

EVALUATION OF MULTILOCATIONAL PERFORMANCE OF ORIENTAL TOBACCO IN CHITTOOR DISTRICT WITH SPECIAL REFERENCE TO NUTRITION, NICOTINE CONTENT AND YIELD

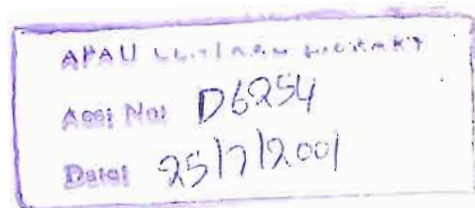
By

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**THESIS SUBMITTED TO THE
ACHARYA N.G. RANGA AGRICULTURAL UNIVERSITY
IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE OF
MASTER OF SCIENCE IN AGRICULTURE
(SOIL SCIENCE AND AGRIL. CHEMISTRY)**

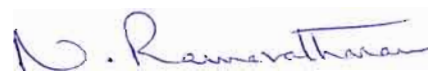


**DEPARTMENT OF SOIL SCIENCE AND AGRICULTURAL CHEMISTRY
SRI VENKATESWARA AGRICULTURAL COLLEGE
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JANUARY, 2001

CERTIFICATE

Mr. M. Somalinga Reddy, has satisfactorily prosecuted the course of research and that the thesis entitled "**Evaluation of Multilocational Performance of Oriental Tobacco in Chittoor District with special reference to Nutrition, Nicotine Content and Yield**" submitted is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination. I also certify that the thesis or part thereof has not been previously submitted by him for a degree of any University.



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CERTIFICATE

This is to certify that thesis entitled "**Evaluation of Multilocal Performance of Oriental Tobacco in Chittoor District with special reference to Nutrition, Nicotine Content and Yield**" submitted in partial fulfilment of the requirements for the degree of '**Master of Science in Agriculture**' of the Acharya N.G.Ranga Agricultural University, Hyderabad is a record of the bonafide research work carried out by **Mr. M. Somalinga Reddy**, under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee.

No part of the thesis has been submitted for any other degree or diploma. The published part has been fully acknowledged. All the assistance and help received during the course of investigations have been duly acknowledged by the author of the thesis.



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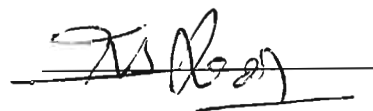
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LIST OF ABBREVIATIONS

CD	:	Critical difference
Cl	:	Chloride
Cv	:	Cultivar
CV	:	Coefficient of variation
CV (%)	:	Percent of coefficient of variation
DAS	:	Days after sowing
DAT	:	Days after transplantation
dsm ⁻¹	:	Decisiemens per metre
EC	:	Electrical conductivity
F.C.	:	Flue cured
I P	:	First priming
III P	:	Third priming
LCa ₁	:	Leaf calcium in first priming
LCa ₃	:	Leaf calcium in third priming
LCa ₅	:	Leaf calcium in fifth priming
LCa _A	:	Average leaf calcium
LCl _A	:	Average leaf chlorides
LCu ₁	:	Leaf copper in first priming
LCu ₃	:	Leaf copper in third priming
LCu ₅	:	Leaf copper in fifth priming
LCu _A	:	Average leaf copper
LFe ₁	:	Leaf iron in first priming
LFe ₃	:	Leaf iron in third priming
LFe ₅	:	Leaf iron in fifth priming
LFe _A	:	Average leaf iron
LK ₁	:	Leaf potassium in first priming
LK ₃	:	Leaf potassium in third priming
LK ₅	:	Leaf potassium in fifth priming
LK _A	:	Average leaf potassium
LMg ₁	:	Leaf magnesium in first priming
LMg ₃	:	Leaf magnesium in third priming
LMg ₅	:	Leaf magnesium in fifth priming
LMg _A	:	Average leaf magnesium
LMn ₁	:	Leaf manganese in first priming
LMn ₃	:	Leaf manganese in third priming
LMn ₅	:	Leaf manganese in fifth priming
LMn _A	:	Average leaf manganese

LN ₁	:	Leaf nitrogen in first priming
LN ₃	:	Leaf nitrogen in third priming
LN ₅	:	Leaf nitrogen in fifth priming
LN _A	:	Average leaf nitrogen
LNic _A	:	Average leaf nicotine
LP ₁	:	Leaf phosphorus in first priming
LP ₃	:	Leaf phosphorus in third priming
LP ₅	:	Leaf phosphorus in fifth priming
LRS _A	:	Average leaf reducing sugars
LZn ₁	:	Leaf zinc in first priming
LZn ₃	:	Leaf zinc in third priming
LZn ₅	:	Leaf zinc in fifth priming
LZn _A	:	Average leaf zinc
max.	:	Maximum
me/100 gm	:	milli equivalent per 100 grams
min	:	Minimum
N	:	Nitrogen
Nic	:	Nicotine
NS	:	Non-significant
RS	:	Reducing sugars
SCa	:	Soil calcium
SCl	:	Soil chlorides
SCu	:	Soil copper
SD	:	Standard deviation
SE _m	:	Standard error of mean
SFe	:	Soil Iron
SK	:	Soil potassium
SMg	:	Soil magnesium
SMn	:	Soil manganese
SN	:	Soil nitrogen
SP	:	Soil phosphorus
SZn	:	Soil zinc
V P	:	Fifth priming
viz	:	namely
Zn	:	Zinc

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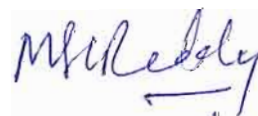
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(M. SOMALINGA REDDY)

DECLARATION

I, M. Somalinga Reddy, hereby declare that the thesis entitled **"Evaluation of Multilocational Performance of Oriental Tobacco in Chittoor District with special reference to Nutrition, Nicotine Content and Yield"** submitted to Acharya N.G. Ranga Agricultural University, Hyderabad for the degree of **Master of Science in Agriculture** is the result of original research work done by me. It is further declared, that no thesis or any part there of has not been published earlier in any manner.

Date : 1.1.2001


(M. SOMALINGA REDDY)

ABSTRACT

Title of the thesis : **EVALUATION OF MULTILOCATIONAL PERFORMANCE OF ORIENTAL TOBACCO IN CHITTOOR DISTRICT WITH SPECIAL REFERENCE TO NUTRITION, NICOTINE CONTENT AND YIELD**

Author : **M. SOMALINGA REDDY**

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Submitted for the : M.Sc. (Ag.)
award of Degree

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An investigation was carried out to study the performance of oriental tobacco with respect to soil nutrient status, leaf nutrient status, leaf quality parameters and yield. For this purpose forty experimental fields were selected in western parts of chittoor district. From each field surface soil samples (0-15 cm depth) were collected twice during the crop period i.e one at the time of planting and the other at 75 DAT. Leaf samples were collected at four stages during the period of investigation i.e one at the time of planting and remaining at I, III and V primings. The soil samples were analysed for physical characteristics, physico-chemical characteristics, available nitrogen, phosphorus, potassium, calcium, magnesium, chloride, zinc, copper, iron and manganese contents. Similarly leaf samples were also analysed for the above nutrients along with quality parameters i.e nicotine and reducing sugar concentrations. Finally nutrient uptake by leaf and yield data were recorded.

Soil texture in the experimental fields varied from sandy loams to sandy clay loams. 70% of the soils are sandy loams while the rest are sandy clay loams. All the soils in Gyarampalli and Rompicherla mandals are sandy loams where as 80% of soils in Madanapalli mandal and 37% of soils in Kallur and Gandaboinapalli mandal are sandy clay loams. The soils are slightly acidic to moderately alkaline in soil reaction and non-saline. Out of the five mandals, the soils of Gandaboinapalli, Madanapalli and Kallur mandals had relatively higher pH and EC values.

All the soils are found to be low in available N, low to medium in available P and medium in available K contents. Exchangeable Ca and Mg status of soils was

sufficiently higher than the required. Without exception all the soils are found to contain Fe, Mn, Zn and Cu contents above their critical limits and soil chloride contents below the critical limit.

The leaf N concentration of aromatic tobacco produced in the present investigation fall in the desired range. Higher N concentrations were found in III priming leaf compared to V priming leaf. P and K concentrations in leaf decreased with increase in leaf position from bottom to top i.e decreased with increasing in priming number. Both leaf P and leaf K concentrations were in the range normally reported for tobacco.

Similar to major nutrients, the secondary nutrients (Ca & Mg) were also decreased from I priming to V priming. All the four micronutrients in leaf (Fe, Mn, Zn and Cu) were found to be above the critical level in all the experimental fields except for Fe in some fields mostly those located in Gandaboinapalli and Madanapalli were low in V priming compared to I and III primings. Of the five mandals, comparatively higher concentrations of these micronutrients were found in Gyarampalli and Rompicherla mandals.

The data on correlation revealed that soil nutrients and respective leaf nutrients were significantly and positively correlated with each other in all the three picks.

The distribution pattern of nicotine was similar to that of nitrogen in leaf i.e high nicotine concentrations in III priming leaf followed by V priming leaf and I priming leaf. Relatively wider variation in nicotine concentration of cured leaf was found in Gyarampalli and Rompicherla mandals. N conc. in leaf was significantly and positively correlated with nicotine concentration in leaf ($r = 0.862^{**}$). Regression coefficient of Soil N was significant at 1% level.

Reducing sugars in leaf were high in III priming followed by V and I primings. Leaf reducing sugars had negative correlation with soil N, leaf N and leaf nicotine.

The concentration of chlorides in leaf was low in III priming and relatively higher chlorides were found in I and V primings. Oriental tobacco grown in Gyarampalli and Madanapalli mandals had high leaf chlorides. Multiple regression analysis showed that the contribution of exchangeable Mg and soil chlorides were significantly high for variations in leaf chloride concentrations.

With regard to leaf yield cured leaf yields ranged from 241.00 kg/ha to 502.00 kg/ha. Correlation data revealed that the yield correlated with soil N significantly and positively at 1% level and with soil K at 5% level. Multiple Regression analysis indicated that soil available N and available K were significantly contributed to yield. Uptake of all the nutrients by leaf estimated was low in field no. 27 i.e. the experimental field which recorded the lowest yield.

INTRODUCTION

CHAPTER - I

INTRODUCTION

Among the cultivated crops, tobacco (*Nicotiana tabacum* L.) has not only a world wide distribution but also a great number of kinds or types with distinct genetic and botanical characteristics, cultural and handling requirements and elements of quality and use of the product. No other crop is more adaptable to such a range of climates, soils and cultural practices and none responds with such sensitivity to differences in ecological and cultural factors.

Tobacco belongs to the genus *Nicotiana* and the two species, *Nicotiana tabacum* L. and *Nicotiana rustica* L. are widely cultivated. Several distinct types have been developed within each of these two species. The most important ones derived from *Nicotiana tabacum* are: (1) cigar tobaccos, including wrapper, binder and filler ; (2) virginia, or flue-cured, (3) Burley; (4) Maryland ; (5) Dark fire - cured ; (6) Dark air - cured ; (7) Perique and (8) Aromatic or oriental.

Oriental tobaccos constitute a distinct type. Visually the plant is much smaller growing to a height of between 30 and 50 cm. These plants produce leaf sizes ranging from 4 to 15 cm, in length. The leaf is characterized as small, aromatic, flavourful, readily combustible and of good filling properties. Oriental tobaccos have low nicotine levels (0.8 - 2.0%), medium sugars

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(5-20%) and high particulate matter (35-45 mg per cigarette). The tobacco gives a mild smoke but has a very characteristic aroma. For this reason the class is referred to as aromatic.

The main growing areas of aromatic tobacco are Turkey, the Greece Balkans, Russia, Syria, Lebanon and Italy. It is grown in an area of 549071 hectares with a production of 702733 metric tonnes (USDA 1998). Oriental tobacco accounts for 10.26% and 11.7% of the total tobacco area and production of the world, respectively.

In the early days, all this tobacco was used for a straight oriental or "Turkish" cigarette and it was not until the beginning of the 20th century that oriental tobacco was used to make blended cigarettes. It is now in this form that most oriental tobacco is used throughout the world. Oriental tobacco possesses certain specific properties that give it the characteristics required for the American blended cigarette. These are derived from the concentration of oils and resins in the leaf that provide the distinct taste and aroma for which oriental tobacco is famous.

The oriental tobaccos comprise several groups within each of which the leaf is quite distinct, even though the source of seed may be the same. These differ in colour, texture, leaf size, kind and volume of aroma, flavour, combustibility, specific weight, nicotine content, content of nitrogenous substances, carbohydrate substances, other compounds and content of ash. These differences are causally related to edaphic and climatic factors such as

soil moisture, slope, available nutrients, elevation, prevailing winds, prevailing temperatures and relative humidity etc.

Exploratory trials on raising aromatic tobacco have been undertaken in the recent past in India, in the states of Andhra Pradesh, Karnataka, Tamilnadu and Westbengal. Adaptative trials are underway in a limited area in western parts of Chittoor District, Andhra Pradesh. The crop is raised utilising the residual moisture of North - East monsoon, without application of inorganic fertilizers. The information on the soil properties, leaf characteristics and climatic factors in the area is not documented. Also the information on the influence of soil properties and environmental parameters on leaf quality and yield of aromatic tobacco under Indian conditions is lacking.

In view, of the above, the present investigation has been taken up entitled "Evaluation of Multilocational Performance of Oriental tobacco in Chittoor district with special reference to nutrition, nicotine content and yield" by taking Izmir type of oriental tobacco. The objectives of investigation are as follows :

1. To study the effect of soil characteristics on nutrient uptake, nicotine content and yield of tobacco.
2. To correlate the soil characteristics and leaf composition with yield, nicotine content and reducing sugars etc.

**REVIEW
OF
LITERATURE**

CHAPTER - II

REVIEW OF LITERATURE

Tobacco has been subjected to more extensive chemical studies than has any other plant species. Multiplied thousands of reports involving such studies have been published in many different languages. In spite of these multitudinous reports, however, much remains to be done. Certainly the chemistry of tobacco offers an inviting field for research, whether the investigator is inclined towards either its pure or applied aspects.

The principal types of tobacco have been shown to be characteristically different in chemical composition. More appears to be known about the constituents for cigar tobaccos, burley tobaccos, and flue cured tobaccos than about tobaccos of the aromatic type. This situation is due largely to the fact that the use of oriental tobaccos in making blended cigarettes is a relatively recent occurrence. The chemical differences between types are partly attributed to genetic differences but mainly to environmental effects arising from differences in soil and climate, fertilizer practices, and methods of cultivation, harvesting, curing, storage, fermentation and aging. It is well established that when meteorologic and edaphic conditions are optimum, the quality of the crop among varieties of a given type is quite variable.

Oriental tobacco in India is of recent origin. Because of this reason, there is dearth of literature related to oriental tobacco soils, leaf chemical composition and quality. Hence, brief literature on soil properties of tobacco growing soils, leaf composition, leaf quality, influence of soils and climate on yield and quality and performance of different varieties of oriental tobacco in different areas of the world are reviewed.

In view of limited research conducted on IZMIR variety of oriental tobacco, the studies on other tobacco types are also included in the present review wherever they are felt necessary.

The literature pertaining to the objectives specified in the research problem under taken has been reviewed and is being presented under the following different headings for convenience and clarity.

- 2.1 PHYSICO-CHEMICAL CHARACTERISTICS AND NUTRIENT STATUS OF ORIENTAL TOBACCO SOILS.**
- 2.2 SOIL PROPERTIES OF CHITTOOR DISTRICT**
- 2.3 LEAF CHEMICAL COMPOSITION OF ORIENTAL TOBACCO.**
- 2.4 QUALITY OF ORIENTAL TOBACCO.**
- 2.5 EFFECT OF INORGANIC AND ORGANIC FERTILIZERS ON YIELD AND QUALITY OF ORIENTAL TOBACCO.**
- 2.6 STUDIES ON FLUE-CURED TOBACCO**

2.1. PHYSICO-CHEMICAL CHARACTERISTICS AND NUTRIENT STATUS OF ORIENTAL TOBACCO SOILS

One of the primary factors governing the growing of aromatic tobacco is type of soil, although in the cultivation of oriental tobacco, variety of soils has been used more or less successfully in different parts of the world.

Reddish soils of the western province of the union of the South Africa which contained about 30% clay are more suitable but good aromatic tobacco can be grown also on grey sandy loams (Stella, 1923).

Taylor (1924) reported that soils in southern Rhodesia where good aromatic tobaccos grown were sandy clay loams derived from granite or schist. The colour and combustibility of leaf grown on sandy soil derived entirely from granite were good but lacked body.

The soils of Greece, Turkey and Italy predominantly suited for oriental tobaccos are mountain soils of lithosolic group. The surface layers are thin or shallow, stony throughout and underlain with rock, and the productivity of soils is low. (Wolf, 1962).

The soils of Macedonian and Thracian area on which the best quality of oriental tobaccos are grown are upland forest soils (Brown, Red and

Yellow podsols) and Mediterranean dry forest soils. These podsollic soils generally are light textured and of low to medium productivity. The brown soils are high in calcium carbonate, granular, dark brown to reddish brown in colour, shallow and of medium productivity. The red and yellow podsols have a greyish surface layer but the clay subsoils are red or yellowish. They are acidic in reaction, low to medium in organic matter and productivity and of good soil structure. The soils of dry Mediterranean group range from very sandy to clay and are alkaline to slightly acidic. Some of them are developed from lime stone and all are shallow and low in humus (Wolf, 1962).

In the Aegean region, the "terra rossa" soils are predominant. But the best tobacco is grown on soils derived from schist. The soils are heavy, red, alkaline, low in organic matter and difficult to work when dry. Oriental tobacco is also grown in the Black sea region or bordering zone of upland brown forest soils. This zone is bagged by mountain soils of lithosolic group, on which tobaccos of excellent quality are being grown. These soils are very sticky when wet and very hard and cloddy when dry (Wolf, 1962).

Laterite soils, low in organic matter in Venezuela have been found suitable for the production of aromatic tobaccos (Wolf, 1962).

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Clay soils of piedmont region in United States are more suitable for aromatic tobacco than the sandy soils of the coastal plain region. Slow and uniform growth throughout the entire season requisite to the development of quality of the crop is promoted by clay soils whereas the plant tends to grow rapidly and the leaf tends to lack body and aroma when tobacco is grown on light sandy soils (Wolf, 1962).

Filiposki (1992) reported that pH values in the acidic range were more preferred for soils for production of oriental tobacco.

Colluvial soils with moderately acid reaction, low content of organic matter, nitrogen and phosphorus and medium content of potassium are typical soils of the regions in the FYROM wherein Prilep tobacco variety is produced. (Filiposki, 1993).

Soils of Radovis region on which high quality aromatic tobacco (Variety Yaka) produced are of light textured in nature with low humus content and high nitrogen supply. These soils are mainly acid in reaction and non-calcareous. Soils of this region have a low phosphorus and high potassium contents (Filiposki *et al.*, 1994).

Filiposki *et al.* (1995) investigated the soils used for oriental tobacco production in FYROM and indicated that the soils were characterised by acid reaction, low content of organic matter, medium to well supply of total N, medium supply of phosphorus and rich supply of potassium. According to the criteria all the soils were suitable for production of oriental aromatic tobacco varieties Prilep, Yaka and Dzebel.

Trajkoski (1995) found that Cinnamon forest soils in tobacco producing region of Prilep were low acid to low alkaline in reaction with good supply of phosphorus and potassium and were sandy clay to heavy clay. Humus content was highest in surface layer and generally decreased with depth.

2.2 SOIL PROPERTIES OF CHITTOOR DISTRICT

Ramamoorthy and Bajaj (1969) found that soils of Chittoor district were low in available nitrogen, low in available phosphorus and medium in available potassium status.

Ranganayakulu *et al.* (1986) reported that the texture of the soils of Chittoor district were gravelly, sandy loams and the colour ranged from red - reddish, yellow - yellowish, red - reddish brown and brown with good subsoil drainage. The soils are slightly acidic to neutral in reaction. The pH ranged from 5.3 to 8.5 with a mean of 6.6 ± 0.3 . All the soils were normal in salt

content and the electrical conductivity ranged from 0.02 to 0.22 m.mhos / cm with a mean of 0.67 ± 0.025 in m.mohs / cm.

The organic carbon content of the soil samples was very low ranging from 0.08 to 0.57% with a mean of $0.21 \pm 0.05\%$. The available P content is low to high, ranging from 3.0 to 34.0 kg P_2O_5 / ha with a mean of 16.2 ± 4.8 kg/ha. 28% of the samples were low and majority of the samples were medium in available P content. The available K content was low to medium and ranged from 45 to 230 kg / ha with a mean of 100 ± 11 kg K_2O / ha. About 81% of the samples were low in available K (Ranganayakulu *et al.*, 1986).

The free calcium carbonate is low, ranged from traces to 8.1% with a mean of $0.76 \pm 0.66\%$. Available Ca ranged from 0.8 to 19.3 me / 100 g of soil with a mean of 2.5 ± 0.8 me / 100 g of soil and available Mg from 0.4 to 9.4 me / 100g of soil with a mean of 2.5 ± 0.7 me / 100 g of soil (Ranganayakulu *et al.*, 1986).

The available Zinc content of soil is low to marginal and ranged from 0.3 to 1.8 ppm with a mean of 0.71 ± 0.16 ppm. The range of available Cu varied from 0.60 to 1.90 ppm with a mean of 1.23 ± 0.29 ppm, available Fe from 4.0 to 33.0 ppm with a mean of 11.5 ± 3.5 ppm and available Mn from

4.0 to 34.0 ppm with a mean value of 13.2 ± 4.1 ppm. (Ranganayakulu *et al.*, 1986).

2.3 LEAF CHEMICAL COMPOSITION OF ORIENTAL TOBACCO

Chemical composition differs among varieties, grades of the same and different varieties among primings among regions and seasons and also differs due to agronomic practices.

Chemical constituents like nitrogenous materials, carbohydrates, polyphenols and ash differ among different varieties (Vladescu and Dimofte, 1935).

Pyriki (1941) found that aromatic tobaccos grown in different region were strikingly different in chemical constituents such as nicotine, total nitrogen, ash, reducing substances, soluble carbohydrates, polyphenols, resins and waxes etc. It is opined that these differences among chemical constituents were entirely due to variations in soils and climate of different regions.

Akkoyunlu (1947) reported that the varieties of aromatic tobacco even though grown in same region were very distinct in composition from each other.

Darkis *et al.* (1947) reported that the chemical composition of tobacco varieties varied widely from grade to grade, from year to year within each region. It was assumed that soil differences, climate differences and varietal differences accounted for such variations.

Paucity of nitrogen in the top leaves is a consequence of the low level of soil fertility and of the withdrawal of nitrogenous materials from the youngest leaves to provide for the growth of the flowers, capsules and seed (Darkis *et al.*, 1947).

Shafix (1974) in a study on quality of Iraqi tobaccos (*Nicotiana tabacum*) found that chemical constituents like total nitrogen, proteins, resins and pH were 2.48%, 6.74%, 5.12% and 5.53 respectively.

Significant differences were found among 6 varieties of oriental tobacco (*Nicotiana tabacum* Linn.) with respect to chemical constituents like average total N (1.69 to 2.08%), protein (4.53 to 6.36%), protein nitrogen (0.72 to 1.02%) ash. (22.33 to 26.73%) and pH (5.36 to 5.75). These constituents showed an increasing trend with increase in stalk position from bottom to top. (Jalal Shafix and Farhad Kaream, 1983).

Mylonas (1984) in a field study with oriental Kabakulak (*Nicotiana tobacum* L.cv. Kabakulak-S₂) concluded that N and K concentrations in leaves showed a decreased trend during the 1st week after transplanting, then increased upto the 3rd or 4th week and again declined there after. P concentration in all plant parts decreased with time after transplanting. Calcium concentration in leaves increased from the 1st to 2nd or 3rd week after transplantation, then declined slowly upto the 8th week and remained constant till the end. Mg concentration in leaves increased from 1st to 4th week after transplantation and remained constant. He has also reported that conc. of N, K and Ca in leaves were similar and much higher than those of Mg and P.

Arsenault and Umesh Gupta (1986) in a field survey on tobacco grown in Prince Edward Island found that the average of five primings leaf tissue concentrations of Ca, Mg, Zn, Cu, Mn and Fe were 1.9%, 0.45%, 28 μgg^{-1} , 6.6 μgg^{-1} , 179 μgg^{-1} and 385 μgg^{-1} respectively. With respect to primings from 1 to 5, the values are 2.7, 2.1, 1.7, 1.5, 1.5% for Ca, 0.65, 0.51, 0.38, 0.37, 0.36% for Mg, 28, 26, 26, 29, 32 μgg^{-1} for Zn, 5.7, 5.0, 6.5, 6.9, 8.8 μgg^{-1} for Cu 256, 220, 167, 128, 124 μgg^{-1} for Mn and 916, 451, 51, 166 and 143 μgg^{-1} for Fe were recorded.

In oriental tobacco the conc. of N, P, K and Ca decreases during the growing season (Bush and Tso 1989).

Survey conducted by Drossopoulos *et al.* (1992) on selected nutrient levels at different leaf positions of oriental field grown tobacco indicated that the N concentration decreased consistently with leaf age. P concentrations were substantially lower for leaves located on the upper half of the plant. K, Ca and Mg concentrations were minimum at the lowest nodes and reached their maximum values between the 4th and 6th nodes. All micronutrients showed low values at the first nodes and reached their maximum concentrations at the 4th node. Fe concentrations were significantly lower for leaves expanding after the end of flowering. Mn concentrations were maximum at the highest nodes. Except N and P all other nutrients exhibited lower values for leaves expanding during flowering (From 70 to 98 DAT). When primings were considered, the variation among them was significant for all nutrients except for N, Zn and Cu.

Drossopoulos *et al.* (1997) found that the total leaf N concentration decreased progressively with increase in plant age. Total N conc. varied among lower nodes (1.6%, 1.9% and 1.8%) and upper nodes (5.5%, 6.3% and 6.1%) in young tobacco plants in the N₀, N₁ and N₂ treatments. While in older plants total N conc. were 1.9%, 2.1%, 2.2% and 3.4%, 3.3%, 3.2% for lower nodes and upper nodes in N₀ (No fertilization), N₁ (NH₄NO₃ @ 50 kg ha⁻¹) and N₂ (NH₄NO₃ @ 100 kg ha⁻¹) treatments respectively.

2.4 QUALITY OF ORIENTAL TOBACCO

It is well known that the strength of tobacco is dependent primarily upon its nicotine content. Aromatic tobaccos are low in nicotine and high in sugars, which are the quality characteristics directly related to quality.

Andreadis and Toole (1933) found that in several varieties of Xanthi oriental tobacco, the nicotine content differed in successive primings. The larger percentage of nicotine was found in the leaves borne near the mid region of stalk and lesser amounts of nicotine were accumulated in lower leaves and in the tips.

Nicotine content of 77% of Greek tobaccos ranged from 0.2% to 1.2% (Thassitis, 1954).

Sixty percent of the tobaccos grown in several locations in Turkey had nicotine content below 1%, while thirty six percent of tobaccos have 1 to 2% nicotine content and remaining four percent tobaccos had over 2% nicotine concentration (Aksu and Enercan, 1958).

Low nicotine contents (1.2 to 1.5%) were observed in tobaccos from Haskovo region, which is one of the most important oriental tobacco producing regions (Veselion, 1966).

A range of 1.52 - 1.77% nicotine content was found in 304 samples of samsun tobacco in the first three qualities (Zujkova and Baskin, 1966).

