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Contents

Preface

Darjeeling Tea Research Centre has been established in 1977 at Kurseong including an experimental farm of 21.6 hectares. The Centre besides catering to the advisory requirement of Darjeeling tea gardens has developed technical know-how on various aspects of tea cultivation. The four main Divisions of research are Farm Management (Botany and Agronomy), Soil Science, Bio-chemistry and Plant Protection. The Centre has *inter alia* a Library. Minitature Manufacturing Unit and an Agro-meteorological Observatory.

Significant Achievements

The notable accomplishments are summarised below.

- The performance of eight popular clones out of thirty clones released for Darjeeling gardens wa- evaluated. The comparative performance had indicated superiority of the clone Bannockburn 157 for large scale commercial cultivation. Other clones which could be used in order of priority are P312, T78 and T383.

- Since distinct clonal variations were noticed, the relationship between growth parameters and their quantitative analysis at an early stage of growth of popular tea clones has been established.

- Tea plants in Darjeeling takes as much as 7-8 years to come into full bearing. Evaluation of different methods of training of young plants has been done and pegging was found to be most advantageous in bringing up young plants.

- Replanting is almost universally considered a necessary but it is rather conservative in Darjeeling. The traditional method of replanting tea by manual uprooting of old tea bushes is expensive and promotes soil erosion. This research centre has formulated recommendations as an alternative to the traditional method which would preserve the top soil and involve less expense.

- Experience with binodal cuttings have shown their superiority in terms of better growth over single node suttings.

- Standardised the frequency of plucking in respect of yield and quality.

- A soil-fertility status viz., N, P & K map of Darjeeling tea growing soils have been published.

- The positive effect of foliar spray of Zinc on yield has been established.

- Effect of six different sources of sulphur fertiliser has been examined and their efficacy in rectifying the deficiency of this mineral has also been established.

- Potassium ion potential and the quantity -- intensity relationship as affected by organic matter and exchangeable aluminium ions has been studied.

- X-ray diffraction studies of the soils of quality and non-quality sections of Darjeeling tea gardens have been made. The genesis of the soils of this area has also been outlined on the basis of detailed morphological, physico-chemical and mineralogical analysis.

- Bioefficacy of different neem products in controlling certain pests of tea has been tested.

Collaborative Research

This Research Centre is recognised as a centre for Ph. D. work by North Bengal University and Kalyani University.

Advisory Service

The Advisory Services are rendered from this Centre and it acted as an efficient channel for transmitting new findings to the fields. The scientists made several advisory visits to different tea estates of the Darjeeling hills.

Visitors

Important visitors to this Centre during 1999-2000 were :--

i) Shri S. A. Habib, Director (R & D) alongwith a 6-member Delegation from Tea Board, Bangladesh.

ii) Prof. N. Arunachalam, Deptt. of Agronomy, TNAU, Coimbatore.

iii) Shri Foirotto and his team from Hediard, France.

Farm Management Division

1.1 **Production and Sale :**

Total production of green leaves was 20,431.0 Kg and this quantity was sold to M/s. Tiru Tea Limited (Castleton Tea Estate) at a cost of Rs. 3,72,865.75

1.2 **Pruning**

The following pruning schedule was followed.

(i)	Light pruning	--	3.24 hectare	--	17.54%
(ii)	Deep / Medium Skiff	--	4.01 hectare	--	21.71%
(iii)	Light Skiff	--	6.71 hectare	--	36.33%
(iv)	Levelling of Skiff	--	4.51 hectare	--	24.42%
	Total		**18.47 hectare**		

1.3 **Manures and fertilisers:**

The following composition and dose of fertilisers were applied.

Mature Tea -- N: P: K :: 120 : 45 : 120
Young Tea -- N: P: K :: 60 : 30 : 60

Trasco - 5 (Tea Special) was also sprayed (400 ml / ha) or 200 ml in 200 litres water.

1.4 **Weed control :**

Glyphosate, Paraquat and 2,4-D were applied at recommended dose and the control of weeds was satisfactory. Weeds were also controlled manually during rainy season.

1.5 **Meteorology :**

Monthly data on various meteorological parameters recorded during the year are presented in Table-1.

1.6 **Research Projects :**

1.6.1 **Determination of suitable pruning cycle of old Chinary tea bushes of Kurseong (DTRC/FM/17)**

The experiment was initiated in the year of 1994. During this year, 4 year pruning cycle treatment was light pruned, 5 year pruning cycle treatment was light skiffed and 3 year pruning cycle treatment was levelling off skiffed. The yield data recorded at 5 days interval during the year is presented in Table -2

1.6.2. **Effect of nutrient management on stomatal behaviour and growth of young Tea Plants (DTRC/FM/19)**

The experiment was initiated in the year 1996. The data on different physiological parameters recorded seasonally in Table no. 3 to 10. Net Photosynthesis (Pn), Stomatal Conductance, Transpiration (E), Intercellular CO_2 conc. Leaf Temp (°C), Water Use Efficiency (WUE) (Pn/E), Stomatal Resistance and Vapour Pressure Deficit (VPD) were measured by Portable Photosynthesis System (LI-6200).

The Chlorophyll contents were measured by using Spectrophotometer. The calculation of the contents of Cholorophyll a and b in 80% acetone solution was based on the coefficient of optical absorptions at wave length of 645 and 663 μ by Arnon Method. The ratio of Chlorophyll a and b contents is generally 3 : 1 (Table 11)

Water potential (ψL) of the leaves has been measured at different seasons using Dew Point Microvoltmeter. (Table no. 12)

Relation between Chlorophyll content and Photosynthesis Rate in Tea :

The study was undertaken to establish the relationship between the Chlorophyll content and Photosynthetic rate. The leaves of the Clone T-78 with varying physiological maturity were subjected to total Chlorophyll quantification adopting destructive sampling method. Prior to extraction, the same leaf was used for *in situ* measurement of photosynthetic rate. Carbon dioxide fixation was monitored between 9.00 and 11.00 a.m. using Portable Photosynthesis System where the leaf temperature ranged from 25 to 30 ^{0}C and photosynthetic active radiation varied between 800 and 1200 μ mol m^{-2} s^{-1}. Extracted Chlorophyll was quantified using UV-visible Spectrophotometer. The values of total Clorophyll content and photosynthetic carbon assimilation rate of respective leaves were regressed for their linear relationship. Strong, positive correlation existed between Chlorophyll content and photosynthetic rate (Fig. 1). Increase in photosynthetic rate was observed with a concurrent increase in total Chlorophyll content fitting the regression equation $Y = a + bx$ (Where Y = photosynthetic rate in μ mol m^{-2} s^{-1}; X = total Chlorophyll content in mg / g fresh weight and a and b are regression contents). Correlation coefficient value (R^2) is significant at one percent probability.

1.6.3. **Response of foliar application of some Micro-nutrients in Darjeeling Tea (DTRC/FM/20).**

The experiment was conducted in the old Chinary Tea Plantation of DTRC. The details of the experiment were discussed in ASR 1998-99 (P-6). The made tea yield for the year 1999 (after application of the Micronutrients) has been recorded (Table 13) and found that the treatment no. T5 (Zn + Mg + B) gave the highest made Tea yield followed by other treatments.

1.6.4. **Diurnal variation of physiological parameters:**

Diurnal reading was taken by Portable Photosynthesis System (LI - 6200) in the month of October 1999. The observations are presented in Table no. 14.

