ICAR - CTRI

Technical Bulletin No. 02/2023

Leaf Quality Assessment of FCV Tobacco

CLASS	INDEX RANGE	COLOUR CODE				
		1.0	1.1	1.2	1.3	1.4
Poor	1.0 -1.4					
		1.5	1.6	1.7	1.8	1.9
Medium	1.5 -1.9					
		2.0	2.1	2.2	2.3	2.4
Good	2.0 - 2.4					
		2.5	2.6	2.7	2.8	2.9
High	2.5 - 2.9					
		3.0	3.1	3.2	3.3	3.4
Very High	3.0-3.4					

भाकृअनुप
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ICAR-CTRI

Division of Crop Chemistry and Soil science

ICAR-CENTRAL TOBACCO RESEARCH INSTITUTE

(An ISO 9001:2015 Certified Institute)

RAJAHMUNDRY - 533 105, ANDHRA PRADESH, INDIA

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Preface

In India, Flue Cured Virginia tobacco which is a quality-conscious crop is grown in an area of 0.14 million hectares producing 270 million kg annually. The FCV tobacco price and export demand depend on leaf quality. The viable price and sustained market benefit the local buyers in turn the tobacco farmers. FCV tobacco quality varies with different agro-climatic regions and crop seasons. To visualize the changes in leaf quality a precise assessment of important leaf quality parameters is a prerequisite. The institute is involved in regular analysis, assessment, and monitoring of important leaf quality parameters, especially in FCV tobacco. Analyzing chemically tobacco leaves grown in different seasons especially for the nicotine, reducing sugar and chlorides play a key role in chemical quality. However, comparing these quality parameters spatially and temporally across regions and seasons is difficult. In this bulletin, the authors illustrated the seasonal leaf quality of FCV tobacco regions and a single index-based tool for assessing the chemical leaf quality of FCV tobacco would certainly assist in better visualizing of the data in spatial and temporal dimensions making process more effective. I sincerely wish that the proposed approach of evaluation of leaf quality is of immense help to the community in tobacco research and development.

Date: 23-01-2023

(M. SHESHU MADHAV)
DIRECTOR

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I. Introduction

FCV tobacco is grown in an area of 1.39 lakh hectares in India, a nation globally known for its production and exports in international market. High quality FCV tobacco is generally influenced by soil types and climatic set up in which it is grown geographically. Being a highly commercial crop regional level monitoring of production and quality is done by concerned organizations and research departments to ensure better market for the leaf tobacco. Analyzing chemically tobacco leaf grown in different seasons especially for nicotine, reducing sugar and chloride contents and studying their ratios for assessing its quality spatially and temporally is a key activity. However, the parameters wise comparison across regions and seasons over a period is complex and difficult to envisage.

A single index-based method of assessment of quality of tobacco leaf involving critical quality parameters, varying time, and space as a tool to help in visualizing the spatial and temporal dimensions of leaf quality. The index based assessment is very much essential to make monitoring process simple and effective.

Keeping in view the present bulletin was designed to assess the FCV tobacco leaf quality and to develop a proposed index-based method for better comparison of leaf quality across regions and seasons which was not attempted earlier.

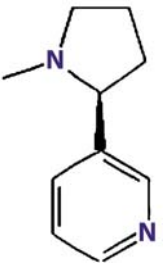
II. Importance of Leaf Quality in FCV Tobacco

The tobacco leaf especially FCV tobacco is a commercial product that is marketed in the national and international market under stringent quality norms which always influence the Indian exports. The competitive price and sustained market benefit the local buyers in turn the tobacco farmers.

To ensure the better acceptability of our tobacco in the national and international market the quality of tobacco produced should be within the limits of acceptability. Therefore, assessment of important quality parameters of tobacco using standard analytical protocols to monitor temporal leaf quality is essential especially in rainfed situations.

The important quality parameters necessary to assess and monitor especially for better commercial use are

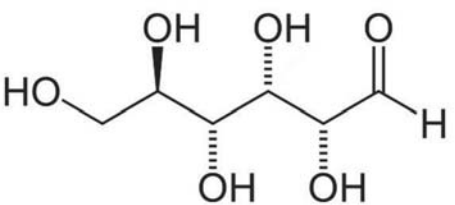
Nicotine: It is synthesized in roots of the plant and transported to leaf and other parts.



$C_{10}H_{14}N_2$

Nicotine content of tobacco by virtue of its stimulatory effect on the smoker is an important constituent. It is considered that a nicotine level of 1.75 to 2.0% in FCV tobacco is most satisfactory.

Reducing Sugar: Reducing Sugar is formed during initial stages of curing process of tobacco leaf. The enzymatic hydrolysis of starch present in the leaf formed during crop growth results in reducing sugars. It is a reducing form of Glucose.



Chlorides (Cl^-): Chlorineis one of the essential nutrients in the production of tobacco. It plays a key role in influencing leaf quality and burn. It is absorbed with ease from the soil solution. It is a free ion mostly accumulated in the leaf from the irrigation water and soil during the crop growth absorbed by the roots. leaf having more chlorides (greater than 2%), which was found to have poor burn and keeping quality.

Important quality parameters and their acceptable limits in Flue Cured Virginia tobacco

Sl. No.	Leaf quality parameters – FCV tobacco	Acceptable Range
1	Nicotine	0.70 - 3.0 %
2	Reducing Sugars	8 – 24 %
3	Chlorides	< 1.0 %
4	Reducing sugars/ Nicotine	7 - 13

Source: Prasad Rao, J.A.V. (2005)

III. Estimation of Nicotine, Reducing Sugars and Chlorides

Nicotine, Reducing Sugars, and chlorides are estimated using colorimetric technique with the help of sophisticated dual channel auto analyser given by Harvey and Smith (1969) for reducing sugars and nicotine. The chlorides are estimated using the method developed by Hanumantha Rao *et al* (1980).

