

PRUNING OPERATIONS IN DARJEELING TEAS: A BIOCHEMICAL PERSPECTIVE



TEA RESEARCH CENTRE

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INTRODUCTION



- ❖ Darjeeling tea is known for its characteristic flavour and unique Darjeeling tea character.
- ❖ Darjeeling Tea is cultivated in 87 tea gardens covering an area of 17500 hectares and employ about one LAKH workers.
- ❖ Total production of tea crop is about 9 million kg/year.
- ❖ Darjeeling hills are sloppy (10-80%) with altitude of 600 ft to 7000ft.
- ❖ 60% tea gardens are now converted to organic tea cultivation.
- ❖ Darjeeling tea fetches a premium price for its unique flavour.
- ❖ Darjeeling tea is protected by GI provisions and has its own logo for its authenticity and checking adulteration.
- ❖ Majority of Darjeeling tea gardens are 150 years old.



PRUNING OPERATIONS IN DARJEELING TEA



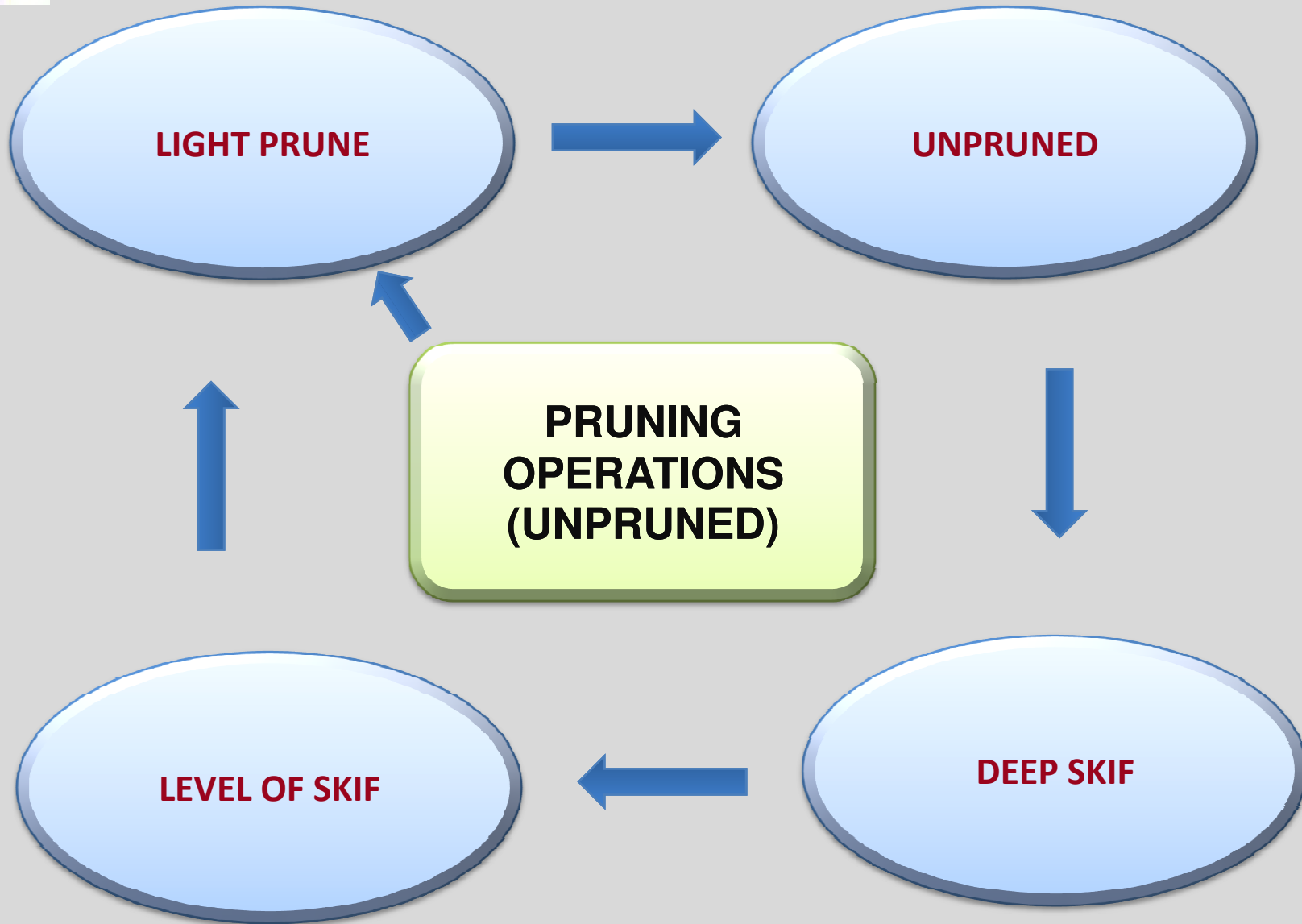
- ❖ Prime objectives is to keep the tea bush in Vegetative phase Productive stage Harvesting Operations
- ❖ Pruning operations are covered through a pruning cycle of 4 to 6 years.
- ❖ It influences crop yield and quality (eg. In case of DS 20% crop is down to UP and 15% up to LP).
- ❖ Assessment of tea quality is based on subjective judgment by Professional Tea tasters.
- ❖ Quality concept dominates over yield.
- ❖ Seasons are classified as 1st Flush, 2nd Flush, Rains Flush and Autumn Flush.
- ❖ Productivity period is confined from **March to November.**
- ❖ A period of 3-4 months from December to March **dormancy** exists.