(i)	Highest rate of Photosynthesis	--	9.00 a.m. to 11.00 a.m.
(ii)	Highest PAR (PPFD)	--	9.00 a.m. to 12.00 a.m.
(iii)	Highest intercellular CO_2 concentration	--	early morning & late evening
(iv)	Highest rate of stomatal conductance	--	7.00 a.m. to 10.00 a.m.
(v)	Highest rate of Transpiration	--	9.00 a.m. to 1.00 p.m.
(vi)	Highest rate of stomatal resistance	--	early morning & late evening
(vii)	Highest Leaf Temperature	--	11.00 a.m. to 12.00 a.m.
(viii)	Highest rate of Relative Humidity	--	10.00 a.m.

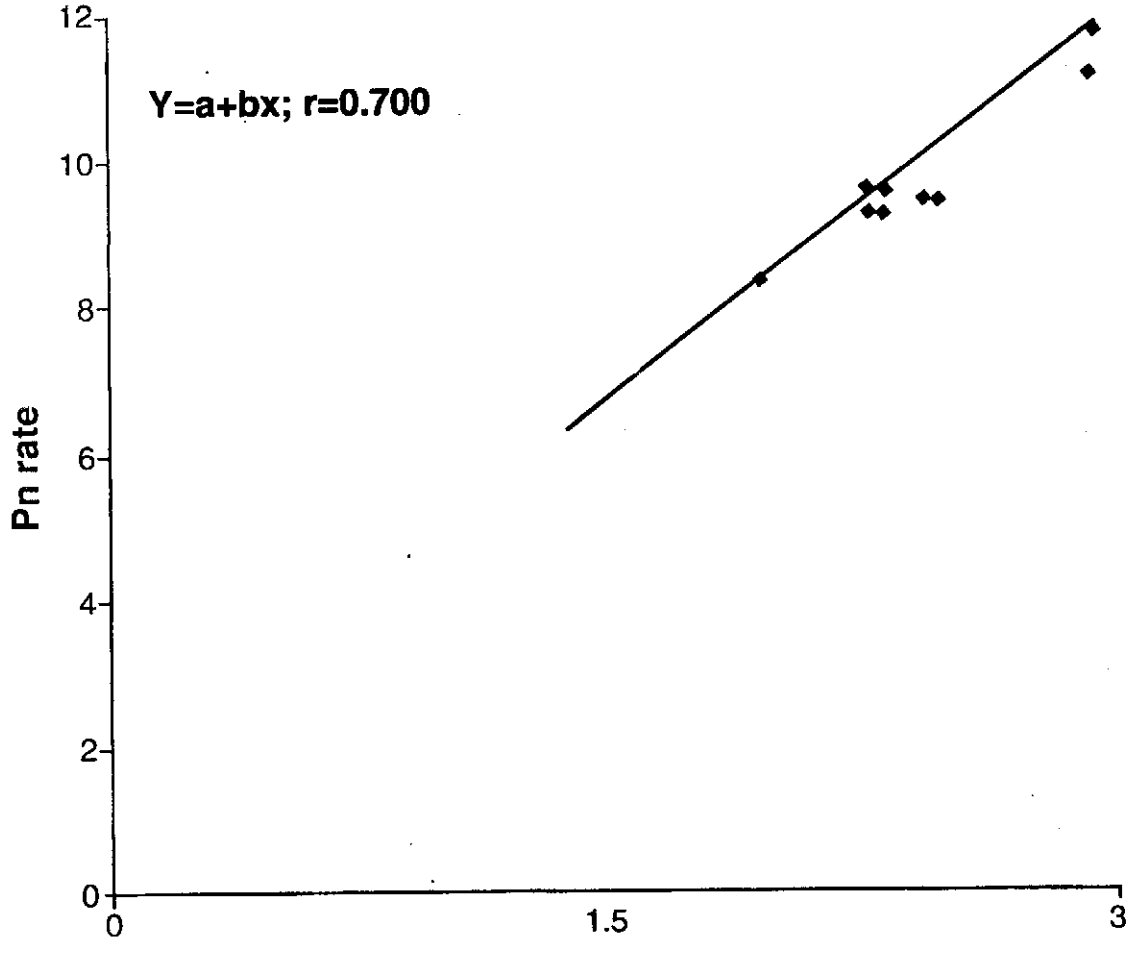

Fig. 1. Relationship between total chlorophyll content and photosynthetic rate in Darjeeling Tea.

Table 1 : Weather observations recorded at the Meteorological observatory in DTRDC (1999-00)

Month	Mean Air Temperature		Mean Soil Temperature						Mean Vapour Pressure		Mean Relative Humidity		Mean Sunshine duration (hd^{-1})	Total Rainfall (mm)	Mean Wind Velocity ($Km\ h^{-1}$)	Mean daily evaporation (mm)
			5 Cm		10 Cm		20 Cm									
	Max	Min	6.39	13.39	6.39	13.39	6.39	13.39	6.39	13.39	6.39	13.39				
	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	%	%				
April	21.6	16.2	18.5	26.8	19.5	25.9	21.4	23.0	14.6	18.5	92.0	95.0	3.8	60.2	---	7.1
May	20.3	16.2	18.8	23.0	19.4	22.4	20.6	21.4	14.9	17.2	96.0	95.0	1.9	427.1	---	3.3
June	22.6	18.4	20.4	25.7	21.3	25.0	22.4	23.2	17.1	19.7	96.0	95.0	1.8	938.6	---	2.9
July	21.2	18.3	20.0	24.2	20.8	23.7	21.8	22.3	16.7	18.1	96.0	95.0	0.2	1013.1	3.4	1.9
August	21.9	18.5	20.3	24.3	21.1	23.7	22.3	22.6	16.9	19.1	96.0	96.0	0.8	732.9	3.1	2.7
September	20.9	17.4	18.9	23.8	19.9	23.0	21.2	21.8	15.9	18.0	96.0	96.0	1.2	569.8	3.2	2.7
October	20.1	16.0	19.0	23.3	19.8	22.4	20.9	21.1	14.8	16.7	94.0	93.0	2.5	274.6	2.0	2.9
November	18.0	11.8	13.7	20.1	14.6	19.2	16.5	17.3	11.4	14.8	93.0	94.0	3.9	00	1.9	2.3
December	15.5	9.0	10.8	18.4	11.9	16.8	14.0	14.5	9.4	12.2	91.0	92.0	3.8	00	1.6	4.2
January 00	12.7	6.3	8.6	14.3	9.8	13.0	11.7	11.8	7.7	10.3	92.0	93.0	4.5	5.0	1.6	4.9
February	13.0	6.0	9.0	15.2	10.2	13.6	11.4	11.6	7.5	10.4	90.0	91.0	3.8	00	1.9	4.5
March	16.0	9.0	11.4	19.8	13.2	18.7	14.6	16.0	9.3	13.0	93.0	94.0	4.3	15.0	2.0	4.4

(DTRDC - Lat - 26°55' N, Long - 88° 12' E , Altitude - 1240 m)

Table 2 : Effect of pruning cycles and time of pruning on yield kg / ha $^{-1}$

Pruning Cycle	Pruning in 1998	Sep.	Nov.	Dec.	Total	Mean
3 Year	LOS	678.7	633.7	699.7	2012.1	670.7
4 Year	LP	306.6	353.5	313.5	973.6	324.5
5 Year	LS	746.5	839.2	878.0	2463.7	821.2
Total	---	1731.8	1826.4	1891.2	---	---
Mean	---	577.3	608.8	630.4	---	---

