*Indian Journal of Agricultural Sciences* **86** (5): 691–5, May 2016/Article
https://doi.org/10.56093/ijas.v86i5.58357

# Effect of N and K levels on growth, yield and nutrient uptake of FCV tobacco cv. Kanchan

S KASTURI KRISHNA[1], S V KRISHNA REDDY[2], V KRISHNAMURTHY[3], C CHANDRASEKHARA RAO[4] and M ANURADHA[5]

*ICAR–Central Tobacco Research Institute, Rajahmundry, Andhra Pradesh 533 105*

Received: 6 May 2014; Accepted: 16 December 2015

ABSTRACT

A field experiment was conducted during *rabi,* 2007-08 and 2008-09 at Jeelugumilli, Andhra Pradesh under irrigated Alfisols conditions to find out the effect of levels of nitrogen and potash on growth, yield and nutrient uptake pattern of flue-cured Virginia tobacco (*Nicotiana tabacum* L.) cv. Kanchan which is a heavy feeder and high yielder. The results of the experiment revealed that leaf dry weight increased from 30-90 days after planting with increase in N dose from 90 to 140 kg N/ha. Maximum accumulation of leaf dry weight was observed between 60-90 days after planting. Stem and root dry weight increased up to 120 days after planting during both the years. Green leaf yield and cured leaf yield increased progressively and significantly with increase in the N level from 90 to 140 kg N/ha. Higher grade index was recorded at 115 kg N/ha followed by 140 and 90 kg N/ha. The concentration of nitrogen in the leaf increased with increase in nitrogen dose but decreased with increase in level of potassium at the same nitrogen level. Nitrogen uptake increased with increased levels of N and K. Potassium content was high in the initial stages and slowly decreased with the advance in the age of the crop. Initially the difference in the uptake of N and K was narrow, the ratio widened with the age of the crop and finally the ratio was 1:1.3 to 1.4. Higher K uptake in leaf was observed at 115 kg N and while, higher K uptake in stem and root were observed at 140 kg N with 140 kg $K_2O$ /ha. The chemical quality parameters, viz. reducing sugars and nicotine in leaf lamina were within the acceptable limits. Higher green leaf yield, cured leaf yield, nitrogen and potassium uptake were recorded with application of 140 kg each of N and $K_2O$/ha in FCV tobacco cv. Kanchan in irrigated Alfisols of Andhra Pradesh.

**Key words:** FCV tobacco, Growth stage, Irrigated Alfisols, Nitrogen, Nutrient uptake, Potassium

The total DMA and the quantity of nutrients taken up vary with the type of tobacco, the field's residual nutrient status, planting density, irrigation, climate and other environmental factors (Collins and Hawks 1993 and Ceotto and Castelli 2002). Nitrogen is the most important element and has a more pronounced effect on the growth, development and quality of flue-cured tobacco than other essential elements. However, excess quantity of N lowers quality and the yield (Collins 2003). Potassium is known to improve the colour, texture, body, elasticity, fire holding capacity and combustibility of cured tobacco leaf besides its role in influencing the water relations and photosynthesis of green plants. Flue cured tobacco (FCV) produced under irrigated conditions in northern light soils (NLS) of Andhra Pradesh is considered semi-flavorful and quality tobacco. FCV tobacco variety Kanchan is a high yielding variety, producing superior quality leaf having 24-26 curable leaves and needs higher quantities of nutrients than the previous varieties grown in NLS region. Research work on growth and nutrient uptake pattern has not been done in the cultivar Kanchan, a light soil variety, which is a heavy feeder and high yielder. Hence, the present work was conducted to study the growth and nutrient uptake pattern of FCV tobacco grown under NLS conditions of Andhra Pradesh.

[1]Principal Scientist and Head (e mail: krishnakasturi@rediffmail.com), Crop Production (Agronomy), [2]Principal Scientist (Agronomy) (e mail: 65svkreddy@gmail.com), [3]Director (Retd.) (e mail: krishnamurthy_ctri@yahoo.co.in), [4]Prinicipal Scientist and Head (e mail: ccsrao30@rediffmail.com), Crop chemistry and Soil Science [5]Principal Scientist and Head (e mail: radhama2k2@yahoo.co.in), CTRI RS, Kandukuru.