OBJECTIVES OF THE STUDY



- ❖ Impact of Pruning operations on biochemical constituents of Darjeeling Tea.
- ❖ Seasonal variations in biochemical constituents of Darjeeling tea.
- ❖ Influence of Pruning operations on volatile flavoury constituents.
- ❖ Shoot component study of biochemical constituents.





Pruning type and level



Prune Type



Rejuvenation Prune

**Medium Prune / Cut
Back**

Light Prune

Deep Skiff

**Pruning Level
(cm)**



< 20

25-30

35-40

45-55



Different Pruning Operations in Darjeeling Tea





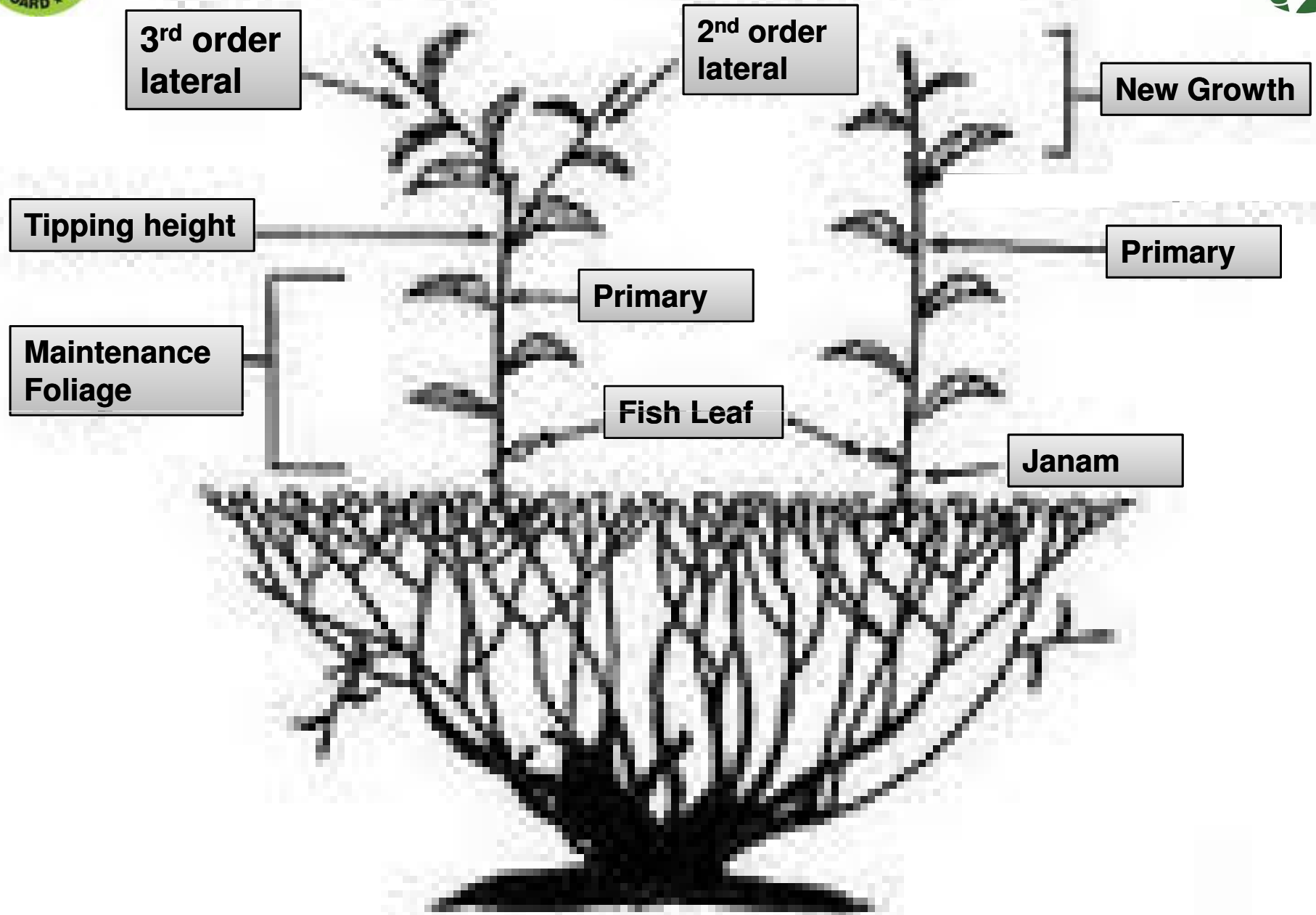
Tipping



Type of Skiff/Prune	Tipping Height over Last Skiffing/Pruning	No. of Leaves Retained in New Lateral/Primaries
Light Skiff	Same level	Nil (pluck to <i>janam</i>)
Medium Skiff	5 cm	1 leaf
Deep Skiff	10-15 cm	2-3 leaves
Light Prune (LP)	20-25 cm	4-5 leaves
Medium Prune (MP)	30 cm	5-6 leaves
Rejuvenation Prune	30 cm	5-6 leaves



Tipping & Regeneration of new shoots





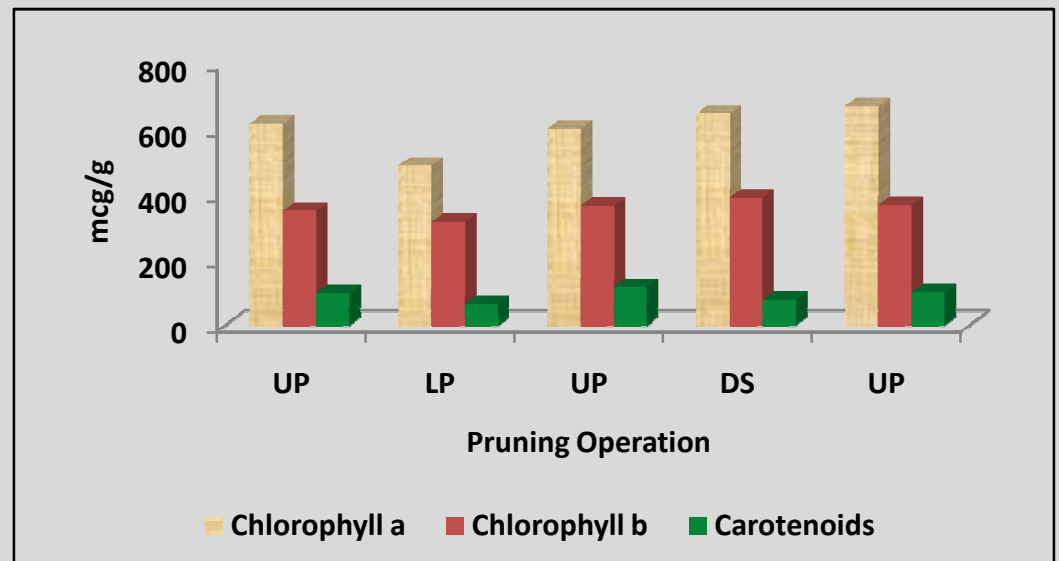
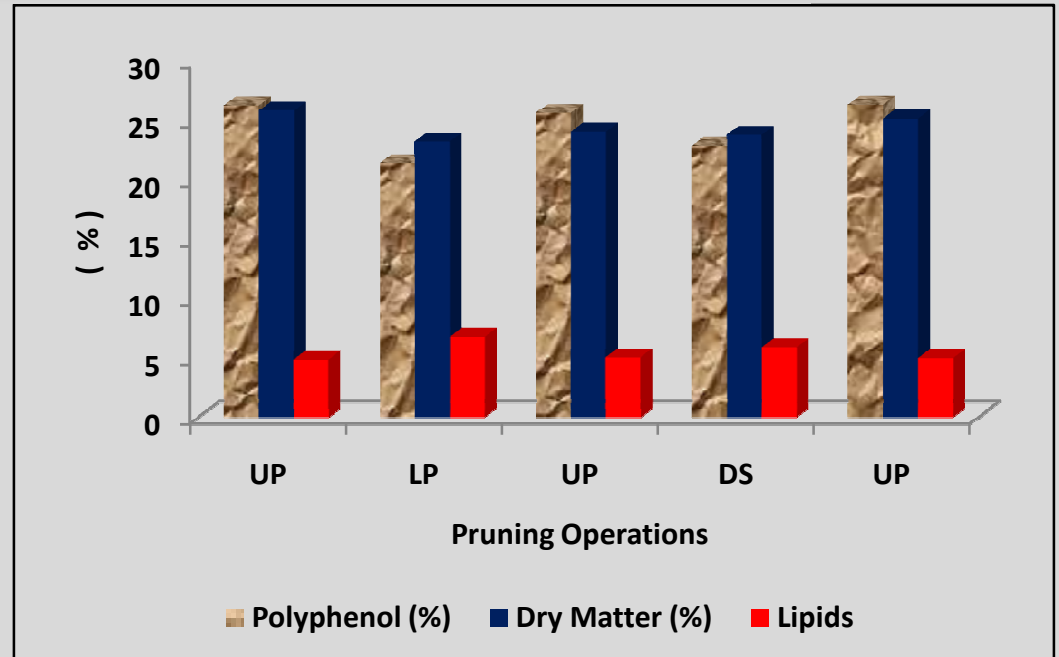
MATERIALS AND METHODS



