid measurement of some major quality attributes in tea (viz. catechins in fresh tea leaves and theaflavins in oxidized leaves), including online monitoring of theaflavins (TF) during tea fermentation. This will be followed by designing and calibrating indigenously developed low cost, portable and user-friendly instrument based on green electronic techniques, such as, near-infrared (NIR) spectroscopy.		Orders were placed to Hamamatsu Corporation, Japan and Thorlabs, USA for internal components like detector and optical components. 3-D printing of housing of the portable prototype is also in progress.	
Biochemistry					
7. Value addition and Product Diversification in Tea	Dr.Podma Pollov Sarmah	Tea contains numerous chemical constituents having nutraceutical, pharmacological and therapeutic value viz. polyphenols, carotenoids, theaflavins, thearubigins etc. The demand for these components with diverse chemical properties have	Development of synthesis protocol for theaflavins of high purity and encapsulation of tea polyphenolic compounds Biological evaluation of the tea polyphenolic compounds for development of value-added nutraceuticals and therapeutic products. Development of speciality tea formulations.	**Mar - Jun 2022 (Q1)** • Recruitment of Research Fellow • Initiated the procedure for instrument procurement • Theaflavins separation and purification using GPC carried out • Propagation of human colon cell line HT 29 initiated	Date of start 12th. Mar 2022 Likely date of completion 12th. Mar 2025

		increased significantly due to better understanding of the nutraceutical as well as pharmaceutical and therapeutic value. In recent year tea by-products have attained popularity. Green tea catechins, due to its antioxidant properties, finds tremendous application in skin care and cosmetic product. . Studies on structure activity relationship analysis showed theaflavin-3,3'-digallate (TFDG) as potent retinoic acid-inducible gene I (RIG-I) inhibitors, an innate immune receptor[12]. The Innate immunity is the first line of body's defense against intruded pathogen and its modulation will be pivotal in terms of the development of nutraceuticals as a nutrition-based immunity booster. *In-vitro* study of Indian black tea; Crush Tear			

		Curl (CTC) leaf and dust as potential scavenger of oxygen free radicals showed their ability to inhibit the formation of hydroxyl radicals. Feeding rats with black tea for sixty days increased their antioxidant activity and their liver microsomes were shown to be protected against peroxidation of lipids as stimulated by metal ions with enzymatic or non-enzymatic reactants[14]. Studies on theaflavins and thearubigins showed inhibition of human epidermoid carcinoma cell proliferation without adversely affecting normal human epidermal keratinocyte cells.			
Analytical Services					
8. Studies on the source and occurrence of Pyrrolizidine alkaloids (PAs) in tea in North-East India	Dr. R. Pal (PI) & Dr. B Kanrar (Co-PI)	We do not have any information on the source and occurrence pattern of PAs in Indian tea.	1. Generate data on occurrence of PAs in made tea, different parts of the tea plants and cultivars, common weeds and herbs grown in tea growing areas in north-east India.	**Mar – Jun 2020 (Q2)** 1. Different parts of the tea plant cultivars and common weeds and herbs grown in tea growing areas in north-east India are being collected and processed.	2019-2021

[Funding Agency: NTRF]			2. Identification of the possible sources of PAs into the tea plant.	2. Analytical Method using LC-MS/MS QQQ are being developed at our TLabs Kolkata. 3. Part of the test samples are being processed for testing at Eurofins Laboratory, Germany. **Jul-Sept 2020 (Q3)** 1. Analytical Method using LC-MS/MS QQQ has been developed. 2. Samples extraction is ongoing for testing of PAs at our lab. **Oct-Dec2020 (Q4)** Analytical Method using LC-MS/MS QQQ has been developed. Samples extraction is ongoing for testing of PAs at our lab. **Apr-Jun 2021 (Q2)** Black tea samples (32 numbers: from different agro-climatic zones of Assam and West Bengal have been analyzed for PAs. The 12 PAs were found below Limit of Quantification (LOQ). **Jul-Dec 2021 (Q3 & Q4)** Preliminary identification of the possible sources of PA contamination into made tea (such as tea plant, herbs and weeds) has been done. Thorough investigation is	

				being conducted for further confirmation. Occurrence pattern of PAs in made teas (Black CTC tea and Orthodox tea, Green tea) collected from different tea gardens of Assam and West Bengal under Tea Research Association (TRA) and Coonoor, The Nilgiris, Tamil Nadu under The United Planter's Association of South India (UPASI) has been conducted, further studies are ongoing. **Jan-Mar 2022 (Q1)** Occurrence of PAs in plant parts of different tea ciltivarsand herbs from South Bank, Assam and black tea collected from Darjeeling, West Bengal has been done. **Apr-Jun 2022 (Q2)** Occurrence pattern of PAs in made teas (Black CTC tea and Orthodox tea, Green tea) collected from different tea gardens of Assam and West Bengal under Tea Research Association (TRA). Effect of herb application on tea plant for PA contamination into made tea	
Plant Physiology and Breeding					
9. Drought stress management in Tea [*Camellia sinensis* (L.) O. Kuntze] by plant growth regulation.	Dr. (Mrs.) Boby Gogoi / Dr. P. K. Patel	Work is started as per the project proposal.	Dose standarization of Plant Growth Regualator for drought stress management	**January- March 2019 (Q1)** • To find out effect of exogenous application of growth promoters on plant growth, rising of planting materials (TV25, TV21, TV2, and S.3A/3) is in progress.	Duration year: 2018 to 2021

Funded by NTRF: 204/2018.				**April- June 2019 (Q2)** • Raised plants are growing well in condition; it will be transfer in the rainout shelter for further evaluation. **July – Sep. 2019 (Q3)** The rainout shelter of the nursery is ready for transfer of experimental plants. Plan has been design for spraying the growth regulator in the upcoming period of moisture stress. Work is in progress. **Oct – December, 2019** • Drought experiment has been setup in the rainout shelter in Tocklai nursery. • Foliar application of plant growth regulators viz. ascorbic acid, glycine betaine, methyl jasmonate, cytokinin, salicylic acid and anti-transperant (kaoline) has given as per the treatments. Evaluation is in progress under winter moisture stress period. **January-June, 2020 (Q1 &Q2)** • Evaluation under rainout shetler was completed. A randomized complete block design was used under rain-out shelter conditions, with eight treatments: seven under drought stress (water stress, water stress + foliar spray	

				with different concentration of plant growth regulators) and one control i.e. total 20 sub-treatments. Results showed significant differences among the observed parameters. It revealed that highest net photosynthesis (32.27 µmol m−2s−1), water use efficiency (68.57µmol mmol-1), carboxylation efficiency (0.74), photochemical efficiency of PSII (0.76) and minimum electrolyte leakage (30.20 %) were recorded in TV25 followed by TV21 compare to the control and water stress under the foliar applied salicylic acid @ 1.0 mM treatment than other growth regulators viz. MeJ, CK, AA, GB and Kaoline. • One year results concluded that the foliar application of SA @1.0 mM mitigate the drought stress in tea. • Annual Scientific report submitted to the funding agency. • As per the project proposal field trial established for evaluation of the plant growth regulation. Work is in progress. **July-September, 2020 (Q3)** • To confirm the result, a field trail has been established at New Botanical Area.	

				• Foliar application of PGR will be apply during winter moisture period. Physiological and crop yield data were collected at regular interval. **October-December, 2020 (Q4)** • As per the projet proposal field experiment was laid out at New Botanical Area for evaluation of growth regulators. • 1st foliar application has been done in mid of November. Treatments are T1-Control (water), T2-Ascorbic acid@200ppm,T3-Glycine betaine@ 100mM,T4Cytokinin@40µM, T5-Salicylic acid@1.0mM and T6-MOP@2%. • The parameters were recorded 15 days after foliar application of growth regulators. • Intial results revealed that the highest net photosynthesis (28.4µmol $m^{-2}s^{-1}$), water use efficiency (16.6 µmolmmol^{-1}),carboxylation efficiency (0.82), mesophyll efficiency (2.50), photochemical efficiency of PSII (0.59), and minimum transpiration (63.0 µmol mmol^{-1}) were recorded in treatment T5 (Salicylic acid@1.0 mM) followed by T6 (Muriate of Potash @2%) and T2 (Ascorbic acid@200ppm) compared to the control.	

				• Work is in progress for other physiological and biochemical parameters i.e. Specific leaf area (SLA), specific leaf weight (SLW), wax content, chlorophyll content, proline content, ABA and electrolyte leakage (EL). **January to March, 2021 (Q1)** • Foliar application of plant growth regulators viz. ascorbic acid, glycine betaine, methyl jasmonate, cytokinin, salicylic acid and anti-transperant (kaoline) is given as per the treatments and schedule. Evaluation is in progress under winter moisture stress period. • Highest net photosynthesis (32.27 µmol m−2s−1), water use efficiency (68.57µmol mmol-1), carboxylation efficiency (0.74) and maximum photochemical efficincy of PSII (0.67) were recorded in TV25 followed by TV21 compare to the control and water stress under the foliar applied salicylic acid @ 1.0 mM treatment than other growth regulators viz. Methayl Jasmonate (MeJ), cytokin (CK), Ascorbic acid (AA), Glycine	

				betaine (GB) and Kaoline. Work is in progress for stress cycle II. • Maximum photochemical efficiency was recorded in TV21 (0.77) compare to the control under T7 foliar applied salicylic acid @ 0.5 mM treatment. Further evaluation is in progress **April-June, 2021(Q_2)** • Foliar application of treatments viz., Control (water spray); Ascorbic acid@200ppm; Glycine betaine@100mM; Cytokinin@40 µM, Salicylic acid@1.0 mM and MOP@2% was conducted. • Plant physiological and biochemical parameters viz., net photosynthetic rate, stomatal conductance, transpiration rate, leaf temperature, water use efficiency, mesophyll efficiency, maximum quantum yield of PSII, proline content, wax content, chlorophyll content, electrolyte leakage, were recorded. • Crop yield and pest infestation was recorded. **July-September, 2021 (Q3):** • Crop yield was recorded in the experimental plot. • Quality analysis of Orthodox and CTC tea samples was performed.	

				• Tainting analysis of made tea samples was completed. Results showed absence of any tainting compound in the samples. **October-December, 2021 (Q4):** • To study effect of anti stress hormone under winter moisture stress condition, experimental sites were selected in different locations. (1) Section No. 5, TRA Tocklai (2) Cinnamara division, TRA, Tocklai (3) Daflating Tea Estate (4) Socklatinga Tea Estate. • Spraying of treatments started from November, 2021. • Data compilation, analysis and progress report preparation is in progress. **January to March, 2022 (Q1):** • Foliar application of treatments viz., T1- Salicylic acid@1.0mM T2-MOP@2% was done in various experimental sites (Section No. 5, TRA Tocklai, Cinnamara division, TRA, Tocklai, Daflating Tea Estate, Socklatinga Tea Estate, Soraipani T.E., NBRRDC Nagrakata). • Plant physiological parameters (net photosynthesis, water use efficiency,stomatal conductance, carboxylationefficiency,leaf temperature and transpiration) were recorded.	