All the three parameters are estimated simultaneously from single sample based on the principle where Cyanogen Bromide reacts with Aniline buffer forming pyridine ring, which reacts with nicotine in sample extracts to form brown colored complex and the absorbance is measured at 460 nm. The Reducing sugars are dialyzed in to an alkaline ferricyanide stream, where they reduce yellow ferricyanide ions in to colourless ferro cyanide in proportion to the amount of reducing sugar present. The reduction in colour is measured by inverse colorimetry at 420 nm. The chloride is reacted with mercuric thiocyanate releasing a proportional concentration of thiocyanate ions, which then reacts with ferric ions forming red complex ferric thiocyanate. The absorbance is measured at 480 nm. Results are expressed in percent concentration of oven dried sample.

Determination of Chemical Leaf Quality Index (CLQI)

The chemical quality index was developed to know the quality of FCV tobacco leaf growing regions of Andhra Pradesh and Karnataka. It was calculated by assigning weights to quality parameters based on their contribution towards quality assessment:

(i) Parameter weights (Wx):

a) 0.8 for Reducing Sugars to Nicotine ratio and

b) 0.2 for Chlorides

The weighted values of each parameter are added to get a single value and square root of the same for obtaining the index i.e.

(ii) CLQI = SQRT (((RS/Nic *0.8) + (Cl *0.2))

The range of index values is categorized to five classes as follows:

Quality Class	Range
Poor	1.0 -1.4
Medium	1.5-1.9
Good	2.0-2.4
High	2.5- 2.9
Very High	3.0 -3.4

* Class is decided on the basis that in which the CLQI value fall under any of the above ranges defined.

IV. Spatial and Temporal Variation of Leaf Quality in FCV Tobacco

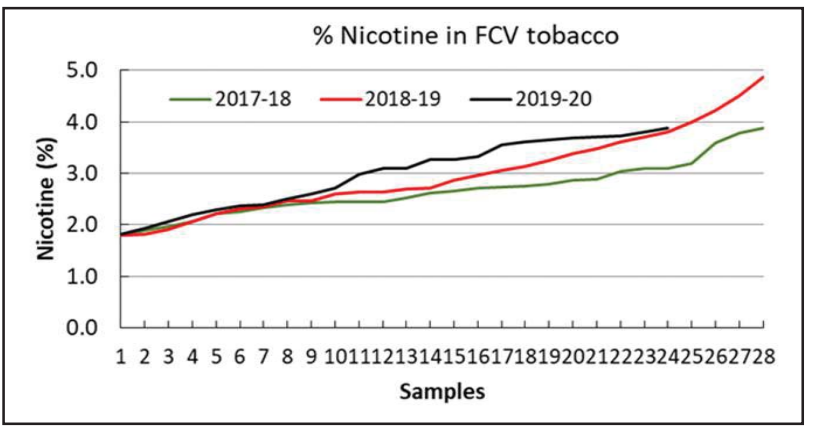
Leaf quality of FCV tobacco in Northern Light Soils

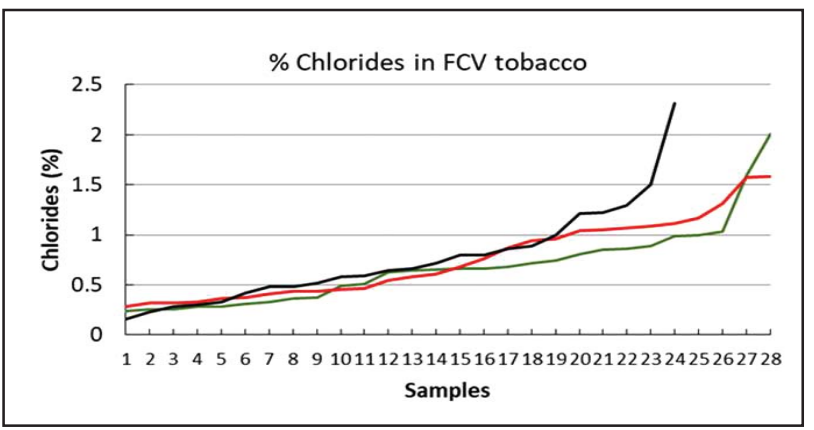
The FCV tobacco is grown in five sub regions (APFs) based on soil type under NLS zone during *Rabi* season under irrigated conditions. The leaf quality is described sub-region wise under NLS.

Leaf nicotine: Northern Light Soils grown FCV tobacco leaf nicotine content varied from 1.88 to 3.94 % with a mean of 2.87 %. The mean nicotine content in the leaf samples of *Devarapalli, Jangareddygudem-I, Koyyalagudem, Jangareddygudem-II, and Gopalpuram* regions were 2.66, 2.86, 3.03, 2.82, and 3.01 %, respectively. Highest mean nicotine was found in *Koyyalagudem* sub region followed by *Gopalapuram* sub region.

Reducing sugars: The reducing sugars of tobacco leaf in NLS ranged from 10.3 to 24.9 % (Mean: 17.7 %) (Table-3 & Fig.1). The highest to lowest mean values of reducing sugars were in the order of *Gopalpuram (19.02 %), Devarapalli (18.92 %), Jangareddygudem-II (18.35%), Koyyalagudem (16.86 %) and Jangareddygudem-I (15.33 %)* sub regions.

Leaf chlorides: The triennial average of NLS ranges from 0.25 to 3.23 % (Mean:1.14 %). Leaf chlorides in different sub-regions were in the order of *Koyyalagudem (0.60 %), Jangareddygudem-II (0.61%), Jangareddygudem-I (0.84 %), Devarapalli (0.89 %) and Gopalpuram (2.77%).* Relatively high chlorides seen in *Gopalapuram* region was due to poor quality irrigation water with high water table.