- ❖ The experiment was conducted at the Darjeeling Tea Research and Development Centre, Kurseong, Darjeeling located at 26.9°N, 88°12E, altitude 700-1349m.
- ❖ The century old chinary bushes were selected for the experiment. Harvested flush was plucked on weekly intervals.
- ❖ Orthodox black teas were manufactured in the miniature tea factory of DTRDC.
- ❖ The **chlorophylls** and **carotenoids** were estimated from their methanolic extract following method of Taylor (1990) using multi-wavelength system Hitachi 2000.
- ❖ Total **polyphenols** were estimated spectrophotometrically following Choudhury and Goswamy (1983).
- ❖ Total **theaflavins** and **thearubigins** were determined by the method of Roberts and Smith (1961) as simplified by Ullah (1972).
- ❖ **Caffeine** content were determined following the method of Ullah *et al* (1987).
- ❖ **Crude lipids** were estimated gravimetrically using chloroform: methanol (2:1) as extractant by the method of Fishwick and Wright (1977).
- ❖ **VFC** of black tea were extracted by the method of Likens and Nickerson(1964).
- ❖ **Flavour** index of teas was calculated as per the method of Owour (1988).

Variation in biochemical parameters in relation to type of pruning

- ❖ Polyphenols and dry matter content decline in pruned teas.
- ❖ Gradual Recovery is observed from the age of pruning.
- ❖ Lipid contents increase in pruned teas.
- ❖ A gradual decrease is noticed from the age of pruning.
- ❖ Total chlorophylls and carotenoids decline in pruned year.
- ❖ Both are detrimental to tea quality.



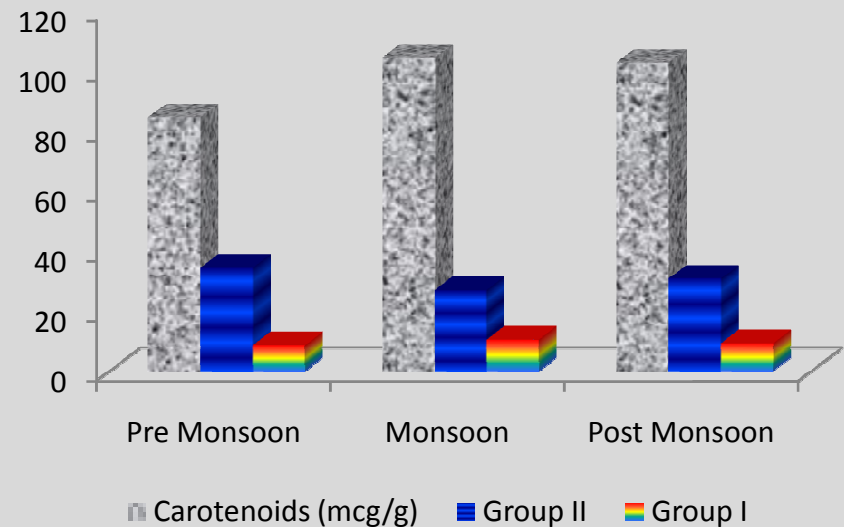
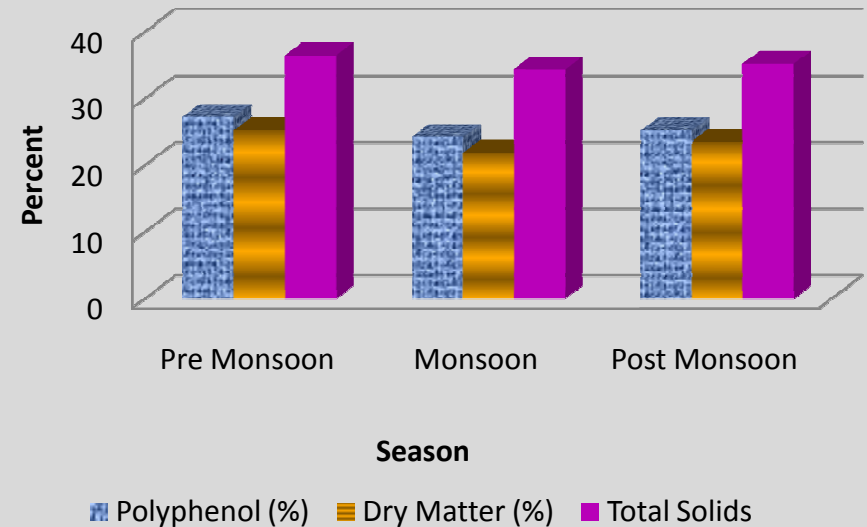