Table 3 : Seasonal variation of Net Photosynthesis

Treatments	Net photosynthesis (μ mol m^{-2} s^{-1})		
	A	B	C
T1	8.225	5.992	8.902
T2	8.667	6.080	9.454
T3	8.137	9.386	10.690
T4	9.153	5.965	10.460
T5	7.437	8.016	9.850
T6	11.23	10.574	11.950
T7	8.746	7.677	10.840
T8	8.513	6.319	10.710
T9	10.501	9.430	12.041

Table 4 : Seasonal variation of Stomatal Conductance

Treatments	Stomatal Conductance (μ mol m^{-2} s^{-1})		
	A	B	C
T1	0.0986	0.1814	0.2580
T2	0.0903	0.1560	0.2539
T3	0.0824	0.1888	0.2847
T4	0.0944	0.1755	0.2650
T5	0.0570	0.2199	0.2640
T6	0.1088	0.2459	0.2660
T7	0.0853	0.1301	0.2570
T8	0.1060	0.2230	0.2583
T9	0.1009	0.1663	0.2446

Table 5 : Seasonal variation of Transpiration

Treatments	Transpiration (μ mol m^{-2} s^{-1})		
	A	B	C
T1	3.905	1.431	5.767
T2	3.114	2.037	5.765
T3	3.015	3.314	6.982
T4	3.869	3.493	5.382
T5	2.069	3.902	5.530
T6	3.790	4.147	5.536
T7	1.916	2.344	5.576
T8	3.216	3.571	5.169
T9	3.442	2.588	5.532

Table 6 : Seasonal variation of W. U. E.

Treatments	W. U. E. (μ mol m^{-2} s^{-1})		
	A	B	C
T1	2.106	4.187	1.544
T2	2.783	2.985	1.640
T3	2.698	2.827	1.531
T4	2.367	1.708	1.944
T5	3.594	2.902	1.781
T6	2.963	2.549	2.159
T7	4.565	3.275	1.944
T8	2.647	1.769	2.072
T9	3.051	3.647	2.177

Table 7 : Seasonal variation of Int. CO_2 conc.

Treatments	Intracellular CO_2 Conc. (ppm)		
	A	B	C
T1	207.3	251.6	262.8
T2	183.4	276.2	258.2
T3	183.8	256.4	242.8
T4	185.4	292.9	254.9
T5	138.6	276.6	261.6
T6	162.4	258.9	236.6
T7	177.0	232.3	268.2
T8	215.9	294.3	260.2
T9	171.9	241.4	243.8

Table 8 : Seasonal variation of Stomatal Resistance

Treatments	Stomatal Resistance (scm^{-1})		
	A	B	C
T1	3.971	3..87	1.351
T2	4.386	2.719	1.376
T3	4.773	2.509	1.512
T4	4.437	2.279	1.387
T5	7.021	1.854	1.319
T6	3.693	1.631	1.360
T7	5.358	3.179	1.183
T8	3.783	1.847	1.430
T9	3.870	2.693	1.499

Table 9 : Seasonal variation of V. P. D.

Treatments	V. P. D. (k Pa)		
	A	B	C
T1	38.30	18.86	21.06
T2	40.75	19.01	21.31
T3	37.84	17.28	28.14
T4	36.30	20.15	20.05
T5	33.21	15.96	21.36
T6	31.98	18.53	19.70
T7	41.46	20.78	20.43
T8	25.09	21.56	17.99
T9	32.23	19.10	21.18

Table 10 : Seasonal variation of Leaf Temp.

Treatments	Leaf Temperature (°C)		
	A	B	C
T1	32.26	27.62	26.65
T2	33.07	24.81	26.63
T3	31.93	24.33	29.77
T4	31.81	25.09	26.13
T5	29.62	24.31	26.28
T6	30.26	26.18	25.89
T7	32.34	24.78	26.70
T8	26.47	24.81	24.95
T9	29.91	25.17	27.13

Table 11 : Seasonal variation of Chlorophyll content (mg, ch/g fresh weight green leaf)

TREATMENTS	APRIL		JUNE		AUGUST		OCTOBER		DECEMBER		FEBRUARY	
	Chlorophyll		Chlorophyll		Chlorophyll		Chlorophyll		Chlorophyll		Chlorophyll	
	a	b	a	b	a	b	a	b	a	b	a	b
T1	0.819	0.323	1.117	0.684	1.267	0.694	1.523	0.688	1.632	0.691	0.671	0.443
T2	1.229	0.509	1.509	0.795	1.870	0.888	1.892	0.803	2.037	0.816	1.320	0.456
T3	1.081	0.475	1.617	0.817	1.610	0.831	1.752	0.757	1.636	0.712	1.014	0.469
T4	1.327	0.650	1.534	0.804	1.582	0.808	1.472	0.706	1.632	0.691	1.247	0.603
T5	1.089	0.552	1.414	0.739	1.610	0.831	1.688	0.744	1.705	0.741	0.955	0.557
T6	1.581	0.765	1.595	0.847	2.020	0.953	2.050	0.855	2.042	0.825	1.528	0.967
T7	1.052	0.511	1.519	0.777	1.752	0.855	1.968	0.830	1.925	0.780	1.005	0.495
T8	1.471	0.718	1.238	0.683	1.611	0.820	1.705	0.741	1.872	0.767	1.427	0.725
T9	1.576	0.731	1.719	0.878	1.993	0.931	2.073	0.868	1.982	0.815	1.556	0.719

Table 12 : Seasonal variation of Water Potential (k Pa)

Treatments	April	June	August	October	December	February
T1	3.33	1.45	1.31	2.26	2.80	2.16
T2	3.01	1.31	1.31	2.23	2.09	1.95
T3	2.84	1.45	1.56	2.41	2.69	2.34
T4	3.09	1.09	1.17	2.27	2.45	2.45
T5	2.41	1.28	1.28	2.27	2.09	2.55
T6	2.45	1.06	1.24	2.19	1.70	1.95
T7	2.69	1.63	1.63	2.02	1.84	2.23
T8	2.80	1.31	1.31	2.27	2.78	2.02
T9	2.34	1.31	1.59	2.09	2.02	2.06

Table 13 : Made tea yield of various micronutrient applied plots (1999)

Treatments	Name of the Micronutrients	Dose	Made tea yield Kg/ha
T1	Control	----	645.9
T2	Trasco-5 (tea special)	400 ml / ha	695.2
T3	Phytonol - Gr + Mi	100 ml / ha	716.2
T4	Zn + Mg	2% + 2%	666.0
T5	Zn + Mg + B	2% + 2% + 1%	794.2
T6	Zn + Mg + B + Mo	2%+2%+2%+1%+0.5%	747.8
T7	Zn + Mn + B	2% + 1% + 1%	689.2

Table 14 : Diurnal variation of Physiological Parameters (October 1999)