				• Maximum quantum efficiency of PSII (fv/fm) was recorded by chlorophyll fluorescence meter (Junior PAM). • Estimated leaf wax content, leaf water potential and chlorophyll content. • Soil moisture content, root starch and leaf proline was estimated. • Estimation of total soluble sugar content is in progress. **April to June, 2022 (Q2):** • Plant physiological parameters (net photosynthesis, water use efficiency, stomatal conductance, carboxylation efficiency, leaf temperature and transpiration) were recorded in the experimental site at NBRRDC, Nagrakata. • Significant increase in net photosynthesis was recorded in Salicylic acid@1.0 mM, followed by MOP@2% with respect to control. • Water Use Efficiency is significantly higher in salicylic acid@1.0mM. • Transpiration rate decreased in SA followed by MOP. • Significantly higher PSII activity recorded in SA@1.0 mM treatment compared to control and MOP. • Crop data recorded in various experimental sites. • Data compilation and analysis is in	

				progress.	
10. Development of improved planting material in Tea [*Camellia sinensis* L. (O) Kuntze] using Gamma Irradiation. Funded by BRNS	Dr. S. K. Singh	Work is started as per the project proposal.	Generation of mutant population through gama radiation	**January- March 2019 (Q1)** • As per the project objective, successfully radiated the clonal cuttings of TV23, TV26 and seeds stocks TS 463, TS 491 and TS520 at four different radiation doses (2 Gy, 4 Gy, 6Gy and 8 Gy). Cuttings of TV23 and TV26 were successfully transferred in the nursery bed. Data recording is in progress. **April- June 2019 (Q2)** Observations have been taken of radiated tea seeds (TS520 & TS463) and nodal cuttings (TV23 & TV26) at Borbhetta tea nursery. Data compilation is in progress. **July – Sep. 2019 (Q3)** Under the BRNS-DAE project- pruned the TV23 and TV 26 bushes for taking up nodal cuttings for radiation in coming future. **Oct.- December, 2019 (Q4)** • Under the BRNS-DAE project- Monitored the growth and development of gamma radiated plants in Tocklai nursery. 65 % radiated plants were died due to treatment effect. • As per the experimental design, morphological data were collected from	October 2018-2021

				the radiated plant such as height of plants, number of leaves, number of primary branches, base diameter and prepared the temporary slides of transverse section of irradiated tea leaf for stomata studies. • A few gamma radiated plants were kept out in direct sunlight for hardening and to collect the required physiological data. • Operating the P.P. System CIRAS-2 for net photosynthesis data and Junior PAM for PS-II data. The observed data are: The net photosynthesis data is highest in TS 491-6G and TS 506-8G in case of seed stock and for cuttings the treatment with 4 Gy and 2 Gy has shown the highest value with corresponding PS-II data. **Jan to June (Q1 +Q2)** • As per the experimental design, morphological data of the radiated tea population were recorded such as height of plants, number of leaves, number of primary branches and base diameter. Prepared slides for stomatal studies of irradiated tea leaf. Plant physiological studies viz. net photosynthesis, water use efficiency and photochemical efficiency of PSII photosystem is in progress.	

				• The Gamma radiated plants were kept out in direct sunlight for hardening of the plant and to separate the radiated plants on the basis of morphological variation as like leaf colour, multiple branching and their arrangement, leaf serration and bullation, leaf undulation, leaf thickness and size. Data collection is in progress. • A new field trial has been established in the New Botanical Area with 700 radiated tea population. Work is in progress for further evaluation. **July-September, 2020 (Q3)** • A field map of Gamma radiated trial plot has been completed. Plant entries were marked with labelled for future reference and removes the weeds from the trial plot. Evaluation is in progress. • First year progress report successfully submitted to the funding agency and received the IInd year budget. **October-December, 2020 (Q4)** • Bushes of TV23 and TV 26 were pruned for taking up nodal cuttings for radiation treatment. • Gamma radiated planting materials as TV23 and TS520 were transferred in	

				the Tocklai nursery. Every 15 days interval, the morphological data were recorded. Data compilation is in progress. • As per the project objective, morphological data of the irradiated tea population were recorded such as height of plants, number of leaves, number of primary branches and base diameter at nursery stage. Compilation of data is in progress. **January to March, 2021 (Q1)** • Compile the the two year work of project and PPT has presented online to review commmitte of the BRNS, DAE. Incorporate the suggestion and final comment of the committee. • The Gamma radiated plants were kept out in direct sunlight for hardening and plan has been prepared for the plantation of radiated population in the month of April, 2021. • Arrange tea seeds of TS 520, TS 463, TS589 and Betjan from Borbhetta Nursery and done the sinker floater test for radiation purpose. Radiated the packed planting materials in the month of March, 2021. Gamma radiated plnating materials have been transferred into the nursery bed for propogation.	

				April-June, 2021(Q_2) • Observed and recorded the germination and survival data of radiated seed and cuttings propagated in Borbhetta nursery. • Studied the microscopic data of TV clones to check the presence of pubescence in apical bud and leaf. **July-September, 2021 (Q3):** • Collected photosynthetic data from 215 samples of mutant population at NBA by using Junior-PAM and recorded the germination percentage data of radiated plant population. • 18 samples collected from gamma radiated field plot are supplied to Biochemistry department for Biochemical analysis of Polyphenol and others parameters. • Collected morphological data from gamma radiated plant samples as - Shoot length, Fresh weight and Dry weight, presence of pubescence, shoot colour. **October-December, 2021 (Q4):** • Collected morphological data from gamma radiated plant population as - Shoot length, leaf area, no. of primary	

				branch, no. of leaves, fresh weight, dry weight, presence of pubescence and shoot colour. Data compilation is in progress. • Collected photosynthetic data from 215 samples of mutant population at NBA by using Junior-PAM and recorded the germination percentage data of radiated plant population. **January to March, 2022 (Q1):** • Physiological observations have been taken from 136 radiated plant populations at New Botanical Area with the Junior Pam-II. Data compilation is in progress. • Collected morphological data from 1st batch gamma radiated plant samples. The parameters are as – Plant height, No. of leaves per plant, Base diameter, Total leaf area. • Recorded photosynthetic data from the randomly selected radiated population with the help of P.P. System. Till date about 200 samples were marked for the collection of data. Work is in Progress. • Observations have been taken from the 2nd-Batch radiated population. The morphological data are as i.e. height of the plants, number of leaves and no. of branching, etc. • Estimated Chl a, Chl b, Carotenoid and Xanthophyll content in 136 selected radiated plants. **April to June, 2022 (Q2):** • Physiological observations have	

				been taken from 136 radiated plant populations at New Botanical Area with the Junior Pam-II. Data compilation is in progress. • 36 gamma radiated samples were sent for biochemical analysis. Work is in progress. • About 500 radiated seed grown plant have been transferred from Borbhetta to NBA for plantation. After hardening, all marked plants will be propagated at NBA, Tocklai. • Cytogenetical studies have been done in seven samples of diverse radiated plant. New set of sample have been included for further work. • Submitted research paper in Journal: IJRB, Title: "Effect of Acute Gamma Radiation on tea seed germination and morphological variation in *Camellia Sinensis*" for publication.	
11. Central Sector Scheme for PPV &FR Authority: Establishment of DUS testing center. Funded by PPV &FRA, New Delhi.	Dr.S. K. Singh	Application for registration of two new clones (TTRI and TTRI 2). One new seed stock (TSS1) and one released clone (TV31) as extant varities were submitted to PPV & FRA, New Delhi for registration.	Finalization of DUS guidelines required for registration of tea varieties	**July-September, 2016 (Q3)** Morphological data of TV 1, TV 15, TV 16, TV 17, TV 20, TV 21, TV 23, TV 25, TV 26, B 22, A 11, DL 13, DL 2, DL 32, and HK 22/14 were recorded. Leaf area measured in TV clones, from TV 1 to TV 31. Polyphenol content recorded in clones DL 13, DL 2, DL 32, TV 1, TV7, TV 23, TV26 and TV 30. **October-December, 2016 (Q4)**	Annually revised

				DUS characters of vegetative part of the clones TV 2, TV 9, TV 14, B 15, B 17, B 18, S3A3, S3A1 and T3E3 were recorded. DUS characters of Floral part of the clones TV 1, TV 4, TV 5, TV 6, TV 7, TV 8, TV 13, TV 15, TV 17, TV 20, TV 29, TV 30, A 11, B 15, B 17, B 18, S3A1, P 126, Teenali 17, DL 2, DL 13 DL 32 and Seed Stock HK 22/14 are recorded. Polyphenol content are recorded from the clones TV 6, TV 7, TV 8, TV 9, TV 10, TV 12, TV 14, TV 18, TV 19, TV 20, S3A1, S3A3, T3E3 and Teenali 17 as well as morphological Characters of these clones were recorded. **January-March, 2017 (Q1)** DUS (Distinctness, Uniformity and Stability) characters of vegetative and floral part of the all Tocklai vegetative clones have been recorded. **April - June 2017 (Q2)** DUS characters of vegetative part of clones are recorded from the following clones:-	

				TV31, TTRI1, TTRI2, DL39, DL25,124/35/28, 3/162, 28.2, GT20, Sikkim1, 14/6/28, 124/48/8, 14/6/28, 14/5/35, RD3.27, 19/31/14, DT2, BAGH10, Upasi8, NF100, P460, 14/12/16, Bhimtal, Clone660, Clone663, clone656, clone657, clone658, L14E5/5, L14E9/6, S13C1/5, MM14F9/9, S13C3/3, S1D3/5, S13C3/6, Bu14A7/1, B9F6/9, Bu6C5/8 and MM2E7/2. Total Polyphenol content are recorded from the following clones:- TV28, TV31, 14/6/28, Kumchung29, TTRI1, TTRI2, P460. 28.2 and Sikkim1, 3.161, GT8.20, DT2, NF100, BAGH10, Bhimtal, 14/12/16, 19/31/14, 124/48/18, RD3.27, 124/35/18. **July - September 2017 (Q3)** DUS characters of vegetative part of clones were recorded from the following clones:- 124/48/8, 14/5/35, 19/31/14, 14/12/16, L.14E5/5, L14E9/6, S.13C1/5, MM.14F9/9, S13C3/3, S.1D3/5, S.13C3/6, Bu.14A7/1, B9F6/9, Bu6C5/8 and MM.2E7/2, Bu14A1/1, B.1C7/1, L.6F7/7, MM14F1/10, B9F9/6, L14E3/7, MM14F7/9, Bu.6C6/10, Shan tea tree progenies. Total Polyphenol content were	

				recorded from the following clones: TTRI-1, TTRI-2, Kumchung 29, P460, 28.2, Sikkim1, 3.161, GT8.20, DT2, and NF100, BAGH10, Bhimtal, RD3.27, 14/12/16, 19/31/14, 124/48/8 and 124/35/18. **October - December 2017 (Q4)** DUS characterization of floral parts the Following clones were done:- Teenali17, S3A3, TTRI1, TTRI2, Clone657, Clone658, ShanteaXS3A3 plant no-60, ShanteaXS3A3 plant no-72, ShanteaXS3A3 plant no-102, ShanteaXS3A3 plant no-96, ShanteaXS3A3 plant no-101, AV2 and Phob312 TS 560" was released to the industry in the 53rd AGM of TRA and application will be submitted to PPV&FRA, New Delhi for registration of the new seed stock. **January – March, 2018 (Q1)** DUS characters recorded for floral parts for the following clones BAGH 10, Mornai 3, KP143, DL25 and DL 39. **April – June, 2018 (Q2)** Morphological characteristics were studied for selected clones based on DUS format.	