Iraqi tobaccos (*Nicotiana tabacum*) have nicotine content of 1.43% and total reducing substances of 11.94% (Shafix, 1974). Again a similar observation was made by Jalal Shafix and Farhad Kaream (1983) in six varieties of oriental tobaccos (*Nicotiana tabacum* Linn.) in which nicotine concentration and total reducing sugars ranged from 0.49 to 1.52% and 9.38 to 14.12% respectively.

The oriental tobacco variety Yubilei had nicotine content of 1.07%, protein content of 5.48 to 6.75% and carbohydrate content of 12.78% (Manolov *et al.*, 1982).

In the leaves of tobacco cv. Krumovgrad 840 and the standard cv. Krumovgrad 988 the nicotine concentration, protein, carbohydrates were 1.07%, 7.19%, 16.07% and 1.13%, 6.28% and 13.88% respectively (Manolov *et al.*, 1985).

Someswara Rao *et al.* (1986) carried out pilot studies on the possibility of growing aromatic tobacco in Chintapalli Tribal area of Visakhapatnam district in Andhra Pradesh. They reported that samsun had more nicotine

(1.46%), reducing sugars (12.68%) than symrna while this variety had nicotine (0.73) and considerably and unacceptably low level of reducing sugars (3.13) than standard Turkish tobaccos. They also indicated the possibility of growing aromatic tobacco in Andhra Pradesh, if need arises.

Oriental tobacco cv. Sistromos Gulsur harvested in two primings found to contain lower content of nicotine and higher content of sugars (Ahmad and Sale 1988).

Oriental tobacco leaf contains lower amounts of nitrogenous substances and higher quantities of carbohydrates and ether solubles. (Bush and Tso, 1989).

Among hybrids (J-90, J-92, P-199 and P-202) of oriental tobacco, the highest nicotine content was found in P-202 and lowest in J-92 while carbohydrate content was maximum in J-90 and minimum was found in P-199 (Popovic *et al.*, 1990).

The leaves of Kharmanli 43 has 1.9%, 7.71% and 14.07% nicotine, proteinnitrogen and soluble carbohydrates respectively (Yancheva and Iordanov, 1997).

2.5 EFFECT OF INORGANIC FERTILIZERS AND ORGANIC FERTILIZERS ON YIELD AND QUALITY

Darkis *et al.* (1947) showed that nitrogenous constituents and carbohydrate constituents were inversely correlated i.e, those tobaccos having the least nitrogenous constituents have the highest carbohydrate content and vice versa.

Application of micronutrients (B, Cu, Mo, Fe, Zn, Mn) individually as well as all elements combinedly increased their content in the leaf when compared with control i.e., no application. The chemical characters like reducing sugars and nicotine were not affected by any of the treatments (Bangarayya *et al.*, 1980).

Liguori *et al.* (1981) reported that increasing nitrogen level has increased the alkaloid and reduction in sugars for Xanthi and Perustiza oriental tobacco types.

The best quality of oriental tobacco was obtained by applying 30 kg N ha⁻¹ before transplanting (Lolas and Mylonas, 1982). In another study Mylonas and Nitzani (1984) suggested that 20 to 40 or 20 to 60 kg N ha⁻¹ depending on soil fertility were adequate for high yields of oriental tobacco.

Significant increase in total cured leaf as well as first grade yield was noticed with application of farm yard manure @ 10 t ha⁻¹ (Singh *et al.*, 1983).

In cigar-wrapper tobacco the total N concentration, protein N concentration and nicotine content were highly significant positively correlated with each other. The K conc. had a high significant negative correlation with nicotine content and significant negative correlation with percentage of protein N. High levels of nitrogenous constituents as well as K and low levels of P in leaves were found to be essential for good quality of leaf (Chaturvedi, 1987).

Jeong *et al.* (1988) reported that organic matter and total nitrogen contents in the soil were positively correlated with nicotine percent in cured leaf and negatively correlated with total sugar content.

Jordanov and Jancheva (1990) recommended application of more than 2 kg N / dka contributed considerably to increase the yield. Filiposki (1992) also made similar observation.

Krishnamurthy *et al.* (1991) observed that no variation in the whole leaf and total leaf yield of cigar tobacco due to different green manures.

Nitrogen has affected cured yield positively and chemical quality negatively. Phosphorus had positive effect on both chemical quality and cured yield but potassium showed a sporadic and weak effect, positive on cured yields and sugars in Xanthi oriental tobacco (Pasquale Greco and Filippo Piro, 1994).

Significantly higher cured leaf yield was observed with application of FYM at 5 t or 10 t ha⁻¹ compared to no FYM (CTRI, 1995-96).

Djukic and Simicevic (1995) have observed that fertilising oriental tobacco plants gave a higher yield than control.

Greco *et al.* (1996) found that the chemical characteristics of oriental tobacco leaves were poor when nitrogen was applied at 60 kg N ha⁻¹.

In six Turkish tobacco genotypes the cured leaf yield was negatively correlated with total alkaloid content (Kara and Esendal, 1996).

Patel *et al.* (1996) recorded increased yield with increased levels of farm yard manure.

Increased levels of nitrogen increased the plant fresh weight and dry weight (Drossopoulos *et al.*, 1997).

Fertilization of oriental tobacco with well decomposed organic fertilizers, at rates of 5-15 t/ha increased yield considerably as compared to the non-fertilized check, and with better results than with chemical fertilizers (Paunescu *et al.*, 1997).

2.6 STUDIES ON FLUE-CURED TOBACCO

In India flue-cured tobacco is grown mainly in the states of Karnataka and Andhra Pradesh. The soils of Karnataka (KLS) range from sands to loamy sands while in Andhra Pradesh the crop is grown in three types of soils. The heavy textured clayey soils (TBS), the light to medium textured red loams (SLS) and the light textured sands and sandy loams (NLS). Details of the soil characteristics of three zones are described here under.

2.6.1 Karnataka Light Soils (KLS)

2.6.1.1 Soil characteristics : These soils are reddish brown in colour derived from granites and gneisses. The soils are very deep, well drained sands and sandy loams. The surface soils contained as much as 70-80% sand, while the subsoil contained clay content which is as low as 6 to 7% and as high as 25 to 30%. Sand content is more in surface soil while silt and clay are more in sub soil.

The data on the fertility status also clearly indicated that these soils are the best suitable for the production of F.C. tobacco. These soils are of

medium acidity tending towards neutral range (pH 5.3 to 6.8), very low to negligible in soluble salts, low in organic carbon, medium in available phosphorus and medium to high in potash (Prasad Rao *et al.*, 1998).

2.6.1.2 Micronutrient status of soil and leaf : The data on available micronutrient composition of Karnataka soils revealed that they are in the range of sufficiency. Further there are no indications of deficiency in the field crop. Analysis of the leaf samples also confirmed that the crop is free from hidden hungers as the micronutrient concentration is much higher than the critical limit. Better root spread, deep rooted nature of the crop, ideal pH at which micronutrient availability would be optimum are probably favourable for the crop in meeting the requirements (Prasad Rao *et al.*, 1998).

2.6.2 Characteristics of flue - cured tobacco soils of Andhra Pradesh

Based on soil texture, the flue - cured tobacco growing pockets of different agro-climatic zones of Andhra Pradesh are classified into three categories viz.,

- (a) Traditional Black Soils (TBS),
- (b) Northern light soils (NLS) and
- (c) Southern light soils (SLS).

Details of the soil characteristics of the different types are described below :

2.6.2.1 Traditional Black Soils (TBS) : Black soils growing flue - cured tobacco in Andhra Pradesh are mostly distributed in Prakasam, Guntur, Krishna, Khammam and Godavari districts. All these soils in general are highly clayey (40-60% clay) throughout the profile, neutral to moderately alkaline in pH, low in organic matter and available nitrogen, low to medium in available phosphorus and high in Potash (Prasad Rao *et al.*, 1998).

2.6.2.2 Northern Light Soils (NLS) : Soils of West and East Godavari and Khammam districts fall in this category. They are sandy to sandy loam (about 70% sand) in texture, acidic in reaction and very low in fertility (Prasad Rao *et al.*, 1998).

2.6.2.3 Southern Light Soils (SLS) : The red soils of Prakasam and Nellore districts are derived from Schists and Old Alluvials. In their profile, clay content increases with depth. These soils are neutral to alkaline in pH, low in organic matter and available phosphorus and low to medium in Potash (Prasad Rao *et al.*, 1998).

2.6.2.4 Micronutrient Status of Soil and Leaf : The data revealed that the available micronutrient status of F.C. tobacco grown soils are in the range of sufficiency. Micronutrient content of leaf produced on these soils also supports these observations. Further neither symptoms of micronutrient

deficiency nor reports of their inadequacy have been recorded on FCV tobacco grown in any of these soil types.

As already mentioned, black soils and southern light soils, in general, are formed from alluvial deposits and are inherently fertile. Northern light soils, although coarse textured, receive both organic and inorganic sources of nutrients. It is probable that these factors are helpful in overcoming the deficiencies of micronutrients in tobacco crop grown in different types of soils of Andhra Pradesh (Prasad Rao *et al.*, 1998).

MATERIALS AND METHODS

CHAPTER - III

MATERIALS AND METHODS

A study on evaluation of multilocal performance of oriental tobacco was carried out during 1998-99 season in 40 farmers fields, spread over 5 mandals in western parts of Chittoor district, Andhra Pradesh. Composite soil samples were collected twice from all the 40 locations for estimation of physical, physico-chemical and chemical properties. Leaf samples were collected for estimation of chemical composition. Data on cured leaf yield were collected to fulfill the objectives of the investigation. The materials used and the methods adopted during the course of investigation are given below :

3.1 MATERIALS

3.1.1 Location

Field experiments were conducted at forty locations spread over five mandals of Western Parts of Chittoor district in association with ITC Limited, ILTD Division, Tirupati. Details of each location with respect to farmers name, village and mandal name are given in Appendix I.

3.1.2 Variety used

The test variety was IZMIR of oriental tobacco. It grows to a height of 80-100cm. producing 26 to 30 usable leaves of lemon yellow to reddish brown in colour of small size.

3.1.3 Season

Rabi 1998-99 (November 1998 to March 1999)

3.1.4 Spacing

35 x 15 cm

3.1.5 Collection and processing of soil samples

Only surface soil samples i.e., soil samples were collected from a depth of 0-15 cm by adopting quartering method. A total of 80 soil samples were collected i.e., 40 soil samples at the time of planting and the remaining 40 soil samples at 75 Days After Planting.

The soil samples were air dried in shade, powdered with wooden pestle and mortar and sieved through a 2 mm sieve. The samples were stored in polythene bags properly labelled for soil analysis.

3.1.6 Leaf sampling, processing and preparation of samples for analysis

Leaf sampling was done 4 times during the period of experimentation i.e., one at the time of planting and remaining three at three primings (Harvests) viz., at 1st, 3rd and 5th primings.

Care was taken to avoid diseased, insect attacked and abnormal leaves and the collected leaves were preserved in polythene bags during transport,

to the laboratory. The leaf samples were washed in the laboratory with tap water, distilled water, dil. HCl (8 ml/lit of water), distilled water. The washed samples were air dried for sometime in shade to exhaust the moisture content and finally dried in hot air oven at $60\pm 5^{\circ}\text{C}$. The dried samples were powdered and preserved in butter paper bags for chemical analysis.

3.2 METHODS OF SOIL ANALYSIS

3.2.1 Particle size distribution analysis

The soil samples were analysed for the content of sand, silt and clay fractions by Bouyoucos hydrometer method as described by Piper (1950), and texture of soil sample was determined by using soil textural triangle (Tamhane *et al.*, 1970).

3.2.2 Soil colour

Soil colour was determined by Munsell soil colour charts.

3.2.3 Soil Reaction

The pH of soils was determined in 1:2.5 soil water suspension (Jackson, 1967).

3.2.4 Electrical Conductivity (EC)

The electrical conductivity was determined in 1:2.5 soil water suspension by using the electrical conductivity bridge, Systronics 305 (Piper, 1950).

3.2.5 Available Nitrogen

The available nitrogen content of soils was estimated by alkaline permanganate method (Subbiah and Asija, 1956).

3.2.6 Available Phosphorus

The available phosphorus was estimated by Olsen's extractant (0.5 M sodium bicarbonate of pH 8.5) followed by the development of blue colour and the concentration was determined at 660 nm by Spectronic - 20 genesys (Olsen *et al.*, 1954).

3.2.7 Available Potassium

The available potassium was extracted with neutral normal ammonium acetate solution and the potassium content was determined using flame photometer systronics model 121 (Jackson, 1967).

3.2.8 Exchangeable calcium and magnesium

The exchangeable calcium and magnesium were extracted with neutral normal ammonium acetate and content of calcium and magnesium was determined volumetrically using EDTA Titration method (Vogel, 1978).

3.2.9 DTPA extractable micronutrients

The DTPA extractable micronutrients i.e., Fe, Mn, Cu and Zn in soil were estimated using 1:2 soil to extractant ratio (Lindsay and Norvell, 1978). The concentration of each nutrient was determined using Atomic Absorption Spectrophotometer (Model 170-0036, Hitachi, Japan) at an air pressure of 1.6 Kg/cm² using acetylene gas. The micronutrients were estimated at the following wavelengths and discharge current.

Element	Wavelength (nm)	Discharge current (mA)
Fe	248.3	10.0
Cu	274.5	7.5
Mn	324.8	10.0
Zn	213.8	10.0

3.2.10 Farm Yard Manure (FYM)

Chemical analysis revealed that FYM contains 0.53% N (Subbiah and Asija, 1957), 0.25% P₂O₅ (Jackson, 1967) and 0.55% K₂O (Jackson, 1967).

3.3 PLANT ANALYSIS

3.3.1 Wet digestion of foliar material

One gram of oven dry sample was digested with diacid mixture (Nitric acid and Perchloric acid in 10:4 ratio). The digested samples were diluted to a known volume (100 ml) with double distilled water and filtered through

Whatman No. 1 filter paper (Jackson, 1973). The filtrate was used for the estimation of P, K, Ca, Mg, Fe, Cu, Mn and Zn by adopting the standard procedures as mentioned below.

3.3.2 Total Nitrogen

The nitrogen content of plant samples was estimated by microkjeldahl method (AOAC, 1970).

3.3.3 Total Phosphorus

The phosphorus content was determined by Vanadomolybdo phosphoric acid yellow colour method. The colour intensity was measured at 470 nm in Spectronic 20 genesys (Jackson, 1967).

3.3.4 Total Potassium

The concentration of potassium in the diacid extract was determined using the flame photometer (Jackson, 1967).

3.3.5 Total calcium and magnesium

The calcium and magnesium contents of leaf sample were estimated by titrating the diacid extract with 0.01 N EDTA (Vogel, 1978).

3.3.6 *Micronutrients*

The diacid extract of leaf samples was fed to Atomic Absorption Spectrophotometer and the concentrations of Fe, Mn, Cu and Zn were estimated (Vogel, 1978).

3.4 LEAF QUALITY ANALYSIS

3.4.1 *Nicotine*

Nicotine in tobacco leaf samples was analysed by the method of Cundiff and Markunas (1955).

Reagents

1. Benzene - chloroform solution in 9:1 ratio.
2. **Crystal violet indicator**

1 gm of crystal violet was dissolved in 100 mL of glacial acetic acid.

3. 0.025 N perchloric acid solution. 2.1 ml of 72% perchloric acid was diluted to 1 litre with glacial acetic acid and standardised as follows:

0.1 g of potassium hydrogen phthalate was weighed into a 125 ml Erlenmeyer flask and 50 ml of glacial acetic acid was added and heated to dissolve, cooled and 2 drops of crystal violet indicator was added and titrated with 0.025 N Perchloric acid solution to blue green end point. Blank titration was performed on 50 ml of glacial acetic acid and 2 drops indicator solution and the volume of titrant was corrected.

$$N = \frac{\text{Weight of KH phthalate} \times 4.897}{\text{ml of HClO}_4}$$

Procedure

1.5 g of finely ground tobacco was weighed into a 250 ml glass stoppered Erlenmeyer flask and one gram of granular barium hydroxide and 7.5 ml of saturated barium hydroxide solution were added. The contents were mixed thoroughly until the tobacco was wetted, adding more barium hydroxide solution, if necessary. 50 ml of benzene: chloroform solution (1:1) was pipetted out into the flask from an automatic dispenser and stoppered tightly. The contents were stirred vigorously for 15 min using a shaking machine. The two liquid phases were allowed to separate and the majority of the hydrocarbon layer was filtered through Whatman No. 2 filter paper into a second flask 25 ml aliquot of the filtrate was pipetted into a 125 ml Erlenmeyer flask, one drop of crystal violet indicator was added to titrate with 0.025 N perchloric acid solution to a green end point.

$$\% \text{ Total alkaloids (as Nicotine)} = \frac{V \times N \times 16.23}{\text{Weight of sample (Moisture free basis)}}$$

Where V = ml. of perchloric acid required to neutralise the aliquot.

N = Normality of perchloric acid solution.

3.4.2 Chlorides

Chlorides in tobacco leaf were determined by the electrometric titration method of Murty *et al.* (1962).

Principle

In this method a silver wire, coated with silver chloride, dips into the unknown suspension and is connected to quinhydrone half cell by means of an agar, potassium nitrate bridge. At the end point in the titration of a chloride solution with silver nitrate, the chloride ion concentration is 1.0×10^{-5} at 25°C and the theoretical potential of a silver-silver chloride electrode in this solution would be -0.521 volts. If this electrode is connected with a quinhydrone reference half cell giving a steady potential of 0.521 volts, the combination will have zero potential at the end of the titration. A quinhydrone, half cell made from a buffer solution of pH 3.2 meets these requirements at a temperature of 25°C. The agar connection is made with potassium nitrate to prevent diffusion of chloride ions into the quinhydrone half cell and sulphuric acid is used in making the phthalate buffer of pH 3.2.

The end point is denoted by the reversal of the direction of the current for the silver - silver chloride electrode is negative in respect to the quinhydrone electrode, so long as free chloride ions remain in solution. As the titration proceeds, silver nitrate is added. The potential difference

decreased until at the theoretical end point, it is zero. Further, addition of silver nitrate solution causes the silver - silver chloride electrode to become the positive pole, so that a reversal of current occurs at this point. With a suitable galvanometer in circuit this reversal of direction can be easily detected in one drop of N/35.5 silver nitrate.

Reagents

1. **Buffer solution (pH 3.2)** : 10.21 g of acid potassium phthalate was dissolved in water and 148 ml of 0.1 N H_2SO_4 was added and diluted to 1 litre.
2. Quinhydrone
3. N / 35.5 silver nitrate - 4.792 g of AgNO_3 was dissolved in water and diluted to 1 litre.

Preparation of Agar - Agar Potassium nitrate bridges :

8 g of Agar - Agar was soaked in 200 ml water and heated in an autoclave for half an hour at a pressure of 0.75 atmospheres. Then 51 g of KNO_3 was added. The moisture was kept hot in water bath and several suitably shaped glass tubes (about 5 mm bore) were filled by siphoning the warm jelly into them. Clean and dry tubes were used to avoid the formation of a mobile film of moisture between the wall of the tube that may act as a siphon.

When not in use, the tubes were kept in a wide mouthed stoppered bottle containing a saturated solution of potassium nitrate.

Procedure :

The buffer solution was poured into the quinhydrone half-cell or electrode vessel and a pinch of quinhydrone was added by means of a spatula and shaken well. It was arranged in such a way that there were not air bubbles in the quinhydrone half cell after the immersion of the platinum electrode into the same. Connections were made with the galvanometer.

1 g of tobacco leaf powder was weighed, into 250 ml beaker and about 50 ml distilled water and 2 ml of normal sulphuric acid were added. The contents were shaken well and titrated against AgNO_3 . At the end point the needle of the galvanometer should not show any deflection. The percent chlorides were calculated using the factor.

$$1 \text{ ml of N / } 35.5 \text{ AgNO}_3 = 1 \text{ mg of Cl.}$$

3.4.3 Reducing Sugars

The method given by Harvey *et al.* (1969) was adopted for estimating the reducing sugars.

3.4.4 Cured Leaf Yield

The cured leaf yield of each location was recorded and calculated in terms of Kg/ha.

3.5 STATISTICAL ANALYSIS

The data was analysed statistically by adopting the simple correlations to find out the extent of relationship between soil characteristics, leaf composition and quality parameters. The Multiple Linear Regression Analysis was used to fit the prediction equations and to find out the extent of contribution of independent variables. on the dependent variable. Completely Randomised Design with unequal number of replications was used (ANOVA-I way). Significance was tested by 'F' value at 1% and at 5% probability level. By using Co-variance Technique and by taking one property (soil nitrogen as concomitant variable), the real effect of locations on quality parameters like yield, nicotine, leaf nitrogen, reducing sugars and chlorides were studied (George *et al.*, 1967).

RESULTS

CHAPTER - IV

RESULTS

Data on physical characteristics, physico-chemical characteristics and nutrient status of soils, chemical composition and quality parameters of leaf, nutrient uptake and cured leaf yields of oriental tobacco raised in forty locations (Experimental fields) are presented in this chapter. Results of the correlations between soil nutrient status, leaf chemical composition, leaf quality and yield and regression equations on yield and nicotine concentration with soil nutrient status are also included in this chapter. Finally, the analysis of data on the performance (yield and quality) of oriental tobacco in different mandals are presented.

4.1 PHYSICAL CHARACTERISTICS OF SOILS

The data pertaining to physical characteristics of soil samples are presented in Table 1, Table 2 and Table 3.

4.1.1 *Soil Colour*

Data presented in Table 1 revealed that most of the soils are either brown or yellowish brown in colour.

4.1.2 *Soil Texture*

Data on particle size analysis of the composite soil samples collected from the forty experimental fields are presented in Table 2. Mean, SD and

Cv of different particles size fractions pertaining to the five mandals are presented in Table 3.

Soil texture of the experimental fields varied from sandy loams to sandy clay loams. 70% of the experimental fields had sandy loam texture and the rest had sandy clay loam texture. Sand fraction ranged from 50.24 to 74.82% with a mean of 62.04%, silt fraction varied from 14.6 to 30.98% with a mean of 22.27% and clay fraction ranged from 8.19 to 24.79% with a mean of 15.68% (Table 2).

All the experimental fields in Gyarampalli and Rompicherla mandals are sandy loams, where as 80% of the experimental fields in Madanapalli mandal and 37% of the experimental fields in Kallur and Gandaboinapalli mandals are sandy clay loams (Table 3).

The textural classes indicate that the experimental fields in Gyarampalli and Rompicherla mandals are more coarser than the fields in other mandals. This can also be seen from the fact that clay content of Gyarampalli and Rompicherla mandals ranged from 8.19 to 13.85% where as clay content in the other three mandals ranged from 10.25 to 24.79%. Mean values of sand are 66.15%, 68.50%, 64.01%, 55.87% and 5.98% in Gyarampalli, Rompicherla, Kallur, Gandaboinapalli and Madanapalli mandals respectively.

Table 1 : Soil colour data on soil samples of experimental fields

Sl.No.	Field No.	Soil Color
1.	1	5YR 4/6 Yellowish red
2.	2.	10YR 5/4 Yellowish brown
3.	3	7.5 YR 5/4 Brown
4.	4	7.5 YR 5/6 Strong brown
5.	5	7.5 YR 5/6 Strong brown
6.	6	7.5 YR 4/4 Dark brown
7.	7.	10 YR 6/4 Light yellowish brown
8.	8	7.5 YR 4/6 Strong brown
9.	9	10 YR 4/3 Dark brown
10.	10	5 YR 4/6 Yellowish red
11.	11	10 YR 5/3 Brown
12.	12	10 YR 5/4 Yellowish brown
13.	13	5 YR 5/6 Yellowish red
14.	14	7.5 YR 6/4 Light brown
15.	15	7.5 YR 5/4 Brown
16.	16	10 YR 4/3 Brown
17.	17	2.5 YR 3/6 Dark red
18.	18	10 YR 6/4 Light yellowish brown
19.	19	7.5 YR 5/6 Strong brown
20.	20	7.5 YR 3/4 Dark brown
21.	21	7.5 YR 6/4 Light brown
22.	22	7.5 YR 5/4 Brown
23.	23	10 YR 4./4 Dark yellowish brown
24.	24	10 YR 6/4 Light yellowish brown
25.	25	7.5 YR 4/4 Dark brown

26.	26	10 YR 5/6 Yellowish brown
27.	27	7.5 YR 5/4 Brown
28.	28	10 YR 5/8 Yellowish brown
29.	29	5 YR 4/6 Yellowish red
30.	30	5 YR 4/6 Yellowish red
31.	31	10 YR 4/4 Dark yellowish brown
32.	32	10 YR 5/6 Yellowish brown
33.	33	10 YR 4/4 Dark yellowish brown
34.	34	10 YR 5/4 Yellowish brown
35.	35	10 YR 3/4 Dark yellowish brown
36.	36	7.5 YR 5/2 Brown
37.	37	10 YR 5/4 Yellowish brown
38.	38	10 YR 7/3 Very pale brown
39.	39	10 YR 5/6 Yellowish brown
40.	40	10 YR 5/4 Yellowish brown

Table 2 : Mechanical composition of soils

Sl. No.	Field No.	Sand (%)	Silt (%)	Clay (%)	Texture
1	1	64.25	25.29	10.46	Sandy loam
2	2	67.14	24.67	8.19	Sandy loam
3	3	66.15	23.45	10.40	Sandy loam
4	4	70.12	18.29	11.59	Sandy loam
5	5	63.04	27.20	9.76	Sandy loam
6	6	68.14	19.28	12.58	Sandy loam
7	7	67.25	22.50	10.25	Sandy loam
8	8	65.50	21.00	13.50	Sandy loam
9	9	63.78	23.99	12.23	Sandy loam
10	10	70.25	19.60	10.15	Sandy loam
11	11	69.54	19.29	11.17	Sandy loam
12	12	66.25	24.30	9.45	Sandy loam
13	13	72.17	17.72	10.11	Sandy loam
14	14	71.89	18.33	9.78	Sandy loam
15	15	65.25	22.44	12.31	Sandy loam
16	16	64.16	21.99	13.85	Sandy loam
17	17	70.26	19.33	10.41	Sandy loam
18	18	74.82	14.93	10.25	Sandy loam
19	19	73.14	14.60	12.26	Sandy loam
20	20	63.72	25.78	10.50	Sandy loam
21	21	54.41	22.47	23.12	Sandy Clay loam
22	22	55.58	23.21	21.21	Sandy Clay loam
23	23	58.21	20.16	21.63	Sandy Clay loam
24	24	61.94	19.24	18.82	Sandy loam
25	25	60.28	20.59	19.13	Sandy loam

26	26	52.55	29.46	17.99	Sandy loam
27	27	51.72	27.40	20.88	Sandy Clay loam
28	28	50.24	30.98	18.78	Loam
29	29	55.56	24.26	20.18	Sandy Clay loam
30	30	62.19	19.17	18.64	Sandy loam
31	31	52.17	23.04	24.79	Sandy Clay loam
32	32	53.89	22.73	23.38	Sandy Clay loam
33	33	62.11	19.42	18.47	Sandy loam
34	34	58.74	23.17	18.09	Sandy loam
35	35	55.20	25.12	19.68	Sandy loam
36	36	50.53	27.23	22.24	Sandy Clay loam
37	37	53.45	26.18	20.37	Sandy Clay loam
38	38	61.49	19.94	18.57	Sandy loam
39	39	60.17	19.76	20.07	Sandy Clay loam
40	40	54.26	23.84	21.90	Sandy Clay loam
	Mean	62.04	22.27	15.68	
	SD	6.97	3.65	5.07	
	CV (%)	11.23	16.38	32.34	
	Min.	50.24	14.60	8.19	
	Max.	74.82	30.98	24.79	

Table 3 : Mandal wise data on mean, SD, CV, min. and max. physical characteristics of soils.