## MATERIALS AND METHODS

A field experiment was conducted during winter (*rabi*) season of 2007-08 and 2008-09 at the research farm of Central Tobacco Research Institute Research Station, Jeelugumilli (17° 11' 30" N and 81° 07' 50" E at 150 m above mean sea-level), West Godavari district in Andhra Pradesh under semi-arid tropical climate. The soil was sandy loam (0-22.5 cm) and deeper layers (22.5-45 cm) were sandy clay classified Typic Haplustalfs, with pH 6.30 (1:2.5) and EC 0.20 dS/m (1:2.5).

Treatments comprised combination of three nitrogen levels, viz. 90, 115 and 140 kg N/ha and two levels of

Table 1 N and K content as influenced by nitrogen and potassium levels (pooled) at different stages of crop growth period

| Treatment | 30 DAP | | | 60 DAP | | | 90 DAP | | |
|---|---|---|---|---|---|---|---|---|---|
| | Leaf | Stem | Root | Leaf | Stem | Root | Leaf | Stem | Root |
| | | | | *N Content* | | | | | |
| $N_{90}$ $K_{120}$ | 3.78 | 2.86 | 2.80 | 2.81 | 1.90 | 1.87 | 2.34 | 1.77 | 1.64 |
| $N_{90}$ $K_{140}$ | 4.11 | 2.81 | 2.40 | 2.90 | 1.94 | 2.00 | 2.83 | 1.80 | 1.60 |
| $N_{115}$ $K_{120}$ | 4.43 | 3.80 | 3.01 | 3.01 | 1.94 | 1.79 | 2.51 | 1.88 | 1.57 |
| $N_{115}$ $K_{140}$ | 4.41 | 3.11 | 2.94 | 3.04 | 2.00 | 1.80 | 2.37 | 1.90 | 1.65 |
| $N_{140}$ $K_{120}$ | 4.12 | 3.15 | 2.91 | 3.10 | 2.11 | 1.84 | 2.87 | 1.85 | 1.72 |
| $N_{140}$ $K_{140}$ | 3.96 | 2.82 | 2.62 | 3.12 | 2.17 | 2.15 | 3.07 | 1.90 | 1.85 |
| | | | | *K Content* | | | | | |
| $N_{90}$ $K_{120}$ | 4.68 | 3.80 | 2.93 | 3.63 | 3.15 | 2.60 | 3.50 | 2.30 | 2.06 |
| $N_{90}$ $K_{140}$ | 4.81 | 3.80 | 2.88 | 4.00 | 3.30 | 2.75 | 3.75 | 2.70 | 2.05 |
| $N_{115}$ $K_{120}$ | 5.00 | 4.00 | 3.00 | 3.80 | 3.10 | 2.60 | 3.75 | 2.25 | 1.80 |
| $N_{115}$ $K_{140}$ | 5.10 | 4.05 | 3.10 | 3.85 | 3.40 | 2.60 | 3.80 | 3.10 | 1.80 |
| $N_{140}$ $K_{120}$ | 5.00 | 4.10 | 3.20 | 4.15 | 3.50 | 2.65 | 3.60 | 2.40 | 1.80 |
| $N_{140}$ $K_{140}$ | 5.00 | 4.20 | 3.20 | 4.10 | 3.55 | 2.75 | 3.65 | 2.80 | 1.90 |