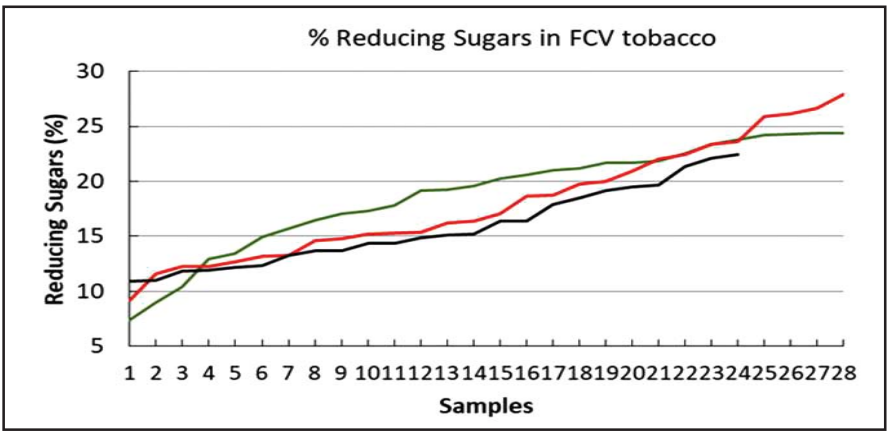


Fig.1:Seasonal variation of % nicotine, reducing sugars and chlorides in FCV tobacco leaf under Northern Light Soil region

Leaf quality of FCV tobacco in Karnataka Light Soils

The FCV tobacco is grown in eleven sub regions (APFs) based on soil type in KLS zone during *Kharif* season under rainfed conditions. The leaf quality of KLS zone is described sub-region wise for better comparison (Table-4 & Fig.2).

Leaf Nicotine: The leaf nicotine content of KLS zone varied from 1.34 to 2.54 % with a mean value of 1.75 %. The mean leaf nicotine content in different sub regions/sub zones were in the order (lowest to highest) of *Periyapatna-I (1.54 %) < Periyapatna-II (1.57 %) < Hunsur-I (1.57 %) < Chilkunda (1.69 %) < Ramnathapura-II (1.72 %) < Periyapatna-III (1.73 %) < Kampalapura(1.76 %) < Hunsur-III (1.77 %) < Ramnathpura-I (1.81 %) < H D Kote (2.01 %) < Hunsur-II (2.04 %).*

Leaf reducing sugars: The reducing sugars varied from 15.71 to 23.79 % with an average of 20.13 % in KLS zone.The mean leaf RS content in different sub regions/sub zones were in the order (highest to lowest) of *Chilkunda (21.8 %) > Hunsur-III (21.3 %) > Hunsur-I (21.26 %) > Periyapatna-II (21.03 %) > Kampalapura (20.30 %) > Ramnathapura-II (20.1 %) > Periyapatna-I (19.86 %) > Ramnathpura-I (19.73 %) > H D Kote (19.47 %) > Periyapatna-III (18.46 %) > Hunsur-II (18.07 %).*

Leaf chlorides: The chlorides ranged from 0.17 to 1.18 % with a mean value of 0.49 % in KLS. The mean leaf chloride content in different sub regions/sub zones were in the order (lowest to highest) of *Hunsur-I (0.33 %) < Periyapatna-II (0.41 %) < Periyapatna-III (0.46 %) < Ramnathpura-I (0.47 %) < Hunsur-II (0.50 %) < Kampalapura (0.50 %) < Ramnathapura-II (0.53 %) < H D Kote (0.53 %) < Hunsur-III (0.54 %) < Periyapatna-I (0.55 %) < Chilkunda (0.61 %).*

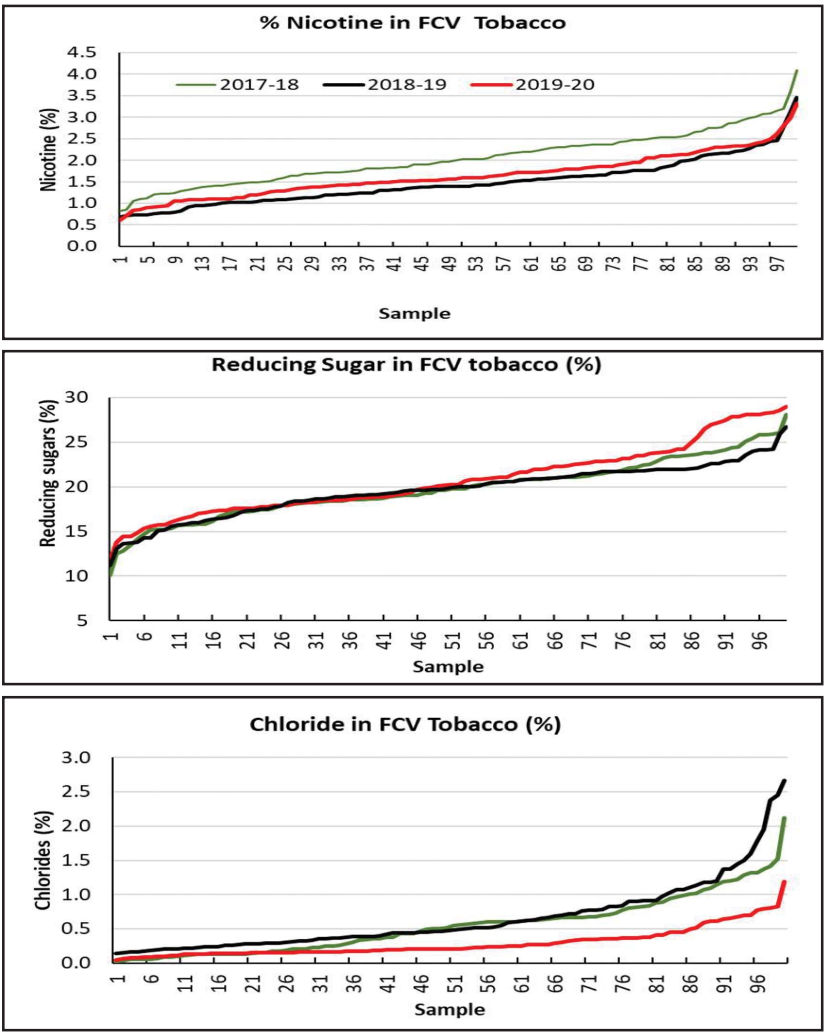


Fig.2: Seasonal variation of % nicotine, reducing sugars and chlorides in FCV tobacco leaf under Karnataka Light Soil region