Sl. No.	Mandal Name	Sand (%)	Silt (%)	Clay (%)
1.	Gyarampalli			
	Mean	66.15	22.85	10.10
	SD	2.27	2.89	1.63
	CV%	3.43	12.66	14.82
	Min:	63.04	18.29	8.19
	Max:	70.12	27.20	13.50
2.	Rompicherla			
	Mean	68.50	20.47	10.94
	SD	3.25	2.45	1.60
	CV%	4.75	11.97	14.54
	Min:	64.16	17.72	9.45
	Max:	72.17	24.30	13.85
3.	Kallur			
	Mean	64.01	19.97	16.03
	SD	7.93	3.87	5.68
	CV%	12.39	19.47	35.46
	Min:	54.41	14.60	10.25
	Max:	74.82	25.78	23.12
4.	Gandboinapalli			
	Mean	55.87	24.12	20.00
	SD	4.29	3.89	2.22
	CV%	7.69	16.08	11.11
	Min:	50.24	19.17	17.99
	Max:	62.19	30.98	24.79
5.	Madanapalli			
	Mean	55.98	23.39	20.64
	SD	4.66	3.46	1.49
	CV%	8.33	14.78	7.23
	Min:	50.53	19.76	18.57
	Max:	61.49	27.23	22.24

The mean silt content in the above respective mandals are 22.85%, 20.47%, 19.97%, 24.12% and 23.39% (Table 3).

4.2 PHYSICO CHEMICAL CHARACTERISTICS OF SOILS

Data on pH and EC of the composite soil samples and mean, SD and Cv of pH and EC of soil samples pertaining to five mandals are presented in Table 4 and 5 respectively.

4.2.1 Soil Reaction (pH)

Soil pH ranged from slightly acidic to moderately alkaline. 35% of them are slightly acidic, 15% of them are medium acidic, 30% are neutral, 15% of them are mildly alkaline and only 5% of soil samples are moderately alkaline. The pH values ranged from 5.8 to 7.9 with a mean of 6.75. Highest pH (7.9) was recorded in field no. 32 and field no. 40 while lowest (5.8) was in field no. 5 and field no. 13.

Sixty six percent of soils in Gyarampalli mandal and 86% in Rompicherla mandal are slightly acidic in reaction. About 38% of soil samples in Kallur mandal are found to be slightly acidic and another 38% samples are neutral in reaction. Around 82% of soils are neutral in Gandaboinapalli mandal where as 80% soils are mildly alkaline in Madanapalli mandal.

The pH in Gyarampalli, Rompicherla and Kallur mandals ranged from 5.8 to 6.4, 5.8 to 6.5 and 5.9 to 7.7 with mean values of 6.09, 6.21 and 6.71 respectively, while it is ranged from 6.8 to 7.9, 7.6 to 7.9 with mean values of 7.21 and 7.76 respectively in Gandaboinapalli and Madanapalli mandals.

4.2.2 *Electrical Conductivity (EC)*

All the soils of experimental fields are non-saline in nature as they had an EC less than 2 dsm^{-1} i.e normal. EC ranged from 0.14 to 0.35 dsm^{-1} with mean of 0.22 dsm^{-1} . Highest EC (0.35 dsm^{-1}) was recorded in field no. 22 while least (0.14 dsm^{-1}) was found in field no. 14.

4.3 MAJOR NUTRIENT (N, P & K) CONTENT OF SOILS

The data pertaining to primary nutrient status (N, P & K) of experimental fields are presented in Table 6 and Mean, SD and Cv of N, P and K contents are presented in Table 7.

4.3.1 *Available Nitrogen Content of Soils*

Without any exception all the soils are found to have low nitrogen content (ranged from 141.12 to 245.56 kg/ha) with a mean value of 206.12 kg /ha. Highest (245.56 kg/ha) and lowest (141.12 kg/ha) nitrogen contents are found in field no. 10 and field no. 7.

Table 4 : Physico chemical characteristics of soils

Sl.No.	Field No.	pH	EC (dsm ⁻¹)
1.	1	6.1	0.18
2.	2.	5.9	0.15
3.	3	6.0	0.19
4.	4	6.2	0.20
5.	5	5.8	0.16
6.	6	6.4	0.17
7.	7.	6.0	0.15
8.	8	6.1	0.20
9.	9	6.2	0.18
10.	10	6.2	0.20
11.	11	6.1	0.19
12.	12	6.3	0.21
13.	13	5.8	0.20
14.	14	6.2	0.14
15.	15	6.5	0.20
16.	16	6.4	0.20
17.	17	6.3	0.18
8.	18	6.2	0.24
19.	19	6.1	0.19
20.	20	5.9	0.20
21.	21	7.7	0.26
22.	22	7.3	0.35
23.	23	7.3	0.32
24.	24	6.9	0.19
25.	25	7.0	0.20

26.	26	6.8	0.30
27.	27	7.3	0.18
28.	28	6.9	0.20
29.	29	7.3	0.28
30.	30	7.1	0.19
31.	31	7.8	0.23
32.	32	7.9	0.27
33.	33	6.9	0.23
34.	34	7.0	0.34
35.	35	7.3	0.27
36.	36	7.8	0.30
37.	37	7.7	0.28
38.	38	7.6	0.25
39.	39	7.8	0.29
40.	40	7.9	0.23
	Mean	6.75	0.22
	SD	0.69	5.34
	CV (%)	10.23	24.01
	Min.	5.8	0.14
	Max.	7.9	0.35

Table 5 : Mandal wise data on mean, SD, CV, min. and max. Physico-chemical characteristics of soils.

Sl. No.	Mandal Name	pH	EC (dsm⁻¹)
1.	Gyarampalli		
	Mean	6.08	0.18
	SD	0.18	1.94
	CV%	2.94	11.07
	Min:	5.8	0.15
	Max:	6.4	0.20
2.	Rompicherla		
	Mean	6.21	0.19
	SD	0.23	2.34
	CV%	3.65	12.22
	Min:	5.8	0.14
	Max:	6.5	0.21
3.	Kallur		
	Mean	6.71	0.24
	SD	0.67	6.45
	CV%	10.02	26.72
	Min:	5.9	0.18
	Max:	7.7	0.35
4.	Gandboinapalli		
	Mean	7.21	0.24
	SD	0.36	0.05
	CV%	5.02	20.96
	Min:	6.8	0.18
	Max:	7.9	0.34
5.	Madanapalli		
	Mean	7.76	0.27
	SD	0.11	2.92
	CV%	1.47	10.80
	Min:	7.6	0.23
	Max:	7.9	0.30

Soils of Gyarampalli mandal contained relatively lower N contents than the soils of other mandals. The nitrogen content ranged from 141.12 to 230.36 kg/ha, 156.48 to 245.56 kg/ha, 200.44 to 220.22 kg/ha, 190.52 to 235.18 kg/ha and 210.62 to 235.20 kg/ha in Gyarampalli, Rompicherla, Kallur, Gandaboinapalli and Madanapalli mandals respectively. Similarly the mean values of N in above mandals are 189.23 kg/ha, 204.38 kg/ha, 211.42 kg/ha, 208.76 kg/ha and 224.69 kg/ha respectively. Relatively higher variations in soil N were observed in Gyarampalli (cv of 15.3%) and Rompicherla mandals (14.62%).

4.3.2 Available Phosphorus Content of Soils

Data on available phosphorus content of soils indicate that 72.5% of soils are found to be medium in P content while the remaining 27.5% soil samples are low in available P status. P content ranged from 8.02 to 18.90 kg/ha with mean value of 11.42 kg/ha (Table 6).

All the soils (Experimental fields) of Gyarampalli and Rompicherla mandals, 75% of soils in Kallur mandal, 45% of soils in Gandaboinapalli mandal and 40% samples in Madanapalli mandal are medium in available P content.

Compared to other mandals, soils of Gandaboinapalli and Madanapalli mandals had relatively lower available P contents with mean values of 9.37 kg/ha and 9.58 kg/ha. P content in Gyarampalli, Rompicherla and Kallur mandals ranged from 10.21 to 16.72 kg/ha, 10.24 to 18.90 kg/ha and 8.32 to 13.40 kg/ha with mean values of 12.92 kg/ha, 14.56 kg/ha and 10.93 kg/ha respectively.

4.3.3 Available Potassium Content of Experimental Fields

Data in Table 6 show that all the soil samples from experimental fields found to be medium in available Potassium content with a mean value of 194.95 kg/ha. Soils of field no. 6 has recorded the highest K content and the lowest was found in soils of field no. 36.

Soils of Gandaboinapalli mandal registered lower mean values for Potassium (178.89 kg/ha) compared to remaining mandals. The K content ranged from 128.52 to 260.64 kg/ha, 160.16 to 260.20 kg/ha, 150.68 to 260.46 kg/ha, 125.44 to 255.48 kg/ha and 114.24 to 255.48 kg/ha in Gyarampalli, Rompicherla, Kallur, Gandaboinapalli and Madanapalli mandals with mean values of 196.57 kg/ha, 213.87 kg/ha, 200.39 kg/ha, 178.89 kg/ha and 192.16 kg/ha respectively (Table 7).

Table 6 : Major nutrient status of soils

Sl. No.	Field No.	N (Kg/ha)	P (Kg/ha)	K (Kg/ha)
1.	1	172.48	15.23	179.20
2.	2.	180.12	16.72	200.50
3.	3	210.24	11.02	240.24
4.	4	230.36	15.25	194.12
5.	5	162.44	16.24	128.52
6.	6	180.88	10.48	260.64
7.	7.	141.12	10.21	215.04
8.	8	215.18	10.75	208.64
9.	9	210.24	10.40	142.24
10.	10	245.56	15.23	260.20
11.	11	194.36	13.56	210.54
12.	12	188.16	15.68	194.88
13.	13	210.42	10.24	254.60
14.	14	156.32	12.42	245.80
15.	15	200.48	18.90	160.16
16.	16	235.20	15.88	170.88
17.	17	210.88	12.09	219.52
18.	18	216.24	10.75	260.46
19.	19	210.38	12.24	240.48
20.	20	200.44	10.22	170.24
21.	21	212.32	8.32	165.26
22.	22	220.18	13.40	150.68
23.	23	220.22	9.78	180.34
24.	24	200.68	10.62	216.16
25.	25	190.52	8.20	197.44

26.	26	195.68	10.75	150.22
27.	27	190.78	8.12	142.24
28.	28	198.22	10.22	125.44
29.	29	220.16	8.75	160.52
30.	30	190.98	10.52	255.48
31.	31	219.52	8.10	152.32
32.	32	220.28	9.82	170.16
33.	33	210.84	10.16	240.42
34.	34	235.18	10.42	190.72
35.	35	224.24	8.02	182.88
36.	36	235.20	9.40	114.24
37.	37	210.62	8.36	170.18
38.	38	225.28	11.22	255.48
39.	39	221.88	10.48	240.52
40.	40	230.48	8.45	180.36
	Mean	206.12	11.42	194.95
	SD	22.66	2.78	42.41
	CV (%)	10.99	24.37	21.76
	Min.	141.12	8.02	114.24
	Max.	245.56	18.90	260.64

Table 7 : Mandal wise data on mean, SD, CV, min. and max. major nutrient status of soils

Sl. No.	Mandal Name	N (Kg/ha)	P (Kg/ha)	K (Kg/ha)
1.	Gyarampalli			
	Mean	189.23	12.92	196.57
	SD	28.97	2.83	42.43
	CV%	15.31	21.92	21.59
	Min:	141.12	10.21	128.52
	Max:	230.36	16.72	260.64
2.	Rompicherla			
	Mean	204.38	14.6	213.87
	SD	29.90	2.78	40.68
	CV%	14.62	19.13	19.02
	Min:	156.48	10.24	160.16
	Max:	245.56	18.90	260.20
3.	Kallur			
	Mean	211.42	10.93	200.39
	SD	7.70	1.60	39.36
	CV%	3.64	14.65	19.64
	Min:	200.44	8.32	150.68
	Max:	220.22	13.40	260.46
4.	Gandaboinapalli			
	Mean	208.76	9.37	178.89
	SD	16.05	1.12	40.37
	CV%	7.69	11.99	22.56
	Min:	190.52	8.02	125.44
	Max:	235.18	10.75	255.48
5.	Madanapalli			
	Mean	224.69	9.58	192.16
	SD	9.36	1.25	57.10
	CV%	4.16	13.09	29.72
	Min:	210.62	8.36	114.24
	Max:	235.20	11.22	255.48

4.4 SECONDARY NUTRIENT (Ca & Mg) STATUS OF SOILS

The data pertaining to exchangeable Calcium and exchangeable Magnesium status of soils are presented in Table 8. Mandal wise data on mean, SD and Cv of soils are presented in Table 9.

4.4.1 *Exchangeable Calcium Content of Soils*

The exchangeable Ca status ranged from 12.20 to 25.50 me/100 g of soil with a mean value of 18.33 me/100 g of soil. Highest Ca content (25.50 me/100 g of soils) was found in field no. 18 and the lowest (12.20 me/100 g of soil) was recorded in field no. 37 (Table 8).

The soils of Gyarampalli, Kallur and Rompicherla mandals have relatively more calcium contents compared to Gandaboinapalli and Madanapalli mandals. The Ca content ranged from 16.21 to 25.50, 16.75 to 22.21, 12.23 to 25.50, 12.34 to 20.50 and 12.20 to 19.25 me/100 g of soil in Gyarampalli, Rompicherla, Kallur, Gandaboinapalli and Madanapalli mandals respectively.

4.4.2 *Exchangeable Magnesium Content of Soils*

Exchangeable Mg content ranged from 5.25 to 8.91 me/100 g of soil. The mean value was found to be 7.21 me/100 g of soil. Maximum Mg content was recorded in field no. 8 while field no. 33 exhibited the lowest.

Table 8 : Secondary nutrient status of soils

Sl. No.	Field No.	Exchangeable Ca (me/ 100 gm)	Exchangeable Mg (me / 100 gm)
1.	1	17.20	7.83
2.	2.	18.17	7.52
3.	3	19.25	8.01
4.	4	24.15	8.44
5.	5	17.77	7.63
6.	6	16.21	7.82
7.	7.	21.25	7.15
8.	8	20.02	8.91
9.	9	25.50	8.54
10.	10	22.21	8.26
11.	11	16.75	6.90
12.	12	18.85	7.32
13.	13	17.50	7.45
14.	14	19.73	7.89
15.	15	21.62	8.35
16.	16	17.21	6.98
17.	17	20.57	8.21
18.	18	25.50	8.72
19.	19	23.25	8.64
20.	20	21.21	8.43
21.	21	14.21	6.20
22.	22	20.58	7.89
23.	23	21.20	7.25
24.	24	12.23	6.58
25.	25	15.30	6.70

26.	26	20.25	6.21
27.	27	13.21	5.78
28.	28	12.34	6.12
29.	29	18.74	6.13
30.	30	13.21	5.92
31.	31	14.21	5.98
32.	32	18.20	6.94
33.	33	13.75	5.25
34.	34	20.50	7.79
35.	35	19.85	7.21
36.	36	19.25	7.02
37.	37	12.20	5.43
38.	38	17.40	6.20
39.	39	14.25	6.21
40.	40	18.20	6.55
	Mean	18.33	7.21
	SD	3.56	0.99
	CV (%)	19.44	13.76
	Min.	12.20	5.25
	Max.	25.50	8.91

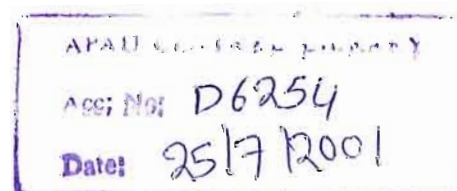


Table 9 : Mandal wise, data on mean, SD, CV, min. and max. secondary nutrient status of soils

Sl. No.	Mandal Name	Exchangeable Ca (me / 100 gm)	Exchangeable Mg (me / 100 gm)
1.	Gyarampalli		
	Mean	19.95	7.98
	SD	3.16	0.55
	CV%	15.86	6.95
	Min:	16.21	7.15
	Max:	25.5	8.91
2.	Rompicherla		
	Mean	19.12	7.59
	SD	2.16	0.59
	CV%	11.32	7.71
	Min:	16.75	6.90
	Max:	22.21	8.35
3.	Kallur		
	Mean	19.84	7.74
	SD	4.44	0.96
	CV%	22.38	12.40
	Min:	12.23	6.20
	Max:	25.50	8.72
4.	Gandaboinapalli		
	Mean	16-32	6.37
	SD	3.19	0.73
	CV%	19.57	11.39
	Min:	12.34	5.25
	Max:	20.50	7.79
5.	Madanapalli		
	Mean	16.26	6.28
	SD	2.94	0.58
	CV%	18.07	9.26
	Min:	12.20	5.43
	Max:	19.25	7.02

The trend of exchangeable magnesium is similar to exchangeable calcium where in higher mean values of Mg were found in Gyarampalli, Kallur and Rompicherla mandals than Gandaboinapalli and Madanapalli mandals. Compared to remaining mandals, high percentage of variation (Cv of 12.40%) in Mg content is found in Kallur mandal.

4.5 MICRO NUTRIENT (Fe, Mn, Zn, Cu AND Cl) STATUS OF SOILS

Data related to Fe, Mn, Zn, Cu and Chloride contents of soil samples are presented in Table 10 and the mandal wise data on mean, SD and Cv of soils are presented in Table 11.

4.5.1 Available Iron Content of Soils

The Fe content of the soils in all experimental fields was found to be above the critical limit of 4.5 ppm (Lindsay and Norwell, 1969). It ranged from 8.10 to 12.84 ppm with a mean value of 10.05 ppm. Minimum Fe content (8.10 ppm) was recorded in soils of Field No. 38 while maximum was found in soils of Field No. 7.

Gyarampalli and Rompicherla mandals recorded relatively higher mean values of 11.24 ppm and 10.65 ppm respectively compared to the mean values of 9.57, 9.27 and 9.52 ppm in Kallur, Gandaboinapalli and Madanapalli mandals.

4.5.2 Available Mn Content of Soils

With regard to Manganese 50% of the soils in experimental fields has Manganese content above the critical limit of 10.0 ppm while the remaining 50% of soils contained lower Mn content than its threshold level. Mn content ranged from 8.15 to 12.85 ppm with mean value of 10.24 ppm. Highest Mn content was observed in soils of field no. 14 and the lowest was found in soils of field no. 36.

All the soils of Gyarampalli and Rompicherla mandals and 50% soils in Kallur mandal had Mn content above the critical limit while the remaining soils in Kallur, Gandaboinapalli and Madanapalli mandals were found to have lower Mn content than the critical limit of 10.0 ppm.

Compared to mean values of Mn in Gyarampalli, Rompicherla and Kallur mandals (Mean values of 11.54, 11.14 and 10.12 ppm respectively) relatively lower mean values of Mn are recorded in Gandaboinapalli (9.22 ppm) and Madanapalli mandals (9.11 ppm).

4.5.3 Available Zinc Content of Soils

Data in Table 10 indicate that the Zn content of soils was found to be below critical limit of 1.0 ppm. It ranged from 0.61 to 0.84 ppm with mean value of 0.71 ppm.

Out of five mandals, slightly higher amounts of Zn are found in soils of Gyarampalli (0.78 ppm) and Rompicherla (0.75 pm) mandals. While soils of Kallur, Gandaboinapalli and Madanapalli mandals recorded lowest Zn content.

4.5.4 Available Copper Content of Soils

The composite soil samples in all the experimental fields had Cu content above the critical limit of 0.2 ppm (Follet, 1969). It ranged from 0.20 to 0.38 ppm with mean value of 0.28 ppm.

With respect to Cu content, soils of Gyarampalli and Rompicherla mandals had relatively higher copper content than the soils of remaining mandals. It ranged from 0.30 to 0.37 ppm, 0.22 to 0.38 pm, 0.23 to 0.33 ppm, 0.21 to 0.30 ppm and 0.20 to 0.26 ppm in Gyarampalli, Rompicherla, Kallur, Gandaboinapalli and Madanapalli Mandals respectively.

4.5.5 Chloride content of Soils

Data presented in Table 10 indicate that soil chlorides ranged from 45.78 to 70.59 ppm with mean value of 58.49 ppm. Highest chloride content of 70.59 ppm was noticed in soils of field no. 36 and the lowest in field no. 7 (45.78 ppm).

Table 10 : Micronutrient status of soils

Sl. No.	Field No.	Fe (ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)	Cl (ppm)
1	1	11.84	12.29	0.78	0.36	50.49
2	2.	11.59	12.03	0.76	0.35	54.58
3	3	10.59	11.00	0.79	0.32	57.10
4	4	9.93	10.31	0.75	0.30	60.17
5	5	12.14	12.64	0.80	0.37	48.19
6	6	11.56	12.01	0.76	0.35	59.25
7	7.	12.84	12.07	0.84	0.36	45.78
8	8	10.34	10.83	0.78	0.32	55.65
9	9	10.26	10.66	0.77	0.31	53.15
10	10	9.11	10.45	0.80	0.28	62.12
11	11	11.12	11.54	0.73	0.34	49.25
12	12	11.32	11.76	0.74	0.34	50.58
13	13	10.59	10.59	0.79	0.22	55.20
14	14	12.37	12.85	0.81	0.38	48.85
15	15	10.26	10.65	0.67	0.31	53.16
16	16	9.77	10.15	0.74	0.30	60.72
17	17	9.25	10.61	0.71	0.28	58.92
18	18	9.73	10.11	0.74	0.29	57.14
19	19	10.59	10.99	0.69	0.32	54.95
20	20	10.92	11.34	0.72	0.33	52.60
21	21	8.52	9.93	0.69	0.24	65.80
22	22	8.26	9.69	0.74	0.24	67.56
23	23	10.92	8.34	0.72	0.23	64.89
24	24	8.50	9.94	0.65	0.25	60.75
25	25	10.24	9.68	0.64	0.24	58.49

26	26	9.07	9.50	0.67	0.25	55.25
27	27	8.23	9.67	0.64	0.24	57.16
28	28	8.20	8.98	0.70	0.27	60.24
29	29	10.92	9.21	0.62	0.23	67.94
30	30	8.23	9.42	0.74	0.30	61.75
31	31	10.29	8.68	0.67	0.25	57.64
32	32	8.26	9.66	0.69	0.29	58.17
33	33	10.57	8.98	0.67	0.24	60.75
34	34	9.77	9.15	0.64	0.23	68.29
35	35	8.18	8.52	0.66	0.21	65.17
36	36	9.77	8.15	0.65	0.22	70.59
37	37	10.58	8.99	0.70	0.20	63.64
38	38	8.10	9.49	0.66	0.21	64.15
39	39	9.25	9.61	0.61	0.26	63.20
40	40	9.92	9.31	0.65	0.24	60.25
Mean		10.05	10.24	0.71	0.28	58.49
SD		1.28	1.23	0.06	0.05	6.01
CV (%)		12.76	11.98	8.28	18.15	10.28
Min.		8.10	8.15	0.61	0.20	45.78
Max.		12.84	12.85	0.84	0.38	70.59

Table 11 : Mandal wise data on mean, SD, CV, min. and max. micronutrient status of soils

Sl. No.	Mandal Name	Fe (ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)	Cl (ppm)
1.	Gyarampalli					
	Mean	11.24	11.34	0.78	0.35	53.82
	SD	0.98	0.84	2.71	0.03	4.9
	CV%	8.73	7.25	3.47	7.52	9.11
	Min:	9.93	10.31	0.75	0.3	45.78
	Max:	12.84	12.64	0.84	0.37	60.17
2.	Rompicherla					
	Mean	10.65	11.14	0.75	0.31	54.27
	SD	1.07	0.95	4.93	5.13	5.38
	CV%	10.09	8.57	6.53	16.55	9.17
	Min:	9.11	10.15	0.67	0.22	48.85
	Max:	12.37	12.85	0.81	0.38	62.12
3.	Kallur					
	Mean	9.57	10.12	0.71	0.27	60.33
	SD	1.12	0.92	3.01	3.85	5.4
	CV%	11.68	9.08	4.26	14.11	8.95
	Min:	8.26	8.34	0.65	0.23	52.6
	Max:	10.92	11.34	0.74	0.33	67.56
4.	Gandaboinapalli					
	Mean	9.27	9.22	0.67	0.25	60.97
	SD	1.1	0.4	3.38	2.68	4.4
	CV%	11.92	4.37	5.06	10.73	7.21
	Min:	8.18	8.52	0.62	0.21	55.25
	Max:	10.92	9.68	0.74	0.3	68.29
5.	Madanapalli					
	Mean	9.52	9.11	0.65	0.23	64.37
	SD	0.93	0.59	3.21	2.41	3.8
	CV%	9.73	6.43	4.91	10.66	5.9
	Min:	8.1	8.15	0.61	0.2	60.25
	Max:	10.58	9.61	0.7	0.26	70.59

The chloride content of soils ranged from 45.78 to 60.17, 48.85 to 62.12, 52.6 to 67.56, 55.25 to 68.29 and 60.25 to 70.59 ppm with mean values of 53.82, 54.27, 60.33, 60.97 and 64.37 ppm in Gyarampalli, Rompicherla, Kallur, Gandaboinapalli and Madanapalli mandals respectively. Among the five mandals, minor variations (Cv of 5.9%) are found in Madanapalli mandal.

4.6 LEAF MAJOR NUTRIENT (N, P & K) CONTENT OF ORIENTAL TOBACCO

Data on Nitrogen, Phosphorus and Potassium composition of oriental tobacco in three primings are presented in Tables 12, 13 and 14 respectively. Mandal wise data on mean, SD, Cv of leaf N, P and K composition are presented in Table 15.

4.6.1 Leaf Nitrogen Concentration

Leaf nitrogen content varied with the position of the leaf on the plant. Bottom leaves had lower nitrogen concentration compared to leaves at middle and top. Leaves from the third priming contained higher concentration of nitrogen. The nitrogen concentration of leaf ranged from 1.81 to 3.00%, 1.94 to 3.04% and 1.91 to 2.95% in first, third and fifth primings respectively. The average leaf nitrogen concentration ranged from 1.88 to 2.99% with a mean value of 2.72%. Highest average leaf nitrogen (2.99%)

Table 12 : Nitrogen concentration in leaf at different primings

Sl. No.	Field No.	I P (%)	III P (%)	V P (%)	Avg. (%)
1	1	2.24	2.39	2.37	2.33
2	2.	2.52	2.63	2.60	2.58
3	3	2.78	2.84	2.80	2.80
4	4	2.94	3.01	2.96	2.97
5	5	2.11	2.23	2.20	2.18
6	6	2.49	2.58	2.54	2.53
7	7.	1.81	1.94	1.91	1.88
8	8	2.89	2.97	2.93	2.93
9	9	2.75	2.87	2.82	2.81
10	10	2.95	3.04	2.93	2.97
11	11	2.58	2.69	2.70	2.65
12	12	2.50	2.63	2.60	2.57
13	13	2.78	2.86	2.81	2.81
14	14	2.13	2.27	2.23	2.21
15	15	2.60	2.68	2.62	2.63
16	16	2.98	3.01	2.91	2.96
17	17	2.78	2.89	2.90	2.85
18	18	2.85	2.94	2.90	2.89
19	19	2.81	2.89	2.85	2.85
20	20	2.64	2.78	2.75	2.72
21	21	2.85	2.93	2.90	2.89
22	22	2.93	2.98	2.91	2.94
23	23	2.85	2.94	2.90	2.89
24	24	2.64	2.79	2.70	2.71
25	25	2.44	2.54	2.50	2.49

26	26	2.55	2.64	2.59	2.59
27	27	2.43	2.54	2.50	2.49
28	28	2.60	2.71	2.66	2.65
29	29	3.00	3.02	2.95	2.99
30	30	2.47	2.59	2.55	2.53
31	31	2.90	2.99	2.90	2.93
32	32	2.89	2.97	2.89	2.91
33	33	2.85	2.94	2.88	2.89
34	34	2.83	2.92	2.81	2.85
35	35	2.84	2.92	2.85	2.87
36	36	2.87	2.95	2.88	2.90
37	37	2.72	2.85	2.80	2.79
38	38	2.73	2.88	2.81	2.80
39	39	2.71	2.83	2.84	2.79
40	40	2.81	2.93	2.87	2.87
Mean		2.68	2.78	2.73	2.72
Min.		1.81	1.94	1.91	1.88
Max.		3.00	3.04	2.95	2.99

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was found in field no. 29 while the lowest (1.88%) was recorded in field no. 7.