Seasonal variation in biochemical parameters



- **Pre-monsoon - 1st and 2nd flush ----- Quality period.**
- **Polyphenols, Dry matter content and total soluble solids decrease in rains teas.**
- **Polyphenols affect the tea quality.**
- **Dry matter content have great impact on outturn of made teas, influencing profitability of a tea garden.**

- **Carotenoids contributing a live taste decrease in rains teas irrespective of pruning.**
- **Group II compounds-mainly terpenoids contributing to sweet aroma decline sharply in rains teas.**
- **Group I volatiles contributing to grassy flavour increase substantially in rains teas.**

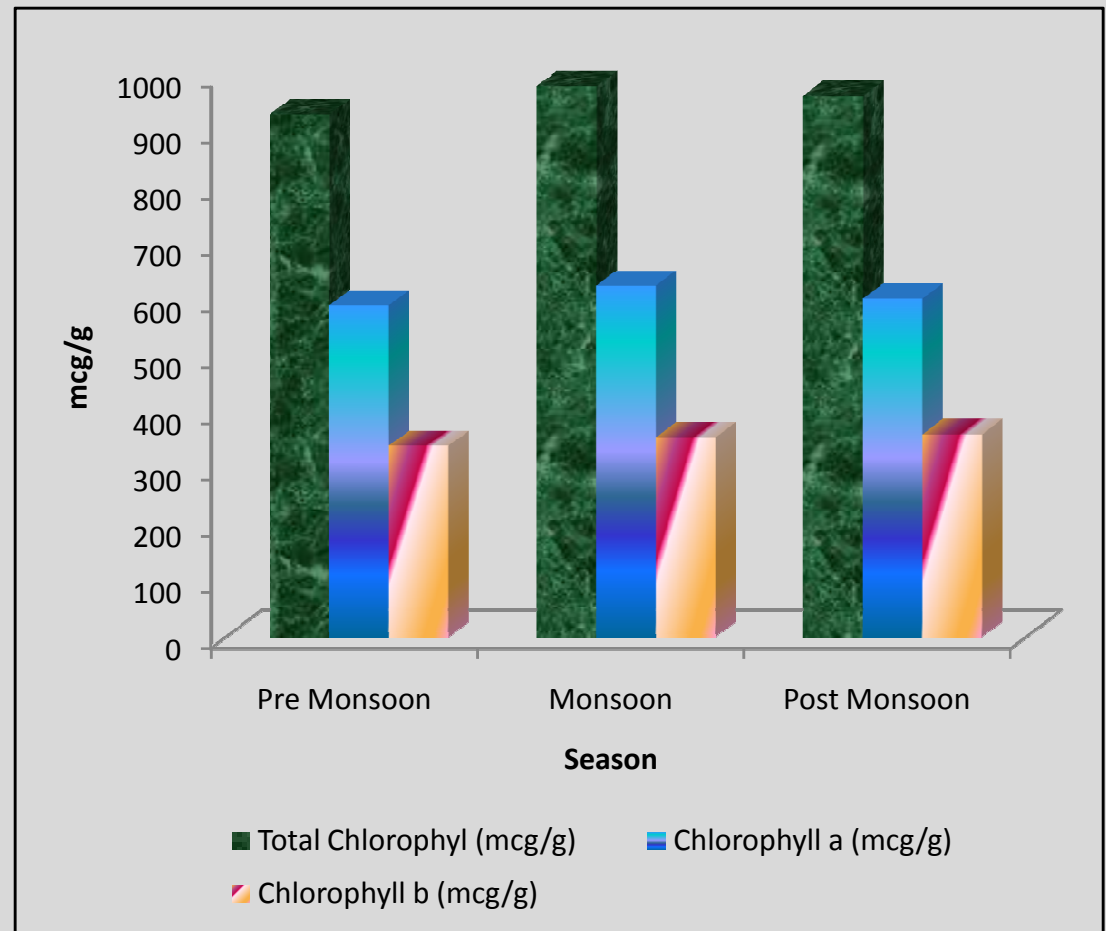




Seasonal variation in biochemical parameters



- **Total chlorophylls increase during rains period.**
- **This affects tea Quality adversely.**
- **In post monsoon chlorophyll synthesis is impaired.**
- **No chlorophyll degradation product is derived to tea volatiles.**





Impact of pruning on liquor characteristics of Darjeeling teas



	TF	TR	Brightness	Total color	Caffeine
UP	0.70	8.36	16.75	3.12	3.78
LP	0.62	9.38	12.65	4.80	3.14
DS	0.64	8.97	10.80	4.16	3.40

- ❖ Tea brew is consumed – it is essential to assess the liquor characteristics.
- ❖ Liquor characteristics are assessed by estimation of TF, TR, B and TLC.
- ❖ TF imparts brightness a desirable feature of tea brew – UP
- ❖ In tasters assessment UP tea brew -mellowness, brightness and less color.
- ❖ Pruned teas produce liquor with grassy taste and more color.



Aroma in Some Foods (Based on Birch *et al.*, 1977)



Food	Character-impact compound
Banana	iso-pentyl acetate
Pear	trans-2 cis-4 Decadienoates
Potato,raw	2-Isopropyl-3-methoxypyrazine