Time	Par	Net Photosynthesis (Pn)	Inter-cellular CO_2	Stomatal Conductance	Transpiration	Stomatal Resistance	W. U. E.	V. P. D.	R. H.	L. T.
	(PPFD)	(μ mol m^{-2} s^{-1})	(PPM)	(μ mol m^{-2} s^{-1})	(μ mol m^{-2} s^{-1})	(SC m^{-1})	(μ mol m^{-2} s^{-1})	(KPa)	%	^{0} C
6.00	28.0	0.8174	310.7	0.0321	0.560	12.600	1.500	17.12	13.90	17.4
7.00	83.5	3.627	307.8	0.2112	2.257	1.921	1.606	11.14	35.30	15.5
8.00	194.9	7.712	239.9	0.1433	1.833	2.826	4.213	13.04	34.50	17.6
9.00	1289.0	11.201	149.6	0.1609	2.617	3.595	4.296	23.80	33.20	25.4
10.00	1311.0	10.650	221.0	0.1546	2.829	2.592	3.625	20.20	40.04	24.3
11.00	1312.0	10.425	180.7	0.1356	3.457	2.909	3.017	25.64	33.34	27.4
12.00	1319.0	10.411	172.4	0.1116	3.340	3.538	3.042	29.90	29.52	29.1
13.00	1193.5	9.433	181.7	0.1175	3.153	3.343	2.984	26.80	30.05	27.8
14.00	857.5	7.133	138.3	0.0618	1.762	6.392	4.068	27.90	22.40	26.8
15.00	761.1	6.952	136.0	0.0584	1.561	5.753	4.452	26.19	25.78	26.1
16.00	178.4	3.575	198.3	0.0402	0.619	10.140	5.790	15.24	31.59	19.3
17.00	13.89	0.407	325.1	0.0221	0.328	18.640	1.247	14.70	29.30	18.5
18.00	0.66	-0.433	451.2	0.0093	0.150	45.000	-2.954	15.90	21.77	17.9

Soil Science Division

SOIL TESTING : Soils from different Tea Estates of Darjeeling, Terai, Dooars and Assam have been ved and tested as per requirement. Recommendations have been offered wherever required for rectifying iencies, correcting soil pH and preparing Fertiliser Schedule etc. of individual garden. Some Manure and liser samples have also been tested for ascertaining the available mineral nutrient per cent. During the year ir report 784 soil samples and 4 Organic Manure/Fertiliser samples have been tested and a total of 4138 nations have been carried out as detailed below :

al No.	Parameters Tested	Number of samples analysed
1	pH	784
2	Organic Carbon	784
3	Mineralisable Nitrogen	676
4	Available Phosphate	784
5	Available Potash	784
6	Available Sulphur	322
7	Organic Manure (for pH, N,P and K)	4
		Total - 4138

e name of the Tea Estates whose soil and Manure/Fertiliser samples have been tested are as follows :

rjeeling Gardens : Thurbo, Castleton, Sivitar, Dilaram, Margaret Hope, Pussimbing, Soureni, Tindharia, Monteviot, Ringtong, Selim Hill, Dooteriah.

ıoars and Terai Gardens : Ramjhora Tea Estate, Toonbarie, T.E., Rydak T.E.

sam Gardens : Kopati T.E.

RESEARCH PROJECTS :

1 **Effect of Different levels of Nitrogen (Basal and Split) on the long term yield and quality of Darjeeling Tea (DTRC/S/9)**

The trial has been launched in 1998. Made tea yield data of 1998 has been presented in the ASR 1998-99. The same for 1999 is presented in Table 15 and Fig. 2 from where it is evident that the treatment no. T7 viz., 100+50: 45:100 kg NPK/ha through 2 splits (Urea, RP and MOP) has the highest made tea yield followed by treatment no. T6 viz., 80+40: 45: 100 kg NPK/ha through 2 splits. During 1998-99 the highest yield was obtained from treatment no. T5 viz., 60+30 : 45: 100 kg NPK/ha in 2 splits.

1.2 **Effect of Organic and Inorganic fertilisers on long term yield of Darjeeling tea and soil fertility (DTRC/S/10)**

This trial has also been launched in 1998. Made tea yield data has been depicted in Table 16 and Fig. 3. From the said table and Fig. it is evident that the treatment no. T4 viz., 90:45 : 90 kg NPK/ha (Urea, RP and MOP) through a single basal dose in the month of May gave the highest made tea yield which is followed by T8 viz., 90:45 : 90 kg NPK/ha through 50% N by Castor Cake and remaining NPK through Urea, RP and MOP.

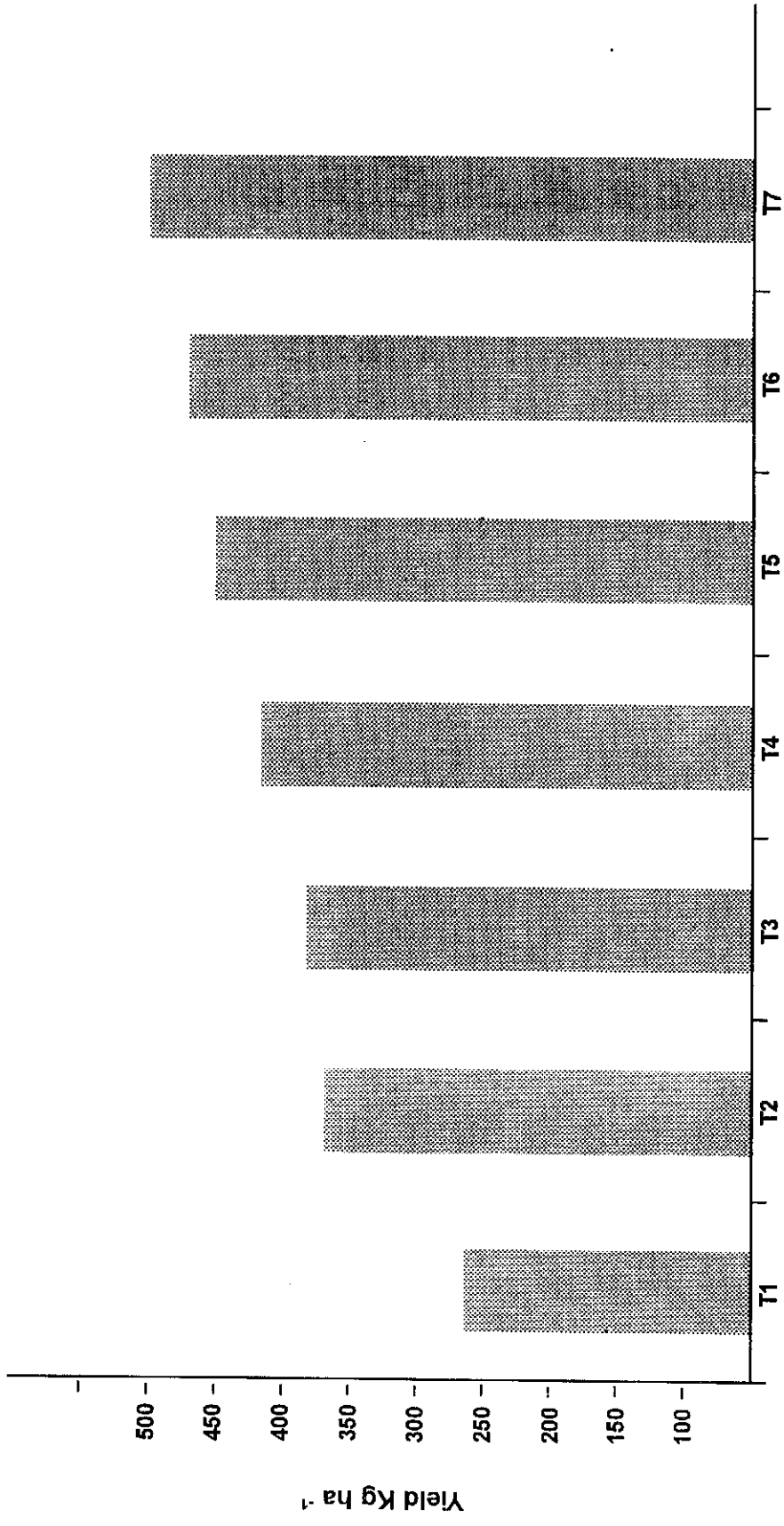

Fig. 2 Effect of different levels of nitrogen (basal and split) on yield during 1999