Mandal wise data in Table 15 indicate that the N concentration in leaf ranged from 1.88 to 2.97, 2.71% to 2.94% and 2.79 to 2.90% in Gyarampalli, Kallur and Madanapalli mandals. Leaf nitrogen was lowest (2.56%) in Gyarampalli mandal and highest in Kallur and Madanapalli mandals (2.84% and 2.83% respectively). The variations in leaf N concentration were minimum in Madanapalli mandal with a Cv of 1.82% and maximum (Cv of 14.4%) in Gyarampalli mandal.

4.6.2 Leaf Phosphorus Concentration

Phosphorus concentration in leaf decreased with increase in leaf position i.e from bottom to top. Maximum P concentration was recorded in first priming compared to third and fifth primings. Leaf P concentration ranged from 0.11 to 0.31%, 0.10 to 0.28% and 0.08 to 0.26% in the three picks respectively. In the forty experimental fields, the average P content ranged from 0.09 to 0.28% with a mean value of 0.16%. Lowest P concentration (0.09%) was registered in field no. 40 while the highest (0.28%) was found in field no. 15.

Table 13 : Phosphorus concentration in leaf at different primings

Sl. No.	Field No.	I P (%)	III P (%)	V P (%)	Avg. (%)
1	1	0.22	0.20	0.19	0.20
2	2.	0.25	0.23	0.22	0.23
3	3	0.16	0.14	0.13	0.14
4	4	0.23	0.20	0.19	0.20
5	5	0.24	0.23	0.21	0.22
6	6	0.15	0.13	0.11	0.13
7	7.	0.16	0.15	0.14	0.15
8	8	0.17	0.15	0.13	0.15
9	9	0.20	0.19	0.17	0.18
10	10	0.25	0.23	0.21	0.23
11	11	0.20	0.18	0.17	0.18
12	12	0.24	0.22	0.20	0.22
13	13	0.15	0.13	0.12	0.13
14	14	0.20	0.19	0.17	0.18
15	15	0.31	0.28	0.26	0.28
16	16	0.28	0.22	0.20	0.22
17	17	0.20	0.19	0.18	0.19
18	18	0.15	0.13	0.11	0.13
19	19	0.21	0.20	0.18	0.19
20	20	0.16	0.14	0.12	0.14
21	21	0.12	0.10	0.09	0.10
22	22	0.20	0.18	0.16	0.18
23	23	0.13	0.12	0.11	0.12
24	24	0.15	0.13	0.11	0.13
25	25	0.12	0.11	0.10	0.11

26	26	0.16	0.14	0.12	0.14
27	27	0.12	0.11	0.10	0.11
28	28	0.15	0.13	0.11	0.13
29	29	0.13	0.12	0.11	0.12
30	30	0.16	0.14	0.12	0.14
31	31	0.13	0.12	0.11	0.12
32	32	0.12	0.11	0.10	0.11
33	33	0.15	0.14	0.13	0.14
34	34	0.16	0.14	0.13	0.14
35	35	0.12	0.11	0.1	0.11
36	36	0.14	0.13	0.12	0.13
37	37	0.15	0.13	0.11	0.13
38	38	0.17	0.15	0.13	0.15
39	39	0.14	0.12	0.11	0.12
40	40	0.11	0.10	0.08	0.09
	Mean	0.17	0.16	0.14	0.16
	Min.	0.11	0.10	0.08	0.09
	Max.	0.31	0.28	0.26	0.28

Rompicherla and Gyarampalli mandals were found to have higher concentrations of P (Mean values of 0.21% and 0.18% respectively) compared to the remaining mandals. Of all the mandals, the variations in P concentration were minimum (Cv of 10.99%) in Gandaboinapalli mandal.

4.6.3 Leaf Potassium Concentration

Like Phosphorus, similar distribution pattern was observed with respect to leaf Potassium concentration i.e bottom leaves found to had higher contents of K compared to the middle and top leaves. Highest K concentration was recorded in first priming compared to third and fifth primings (Mean values of 2.23%, 2.04% and 1.90% in first, third and fifth primings respectively). The K concentration of leaves ranged from 1.12 to 3.10%, 1.00 to 3.01% and 0.83 to 2.83% in the three picks (Primings) respectively but the average K concentration ranged from 0.98 to 2.97 with a mean value of 2.03%.

Higher K concentrations were found in Rompicherla, Gyarampalli and Kallur mandals with mean values of 2.39, 2.13 and 2.12% respectively compared to Madanapalli and Gandaboinapalli mandals with mean values of 1.92 and 1.71% respectively. Among the mandals, the variations in K concentration were maximum in Madanapalli mandal (Cv of 34.08%).

Table 14 : Potassium concentration in leaf at different primings

Sl. No.	Field No.	IP (%)	IIIP (%)	VP (%)	Avg. (%)
1	1	2.18	2.10	2.01	2.09
2	2.	2.42	2.21	2.13	2.25
3	3	2.54	2.28	2.19	2.33
4	4	2.28	2.15	2.03	2.15
5	5	1.54	1.32	1.15	1.33
6	6	2.86	2.83	2.69	2.79
7	7.	2.60	2.44	2.23	2.42
8	8	2.50	2.38	2.17	2.35
9	9	1.65	1.43	1.21	1.43
10	10	3.09	3.01	2.83	2.97
11	11	2.51	2.33	2.20	2.34
12	12	2.35	2.21	2.02	2.19
13	13	3.06	2.89	2.71	2.88
14	14	2.98	2.73	2.59	2.76
15	15	1.90	1.71	1.59	1.73
16	16	2.01	1.89	1.73	1.87
17	17	2.63	1.41	1.20	1.74
18	18	3.10	2.85	2.69	2.88
19	19	2.84	2.71	2.59	2.71
20	20	2.00	1.88	1.69	1.85
21	21	1.80	1.63	1.49	1.64
22	22	1.65	1.50	1.39	1.51
23	23	2.43	2.31	2.20	2.31
24	24	2.45	2.31	2.21	2.32
25	25	2.31	2.15	2.00	2.15

26	26	1.49	1.31	1.19	1.33
27	27	1.45	1.23	1.15	1.27
28	28	1.30	1.19	1.10	1.19
29	29	1.71	1.49	1.25	1.48
30	30	2.75	2.52	2.39	2.55
31	31	1.63	1.50	1.36	1.49
32	32	1.81	1.65	1.51	1.65
33	33	2.73	2.58	2.40	1.66
34	34	2.17	2.09	1.94	2.06
35	35	2.09	1.93	1.85	1.95
36	36	1.12	1.00	0.83	0.98
37	37	1.80	1.61	1.45	1.62
38	38	2.79	2.54	2.31	2.54
39	39	2.73	2.55	2.30	2.52
40	40	2.08	1.94	1.88	1.96
	Mean	2.23	2.04	1.90	2.03
	Min.	1.12	1.00	0.83	0.98
	Max.	3.10	3.01	2.83	2.97

Table 15 : Mandal wide data on mean, SD, CV, min. and max. leaf major nutrient concentrations

Sl. No.	Mandal Name	N (%)	P (%)	K (%)
1.	Gyarampalli			
	Mean	2.56	0.18	2.13
	SD	0.37	3.67	0.47
	CV%	14.41	20.63	22.02
	Min:	1.88	0.13	1.33
	Max:	2.97	0.23	2.79
2.	Rompicherla			
	Mean	2.69	0.21	2.39
	SD	0.26	4.76	0.49
	CV%	9.80	23.12	20.64
	Min:	2.21	0.13	1.73
	Max:	2.97	0.28	2.97
3.	Kallur			
	Mean	2.84	0.15	2.12
	SD	8.36	3.45	0.51
	CV%	2.94	23.42	2.4.06
	Min:	2.71	0.10	1.51
	Max:	2.94	0.19	2.88
4.	Gandaboinapalli			
	Mean	2.74	0.12	1.71
	SD	0.19	1.37	0.42
	CV%	7.09	10.99	24.82
	Min:	2.49	0.11	1.19
	Max:	2.99	0.14	2.55

5. Madanapalli

Mean	2.83	0.12	1.92
SD	5.15	2.19	0.66
CV%	1.82	17.67	34.08
Min:	2.79	0.09	0.98
Max:	2.90	0.15	2.54

All Mandals

Mean	2.72	0.16	2.03
SD	0.25	4.37	0.53
CV%	9.06	28.17	25.93
Min.	1.88	0.09	0.98
Max.	2.99	0.28	2.97

4.7 LEAF SECONDARY NUTRIENT (Ca & Mg) CONTENT OF ORIENTAL TOBACCO

The data pertaining to Calcium and Magnesium concentration of leaf samples at three primings are presented in Table 16 and Table 17. Mandal wise data on Mean, SD and Cv of Ca and Mg are presented in Table 18.

4.7.1 *Leaf Calcium Concentration*

Data in Table 16 show that Ca concentration decreased with increase in leaf position from bottom to top. The Ca concentration ranged from 1.01 to 2.22%, 0.91 to 2.11% and 0.83 to 2.00% with mean values of 1.51%, 1.37% and 1.29% in first, third and fifth primings respectively. The Ca concentration on an average ranged from 0.92 to 2.10% with a mean value of 1.39%.

Compared to Gyarampalli, Rompicherla and Kallur mandals relatively lower Ca concentrations were found in Gandaboinapalli and Madanapalli mandals. It ranged from 1.26 to 2.10%, 1.28 to 1.78%, 0.92 to 2.07%, 0.92 to 1.53% and 0.92 to 1.44% in Gyarampalli, Rompicherla, Kallur, Gandaboinapalli and Madanapalli mandals respectively. The contrast to other mandals minor variations in Ca concentration were found in Rompicherla mandal with Cv of 13.12%.

Table 16 : Calcium concentration in leaf at different primings

Sl. No.	Field No.	IP (%)	IIIP (%)	VP (%)	Avg. (%)
1	1	1.45	1.21	1.12	1.26
2	2.	1.53	1.42	1.39	1.44
3	3	1.58	1.43	1.34	1.45
4	4	2.11	2.00	1.91	2.00
5	5	1.48	1.29	1.20	1.32
6	6	1.41	1.25	1.20	1.28
7	7.	1.82	1.60	1.51	1.64
8	8	1.84	1.71	1.64	1.73
9	9	2.21	2.11	2.00	2.10
10	10	1.92	1.73	1.69	1.78
11	11	1.40	1.25	1.20	1.28
12	12	1.52	1.39	1.30	1.40
13	13	1.54	1.41	1.32	1.42
14	14	1.64	1.43	1.34	1.47
15	15	1.85	1.74	1.70	1.76
16	16	1.49	1.35	1.25	1.36
17	17	1.80	1.47	1.38	1.55
18	18	2.22	2.04	1.96	2.07
19	19	2.00	1.88	1.81	1.89
20	20	1.84	1.75	1.70	1.76
21	21	1.12	1.01	0.92	1.01
22	22	1.56	1.41	1.35	1.44
23	23	1.63	1.51	1.40	1.51
24	24	1.01	0.94	0.83	0.92
25	25	1.12	1.03	0.95	1.03

26	26	1.53	1.41	1.39	1.44
27	27	1.04	0.95	0.88	0.95
28	28	1.01	0.91	0.84	0.92
29	29	1.49	1.30	1.21	1.33
30	30	1.07	0.95	0.83	0.95
31	31	1.11	1.00	0.91	1.00
32	32	1.43	1.25	1.14	1.27
33	33	1.08	0.97	0.86	0.97
34	34	1.63	1.51	1.47	1.53
35	35	1.67	1.52	1.40	1.53
36	36	1.52	1.44	1.38	1.44
37	37	1.01	0.91	0.85	0.92
38	38	1.12	1.01	0.92	1.01
39	39	1.15	1.04	0.95	1.04
40	40	1.43	1.20	1.11	1.24
Mean		1.51	1.37	1.29	1.39
Min.		1.01	0.91	0.83	0.92
Max.		2.22	2.11	2.00	2.01

Table 17 : Magnesium concentration in leaf at different primings

Sl. No.	Field No.	IP (%)	IIIP (%)	VP (%)	Avg. (%)
1	1	0.19	0.17	0.15	0.17
2	2.	0.20	0.19	0.17	0.18
3	3	0.21	0.19	0.16	0.18
4	4	0.22	0.20	0.18	0.20
5	5	0.15	0.13	0.11	0.13
6	6	0.17	0.14	0.11	0.14
7	7.	0.14	0.11	0.08	0.11
8	8	0.23	0.20	0.18	0.20
9	9	0.22	0.20	0.18	0.20
10	10	0.21	0.18	0.15	0.18
11	11	0.15	0.12	0.10	0.12
12	12	0.18	0.16	0.14	0.16
13	13	0.19	0.17	0.14	0.16
14	14	0.19	0.16	0.14	0.16
15	15	0.20	0.18	0.15	0.17
16	16	0.15	0.13	0.10	0.12
17	17	0.19	0.16	0.13	0.16
18	18	0.22	0.20	0.18	0.20
19	19	0.23	0.20	0.18	0.20
20	20	0.21	0.18	0.15	0.18
21	21	0.12	0.10	0.09	0.10
22	22	0.14	0.12	0.10	0.12
23	23	0.17	0.15	0.13	0.15
24	24	0.16	0.14	0.12	0.14
25	25	0.13	0.12	0.11	0.12

26	26	0.13	0.12	0.10	0.11
27	27	0.12	0.11	0.10	0.11
28	28	0.14	0.12	0.10	0.12
29	29	0.14	0.13	0.11	0.12
30	30	0.12	0.10	0.09	0.10
31	31	0.12	0.11	0.10	0.11
32	32	0.14	0.12	0.10	0.12
33	33	0.12	0.10	0.08	0.10
34	34	0.18	0.15	0.12	0.15
35	35	0.17	0.15	0.12	0.14
36	36	0.16	0.13	0.12	0.13
37	37	0.13	0.11	0.10	0.11
38	38	0.14	0.12	0.10	0.12
39	39	0.14	0.13	0.10	0.12
40	40	0.15	0.13	0.11	0.13
	Mean	0.17	0.15	0.12	0.14
	Min.	0.12	0.10	0.08	0.10
	Max.	0.23	0.20	0.18	0.20

Table 18 : Mandal wide data on mean, SD, CV, min. and max. leaf secondary nutrient concentrations

Sl. No.	Mandal Name	Ca (%)	Mg (%)
1.	Gyarampalli		
	Mean	1.58	0.17
	SD	0.31	3.35
	CV%	19.63	19.94
	Min:	1.26	0.11
	Max:	2.10	0.20
2.	Rompicherla		
	Mean	1.50	0.15
	SD	0.20	2.36
	CV%	13.12	15.44
	Min:	1.28	0.12
	Max:	1.78	0.18
3.	Kallur		
	Mean	1.52	0.16
	SD	0.40	3.62
	CV%	26.39	23.19
	Min:	0.92	0.10
	Max:	2.07	0.20
4.	Gandaboinapalli		
	Mean	1.17	0.11
	SD	0.25	1.54
	CV%	21.11	13.00
	Min:	0.92	0.10
	Max:	1.53	0.15

5. Madanapalli

Mean	1.13	0.12
SD	0.21	8.37
CV%	18.50	6.86
Min:	0.92	0.11
Max:	1.44	0.13

7. All Mandals

Mean	1.39	0.14
SD	0.33	0.032
CV%	23.97	22.51
Min.	0.92	0.10
Max.	2.10	0.20

4.7.2 Leaf Magnesium Concentration

The distribution pattern of Mg was similar to that of Ca i.e bottom leaves had higher Mg concentrations compared to middle and top leaves. The ranges of Mg concentration are 0.12 to 0.23%, 0.10 to 0.20% and 0.08 to 0.18% with a mean of 0.17%, 0.15% and 0.12% in first, third and fifth primings respectively. Average Mg concentration ranged from 0.10 to 0.20% with a mean value of 0.14%.

With regard to Mg concentration relatively higher Mg contents were found in Gyarampalli followed by Rompicherla and Kallur mandals. In Madanapalli mandal relatively minor variations (cv of 6.86%) in Mg concentration were recorded.

4.8 LEAF MICRO NUTRIENT (Fe, Mn, Zn and Cu) CONTENT OF ORIENTAL TOBACCO

Data on Iron, Manganese, Zinc and Copper concentrations of leaf samples are presented in Tables 19, 20, 21 and 22 respectively. Data on mean, SD and Cv of above micronutrients in five mandals are presented in Table 23.

4.8.1 Leaf Iron Concentration

Data in Table 19 revealed that first primed leaves have higher Fe concentrations (Mean value of 64.6 ppm) compared to leaves from third (Mean value of 54.6 ppm) and fifth primings (Mean value 47.0 ppm). It

Table 19 : Iron concentration in leaf at different primings

Sl. No.	Field No.	IP (ppm)	IIIP (ppm)	VP (ppm)	Avg. (ppm)
1	1	70.4	60.5	55.3	63.7
2	2.	72.1	57.4	53.5	61.0
3	3	68.4	75.0	70.0	71.1
4	4	65.3	79.0	74.0	72.7
5	5	88.3	82.1	55.4	78.6
6	6	95.3	89.0	83.0	89.1
7	7.	94.4	81.3	74.5	83.4
8	8	64.4	53.3	46.3	54.6
9	9	65.2	40.3	33.8	46.4
10	10	60.4	42.3	35.2	45.9
11	11	72.3	53.0	44.0	56.4
12	12	78.5	63.1	57.3	66.3
13	13	60.2	84.0	79.0	74.4
14	14	95.5	79.6	68.7	81.2
15	15	67.4	51.3	43.1	53.9
16	16	59.3	44.5	38.6	47.5
17	17	62.5	51.4	45.3	53.0
18	18	63.1	52.5	45.4	53.7
19	19	66.5	48.4	39.0	51.3
20	20	64.4	53.3	44.4	54.0
21	21	62.1	55.5	49.0	55.5
22	22	60.1	54.5	48.9	54.5
23	23	58.4	47.0	34.4	46.6
24	24	50.2	39.1	34.5	41.2
25	25	61.1	53.4	50.5	55.0

26	26	60.0	48.3	44.2	50.8
27	27	55.5	47.4	40.0	47.6
28	28	55.1	48.0	35.5	46.2
29	29	62.0	49.4	41.5	50.9
30	30	52.2	39.9	33.1	41.7
31	31	56.0	49.1	39.4	48.1
32	32	52.1	40.0	31.4	41.1
33	33	65.6	51.0	43.1	53.2
34	34	55.2	43.4	38.5	45.7
35	35	50.7	42.0	35.1	42.6
36	36	60.0	42.2	38.1	46.7
37	37	60.5	46.0	39.1	48.5
38	38	50.3	44.3	38.5	44.3
39	39	60.4	48.3	34.0	47.5
40	40	61.5	54.0	47.1	54.2
	Mean	64.6	54.6	47.0	55.50
	Min.	50.2	39.1	31.4	41.10
	Max.	95.5	89.0	83.0	89.10

ranged from 50.2 to 95.5 ppm, 39.1 to 89.0 ppm and 31.4 to 83.0 ppm in the above three picks respectively. Average Fe concentration ranged from 41.1 to 89.1 ppm with mean value of 55.5 ppm (Table 19).

Higher concentration of Fe was found in Gyarampalli and Rompicherla mandals (Mean values of 68.96 ppm and 60.80 ppm). Compared to these mandals, tobacco cultivated in other mandals had lower values of iron concentration in leaves. Large variation in Fe concentration was found in Gyarampalli (Cv of 20.07%) and Rompicherla (Cv of 22.24%) mandals in which Fe content of the leaf ranged from 46.4 to 89.1 ppm and 45.9 to 81.2 ppm respectively (Table 23).

4.8.2 Leaf Manganese Concentration

Data presented in Table 20 show that with increase in leaf position, the Mn concentration decreased i.e., higher Mn concentrations were found in first primings (Mean value of 73.6 ppm) and lower amounts were recorded in third and fifth primings (Mean values of 63.4 ppm and 58.5 ppm respectively). Average Mn concentration ranged from 50.9 to 82.7 ppm with mean value of 65.08 ppm (Table 20).

Slightly higher Mn concentration was found in Gyarampalli and Rompicherla mandals (Mean values of 77.32 and 72.09 ppm respectively) compared to Kallur, Gandaboinapalli and Madanapalli mandals (62.24, 56.89 and 55.82 ppm respectively). Out of five mandals, the variations in Mn

Table 20 : Manganese concentration in leaf at different primings

Sl. No.	Field No.	IP (ppm)	IIIP (ppm)	VP (ppm)	Avg. (ppm)
1	1	92.3	80.4	73.5	82.0
2	2.	90.4	78.5	74.3	81.0
3	3	89.1	81.7	75.4	82.0
4	4	91.9	70.8	60.0	72.0
5	5	88.4	76.8	70.1	78.4
6	6	88.3	75.4	69.8	77.8
7	7.	89.5	73.1	68.4	77.0
8	8	82.2	70.5	64.9	72.5
9	9	81.7	70.4	65.7	72.6
10	10	79.4	70.3	65.5	71.7
11	11	83.4	71.7	65.1	73.4
12	12	82.3	70.5	66.3	73.0
13	13	78.1	66.4	60.3	68.2
14	14	92.1	80.4	75.6	82.7
15	15	79.1	68.3	62.5	69.9
16	16	75.1	63.5	58.7	65.7
17	17	74.2	62.8	57.1	64.7
18	18	75.6	65.1	60.8	67.1
19	19	78.1	63.7	58.1	66.6
20	20	82.1	71.9	65.4	73.1
21	21	65.4	60.0	55.1	60.1
22	22	63.3	60.2	54.5	59.3
23	23	60.6	52.7	48.5	53.9
24	24	61.4	52.1	46.3	53.2
25	25	65.4	58.1	52.1	58.5

26	26	63.2	51.4	48.9	54.5
27	27	64.2	52.8	49.3	55.4
28	28	60.2	52.1	47.3	53.2
29	29	66.1	54.2	50.5	56.9
30	30	68.5	62.1	57.4	62.6
31	31	64.3	58.1	52.4	58.2
32	32	66.2	60.8	54.1	60.3
33	33	60.3	55.3	50.1	55.2
34	34	67.1	58.1	53.2	59.4
35	35	61.7	49.8	43.5	51.6
36	36	60.5	48.1	44.2	50.9
37	37	62.3	51.4	47.3	53.6
38	38	66.7	58.1	53.1	59.3
39	39	69.4	56.3	51.3	59.0
40	40	65.7	53.4	49.8	56.3
Mean		73.66	63.4	58.3	65.08
Min.		60.2	51.4	50.1	50.90
Max.		92.3	80.4	75.6	82.70

concentration were slightly higher (Cv of 11.01%) in Kallur mandal (Table 23).

4.8.3 Leaf Zinc Concentration

Zn concentration ranged from 19.5 to 28.8 ppm, 17.0 to 23.5 ppm and 12.0 to 18.0 ppm with mean values of 23.3, 19.0 and 15.2 ppm in first, third and fifth primings respectively. Average Zn concentration ranged from 16.20 to 22.90 ppm with a mean value of 19.13 ppm. The highest Zn content (22.90 ppm) was recorded in field no. 6 and the lowest (16.20 ppm) was found in field no. 25 (Table 21).

Mandal wise data on mean leaf Zn concentration indicate that mandals were not distinctly differ with respect to Zn concentration i.e minimum variations in Zn concentration were found in all five mandals (Table 23).

4.8.4 Leaf Copper Concentration

The concentration of copper decreased with increase in leaf position from bottom to top. In three primings it varied from 19.0 to 35.4, 15.4 to 29.5 and 12.2 to 27.7 ppm with mean values of 26.5, 22.3 and 18.3 ppm. Average Cu ranged from 15.70 to 30.40 ppm with mean value of 22.32 ppm. The highest and lowest Cu concentrations were found in field no. 14 and field no. 35 (Table 22).