Garlic	Di-2 propenyl disulphide
Apple	Ethyl 2-methyl butyrate Hexanal, trans 2-hexenal
Cabbage	Dimethylsulphide Dimethyl trisulphide 2- propenyl isothiocyanate
Tea	No character-impact compound >700 volatiles present in flavour



Some volatile flavoury components of black tea



Group II

Linalool oxide(Z-furanoid)
Linalool oxide(E-furanoid)
Linalool
 β -cyclocitral
 α -terpeneol
Linalool oxide(Z-furanoid)
Nerol
Geraniol
 β -ionone
Nerolidol
Indole
E- Geranoic acid
Geranyl acetone

Group I

1. Hexanal
2. Penten-3-ol
3. (Z)-3-hexenal
4. (E)-2-hexenal
5. (Z)-2-pentenol
6. Hexanol
7. (Z)-3-hexenol
8. Nenanol
9. (E)-2-hexenol
10. (E)-4-heptadienol
11. Benzaldehyde
12. Octanol
13. Phenylacetaldehyde
14. (Z)-3-hexenyl hexanoate
15. Methyl salicylate
16. Phenyl methanol
17. 2-Phenyl ethanol

- ❖ Many times more in Darjeeling teas (Gp.II)
- ❖ Higher in Assam and Cambod (Gp.I)
- ❖ Amount of Gp.II and Gp.I bring about the changes in flavor



Impact of Pruning operations on VFC



Flavour Compounds

Pruning Operations

	UP	LP	UP	DS	UP
Low boiling alcohols and aldehydes	8.70	10.76	9.10	9.80	8.52
Linalool oxide cis	1.42	1.22	1.34	1.28	0.90
Linalool oxide trans	0.45	0.32	0.98	0.58	0.54
Benzaldehyde	5.16	6.95	5.41	5.85	5.26
Linalool	0.62	0.48	0.52	0.48	0.60
Benzyl alcohol	3.68	2.80	3.29	2.97	3.53
Phenyl acetaldehyde	2.64	1.72	2.26	1.50	2.47
2 phenyl ethanol	1.78	1.45	1.85	1.60	1.88
Methyl salicylate	1.20	0.74	1.08	0.75	1.53
Geraniol	20.18	12.36	18.56	14.29	18.07
α -ionone	0.16	0.13	0.11	0.08	0.82
Indole	0.19	0.06	0.08	0.04	0.09
β -ionone	0.98	0.48	1.06	0.74	0.86
Group I compounds	10.12	11.98	10.44	11.08	9.42
Group II compounds	37.04	27.49	35.26	28.88	35.65
Flavour Index	03.66	02.29	03.37	02.61	03.78