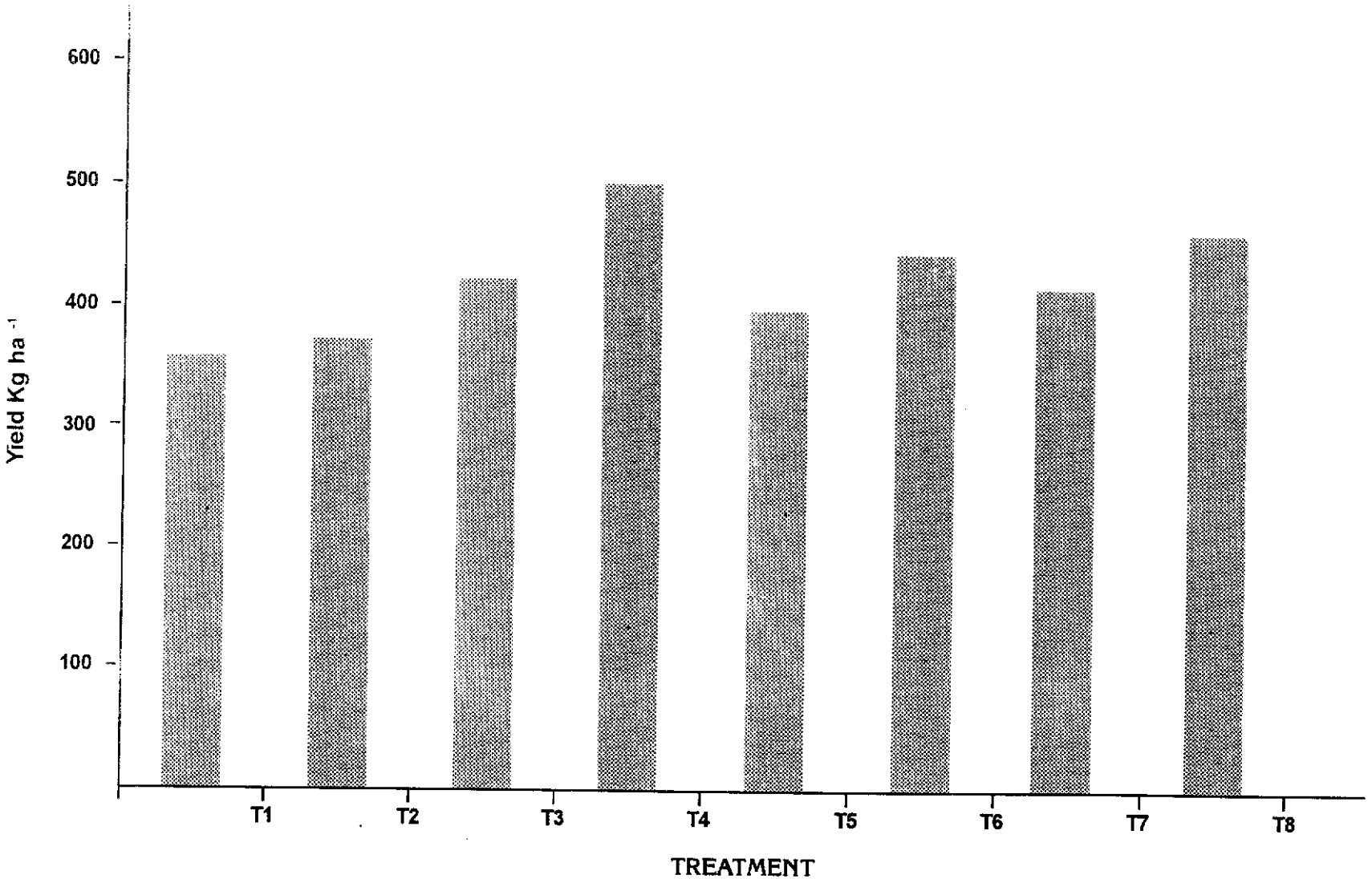

Fig. Effect of organic and inorganic fertilisers on yield during 1999

Table : 15. Effect of different levels of nitrogen (basal and split) on the yield during 1999 (DTRC/S/9)

Treat No.	Dose	Source	Made tea yield kg/ha
T1	Control		218
T2	0:45:100 Kg NPK/ha	Urea : RP:MOP	327
T3	30:45:100 Kg NPK/ha	Urea : RP:MOP	346
T4	60:45:100 Kg NPK/ha	Urea : RP:MOP	378
T5	60+30:45:100 NPK/ha	Urea : RP:MOP (Split Nitrogen)	418
T6	80+40:45:100 NPK/ha	Urea : RP:MOP (Split Nitrogen)	437
T7	100+50:45:100 NPK/ha	Urea : RP:MOP (Split Nitrogen)	465
	C.D. at 5%		55

Table : 16. Effect of organic and inorganic fertilisers on long term yield and soil fertility during 1999 (DTRC/S/10)

Treat No.	Dose	Source	Made yield kg/ha
T1	Control	---	373
T2	60:30:60 Kg NPK/ha	100% N by FYM remaining P and K by RP and MOP	392
T3	60:30:60 Kg NPK/ha	Urea : RP : MOP	450
T4	90:45:90 Kg NPK/ha	Urea : RP : MOP	530
T5	60:30:60 Kg NPK/ha	50% N by FYM remaining N, P and K by Urea, RP, MOP	416
T6	90:45:90 Kg NPK/ha	50% N by Castor cake, remaining N, P and K by Urea, R/P, MOP	473
T7	60:30:60 Kg NPK/ha	50% N by FYM remaining N, P and K by Urea, RP, MOP	435
T8	90:45:90 Kg NPK/ha	50% N by Castor cake, remaining N, P and K by Urea, RP, MOP	490
	C.D. at 5%		49

Biochemistry

RESEARCH PROJECT.

1. **Studies on Biochemical composition of clones released for Darjeeling Tea Industry --- Assessment of Fermentation period (DTRC/BIO/2).**

During 1999 fermentation behaviour of clones viz. T135, T78, T383, AV2, Sundaram and Springfield was studied in monsoon and postmonsoon seasons. Fermented tea samples were analysed for total polyphenols, theaflavins, thearubigins and caffeine contents. Clone T135 and sundaram were found fast fermenting clones. Browning of leaf during withering could hardly be prevented in order to achieve the high degree of wither in a specified period of total withering of 16 to 18 hours. However, with increased withering period of 20 to 21 hrs and air circulation at 90-95° F these two clones could be managed better. Clone T135 was ranked superior when fermented at 2-05 hours. Flavour development of this clone deteriorated faster and even a difference of 10 minutes in fermentation caused a substantial loss to the flavour quality. The high yielding clone Sundaram which is a Assam hybrid could betterly be exploited at 1 hr 50 mts and its flavour did not match with other clones of Darjeeling. Like T135, its flavour was also lost very fast in the fermentation. Clone T383 produced more flavour when fermented at2hrs 35 mts. The flavour development in this clone started at 2 hrs 20 mts. Clone AV2 always produced rose-like aroma and its flavour retention was maximum at 2 hrs 30 mts of fermentation and thereafter the flavour started declining. Within 15 mts of fermentation in this case about 28 percent flavour was lost. Interestingly, theaflavin contents at this stage were found little higher. The South Indian clone Springfield produced better flavour at 2 hrs 15 mts and its theaflavin contents were quite high at this stage. A slow deterioration/decline in flavour was noticed for this clone with a further increase in fermentation period by 10 mts.

