

EFFECT OF NITROGEN DOSE AND TOPPING LEVEL ON YIELD AND QUALITY OF LT-KANCHAN (JS-117) UNDER IRRIGATED ALFISOLS OF ANDHRA PRADESH. (2012-14)

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Field experiments were conducted for two consecutive seasons during 2012-13 and 2013-14 seasons to study the influence of nitrogen doses and topping levels on yield and quality of FCV tobacco cv. LT-Kanchan in a factorial randomized block design replicated three times with two varieties, three N levels and two topping levels in irrigated Alfisols (Northern light soils) of Andhra Pradesh. The results of the experiment revealed that the varieties LT Kanchan and Kanchan were on a par with regard to green leaf yield and cured leaf yield and grade index was significantly higher in cv. Kanchan.

Mean green leaf yield at 130 and 115 kg N/ha was higher by 4398 (37.09%) and 2541kg/ha (17.93%), respectively than at 100 kg N/ha. Mean cured leaf yield was on a par with 115 and 130 kg N/ha and increased progressively and significantly with increased N level from 100 to 115 kg N/ha. Mean grade index showed significant increase up to 115 kg N/ha only and was at par with that of 130 kg N/ha. Mean green-leaf/cured-leaf increased progressively and significantly from 100 to 130 kg N/ha. Mean cured leaf yield and grade index at 26 leaves were significantly higher than at 24 leaves topping levels. Mean cured leaf yield and grade index at 26 leaves topping level was 78 kg (3.45%) 73 (4.7%) kg higher when compared with 24 leaves level of topping. LT-Kanchan and cv. Kanchan were on a par with regard to quality characters. Higher leaf nicotine contents were recorded with 130 kg N/ha and decreased gradually with decrease in N level up to 100 kg N/ha. Reducing sugars and reducing sugars: nicotine were significantly higher with 100 kg N/ha, and decreased gradually with

increase in N level up to 130 kg/ha. Lower level of topping (24 leaves) showed higher nicotine and reducing sugars and lower sugars/ nicotine than higher level of topping (26 leaves). On overall observation of yield and quality characters, it can be concluded that the LT Kanchan performed on a par with control cv. Kanchan with regard to green leaf yield and cured leaf yield. A nitrogen dose of 115 kg N/ha and topping at 26 leaves are optimum LT Kanchan.

INTRODUCTION

The Flue Cured Virginia (FCV) tobacco (*Nicotiana tabacum* L.) used for smoking that belongs to family Solanaceae is commonly known as cigarette tobacco and grown as cash crop worldwide due to high economic return than any other crop. Tobacco is a leading commercial crop valued for its leaf containing several important phyto-chemicals including nicotine. In India, FCV tobacco is one of the major sources of income in government revenues due to taxes and levies imposed upon it and accepted by growers and users. Export-quality flue-cured Virginia tobacco known for its premium leaf quality that is exported to several countries is being cultivated during *Rabi* season under irrigated conditions in sands, sandy loams and loamy sands of East and West Godavari districts of Andhra Pradesh and Khammam district of Telangana states in 23,696 ha, producing 64.32 million kg with a productivity of 27414 kg/ha semi-flavourful tobacco leaf annually (Tobacco Board, Annual report, 2022-23).

Research efforts resulted in the development and release of a low tar variety LT-Kanchan (JS

117). Agronomic evaluation becomes most important to find out the expression of a genotype for a given environment. 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). The desired leaf quality aspects such as nicotine, nitrogen, sugars, ash and chlorine etc. that determine the ultimate export quality can be achieved by topping the leaves at optimum level. Research work is not explored on N, and topping requirement of low tar variety LT Kanchan. Hence, this study was undertaken to evaluate the productivity, quality of LT Kanchan along with ruling standard variety cv. Kanchan, at different doses of N and topping levels in NLS of AP.