DERIVATION of FLAVOUR INDEX



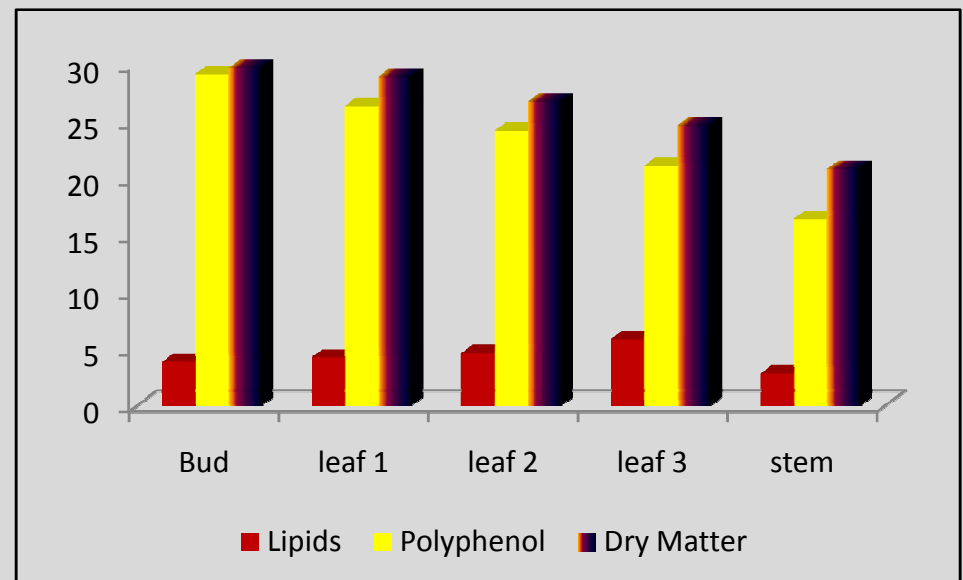
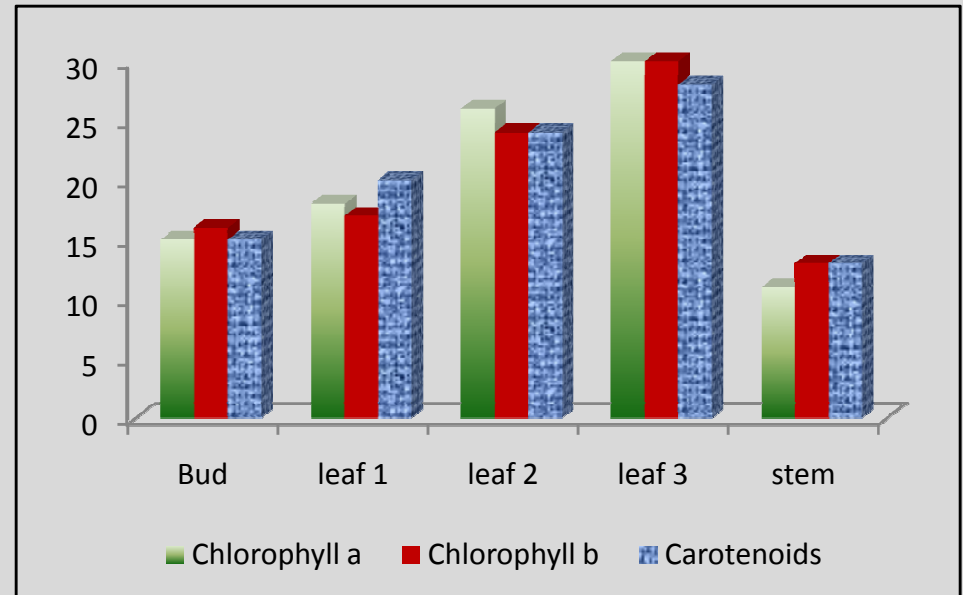
Volatiles	UP	LP	UP	DS	UP
Compounds eluting before linalool	15.73	19.25	16.83	17.51	15.22
Compounds eluting from linalool to b-ionone	31.43	20.22	28.81	22.45	29.85
Linalool to benzaldehyde	5.61	7.27	6.39	6.43	5.80
Group I (1-3)	10.12	11.98	10.44	11.08	9.42
Group II(2+3)	37.04	27.49	35.26	28.88	35.65
Flavour Index	03.66	02.29	03.37	02.61	03.78



Tea Shoot component study



- Chlorophylls and Carotenoids content increase from the bud to the coarser leaf.
- Contribution of 3rd leaf is maximum.
- Composition of harvested tea flush would affect proportionately the concentration of chemical constituents.
- Polyphenols and dry matter content decrease from the bud to coarser leaf.
- Quality and recovery of made tea is influenced by the composition of harvested tea flush.
- Unlike to above constituents lipids increase from bud to the coarser leaf.