potassium, viz. 120, 140 kg/ha application. The treatments were replicated six times in randomized block design. Sunnhemp [*Crotalaria juncea* (L.) Rotar and Joy] seed @ 50 kg/ha was sown in the first week of June and incorporated *in situ* before flowering in the first week of August. The gross plot size was 6.0m x 6.0m and net plot size was 4.0m x 4.2m. The tobacco seedlings of 60 days were transplanted in the first week of October in two years. Nitrogen was applied in three splits in 1:2:1 proportion at 10, 30 and 45 days after planting and potassium was applied in two splits in 1:1 proportion at 10 and 30 days after planting as per the treatment. Phosphorus was applied @ 60 kg $P_2O_5$/ha. First split of N and full dose of P in the form of di-ammonium phosphate and 50% $K_2O$ in the form of potassium sulphate were applied 10 days after planting as basal dose. Second split of N was given through calcium ammonium nitrate along with remaining 50% $K_2O$ in the form of potassium sulphate at 30 days after planting. Remaining 25% N was top dressed at 45 days after planting at a spacing of 10 cm away and at a depth of 10 cm on either side of the plant by adopting dollop method (in the basal dose, over and above 23.4 kg N/ha which was supplied through di-ammonium phosphate was supplemented by application of calcium ammonium nitrate). The recommended packages of practices were followed to raise FCV tobacco in *rabi*. Tobacco leaves were harvested at maturity by priming 2-3 matured leaves each time at 7-8 days interval and cured in the flue-curing barn and on an average 11 primings were done to complete harvesting of tobacco. The data on green and cured leaf was recorded.

Plant and soil samples were collected at different stages of crop growth and at final harvest. Dry weights of the plant parts were taken and N and K content were estimated in various plant parts, viz. root, stem, leaves. The total amount of N and K uptake by various plant parts was calculated as a dry weight of leaves, stems and roots times the concentration of the respective element. Soil and plant samples were processed and analysed for the nutrient status as per the standard procedure. Data were subjected to statistical analysis as per the standard methods.

## RESULTS AND DISCUSSION

*Effect of N and K doses on dry matter production*

Leaf is the most important commercial product of the FCV tobacco. The distribution of the average dry matter production of leaves of FCV tobacco with time is presented in Fig 1. Leaf dry weight increased with increase in fertilizer doses from 115 to 140 kg N/ha and from 120 to 140 kg $K_2O$/ha. Among all the doses 140 N with 120 $K_2O$ kg/ha

Table 2 Nitrogen and Potassium uptake (kg/ha) as influenced by nitrogen and potassium levels at different stages of crop growth period (pooled)

| Treatment | 30 DAP | | | | 60 DAP | | | | 90 DAP | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Leaf | Stem | Root | Total | Leaf | Stem | Root | Total | Leaf | Stem | Root | Total |
| | | | | | | *N uptake* | | | | | | |
| $N_{90}$ $K_{120}$ | 5.27 | 1.67 | 0.96 | 7.89 | 23.41 | 7.71 | 4.56 | 35.67 | 40.61 | 12.88 | 10.06 | 63.55 |
| $N_{90}$ $K_{140}$ | 5.15 | 1.75 | 0.94 | 7.84 | 22.89 | 8.31 | 4.82 | 36.02 | 34.97 | 13.38 | 10.39 | 58.74 |
| $N_{115}$ $K_{120}$ | 6.01 | 1.88 | 1.15 | 9.05 | 27.86 | 9.97 | 6.59 | 44.42 | 42.42 | 15.21 | 11.32 | 68.95 |
| $N_{115}$ $K_{140}$ | 6.42 | 1.85 | 1.22 | 9.50 | 28.02 | 9.27 | 6.71 | 44.00 | 41.61 | 16.10 | 12.50 | 70.22 |
| $N_{140}$ $K_{120}$ | 7.28 | 2.27 | 1.35 | 10.90 | 30.33 | 10.36 | 7.77 | 48.46 | 45.39 | 18.35 | 13.83 | 77.57 |
| $N_{140}$ $K_{140}$ | 7.19 | 2.17 | 1.33 | 10.69 | 28.33 | 10.16 | 8.40 | 46.89 | 46.50 | 19.68 | 12.94 | 79.14 |
| | | | | | | *K uptake* | | | | | | |
| $N_{90}$ $K_{120}$ | 5.41 | 3.19 | 0.91 | 9.52 | 33.13 | 15.5 | 6.12 | 54.75 | 43.98 | 16.78 | 7.41 | 68.17 |
| $N_{90}$ $K_{140}$ | 5.32 | 3.20 | 1.00 | 9.52 | 33.38 | 15.67 | 6.88 | 55.92 | 46.29 | 17.31 | 8.06 | 71.66 |
| $N_{115}$ $K_{120}$ | 5.72 | 3.47 | 1.27 | 10.46 | 37.21 | 16.73 | 7.39 | 61.33 | 49.15 | 19.38 | 9.29 | 77.82 |
| $N_{115}$ $K_{140}$ | 6.52 | 3.50 | 1.36 | 11.38 | 38.73 | 17.58 | 8.38 | 64.70 | 57.10 | 20.55 | 10.00 | 87.66 |
| $N_{140}$ $K_{120}$ | 6.92 | 3.74 | 1.48 | 12.14 | 39.07 | 17.07 | 8.94 | 65.08 | 55.51 | 23.44 | 10.45 | 89.41 |
| $N_{140}$ $K_{140}$ | 6.76 | 3.81 | 1.55 | 12.12 | 37.65 | 19.59 | 9.81 | 67.05 | 59.43 | 23.93 | 10.81 | 94.17 |