On line fermentation experiments further revealed that the production of theaflavins increased linearly for most of these clones upto their optimum fermentation period. However, clone Sundaram and Tukdah 135 showed irregular trend in this regard. For monsoon teas it was also observed that level of brightness were quite high even upto 56.29 percent. Perhaps, the high production of thearubigins masked the brightness character in such teas. Also, in our observations no marked differences in caffeine synthesis were noticed with regard to fermentation period (Table 17).

2. **Influence of pruning cycle on chemical compositions of Darjeeling Tea (DTRC/BIO/7).**

Impact of various pruning treatments on the biochemical parameters is shown in tables 18, 19 & 20. Total polyphenols were recorded highest in LP-UT sections which was closely followed by DS-LOS and UT-LS sections. A remarkable recovery of polyphenols registered in LP-UT sections over LOS-LP and secondly in DS-LOS sections over the UT-DS pruned areas. On the other hand production of polyphenols declined in UT-LS sections as compared to LP-UT pruned tea. The formation of theaflavins was enhanced in the pruned sections of last year (LP and DS sections). The maximum content of caffeine were found in UT-LS pruned teas. The synthesis of chlorophyll pigments was recorded maximum in DS-LOS sections which was further closely followed by MS-LOS area. The production of chlorophyll 'a' and chlorophyll 'b' was also observed maximum in these teas. During this period production of carotenoids was however, increased almost in each treatment. It was maximum in MS-LOS sections which was followed by LP-UT sections. In pre-monsoon period production of these pigments remained low over the monsoon period.

3.3 Isolation and chracterisation of β-D glucosidase in Tea (DTRC/BIO/9).

β-D glucosidase is an enzyme which occurs widely in plant kingdom. The role of enzyme is well established in pathogenecity and lignification in certain crops. However, no report is available about the behaviour and its role in lignification, quality and flavour in Indian tea specifically Darjeeling flavour teas. The discovery of terpenoid glycosides and their increasing role in tea has prompted us to isolate the enzyme in Darjeeling teas and find out the basic information initially about its effects on pH and temperature. The enzyme was extracted from fresh leaf tissue using sodium acetate buffer and all preparations were carried out at 4° C. The study revealed that the enzyme was most active in between pH 4-4.5. Interestingly, it gradually declined with increase in pH value. The optimum temperature for this enzyme was recorded 40-45° C. The enzyme was further studied on PAGE which showed a single dark band. Harvested shoot of different clones viz. AV2, T78, SP/4/5, B/5/63 including China and Assam teas were also subjected for PAGE study and activity of β-D glucosidase in thee teas was recorded on 8% gel. The China varieties showed more activity as compared to Assam teas. Therefore, qualitative study of the enzyme on PAGE suggests that China varieties were having more amount of β-D glucosidase as compared to Assam cultivar (Fig. 4, 5 & 6). Further, the study for this parameteris in progress to screen the various clones released for Darjeeling tea industry.

Table : 17. Chemical composition of clones in relation to Fermentation.

Sl No.	Clones	Total Polyphenols	Theaflavins	Thearubigins	Caffeine	Fermentation hrs.	Flavour
1.	T135	20.85	0.67	10.24	4.21	2.05	6
		19.70	0.58	10.86	4.20	2.15	4
2.	T78	22.56	0.68	8.57	3.64	2.25	6½
		21.20	0.62	8.32	3.27	2.40	5
3.	T383	23.48	0.64	9.54	3.86	2.25	4
		21.63	0.58	9.82	3.40	2.35	5
4.	AV2	22.15	0.62	7.60	4.10	2.30	7
		20.82	0.66	7.35	3.92	2.45	5
5.	SUND	23.17	0.72	11.24	4.42	1.50	4
		21.26	0.64	11.88	4.38	2.05	3
6.	SP/F	21.92	0.66	8.40	3.68	2.15	5½
		20.43	0.62	8.62	3.90	2.25	5

Table : 18. Chemical composition of teas in relation to different pruning treatment

Sl. No.	Treatments	Total Polyphenols	TF	TR	Caffeine	Remarks.
1.	MS-LOS	24.80	0.62	10.42	3.94	
2.	DS-LOS	26.32	0.66	8.42	3.64	
3.	LP-UT	25.62	0.70	8.36	3.88	
4.	LP-UT	25.40	0.67	8.40	3.80	
5.	LP-UT	26.80	0.62	8.72	3.46	
6.	UT-LS	26.30	0.68	8.92	4.18	

Table : 19. Pigment composition of pre-monsoon teas in relation to different pruning treatment

Sl. No.	Treatments	Chl a	Chl b	Total Chlorophyll µg/g	TC	Remarks
1.	MS-LOS	703.46	394.20	1097.66	92.74	
2.	DS-LOS	670.58	368.39	1038.97	100.96	
3.	LP-UT	584.32	372.28	956.60	80.46	
4.	LP-UT	590.27	340.18	930.45	84.38	
5.	LP-UT	540.28	384.62	924.90	76.60	
6.	UT-LS	580.60	349.28	929.88	80.47	

Table : 20. Pigment composition of monsoon teas in relation to different pruning treatments.

Sl. No.	Treatments	Chl a	Chl b	Total Chlorophyll µg/g	TC	Remarks
1.	MS-LOS	760.37	425.90	1186.27	125.27	
2.	DS-LOS	816.26	450.10	1266.36	109.32	
3.	LP-UT	632.78	380.98	1013.76	102.16	
4.	LP-UT	625.19	355.38	980.57	104.28	
5.	LP-UT	590.17	402.32	992.49	116.64	
6.	UT-LS	627.30	380.10	1007.40	108.40	