Table 21 : Zinc concentration in leaf at different primings

Sl. No.	Field No.	IP (ppm)	IIIP (ppm)	VP (ppm)	Avg. (ppm)
1	1	23.4	18.5	15.0	18.9
2	2.	21.5	16.0	14.1	17.3
3	3	26.5	19.2	16.4	20.7
4	4	25.5	20.0	16.0	20.5
5	5	24.5	20.5	17.0	20.6
6	6	28.8	22.6	17.5	22.0
7	7.	28.0	23.5	15.1	22.2
8	8	21.7	18.5	16.6	18.9
9	9	27.0	20.5	16.4	21.3
10	10	26.1	20.0	15.4	20.5
11	11	24.0	18.6	16.3	19.6
12	12	23.5	16.8	14.9	18.4
13	13	28.4	21.1	17.0	22.1
14	14	27.4	19.5	15.8	20.9
15	15	23.5	20.2	16.4	20.0
16	16	24.5	18.4	14.0	18.9
17	17	23.0	18.3	15.2	18.8
18	18	26.5	21.6	17.7	21.9
19	19	22.1	19.4	14.5	18.6
20	20	23.3	18.2	14.1	18.5
21	21	21.5	19.0	15.5	18.6
22	22	23.8	19.2	14.1	19.0
23	23	25.6	19.7	16.8	20.7
24	24	21.4	19.3	14.0	18.2
25	25	20.1	15.0	13.5	16.2

26	26	22.2	17.0	14.1	17.7
27	27	19.9	19.6	15.0	18.1
28	28	24.3	18.0	14.1	18.8
29	29	20.1	18.5	15.4	18.0
30	30	23.2	20.1	18.0	20.4
31	31	21.1	19.0	15.2	18.4
32	32	22.7	18.2	14.4	18.4
33	33	20.4	19.0	15.9	18.4
34	34	19.7	18.3	14.0	17.3
35	35	21.2	18.0	12.0	17.0
36	36	22.7	19.4	14.3	18.8
37	37	23.5	17.5	14.0	18.3
38	38	20.3	16.2	14.5	17.0
39	39	19.5	17.0	13.4	16.6
40	40	20.9	18.7	14.0	17.8
	Mean	23.3	19.0	15.2	19.13
	Min.	19.5	17.0	12.0	16.20
	Max.	28.8	23.5	18.0	22.90

Table 22 : Copper concentration in leaf at different primings

Sl. No.	Field No.	IP (ppm)	IIIP (ppm)	VP (ppm)	Avg. (ppm)
1	1	32.0	28.0	26.5	28.8
2	2.	33.4	27.5	24.7	28.5
3	3	30.0	26.5	24.0	26.8
4	4	29.0	24.1	20.2	24.4
5	5	35.4	28.5	14.0	25.9
6	6	32.0	21.6	18.9	24.1
7	7.	35.0	20.7	18.8	24.8
8	8	29.6	27.0	24.0	26.8
9	9	28.2	21.5	17.0	22.2
10	10	24.4	21.8	18.0	21.4
11	11	31.4	29.1	26.3	28.9
12	12	32.0	29.5	25.0	28.8
13	13	21.3	18.2	16.4	18.6
14	14	34.6	29.5	27.7	30.4
15	15	30.4	28.2	25.1	27.9
16	16	31.0	28.4	26.5	28.6
17	17	25.4	22.2	18.0	21.8
18	18	26.0	22.5	17.5	22.0
19	19	30.4	26.5	19.9	25.6
20	20	32.3	29.0	24.4	28.5
21	21	21.3	18.5	14.3	18.0
22	22	22.1	17.3	13.2	17.5
23	23	20.3	18.4	15.0	17.9
24	24	21.5	19.0	14.1	18.2
25	25	25.3	21.5	19.5	22.1

26	26	24.4	17.5	14.0	18.6
27	27	27.3	22.0	14.5	21.2
28	28	29.3	22.2	16.1	22.5
29	29	20.5	19.6	15.7	18.6
30	30	26.4	20.3	17.1	21.2
31	31	22.8	20.1	15.4	19.4
32	32	25.5	21.5	18.0	21.6
33	33	25.1	19.4	14.1	19.5
34	34	19.3	16.4	12.6	16.1
35	35	19.5	15.4	12.2	15.7
36	36	20.3	19.0	15.4	18.2
37	37	19.1	17.4	13.5	16.6
38	38	19.0	21.5	16.5	19.0
39	39	24.2	19.6	13.4	19.0
40	40	21.2	16.1	14.0	17.1
	Mean	26.5	22.3	18.3	22.32
	Min.	19.0	15.4	12.2	15.70
	Max.	35.4	29.5	27.7	30.40

Table 23 : Mandal wise data on mean, SD, CV, min. and max. leaf micronutrient concentration

Sl. No.	Mandal Name	Fe (ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)
1	Gyarampalli				
	Mean	68.96	77.32	20.37	25.81
	SD	13.84	4.16	1.75	2.15
	CV%	20.07	5.38	8.60	8.34
	Min:	46.4	72.0	17.3	22.2
	Max:	89.1	82.6	22.9	28.8
2	Rompicherla				
	Mean	60.80	72.09	20.06	26.37
	SD	13.52	5.42	1.25	4.49
	CV%	22.24	7.51	6.23	17.02
	Min:	45.9	65.7	18.4	18.6
	Max:	81.2	82.7	22.1	30.4
3	Kallur				
	Mean	51.23	62.24	19.29	21.19
	SD	4.90	6.86	1.30	4.10
	CV%	9.56	11.01	6.76	19.33
	Min:	41.2	53.2	18.2	17.50
	Max:	55.5	73.0	21.9	28.5
4	Gandaboinapalli				
	Mean	47.54	56.89	18.06	19.68
	SD	4.64	3.27	1.08	2.31
	CV%	9.76	5.76	5.98	11.72
	Min:	41.10	51.6	16.2	15.7
	Max:	55.0	62.6	20.4	22.5

5 Madanapalli

Mean	48.24	55.82	17.7	17.98
SD	3.68	3.59	0.91	1.10
CV%	7.62	6.43	5.12	6.10
Min:	44.3	50.9	16.6	16.6
Max:	54.2	59.3	18.8	19.0

7 All Mandals

Mean	55.50	65.08	19.13	22.32
SD	12.40	9.77	1.63	4.35
CV%	22.34	15.02	8.51	19.50
Min.	41.10	50.90	16.20	15.7
Max.	89.10	82.70	22.90	30.4

Data presented in Table 23 revealed that oriental tobacco cultivated in Gyarampalli and Rompicherla mandals (Mean values of 25.81 and 26.37 ppm) had higher Cu concentrations. Least variations in Cu content were found in Gyarampalli (Cv of 8.34%) and Madanapalli mandals (Cv of 6.10%) while wider variations were found in rest of the mandals.

4.9 LEAF QUALITY PARAMETERS (NICOTINE, REDUCING SUGARS AND CHLORIDES)

Data on leaf quality parameters such as Nicotine, Reducing sugars and Chlorides are presented in Table 24, 25 and 26 respectively. Mandal wise mean, SD and Cv on quality parameters are presented in Table 27.

4.9.1 Leaf Nicotine Concentration

Data on nicotine concentration indicated that leaves from third priming had higher nicotine concentration (Mean value of 0.84%) followed by fifth (mean value of 0.73%) and first primings (mean value of 0.65%). It varied from 0.50 to 0.75%, 0.71 to 0.94% and 0.62 and 0.82% in first, third and fifth primings respectively. Average leaf nicotine concentration ranged from 0.62 to 0.82% with a mean value of 0.74% (Table 24).

Mandal wise data revealed that nicotine concentration of leaves in all the five mandals was almost the same while relatively wider variations in

Table 24 : Nicotine concentration in leaf at different primings

Sl. No.	Field No.	IP (%)	IHIP (%)	VP (%)	Avg. (%)
1	1	0.52	0.73	0.62	0.62
2	2.	0.57	0.78	0.64	0.66
3	3	0.65	0.83	0.75	0.74
4	4	0.71	0.89	0.80	0.80
5	5	0.51	0.73	0.69	0.64
6	6	0.58	0.80	0.71	0.69
7	7.	0.50	0.75	0.69	0.64
8	8	0.67	0.83	0.75	0.75
9	9	0.68	0.85	0.79	0.77
10	10	0.75	0.92	0.78	0.82
11	11	0.63	0.82	0.74	0.73
12	12	0.57	0.75	0.66	0.66
13	13	0.65	0.81	0.75	0.73
14	14	0.52	0.71	0.64	0.62
15	15	0.65	0.82	0.74	0.73
16	16	0.70	0.91	0.80	0.80
17	17	0.65	0.82	0.74	0.73
18	18	0.67	0.81	0.75	0.74
19	19	0.64	0.82	0.73	0.73
20	20	0.63	0.84	0.77	0.74
21	21	0.64	0.87	0.79	0.76
22	22	0.70	0.93	0.80	0.81
23	23	0.72	0.90	0.82	0.81
24	24	0.62	0.81	0.74	0.72
25	25	0.61	0.80	0.71	0.70

26	26	0.64	0.83	0.74	0.73
27	27	0.61	0.80	0.72	0.71
28	28	0.65	0.84	0.78	0.75
29	29	0.71	0.94	0.76	0.80
30	30	0.62	0.80	0.73	0.71
31	31	0.72	0.85	0.74	0.78
32	32	0.71	0.83	0.75	0.76
33	33	0.69	0.80	0.73	0.74
34	34	0.74	0.89	0.78	0.80
35	35	0.73	0.90	0.81	0.81
36	36	0.75	0.93	0.80	0.82
37	37	0.69	0.88	0.79	0.78
38	38	0.71	0.89	0.72	0.77
39	39	0.70	0.84	0.73	0.75
40	40	0.72	0.90	0.80	0.80
	Mean	0.65	0.84	0.73	0.74
	Min.	0.50	0.71	0.62	0.62
	Max.	0.75	0.94	0.82	0.82

nicotine content were found in Gyarampalli (Cv of 9.34%) and Rompicherla (Cv of 9.72%) mandals (Table 27).

4.9.2 Leaf Reducing Sugars Concentration

Compared to first priming, reducing sugars concentration was found to be high in third priming (mean value of 17.02%) followed by fifth priming (Mean value of 15.91%). Reducing sugars ranged from 5.44 to 7.05%, 15.24 to 18.49% and 14.12 to 17.92% in first, third and fifth primings. Average reducing sugars ranged from 11.25 to 14.55% with a mean value of 13.04%. Highest reducing sugars (14.55%) were found in field no. 7 and lowest (11.25%) reducing sugars in field no. 36 (Table 25).

The reducing sugars ranged from 12.33 to 14.55%, 12.51 to 14.20%, 12.50 to 13.97%, 11.66 to 13.36%, and 11.25 to 13.26% with mean values of 13.56%, 13.48%, 13.22%, 12.44% and 12.49%. in Gyarampalli, Rompicherla, Kallur, Gandaboinapalli and Madanapalli mandals respectively. Compared to remaining mandals, Madanapalli mandal showed slightly higher variations (Cv. 6.09%) in leaf reducing sugars (Table 27).

4.9.3 Leaf Chloride Concentration

Lower chloride concentrations were found to be low in the leaves of third priming (Mean value of 0.26%) while more chlorides were found in first

Table 25 : Reducing sugars concentration in leaf at different primings

Sl. No.	Field No.	IP (%)	IIP (%)	VP (%)	Avg. (%)
1	1	6.80	17.21	16.15	13.38
2	2.	6.82	18.02	17.49	14.11
3	3	6.25	17.50	16.12	13.29
4	4	5.78	16.21	15.02	12.33
5	5	7.02	18.25	17.11	14.12
6	6	6.85	18.24	17.15	14.08
7	7.	7.52	18.94	17.20	14.55
8	8	5.94	17.21	16.10	13.08
9	9	6.12	17.20	16.05	13.12
10	10	5.25	16.78	15.50	12.51
11	11	6.73	17.29	16.14	13.38
12	12	6.90	17.15	16.21	13.42
13	13	6.36	18.01	17.92	14.09
14	14	7.05	18.24	17.32	14.20
15	15	6.40	17.94	16.23	13.52
16	16	5.54	17.25	16.92	13.23
17	17	6.40	18.27	17.25	13.97
18	18	6.29	17.21	16.40	13.30
19	19	6.32	17.30	16.72	13.44
20	20	6.30	18.49	17.05	13.94
21	21	6.14	16.12	15.24	12.50
22	22	6.10	16.74	15.25	12.69
23	23	6.18	17.25	16.50	13.31
24	24	6.33	16.34	15.21	12.62
25	25	5.84	15.74	14.21	11.93

26	26	6.02	16.21	15.00	12.41
27	27	6.12	16.72	15.12	12.65
28	28	6.25	15.75	14.40	12.13
29	29	6.15	17.75	16.20	13.36
30	30	5.63	15.24	14.12	11.66
31	31	6.10	16.25	15.13	12.49
32	32	6.04	17.02	15.99	13.01
33	33	6.00	16.82	15.04	12.62
34	34	5.89	15.78	14.34	12.00
35	35	5.64	16.70	15.25	12.53
36	36	5.44	15.24	14.58	11.25
37	37	6.74	16.27	15.58	12.86
38	38	5.99	16.72	15.40	12.70
39	39	6.02	17.23	16.54	13.26
40	40	5.75	16.25	15.20	12.40
	Mean	6.23	17.02	15.91	13.04
	Min.	5.44	15.24	14.12	11.25
	Max.	7.05	18.49	17.92	14.55

Table 26 : Chloride concentration in leaf at different primings

Sl. No.	Field No.	IP (%)	IIIP (%)	VP (%)	Avg. (%)
1	1	0.30	0.21	0.38	0.29
2	2.	0.32	0.20	0.39	0.30
3	3	0.35	0.25	0.43	0.34
4	4	0.40	0.28	0.51	0.39
5	5	0.28	0.20	0.34	0.27
6	6	0.39	0.24	0.48	0.37
7	7.	0.25	0.17	0.29	0.23
8	8	0.33	0.25	0.38	0.32
9	9	0.30	0.21	0.41	0.30
10	10	0.41	0.27	0.49	0.39
11	11	0.28	0.16	0.38	0.27
12	12	0.30	0.24	0.36	0.30
13	13	0.32	0.25	0.41	0.32
14	14	0.29	0.17	0.37	0.27
15	15	0.31	0.20	0.36	0.29
16	16	0.42	0.30	0.47	0.39
17	17	0.36	0.21	0.45	0.34
18	18	0.36	0.24	0.43	0.34
19	19	0.31	0.19	0.39	0.29
20	20	0.30	0.18	0.36	0.28
21	21	0.45	0.31	0.52	0.42
22	22	0.48	0.35	0.54	0.45
23	23	0.41	0.28	0.49	0.39
24	24	0.40	0.29	0.46	0.38
25	25	0.39	0.27	0.44	0.36

26	26	0.31	0.20	0.41	0.30
27	27	0.33	0.24	0.40	0.32
28	28	0.42	0.34	0.51	0.42
29	29	0.50	0.37	0.57	0.48
30	30	0.44	0.31	0.50	0.41
31	31	0.38	0.29	0.47	0.38
32	32	0.40	0.28	0.52	0.40
33	33	0.43	0.31	0.55	0.43
34	34	0.51	0.39	0.62	0.50
35	35	0.43	0.30	0.49	0.40
36	36	0.50	0.34	0.57	0.47
37	37	0.44	0.29	0.53	0.42
38	38	0.43	0.30	0.48	0.40
39	39	0.45	0.33	0.51	0.43
40	40	0.43	0.29	0.50	0.40
	Mean	0.38	0.26	0.45	0.36
	Min.	0.25	0.16	0.29	0.23
	Max.	0.51	0.39	0.57	0.50

Table 27 : Mandal wise data on mean, SD, CV, min. and max. leaf Nicotine, Reducing sugars and Chloride concentrations

Sl. No.	Mandal Name	Nicotine (%)	Reducing Sugars (%)	Chlorides (%)
1	Gyarampalli			
	Mean	0.70	13.56	0.31
	SD	6.55	0.70	4.94
	CV%	9.34	5.15	15.83
	Min:	0.62	12.33	0.23
	Max:	0.80	14.55	0.39
2	Rompicherla			
	Mean	0.73	13.48	0.32
	SD	7.06	0.56	5.18
	CV%	9.72	4.18	16.25
	Min:	0.62	12.51	0.27
	Max:	0.82	14.20	0.39
3	Kallur			
	Mean	0.76	13.22	0.36
	SD	3.59	0.57	5.97
	CV%	4.75	4.34	16.57
	Min:	0.72	12.50	0.28
	Max:	0.81	13.97	0.45
4	Gandaboinapalli			
	Mean	0.75	12.44	0.40
	SD	3.96	0.49	6.02
	CV%	5.25	3.95	15.04
	Min:	0.70	11.66	0.30
	Max:	0.81	13.36	0.50

5 Madanapalli

Mean	0.78	12.49	0.42
SD	2.70	0.76	2.88
CV%	3.45	6.09	6.79
Min:	0.75	11.25	0.40
Max:	0.82	13.26	0.47

7 All Mandals

Mean	0.74	13.04	0.36
SD	5.55	0.76	0.066
CV%	7.48	5.82	18.32
Min.	0.62	11.25	0.23
Max.	0.82	14.55	0.50

(Mean value of 0.38%) and fifth primings (Mean value of 0.45%). Its concentration ranged from 0.25 to 0.51%, 0.16 to 0.39% and 0.29 to 0.57% in the three picks respectively. Average leaf chlorides varied from 0.23 to 0.50% with mean value of 0.36% (Table 26).

Gandaboinapalli and Madanapalli mandals recorded slightly higher leaf chlorides (Mean values of 0.40% and 0.42% respectively) than Gyarampalli, Rompicherla and Kallur mandals. Least variations (Cv of 6.79%) in respect of leaf chlorides were found in Madanapalli mandal (Table 27).

4.10 CURED LEAF YIELDS

Data on cured leaf yields from all the forty experimental fields are presented in Table 28. Mandal wise means and ranges of cured leaf yields are presented in Table 29.

Cured leaf yields ranged from 241.00 to 502.00 kg/ha with a mean of 368.00 kg/ha. Lowest yield (241.00 kg/ha) was recorded in field no. 27 and highest yield (502.00 kg/ha) was recorded in field no. 10 (Table 28).

Mean cured leaf yields in different mandals indicate that lowest mean yield (341.00 kg/ha) was recorded in Gandaboinapalli mandal while the highest mean yield (394.00 kg/ha) in Madanapalli mandal variations in cured

Table 28 : Cured leaf yield data of experimental fields.

Sl. No.	Field No.	Cured leaf yield (kg /ha)
1	1	317.00
2	2	340.00
3	3	416.00
4	4	464.00
5	5	312.50
6	6	361.30
7	7	271.00
8	8	399.00
9	9	425.50
10	10	502.00
11	11	337.00
12	12	300.00
13	13	382.50
14	14	294.00
15	15	381.00
16	16	372.00
17	17	392.50
18	18	425.00
19	19	412.00
20	20	354.50
21	21	375.00
22	22	344.40
23	23	421.50
24	24	385.00
25	25	299.40

26	26	274.50
27	27	241.00
28	28	373.50
29	29	339.00
30	30	399.00
31	31	301.50
32	32	354.00
33	33	372.00
34	34	402.00
35	35	399.00
36	36	378.00
37	37	380.00
38	38	410.50
39	39	401.50
40	40	398.00
	Mean	367.68
	Min.	241.00
	Max.	502.00

Table 29 : Mandal wise data on mean, SD, CV, min. and max. cured leaf yield in experimental fields.

Sl. No.	Mandal Name	Cured leaf yield (kg / ha)
1	Gyarampalli	
	Mean	367.37
	SD	62.95
	CV%	17.14
	Min:	271.00
	Max:	464.00
2	Rompicherla	
	Mean	366.93
	SD	70.00
	CV%	19.08
	Min:	294.00
	Max:	502.00
3	Kallur	
	Mean	388.74
	SD	29.96
	CV%	7.71
	Min:	344.40
	Max:	425.00
4	Gandaboinapalli	
	Mean	341.35
	SD	55.09
	CV%	16.14
	Min:	241.00
	Max:	402.0

5 Madanapalli

Mean	393.5
SD	14.04
CV%	3.57
Min:	378.00
Max:	410.50

6. All Mandals

Mean	367.68
SD	53.84
CV%	14.64
Min.	241.00
Max.	502.00

leaf yields were large in Rompicherla mandal (Cv of 19.08%) and small in Madanapalli mandal with Cv of 3.57% (Table 29).

4.11 MAJOR NUTRIENT (N, P & K) UPTAKE BY LEAF

Data pertaining to major nutrient (Nitrogen, Phosphorus and Potassium) uptake by leaf are presented in Table 30. Mean, SD and CV of major nutrient uptake are presented in Table 31.

4.11.1 Nitrogen uptake by leaf

N uptake by leaf ranged from 5.09 to 14.90 kg/ha with a mean value of 10.09 kg/ha. Maximum uptake (14.90 kg/ha) of N was found in field no. 10 and least uptake (5.09 kg/ha) was recorded in field no. 7 (Table 30).

Out of the five mandals, higher N uptake by leaf was found in Kallur (Mean value of 11.05 kg/ha) and Madanapalli mandals (Mean value of 11.13 kg/ha). Similarly, the variations in N uptake were minimum in these mandals (Cv of 8.75% and 3.62% respectively). (Table 31).

4.11.2 Phosphorus uptake by leaf

Data presented in Table 30 showed that P uptake varied from 0.27 to 1.15 kg/ha with mean value of 0.57 kg/ha. Maximum P uptake was found in field no. 10 and minimum in field no. 27 (Table 30).

Table 30: Major nutrient uptake by leaf

Sl. No.	Field No.	N (Kg/ha)	P (Kg/ha)	K (Kg/ha)
1	1	7.38	0.63	6.63
2	2	8.77	0.78	7.65
3	3	11.64	0.58	9.69
4	4	13.78	0.93	9.98
5	5	6.81	0.69	4.16
6	6	9.13	0.46	10.08
7	7	5.09	0.41	6.56
8	8	11.69	0.60	9.38
9	9	11.95	0.77	6.08
10	10	14.90	1.15	14.90
11	11	8.93	0.61	7.89
12	12	7.71	0.66	6.57
13	13	10.74	0.50	11.02
14	14	6.49	0.53	7.29
15	15	10.02	1.07	6.59
16	16	11.01	0.82	6.96
17	17	11.18	0.75	6.83
18	18	12.28	0.55	12.24
19	19	11.74	0.78	11.17
20	20	9.64	0.50	6.56
21	21	10.84	0.38	6.15
22	22	10.13	0.62	5.20
23	23	12.18	0.51	9.74
24	24	10.43	0.50	8.93
25	25	7.46	0.33	6.44

26	26	7.10	0.38	3.65
27	27	6.00	0.27	3.06
28	28	9.90	0.49	4.44
29	29	10.14	0.41	5.02
30	30	10.09	0.56	10.17
31	31	8.83	0.36	4.49
32	32	10.30	0.39	5.84
33	33	10.75	0.52	6.18
34	34	11.46	0.56	8.28
35	35	11.45	0.44	7.78
36	36	10.96	0.49	3.70
37	37	10.60	0.49	6.16
38	38	11.49	0.62	10.43
39	39	11.19	0.48	10.10
40	40	11.42	0.36	7.80
	Mean	10.09	0.57	7.54
	SD	2.09	0.19	2.59
	CV (%)	20.72	33.56	34.28
	Min.	5.09	0.27	3.06
	Max.	14.90	1.15	14.90

Table 31 : Mandal wise data on mean, SD, CV, min. and max. major nutrient uptake by leaf.

Sl. No.	Mandal Name	N (Kg/ha)	P (Kg/ha)	K (Kg/ha)
1	Gyarampalli			
	Mean	9.58	0.65	7.80
	SD	2.86	0.16	2.10
	CV%	29.86	25.09	26.87
	Min:	5.09	0.41	4.16
	Max:	13.78	0.93	10.08
2	Rompicherla			
	Mean	9.97	0.76	8.74
	SD	2.72	0.26	3.12
	CV%	27.24	34.05	35.69
	Min:	6.49	0.50	6.57
	Max:	14.90	1.15	14.90
3	Kallur			
	Mean	11.05	0.57	8.35
	SD	0.97	0.14	2.55
	CV%	8.75	23.64	30.57
	Min:	9.64	0.38	5.20
	Max:	12.28	0.78	12.24
4	Gandaboinapalli			
	Mean	9.41	0.43	5.94
	SD	1.82	9.52	2.14
	CV%	19.40	22.23	36.03
	Min:	6.00	0.27	3.06
	Max:	11.46	0.56	10.17
5	Madanapalli			
	Mean	11.13	0.49	7.64
	SD	0.36	9.20	2.81
	CV%	3.26	18.86	36.78
	Min:	10.60	0.36	3.70
	Max:	11.49	0.62	10.43

Relatively higher P uptake by leaf was noticed in Rompicherla mandal (Mean value of 0.76 kg/ha) followed by Gyarampalli (Mean value of 0.65 kg/ha) and Kallur mandal (mean value of 0.57 kg/ha). Similar trend was observed with respect to variations in P uptake in the above mandals (Table 31).

4.11.3 Potassium uptake by leaf

Potassium uptake ranged from 3.06 to 14.90 kg/ha. The mean value was found to be 7.54 kg/ha. Maximum and minimum K uptake were recorded in field no. 10 and field no. 27 respectively.

In all the five mandals leaf K uptake was almost similar i.e mean values of K uptake are almost similar while slightly wider variations in K uptake was found in Madanapalli (Cv of 36.78%), Gandaboinapalli (36.03%) and Rompicherla mandals (Cv of 35.69%) compared to Kallur (Cv of 30.57%) and Gyarampalli (Cv of 26.87%) mandals (Table 31).

4.12 Secondary nutrient (Ca & Mg) uptake by leaf

Data on secondary nutrient (Ca & Mg) uptake by leaf are presented in Table 32 and the data pertaining to Mean, SD and CV of secondary nutrient uptake in five mandals are presented in Table 33.

Table 32 : Secondary nutrient uptake by leaf

Sl. No.	Field No.	Ca (Kg/ha)	Mg (Kg/ha)
1	1	3.99	0.54
2	2.	4.90	0.61
3	3	6.03	0.75
4	4	9.28	0.93
5	5	4.13	0.41
6	6	4.62	0.51
7	7.	4.44	0.30
8	8	6.90	0.80
9	9	8.94	0.85
10	10	8.94	0.90
11	11	4.31	0.40
12	12	4.20	0.48
13	13	5.43	0.61
14	14	4.32	0.47
15	15	6.71	0.65
16	16	5.06	0.45
17	17	6.08	0.63
18	18	8.80	0.85
19	19	7.79	0.82
20	20	6.24	0.64
21	21	3.79	0.38
22	22	4.96	0.41
23	23	6.36	0.63
24	24	3.54	0.54
25	25	3.08	0.36

26	26	3.95	0.30
27	27	2.29	0.27
28	28	3.44	0.45
29	29	4.51	0.41
30	30	3.79	0.40
31	31	3.02	0.33
32	32	4.50	0.42
33	33	3.61	0.37
34	34	6.15	0.60
35	35	6.10	0.56
36	36	5.44	0.49
37	37	3.50	0.42
38	38	4.15	0.49
39	39	4.17	0.48
40	40	4.94	0.52
Mean		5.16	0.54
SD		1.75	0.17
CV (%)		33.87	32.58
Min.		2.29	0.27
Max.		9.28	0.93

Table 33 : Mandal wise data on mean, SD, CV, min. and max. leaf secondary nutrient uptake by leaf

Sl. No.	Mandal Name	Ca (Kg/ha)	Mg (Kg/ha)
1	Gyarampalli		
	Mean	5.91	0.63
	SD	2.04	0.21
	CV%	34.46	33.58
	Min:	3.99	0.30
	Max:	9.28	0.93
2	Rompicherla		
	Mean	5.57	0.57
	SD	1.73	0.17
	CV%	31.08	30.46
	Min:	4.2	0.40
	Max:	8.94	0.90
3	Kallur		
	Mean	5.95	0.61
	SD	1.82	0.17
	CV%	30.64	27.68
	Min:	3.54	0.38
	Max:	8.80	0.85
4	Gandaboinapalli		
	Mean	4.04	0.41
	SD	1.22	0.10
	CV%	30.08	24.91
	Min:	2.29	0.27
	Max:	6.15	0.60
5	Madanapalli		
	Mean	4.44	0.48
	SD	0.76	3.67
	CV%	17.04	7.65
	Min:	3.50	0.42
	Max:	5.44	0.52

Data presented in Table 32 revealed that the Ca & Mg uptake by leaf ranged from 2.29 to 9.28 kg/ha and 0.27 to 0.93 kg/ha with mean values of 5.16 kg/ha and 0.54 kg/ha respectively. Maximum values of Ca & Mg uptake were found in field no. 4 and least uptake was recorded in field no. 27.

Mandal wise data presented in Table 33 showed that relatively higher uptake of Ca and Mg by leaf was recorded in Gyarampalli, Rompicherla and Kallur mandals (Mean values of 5.91, 5.57 and 5.95 Kg/ha respectively). Where as minor variations in Ca and Mg uptake were observed in Madanapalli mandal compared to the remaining mandals.

4.13 MICRONUTRIENT (FE, MN, ZN, CU AND CL) UPTAKE BY LEAF

Data on micronutrient (Iron, Manganese, Zinc, Copper and Chloride) uptake by leaf are presented in Table 34 and mandal wise data pertaining to mean, SD and CV are presented in Table 35.

4.13.1 Iron uptake by leaf

The uptake of Fe by leaf ranged from 11.47 to 33.73 gm/ha with a mean value of 20.22 gm/ha. Maximum Fe uptake was recorded in field no. 4 and minimum was found in field no. 27 (Table 34).