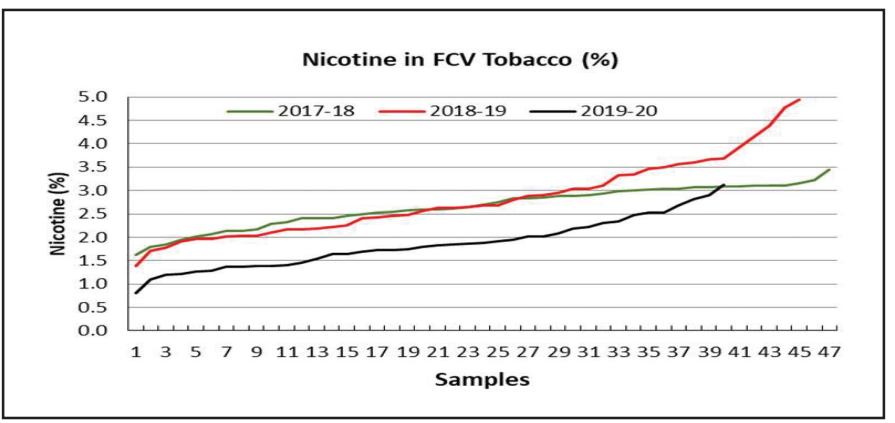
Leaf quality of FCV tobacco in Southern Light Soils (SLS)

The FCV tobacco is grown in six sub regions (APFs) based on soil type in SLS zone during *rabi* season under rainfed conditions. Due to erratic rainfall the crop growth and leaf yield is low compared to irrigated conditions. Rainfed situation dictates the leaf quality and chemical quality parameters in general poor compared to irrigated zones. The leaf quality of SLS zone is described sub-region wise for better comparison (Table-5 & Fig.3).

Leaf nicotine: The leaf nicotine content of whole SLS zone variedfrom 1.42 to 3.54 % with an average of 2.44 %. The mean leaf nicotine content in different sub regions/sub zones of SLS were in the order (lowest to highest) of *D.C Palli (2.19 %) < Podili (2.32 %) < Kaligiri (2.38 %) < Kandukur-II (2.53 %) <* Kanigiri (2.57 %) *< Kandukur- I (2.68 %).*

Leaf reducing sugars: *The* reducing sugars varied from 8.47 to 20.4 % with an average of 13.11 % in SLS zone. The mean leaf RS content in different sub regions/sub zones of SLS were in the order (highest to lowest) of *Podili (14.29 %) > Kaligiri (13.95 %) > D.C Palli (13.11 %) > Kandukur-II (12.63 %) > Kandukur- I (12.61 %) >* Kanigiri (12.21 %).

Leaf chlorides: The reducing sugars varied from chlorides varied from 0.18 to 2.02 % with a mean of 0.58 % in SLS zone. The mean leaf chloride content in different sub regions/sub zones of SLS were in the order (highest to lowest) of *Podili (0.77 %) > D.C Palli (0.65 %) > Kaligiri (0.60 %) > Kandukur-II (0.58 %) > Kandukur- I (0.56 %) >* Kanigiri (0.35 %).



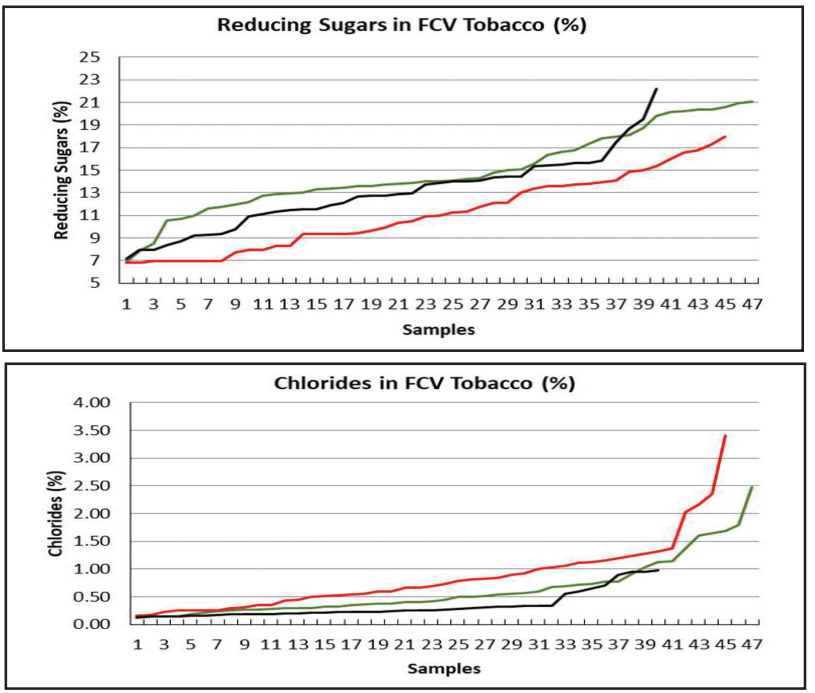


Fig.3: Seasonal variation of % nicotine, reducing sugars and chlorides in FCV tobacco leaf under Southern Light Soil region

Leaf quality of FCV tobacco in Southern Black Soils (SBS)

The FCV tobacco is grown in six sub regions based on soil type in SBS zone during *rabi* season under rainfed conditions. The soil in this zone is mostly black soil followed by mixed soils. The area experiences erratic rainfall and sometimes the crop withstand on a critical irrigation. The leaf quality of SBS is described sub-region wise for better comparison (Table-6 & Fig.4).