				Cuttings of the selected bushes were propagated in nursery. **July – September, 2018 (Q3)** DUS characterizations of the vegetative parts of Bi clonal seed stocks namely TS-450, TS-464, TS-491, TS-506, TS-557 and TS-569 were done. Compilation of DUS characterization database is in progress. **October - December 2018 (Q4)** DUS characterization of vegetative parts of the following clones were done; Mazbat110, Dhul41, N325, P133, HLK 23/14 and HLK 23/19, HLK 23/15, and HLK 23/36, SS 28, SS 42, Mornoi 30, Mornoi 33, SS 6, 650/5, 650/8 and 650 /11. DUS characterization of floral parts of the following clones were done; GT 20, HLK 23/15, HLK 23/36, SS 28, Mornoi 33, 650/5, 650/8, 650/11, 650/12 and 650/19. **January- March 2019 (Q1)** • DUS characterizations of floral parts of the Following clones were done. NF100, 270/2/13, BJ19, MM14F1/10, MM2E7/10, B.9F2/10, L.6F7/7, Bu14A7/1, MM2E7/2, MM14F9/9, B.9F1/9, LG26, LG17, GT30, T78,	

				MK76, Kol26, Goh33, KG5, TJ34, Bagh35, 818/1, 818/2, 818/3, 818/4. 818/5, 818/6, 818/7, 818/8, 818/9, 818/10, 818/11, 818/12, 818/13, 818/14, 818/15, 818/16, 818/17, 818/18. 818/19, 818/20, 818/21, 818/22, 818/23, 818/24, 818/26, 818/27, 527/1, 527/2, 527/3, 527/4, 527/5, 527/6, 527/7, 527/8, 527/9 and 527/10. **April- June 2019 (Q2)** DUS characterization of vegetative parts of the following clones were done- P133, BJ19, 111/1, LG26, LG17, GP19, GT30, MK76 Kol 26, GOH33, TJ37, KG5, TJ34 and BAGH35. **July - Sep 2019 (Q3)** Completed the DUS characterization of vegetative parts of the following planting materials: 527/1, 527/2, 527/3, 527/4, 527/5, 527/6, 527/7, 527/8, 527/9, 527/10, 16.2.15, 14.5.35, 119.4, 170.39, 124.24, 3.161, 184.21.8 and 28.2. **October – December 2019 (Q4)** • Completed the DUS characterization of vegetative parts of the following: Stock 673, Stock 643, Tingalibam1, Kehang1, Huldibari19, 818/5, 818/6, 818/7, 818/8, 818/9, 818/10. 818/11	

				and 818/12. • DUS characterization of floral parts of the following clones- BJ2, BJ5, BJ19,MB107, Bagh20, HLK2319, KG5, CP1, Testa valley1, SS42, BS2A, CB38, KP6.37, KP4.10, KP1.7, 818/25, 818/28, TV34, TV35, Huldibari19, Shantea X S3A3 plant no64, Shantea X S3A3 plant no71, Shantea X S3A3 plantno104, and Shantea X S3A3 plant no105. • One research paper has been submitted in 'Two & a bud' journal for publication. **January to June 2020 (Q1 + Q2)** • DUS characterization of floral and vegetative parts of the following clones completed: Narsingpore4, Narsingpore18, Narsingpore22, Nuplongchera18, Huplongchera22, Huplongchera26, KP1.1, KP4.10, KP17, KP6.20, KP6.25, KP6.32, KP6.31, KP11, KP 6.31, KP 6.32, KP 6.20, Bu6C6/10, L.14E5/5, L.14E3/7, S.13C1/5, S.1D3/5, S13C3/6, MM14F7/9, B1C7/1, Bu6C9/10, S.13C1/3, B9F6/9, Bu6C5/8, L14E2/9, N325, L100,HV39, RR17.144, Badamtam15.263, CB38 and CB43. Cinnamara betjan, 19/33/41, St. 481/2, TG22, B/6/51, 19/11/20, 19/11/50,	

				19/33/1 and St.464/12. • DUS characterization of floral parts of the following clones completed St. 643, St. 673, P-7, KP 6.25, HLK2314, SS6, SS40A, Mornoi30, CB43, Dhul41, DT1, P-36, GP19, LG4, CB27, 299/9, 480/13. 480/17, N-89, MRG1, H137, 63.1, 16.2.15, 14.5.35, 119.4, P-133, SA, LV18N, LV21, TG22, B/6/51, 19/11/20, 19/11/50 and 19/33/1. • Compilation of DUS characterization data were entered in Data Base sheet and project report (FY 2019-2020) was submitted to the funding agency. • Marked the tea bushes for DUS characterization and prepared the field map for DUS Characterization. **July-September, 2020 (Q3)** • Compilation of DUS characterization data were entered in Data Base sheet and project report (FY 2019-2020) was submitted to the funding agency. Annual budget of the project received. • Marked the tea bushes for DUS characterization for Yr. 2021 and prepared the field map for DUS testing and variety registration. **October-December, 2020 (Q4)**	

				• Completed the DUS characterization of 116 tea bushes (vegetative parts) selected from the Dufflating tea estate. • DUS characterization of floral and vegetative parts of the following clones and germplasms were completed: • 124.26.4, 297.9, 4.5, 16.11.12, 23.16, BJ5, BJ19, MB107, BAGH20, BJ2, 480/17, N-89, MRG1, H137, 63.1, 16.2.15, 14.5.35, 119.4, P-133, SA, LV18N, LV21, TG22, B/6/51, 19/11/20, 19/11/50 and 19/33/1. **January to March, 2021 (Q1)** • DUS characterization of floral parts of the following clones- • Narsingpore4,Narsingpore18,Narsing pore22, L14E3/7, L14E5/5, Huplongchera22, KP11, KP 6.31, KP 6.32, KP 6.20, Bu6C6/10, , S.13C1/5, S.1D3/5, S13C3/6, MM14F7/9, B1C7/1, Bu6C9/10, S.13C1/3, B9F6/9, Bu6C5/8, L14E2/9, N325, L100, HV39,RR17.144 and Badamtam15.263, Huplongchera18. • Prepared the map of Tocklai campus area and calculated the available germplasm at the trial plot. Vacancies have been found in the clonal plot. Vacant places have been marked in	

				the map. **April-June, 2021(Q_2)** • DUS characterization of vegetative parts of the following germplasms were done- • Narsingpore4,Narsingpore18,Narsingpore22,Huplongchera18,Huplongchera22, KP11, KP 6.31, KP 6.32, KP 6.20, Bu6C6/10, L.14E5/5, L.14E3/7, S.13C1/5, S.1D3/5, S13C3/6, MM14F7/9, B1C7/1, Bu6C9/10, S.13C1/3, B9F6/9, Bu6C5/8, L14E2/9, N325, L100, HV39,RR17.144 and Badamtam 15.263. **July-September, 2021 (Q3)** • DUS Characterization of vegetative parts of the following garden series clones was completed. Gotoonga 20, Cherideopurbat 23, Thowra 2/11, Digulturrung2/14, Dinjoye 16, Lengree 51, Lengree 56, Dhulapadang 10, Dhulapadang 36, Mazbat 110, Phoobsering 4, Sanyasithan 8, Sanyasithan 9, Sanyasithan 10, Sanyasithan 27.Work is in Progress. **October-December, 2021 (Q3)** • DUS characterization of vegetative parts of the following garden series clones were completed-Gotoonga 20, Cherideopurbat 23, Thowra 2/11, Digulturrung 2/14, Dinjoye 16, Lengree 51, Lengree 56, Dhulapadang 10, Dhulapadang 36, Mazbat 110,	

				Phoobsering 4, Sanyasithan 8, Sanyasithan 9, Sanyasithan 10, Sanyasithan 27. For the registration of 04 tea varieties (TV 31, TTRI 1, TTRI 2 and TSS 1), DUS data were submitted to PPV&FRA, New Delhi. **January to March, 2022 (Q1)** • DUS characterization of vegetative and floral parts of Tingalibam, S3A3, Dhul 41, Camellia Japanica (Wild tea), Majbat 110 and Dinjoye 16 at Tocklai campus and New Botanical Area (NBA). • DUS characterization of vegetative parts of crossed seeds of following combinations was completed. L-1100 x P-126, St-398 x P-126, BJ-2 x P-126, BJ-2 x DT-2, BJ- 2 x HC-311, BJ-2 x L-1100, HC-311 x P-126, DT-2 x P-126, St-338 x L-1100, St-398 x HC-311, L- 1100xHC-311, HC-311xDT-2 and HC-311xBJ-2 at Tocklai campus. • Marked the selected bushes (J272 x TTRI 1, TV35 x MM120, S3A1 x TRF 1) in the Tocklai campus area for DUS test and plan has been set for the crossing of diverse planting material. • Microscopic analysis of stomata aperture was done in following clones: TV 1, TV 13, TV 17, TV 25, TV 31, TTRI 1, TTRI 2, TV 34 and, TV 35	

				April to June, 2022 (Q2): • Collected the DUS characterization data from St. 851 population at New Botanical Area. Total 413 samples have been used for characterization out of 1,116 plant population. DUS data compilation of is in progress. • Collected DUS characterization data from the 19 garden series clones. Gotonga 20, Cherideopurbat 23, Thowra 2/11, Digulturrung 2/14, Dinjoye 16, Lengree 51, Lengree 56, Dhulapadang 36, Majbat 110, Dhul 41, Narsingpore 4, Tukdah 78, AV2, Sundaram (B/5/63), Koomsong 23, Sanyasithan 8, Sanyasithan 9, Sanyasithan 10, and Sanyasithan 27. • DUS characterization of vegetative parts of crossed seeds of 12th Plan planting materials- L-1100 x P-126, St-398 x P-126, BJ-2 x P-126, BJ-2 x DT-2, BJ- 2 x HC-311, BJ-2 x L-1100, HC-311 x P-126, DT- 2 x P-126, St-338 x L-1100, St-398 x HC-311, L- 1100 x HC-311, HC-311 x DT-2 and HC-311 x BJ-2 at Tocklai campus.	
Mycology and Microbiology					
12. Studies on the perspective of microbial biocides and upscaling of commercial production unit at Tocklai Tea	Dr. S.R.Sarmah	Tocklai tea Research Institute has made significant contribution in this regard, and successfully established the beneficial effect of several native microbial biopesticides and	The beneficial microbes that establishes positive interaction with plant ecosystem is proposed to exploit in tea plantations to protect from pathogenic infection as well as to increase productivity.	**April-June, 2018 (Q2)** Initiated the project on "Studies on the perspective of microbial biocides and up scaling of commercial production unit at Tocklai Tea Research Institute" (Code No. NTRF:201/2017). Infrastructure developement of the laboratory, purchase	April 2018-March 2021 (completed)