Among the five mandals, the uptake of Fe by plants in Gyarampalli mandal was high (Mean value of 25.01 gm/ha) and variations in Fe uptake were also maximum (CV of 21.62%) in this mandal (Table 35).

4.13.2 Manganese uptake by leaf

In experimental fields the Manganese uptake ranged from 13.35 to 35.99 gm/ha with mean value of 23.89 gm/ha. Maximum and minimum Mn uptake was recorded in field no. 10 and field no. 27 respectively (Table 34).

Among five mandals, relatively minor variations (Cv of 9.82%). In Mn uptake were observed in Madanapalli mandal.

4.13.3 Zinc uptake by leaf

Zn uptake ranged from 4.36 to 10.29 gm/ha with mean value of 7.05 gm/ha. As in the case of Manganese, Zn uptake also found to be maximum (10.29 gm/ha) in field no. 10 and minimum (4.36 gm/ha) in field no. 27 (Table 34).

In all the five mandals, almost uniform uptake of Zinc was noticed by the plants.

4.13.4 Copper uptake by leaf

Data in Table 34 indicated that Cu uptake ranged from 5.11 to 11.32 gm/ha with a mean value of 8.15 gm/ha. Maximum uptake was found in field no. 4 and minimum uptake in field no. 26 and 27.

Among the five mandals, slightly higher Cu uptake values were registered in Gyarampalli, Rompicherla and Kallur mandals while minor variations in Cu uptake were observed in Madanapalli mandal with Cv of 8.69% (Table 35).

4.13.5 Chloride uptake by leaf

The uptake of chlorides by leaf ranged from 0.62 to 2.01 with a mean value of 1.34 kg/ha. Maximum uptake was recorded in field no. 34 and minimum was found in field no. 7 (Table 34).

Data presented in Table 35 showed that mean values of chloride uptake were almost similar in all the five mandals (Mean values of 1.17, 1.19, 1.39, 1.39 and 1.67 kg/ha in Gyarampalli, Rompicherla, Kallur, Gandaboinapalli and Madanapalli mandals respectively). where as minor variations (Cv. of 4.91%) in chloride uptake by leaf were found in Madanapalli mandal.

Table 34 : Micronutrient uptake by leaf

Sl. No.	Field No.	Fe (gm/ha)	Mn (gm/ha)	Zn (gm/ha)	Cu (gm/ha)	Cl (kg/ha)
1	1	20.20	25.99	5.99	9.13	0.92
2	2.	20.74	27.54	5.88	9.69	1.02
3	3	29.58	34.11	8.61	11.15	1.41
4	4	33.73	33.41	9.51	11.32	1.81
5	5	24.56	24.50	6.44	8.09	0.84
6	6	32.19	28.11	8.27	8.71	1.34
7	7.	22.60	20.87	6.02	6.72	0.62
8	8	21.79	28.93	7.54	10.69	1.28
9	9	19.74	30.89	9.06	9.45	1.28
10	10	23.04	35.99	10.29	10.74	1.96
11	11	19.01	24.74	6.61	9.74	0.91
12	12	19.89	21.90	5.52	8.64	0.90
13	13	28.46	26.09	8.45	7.11	1.22
14	14	23.87	24.31	6.14	8.94	0.79
15	15	20.54	26.63	7.62	10.63	1.10
16	16	17.67	24.44	7.03	10.64	1.45
17	17	20.80	25.39	7.38	8.56	1.33
18	18	22.82	28.52	9.31	9.35	1.45
19	19	21.14	27.44	7.66	10.55	1.19
20	20	19.14	25.91	6.56	10.10	0.93
21	21	20.81	22.54	6.98	6.75	1.58
22	22	18.77	20.42	6.54	6.03	1.55
23	23	19.64	22.72	8.73	7.54	1.64
24	24	15.86	20.48	7.01	7.01	1.46
25	25	16.47	17.51	4.85	6.62	1.08

26	26	13.94	14.96	4.86	5.11	0.82
27	27	11.47	13.35	4.36	5.11	0.77
28	28	17.26	19.87	7.02	8.40	1.57
29	29	17.26	19.29	6.10	6.31	1.63
30	30	16.64	24.98	8.14	8.46	1.64
31	31	14.50	17.55	5.55	5.85	1.15
32	32	14.55	21.35	6.51	7.65	1.42
33	33	19.79	20.53	6.84	7.25	1.60
34	34	18.37	23.88	6.95	6.47	2.01
35	35	16.99	20.59	6.78	6.26	1.60
36	36	17.65	19.24	7.11	6.88	1.78
37	37	18.43	20.37	6.95	6.31	1.60
38	38	18.19	24.34	6.98	7.80	1.64
39	39	19.05	23.66	6.66	7.62	1.72
40	40	21.57	22.41	7.08	6.81	1.59
	Mean	20.22	23.89	7.05	8.15	1.34
	SD	4.60	4.86	1.29	1.75	0.35
	CV (%)	22.76	20.34	18.33	21.51	26.49
	Min.	11.47	13.35	4.36	5.11	0.62
	Max.	33.73	35.99	10.29	11.32	2.01

Table 35 : Mandal wise data on mean, SD, CV, min. and max. leaf micronutrient uptake by leaf.

Sl. No.	Mandal Name	Fe (gm/ha)	Mn (gm/ha)	Zn (gm/ha)	Cu (gm/ha)	Cl (kg/ha)
1	Gyarampalli					
	Mean	25.01	28.26	7.48	9.44	1.17
	SD	5.41	4.22	1.44	1.50	0.36
	CV%	21.62	14.94	19.21	15.86	30.50
	Min:	19.74	20.87	5.88	6.72	0.62
	Max:	33.73	34.11	9.51	11.32	1.81
2	Rompicherla					
	Mean	21.78	26.30	7.38	9.49	1.19
	SD	3.66	4.53	1.60	1.35	0.41
	CV%	16.79	17.23	21.70	14.22	34.17
	Min:	17.67	21.90	5.52	7.11	0.79
	Max:	28.46	35.99	10.29	10.74	1.96
3	Kallur					
	Mean	19.87	24.18	7.52	8.24	1.39
	SD	2.07	3.08	1.01	1.66	0.24
	CV%	10.41	12.75	13.43	20.13	16.92
	Min:	15.86	20.42	6.54	6.03	0.93
	Max:	22.82	28.52	9.31	10.55	1.64
4	Gandaboinapalli					
	Mean	16.11	19.44	6.18	6.68	1.39
	SD	2.32	3.48	1.15	1.16	0.39
	CV%	14.39	17.91	18.65	17.31	27.76
	Min:	11.47	13.35	4.36	5.11	0.77
	Max:	19.79	24.98	8.14	8.46	2.01
5	Madanapalli					
	Mean	18.98	22.00	6.96	7.08	1.67
	SD	1.53	2.16	0.18	0.62	0.08
	CV%	8.08	9.82	2.56	8.69	4.91
	Min:	17.65	19.24	6.66	6.31	1.59
	Max:	21.57	24.34	7.11	7.80	1.78

4.14 CORRELATION STUDIES BETWEEN SOIL NUTRIENTS AND LEAF NUTRIENTS BETWEEN SOIL NUTRIENTS AND LEAF COMPOSITION AND CORRELATION BETWEEN SOIL PROPERTIES AND LEAF QUALITY PARAMETERS

4.14.1 *Correlation coefficients between soil major nutrients (N, P & K) and leaf major nutrient (N, P & K)*

Simple correlation coefficients were worked out between soil major nutrients and leaf major nutrients and the values are presented in Table 36.

The results showed that soil nitrogen was significantly and positively correlated at 1% level with leaf nitrogen (0.939**, 0.945** and 0.926**) in all the three picks. Similarly soil phosphorus and soil potassium were significantly correlated at 1% level with leaf phosphorus and leaf potassium in all the three picks. Soil nitrogen content had no correlation with soil phosphorus, soil potassium, leaf phosphorus and leaf potassium. Similarly soil phosphorus content had no correlation with soil nitrogen, leaf nitrogen, soil potassium and leaf potassium. Soil potassium content also did not have significant correlation with soil nitrogen, soil phosphorus, leaf nitrogen and leaf phosphorus.

For the correlation between soil N and leaf N highest correlation coefficient was observed for the correlation between soil N and leaf N of the

Table 36 : Correlation coefficients between soil major nutrients and leaf major nutrients

S No	SN	LN ₁	LN ₃	LN ₅	LN _A	SP	LP ₁	LP ₃	LP ₅	LP _A	SK	LK ₁	LK ₃	LK ₅	LK _A
1	SN	1.000													
2	LN ₁	0.939**	1.000												
3	LN ₃	0.945**	1.000												
4	LN ₅	0.926**	0.994**	1.000											
5	LN _A	0.939**	0.997**	0.996**	1.000										
6	SP	-0.183	-0.181	-0.194	-0.191	1.000									
7	LP ₁	-0.137	-0.134	-0.148	-0.146	0.955**	1.000								
8	LP ₃	-0.198	-0.193	-0.204	-0.202	0.944**	0.984**	1.000							
9	LP ₅	-0.204	-0.194	-0.208	-0.203	0.943**	0.974**	0.994**	1.000						
10	LPA	-0.185	-0.179	-0.191	-0.188	0.952**	0.987**	0.997**	0.994**	1.000					
11	SK	-0.043	-0.034	-0.018	-0.022	0.053	0.023	0.016	0.011	0.022	1.000				
12	LK ₁	-0.083	-0.073	-0.056	-0.060	0.149	0.117	0.119	0.118	0.121	0.971**	1.000			
13	LK ₃	-0.072	-0.075	-0.062	-0.068	0.138	0.091	0.079	0.070	0.081	0.922**	0.947**	1.000		
14	LK ₅	-0.081	-0.081	-0.069	-0.075	0.145	0.089	0.076	0.067	0.078	0.911**	0.935**	0.996**	1.000	
15	LK _A	-0.090	-0.107	-0.093	-0.099	0.166	0.122	0.109	0.098	0.110	0.906**	0.939**	0.957**	0.955**	1.000

* Significant at 5% level

** Significant at 1% level

3rd priming. (0.945**). Correlation coefficients were maximum for the correlations between soil nutrients and leaf nutrients in respect of P and K in the first priming (0.955** & 0.971**) and low in the fifth priming (0.943** & 0.911**).

4.14.2 *Correlation coefficients between soil secondary nutrients (Ca & Mg) leaf secondary nutrients (Ca & Mg)*

The effect of soil secondary nutrients on leaf secondary nutrients were studied with respect to their correlation and are presented in Table 37.

Highly significant positive correlation existed among soil calcium, soil magnesium, leaf calcium and leaf magnesium in all the three primings. Correlation coefficients ranged from 0.68 to 0.998 for the correlations between Soil Ca, soil Mg, leaf Ca and leaf Mg. Correlations between soil Ca and leaf Ca in different primings indicated maximum correlation values for the first priming (0.966**) and minimum in the fifth priming (0.953**). Similarly correlation coefficient was high for the correlation between soil Mg and leaf Mg in the first priming (0.737**). Correlation coefficients were decreased with the increase in priming number for the correlations between soil Mg and leaf Mg.

Table 37 : Correlation coefficients between soil secondary nutrients and leaf secondary nutrients

S. No.	SCa	LCa ₁	LCa ₃	LCa ₅	LCa _A	SMg	LMg ₁	LMg ₃	LMg ₅	LMg _A
1.	SCa	1.000								
2.	LCa ₁	0.966**	1.000							
3.	LCa ₃	0.957**	0.988**	1.000						
4.	LCa ₅	0.953**	0.984**	0.997**	1.000					
5.	LCa _A	0.962**	0.995**	0.998**	0.997**	1.000				
6.	SMg	0.808**	0.871**	0.858**	0.860**	0.867**	1.000			
7.	LMg ₁	0.737**	0.823**	0.831**	0.831**	0.832**	0.907**	1.000		
8.	LMg ₃	0.719**	0.797**	0.812**	0.811**	0.809**	0.867**	0.983**	1.000	
9.	LMg ₅	0.680**	0.751**	0.776**	0.774**	0.769**	0.821**	0.951**	0.979**	1.000
10.	LMg _A	0.722**	0.800**	0.813**	0.811**	0.811**	0.883**	0.987**	0.992**	0.981**
										1.000

4.14.3 *Correlation coefficients between soil micronutrients (Fe, Mn, Zn & Cu) and leaf micronutrients (Fe, Mn, Zn and Cu)*

The correlation coefficients were worked out between soil micronutrients and leaf micronutrients and results are presented in Table 38.

Highly significant positive correlations were observed between soil Fe status and leaf Fe concentration, soil Mn status and leaf Mn concentration, soil Zn status and leaf Zn concentration and soil Cu status and leaf Cu concentration in all the three primings.

Correlation coefficients between micronutrient status in soils and leaf were high in the first priming and low in the fifth priming. All the four micronutrients studied in this investigation exhibited highly significant positive correlation among themselves in respect of DTPA extractables.

4.14.4 *Correlation coefficients between soil nutrients and leaf composition*

The relationship between soil nutrients and leaf components were worked out and are presented in Table 39.

Among the soil nutrients, soil available N status showed highly significant positive correlation with soil chloride status and highly significant

able 38 : Correlation coefficients between soil micronutrients and leaf micro nutrients

S. No.	SFe	LFe ₁	LFe ₃	LFe ₅	LFe _A	SMn	LMn ₁	LMn ₃	LMn ₅	LMn _A
1.	SFe	1.000								
2.	LFe ₁	0.821**	1.000							
3.	LFe ₃	0.645**	0.788**	1.000						
4.	LFe ₅	0.585**	0.716**	0.959**	1.000					
5.	LFe _A	0.723**	0.881**	0.981**	0.950**	1.000				
6.	SMn	0.667**	0.805**	0.665**	0.619**	0.742**	1.000			
7.	LMn ₁	0.706**	0.759**	0.667**	0.642**	0.734**	0.933**	1.000		
8.	LMn ₃	0.637**	0.704**	0.647**	0.623**	0.702**	0.906**	0.967**	1.000	
9.	LMn ₅	0.653**	0.725**	0.643**	0.624**	0.706**	0.908**	0.970**	0.995**	1.000
10.	LMn _A	0.673**	0.736**	0.657**	0.635**	0.720**	0.924**	0.988**	0.995*	1.000
11.	SZn	0.527**	0.620**	0.615**	0.588**	0.650**	0.712**	0.774**	0.808**	0.800**
12.	LZn1	0.421**	0.556**	0.602**	0.592**	0.616**	0.487**	0.572**	0.577**	0.576**
13.	LZn3	0.270	0.426**	0.447**	0.404**	0.451**	0.257	0.321*	0.294	0.304
14.	LZn5	0.319*	0.368*	0.421**	0.365*	0.413**	0.329*	0.411**	0.476**	0.451**

15.	1/ZnA	0.406**	0.542**	0.586**	0.561**	0.593**	0.437**	0.528**	0.533**	0.541**	0.536**
16.	SCu	0.630**	0.759**	0.521**	0.451**	0.611**	0.897**	0.888**	0.875**	0.878**	0.888**
17.	LCuI	0.599**	0.734**	0.530**	0.456**	0.608**	0.845**	0.817**	0.793**	0.797**	0.809**
18.	LCu3	0.502**	0.499**	0.319*	0.257	0.382*	0.751**	0.748**	0.749**	0.743**	0.753**
19.	LCu5	0.506**	0.450**	0.301	0.346*	0.378*	0.681**	0.738**	0.740**	0.740**	0.745**
20.	LCuA	0.574**	0.604**	0.414**	0.382*	0.492**	0.812**	0.823**	0.813**	0.813**	0.823**

S. No.	SZn	LZn ₁	LZn ₃	LZn ₅	LZn _A	SCu	LCu ₁	LCu ₃	LCu ₅	LCu _A
1	SFe									
2	LFe ₁									
3	LFe ₃									
4	LFe ₅									
5	LFe _A									
6	SMn									
7	LMn ₁									
8	LMn ₃									
9	LMn ₅									
10	LMn _A									
11	SZn	1.000								
12	LZn ₁	0.813**	1.000							
13	LZn ₃	0.501**	0.689**	1.000						
14	LZn ₅	0.522**	0.568**	0.636**	1.000					
15	LZn _A	0.747**	0.921**	0.874**	0.790**	1.000				
16	SCu	0.693**	0.482**	0.297	0.382*	0.464**	1.000			

17	LCu ₁	0.629**	0.434**	0.241	0.303	0.397*	0.946**	1.000	
18	LCu ₃	0.476**	0.251	0.033	0.264	0.198	0.815**	0.841**	1.000
19	LCu ₅	0.497**	0.325*	0.053	0.208	0.216	0.739**	0.731**	0.883**
20	LCu _A	0.574**	0.364*	0.063	0.276	0.294	0.893**	0.920**	0.966**
									0.927**
									1.000

negative correlation with the micronutrient status viz., DTPA extractable Fe, Mn, Zn and Cu. It did not show correlation with available P, available K, exchangeable Ca and exchangeable Mg status of soils. High significant positive correlation was observed between soil nitrogen and leaf nitrogen ($r = 0.939^{**}$) and highly significant negative correlation between soil available N and leaf Fe ($r = -0.625^{**}$) between soil available N and leaf Mn ($r = -0.525^{**}$) and between soil available N and leaf Cu ($r = -0.525^{**}$). Soil available P status showed significant positive correlation with exchangeable Ca ($r = 0.321^{*}$), exchangeable Mg ($r = 0.475^{**}$), DTPA extractable Mn ($r = 0.361^{*}$), DTPA extractable Zn ($r = 0.441^{**}$), DTPA extractable Cu ($r = 0.592^{**}$), leaf P ($r = 0.952^{**}$), leaf Ca ($r = 0.359^{*}$), leaf Mg ($r = 0.408^{**}$), leaf Mn ($r = 0.600^{**}$) and leaf Cu ($r = 0.654^{**}$). It showed significant negative correlation with soil chlorides ($r = -0.407^{**}$). Available K status of soil showed significant positive correlation with leaf K ($r = -0.906^{**}$) and leaf Mn ($r = 0.330^{*}$).

Soil exchangeable Ca showed highly significant correlations with soil exchangeable Mg status ($r = 0.808^{**}$), leaf Ca ($r = 0.962^{**}$) and leaf Mg ($r = 0.722^{**}$). It also showed, positive significant correlation with phosphorus, Mn and Zn concentrations in leaf. Soil exchangeable Mg showed highly significant positive correlation with DTPA extractable Zn ($r = 0.534^{**}$) and Cu ($r = 0.530^{**}$) and with leaf Ca ($r = 0.867^{**}$), leaf Mg ($r = 0.883^{**}$), leaf

Mn ($r = 0.632^{**}$), leaf Zn ($r = 0.444^{**}$) and Cu ($r = 0.484^{**}$). K and Fe conc. in leaf were also significantly correlated with soil exchangeable Mg status.

Micronutrient (Fe, Mn, Zn and Cu) concentration in soil and leaf were significantly and positively correlated among themselves at 1% level. Soil chlorides exhibited significant positive correlation with leaf N ($r = 0.684^{**}$) and significant negative correlation with leaf P ($r = -0.428^{**}$), leaf Fe ($r = -0.556^{**}$), leaf Mn ($r = -0.717^{**}$), leaf Zn ($r = -0.374^{*}$) and leaf cu ($r = -0.756^{**}$).

Among the major nutrients soil available nitrogen status showed highly significant and positive correlation with leaf nicotine ($r = 0.926^{**}$), leaf chlorides ($r = 0.697^{**}$), where as reducing sugars in leaf were negatively correlated ($r = -0.545^{**}$) with soil available N status. Soil available K did not show significant correlation with leaf quality parameters. The correlation between soil available P and reducing sugars concentration in leaf was significant and positive ($r = 0.359^{*}$), where as it was significant and negative with leaf chlorides ($r = -0.393^{**}$).

Soil exchangeable Mg status showed highly significant positive correlation with reducing sugars ($r = 0.403^{**}$) and highly significant negative

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relationship with leaf chlorides ($r = -0.420^{**}$). Soil exchangeable Ca did not show significant correlation with leaf quality parameters. Nicotine concentration and chloride concentration in leaf were significantly and negatively correlated with DTPA extractable Fe, Mn, Zn and Cu concentrations in soils, where as reducing sugars concentration in leaf had highly significant positive correlation with DTPA extractable Fe, Mn, Zn and Cu in soil. Soil chlorides and leaf chlorides were highly correlated ($r = 0.945^{**}$). Correlation between soil chloride and leaf nicotine was highly significant and positive ($r = 0.778^{**}$) where as the correlation between soil chlorides and leaf reducing sugars was significant and negative ($r = -0.650^{**}$).

Nitrogen concentration in leaf was significantly positively correlated with nicotine concentration in leaf ($r = 0.862^{**}$). The correlation between leaf N and leaf reducing sugars was negative and highly significant ($r = -0.423^{**}$).

Leaf nicotine did not show correlation with leaf P, leaf K, leaf Ca, leaf Mg and leaf Zn, while it showed highly significant negative correlation with Fe ($r = -0.610^{**}$) with Mn ($r = -0.620^{**}$) and Cu ($r = -0.619^{**}$) concentration in leaf. Reducing sugar concentration in leaf was positively correlated with leaf P ($r = 0.368^{*}$), leaf K ($r = 0.344^{*}$) and leaf Mg ($r = 0.322^{*}$) at 5% level and with leaf Fe ($r = 0.631^{**}$), leaf Mn

Table 39 : Correlation coefficients between Soil nutrients and Leaf composition

S. No.	SN	SP	SK	SCa	SMg	SFe	SMn	SZn	SCu	SCI
1. SN	1.000									
2. SP	-0.183	1.000								
3. SK	-0.043	0.053	1.000							
4. SCa	0.155	0.321*	0.014	1.000						
5. SMg	-0.006	0.475**	0.145	0.808**	1.000					
6. SFe	-0.579**	0.298	0.118	0.227	0.303	1.000				
7. SMn	-0.503**	0.361*	0.048	-0.013	0.175	0.667**	1.000			
8. SZn	-0.454**	0.441**	0.266	0.350*	0.534**	0.527**	0.712**	1.000		
9. SCu	-0.653**	0.592**	0.176	0.279	0.530**	0.630**	0.897**	0.693**	1.000	
10. SCI	0.743**	-0.407**	-0.101	-0.186	-0.329*	-0.617**	-0.477**	-0.586**	-0.792**	1.000
11. LN _A	0.939**	-0.191	-0.041	0.138	0.026	-0.519**	-0.498**	-0.409**	-0.584**	0.684
12. LP _A	-0.185	0.952**	0.022	0.388	0.508**	0.329*	0.287	0.456**	0.573**	-0.428**
13. LK _A	-0.090	0.166	0.906**	0.203	0.361*	0.230	0.098	0.392*	0.292	-0.206
14. LCa _A	0.121	0.359*	0.034	0.962**	0.867**	0.273	0.018	0.424**	0.363*	-0.257

15.	LMg _A	0.088	0.408**	0.208	0.722**	0.883**	0.281	0.063	0.422**	0.422**	-0.298
16.	LFe _A	-0.625**	0.289	0.261	0.162	0.330*	0.723**	0.742**	0.650**	0.611**	-0.556**
17.	LMn _A	-0.525**	0.600**	0.330*	0.374*	0.632**	0.673**	0.924**	0.801**	0.888**	-0.717**
18.	LZn _A	-0.299	0.204	0.244	0.364*	0.444**	0.406**	0.437**	0.747**	0.464**	-0.374*
19.	LCu _A	-0.525**	0.654**	0.129	0.221	0.484**	0.574**	0.812**	0.574**	0.893**	-0.756**
20.	LNic _A	0.926**	-0.310	-0.215	0.149	0.092	-0.560**	-0.510**	-0.441**	-0.708**	0.778**
21.	LRS _A	-0.545**	0.359*	0.269	0.263	0.403**	0.665**	0.450**	0.552**	0.620**	-0.650**
22.	LCl _A	0.697**	-0.393*	-0.109	-0.293	-0.420**	-0.556**	-0.395*	-0.574**	0.725**	0.945**
23.	Avg. Yield	0.680**	0.082	0.340*	0.343*	0.352*	-0.306	-0.290	0.035	-0.214	0.440**

S. No.	I.N _A	LP _A	LK _A	LCa _A	LMg _A	LFe _A	LMn _A	LZn _A	LCu _A	LNic _A
1.	I.N _A									
2.										
3.	Av. K									
4.	Fix. Ca									
5.	Fix. Mg									
6.	Soil Fe									
7.	Soil Mn									
8.	Soil Zn									
9.	Soil Cu									
10.	Soil Cu									
11.	Avg.LN	1.000								
12.	Avg.L.P	-0.188	1.000							
13.	Avg.LK	-0.099	0.110	1.000						
14.	Avg. LCa	0.132	0.437**	0.238	1.000					

[illegible]

S. No.	LRS _A	LCl _A	Yield
21. Av. L.R'S	1.000		
22. Avg. L.Cl	-0.667**	1.000	
23. Yield	0.228	0.384*	1.000

($r = 0.678^{**}$), leaf Zn ($r = 0.444^{**}$) and leaf Cu ($r = 0.556^{**}$) at 1% level. Chloride concentration in leaf exhibited negative correlation with leaf P, leaf Ca, leaf Mg, leaf Fe, leaf Mn, leaf Zn and leaf Cu. Yield of different locations showed significant positive correlation with soil N ($r = 0.680^{**}$), soil chlorides ($r = 0.440^{**}$), leaf nitrogen ($r = 0.643^{**}$), leaf magnesium ($r = 0.468^{**}$) and leaf nicotine ($r = 0.593^{**}$) at 1% level and with soil potassium ($r = 0.340^{*}$) exchangeable Ca ($r = 0.343^{*}$), exchangeable Mg ($r = 0.352^{*}$), leaf potassium ($r = 0.353^{*}$), leaf calcium ($r = 0.382^{*}$) and leaf chlorides ($r = 0.384^{*}$) at 5% level.

4.14.5 *Correlation coefficients between soil physico chemical characteristics and leaf quality parameters*

The correlation coefficients between soil physico chemical characteristics and leaf quality parameters are presented in Table 40.

Sand fraction in soils showed highly significant positive correlation with reducing sugars in leaf ($r = 0.597^{**}$) and highly significant negative correlation with nicotine ($r = -0.403^{**}$) and chlorides ($r = -0.549^{**}$). Highly significant positive correlation was observed between soil clay and leaf nicotine ($r = 0.544^{**}$) and between soil clay and leaf chlorides ($r = 0.710^{**}$). The correlation between soil clay fraction and reducing sugars in leaf was highly significant and negative ($r = -0.669^{**}$).

Table 40 : Correlation coefficients between physico-chemical characteristics and leaf quality parameters

S. No.	NiC	RS	Cl	Yield	Sand	Silt	Clay	pH	EC
1. NiC	1.000								
2. RS	-0.562**	1.000							
3. Cl	0.716**	-0.667**	1.000						
4. Yield	0.593**	-0.228	0.384*	1.000					
5. Sand	-0.403**	0.597**	-0.549**	0.275	1.000				
6. Silt	0.100	-0.209	0.060	-0.438**	-0.714**	1.000			
7. Clay	0.544**	-0.669**	0.710**	-0.067	-0.864**	0.263	1.000		
8. pH	0.522**	-0.621**	0.721**	-0.013	-0.807**	0.224	0.950**	1.000	
9. EC	0.678**	-0.493**	0.712**	0.174	-0.584**	0.175	0.678**	0.674**	1.000

Soil pH and Ec showed highly significant positive correlations with the quality parameters viz., nicotine and chlorides and negative correlation with reducing sugars.