CONCLUSION



- ❖ **Pruning operations affect the Darjeeling tea Quality.**
- ❖ **Quality is deteriorated sharply in the pruned year.**
- ❖ **During DS operations quality constituents are less affected.**
- ❖ **Recovery of biochemical constituents occur in the 4th year from pruning.**
- ❖ **Study suggest for modification in existing pruning cycle for early recovery of quality constituents and more crop.**
- ❖ **Pruning is an essential agronomic operation on century old bushes to bring the tea bush to its full vigor for sustainable crop Yield and Quality.**



A View of Darjeeling Tea Garden

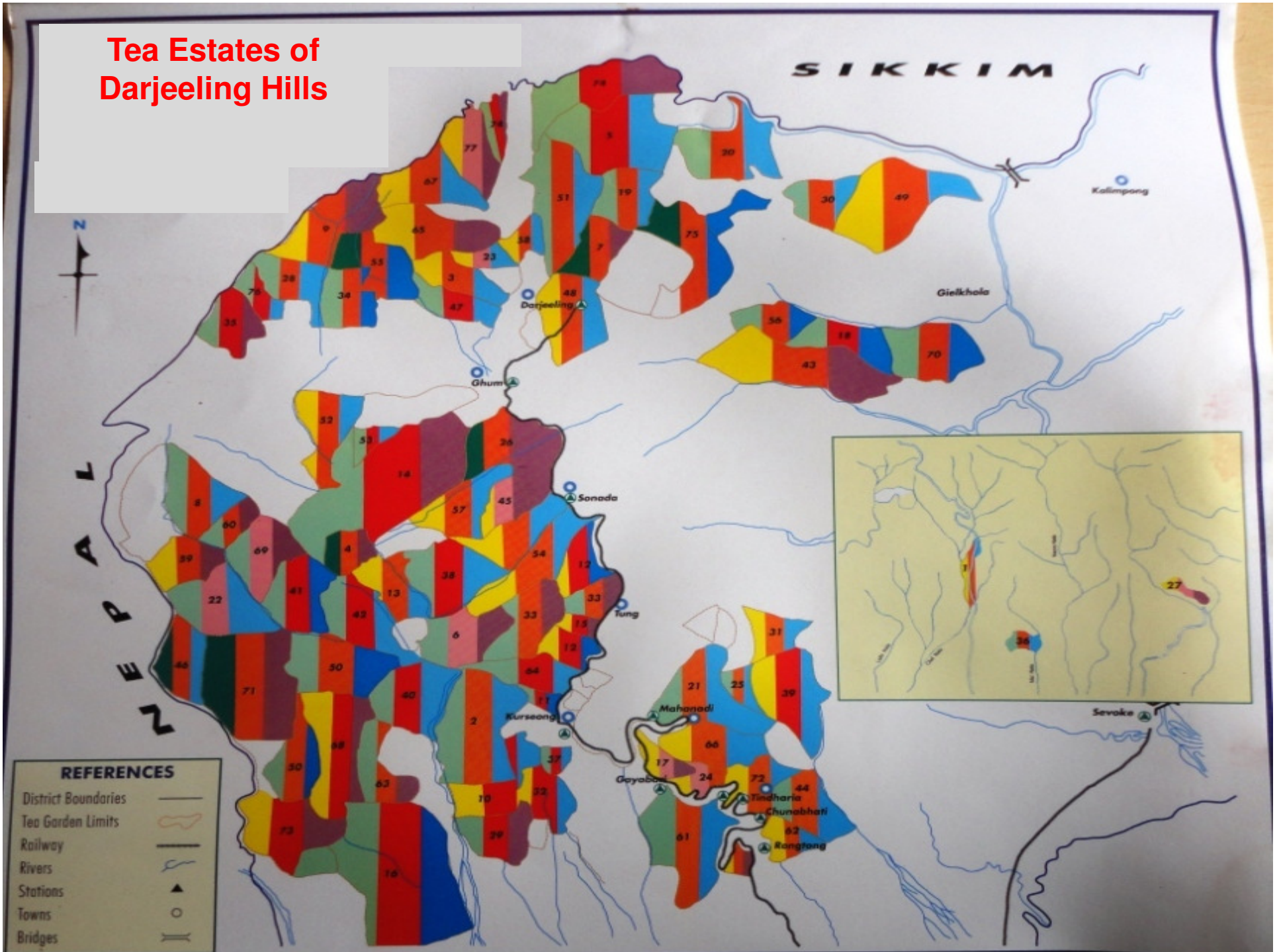
- plucking in progress

**Prevailing Climatic
Conditions**





Tea Estates of Darjeeling Hills





THANK
YOU



चाय पियो मस्त जियो !

Chai piyo mast jiyo !