Research Institute		biofertilizers (Phukon *et.al*.2012, Barthakur et al. 1993, 1994, 2001, 2004; Sarmah et al. 2005; Dutta et al.2005). Tocklai Tea Research Institute have the patent right on the use of *Trichoderma* technology in controlling tea diseases (Barthakur et al. 2002, Barthakur et al. 2004, Sarmah et al. 2005). Besides *Trichoderma*, the Institute have also its own microbial strains such as *Beauveria bassiana, Metarhizium anisopliae, Peacilomyces lilacinus* etc. that act as biopesticides respectively and *Azotobacter* sp. *Azospirillus*, *Bacillus subtilis*, *Aspergillus niger* and Arbuscular Mycorrhizal (AM) fungi etc., that act as biofertilizers respectively.	Production of diverse quality biopesticide and biofertilizer for sustainable tea disease and nutrient management. Enhance or upscaling the production capacity of pure biocides with desired cfu load to meet the demand of tea industry. Popularization of the application technology of exploiting microbial in tea cultivation.	of the equipments and manpower recruitment are in progress. **July-September, 2018 (Q3)** Four instruments namely laminar air flow chamber, deep fridge, refrigerator and hot air oven has been procured and installed in the laboratory. Purchase orders have also been issued for other instruments. Re-tendering for the purchase of required glassware is in process. Under the upgradation of the laboratory infrastructure facilities, the civil construction of the laboratory is on progress. Appointed two project assistant and joined in the project in the month of July and since joining, they have been trained and later engaged in the production of microbial biopesticide and other project activities. *In vitro* experimentation is under process to evaluate the efficacy of *Trichoderma viride* against significant tea pathogens at different inoculums densities ranging from 1-10% spore concentrations. **Oct-Dec 2018(Q4)** Studied the efficacy of *T. viride* at different spore concentrations with increasing densities (@ 1%, 2%, 3%, 4%, 5%, 7% and 10%) and observed	

				significant differences in pigmentation. The fungus, also, exhibited significant growth reduction of the brown root rot pathogen (up to 85.5% disease reduction *in vitro*) @ 10^6 CFU/ml of the sample, with least variation among different spore densities. Mass production of microbial biocides is being continued and supplied 1624 lit. of *Trichoderma* biocides and 200 lit. of *B. subtilis* to different commercial T.Es as well the STGs and earned revenue of Rs. 3,81,136/-. **Jan-Mar, 2019 (Q1)** The production and supply of microbial biocides are in progress. 1219 liters of *Trichoderma* supplied to member Estates and STGs and earned a revenue of Rs. 2,34,144/- Under the upgradation of the laboratory infrastructure facilities, the remaining civil construction of the laboratory is on progress. Five industrial autoclave has been installed for production of biocides. **April-June, 2019 (Q2)** The installation of industrial autoclaves is completed.	

				The production and supply of microbial biocides are in progress. 730 L of different biocides was supplied to member tea estates and earned revenue of Rs. 1,63,520/-. **July-August, 2019 (Q3)** The production of microbials continues and 670 L of different biocides was supplied to member tea estates and earned revenue of Rs. 1,45,600/-. **Sep-Dec, 2019 (Q4)** The production of microbials continues and 7817 L and 400 kg of different biocides was supplied to member tea estates and earned revenue of Rs. 13,38,743/-. Prepared and distributed a brochure on 'Microbial Bioformulations for use in tea' for the benefit of tea growers. **Jan-March, 2020 (Q1)** Production and supply of microbial biocides are in progress. 1732 Lit. of *Trichoderma*, 200 L of *Bacillus*, 290 L of *Metarhizium*, 850 Kg of VAM and 4000 Kg of *Trichoderma* (Solid formulations) were supplied to member tea estates and earned revenue of Rs 8,07,162/-.	

				April-June, 2020 (Q2) The production and supply of microbial biocides are in progress. 1400 L of *Trichoderma* was supplied to member tea estates and earned revenue of Rs. 3,76,096/-. **July-September, 2020 (Q3)** The treatment application and periodical data generation in the ongoing field trial at Tocklai T.E. for evaluation of the efficacy of *Trichoderma* in different concentrations (@ 1%, 2% and 5% SC respectively) against *Poria* branch canker disease as suggested by NTRF advisor is in progress. The production and supply of microbial biocides are in progress. 4675 L of biocide and 500 kg VAM was supplied to member tea estates and earned revenue of Rs. 8,60,382/-. **Oct-Dec 2020** The production and supply of microbial biocides are in progress 22236 L of *Trichoderma* was supplied to member tea estates and earned revenue of Rs. 37,83,260/-. **Jan-March,2021 (Q1)** The production and supply of microbial	

				biocides are in progress 5785 L of *Trichoderma* was supplied to member tea estates and earned revenue of Rs. 10,17,912/- **April-June 2021(Q2)** The production and supply of microbial biocides is continued for the month. 6022L of *Trichoderma*, 751 L of PGP,100 L of *Meterhizum* were supplied to the member tea estates and earned a revenue of Rs. 12,21,481/-. **July-Sep,2021(Q3)** The production and supply of microbial biocides is continued for the month. 3587 L of *Trichoderma* and other biocides were supplied to the member tea estates and earned a revenue of Rs. 6,24,568/- **The project tenure ended during Sep,2021** **Oct-Dec, 2021 (Q4)** Production and supply of microbial biocides were in progress and 8140 Liter of *Trichoderma* were supplied to the member gardens with a revenue earning of Rs. 14,60,480/-(till 9th Dec). **Jan-March,2022 (Q1)** Production and supply of microbial	

				biocides were in progress and 9636 Liter of *Trichoderma*, entomopathgens and PGP were supplied to the member gardens with a revenue earning of Rs. 16,53,496/-. **April-June, 2022 (Q2)** Production and supply of microbial biocides were in progress and *Trichoderma*, entomopathgens and PGP were supplied to the member gardens with a revenue earning of Rs. 10,18,746/-	
13. Multiinstitutional approach on development of technology driven bio-input production clusters for mass production of biofertilizers and bio pesticides for promotion of eco friendly farming with collateral development of bio-enterpreneurship in vegetables, spices and small tea growers of North East region	Dr. S. R. Sarmah	Tocklai tea Research Institute has made significant contribution in the organic tea production by promoting the use of microbials, herbal extracts and other integrated pest and disease management strategy. Successfully established the beneficial effect of several native microbial biopesticides and biofertilizers (Phukon*et.al*.2012, Barthakur et al. 1993, 1994, 2001, 2004; Sarmah et al. 2005; Dutta et al.2005). Tocklai Tea Research Institute have the patent right on the use of *Trichoderma* technology	Biopesticides and biofertilizer will help in suitable management of plant health. The technology of biopesticides and biofertilizer will help in livelihood security of rural framers. Beneficial microorganisms were tried as an alternative use for growth promotion, nutrient uptake and pest & disease management in different crops of throughout the globe. It is the necessity to popularize the microbe based bioinputs among the tea growers to exploit their beneficial aspects to create awareness among the promising entrepreneurs and small tea growers for upliftment of their livelihood. This will help to produce a safe cup of tea to the consumers which is the need of	**Jan-March,2022 (Q1)** Received the amount sanctioned in the project and initiated the work and including appointment of manpower. **April-June, 2022(Q2)** Two demonstration programmes on pest and diseases were conducted at two locations *i.e.* Sotai & Mariani circles of Jorhat district among the STGs. Survey was done for pest and disease infestation and conducting field trials at two locations of Jorhat district *i.e.* Rangajan and Mahimabari, Titabor	2021-2023

of India for better livelihood.		in controlling tea diseases (Barthakur et al. 2002, Barthakur et al. 2004, Sarmah et al. 2005, Sarmah et al. 2019). Besides *Trichoderma*, the Institute have also its own microbial strains such as *Beauveria bassiana, Metarhizium anisopliae, Peacilomyces lilacinus*etc. that act as biopesticides respectively and *Azotobacter* sp. *Azospirillus, Bacillus subtilis, Aspergillus niger* and Arbuscular Mycorrhizal (AM) fungi etc., that act as biofertilizers respectively. Some of the nucleotide sequences of certain effective biocides including *Trichoderma viride, T. harzianum, Metarhiziumanisopliae, Beauveria bassiana, Bacillussubtilis* were submitted in GenBank sequence database and Tocklai obtained the NCBI accession	the hour.		

		numbers MH030275, MH027645, MG547580, MG547581 and MG563222 respectively. In a Tea Board sponsored programme, Tocklai is continuously producing Microbial biocides under the guidance of Dr. S.R.Sarmah (*Trichoderma viride, T. harzianum, Metarhiziumanisopliae*a nd *Bacillus subtilis*) and supplying to the member tea estates as well as to the small tea growers for use in tea industry.			
Biotechnology					
14. Tea Genome Sequencing	Dr.S Borchetia and B. Das	The presence of a mapped tea genome is always better for linkage study. However in the absence of tea genome, few groups have reported to have created tea linkage maps **(**Hackett et al. 2000**,** Ota and Tanaka 1999**,** Tanaka et al. 1995**)** based on the pseudo-testcross theory **(**Grattapaglia. and	• Genes responsible for important traits in tea • Plants having high yield, better quality and tolerance to abiotic/biotic stress.	**July to September, 2017 (Q3)** • Morphological characterization was done following DUS guidelines of 121 progenies of S.3A/3 x Shan tea. • Electrolyte leakage measurement was done on 79 progenies of S.3A/3 x Shan tea with two replications from each progeny by electrical conductivity meter. **October-December,2017 (Q4)** • Wax content measurement of S.3A/3 x Shan tea Progeny: Wax content was	April 2019 to March 2021 (Phase II)