Leaf nicotine: The leaf nicotine content under SBS varied from 1.55 to 4.03 % with a mean of 2.76 %. The mean leaf nicotine content in different sub regions/sub zones of SBS were in the order (lowest to highest) of *Ongole-I (2.53 %) < Kondapi (2.57 %) < Tangutur-II (2.77 %) < Vellampalli (2.79 %) < Tangutur-I (2.95 %) < Ongole-II (2.97 %).*

Leaf reducing sugars: The leaf reducing sugar content of SBS varied from 17.34 to 18.0 % with an average of 12.0 %. The mean RS content in

different sub regions/sub zones of SBS were in the order (highest to lowest) of *Tangutur-I (17.53 %) > Ongole-II (16.74 %) > Ongole-I (15.11 %) > Kondapi (12.17 %) > Vellampalli (10.97 %) > Tangutur-II (10.72 %).*

Leaf chlorides: The leaf chlorides content of total SBS varied from 0.24 to 2.36 % with a mean of 0.94 %. The mean chloride content in different sub regions/sub zones of SBS were in the order (lowest to highest) of *Kondapi (0.61 %) < Tangutur-I (0.63 %) < Tangutur-II (0.92 %) < Ongole-I (0.95 %) < Ongole-II (1.04 %) < Vellampalli (1.51 %).*

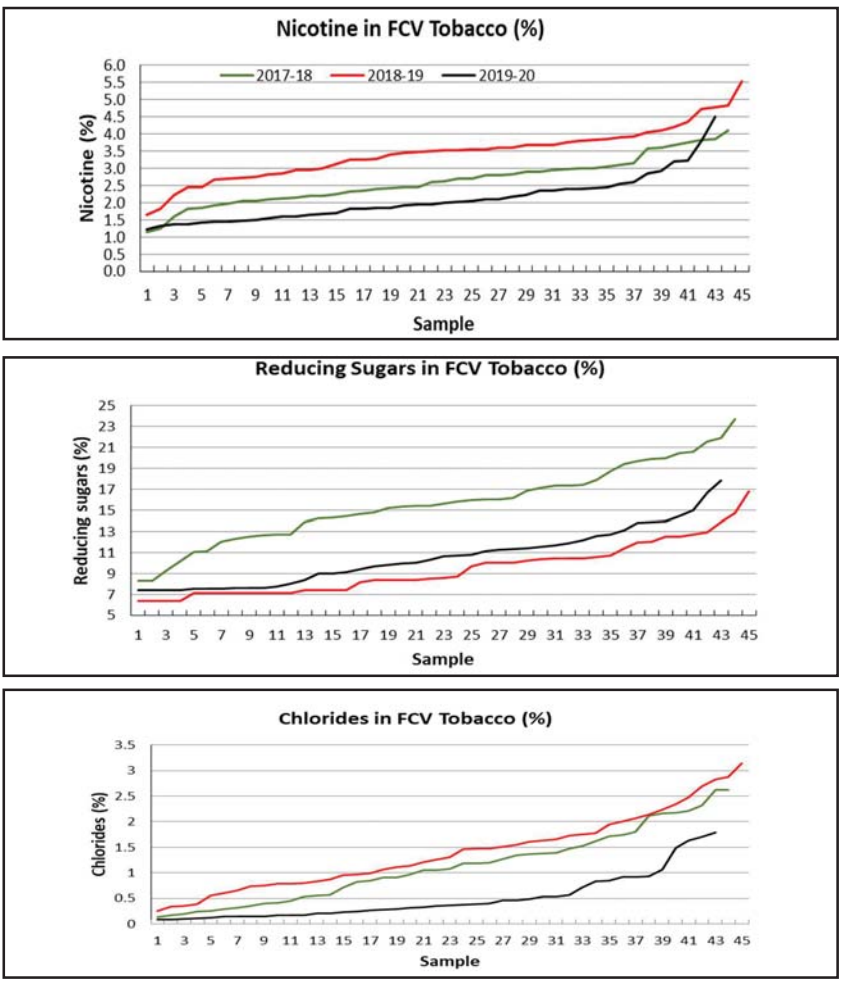


Fig.4: Seasonal variation of % nicotine, reducing sugars and chlorides in FCV tobacco leaf under Southern Black Soil zone

V. Chemical Leaf Quality Index of different FCV tobacco regions

Leaf quality status (nicotine, reducing sugars and chlorides) of FCV tobacco growing areas in Karnataka Light Soils, Northern Light Soils, Southern Light Soils and Southern Black Soils was studied from 2017-2020. Based on the data obtained from the analysed quality parameters, the Chemical Leaf Quality Index (CLQI) was calculated.

The CLQI in FCV tobacco growing areas of Andhra Pradesh ranges from 1.8 to 2.4 (Class: Medium-Good). The Chemical Leaf Quality Index (CLQI) of Northern Light Soils varied from 2.1 to 2.4 (Class: Good) with a mean index of 2.35 (Class: Good). Among the sub regions, CLQI under APF-33, *Gopalapuram* is the highest (2.4) (Table-3). The Chemical Leaf Quality Index of FCV tobacco of Karnataka Light Soils varied from 2.7 to 3.3 (Class: High -Very High) with a mean index of 3.3. Among the sub regions (APFs), CLQI is highest in *Hunsur– III and Chilkunda whereas* lowest is in *Hunsur-II and Periyapatna-III* (Table-4). In Southern Light Soils,CLQI varied from 2.0 to 2.3 (Class: Medium) with a mean of 2.1. The CLQI under APF-22, *Podili* is the highest, and followed by APF-35, *Kaligiri* (Table-5). The Chemical Leaf Quality Index (CLQI) of Southern Black Soils varied from 1.8 to 2.0 (Class: Medium-Good) with a mean index of 1.91. The CLQI of sub zones: APF-24, *Tangutur-I* is the highest (2.0) followed by APF-20, *Ongole -I* in SBS (Table-6).