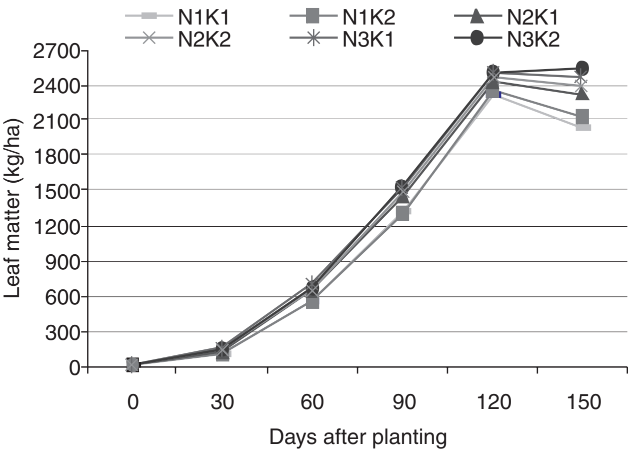


Fig 1 Leaf dry matter production in FCV tobacco as influenced by nitrogen and potassium levels during crop growth period

recorded higher leaf dry weight, whereas lower leaf dry weight by 90 kg N either with 120 or 140 $K_2O$ kg/ha. Nitrogen availability to the plant during development phase determines the rate of growth and drymatter accumulation in tobacco. Per cent accumulation of leaf dry matter at different N and K levels was low initially and increased with the age of the crop. Around 4.5 - 5.3 and 18.6 – 20.3% accumulation was observed at 30 and 60 days and maximum accumulation of leaf dry weight was 57.5- 63.9 % between 60-90 days after planting.

Of the total stem and root dry matter 3-4, 7-10, 18-23, 84-92% was accumulated at 30,60 and 90 days after planting. Stem and root dry weight increased up to 120 days after planting during both the years of experimentation and there after slowly reduced. This might be due to completion of 4-5 harvestings and also depletion of applied nutrients from the soil by that time. Stem and root dry weight increased with increase in fertilizer doses from 115 to 140 kg N/ha and from 120 to 140 kg $K_2O$/ha. Total dry matter increased with increased N application and of the total dry matter production 74-77% was accumulated at 90 DAP. Gopalachari et al (1978) reported that maximum dry matter was produced during reproductive stage (60-90) followed by at active vegetative stage (30-60 days) in FCV tobacco. Moustakas and Ntzanis (2005) reported that dry matter accumulation in flue cured tobacco coincides with knee-high and budding stage. Many workers reported that the total accumulation of dry matter by FCV tobacco from the time of transplanting until the final harvest is characterized by sigmoid curve.

*FCV tobacco productivity*

Green leaf yield and cured leaf yield increased progressively and significantly with increase in the N level from 90 to 140 kg N/ha (Table 3). Among the three levels of N and K, 140 kg N and 140 kg $K_2O$ being on a par with 115 kg N and 140 kg $K_2O$/ha recorded significantly higher green leaf , cured leaf and grade index. Significantly lower green and cured leaf yields were observed with 90 kg N either with 120 or 140 kg $K_2O$ /ha. Application of 115 kg N and 140 kg N/ha increased the yields of green-leaf by 1 979 (14.9) and 3 748 (28.2), of cured-leaf by 294 (14.5) and 442 (21.7), and of grade index by 179 (12.5) and 197 (13.8%), respectively, compared with that of 90 kg N/ha at 120 kg $K_2O$/ha as higher rates of application have a better edge for growth due to higher degree of retention of nutrient in soil and further its uptake by plant. Dinesh *et al.* (2013) also observed that the response for cured leaves with respect to different levels of either nitrogen or potassium was linear. Higher grade index which indicates the quality of the crop was recorded at lower level of N, i.e 115 followed by 140 and 90 kg N/ha with 140 kg $K_2O$/ha. The data at the same level of N in comparison showed that potassium could not influence yields to the level of significance but grade index increased with increased doses. Lee and Lee (1981) reported