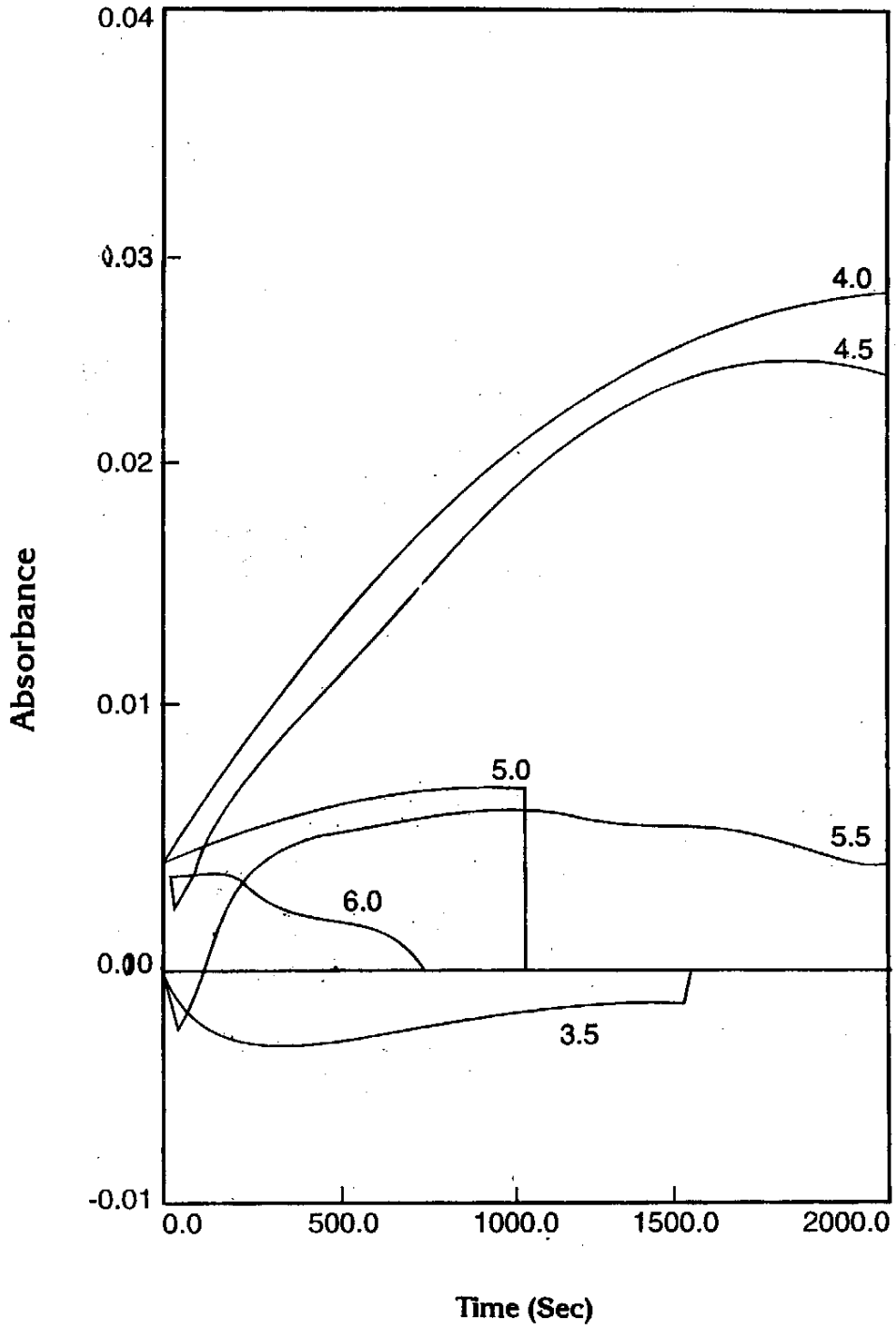

Fig. 2. Time scan of enzyme activity under different pH conditions.

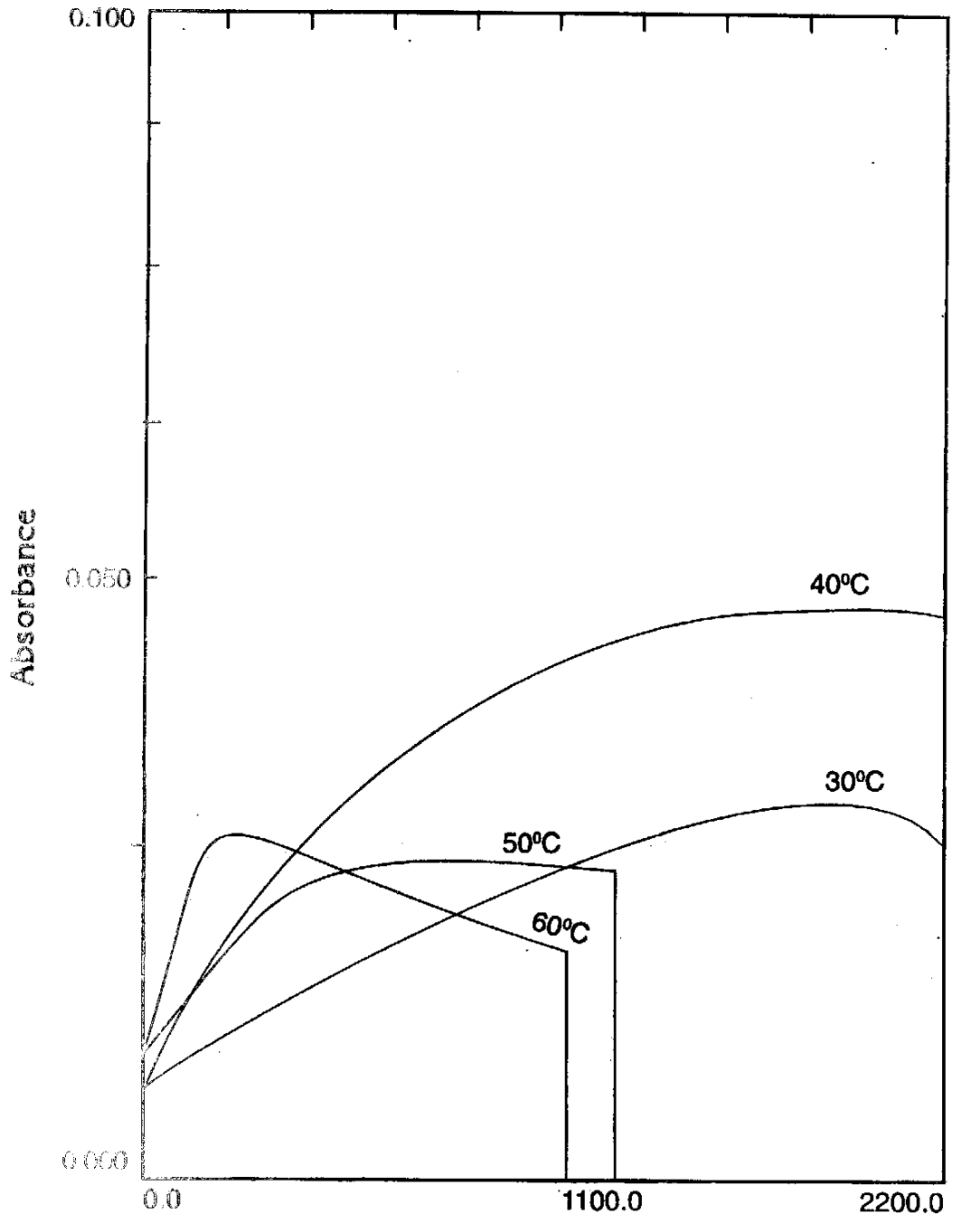

Fig. 5 : Effect of Temperature on β-D glucosidase.