Table 1: Standard Chart of Quality Class based on CLQI in FCV Tobacco

CLASS	INDEX RANGE	COLOUR CODE				
		1.0	1.1	1.2	1.3	1.4
Poor	1.0 -1.4					
		1.5	1.6	1.7	1.8	1.9
Medium	1.5 -1.9					
		2.0	2.1	2.2	2.3	2.4
Good	2.0 - 2.4					
		2.5	2.6	2.7	2.8	2.9
High	2.5 - 2.9					
		3.0	3.1	3.2	3.3	3.4
Very High	3.0-3.4					

Table-2: Pixel Map of Quality Class based on CLQI in FCV Tobacco Regions (2017-2020)

KLS	APF No	1	2	3	4	5	6	7	61	62	63	64
	Class											
SBS	APF No	20	23	24	25	31	34					
	Class											
NLS	APF No	17	18	30	32	33						
	Class											
SLS	APF No	22	26	27	28	29	35					
	Class											

Note: Colours are depicted based on the standard chart given in Table1.

Conclusion

The index-based quality assessment is helpful in monitoring the leaf quality parameters which are essential for marketing and obtaining a better price. Seasonal monitoring of leaf quality of FCV tobacco grown under different soil types and climatic conditions assists in improving the leaf quality by means of implementing recommended interventions/ strategies through the concerned agencies and institutes. The above analysis indicated that the leaf quality of KLS region was high to very high. The NLS region recorded medium to good quality while the other two regions i.e SBS and SLS regions recorded medium quality index class in the years of 2017 to 2020.

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Table.3: Leaf quality status of FCV tobacco in Northern Light Soils of Andhra Pradesh.

Year	Nicotine (%)				Red Sugars (%)				Chlorides (%)				CLQI
	2017-18	2018-19	2019-20	Triennial Mean	2017-18	2018-19	2019-20	Triennial Mean	2017-18	2018-19	2019-20	Triennial Mean	
					APF-17: Devarapalli								
Min	1.89	1.92	2.20	2.00	8.93	18.77	13.66	13.78	0.63	0.41	0.64	0.56	
Max	3.09	3.99	2.71	3.26	23.82	26.62	22.14	24.19	1.03	1.58	1.22	1.28	
Mean	2.59	2.99	2.42	2.66	17.42	21.74	17.61	18.92	0.80	0.91	0.95	0.89	**2.4**
					APF-18:Jangareddygudem - I								
Min	2.45	2.06	1.82	2.11	7.32	12.70	10.91	10.31	0.26	0.32	0.33	0.3	
Max	3.87	3.14	3.88	3.63	21.86	18.62	21.33	20.60	2.01	1.57	1	1.52	
Mean	3.20	2.53	2.87	2.86	15.52	15.23	15.26	15.33	0.88	0.99	0.66	0.84	**2.1**
					APF-30: Koyyalagudem								
Min	1.97	1.81	3.10	2.29	10.35	11.61	11.80	11.25	0.28	0.32	0.16	0.25	
Max	3.79	4.23	3.80	3.94	24.29	25.86	16.40	22.18	1.00	1.17	0.80	0.99	
Mean	2.73	2.94	3.44	3.03	19.14	17.64	13.82	16.86	0.60	0.76	0.45	0.60	**2.1**
					APF-32: Jangareddygudem -II								
Min	1.80	1.79	2.06	1.88	12.90	9.17	10.96	11.01	0.26	0.28	0.23	0.26	
Max	2.87	3.80	3.72	3.46	24.35	27.87	22.47	24.90	0.89	0.58	1.50	0.99	
Mean	2.45	2.95	3.05	2.82	19.11	19.80	16.13	18.35	0.63	0.43	0.76	0.61	**2.3**
					APF-33: Gopalapuram								
Min	2.22	2.63	2.43	2.43	19.27	12.22	19.63	17.04	2.22	2.63	2.31	2.38	
Max	2.53	4.87	3.70	3.70	24.36	23.60	19.63	22.53	2.53	4.87	2.31	3.23	
Mean	2.36	3.65	3.01	3.01	22.12	15.32	19.63	19.02	2.36	3.65	2.31	2.77	**2.4**
					Northern Light Soils								
Min	1.8	1.79	1.82	1.88	7.32	9.17	10.91	10.31	0.26	0.28	0.16	0.25	**2.35**
Max	3.87	4.87	3.88	3.94	24.36	27.87	22.47	24.90	2.53	4.87	2.31	3.23	
Mean	2.66	3.01	2.95	2.87	18.66	17.94	16.49	17.69	1.05	1.34	1.02	1.14	

Table.4: Leaf quality status of FCV tobacco in Karnataka Light Soils.