		Sederoff, 1994**)**. As tea doesn't have pure inbred lines due to high level of heterozygosity, pseudo-testcross is the way out for linkage maps. However the above stated linkage maps were created using dominant markers and posed some limitation. Dominant markers are not universal markers and its utility depends on the particular material being tested. Taniguch F *et al.* (2012) on the other hand used co-dominant SSR markers as landmark markers to create high density reference map of tea. Bali et al. (2015) constructed a linkage map of Indian teas using two-way pseudo test cross approach for mapping drought tolerant trait. Recently Tan *et al* (2013) reported tea floral transcriptome sequencing for SSR marker development and linkage map construction. The application DNA based molecular marker in tea		measured by following laboratory standardized protocol for 45 plant samples of S.3A/3 X Shan tea Progeny with two replications each. • Seeds from different progenies i.e. TSS1, TS506, TS491, TS463 were sown for germination for development of the F2 generation. • Measurement of Chlorophyll contents: Chlorophyll "a", "b", carotenoid content was measured for 31 plants of S.3A/3 X Shan tea Progeny with two replications each. For this leaf samples were weighed and dissolved in 10 ml 80% acetone. They were kept in 4ºC for 72 hours. After incubation OD was taken at different wavelength i.e. 663nm, 645nm, 470nm. • Leaf area, Specific leaf area, Specific leaf weight were measured for 31 plants of S.3A/3 X Shan tea Progeny with three replications each. **January-March, 2018 (Q1)** Mapping population of [S.3A/3 x Shan tea] plants • Plants showed significant difference in physiological parameters except leaf temperature. Plant no. 19 recorded highest rate of net photosynthesis (Pn, 23.10) and water use efficiency (WUE, 5.96) followed by plant no. 105. • Plants showed significant difference for all the character studied. Highest Chlorophyll a/b was observed in plant	

		is mainly limited to genetic fingerprinting **(**Mondal 2000**,** Mondal 2002b**)**, detection of genetic instability **(**Mondal and Chand 2002), kinship identification, diversity analysis **(**Mondal 2002c**)**, etc. Its use in mapping of QTL, gene introgression by MAS are still inadequate in tea **(**Kamunya et al, 2010**)**.		no. 101 (4.08) followed by plant no. 107 (3.96). • Plants showed significant difference among electrolyte leakage (EL %) and wax contents. Plant no. 39 scored minimum EL and maximum wax deposition (79.75 µg cm-1). • Plants exhibited non significant difference for Relative water content (RWC). Plant no. 19 recorded highest RWC (88.30%) followed by plant no. 60 (87.83%). However, plants showed significant difference for specific leaf area (SLA) and specific leaf weight (SLW). Plant no. 25 recorded highest SLA (204.60 cm^2 g^{-1}) followed by plant no. 94 (SLA 188.21 cm^2 g^{-1}) whereas SLW recorded highest in plant no. 72 (0.0114 cm^2 g^{-1}). • DUS characteristics of the mapping population [S.3A/3) x Shan tea] plants. • For the Hybridity Test in tea population [S.3A/3 X Shan tea], 30 EST-SSR primers were designed from Tea ESTs (Gogoi et al. 2013) and 33 *Camellia assamica* genomic SSR primers (Kumar et al. 2017). 39 Simple Sequence Repeat (SSR) primers were used for standardization in DNA of S.3A/3. For this process, 3 different annealing temperatures were used, which were 53 ºC, 55ºC, 58ºC. After standardizing, 25 SSR primers were chosen for amplifying in parents and progenies.	

				April – June, 2018 (Q2) 1) DNA extraction was done from 40 plants of Shan tea x S_3A_3 population by following Doyle and Doyle protocol. 2) Polymorphism study was done on 105 progenies and 2 parents using 4 ISSR primers for hybridity test in Shan tea X S3A3 tea population. 3) Standardization of SSR primers is being continued for hybridity test . 4) Standardization of protocol for assaying catalase activity for Shan tea x S_3A_3 progeny. Catalase activity was assayed in 15 selected plants of Shan tea x S_3A_3 progeny, using the standardized protocol (modified Aebi *et al*.). **July – September, 2018 (Q3)** • Biochemical assay was done for selected plant under mapping population: Superoxide dismutase activity (SOD) and peroxidase activity (POX) were assayed for 15 sorted progeny and mother plant of Shan Tea x S.3A/3. Highest SOD activity was recorded in progeny plant no. 101 (1.834 EU g^{-1} fresh weight) whereas as in Shan Tea and S.3A/3 it was recoreded 1.286 EU g^{-1} fresh weight and 1.834 EU g^{-1} fresh weight respectively. Peroxidase activity noticed maximum in the progeny plant no. 15 (1.070 unit ml^{-1}) compare	

				to the Shan Tea (0.080 unit ml^{-1}) and S.3A/3 (0.028 unit ml^{-1}). • Polymorphism study for hybridity tests on Tea population Shan tea x S.3A/3 was done using ISSR Primer 8 and 10 on 20 progenies and standardized SSR primer 5 on 30 progeny plants, SSR 14 on 60 progeny plants and SSR 16 on 30 progeny plants. **October to December 2018 (Q4)** • Electrolyte leakage measured in 15 sorted progeny plants of ShanTea × S.3A/3 in replications for assessment of membrane stability index. • Wax content, specific leaf area and specific weight measured in 15 sorted progeny plants of ShanTea × S.3A/3 in replications. **January to March 2019 (Q1)** • Morphological study (DUS characters) on 55 progeny plants of TSS1 (TV13X TV17). Measurement of wax content in 68 progeny plants of TSS1 (TV13 × TV17). Measurement of RWC in 69 progeny plants of TSS1 (TV13 × TV17). • Molecular hybridity was tested on 108 progeny plants of Shan tea × S.3A/3 tea population using ISSR and SSR molecular markers. Percentage of	

				polymorphioc loci and heterozygosity determined using GenAlex software. The mapping population was grouped into 7 main clusters based on Nei's genetic distance. **March to June 2019 (Q2)** • Electrolyte leakage, maximum quantum efficiency of the PS II , Specific leaf area (SLA), Specific leaf weight (SLW) were measured and Chlorophyll content was estimated in 54 progeny plants of TSS1 (TV13 × TV17) • Peroxidase activity (POX) measured in 15 progeny plants of TSS1 (TV13 × TV17). • Specific leaf area (SLA) and specific leaf weight (SLW) were measured in 66 progeny plants of Shan tea × S.3A/3. **July to August 2019(Q3)** • Specific leaf area (SLA), specific leaf weight (SLW) and wax content were measured in 108 progeny plants and parents (Shan tea and S.3A/3). • Chlorophyll content were measured in 90 progeny plants and Relative water content (RWC) were measured in 20 progeny plants of Shan tea x S.3A/3 **March – June 2020 (Q2)** • Karyotype study was done in TV 1 samples.	

				• Morphological and physiological observations recorded in the 96 diverse tea germplasm mapping population. • Measurement of chlorophyll fluorescence (PS II activity) of 43 diverse TRA germplasms. • Measurement of Specific Leaf Area (SLA), Specific Leaf Weight (SLW) and Relative Water content (RWC) of 52 plants. • Proline and wax was estimated in 9 samples. • Measurement of Chlorophyll content (Chlorophyll a, chlorophyll b, chl a/b, carotenoids chl/car ratio) of 7 plants. • Biochemical analysis in purple tea mapping population. • Quantification of anthocyanin in 30 purple tea plants. • Processing of 45 samples for total catechin estimations. **July-September 2020 (Q3)** • Study of 96 Diverse germplasm mapping population: Work is in progress based on 45 traits i) Measurement of Specific Leaf Area (SLA) and Specific Leaf Weight (SLW) completed for 44 plants. ii) Measurement of Relative Water	

				content (RWC) completed for 96 plants. iii) Measurement of Chlorophyll content (total chlorophyll content, chlorophyll a, chlorophyll b, chlorophyll a/b ratio, carotenoid and chlorophyll/carotenoid ratio) of 15 plants. iv) Measurement of fv/fm (PS II system) completed for 53 plants. v) Measurement of Electrolyte leakage (EL%) and Membrane stability Index of 17 plants. vi) Morphological analysis in 20 plants for 20 different traits. vii) Physiological analysis for Net photosynthesis (Pn), Stomatal conductance (gs), Leaf temperature (Lt), Transpiration (E), Carboxilation efficiency (ci/ca) and Water use efficiency (WUE) completed in 72 clones. • Study of Purple Tea mapping population: Work is in progress based on 12 traits i) Estimation of Anthocyanin content in 15 plants of Purple tea population. ii) Study related to flushing behaviour: Shoot per 30 cm^2, Weight of shoots, Internodal length of 12 plants of Purple tea population completed. • For study of Biochemical parameters: Caffeine estimation, Total catechins completed in 45 samples. • Karyotyping of TV1 completed • Bioinformatics analysis of evolutionary	

				aspects of ABC transporter genes in *Camellia assamica* in progress. Secondary metabolite pathways identified and genes annotated. **October-December, 2020 (Q4)** • Study of 96 Diverse germplasm mapping population: Work is in progress based on 45 traits. i. Estimation of total chlorophyll content, chlorophyll a, chlorophyll b, chlorophyll a/b ratio, carotenoids and chlorophyll/carotenoid ratio in 29 plants. ii. Measurement of Wax Content in 96 plants. iii. Measurement of Electrolyte leakage (EL %) and Membrane stability Index (MSI) have been completed. • Study of 96 Purple Tea mapping population: Work is in progress based on 12 traits i. Estimation of Anthocyanin content in 15 plants of Purple tea population. ii. Studies related to flushing behaviour: Shoot number per 30 cm^2 and shoot weight (Fresh and Dry) were done for 96 plants of purple tea mapping population. iii. Morphological observations (Leaf Characters: Leaf colour, leaf shape and leaf size) were done for 96	

				plants of purple tea mapping population. iv. Measurement of inter nodal length (5th and 6th leaf) were done in 77 plants of purple tea mapping population. v. Visual estimates of Anthocyanin through image analysis completed in 96 plants. • Phylogenetic analysis of evolutionary aspects of ABC transporter genes and gene structure and functional annotations in *Camellia assamica* progress. **January-March, 2021 (Q1)** • Phylogenetic analysis of evolutionary aspects of ABC transporter genes and gene structure and functional annotations in *Camellia assamica* completed. A. Study of 96 Purple tea mapping population • Estimation of Total polyphenol content completed • Sample preparation, extraction and HPLC analysis for estimation of Total Catechins (+C, EC, EGC, ECG and EGCG) and Caffeine in 31 plants. • Extraction and Determination of Total Amino Acids in 96 purple plants • Extraction and Determination Total Protein in 96 purple plants	

				• Study of flushing behaviour has been completed. • Estimation of total monomorphic anthocyanin content is in progress B. Study of 96 diverse tea germplasm mapping population • Estimation of Total polyphenol content completed. • Sample preparation, extraction and HPLC analysis for estimation of Total Catechins (+C, EC, EGC, ECG and EGCG) and Caffeine in completed. • Extraction and Determination of Total Amino Acids in 96 diverse plants • Extraction and Determination Total Protein in 96 diverse plants. • Extraction and determination of Proline in 96 diverse plants. • Study of flushing behaviour completed in 96 plants. **April-June, 2021 (Q2)** **Study of 96 Purple tea mapping population (12 traits)** • Sample preparation, extraction and HPLC analysis for estimation of Total Catechins (+C, EC, EGC, ECG and EGCG) and Caffeine in 15 plants. • Estimation of anthocyanin in 96 purple tea plants completed.	