Table 3 FCV Tobacco leaf yields (kg/ha), grade index and N and K uptake as influenced by nitrogen and potassium levels at harvest (pooled)

| Treatment | Green leaf | Cured leaf | Grade index | Nitrogen uptake (kg/ha) | | | | Potassium uptake (kg/ha) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Leaf | Stem | Root | Total | Leaf | Stem | Root | Total |
| $N_{90}$ $K_{120}$ | 13276 | 2034 | 1432 | 44.02 | 14.57 | 10.88 | 69.47 | 65.03 | 22.54 | 7.60 | 98.17 |
| $N_{90}$ $K_{140}$ | 13776 | 2127 | 1515 | 44.79 | 14.72 | 11.35 | 70.89 | 70.10 | 28.53 | 8.51 | 107.15 |
| $N_{115}$ $K_{120}$ | 15255 | 2328 | 1611 | 50.81 | 17.04 | 14.72 | 82.76 | 72.34 | 31.16 | 9.18 | 112.69 |
| $N_{115}$ $K_{140}$ | 16218 | 2411 | 1689 | 53.54 | 16.64 | 13.95 | 84.14 | 78.39 | 31.59 | 10.14 | 120.12 |
| $N_{140}$ $K_{120}$ | 17024 | 2476 | 1629 | 56.10 | 17.35 | 15.59 | 88.98 | 74.22 | 32.67 | 9.53 | 116.42 |
| $N_{140}$ $K_{140}$ | 17525 | 2549 | 1685 | 57.37 | 17.74 | 15.40 | 90.51 | 76.98 | 33.87 | 11.02 | 121.88 |
| SEm+ | 339 | 44 | 34 | 0.45 | 0.33 | 0.29 | 0.61 | 0.65 | 0.57 | 0.20 | 0.83 |
| CD(P=0.05) | 941 | 121 | 95 | 1.24 | 0.91 | 0.79 | 1.69 | 1.80 | 1.58 | 0.54 | 2.30 |
| *Seasons* | | | | | | | | | | | |
| $1^{st}$ year | 15196 | 2289 | 1597 | 43.60 | 15.69 | 13.59 | 72.95 | 67.80 | 22.75 | 8.92 | 99.45 |
| $2^{nd}$ year | 15828 | 2351 | 1591 | 58.61 | 17.00 | 13.70 | 89.29 | 77.89 | 38.38 | 9.74 | 126.00 |
| SEm+ | 293 | 39 | 31 | 0.40 | 0.27 | 0.08 | 0.49 | 0.57 | 0.54 | 0.05 | 0.79 |
| CD(P=0.05) | NS | NS | NS | 1.30 | 0.88 | NS | 1.60 | 1.85 | 1.75 | 0.17 | 2.56 |

that the quality of leaf tobacco was decreased by increasing nitrogen and positively related to application rates of potassium.

*Nutrient uptake*

Average N and K content and uptake by leaf, stems and roots are given in Tables 1 and 2. In general nitrogen and K levels in tobacco plants was higher in the early stages of development. The concentration of N in the leaf increased with increase in nitrogen dose but decreased with increase in level of potassium application at the same level of N in the cured samples. This might be due to the effective N utilization and rapid conversion into proteins by the tobacco plant in the presence of K ions as observed by Krishnamurthy *et al.* (1996). N and K content were high in the initial stages and slowly decreased with the age of the FCV tobacco crop. Sriramamurthy and Gopalachari (1987) reported that total N concentration in the leaf was highest at 30 and gradually decreased from 60 to 105 Days after planting. At 60 days after planting i.e after application of total N to the crop, N content increased with increase in the dose of nitrogen though the differences were not much in the initial stages. At 60 days after planting the differences in N and K content was clearly showed that K content was higher in all the plant parts. N and K content in leaves was considerably higher than stems and roots. In case of N content differences for stem and root was less but for K content conspicuous differences were found for stem and root where K content in stems was higher than N content.