4.15 MULTIPLE LINEAR REGRESSION ANALYSIS BETWEEN LEAF QUALITY PARAMETERS AND YIELD AND SOIL NUTRIENTS.

The relative contribution of the soil nutrients and yield to leaf quality parameters was found out by fitting multiple regression equation.

4.15.1 *Multiple regression between Nicotine and yield and soil nutrients*

Nicotine concentration in leaf was regressed over yield and soil properties which showed significant correlation with nicotine. The resulting multiple regression equation is given below.

$$Y = 0.2284 + 0.0020x_1^{**} + 0.0013x_2 - 0.0018x_3 \\ + 0.1386x_4 - 0.1734x_5 + 0.0015x_6 - 0.0001x_7.$$

$$R^2 \text{ (Coefficient of determination)} = 88.95\%$$

$$Y = \text{Nicotine (\% in leaf)}$$

$$x_1 = \text{Soil available N (Kg / ha)}$$

$$x_2 = \text{DTPA extractable Fe (ppm)}$$

$$x_3 = \text{DTPA extractable Mn (ppm)}$$

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- x_4 = DTPA extractable Zn (ppm)
 x_5 = DTPA extractable Cu (ppm)
 x_6 = Soil chlorides (ppm)
 x_7 = Yield (kg / ha)
 r (Multiple correlation coefficient) = 0.9432

Coefficient of multiple correlation was found to be highly significant. About 89.0% of variation in nicotine were explained by available N, DTPA extractable Fe, Mn, Zn, Cu, soil chlorides and yield. Regression coefficient with respect to available N status of soil was significant at 1% level, where as other regression coefficient did not reach the level of significance.

4.15.2 Multiple regression between reducing sugars and soil nutrients

Concentration of reducing sugars in leaf was regressed over soil nutrient status which showed significant correlation with it. The resulting multiple regression equation is given below.

$$Y = 12.2368 - 0.0051 x_1 + 0.0103 x_2 + 0.1666 x_3 + 0.2118^{**} x_4 + 0.0409 x_5 + 0.6182 x_6 - 1.9392 x_7 - 0.0325 x_8.$$

$$R^2 \text{ (Coefficient of determination)} = 57.91\%$$

$$Y = \text{Reducing Sugars (\% in leaf)}$$

$$x_1 = \text{Soil available N (Kg / ha)}$$

- x_2 = Soil available P (kg / ha)
 x_3 = Soil exchangeable Mg (me / 100 g)
 x_4 = DTPA extractable Fe (ppm)
 x_5 = DTPA extractable Mn (ppm)
 x_6 = DTPA extractable Zn (ppm)
 x_7 = DTPA extractable Cu (ppm)
 x_8 = Soil chlorides (ppm)
 r (Multiple correlation coefficient) = 0.7610**

Of the soil nutrients only DTPA extractable Fe had significant regression coefficient at 1% level, where as the regression coefficient of other nutrients was not significant. About 57.9% of variations in reducing sugars conc. in leaf was explained by available N, available P, exchangeable Mg, DTPA extractable Fe, Mn, Zn and Cu and soil chlorides.

4.15.3 *Multiple regression between leaf chlorides and yield and soil nutrients*

Variations in leaf chlorides were regressed over yield and soil nutrients which had significant correlations with it. The resulting multiple regression equation is given below.

$$Y = -0.3810 + 0.0006 x_1 - 0.0009 x_2 - 0.0162^{**} x_3 + 0.00314 x_4 + 0.0029 x_5 - 0.0382 x_6 + 0.3382^* x_7 + 0.0106^{**} x_8 + 0.0001 x_9.$$

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R^2 (Coefficient of determination) = 93.02%

Y = Leaf chlorides (%)

x_1 = Soil available N (Kg / ha)

x_2 = Soil available P (kg / ha)

x_3 = Soil exchangeable Mg (me / 100 g)

x_4 = DTPA extractable Fe (ppm)

x_5 = DTPA extractable Mn (ppm)

x_6 = DTPA extractable Zn (ppm)

x_7 = DTPA extractable Cu (ppm)

x_8 = Soil chlorides (ppm)

x_9 = Yield (kg / ha)

r (Multiple correlation coefficient) = 0.9645

The multiple correlation coefficient was highly significant. About 93.0% of variations in leaf chlorides were explained by available N, available P, exchangeable Mg, DTPA extractable Fe, Mn, Zn and Cu chlorides and yield. Among these regression coefficients, the regression coefficients of exchangeable Mg and soil chlorides were significant at 1% level. The regression coefficient with respect to DTPA extractable Cu was also found to be significant at 5% level.

4.15.4 Multiple Regression between yield and soil nutrients

Data on yield were regressed over soil properties which exhibited significant correlations with yield and the multiple regression equation is given below.

$$Y = -229.0108 + 1.4035^{**}x_1 + 0.4344^{**}x_2 - 0.5811x_3 + 21.1333x_4 + 1.3933x_5.$$

$$R^2 \text{ (Coefficient of determination)} = 70.67\%$$

$$Y = \text{Yield (kg / ha)}$$

$$x_1 = \text{Soil available N (Kg / ha)}$$

$$x_2 = \text{Soil available P (kg / ha)}$$

$$x_3 = \text{Soil exchangeable Ca (me / 100 g)}$$

$$x_4 = \text{Soil exchangeable Mg (me / 100 g)}$$

$$x_5 = \text{Soil chlorides (ppm)}$$

$$r \text{ (Multiple correlation coefficient)} = 0.8406$$

Multiple correlation coefficient was highly significant. 70.7% of variations in yield were explained by the variations in available N, available K, exchangeable Ca, exchangeable Mg and soil chlorides. Regression coefficients for available N and available K status of soil were highly significant.

4.16 CO-VARIANCE ANALYSIS

In order to estimate the multilocal performance of oriental tobacco in Chittoor district, the 40 locations (experimental fields) were grouped according to mandal wise into 5 groups. Taking each mandal as a group of locations and different locations within the mandal as replications, the data on yield and quality parameters were analysed according to completely Randomised Design with unequal number of replications.

The analysis of variance for the characters (cured leaf yield, leaf nitrogen, leaf nicotine, leaf reducing sugars and leaf chlorides) is presented in Tables 41 to 45.

The variations in yield between locations (Mandals) are not significant. As the yield was highly correlated with soil N, the effect of it on yield has been removed by using the analysis of covariance technique, taking soil N as the concomitant variable. After removing the effects of soil N, the adjusted means of yields varied significantly between locations (Mandals). The yields in Gyarampalli (M_1) mandal were significantly higher than the yields in Gandaboinapalli (M_4) and Madanapalli mandals (M_5) and were on a par with the yields in Rompicherla (M_2) and Kallur (M_3) mandals. Significant differences in adjusted mean yields were also observed in Rompicherla (M_2) and Gandaboinapalli (M_4) mandals and Kallur (M_3) and Gandaboinapalli (M_4) mandals.

Nitrogen concentration in leaf varied significantly between locations (mandals). Significant differences were observed between Gyarampalli (M_1) and Madanapalli (M_5) mandals, Kallur (M_3) and Madanapalli (M_5) mandals.

Nicotine concentration in leaf varied significantly between locations (Mandals). Leaf nicotine in Gyarampalli (M_1) mandal was significantly lower than the leaf nicotine in Gandaboinapalli (M_4) and Madanapalli (M_5) mandals. In rest of the comparisons, there were no significant differences in leaf nicotine concentration between locations.

Reducing sugars concentration in leaf varied significantly between locations (Mandals). Leaf reducing sugars were significantly lower in Gandaboinapalli (M_4) and Madanapalli (M_5) mandals than that in Gyarampalli (M_1), Rompicherla (M_2) and Kallur (M_3) mandals. It did not vary between Gandaboinapalli (M_4) and Madanapalli (M_5) mandals.

Leaf chloride concentration varied significantly between locations (Mandals). Significantly higher chlorides in leaf were recorded in Gandaboinapalli (M_4) and Madanapalli (M_5) mandals than in Gyarampalli (M_1) and Rompicherla (M_2) mandals. Leaf chlorides were on a par in Gandaboinapalli (M_4) and Madanapalli (M_5) mandals.

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Table 41 : Mean values of cured leaf yield in different locations after removing the effect of concomitant variable soil nitrogen

Locations		Cured leaf yield kg ha ⁻¹ (Means)
(Gyarampalli)	M ₁	400
(Rompicherla)	M ₂	370
(Kallur)	M ₃	378
(Gandaboinapalli)	M ₄	336
(Madanapalli)	M ₅	358
	GM	368
	CV%	14.43
	F value	14.44**

Table of SE of difference of means and CD at 5% and 1% for different treatment combinations. (CD are given in parentheses).

	M ₁	M ₂	M ₃	M ₄	M ₅
M ₁		17.436 (34.17) (44.98)	16.81 (32.94) (43.36)	15.55** (30.47) (40.12)	19.298* (37.82) (49.79)
M ₂			17.907 (35.10) (46.20)	16.728* (32.78) (43.15)	20.26 (39.71) (52.27)
M ₃				16.078** (31.51) (41.48)	19.727 (38.66) (50.89)
M ₄					18.66 (36.57) (48.14)

* CD at 0.05 and 0.01 levels are given in paranthesis

Table 42 : Mean values of leaf nitrogen in different locations after removing the effect of concomitant variable soil nitrogen

Locations	% leaf Nitrogen (Means)
(M ₁)	2.74
(M ₂)	2.71
(M ₃)	2.78
(M ₄)	2.71
(M ₅)	2.63
GM	2.72
CV%	8.65
F value	3.0*

Table of SE of difference of means and CD at 5% and 1% for different treatment combinations. (CD are given in parentheses).

	M ₁	M ₂	M ₃	M ₄	M ₅
M ₁		0.0392 (0.08)	0.0451 (0.09)	0.035 (0.07)	0.0434* (0.09)
M ₂			0.0403 (0.08)	0.0376 (0.07)	0.0455 (0.09)
M ₃				0.0362 (0.07)	0.0444* (0.09)
M ₄					0.042 (0.08)
M ₅					

Table 43 : Mean values of leaf nicotine in different locations after removing the effect of concomitant variable soil nitrogen

Locations	% leaf nicotine (Means)
M ₁	0.70
M ₂	0.73
M ₃	0.75
M ₄	0.75
M ₅	0.78
GM	0.74
CV%	6.91
F value	4.69**

Table of SE of difference of means and CD at 5% and 1% for different treatment combinations. (CD are given in parentheses).

	M ₁	M ₂	M ₃	M ₄	M ₅
M ₁		0.0257 (0.05)	(0.0248) (0.05)	0.0229* (0.04)	0.0284* (0.06)
M ₂			0.0264 (0.05)	0.0247 (0.05)	0.0299 (0.06)
M ₃				0.0237 (0.05)	0.0291 (0.06)
M ₄					0.0275 (0.05)
M ₅					

Table 44 : Mean values of leaf reducing sugars in different locations after removing the effect of concomitant variable soil nitrogen

Locations	% Leaf Reducing Sugar (Means)
M ₁	13.68
M ₂	13.49
M ₃	13.22
M ₄	12.43
M ₅	12.48
GM	13.04
CV%	4.65
F value	5.36**

Table of SE of difference of means and CD at 5% and 1% for different treatment combinations. (CD are given in parentheses).

	M ₁	M ₂	M ₃	M ₄	M ₅
M ₁		0.2687 (0.53) (0.69)	0.259 (0.51) (0.67)	0.2396** (0.47) (0.62)	0.2974** (0.58) (0.77)
M ₂			0.2759 (0.54) (0.71)	0.2578** (0.51) (0.67)	0.3122** (0.61) (0.81)
M ₃				0.2477** (0.49) (0.64)	0.304* (0.60) (0.78)
M ₄					0.2876 (0.56) (0.74)
M ₅					

Table 45 : Mean values of leaf chlorides in different locations after removing the effect of concomitant variable soil nitrogen

Locations	% leaf chlorides (Mean)
M ₁	0.31
M ₂	0.32
M ₃	0.36
M ₄	0.40
M ₅	0.42
GM	0.36
CV%	14.81
F value	6.16**

Table of SE of difference of means and CD at 5% and 1% for different treatment combinations. (CD are given in parentheses).

	M ₁	M ₂	M ₃	M ₄	M ₅
M ₁		0.0271 (0.05) (0.07)	0.0262 (0.05) (0.07)	0.0242** (0.05) (0.06)	0.030** (0.06) (0.08)
M ₂			0.0279 (0.05) (0.07)	0.0260** (0.05) (0.07)	0.03** (0.06) (0.08)
M ₃				0.0250 (0.05) (0.06)	0.03* (0.06) (0.08)
M ₄					0.029 (0.06) (0.08)
M ₅					

DISCUSSION

CHAPTER - V

DISCUSSION

The results obtained in the present investigation are discussed in this chapter.

Soil properties

Soil texture in the experimental fields varied from sandy loams to sandy clay loams. Majority of the soils (70%) are sandy loams while the rest are sandy clay loams with the exception of one field. Mean values of sand, silt and clay are 62.04% , 22.27% and 15.68%, respectively. Similar results were reported by Ranganayakulu *et al.* (1986) in their study of the nutrient status of alfisols of Chittoor district. The reports of Stella (1923) and Taylor (1924) also indicated that good aromatic tobacco can be grown on sandy loams and sandy clay loams.

All the soils in Gyarampalli and Rompicherla mandals were sandy loams where as 80 % of soils in Madanapalli mandal and a few soils (37 %) in Kallur and Gandaboinapalli mandals were sandy clay loams. The mean clay content was found to be higher in Kallur, Gandaboinapalli and Madanapalli mandals. This could be due to variations in parent material and weathering processes.

Soil pH ranged from slightly acidic to moderately alkaline. Thirty five per cent of soils were slightly acidic, 15% were medium acidic, 30% were neutral, 15% were mildly alkaline and only 5% were moderately alkaline. Soil pH varied from 5.8 to 7.9 with a mean value of 6.75. Similar observations were made by Ranganayakulu et al.(1986) in their studies of alfisols of Chittoor district. Soils with pH in acidic range were more suitable for production of oriental tobacco (Filiposki, 1993) while Trajkoski (1995) found that tobacco producing region of cinnamon forest soils were low acid to low alkaline in reaction. The values obtained in the present investigation were within the ranges reported by the above workers and also the quality of aromatic tobacco produced in those soils was good. Gandaboinapalli, Madanapalli and Kallur mandals recorded higher pH values (Mean values of 7.21, 7.76 and 6.71, respectively) than Gyrapalli and Rompicharla mandals. These high pH values can be attributed comparatively to less leaching of bases in sandy clay loams than in sandy loams.

All the soils were non-saline in nature as the E.C of soils was less than 0.4 dSm^{-1} which are ideally suitable for tobacco cultivation. Out of the five mandals, the soils of Kallur, Gandaboinapalli and Madanapalli mandals had relatively higher EC values (Mean values of 0.25, 0.24 and 0.27 dSm^{-1} , respectively). This could be due to retention of more salts in sandy clay loams than in sandy loams.

Distribution and availability of soil nutrients

With out any exception all the soils were found to have low N content ranging from 141.12 to 245.56 kg N/ha. Low nitrogen status could be due to low organic matter content and the semi arid conditions of the areas might have favoured rapid oxidation and lesser accumulation of organic matter releasing more nitrate nitrogen which would have been lost by leaching. Similar results were reported by Ramamoorthy and Bajaj (1969) and Ranganayakulu et al. (1986).

The available P content of soils ranged from low to medium. Seventy three percent of soils were found to be medium and the remaining were low in available P status. Phosphorus content ranged from 8.02 to 18.90 kg P/ha with a mean value of 11.42 kg P/ha. The mean P content in Gandaboinapalli and Madanapalli mandals was reletively lower than the other mandals. The reason for the low availability of P in these mandals might be due to low native P and fixation of P by clay minerals in these sandy clay loams.

All the soils except one had medium available K content with a mean value of 194.95 kg K/ha. Similar findings in soils of Chittoor district were reported by Rammoorthy and Bajaj (1969). Of the five mandals, Gandaboinapalli mandal recorded lowest mean value of 178.89 kg K/ha. The lowest mean value of available K content in Gandaboinapalli mandal could

be attributed to lower amounts of K bearing minerals/total K content/K activity ratio.

The exchangeable Ca content ranged from 12.20 to 25.50 me/100 g of soil with a mean value of 18.33 me/100 g of soil. Exchangeable Mg content ranged from 5.25 to 8.91 me/100 g of soil with a mean value of 7.21 me/100 g of soil. These results were in confirmity with the reports of Ranganayakulu et al. (1986). Exchangeable Ca and Mg status of soils was sufficiently higher than the required, hence no deficiencies of either Ca or Mg were observed in the crop raised on these soils.

The available Fe content of experimental soils was above the critical limit of 2.5 ppm suggested for flue cured tobacco. It ranged from 8.10 to 12.84 ppm with a mean value of 10.55 ppm. Kallur, Gandaboinapalli and Madanapalli mandals recorded reletively lower mean values of Fe (Mean values of 9.57, 9.27 and 9.52 ppm. respectively) than Gyrapalli and Rompicherla mandals. This could be expected since a part of the soils were sandy clay loams. In these sandy clay loams the availability of Fe was comparitively low due to the fixation of Fe in layer lattice structures.

All the experimental fields had Mn content above the critical limit of 5.0 ppm in soil suggested for flue cured tobacco. All the soils of Gyrapalli and Rompicharla mandals and 50% soils in Kallur mandal had Mn content

above 10 ppm , while remaining soils in Kallur, Gandaboinapalli and Madanapalli mandals were found to have lower than 10 ppm Mn content. This could be attributed to the texture of soils. Zinc and Cu content of all the experimental soils was found to be above the critical limit of 0.2 ppm suggested for flue cured tobacco. Zn and Cu contents ranged from 0.61 to 0.84 ppm and 0.20 to 0.38 ppm with mean values of 0.71 ppm and 0.28 ppm respectively. Soils of Kallur, Gandaboinapalli and Madanapalli mandals have recorded relatively lower Zn and Cu content which may be due to comparatively heavy texture of soils. The values obtained in the present investigation with respect to soil micronutrients are within the ranges reported by Ranganayakulu et al. (1986).

Soils had chloride content below the critical limit of 100 ppm. Due to sandy clay loam texture, the soils of Kallur, Gandaboinapalli and Madanapalli mandals were found to have relatively higher chloride content (Mean values of 60.23, 60.97 and 64.37 ppm, respectively). As the soil chloride content was less than the permissible value, leaf chloride content of tobacco grown on these soils was low.

Leaf chemical composition and its distribution

Average leaf N concentration ranged from 1.88 to 2.99 % with a mean value of 2.72 % . It ranged from 1.81 to 3.00% in I priming, 1.94 to 3.04 %

in III priming and from 1.91 to 2.95 % in V priming. The total N content of leaf around 2.48 % was observed in Iragi tobaccos by Shafix (1974) and a range of 1.69 to 2.08 % in six varieties of oriental tobacco was noticed by Jalal shafix and Farhed Kaream (1983). The N content of aromatic tobacco produced in the present investigations falls in the desired range. High N concentration was found in III priming leaf compared to V priming leaf. This could be due to translocation of nitrogenous materials from the top leaves for the growth of the flowers, capsules and seeds (Darkis et al., 1947). Leaf N was lowest (mean value of 2.56 %) in Gyrampalli mandal is a consequence of low N status of soils in this mandal. Correlation data between leaf N and soil N in III priming was found to be significant at 0.01 level ($r=0.945^{**}$) followed by I priming ($r=0.939^{**}$) and V priming ($r=0.926^{**}$).

Phosphorus concentration in leaf decreased with increase in leaf position from bottom to top. Maximum P concentration was recorded in I priming compared to III and V primings. This could be due to utilisation of solution P by the first emerging leaves of the plant and also due to reduced availability in later stages due to limited soil water conditions. It could also be due to translocation of P to floral parts and seeds where preferential accumulation of P exists. Gyramapalli and Rompicharla mandals had higher leaf P concentration (mean values of 0.18 % and 0.21 % , respectively) which is accounted for the reletively higher available P content of soils in

these mandals. Correlation between leaf P and soil P revealed that soil P was significantly and positively correlated at 1% level with leaf P in all the three primings. Leaf P content was in the range normally reported for tobacco.

Compared to I and III primings lower K concentration was found in V priming (mean values of 2.23%, 2.04 and 1.90 % respectively). This gradual decrease in K concentration with increase in priming number was due to translocation of K for the growth and development of flowers and seeds. Higher leaf K concentration in Rompicherla, Gyarampalli and Kallur mandals compared to Madanapalli and Gandaboinapalli mandals could be attributed to soil available K status and soil texture. Highest activity ratio of potassium naturally expected in sandy loams than in sandy clay loams could be the reason for greater accumulation of K in tobacco leaves in Rompicherla and Gyarampalli mandals. Correlation between leaf K and soil K showed that soil K was positively and significantly correlated with leaf K in all the three primings. Leaf K content was in the range normally reported for tobacco.

In general, the paucity of major nutrients in the top leaves i.e V priming might be due to withdrawal of these nutrients from the youngest leaves to provide for the growth of the flowers and seeds and also due to reduced availability of nutrients under limited soil water conditions. Similar findings were reported by Mylonas (1984), Bush and Tso (1989), Drossopoulos et al. (1992) and Drossopoulos et al. (1997).

Calcium concentration ranged from 1.01 to 2.22 %, 0.91 to 2.11 % and from 0.83 to 2.00 % with mean values of 1.51, 1.37 and 1.29 % in I, III and V primings, respectively. This indicated a decrease in Ca concentration in leaf from I to V priming. This could be due to reduced availability of Ca in the later stages due to decreased soil water content. Relatively higher Ca concentration in leaf was observed in Gyaramapalli, Rompicherla and Kallur mandals which was found to be in accordance with soil Ca content in these mandals. Correlation between leaf Ca and soil Ca was found to be of higher order in I priming ($r = 0.966^{**}$) compared to III and V primings. Bush and Tso (1989) also reported a decrease of Ca during the growing season.

Leaf Mg concentration was in a similar way as that of leaf Ca i.e lower Mg concentration in top leaves and relatively higher Mg concentration in bottom and middle leaves. Further correlation coefficient was high for the correlation between soil Mg and leaf Mg in the I priming ($r = 0.737^{**}$) compared to III and V primings. This indicate that the nutrients were translocated to seeds in post flowering stage. Similar findings were reported by Mylonas (1984).

Similar to major nutrients (N,P and K) the secondary nutrients (Ca, Mg) also decreased from I priming to V priming. The correlation data also revealed a highly significant positive correlation between leaf Ca and soil Ca and leaf Mg and soil Mg.

Average Fe, Mn, Zn and Cu concentrations in leaves ranged from 41.10 to 89.10 ppm, 50.90 to 82.70 ppm, 16.20 to 22.90 ppm and 15.70 to 30.40 ppm with mean values of 55.50 ppm, 65.08 ppm, 19.13 ppm and 22.32 ppm respectively. Micronutrients concentration in leaf (Fe, Mn, Zn & Cu) was found to be above critical level in all the experimental fields except for Fe in some experimental fields mostly in Gandaboinapalli and Madanapalli mandals. Even though soils contained DTPA extractable iron well above the level of critical limits of 2.5 ppm in all the fields, the leaf produced in some fields showed less than the critical level of 50 ppm iron in leaves of F.C. tobacco.

Lower amounts of these micronutrients were accumulated in V priming compared to I and III primings. This decreased trend in concentration of these micronutrients with increase in priming number might be due to translocation of these nutrients for growth and development of seeds. Out of 5 mandals comparatively higher concentration of these micronutrients were found in Gyarampalli and Rompicherla mandals which may be due to relatively higher native micronutrient status of soils in these mandals. Further the correlation coefficients among micronutrients in soil and leaf were also significant and positive at 1 % level suggesting that soil micronutrients had contributed to leaf micronutrients. (Table 38).

Leaf quality parameters

Average leaf nicotine ranged from 0.62 to 0.82 % with a mean value of 0.74 % (Table 24). Nicotine content of 0.20 to 1.2 % in 77 % of Greek Tobaccos was observed by Aksu and Enercan (1958), Veselion (1966) and Znjkova and Baskin (1966). The distribution pattern of nicotine was similar to that of nitrogen in leaf i.e III primings leaf had higher nicotine concentration (mean value of 0.84 %) followed by V primings leaf (mean value of 0.75 %) and I primings leaf (mean value of 0.65 %). Similar obseravtions were made by Andrealis and Toole (1933) who found higher concentration of nicotine in the leaves borne near the mid region of stalk and lower amounts of nicotine in the lower leaves and in the tips. This might be due to nitrogen being the principal element playing active role in alkaloid synthesis. Nitrogen concentration in leaf was significantly and positively correlated with nicotine concentration in leaf ($r= 0.862^{**}$). Maximum nicotine concentration was found in field No.10 in which the soil available N status was relatively high. Increased supply of N has direct effect on nicotine concentration of the cured leaf. Similar observations were reported by Linguori et al. (1981). More over, correlation studies revealed a highly significant positive correlation between soil N and leaf nicotine ($r=0.926^{**}$). Jeong et al. (1988) found that organic matter and total N content in the soil were positively correlated with nicotine concentration in cured leaf. Reletively wider variations in nicotine concentration of cured leaf was found

in Gyarampalli and Rompicherla mandals which could be attributed to comparatively higher variations of soil N in Gyarampalli and Rompicherla mandals. Multiple regression equation showed that 89 % variation in nicotine concentration was due to combined effect of soil N , DTPA extractable Fe, Mn, Zn, Cu , soil chlorides and yield. The regression coefficient of soil N was significant at 1 % level.

Reducing sugars ranged from 11.25 to 14.55 % with mean value of 13.04 % . The results obtained in the present investigation fall within the ranges reported by Jalal shafix and Farhad Kaream (1983) who reported a range of 9.38 to 14.12 % in six varieties of oriental tobacco. Similar results were observed by Shafix (1974) and Manolov et al. (1982). High reducing sugars were found in III priming (17.02 %) followed by V (15.91 %) and I primings (6.23 %). Reducing sugars in leaf had negative correlation with soil N ($r = -0.545^{**}$), leaf N ($r = -0.423^{**}$) and leaf nicotine. Similar observations were made by Darkis (1974) who reported that nitrogenous and carbohydrate constituents were inversely correlated. Multiple regression analysis indicated that soil nutrients like available Fe, Mn, Zn, Cu and soil chlorides accounted for 58.0 % variations of the reducing sugar concentration in leaf.

Lower leaf chloride concentrations were found in III priming (mean value of 0.26 %) and relatively higher chlorides were found in I (mean value of 0.38 %) and V priming (mean value of 0.45 %). High leaf chlorides were found in Gyrampalli and Madanapalli mandals. It could be due to higher soil chloride content in these mandals resulting in higher uptake of chlorides. Correlation studies indicated that soil chlorides and leaf chlorides were highly correlated ($r = 0.945^{**}$). Multiple regression analysis indicated that soil nutrients like available N , available P, exchangeable Mg, DTPA extractable Fe, Mn, Zn, Cu, and chlorides and yield accounted for 93.0 % variation in leaf chloride. The relative contribution of exchangeable Mg, and soil chlorides were significantly high.