				Study of 96 diverse tea germplasm mapping population • Estimation of Total polyphenol completed in 96 plants. • Sample preparation and extraction for estimation of Total Catechins (+C, EC, EGC, ECG and EGCG) and Caffeine completed in 96 plants. **July-September, 2021 (Q3)** **1. Study of 96 Purple tea mapping population (12 traits) for the 2nd year.** • Morphological analysis of 70 germplasms has been completed. • Chlorophyll content estimation for 31 germplasms has been completed. • Sampling for biochemical analysis of 68 germplasms has been completed. **2. Study of 96 diverse tea germplasm mapping population (45 traits) for the 2nd year.** • Morphological analysis of 96 germplasms has been completed. • Sampling for biochemical analysis of 96 germplasms has been completed. • Chlorophyll estimation of 96 germplasms has been completed. • Proline estimation of 30 diverse tea germplasms was done. • Measurement of photochemical efficiency (fv/fm) of photosystem	

				PSII was done in 10 germplasms. **October-December, 2021 (Q3)** **1. Study of 96 Purple tea mapping population (12 traits) for the 2nd year.** • Completion of field verification of morphological observations in 96 diverse germplasms for the year 2021 and statistical analysis. • Estimation of Total leaf wax content in 50 diverse germplasm. • Completion of estimation of Chlorophyll and Carotenoid content in 96 germplasm. **January-March, 2022 (Q3)** • For correlation of morphological, physiological and biochemical data with the Tea Genome : Data analysis was done for 45 traits in 96 diverse germplasms and 12 traits in 96 purple tea germplasms in statistical software WASP-2.0 software (ICAR) and Graph Pad Prism software. Principal component analysis of 96 TRA diverse germplasms was done to identify the potential germplasms with drought, quality traits. • Phytohormone analysis of Gibberellic acid, Indole 3 acetic acid, 6 Benzyl amino purine in TV1, Extreme China germplasm (Vimtal) and Extreme Assam germplasm (Betjan) completed. Below 10ppb was detected in all the clones through LC-MS/MS ion	

				chromatography in QTRAP 400 instrument. **April-June, 2022 (Q2)** • Retrospective analysis of TV clones for their Drought Response followed by derivation of Multiple Logistic Regression Model based on Morphological and physiochemical traits, for predictive classification of candidate germplasms into drought tolerant and drought susceptible categories. • Selection of promising clones at 10% selection intensity and initiation of cutting raising for propagation as needed for further evaluation.	
15. Evaluation of anti-flavivirus activity of *Camellia sinensis* derived natural compounds and elucidating its effect on virion particles (Funded by Department of Health Research (DHR), GOI)	Dr. Pritom Chowdhury	In a collaborative work with Pasteur Institute, theaflavins the major black tea polyphenol was found to inhibit Hepatitis C virus in human liver cell line Huh7. Additive effect of theaflavin with major FDA approved drugs daclatasvir & sofosbuvir was also observed. HCV is a flavivirus which prompt us to interrogate effect of tea polyphenols against Japanese encephalitis virus (JEV)	The study will further establish the health effect of tea polyphenols. This will add to value addition of tea especially black tea.	**October – December 2018(Q2)** • Maintenance of BHK21 Cell lines • JEV and West Nile virus (WNV)strain propagation • Quantification of virus load and pool preparation for storage **January – March 2019 (Q3)** • Extraction and purification of theaflavin (TF1), Theaflavin Monogallate (TF2) and Theaflavin digallate (TF3) • Extraction and purification of catechin • HPLC analysis revealed >95% purity of extracted compounds **April – June 2019 (Q4)**	July, 2018 to Likely completion on July, 2021 (completed)

		which is endemic in this part of the world and is a major public health issues in southeast Asia.		• Toxicity assessment of compounds using cell counting kit -8 (Sigma) revealed BHK-21 cells are viable with 100µg treated compounds till 72hrs. • Cytopathic inhibition assay (CPE) showed protection. Repetition of assay and Plaque reduction neutralization assay standardization is under process. **July to August 2019** • Cytopathic inhibition assay (CPE) showed protection. Repetition of assay and Plaque reduction neutralization assay standardization is under process. • Repetition and further assay in triplicate is under process. • Fresh stocks of virus pools are being propagated for maintaining the titer of the virus for simultaneous anti-viral experiments. **March – June 2020 (Q2)** • Virus stock of GP-78 (JEV GORAKHPUR) strain has been passaged in mice (Animal house facilty, ICMR-RMRC, Dibrugarh). Passaged is done to prepare stock of 1 Multiplicity of infection (1 MOI) to be used in anti-viral assays. • Fresh stocks of purified theaflavins(TFs) are being assess for cytotoxicity in BHK 21 cell lines. • Different doses TFs from 2.5µg/ml to	

				250 5µg/ml in DMSO is being used for dose response cytotoxicity by using Sigma cell counting kit-8. • Standard pool of viruses (Japanese Encheplalities Virus and West Nile virus) were titrated in BHK 21 cell line for stock preparation of 1MOI (Multiplicity of Infection). **July-September 2020(Q3)** • Cytotoxicity of the Purified Theaflavins: The viability of Baby Hamster Kidney (BHK)-21 cells against different doses of TFs has been determined by using cell counting kit-8 (Sigma) by analyzing the reduction of using WST-8(2-(2-methoxy-4-nitrophenyl)-3-(4-nitrophenyl)-5-(2,4 disulfophenyl)-2H-tetrazolium,monosodium salt to formazan as per the standard procedure. • Virus titration: Multiplicity of infection (M.O.I) of standard Japanese encephalitis virus (JEV) pool has been done. • Virus titration of JEV was attempted in continuation of earlier experiment to check whether virus titer has been increased after subsequent passage in BHK-21 cell line. But the experiment was not successful as viral plaques didn't show uniformity. A fresh batch of BHK-21 cells were prepared for	

				fresh infection. **October-December, 2020 (Q4)** • Cytopathic effect (CPE) inhibition assay was performed with 1 Multiplicity of infection (MOI) of JEV and WNV. Cells were observed daily under inverted microscope and after three days based on appearance of CPE, the plates were stopped with amido black dye. Protection at the range of 10µg/ml of compounds was observed. • Plaque Reduction neutralization test (PRNT) was performed for JEV standard strains. The same procedure will be followed for anti-viral assay using TFs. Standardization for WNV PRNT assay is under progress. • qPCR standardization was done for both JEV and WNV. **January-March, 2021 (Q1)** • Cytotoxicity of purified Theaflavins was studied in VERO cell line. Virus titration of Japanese encephalitis virus was done. • Plaque Reduction neutralization test (PRNT) is under process for anti-Japanese encephalitis virus activity of purified theaflavins. Standardization for WNV PRNT assay is under progress. **April-June, 2021 (Q1)**	

				• Virus titration of Japanese encephalitis virus (JEV) to prepare 1 Multiplicity of infection (1 MOI) of virus pool for use in antiviral assays. • Mycoplasma detection was done in cultured vero cells as contamination has been observed after 6-5 cell passaging. • qPCR standardization was done for both JEV and WNV. • Theaflavin 3,3'di Gallate (TF3) showed protection against Japanese encephalitis virus (JEV), as an entry inhibitor against the virus, as TF3 was added along with the 1MOI of the virus pool followed by incubation. The assay will be repeated with fresh lot of extraction especially with commercially available theaflavin. **July-September, 2021 (Q3)** • The Baby Hamster Kidney (BHK21) cell line which was procured from ICMR-RMRC dibrugarh and CACO-2 cells purchased from ATCC has been revived in the TRA cell culture lab. • Three independent experiments for cytotoxicity using Roche cell proliferation kit I (MTT) with triplicates in each assay was done in BHK21 cells for theaflavin	

				cytotoxicity. **October-December, 2021 (Q3)** • Theaflavin cytotoxicity experiments using Roche cell proliferation kit I (MTT) was done in BHK21 cells for theaflavin cytotoxicity. • Revival and culture of CACO-2 cells. **January-March 2022 (Q1)** • Theaflavins in different percentage of purity (20-30%) are being compared with high purity theaflavins (>90%) for cytotoxicity in vero cells and human colon HT29 cells. • Vero cells and Human colon (HT29) cell lines are being cultured and revived for cytotoxicity analysis of Theaflavins (Different purity grades, 20-25% and high purity>95%). • RNA extraction from cells propagated in 96 well culture plates has been standardized • Intracellular ROS Generation in Vero Cells: Established steroids dexamethasone and prednisone were used as controls. The experiment is in standardization process and once completed can give a clear picture on antioxidant potential of varied purity theaflavins in comparison to high purity TFs and steroids. **April-June 2022 (Q2)** • H_2O_2 induced oxidative stress on HT-29 colon cell revealed that theaflavins showed protection against induced	

				free radicals with crude theaflavin (estimated 60 % purity) showed significant protection to HT-29 cell compared to TF 1, TF 3 and PRE (prednisone). • PCR primers for studying oxidative stress related gene expression were designed using NCBI database. Elongation factor, glutathione peroxidise, nuclear factor kappa-B kinase, nuclear respiratory factor along with housekeeping genes, B-actin and GADPH were selected for the study. The selected primers are being standardized using isolated RNA of both VERO and HT-29 cells. B-actin, GAPDH and Elongation factor have shown DNA bands after PCR amplification	
16. Development of polyclonal and recombinant monoclonal antibody coated lateral flow immunochromato graphic strips (LFICSs) for rapid onsite qualitative and semi-quantitative detection of unapproved pesticides from green leaf.	Dr S Borchetia	Although a few enzyme linked immunosorbent assay based pesticide detection kits have been reported, however, these does not work for tea and provide variable results as tea matrix interferences makes detection of pesticides based on colour a challenge.	A simple and easy to use onsite kit for qualitative and semi-quantitative detection of unapproved pesticides (Monocrotophos and acetamaprid) from green tea leaves.	**March – June 2020 (Q2)** • Monoclonal and Polyclonal antibody preparation in progress • Standardization of hapten by conjugation of monocrotophos and acetamiprid with KLH(Keyhole limpet hemocyanin) for immunization of mice and rabbits was carried out for polyclonal and monoclonal antibodies • Subsequent booster doses are given with incomplete adjuvants to generate immune response in mice and rabbits. • Paper based competitive binding of Acetyl choline esterase (AChe) enzyme was studied with pesticide monocrotophos for visual colour detection.	October 2019 to October 2021

				July-September, 2020 (Q3) Polyclonal antibody against acetamiprid and monocrotophos was raised in rabbit serum. Antibody titer of the sera was checked by ELISA which is measurement of how much antibody an organism has produced that recognizes a particular epitope, expressed as the inverse of the greatest dilution that still gives a positive result. There was good antibody titer after 4th booster for Acetamiprid conjugated to Ovalbumin. For Monocrotophos, antibody titre was produced after 7th booster dose conjugated with bovine serum albumin. Anti sera was used for purification of total Anti monocrotophos antibody by Protein-A affinity Column. **October-December, 2020 (Q4)** • Monoclonal antibody against acetamiprid and monocrotophos was raised in mice serum. • Purification of monocrotophos and acetamiprid monoclonal antibodies was done by A/G Spin kit according to manufacturer's protocol. • Standardization of Indirect ELISA were performed for Antigen-Antibody reaction for different concentration of conjugated antigens (monocrotophos and acetamiprid) were coated to the bottom of the microtitre plate and incubated	

				overnight. After blocking the unbound sites, purified monoclonal antibodies were added to bind to the antigens and incubated. After washing the unbound proteins, horseradish peroxidase conjugated secondary antibody were added to quantify the concentration of pesticide by the intensity of the colour with 3,3',5,5'-tetramethylbenzidine(TMB) substra. • Optimization of experiments are continued for detection of 50ppb of pesticides. **January-March, 2021 (Q1)** • Optimization of Antigen (Monocrotophos) and polyclonal antibody (pAB) concentration with pAB 2.1µg/mL & 4.2µg/mL and different monocrotophos concentration at 4 different time points of TMB (3,3',5,5'-Tetramethylbenzidine) substrate incubation (15, 20, 30, 45 mins). Substrate incubation time was standardized at 15 mins and antibody concentration at 4.2µg/mL. • Sandwich ELISA standardization is in process for detection of monocrotophos, where monoclonal antibody (Mab) raised against monocrotophos was coated into ELISA plates. Standard pesticide solution of different range *viz*. 20ppm to 0.05 ppm was used as	

				sample for detection. In addition leaf samples spiked with monocrotophos was also used to screen for detection capability of ELISA assay under standardization. In both screening sample condition i.e., standard monocrotophos solution and leaf solution, a detection limit of 1 ppm and 0.2ppm was observed respectively. Further standardization with large sample set is under process. **April-June, 2021 (Q2** • Sandwich ELISA was performed with spiked monocrotophos in tea leaf extracts by coating monoclonal antibodies on the ELISA plate. The spiked samples S1 to S8 were analysed by HPLC for quantification of monocrotophos. The graph showing linear trend for samples S1 to S5 with higher the concentration, lower was the absorbance. The concentration of S1 to S5 ranged from 124.76 ppb to 1.91ppb. Samples S6, S7 and control sample (S8) with no monocrotophos detected by HPLC formed outliers. • The same linear inverse trend line was also observed in Sandwich ELISA with spiked Acetamiprid tea leaf samples with concentration ranging from 26.49 ppb to 2.05 ppb detected by HPLC. **July-September, 2021 (Q3)**	