MATERIALS AND METHODS

The field experiment was conducted for two consecutive seasons in fixed plots during *rabi* seasons from 2012-13 and 2013-14 at the research farm of ICAR-National Institute for research on commercial Agriculture research station (formerly ICAR-CTRI), Jeelugumilli, (17° 11' 30" N and 81° 07' 50" E at 150 m above mean sea-level, average annual rainfall 1100 mm), West Godavari district, Andhra Pradesh under semi arid tropical climate. The soil of the experiment was Typic Haplustalfs with sandy loam surface (0-22.5 cm) and sandy clay sub surface (22.5-45.0 cm) with slightly acidic pH (1:2.5) 6.27, low electrical conductivity (1:2.5) 0.20 dS/m, chlorides 27 mg/kg, organic C (0.20%), available N (150 kg/ha), medium in available P (24 kg/ha) and available K (230 kg/ha).

The experiment consisted of 12 treatment combinations replicated thrice in a factorial RBD with combinations of two varieties i.e. low tar advanced breeding cv. LT Kanchan along with control cv. Kanchan and consisted of three nitrogen doses viz. 100, 115 and 130 kg N/ha and two topping levels viz. topping at 24 and 26 leaves. The experiment was conducted to find out optimum nitrogen dose, topping level and the interaction effect of nitrogen and topping if any, for higher yield and better quality of LT Kanchan.

Sunnhemp [*Crotalaria juncea* (L.) Rotar and Joy] seed @ 50 kg/ha was sown in the first week

of June and *in situ* incorporation was done before flowering i.e. in first week of August. It was seen that there is a minimum of 30 days interval between sunnhemp *in situ* incorporation and tobacco planting. The incorporated dry matter of sunnhemp was about 4.0 t/ha with N content of 2.15% (on oven dry weight basis) in two years. The gross plot size was 6 X 6 m (60 plants) and the net plot size was 4 X 4.8 m (32 plants) with spacing of 100 X 60 cm. About sixty-day-old conventional seedlings of tobacco cv 'Kanchan' and LT Kanchan were planted during 2012-13 and 13-14 as per the treatment during first and second seasons, respectively.

Nitrogen as per the treatment (@100 or 115 or 130 kg/ha) and potassium @ 120 kg/ha were applied in three splits in 1:2:1 proportions at 7-10 DAP, 25-30 DAP and 40-45 DAP. Phosphorus was applied @ 60 kg P₂O₅/ha. In basal dose, first split of N and full dose of P in the form of di-ammonium phosphate and K₂O in the form of potassium sulphate were applied 10 days after planting. In basal dose calcium ammonium nitrate (CAN) was applied to supply higher levels of N (above 60 kg P₂O₅/ha through di-ammonium phosphate level i.e. above 23.4 kg N/ha). In top dressing second and third splits of N and K were applied through CAN and potassium sulphate at 25-30 days after planting and 40-45 DAP. All the fertilizers were applied in dollop method at 10 cm away and at a depth of 10 cm on either side of the plant by making holes by either sticks (Gasika) or spades.

Recommended cultural practices were followed for raising the crop. The crop was topped at 24 and 26 leaves as per the treatment at bud stage. Decanol 4% was applied @ 10-15 ml/plant for preventing the sucker growth immediately after topping. At later stages suckers were removed through manual desuckering. The first priming was done 90 days after planting. Mature green leaves were harvested by priming and cured in the barn.

The data of green leaf and cured leaf were recorded and grade index was calculated (Gopalachari, 1984). The cured leaf samples collected from P, X, L and T positions were analysed for sugars and nicotine (Harvey *et al.*, 1969), and chlorides (Hanumantha Rao *et al.*, 1981). The data were statistically analysed as per the methods suggested by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Productivity

Variety

The FCV tobacco cv. 'Kanchan' and 'LT-Kanchan' were on a par with regard to green leaf yield, cured leaf yield and 'Kanchan' recorded higher grade index and grade index / cured leaf (%) while 'LT-Kanchan' recorded higher green leaf /cured leaf ratio during individual years and in pooled data, indicating proportionately better grade index in cv 'kanchan' (Table 1). These minor variations might be due to the inherent genetic differences among the varieties. (Krishna Reddy *et al.*, 2017).