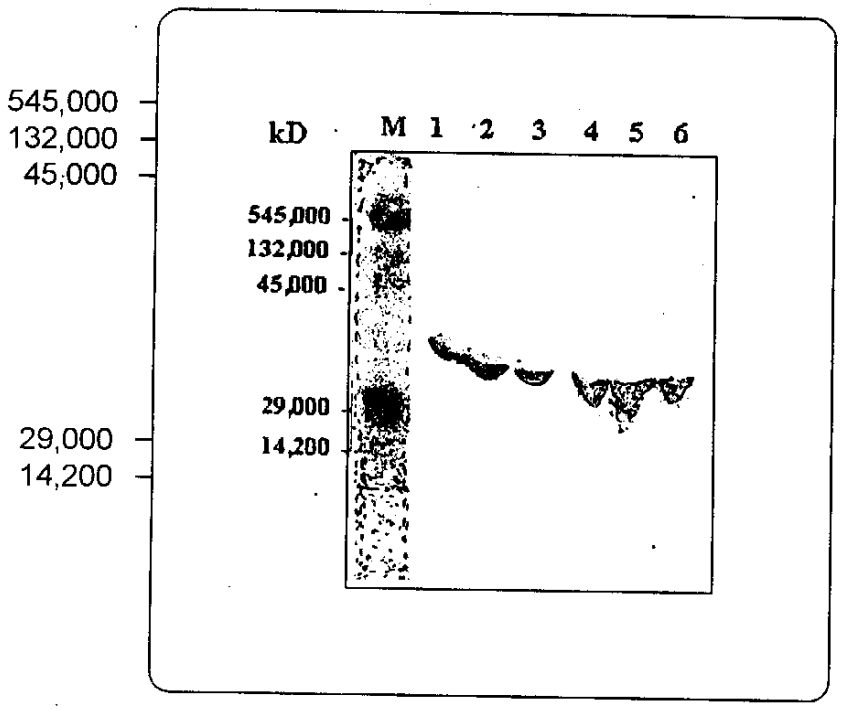

Fig.- 6. Activity gel of β-D glucosidase of tea clones (lane 1-ZA/CT/A, lane 2-T78, lane 3- B/5/63 lane 4-AV2, lane 5-SP/F, lane 6-ZA/CT/CH); run on polyacrylamide gel (8%).

Library

The subscription of foreign journals has been curtailed due to budgetary constraints. Alternatively, the centre is enrolled with INSDOC, New Delhi, who are regularly sending contents and abstracts of opted journals. Besides these 14 books and 6 Indian journals were procured during this period.

APPENDIX

Serial No.	Name of the Division	Project Code No.	Title of the Project	Remarks
1.	Farm Management (Botany & Agronomy)	DTRC/FM/16	Effect of Environmental factors on the Physiological and Biochemical attributes in Tea	*Ongoing*
		DTRC/FM/17	Determination of suitable pruning cycle of old chinary Tea Bushes of Kurseong	*Ongoing*
		DTRC/FM/19	Effect of Nutrient management on stomatal behaviour and growth of young tea plants.	*Ongoing*
		DTRC/FM/20	Effect of various micronutrients in optimising yield and quality of Darjeeling Tea.	*Ongoing*
		DTRC/FM/7	Performance of certian Tea clones in Kurseong	*Concluded*
		DTRC/FM/8	Comparison of methods of replanting old tea bushes.	*Concluded*
		DTRC/FM/9	Evalution of herbicides for weed control in Darjeeling Tea.	*Concluded*
		DTRC/FM/10	Training of young tea in Darjeeling	*Concluded*
		DTRC/FM/11	Effect of plucking interval on crop yield and flavour of made tea.	*Concluded*
		DTRC/FM/12	Growth analysis of five clones under Kurseong condition.	*Concluded*
	Soil Science	DTRC/S/3	Phosphate fixation studies in Darjeeling tea soils.	*Ongoing*
		DTRC/S/8	Effect of organic and inorganic forms of fertilisers on long term yield and soil fertility.	*Ongoing*
		DTRC/S/9	Effect of different levels of nitrozen (Basal and split) on the long term tield and soil fertility.	*Ongoing*
		DTRC/S/10	Effect of organic and inorganic fertilisers on long term yield and soil fertility.	*Ongoing*
		DTRC/S/2	Effect of foliar application of Zinc on Tea in Darjeeling	*Concluded*
		DTRC/S/4A	Tea soils of Darjeeling - Morphology, classification, mineralogy and genesis.	*Concluded*
		DTRC/S/4B	NPK Soil fertility status map of Darjeeling tea growing soils.	*Concluded*
		DTRC/S/5	Studies on potassium ion potential and quantity intensity (Q/I) relationships of some Acidic tea growing soils of Darjeeling.	*Concluded*
		DTRC/S/6	Sulphur in Darjeeling tea soils - deficiencies and remedies.	*Concluded*
		DTRC/S/7	Phosphorus and potassium fertilisers in optimisation of yield and quality of Darjeeling tea.	*Concluded*

3.	Plant Protection	DTRC/PP/7	Effet of neem products in controlling of tea pests and its effects on quality	*Ongoing*
		DTRC/PP/8	Population dynamics of some tea pests infesting chinary bushes.	*Ongoing*
		DTRC/PP/9	Effect of inorganic, organic fertilisers and green manure crops in the optimisation of yield as well as pest management.	*Ongoing*
		DTRC/PP/12	Bioefficacy, phytotoxicity and compatibility of organic pesticides against tea pests.	*Ongoing*
		DTRC/PP/13	Bioefficacy of certain plant extracts against sucking pests of tea.	*Ongoing*
		DTRC/PP/14	Efficacy of certain fungicides against blister blight of tea.	*Ongoing*
		DTRC/PP/2	Effect of neemoil, neemcake and neem seed kernel powder in controlling tea pests.	*Ongoing*
		DTRC/PP/4	Ineffectivity of *Baccillus thuringiensis* var *kurustaki* against bunch caterpillar.	*Ongoing*
		DTRC/PP/5	Bioefficacy of neem products in controlling certain pest of tea.	*Ongoing*
		DTRC/PP/10	Testing of Delfin *(Baccillus thuringiensis* var. *kurustaki* serotype 3a, 3b) against flush worm *(Cydia leucostoma)* in young tea in Darjeeling.	*Ongoing*
		DTRC/PP/11	Studies on the residue and persistence of monocrotophos, malathion, quinalphos, fenvalerate, dimethoate and dicofol in made tea of Darjeeling	*Paper under preparation.*
4.	Biochemistry	DTRC/Bio/2	Studies of biochemical parameters of clones of tea grown in the Darjeeling hills - assessment of fermentation periods.	*Ongoing*
		DTRC/Bio/7	Influence of pruning on chemical composition of aroma precursors of Darjeeling flavoury teas.	*Ongoing*
		DTRC/Bio/8	Degradation of polyphenols and chlorophyll during manufacture of Darjeeling flavoury and nonflavoury teas.	*Ongoing*
		DTRC/Bio/9	Isolation, identification and characterisation of b-D-Glucosides in Darjeeling flavoury teas.	
		DTRC/Bio/1	Darjeeling teas in perspective of ISO specification 3720	*Concluded*
		DTRC/Bio/4	Determination of clonal compatibility in relation to improvement of flavour and quality of Darjeeling clones.	*Concluded*
		DTRC/Bio/5	Effect of copper and zinc on the chemical composition and quality of Darjeeling teas.	*Concluded*
		DTRC/Bio/6	Effect of plucking intervals on the flavour and quality of Darjeeling teas.	*Concluded*

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J. S. Bisen, M.Sc. (Ag)	Junior Scientific Assistant
R. Kumar, M.Sc. (Ag)	Junior Scientific Assistant

Plant Protection

M. Singh, M.Sc. (Ag)	Senior Scientific Assistant

The total staff of the centre is sixteen which includes 2 scientists, 6 scientific assistants and 8 administrative personnel.