				• Acetylcholine esterase (AChE) inhibition assay was done for detection of organophosphate (Monocrotophos) pesticide using three different filter papers viz. Millipore Immobilon-NY+ nucleic acid blotting membrane, Whatman filter paper and Whatman chromatography paper with different concentrations of monocrotophos (0-100ppm). A decreasing order of color intensity was observed from 0 to 100 ppm in the Millipore Immobilon-NY+ nucleic acid blotting membrane. • Immobilization of the reagents was done for standardization of Lateral flow assay. 4% BSA was used as blocking reagent of conjugate pad. Gold labelled monoclonal antibody concentration 1.65 µg/ml and the antigens (Monocrotophos-BSA, 1ppm) and Secondary antibody (0.16 µg/ml) was dispensed onto the Nitrocellulose (NC) membrane and allowed to dry. The NC membrane, conjugate pad, sample pad, absorbent pad were pasted on a plastic adhesive. Pesticide sample (100 ppb) and control were tested in the strip for monocrotophos. Lateral flow was observed, control line was slightly visible when secondary antibody concentration was increased to 0.8 mg/ml. Further optimization is in progress. • ELISA was done for checking the	

				reactivity of monoclonal /polyclonal antibody conjugated with gold nano particles with spiked monocrotophos and Acetamiprid tea leaf samples. HPLC analysis was done for validation in the spiked samples. **October-December, 2021 (Q3)** • Lateral flow immunochromatographic strips are being standardized for detection of monocrotophos via antigen antibody reaction. Immobilization of the reagents was done for standardization of Lateral flow assay. Pesticide standard samples and spiked tea leaf samples were tested in the strip for monocrotophos residues. Lateral flow was observed, control and test lines was visible when secondary antibody concentration was increased to 1500ng and Monocrotophos-BSA hapten was increased to 2250ng in carbonate buffer. Further optimization of coating antigens, concentration of gold nanoparticles mAb for sensitivity of the strip for target 50ppb of monocrotophos pesticide is in progress. • Quantification of monocrotophos and chloropyriphos spiked tea samples done by HPLC. **January--March, 2022 (Q1)** • Due to high degree of non specific bindings in the test line of lateral flow	

				immunochromatographic strips for detection of monocrotophos via antigen antibody reaction, combinations of different pH and conjugating buffers, salinity of the detergents are studied for improving target binding. • Cross-reactivity was studied for evaluating the selectivity of the lateral flow strips, using the standard solution of the acetamiprid, thiacloprid, thiamethoxam and imidacloprid. Spiking of tea leaves with acetamiprid, preparation and detection of acetamiprid pesticide in samples with gold conjugated monoclonal antibodies in lateral flow strips. **April—June, 2022 (Q2)** Tea matrix was prepared by taking 10 gm of tea shoot samples in 50 ml millipore water. Stoppered and shaked for 2 hrs. on a mechanical shaker and the extract (5 ml. Extract = 1 gm. of Tea shoots) prepared by surface rinsing were spiked with different concentrations (50-500ppb) of Monocrotophos and Acetamiprid and Matrix interference and response of sensor was studied with LFICS	
17. Germplasm characterization, genomics analysis and gene discovery for yield, metabolite and stress tolerance in tea - Funded by	Dr Pritom Chowdhury	The traits to be studied for drought analysis have been streamlined. TV1 genotype was decoded using NGS (next generation sequencing) data including Illumina, PacBio and Hi-C long reads. Mitochondrial and	Identification of Drought tolerant germplasms and development of mapping population for generation of drought tolerant plants.	**April-June, 2022 (Q2)** • Initiation of genetic resource survey for mapping potential unutilized Drought tolerant germplasms and sitemap preparation. • Initiation of germplasm assessment for Diversity panel assemblage primarily focusing on Drought tolerant traits as a	Date of Start: 15.03.2022 Till 15.03.2025

DBT NER.		chloroplast genome of clone TV1 was assembled using Illumina & PacBio reads where exhibited mitochondrial genome result was 707,441bp long and chloroplast genome was 157,353bp long. This genome will be utilized as reference for gene identification.		prerequisite for Genome-wide Association study. • Finalizing agronomically beneficial morphological and biochemical traits related to yield, quality and Drought tolerant traits for preliminary evaluation of unutilized germplasm set.	
18. Establishing Efficient Platform for Genetic Engineering in Indian Tea – Funded by DBT NER	Dr S. Borchetia	Ostacles have been observed in application of transgenic technologies in tea plant such as low transformation efficiency from somatic embryogenesis.	1. To establish an efficient *in vitro* regeneration system in Assam Tea genotypes TV1, TV20 and Betjan. 2. To develop a high throughput Agrobacterium mediated genetic transformation system in Assam tea.	**April-June, 2022 (Q2)** • For direct somatic embryogenesis, culture of TV1/Betjan immature cotyledons in embryo initiation media.	Date of Start: 15.03.2022 till 15.03.2024
19. Value Addition and Product diversification in Tea	Dr Pritom Chowdhury (Co.Pi) Dr Podmo Pollov (Pi)	Antioxidant activity of theaflavins has been demonstrated in HT-29 cells	1. Devlopment of tea based neutraceuticals. 2. Development of antiviral gargling solution.	**April-June, 2022 (Q2)** • Human colon HT-29 cells is being maintained in the cell culture lab	Date of Start 15.03.2022 Till 15.03.2025
Climate and GIS					
20. Studies on the impact of elevated carbon dioxide and temperature on carbon sequestration potential of different tea cultivars and soil	Dr. K. Z. Ahmed	The consensus of many studies of the effects of elevated carbon dioxide on plants is that the carbon dioxide fertilization effect is real (Kimball, 1983; Acock and Allen, 1985; Cure and Acock, 1986; Allen, 1990; Rozema et al., 1993;	The project will help to screen out clones on the basis of carbon sequestration potential to mitigate the impact of future climate change. Impact of climate change on soil carbon and microbial dynamics will be figured out.	**July-September 2016 (Q3)** - **October- December 2016 (Q4)** • Project is approved. **January – March 2017 (Q1)** • Fund was released. • Project was launched on 1st March,2017.	Likely Date of start 2017 Likely date of completion: 2020 (completed)

organic carbon		Allen, 1994; Allen and Amthor, 1995). Increased biomass accumulation with elevated carbon dioxide mostly affected soil organic matter pools with fast turnover rates (labile C, microbial biomass), but had no significant effect on total soil C and N pools, or the decomposition of the more recalcitrant C (Feike et al.,2005). Increasing the belowground translocation of assimilated carbon by plants grown under elevated CO_2 can cause a shift in the structure and activity of the microbial community responsible for the turnover of organic matter in soil (Blagodatskaya et. al., 2010).Two hevea clones were exposed to elevated carbon dioxide, humidity and temperature. Both the clones showed positive response but the percent increase were different (Devakumar Et al.,1998)		•Project work is initiated. **April-June 2017 (Q2)** • Research fellow recruited • Preliminary works for the experiment are in progress (earth filling in the pots for planting nursery plants, preparation of shed) • Soil samples were analyzed for Microbial respiration and Microbial biomass carbon as a trial by using standardized procedure. Both these estimations will be required for carrying out the analysis mentioned under the objectives of the project. **July-September 2017 (Q3)** • Soil samples collected from the pots were analyzed for Microbial respiration and Microbial biomass carbon before planting nursery plants. • Planting of nursery plants in the pots initiated. **October – December 2017 (Q4)** • Soil samples were analysed for pH and organic carbon. • Planting of nursery plants in the pots were completed. • Open Top Chamber facility was calibrated. • Potted plants were shifted to the experimental area and placed in the	

				Open Top Chamber and in ambient condition. **January-March 2018(Q1)** • Benchmark soil samples were analysed for hot water soluble carbon. • Initial readings of plant height, collar diameter, branch number and leaf numbers were measured after placing the pots in the experimental area. • Soil samples were collected from pots for further soil sample analysis. • Soil moisture and microbial respiration was measured. **April-June 2018 (Q2)** • Enrichment of plants with carbon dioxide (550ppm) has been started. • Plant height, collar diameter, branch number and leaf number of the pot plants placed in the three environmental condition of the OTC experiment were measured after hundred and two hundred hours of carbon dioxide enrichment at the level of 550ppm.After two hundred hours of enrichment increase of plant collar diameter varied from 0-0.31 cm, 0.02-0.38 cm and 0.01-21 cm under elevated temperature, elevated temperature + carbon dioxide and	

				ambient condition respectively. • Soil moisture and microbial biomass carbon measured. **July-September 2018(Q3)** • Chlorophyll estimation of leaves of the potted plants of the OTC experiment was done after two hundred hours of enrichment of plants with carbon dioxide at the level of 550ppm. • After completion of three hundred hours of carbon dioxide enrichment, height, collar diameter, branch number and leaf numbers of plants were measured. Increase of plant height varied from 4.3-64.9 cm, 1.4-116.4 cm and 0.1-37.2 cm under elevated temperature, elevated temperature + carbon dioxide and ambient environment respectively. • Soil moisture measured. **October – December 2018 (Q4)** • Leaf Length and width of pot plants placed in the three environmental condition of the OTC experiment were measured after three hundred hours of carbon dioxide enrichment at the level of 550ppm.Leaf length varied from 9-24.7cm, 9-25.8cm and 8.5-18cm and leaf width varied from 3.5-10.1cm, 3-9.1cm and 3-8cm under elevated temperature, elevated	

				temperature + carbon dioxide and ambient condition respectively. • Photosynthesis,Stomatal conductance and Transpiration of pot plants placed in the three environmental condition of the OTC experiment were measured after three hundred hours of carbon dioxide enrichment. • Plant height, collar diameter, branch number and leaf number of the pot plants placed in the three environmental condition of the OTC experiment were measured after four hundred hours of carbon dioxide enrichment. **January-March 2019(Q1)** • Chlorophyll estimation of leaves of the potted plants of OTC experiment after four hundred hours of enrichment is completed. Average data of total chlorophyll showed 4.905, 4.598 and 4.692 mg/g in elevated temperature and carbon dioxide, elevated temperature and ambient condition respectively. • Soil sample analysis for microbial respiration has been completed. • Soil sample analysis for microbial biomass carbon is under progress. • Uprooting of plants of the OTC experiment for plant biomass has been started.	