Different levels of N significantly influenced the uptake of N and K (Table 3). Increased doses of N increased the uptake of N in leaf, stem and root . At the same level of N, K could not influence the uptake of N in all the plant parts. Uptake of N increased with increased levels of N and K application. Initially, the difference in the uptake of N and K was narrow, the ratio widened with the age of the crop and finally it reached 1:1.3 to 1.4. Of the total N uptake 8.6-10.7, 33.8-39.6, 87.8-90.7% and K uptake 6.7- 8.7, 28.4- 34.5, 70.3-76.3 % was accumulated at 30, 60, 90 days after planting, respectively. In the variety Kanchan at 90 days the uptake was higher than 30-75 days after planting. Gopalachari et al (1978) reported that maximum percentage of dry matter and nutrient uptake occurred during reproductive stage (60-90 ) followed by at active vegetative stage (30-60 days) in FCV tobacco. Moustakas and Ntzanis (2005) reported that dry matter accumulation and nutrient uptake in flue cured tobacco coincides with knee-high and budding stage (41-75 days). Higher total K uptake by the tobcco crop than N uptake indicates the importance of K in the mineral nutrition of FCV tobacco and N and K accumulation in leaf was higher than in stem and root.

At harvest N uptake increased with increase in N levels due to increased dry matter production in cured leaf , stem and root after harvesting. Significantly higher N uptake was observed by 140 kg N with 140 kg $K_2O$/ha. K levels could influence the N uptake significantly at 115 and 140 kg N/ha in leaf and total. Higher K uptake was observed at 115 kg N and 140 kg $K_2O$/ha in leaf, but higher values were observed at 140 kg N and 140 kg $K_2O$ /ha for stem and root than other treatments. Total uptake at 140kg N and 140 $K_2O$/ha and 115kg N and 140 kg$K_2O$/ha was on par with each other. Lower uptake of K was observed at 90 kg N either with 120 or 140 kg $K_2O$/ha. The soils of the experimental plot is low in K status, hence application of K might have increased the uptake by the crop. Hardter *et al.* (2000) also reported that in the highly weathered soils with low K status of Yunnan Province, the placement and timing of potassium application also improved access to K and hence potassium uptake and quality of flue-cured tobacco.

*Quality characters*

Leaf chemical quality characters were given in Table 4. In general reducing sugars increased from P to L position and decreased in T position. N fertilization significantly increased the nicotine content in the lamina. With increase in N levels reducing sugars decreased in all the positions whereas potassium increment increased the sugars. Nicotine content increased from P to T position. Increase in N and K levels increased nicotine content in all the positions. Chlorides were within the acceptable range.

There was a significant increase in leaf lamina nicotine content with successive increase in N level up to 140 kg N/ha. Higher leaf nicotine content was recorded with 140 kg N/ha and decreased gradually with decrease in N level up to 90 kg N/ha. Reducing sugars were significantly higher with 90 kg N/ha, which decreased gradually with increase in level of fertilizer N up to 140 kg N/ha. It is the interplay of the N and carbohydrate metabolism that predetermines the quality and chemical composition of cured leaf of tobacco. Nitrate reductase is an important substrate-inducible enzyme and its activity is affected by the $NO_3$-N concentration of leaves, and consequent availability of the amount of N in the soil (Flower 1999). There is a negative relationship between nitrate reductase activity and accumulation of starch in the leaves. Nitrogen is a component of the nicotine molecule and is important in its synthesis in tobacco. The concentration of nitrogen in leaves is positively correlated with nicotine and negatively with starch and sugar concentrations (Flower 1999). Thus, in the present study, an increase in the rate of fertilizer N increased the concentration of total nitrogen and nicotine and decreased the sugars in tobacco cured leaf. These results are in conformity with the findings of Lamerre (1983), Kasturi-krishna *et al.* (2007) and Krishna-Reddy *et al.* (2008). All the chemical quality characters were well within the acceptable limits of good quality leaf. Distribution of nicotine, reducing sugars, and sugars: nicotine in lamina in different plant positions of tobacco followed the normal trend in all the treatments (Gopalachari 1984).