Nitrogen level

There was a progressive increase in yields of green-leaf, cured-leaf and grade index with increase in N level from 100 to 130 kg N/ha (Table 1) Linear and significant increase in green leaf yield was observed with increased N level from 100 to 130 kg N/ha in two individual years and pooled data. Mean green leaf yield at 130 and 115 kg N/ha was higher by 4398 (37.09%) and 2541 kg/ha (17.93%), respectively than at 100 kg N/ha. Cured leaf yield was on a par with 115 and 130 kg N/ha and increased progressively and significantly with increased N level from 100 to 115 kg N/ha during 2012-13, 2013-14 and pooled data. However there was significant increase in cured leaf yield with each increment of N from 100 to 130 kg in pooled data: Mean cured leaf yield at 130 and 115 kg N was significantly higher by 342 (16.19%) and 223 kg/ha (10.56%), respectively than at 100 kg N/ha. Grade index showed significant increase up to 115 kg N/ha only and was at par with that of 130 kg N/ha in individual years and pooled data. Green-leaf/cured-leaf increased progressively and significantly from 100 to 130 kg N/ha in both individual years and pooled data. This was mainly due to more succulence of leaf and higher photosynthetic area in higher N treatment with each increment of N from 100 to 130 kg N/ha. Grade index/ cured-leaf percent was higher at 115 kg N/ha, because with increase in N level, cured-leaf yield increases proportionately more than that of bright grades up to optimum N level and thereafter cured leaf yield and bright grades decline (Flower, 1999).

The Increase in N dose from 100 to 115 kg resulted in mean increase of 2541 in green leaf yield, 223 in cured leaf yield and 196 kg/ha in grade index, but the same increment of N from 115 to 130 kg/ha showed increase of only 1857 in green leaf, 119 in cured leaf and 50 kg/ha in grade index. This follows the Mitscherlich's equation, which states that the increase in growth with each successive addition of nutrient in question was progressively smaller. Partial factor productivity of N for cured leaf (kg cured leaf/kg N applied) varied between 18.87 and 21.12 (Data not given) and was higher with application of 100 kg N/ha and lower with 130 kg N/ha. The increase in yield with successive addition of N was progressively smaller, because the agronomic- use efficiency of N decreases with increase in N level. These results corroborate the findings of Chandrasekhara Rao, *et al* (2014), Krishna-Reddy *et al.* (2006; 2008a, 2017) and Kasturi-krishna *et al.* (2007 and 2016).

Topping level

There were no significant differences between topping levels with regard to green leaf yield. However, topping levels significantly differed among themselves, with regard to cured leaf yield and grade index in pooled data. Mean cured leaf yield at 26 leaves topping level was 78 kg (3.45%) higher when compared with 24 leaves level of topping. Mean grade index at 26 leaves topping level was 73 (4.7%) kg more when compared with 24 leaves level of topping. These results are in agreement with the findings of Suryanarayana Reddy *et al.* (1997) that topping at higher level resulted in significantly higher cured leaf, bright leaf yield and TBLE (total bright leaf equivalent) as compared to low level of topping. King (1986) also reported yield increase with increase in topping level. Collins and Hawks Jr. (1993) also reported that within a given row width and spacing within a row, as plants were topped with fewer leaves, the yield was lowered.

Seasons

Green leaf yield cured leaf yield, grade index, green leaf yield/ cured leaf yield and grade index percent were more in second season than in first season. This might be due to favourable environmental conditions during the second season.