				April-June 2019 (Q2) • Soil sample analysis for microbial biomass carbon is completed. • Uprooted plants of seven cultivars which were separated in to stem leaves and roots were dried.Dry weights were measured. The ranges for the dry weight of stems were found to be 2.24-30.68, 4.57-32.6 and 1.48-10.59 gm under elevated temperature, elevated temperature + carbon dioxide and ambient condition respectively. In case of dry weight of leaves, the ranges were found to be 1.63-30.07, 2.34-29.03, and 0.24-6.82 gm under elevated temperature, elevated temperature + carbon dioxide and ambient condition respectively. Ranges for dry weight of roots were found to be 1.1- 29.29, 0.59-24.77 and 0.19-10.25 gm under elevated temperature, elevated temperature + carbon dioxide and ambient condition respectively. • Soil samples from the pots were collected for analysis of different parameters. **July - September 2019 (Q3)** • Uprooted plants of rest of the three cultivars were separated into stem leaves and roots.Fresh weights were	

				taken and samples were dried and dry weights were measured. The ranges for the dry weight of stems were found to be 3.92-18.72, 8.08-16.2 and 0.9-7.58 gm under elevated temperature, elevated temperature + carbon dioxide and ambient condition respectively. In case of dry weight of leaves, the ranges were found to be 7.05-18.09, 6.76-16.09, 0.17-6.54 under elevated temperature, elevated temperature + carbon dioxide and ambient condition respectively. Ranges for dry weight of roots were found to be 1.33-11.36, 5.16-11.42 and 1.31- 7.09 gm under elevated temperature, elevated temperature + carbon dioxide and ambient condition respectively. • Analysis of soil pH from the soil samples collected after uprooting of the OTC plants is under progress. **October-December 2019 (Q4)** • Leaf samples collected after uprooting of the OTC plants which were oven dried, has been prepared for analysis of leaf carbon. • The range of leaf carbon of the ten cultivars was found to be 31.26 - 39.73%, 34.28 - 44.65% and 31.26 - 37.45% under elevated temperature, elevated temperature + carbon dioxide and ambient condition respectively.	

				• Stem samples collected after uprooting of the OTC plants which were oven dried, has been prepared for analysis of stem carbon. Estimation of carbon content of stem of the OTC plants is under progress. **<u>March-June,2020</u>** • Analysis of organic carbon content of soil samples collected after uprooting of OTC plants were completed. The range of organic carbon of the soils collected from the pots of the ten cultivars were found to be 0.80-1.47%, 0.83-1.55% and 0.60-1.20% under elevated temperature, elevated temperature + carbon dioxide and ambient condition respectively. • Analyses of carbon content of stem samples collected after uprooting of OTC plants were completed. The ranges of stem carbon in the ten cultivars were found to be 32.3-38.2%, 33.0-38.7% and 28.0-35.5% under elevated temperature, elevated temperature + carbon dioxide and ambient condition respectively. • Data of soil pH, plant above ground biomass, below ground biomass ,total plant biomass and root volume has been statistically analysed.Among the ten tested cultivars eight cultivars showed significant increase in total plant biomass in elevated temperature and carbon dioxide condition	

				compared to ambient, while seven cultivars showed significant increase in temperature elevated condition compared to ambient. Among the ten tested cultivars, six cultivars showed significant increase in root volume in elevated temperature and carbon dioxide condition compared to ambient, while seven cultivars showed significant increase in temperature elevated condition compared to ambient. • Materials for Annual Scientific Report 2019-2020 are submitted to NTRF. **<u>July -September, 2020</u>** • Analyses of carbon content of root samples collected after uprooting of OTC plants were completed. The ranges of root carbon in the ten cultivars were found to be 27.8-33.4 %, 27.8-33.4 % and 26.5-32.2% under elevated temperature, elevated temperature + carbon dioxide and ambient condition respectively. • Statistical analysis of soil organic carbon, stem carbon and root carbon were done. **<u>October-December 2020 (Q4)</u>** Soil samples collected after uprooting of the OTC plants were analyzed for water	

				soluble carbon content.In the estimated samples the ranges of water soluble carbon content were found to be 1056-1596 µg/g,1116-1596 µg/g and 1056-1356 µg/g under elevated temperature, elevated temperature + carbon dioxide and ambient condition respectively. **<u>January-March 2021(Q1):</u>** • Annual report submitted to NTRF (2020-2021). **<u>April-June 2021 (Q2):</u>** Data compilation work is in progress for final project report preparation. **<u>July -September, 2020:</u>** Data compilation work is in progress for final project report preparation. **<u>Oct-Dec 2021 (Q 4):</u>** Preparation of final project report is in progress.	
21. .National Mission for Sustaining the Himalayan Ecosystem:	Dr. R.D. Baruah			Approval of the proposal with Tocklai Tea Research Institute, Jorhat, (CCPI Dr. Rupanjali Deb Baruah; CC-CoPI – Dr. Kamruza Zaman Ahmed) has been accorded by the competent authority with	Likely Date of start : The project is yet to be launched

Agriculture (DST)				a financial outlay of Rs. 3255040.00 for a period of 5 years. **<u>January-March 2022(Q1):</u>** • A Consultative Meeting was held by the team of the NMSHE Task Force on Himalayan Agriculture (Phase-2) in an online mode on 22nd February, 2022, in order to discuss important agenda pertaining to the implementation of the project, as per the approved objectives. • The recruitment of Project staff has been done during this period. **<u>April-June 2022 (Q2):</u>** • Review of literature related to the objectves taken up in the project. • Database development of climatic parameters is being done. • Preparation and submission of annual progress report, utilization certificate and statement of expenditure of the project for the financial year ending March, 2022 has been done.	officially. Likely date of completion: **(1st year : Rs. 601760)**
Mycology and Microbiology, NBRRDC, Nagrakata					
22. Unraveling Interaction of Tea Crops and Rhizospheric Microbiota from Organic Tea Gardens for	Dr. Abhay K. Pandey		• Isolation and characterization of microbial antagonists associated with soils of organic tea gardens • Evaluation of the functional properties of isolated microbial antagonists to identify	Janury –March 2022 (Q1): • Recruitment of project staff • Purchase of Chemicals and Equipments • Standardization of protocols **April-June 2022 (Q2)** • Collection of soil samples from Tindharia, Gidapahad, Selim Hills,	Durations 2 years

Management of Grey Blight (SRG/2021/00299)			potential antagonists against gray blight pathogen infecting tea crops • Understanding the tritrophic interactions between tea crops, potential antagonists and grey blight pathogen with a focus on PR protiens expression	Samabeong, Amboek, Sepoydhura, Makaibari, and Singell, tea gardens. • Standardization of protocols for isolation of microbes • Microbial analysis of collected soil samples from different tea gardens. • Antagonistic activity of isolated *Trichoderma* and bacterial species against Fusarium dieback and grey blight pathogens. • Compilation of review on gray blight	
23. Development of sustainable agriculture practices for biotic and abiotic stress management in conventional and organic tea plantationsEstablishment of Organic Hub for supporting organic and alike farming through promotion of bio-inputs technologies in farmers' fields of North East India.	Dr. Abhay K. Pandey Dr. B. Deka	Potential antagonists and entomopathogens identified from tea rhizosphere	• Standardization of protocol for formulation of low-cost biofungicides from Trichoderma spp. Actinomycetes and Bacillus subtillis and bioinsecticide from Metarhizium anisopliae in various carrier agents • Comparative in-vitro screening of developed bio-pesticides in various carrier agents against Fusarium, gray blight, blister blight anf Red rust • Efficacy of bio-pesticides having most compatible carrier agensts through microplot and multilocation field study and impact analysis	**April-June 2022 (Q2)** • Re-culturing *Bacillus subtills, Trichoderma* spp., *Bacillus thuringiensis, Microbacterium paraoxydans, Metarhizium robertsii s.l.* (*M. anisopliae s.l.*) • Standardization of protocol for development of bioformulations.	Three years
24. Establishment of Organic hub for supporting organic and alike farming	Dr. Abhay K Pandey	Potential antagonists and entomopathogens identified from tea rhizosphere	• Imparting trainings to farmers & small tea growers (STG) of Meghalaya and Sikkim to spread knowledge and skill	**April-June 2022 (Q2)** • Project just initiated and discussion with partner institutes regarding sharing of biomaterials, activities, training of	Two years continue upto five years

though promotion of bio-inputs technologies in farmers' field of north east India			enhancement on value-added microbial biopesticides like Um-Tricho, Um-Bir, Um-Met etc. and macrobials (Trichogrammatids, Chrysopids, Anthocorids, Chelonus blackburni, predatory mites) for sustainable agriculture. • Demonstration on development of low-cost biopesticides of effective and proven Trichoderma harzianum, Beauveria bassiana, Metarhizium anisopliae based technologies like Um-Tricho, Puth-Tricho Um-Bir, BKN114 Um-Met, respectively, and mass rearing of macrobials like Trichogrammatids, Chrysopids, Anthocorids, Chelonus blackburni, predatory mites among farmers and their validation in the field. • Promote rapid production of on-farm native biocontrol agents (microbial and macrobials), their ex-situ conservation by setting up	farmers/tea growers was discussed. • Package of practices of different crops are under preparation, selection of farmers/tea growers for demonstration trials	

			biocontrol units and scaling up the wellproven and useful technologies		
Soil Department, NBRRDC, Nagrakata					
25. Enrichment of carbon pool in tea soils and mitigation of greenhouse gas emission by recyclingtea waste: A green strategy towards organic tea cultivation	Dr. Prabhat Pramanik	Development of a method to recycle tea waste in large scale to prepare compost and optimization of its application technique to improve soil health and nutrient availability in soil	• To develop a cost-effective technique for recycling tea waste as the source ofnutrient-rich organic amendment by incorporating suitable microbial consortium • To optimize and validate a package of soil management involving tea waste derivedorganic amendment to boost carbon pool in soil, increase crop productivity andimprove the health of soil and environment during tea cultivation in India	**April – June, 2022 (Q2)** **The project is initiated in April 2022 and the research fellow is already recruited. The procurement of capital items and purchase of chemicals is in progress.**	It is a three (3) years project Date of Initiation: April 2022 Date of Completion: March 2025
1. Sustainable Management of Tea Waste to Transform the Tea Industry into Carbon Neutral andZero Waste Industry	Dr. Prabhat Pramanik	Development of a method for on-field decomposition of pruning litters to improve nutrient availability in soil and estimating its effect on soil health and crop yield	• To isolate effective cellulolytic microbial strain capable of degrading pruning litters • To develop a method of pruning litter decomposition under field condition for increase nutrient release in soil • Optimize a package of soil management by introducing the developed technology to	**April – June, 2022 (Q2)** **The project is initiated in April 2022 and the research fellow is already selected for the project.**	It is a three (3) years project Date of Initiation: April 2022 Date of Completion: March 2025

			improve soil health		