Application of potassium fertilizer caused progressive and significant increase in reducing sugars and nicotine content in X and L positions with increase in potassium level. These results are in conformity with the findings of Krishnamurthy and Ramakrishnayya (1994) and

Table 4 Reducing sugars, Nicotine and chlorides in different plant positions as influenced by nitrogen and potassium levels

| Treatment | Reducing sugars | | | | Nicotine | | | | Chlorides | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | P | X | L | T | P | X | L | T | P | X | L | T |
| $N_{90}$ $K_{120}$ | 11.89 | 14.80 | 18.67 | 13.66 | 1.60 | 1.941 | 2.24 | 2.62 | 0.64 | 0.60 | 0.52 | 0.62 |
| $N_{90}$ $K_{140}$ | 12.50 | 15.67 | 18.59 | 13.55 | 1.66 | 2.02 | 2.27 | 2.77 | 0.67 | 0.59 | 0.50 | 0.58 |
| $N_{115}$ $K_{120}$ | 11.51 | 14.42 | 17.47 | 12.87 | 1.72 | 2.05 | 2.43 | 2.94 | 0.60 | 0.59 | 0.50 | 0.57 |
| $N_{115}$ $K_{140}$ | 11.80 | 14.07 | 18.04 | 13.39 | 1.85 | 2.12 | 2.35 | 2.82 | 0.64 | 0.59 | 0.48 | 0.56 |
| $N_{140}$ $K_{120}$ | 11.87 | 14.29 | 17.78 | 13.16 | 1.81 | 2.12 | 2.39 | 2.90 | 0.58 | 0.58 | 0.48 | 0.55 |
| $N_{140}$ $K_{140}$ | 11.20 | 14.56 | 16.95 | 11.60 | 1.81 | 2.23 | 2.35 | 2.89 | 0.57 | 0.56 | 0.46 | 0.55 |
| SEm+ | 0.50 | 0.51 | 0.37 | 0.38 | 0.05 | 0.06 | 0.08 | 0.06 | 0.02 | 0.02 | 0.01 | 0.02 |
| CD(P=0.05) | NS | NS | 1.04 | 1.05 | 0.14 | 0.18 | NS | 0.18 | 0.06 | NS | 0.03 | NS |
| *Seasons* | | | | | | | | | | | | |
| 1st year | 11.89 | 13.48 | 15.44 | 13.30 | 1.77 | 2.46 | 2.68 | 2.87 | 0.48 | 0.44 | 0.46 | 0.56 |
| 2nd year | 11.69 | 15.79 | 20.39 | 12.78 | 1.71 | 1.69 | 2.00 | 2.78 | 0.75 | 0.73 | 0.52 | 0.58 |
| SEm+ | 0.29 | 0.30 | 0.40 | 0.18 | 0.03 | 0.04 | 0.05 | 0.06 | 0.02 | 0.01 | 0.01 | 0.01 |
| CD(P=0.05) | NS | 0.99 | 1.30 | NS | NS | 0.13 | 0.16 | NS | 0.06 | 0.04 | 0.04 | NS |

P = Primings (first and second harvest from bottom), X = Lugs and cutters (third and fourth harvest), L = Leaf (fifth to 9th harvest) and T= Tips (10th and 11th harvest) @ two leaves per harvest.

Krishnamurthy *et al.* (1996).

The finding from the present study revealed that maximum accumulation of leaf dry weight was 57.5- 63.9 % between 60-90 days after planting. Stem and root dry weight increased up to 120 days after planting. Total dry matter increased with increased N application and of the total dry matter production 74-77% was accumulated at 90 DAP. Significantly higher N and K uptake was observed by 140 kg N with 140 kg $K_2O$/ha and K uptake at 115 kg N with 140 kg $K_2O$/ha in leaf, but higher values were observed at 140 kg N and 140 kg $K_2O$ /ha for stem and root. Among the levels of N and K, 140 N and 140 $K_2O$ being on a par with 115 N and 140 kg $K_2O$/ha recorded significantly higher green leaf, cured leaf and grade index.

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