Year	Nicotine (%)			Trien nial Mean	Red Sugars (%)			Trien nial Mean	Chlorides (%)			Trien nial Mean	CLQI
	2017-18	2018-19	2019-20		2017-18	2018-19	2019-20		2017-18	2018-19	2019-20		
APF-1 & 65: H D Kote													
Min	1.32	0.94	1.06	1.66	10.11	17.94	11.24	16.93	0.02	0.09	0.24	0.17	
Max	3.58	2.11	3.32	2.41	20.86	28.54	21.17	21.29	1.01	0.59	2.45	1.03	
Mean	2.58	1.44	2.01	2.01	15.46	25.75	17.19	19.47	0.41	0.25	0.94	0.53	**2.8**
APF-2: Hunsur - I													
Min	1.24	1.24	0.90	1.26	16.69	22.71	16.48	20.35	0.05	0.20	0.36	0.26	
Max	3.20	1.64	2.34	2.20	25.88	25.57	22.06	23.55	0.23	0.68	0.67	0.36	
Mean	1.83	1.45	1.43	1.57	21.04	23.88	18.86	21.26	0.13	0.38	0.47	0.33	**3.3**
APF-3: Husur-II													
Min	1.40	2.00	0.72	1.68	15.25	13.79	15.98	16.20	0.20	0.16	0.14	0.20	
Max	2.37	3.46	2.49	2.49	21.74	18.82	21.99	20.77	1.29	0.77	1.50	0.75	
Mean	1.89	2.59	1.64	2.04	19.41	16.33	18.47	18.07	0.66	0.30	0.55	0.50	**2.7**
APF-4: Periyapatana - I													
Min	1.12	0.68	0.61	1.15	12.53	14.88	13.08	15.87	0.03	0.24	0.16	0.28	
Max	2.86	1.77	2.98	2.15	28.08	23.20	24.18	22.59	1.02	0.80	2.67	1.18	
Mean	1.96	1.03	1.63	1.54	21.21	19.05	19.33	19.86	0.36	0.51	0.77	0.55	**3.2**
APF-5: Periyapatana - II													
Min	0.85	0.77	2.61	1.21	13.45	17.60	13.66	18.42	0.10	0.13	0.18	0.19	
Max	3.15	2.44	0.93	1.99	25.86	26.46	24.14	23.50	1.15	0.45	1.60	0.66	
Mean	1.74	1.49	1.48	1.57	20.66	21.85	20.59	21.03	0.42	0.22	0.60	0.41	**3.3**
APF-6: Periyapatana -III													
Min	1.10	0.76	1.20	1.32	17.16	15.34	13.83	15.71	0.17	0.15	0.26	0.21	
Max	3.09	2.17	2.12	2.14	24.47	21.38	21.19	20.23	0.89	0.38	1.37	0.77	
Mean	2.19	1.39	1.61	1.73	19.06	17.76	18.56	18.46	0.63	0.20	0.54	0.46	**2.9**

Table.4: Leaf quality status of FCV tobacco in Karnataka Light Soils (Contd..).

Year	Nicotine (%)			Trien nial Mean	Red Sugars (%)			Trien nial Mean	Chlorides (%)			Trien nial Mean	CLQI
	2017-18	2018-19	2019-20		2017-18	2018-19	2019-20		2017-18	2018-19	2019-20		
					APF-7: Ramanathapura -I								
Min	1.70	0.80	1.13	1.45	15.13	11.73	16.24	16.58	0.07	0.04	0.15	0.25	
Max	2.98	2.27	2.14	2.27	24.15	27.21	22.88	23.79	1.32	0.27	1.37	0.94	
Mean	2.24	1.55	1.64	1.81	20.28	19.16	19.74	19.73	0.56	0.13	0.72	0.47	**3.0**
					APF-61:Kamalapura - I								
Min	1.84	1.08	1.28	1.49	18.08	17.57	17.54	19.05	0.38	0.11	0.19	0.37	
Max	3.01	2.15	2.18	2.15	23.94	23.13	22.35	21.48	2.12	0.37	1.07	0.85	
Mean	2.18	1.43	1.66	1.76	19.64	20.95	20.31	20.30	0.73	0.22	0.56	0.50	**3.1**
					APF-62: Chilkunda								
Min	0.82	1.02	0.86	1.34	15.25	19.24	15.83	20.27	0.12	0.14	0.17	0.33	
Max	2.53	2.45	2.79	2.17	25.41	28.94	22.62	22.90	1.52	0.61	2.38	0.97	
Mean	1.69	1.70	1.67	1.69	20.32	25.16	19.94	21.80	0.85	0.29	0.68	0.61	**3.2**
					APF-63: Ramnathapura-II								
Min	1.06	1.21	0.91	1.45	15.29	16.29	17.08	17.73	0.06	0.08	0.22	0.23	
Max	4.09	1.71	1.92	2.54	23.84	20.19	26.70	21.74	1.37	1.19	1.78	0.85	
Mean	2.25	1.43	1.47	1.72	19.15	18.42	22.74	20.10	0.72	0.28	0.58	0.53	**3.1**
					APF-64:Hunsur -III								
Min	1.81	1.02	1.80	1.73	19.78	21.95	15.07	19.90	0.25	0.16	0.27	0.39	
Max	2.36	1.38	2.32	1.88	22.49	22.39	22.11	22.30	1.07	0.83	1.03	0.72	
Mean	2.02	1.20	2.11	1.77	21.48	22.22	20.19	21.30	0.52	0.44	0.63	0.53	**3.1**
					Karnataka Light Soils								
Min	0.82	0.68	0.61	1.34	10.11	11.73	11.24	15.71	0.02	0.04	0.14	0.17	
Max	4.09	3.46	3.32	2.54	28.08	28.94	26.70	23.79	2.12	1.19	2.67	1.18	
Mean	2.05	1.52	1.67	1.75	19.79	20.96	19.63	20.13	0.54	0.29	0.64	0.49	**3.05**

Table.5: Leaf quality status of FCV tobacco in Southern Light Soils.