Nutrient uptake by leaf

Uptake of N, P and K by leaf was maximum in Field No. 10 which recorded the highest leaf yield and the leaf of which had relatively high concentration of N, P and K. Uptake of P and K were minimum in Field No. 27 which recorded the lowest yield and also relatively low concentration of P and K in leaf. Uptake of Zn and Mn by the leaf was also maximum in Field No 10. Uptake of Ca, Mg, Fe and Cu was maximum in Field No 4 which also recorded next highest yield in the investigation. Uptake of all the nutrients by leaf estimated in this investigation were low in Field No. 27 which recorded the lowest yield. The values of uptake of nutrients by leaf

were comparatively low because the uptake only by leaf part has been estimated.

Leaf yields

Cured leaf yields ranged from 241.00 to 502.00 kg/ha with a mean of 368.00 kg/ha. Lowest yield (241.00 kg/ha) was recorded in field No. 27 and highest yield (502.00 kg/ha) was recorded in field No. 10. Highest yield was associated with high soil available N and K status. Correlation data also indicated that yield correlated with soil N significantly and positively at 1 % level ($r = 0.680^{**}$) and with soil K at 5 % level ($r = 0.340^{**}$). Similar results were reported by Greco & Piro (1994). Multiple regression analysis also indicated that 71.0 % variation in yield was due to the combined effect of soil available N, available K, exchangeable Ca, exchangeable Mg and chlorides. Among these, available N and available K have significantly contributed to the yield.

Correlation of soil characteristics and leaf composition with nicotine and reducing sugars concentration in leaf and with yield

Major (N, P & K), secondary (Ca & Mg) and minor (Fe, Cu, Mn, Zn & Cl) elements in leaf showed highly significant correlation with the respective nutrient status in soil.

Nicotine concentration in leaf showed highly significant and positive correlation with total nitrogen concentration in leaf and highly significant negative correlation with concentrations of Fe, Mn and Cu in leaf. Leaf nicotine accumulation also showed negative tendency with P, K and Mg of leaf and positive tendency with leaf Ca but the correlations were not significant. The results are in agreement with the results of Woltz et al. (1948).

Nicotine is synthesized in the roots of the tobacco plant. The starting materials for its production are relatively simple organic materials photosynthesized in the leaves plus simple forms of nitrogen absorbed from the soil. Once formed, the nicotine is transported to the leaves and stems where it accumulates. Therefore, climatological and cultural factors particularly those which would result in disproportion between the relative amounts of synthesizing roots and storage tops and the length of time the plants are in the field would affect the nicotine content in leaf (Hawks and Collins, 1983). Since nicotine synthesis is predominantly localized in tissues near root tip, plants having the largest root systems accordingly synthesise the largest extent of nicotine (Wolf and Bates, 1964). This is the main reason why leaf nicotine showed highly significant positive correlation with soil available N status and light textured nature of soil.

Micronutrient status of soils did not show any deficiency levels. As these are in the sufficiency range, these did not influence the yield and growth of tobacco plants in either way. Highly significant negative correlation was observed between leaf nicotine and DTPA extractable Fe, Zn, Mn and Cu. Since leaf microelement concentration and soil micronutrient status was highly correlated, similar negative correlation between nicotine and microelement concentration in leaf was observed.

Reducing sugars content in leaf was inversely related to total nitrogen content in leaf as seen by the highly significant negative correlation between the two. Similar results were reported earlier by Woltz et al. (1948), Tso (1972) and Hawks and Collins (1983). Highly significant positive correlation was observed with leaf Mg, Fe, Mn, Cu and Zn concentrations. The correlation with leaf P content was positive and significant at 0.05 significance level. Similar relationship was earlier reported in literature for flue-cured tobacco by Woltz et al. (1948), Tso et al. (1960) and Merker (1959).

Reducing sugar content in leaf showed highly significant negative correlation with soil available N status and chloride content. Highly significant positive correlation of reducing sugars content in leaf was observed with soil exchangeable Mg, DTPA extractable Fe, Zn, Cu and Mn. Also

significant positive correlation was observed with soil available P status. The relationship of reducing sugars content in leaf with soil and plant nutrient status was similar because of high degree of correlation between soil and plant composition in respect of all the nutrients estimated in this investigation.

Among the soil physico-chemical properties, pH and electrical conductivity showed highly significant positive correlation with nicotine. As nicotine and reducing sugars content in leaf are inversely related, soil pH and electrical conductivity showed highly significant negative correlation with reducing sugars content in leaf. Clay content exhibited highly significant positive correlation with leaf nicotine due to association of clay soils with higher soil available N status. As a consequence, clay content showed highly significant negative correlation with leaf reducing sugar content.

Leaf yields had a significant positive correlation with available N, available K, exchangeable Ca, exchangeable Mg and chloride content of soil. Soil micronutrient content did not show correlation with leaf yield. Since all the micronutrient contents were in the range above the critical limits, these micronutrients did not contribute to yield increase, hence no significant correlation with leaf yields. Similar correlations were observed between leaf yield and nutrient concentrations in leaf.

Analysis of data on leaf yields, mandal wise, by completely randomised block design with unequal number of replications did not show significant variation in cured leaf yields between mandals. Higher yields

were obtained in Madanapalli and Kallur mandals. Whereas lowest yield was obtained in Gandaboinapalli mandal. Leaf yields in Gyarampalli and Rompicherla mandals were intermediate. As discussed earlier, the dominant variable to influence the yield was soil available N status. Hence, soil nitrogen was taken as concomitant variable in the statistical analysis and the results indicated significant variation in leaf yields of mandals. The adjusted mean yields of mandals indicated that leaf yields were maximum in Gyarampalli mandal and minimum in Gandaboinapalli mandal. Leaf yields of Gandaboinapalli mandal were significantly lower than the leaf yields of Gyarampalli and Rompicherla mandals. Leaf yields of Madanapalli were significantly lower than the leaf yields of Gyarampalli mandal. Other comparisons were not significant. This indicates that sandy loams were more suitable than sandy clay loams with proper nitrogen management. Leaf quality in terms of leaf chemistry (nicotine, reducing sugars and chlorides) was superior in Gyarampalli and Rompicherla mandals to Gandaboinapalli and Madanapalli mandals with lower nicotine, higher reducing sugars and lower chlorides.

Of all the soil properties, soil available N was proved to be dominant in influencing nicotine and reducing sugars content in leaf and in influencing nutrient uptake and ultimately the yield and quality of oriental tobacco.

SUMMARY

CHAPTER - VI

SUMMARY AND CONCLUSIONS

Soil texture in the experimental fields varied from sandy loams to sandy clay loams. 70% of the soils were sandy loams and the remaining were sandy clay loams with the exception of one field which is loamy one. All the soils in Gyarampalli and Rompicherla mandal were sandy loams where as 80% of soils in Madanapalli mandal and a few soils (37%) in Kallur and Gandaboinapalli mandals were sandy clay loams. These differences in soil texture could be due to variations in parent material and weathering processes.

Soil pH ranged from slightly acidic to moderately alkaline. About 35% of soils were slightly acidic, 15% were medium acidic, 30% were neutral, 15% were mildly alkaline and only 5% were moderately alkaline. All the soils were found to be non-saline in nature as the E.C. of soils was less than 0.4 dSm^{-1} . Out of the five mandals, the soils of Kallur, Gandaboinapalli and Madanapalli mandals had relatively higher soil pH and salt content.

The available N content of all the soils was found to be low, may be due to low organic matter content of soils in this semiarid tract. The available P content of soils ranged from low to medium. The mean P content in

Gandaboinapalli and Madanapalli mandals was relatively lower than the other mandals which may be attributed to fixation of P by clay minerals in these sandy clay loams. Except one field all the other fields have medium available K content. The soils of Gandaboinapalli mandal have low potassium content. It could be accounted to lower amounts of K bearing minerals. All the soils had sufficiently higher exchangeable Ca and Mg contents with mean values of 18.33 me/100 gm of soil and 7.21 me/100 gm of soil respectively. Similarly micronutrients contents (Fe, Cu, Mn and Zn) were found to be above their critical limits while soil chlorides were below the critical limit of 100 ppm in all the experimental fields.

Average leaf N concentration ranged from 1.88 to 2.99% with a mean value of 2.72%. Leaf N concentration was lowest (mean value of 2.56%) in Gyarampalli mandal. Leaf P concentration decreased with increase in leaf position from bottom to top. Maximum P concentration was recorded in I priming compared to III and V primings. Gyarampalli and Rompicherla mandals had higher leaf P concentrations. Leaf K concentration decreased with increase in priming number from I to V. Higher leaf K concentrations were found in Rompicherla, Gyarampalli and Kallur mandals.

The Ca concentration showed a decreasing trend from I to V primings. Relatively higher Ca concentration in leaf was recorded in Gyarampalli,

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Rompicherla and Kallur mandals. The concentration of magnesium in leaf was followed the same trend as that of leaf calcium i.e lower Mg concentrations in top leaves and relatively higher Mg concentrations in bottom and middle leaves. All the four leaf micronutrients were found to be above their critical limits and relatively higher concentrations of these micronutrients were found in Gyarampalli and Rompicherla mandals.

In general, for all the leaf nutrients estimated it was observed that the concentration of these nutrients decreased with increase in priming number i.e decreasing concentrations of these nutrients with increase in leaf position from bottom to top. Many reasons can be attributed to this such as dilution effect or utilisation of these nutrients for the growth of the flowers and seeds or the reduced availability of nutrients under limited soil water conditions. Relatively higher concentrations of these nutrients in leaf some mandals may be due to higher native soil available nutrient status which in turn may be due to variations in soil texture in those mandals. Further correlation studies have indicated that leaf nutrients and soil nutrients were correlated significantly and positively with each other.

Average leaf nicotine concentration ranged from 0.62 to 0.82% with a mean value of 0.74%. Nicotine was distributed in a similar way as that of N in leaf i.e III priming leaf had higher nicotine concentration followed by

V and I primings leaf. A significant and positive correlation was obtained between leaf nitrogen and nicotine content ($r = 0.862^{**}$). This might be due to N being the principal element playing an active role in alkaloid synthesis. Relatively wider variations in nicotine concentration of cured leaf was found in Gyarampalli and Rompicherla mandal which could be attributed to more variations in soil N in these mandals. Further multiple regression analysis showed that 89% variation in nicotine concentration was due to combined effect of soil N, DTPA extractable Fe, Mn, Zn, Cu soil chlorides and yield. The regression coefficient of soil N was significant at 1% level.

The leaf reducing sugars were ranged from 11.25 to 14.55% with mean value of 13.04%. More reducing sugars were found in III priming followed by V and I primings. Reducing sugars in leaf had negative correlation with soil N, leaf N and leaf nicotine. Multiple regression analysis indicated that soil nutrients like available Fe, Mn, Zn, Cu and soil chlorides accounted for 58.0% variation of the reducing sugar concentration in leaf.

The concentration of chlorides in leaf was found to be low in III priming and relatively more chlorides were found in I and V primings. More chlorides in leaf were found in Gyarampalli and Madanapalli mandals may be due to high chloride content of these soils. Multiple regression analysis indicated that for the variation of leaf chlorides the relative contribution of exchangeable Mg and soil chlorides was significantly high.

The yield of cured leaf ranged from 241.00 to 502.00 kg/ha with a mean of 368.00 kg/ha. Highest yield was associated with high soil available N and K status. Correlation data revealed that yield correlated with soil N significantly and positively at 1% level ($r = 0.680^{**}$) and with soil K at 5% level ($r = 0.340^{**}$). More over, multiple regression analysis also showed that 71.0% variation in yield was due to combined effect of soil available N, available K, exchangeable Ca, exchangeable Mg and chlorides. Among these, available N and K have significantly contributed to yield. Uptake of all the nutrients by leaf estimated were low in field No. 27 which recorded the lowest yield. The values of uptake of nutrients by leaf were comparatively low because the uptake only by leaf part has been estimated.

It could thus be inferred that for higher yields and good quality of tobacco, sandy loams are more suitable than sandy clay loams with proper nitrogen management. Leaf quality was found to be excellent (leaf with lower nicotine, higher reducing sugars and lower chlorides) in Gyarampalli and Rompicherla mandals than the rest of the mandals. Among all the soil nutrients soil available N was proved to be dominant in influencing quality and yield of oriental tobacco.

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* Originals are not seen

APPENDICES

Appendix - I

Mandal wise village and farmer names

Sl.No	Field No.	Farmer Name	Village Name
Mandal Name : Gyarampalli			
1.	1	Siddha Reddy	Chettivaripalli
2.	2	Venugopal Reddy	Kottapalli
3.	3	Ramana	Reddivari Colony
4.	4	Nagaraja Naidu	Durevandlapalli
5.	5	Chandra Reddy	Gyarampalli Kaspas
6.	6	Venkataramana Reddy	Seenappagaripalli
7.	7	Reddy Shankar Reddy	Kuravapalli
8.	8	Satyam Reddy	Kotlapalli
9.	9	Venkata Reddy	Sankenaguttapalli
Mandal Name : Rompicherla			
10.	10	Mahaboob	Rompicherla Colony
11.	11	Khadar Basha	Chenchureddigari Palli
12.	12	Ramesh Reddy	Nallapa Reddigari Palli
13.	13	Abdul	Murevandlapalli
14.	14	Viswanath Reddy	Vaddipalli
15.	15	Magbul	Picchiguntlavaripalli
16.	16	Narayanaswamy	Bhakharpet
Mandal Name : Kallur			
17.	17	Neelamachari	Agraharam
18.	18	Venkataramaraju	Kamitipalli
19.	19	Chand Basha	Sadam
20.	20	Prabhakar Shetty	Cherakuvaripalli
21.	21	Yerram Reddy	Mutukuvaripalli

22.	22	Arif Khan	Rachavaripalli
23.	23	Reddapa Reddy	Reddivaripalli
24.	24	Khazamohamuddin	Chintalavaripalli
Mandal name : Gandaboinapalli			
25.	25	Lakshmanna	Yarthavandlapalli
26.	26	Siddaiah	Kambamvaripalli
27.	27	Shankar Reddy	Gandboinapalli
28	28	Krishna Reddy	Gandboinapalli Kasp
29	29	Ramachendrudu	Harizanawada
30	30	Viswanath	Kuraparthi
31	31	Chinna Reddappa Reddy	Arumadaka
32.	32	Rajanna	Bedavandlapalli
33.	33	Dwarakantha Reddy	Itlamvaripalli
34.	34	Raja Reddy	Kothapalli
35.	35	Venkataramana	Soutanapalli

Mandal Name : Madanapalli

36.	36	Ramakrishna Naidu	Neeruguttavaripalli
37.	37	Mallikarjuna Reddy	Pulaguravaripalli
38.	38	Krishnaiah	Bandlapalli
39	39	Krishnamurthy	Ramarao Colony
40.	40	Ramanaiah	Angallu

22.	22	Arif Khan	Rachavaripalli
23.	23	Reddapa Reddy	Reddivaripalli
24.	24	Khazamohamuddin	Chintalavaripalli

Mandal name : Gandaboinapalli

25.	25	Lakshmanna	Yarthavandlapalli
26.	26	Siddaiah	Kambamvaripalli
27.	27	Shankar Reddy	Gandboinapalli
28	28	Krishna Reddy	Gandboinapalli Kasp
29	29	Ramachendrudu	Harizanawada
30	30	Viswanath	Kuraparthi
31	31	Chinna Reddappa Reddy	Arumadaka
32.	32	Rajanna	Bedavandlapalli
33.	33	Dwarakantha Reddy	Itlamvaripalli
34.	34	Raja Reddy	Kothapalli
35.	35	Venkataramana	Soutanapalli

Mandal Name : Madanapalli

36.	36	Ramakrishna Naidu	Neeruguttavaripalli
37.	37	Mallikarjuna Reddy	Pulaguravaripalli
38.	38	Krishnaiah	Bandlapalli
39	39	Krishnamurthy	Ramarao Colony
40.	40	Ramanaiah	Angallu

APPENDIX - II

**Final Soil Nutrient Contents (N, P, K Ca & Mg)
of Experimental Fields**

Sl.No	Field No.	N (kg/ha)	P (kg/ha)	K (kg/ha)	Ca (kg/ha)	Mg (kg/ha)
1.	1	170.14	15.00	175.50	17.00	7.80
2.	2	178.21	15.50	198.25	18.15	7.48
3.	3	208.04	12.00	235.00	19.15	8.00
4.	4	230.00	14.17	191.20	24.0	8.40
5.	5	160.15	15.20	125.55	17.70	7.60
6.	6	180.00	8.40	255.75	16.20	7.78
7.	7	140.22	10.00	210.00	21.30	7.10
8.	8	218.20	9.80	205.65	20.00	8.80
9.	9	210.0	10.00	140.20	26.00	8.50
10.	10	244.16	13.98	255.58	22.20	8.30
11.	11	195.0	13.00	205.60	16.70	6.85
12.	12	185.80	14.58	190.00	18.82	7.35
13.	13	208.54	9.45	250.50	17.00	7.40
14.	14	155.15	11.50	240.70	19.24	7.90
15.	15	198.50	18.00	155.25	21.00	8.30
16.	16	234.10	15.50	170.00	17.15	6.90
17.	17	208.60	11.10	218.15	20.50	8.20
18.	18	215.20	9.90	255.41	25.00	8.70
19.	19	211.00	11.50	236.59	23.30	8.58
20.	20	200.00	10.00	164.10	21.20	8.40
21.	21	200.55	8.25	164.21	14.15	6.18
22.	22	218.84	12.80	150.00	20.50	7.80
23.	23	220.00	9.60	180.14	21.20	6.55

24.	24	200.14	10.00	216.00	12.20	6.20
25.	25	191.18	8.25	195.40	15.40	6.60
26.	26	194.20	9.70	150.00	20.00	6.60
27.	27	190.00	8.00	140.20	13.20	5.75
28.	28	196.75	9.15	120.45	12.25	6.00
29.	29	220.15	8.20	155.50	18.65	6.15
30.	30	190.25	11.00	252.40	13.00	5.90
31.	31	220.00	8.25	150.00	14.20	6.00
32.	32	218.58	8.84	170.15	18.10	6.95
33.	33	211.00	10.00	238.55	13.80	5.00
34.	34	234.15	10.20	188.70	20.25	7.14
35.	35	224.00	8.00	180.80	19.80	7.00
36.	36	234.15	9.25	112.25	19.20	7.12
37.	37	208.16	8.75	170.10	12.25	5.15
38.	38	224.10	11.50	254.50	17.50	6.10
39.	39	220.25	10.40	239.15	14.00	6.00
40.	40	228.50	9.00	178.00	18.10	6.50

APPENDIX - III

Final Soil Nutrient Contents (Fe, Mn, Zn, Cu & Cl)
of Experimental Fields

Sl.No	Field No.	Fe (ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)	Cl (ppm)
1.	1	11.00	12.20	0.75	0.35	50.00
2.	2	11.12	12.00	0.74	0.32	52.18
3.	3	10.00	11.12	0.76	0.30	55.12
4.	4	9.90	10.10	0.70	0.25	58.20
5.	5	12.02	12.62	0.80	0.30	45.13
6.	6	11.50	12.00	0.75	0.28	57.24
7.	7	12.81	12.05	0.82	0.32	44.00
8.	8	10.30	10.80	0.75	0.29	53.25
9.	9	10.25	10.61	0.71	0.30	50.00
10.	10	9.00	10.50	0.79	0.30	60.15
11.	11	11.10	11.60	0.74	0.32	48.20
12.	12	11.31	11.75	0.75	0.31	48.25
13.	13	10.60	10.00	0.80	0.20	54.10
14.	14	12.35	12.58	0.81	0.35	47.20
15.	15	10.30	10.54	0.60	0.30	50.28
16.	16	9.55	10.00	0.72	0.28	58.70
17.	17	9.00	10.50	0.70	0.25	57.20
18.	18	9.75	10.00	0.72	0.24	55.00
19.	19	10.60	10.90	0.70	0.30	50.80
20.	20	10.75	11.32	0.70	0.27	50.15
21.	21	8.50	9.95	0.65	0.20	64.15
22.	22	8.21	9.70	0.71	0.22	65.45
23.	23	10.90	8.30	0.64	0.20	60.90

24.	24	8.45	9.78	0.60	0.19	57.20
25.	25	10.20	9.70	0.58	0.25	55.78
26.	26	9.00	9.45	0.61	0.25	53.20
27.	27	8.20	9.70	0.62	0.20	55.15
28.	28	8.00	9.00	0.68	0.28	58.10
29.	29	10.75	9.12	0.63	0.22	65.25
30.	30	8.20	9.25	0.70	0.28	60.00
31.	31	10.30	8.45	0.70	0.20	55.62
32.	32	8.25	9.60	0.65	0.30	55.60
33.	33	10.50	9.00	0.63	0.22	57.15
34.	34	9.75	9.17	0.60	0.23	65.20
35.	35	8.20	8.50	0.60	0.20	63.25
36.	36	9.70	8.12	0.59	0.21	67.25
37.	37	10.60	9.00	0.68	0.18	60.15
38.	38	8.15	9.45	0.66	0.19	60.28
39.	39	9.20	9.65	0.63	0.25	61.30
40.	40	9.90	9.30	0.60	0.20	58.20

APPENDIX - IV

**Leaf Nutrient (N, P, K, Ca & Mg) concentration of
oriental tobacco at the time of planting**

Sl.No	Field No.	N (%)	P (%)	K (%)	Ca (%)	Mg (%)
1.	1	2.10	0.12	2.00	1.30	0.15
2.	2	2.22	0.17	2.15	1.25	0.13
3.	3	2.14	0.10	2.48	1.27	0.17
4.	4	2.52	0.15	2.21	2.00	0.20
5.	5	1.99	0.18	1.40	1.30	0.10
6.	6	2.09	0.09	2.65	1.12	0.12
7.	7	1.50	0.10	2.40	1.65	0.10
8.	8	2.62	0.12	2.35	1.70	0.18
9.	9	2.14	0.14	1.50	2.00	0.15
10.	10	2.30	0.16	3.00	1.75	0.19
11.	11	2.28	0.15	2.25	1.22	0.11
12.	12	2.00	0.17	2.20	1.40	0.13
13.	13	2.28	0.10	2.99	1.41	0.15
14.	14	1.95	0.13	2.70	1.49	0.16
15.	15	2.00	0.20	1.54	1.70	0.14
16.	16	2.54	0.19	1.90	1.35	0.10
17.	17	2.45	0.14	2.40	1.68	0.15
18.	18	2.70	0.10	3.00	2.12	0.18
19.	19	2.45	0.16	2.62	1.89	0.17
20.	20	2.60	0.11	1.80	1.75	0.18
21.	21	2.24	0.10	1.54	1.0	0.10
22.	22	2.65	0.15	1.38	1.28	0.11
23.	23	2.72	0.10	2.20	1.50	0.12

APPENDIX - IV

**Leaf Nutrient (N, P, K, Ca & Mg) concentration of
oriental tobacco at the time of planting**

Sl.No	Field No.	N (%)	P (%)	K (%)	Ca (%)	Mg (%0)
1.	1	2.10	0.12	2.00	1.30	0.15
2.	2	2.22	0.17	2.15	1.25	0.13
3.	3	2.14	0.10	2.48	1.27	0.17
4.	4	2.52	0.15	2.21	2.00	0.20
5.	5	1.99	0.18	1.40	1.30	0.10
6.	6	2.09	0.09	2.65	1.12	0.12
7.	7	1.50	0.10	2.40	1.65	0.10
8.	8	2.62	0.12	2.35	1.70	0.18
9.	9	2.14	0.14	1.50	2.00	0.15
10.	10	2.30	0.16	3.00	1.75	0.19
11.	11	2.28	0.15	2.25	1.22	0.11
12.	12	2.00	0.17	2.20	1.40	0.13
13.	13	2.28	0.10	2.99	1.41	0.15
14.	14	1.95	0.13	2.70	1.49	0.16
15.	15	2.00	0.20	1.54	1.70	0.14
16.	16	2.54	0.19	1.90	1.35	0.10
17.	17	2.45	0.14	2.40	1.68	0.15
18.	18	2.70	0.10	3.00	2.12	0.18
19.	19	2.45	0.16	2.62	1.89	0.17
20.	20	2.60	0.11	1.80	1.75	0.18
21.	21	2.24	0.10	1.54	1.0	0.10
22.	22	2.65	0.15	1.38	1.28	0.11
23.	23	2.72	0.10	2.20	1.50	0.12

24.	24	2.50	0.11	2.15	1.00	0.11
25.	25	2.15	0.10	2.17	1.02	0.10
26.	26	2.20	0.12	1.18	1.40	0.11
27.	27	2.17	0.10	1.20	1.00	0.10
28.	28	2.28	0.11	1.15	1.00	0.12
29.	29	2.75	0.10	1.18	1.38	0.11
30.	30	2.31	0.11	2.20	1.02	0.10
31.	31	2.80	0.10	1.45	1.05	0.10
32.	32	2.70	0.09	1.70	1.35	0.11
33.	33	2.63	0.12	2.50	1.00	0.11
34.	34	2.45	0.12	2.00	1.50	0.13
35.	35	2.25	0.10	2.00	1.56	0.14
36.	36	2.30	0.11	1.02	1.40	0.11
37.	37	2.54	0.11	1.45	1.00	0.10
38.	38	2.38	0.13	2.38	1.04	0.12
39.	39	2.60	0.12	2.49	1.08	0.10
40.	40	2.50	0.10	1.95	1.20	0.11

APPENDIX - V

**Leaf Nutrient (Fe, Mn, Zn & Cu) concentration of
oriental tobacco at the time of planting**

Sl.No	Field No.	Fe (ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)
1.	1	50.2	75.5	18.4	28.5
2.	2	51.5	73.0	17.5	25.8
3.	3	45.2	81.4	20.2	24.5
4.	4	48.5	78.5	21.1	25.2
5.	5	70.0	75.0	19.8	28.1
6.	6	81.4	73.5	22.4	26.0
7.	7	82.5	78.0	23.2	29.4
8.	8	44.5	75.0	17.8	25.2
9.	9	47.5	68.9	18.5	25.4
10.	10	43.8	65.5	21.4	20.0
11.	11	58.5	70.0	19.0	25.5
12.	12	59.0	71.5	20.0	27.2
13.	13	48.6	65.4	23.5	18.0
14.	14	78.6	80.0	21.8	29.5
15.	15	49.5	65.0	19.0	25.3
16.	16	48.8	60.4	20.1	27.5
17.	17	50.5	62.3	18.4	21.2
18.	18	51.7	64.5	21.5	22.5
19.	19	50.5	62.3	18.8	25.5
20.	20	51.8	70.5	19.5	28.0
21.	21	49.7	53.5	17.0	18.0
22.	22	48.5	50.4	18.5	20.0
23.	23	45.6	52.7	20.0	15.5

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24.	24	40.0	48.0	16.5	16.7
25.	25	45.5	52.3	17.3	20.0
26.	26	42.7	49.5	16.5	21.2
27.	27	43.5	50.0	14.0	22.7
28.	28	42.8	45.4	20.5	25.3
29.	29	50.0	49.0	15.4	18.2
30.	30	42.0	52.5	20.1	22.5
31.	31	43.5	53.1	18.4	20.0
32.	32	38.0	52.5	18.5	20.4
33.	33	52.5	49.8	16.4	21.5
34.	34	40.5	53.5	15.8	15.9
35.	35	39.6	49.8	18.0	16.2
36.	36	48.5	48.9	18.5	17.0
37.	37	50.4	50.5	19.2	15.5
38.	38	40.5	52.8	16.5	16.2
39.	39	48.4	58.0	17.4	20.2
40.	40	51.3	58.4	17.0	18.4