Year	Nicotine (%)			Trien nial Mean	Red Sugars (%)			Trien nial Mean	Chlorides (%)			Trien nial Mean	CLQI
	2017-18	2018-19	2019-20		2017-18	2018-19	2019-20		2017-18	2018-19	2019-20		
APF-22: Podili													
Min	1.62	1.38	1.27	1.42	8.53	7.70	10.89	9.04	0.19	0.16	0.23	0.19	
Max	3.22	3.03	2.90	3.05	21.05	17.99	22.18	20.40	1.69	3.41	0.98	2.02	
Mean	2.47	2.38	2.12	2.32	14.33	13.83	14.73	14.29	0.70	1.10	0.51	0.77	**2.3**
APF-26: Kandukur-I													
Min	2.89	2.68	1.09	2.22	6.90	9.35	9.18	8.47	0.27	0.52	0.18	0.32	
Max	3.16	4.95	1.82	3.31	18.74	16.54	14.42	16.56	0.57	1.28	0.60	0.82	
Mean	3.04	3.56	1.45	2.68	12.77	12.94	12.13	12.61	0.43	0.93	0.32	0.56	**2.0**
APF-27: Kandukur-II													
Min	2.32	2.03	0.81	1.72	10.54	6.96	7.97	8.49	0.12	0.35	0.2	0.22	
Max	3.11	4.39	3.13	3.54	17.31	13.74	19.50	16.85	1.65	2.03	0.65	1.44	
Mean	2.71	2.88	2.00	2.53	13.82	10.35	13.74	12.63	0.66	0.71	0.36	0.58	**2.0**
APF-28: Kaligiri													
Min	2.52	1.71	1.20	1.81	13.61	8.26	8.72	10.19	0.14	0.25	0.16	0.18	
Max	3.44	4.15	2.53	3.37	20.92	13.96	15.62	16.83	2.48	1.16	0.95	1.53	
Mean	2.87	2.42	1.86	2.38	17.75	11.11	12.69	13.85	0.78	0.60	0.42	0.60	**2.2**
APF-29: D C Palli													
Min	1.85	1.97	1.36	1.72	12.2	7.94	7.15	9.09	0.25	0.26	0.15	0.22	
Max	2.29	3.47	2.68	2.81	20.58	13.79	15.6	16.65	1.8	1.37	0.25	1.14	
Mean	2.11	2.68	1.8	2.19	15.79	10.87	12.7	13.11	0.85	0.91	0.19	0.65	**2.2**
APF-35: Kanigiri													
Min	2.49	2.10	1.39	1.99	13.30	6.25	8.36	9.30	0.14	0.44	0.13	0.23	
Max	2.84	4.78	2.02	3.21	20.39	15.36	11.55	15.76	0.45	0.73	0.34	0.50	
Mean	2.64	3.37	1.71	2.57	15.88	10.81	9.96	12.21	0.29	0.56	0.20	0.35	**2.0**
Southern Light Soils													
Min	1.62	1.38	0.81	1.42	6.9	6.25	7.15	8.47	0.12	0.16	0.13	0.18	
Max	3.44	4.95	3.13	3.54	21.05	17.99	22.18	20.4	2.48	3.41	0.98	2.02	
Mean	3.04	2.29	1.82	2.44	15.05	11.65	12.65	13.11	0.62	0.8	0.33	0.58	**2.10**

Table.6: Leaf quality status of FCV tobacco in Southern Black Soils.

Year	Nicotine (%)			Trien nial Mean	Red Sugars (%)			Trien nial Mean	Chlorides (%)			Trien nial Mean	CLQI
	2017-18	2018-19	2019-20		2017-18	2018-19	2019-20		2017-18	2018-19	2019-20		
						APF-31:Vellampalli							
Min	1.60	1.65	1.42	1.55	8.28	7.14	7.53	7.65	0.32	0.79	0.15	0.42	**1.9**
Max	4.09	4.06	3.81	3.98	23.66	12.54	17.80	18.00	2.62	2.69	1.79	2.36	
Mean	2.90	3.14	2.35	2.79	14.4	7.98	10.53	10.97	2.18	1.52	0.85	1.51	
						APF-20:Ongole - I							
Min	1.97	2.45	1.45	1.95	12.73	8.40	8.96	10.03	0.56	0.35	0.12	0.34	
Max	3.09	3.79	2.93	3.27	20.60	12.03	12.72	15.11	1.38	2.83	0.71	1.64	
Mean	2.57	3.09	1.94	2.53	16.52	9.85	10.91	12.42	1.12	1.37	0.37	0.95	**2.0**
						APF-23:Ongole-II							
Min	2.36	1.83	1.23	1.80	10.17	7.40	7.60	8.39	0.19	1.11	0.32	0.54	
Max	3.76	3.83	4.51	4.03	19.71	13.86	16.65	16.74	2.16	3.14	1.06	2.12	
Mean	3.11	3.29	2.52	2.97	14.04	9.35	10.97	11.45	0.83	1.59	0.70	1.04	**1.8**
						APF-24:Tangutur-I							
Min	1.24	3.48	1.60	2.11	17.34	10.45	8.03	11.94	0.13	0.74	0.21	0.36	
Max	3.06	4.83	2.40	3.43	21.92	16.77	13.91	17.53	1.05	1.48	0.46	1.00	
Mean	3.08	3.89	1.88	2.95	19.56	12.13	11.23	14.31	0.39	1.17	0.34	0.63	**2.0**
						APF-34:Tangutur-II							
Min	2.21	2.82	1.33	2.12	12.29	2.01	7.74	7.34	0.97	0.65	0.14	0.58	
Max	2.99	4.77	2.35	3.37	16.89	12.72	15.01	14.87	2.11	2.48	0.20	1.59	
Mean	2.72	3.79	1.80	2.77	14.76	6.36	11.04	10.72	1.48	1.13	0.16	0.92	**1.8**
						APF-25:Kondapi							
Min	1.15	2.70	1.38	1.74	11.03	10.02	7.43	9.49	0.40	0.25	0.08	0.24	
Max	2.21	5.54	2.36	3.37	20.42	14.71	13.10	16.07	1.48	2.23	0.29	1.33	
Mean	1.93	3.92	1.86	2.57	16.27	10.92	9.32	12.17	0.79	0.90	0.15	0.61	**2.0**
						Southern Black Soils							
Min	1.15	1.65	1.23	1.55	8.28	2.01	7.43	7.34	0.13	0.25	0.08	0.24	
Max	4.09	5.54	4.51	4.03	23.66	16.77	17.8	18	2.62	3.14	1.79	2.36	
Mean	2.72	3.52	2.05	2.76	15.92	9.43	10.66	12	1.13	1.28	0.42	0.94	**1.91**

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