Quality characters

In general, mean nicotine concentration increased from P to T position, while mean reducing sugars increased from P to L position and there after decreased in T position. Reducing sugars/ nicotine ratio decreased from P to T position (Table 2 and 3). The increase in nicotine content from P to T position with increased leaf height is due to the fact that the nicotine is synthesized in the roots and its rate of synthesis is accelerated after the plants are topped. Nicotine is concentrated in to the remaining tissues after the tobacco is topped and de-suckered. Thus, the degree of nicotine accumulation is directly related to the duration that the leaves remain on the plants after topping. As the FCV tobacco in irrigated Alfisols is topped and complete sucker control is practiced, top leaves at the tip of the plant remain for a longer period on the plant and thus the nicotine concentration is increased from P to T position with increase in stalk position (Collins and Hawks, 1993).

Variety

FCV tobacco hybrid 'Kanchan' recorded significantly higher nicotine content in P and L position and LT-'Kanchan' in X and T plant positions. Kanchan variety recorded higher reducing sugars in P and T positions LT- Kanchan recorded higher reducing sugars in X position. However, the reducing sugars concentration in L position was on a par in both the cultivars. Reducing sugars/ nicotine ratio was higher in 'LT-'Kanchan' as compared to 'Kanchan'. The lower RS/nicotine ratio in 'Kanchan' was due to more proportionate increase in nicotine as compared to RS. These minor differences may be probably due to the genetic variations of the cultivars (Krishna Reddy et al., 2017).

Nitrogen level

There was a significant increase in leaf lamina nicotine content with successive increase in N level up to 130 kg N/ha. Higher leaf nicotine contents were recorded with 130 kg N/ha (Table 2) and decreased gradually with decrease in N level up to 100 kg N/ha. Reducing sugars and reducing sugars: nicotine were significantly higher with 100 kg N/ha, which decreased gradually with increase in level of fertilizer N up to 130 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 $\text{NO}_3\text{-N}$ 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 nicotine and decreased the sugars thereby resulting in decreased sugar: nicotine ratio in tobacco cured leaf with increase in N levels. These results are in conformity with the findings of Krishnamurthy and Ramakrishnayya (1994) Kasturi-krishna *et al.* (2007) and Krishna-Reddy *et al.* (2008a; 2008b). The chemical quality characters were well within the acceptable limits of good quality leaf. The lower sugars: nicotine ratio in T position was because lamina nicotine concentration increased and sugar concentration decreased due to more N accumulation, as the leaves of this position remained for a longer period on the plant after topping (and also due to higher N mobility from lower to top leaves it being a highly mobile nutrient) compared to the P, X and L position leaves. The study also revealed that the lamina nicotine content increased gradually from P to T positions and reducing sugars concentration and sugars: nicotine ratio increased from P to L position and there after decreased in T position in all the treatments (Table 2 to 3). Distribution of nicotine, reducing sugars, and sugars: nicotine in lamina in different plant positions of tobacco followed the normal trend in all the treatments. Chloride content in leaf was well within the acceptable limit with different treatments. Usually leaf chlorides >1.50% is not preferred as the leaf absorbs more moisture, becomes pale and slick and adversely affects leaf burning quality (Gopalachari, 1984a).

Topping level

Lower level of topping (24 leaves) showed higher nicotine and reducing sugars and lower sugars/ nicotine than higher level of topping (26

Table 1: Effect of nitrogen and topping on yield and quality of FCV tobacco cv.LT-Kanchan (2012-14 pooled)

Treatment	Tobacco yield (kg/ha)										GL/CL		GI/CL (%)			
	Green leaf					Cured leaf					Grade index					
	12-13	13-14	pooled	12-13	13-14	12-13	13-14	pooled	12-13	13-14	12-13	13-14	pooled	12-13	13-14	pooled
Variety																
JS-117	13459	14871	14165	2142	2387	2264	1306	1732	1519	6.26	6.21	6.23	61	73	66.8	
Kanchan	13363	14985	14174	2227	2446	2337	1417	1818	1617	5.98	6.11	6.04	64	74	68.9	
SEm ±		233	265	177	35.7	39.84	26.75	22.2	28.9	18.22	0.03	0.03	0.02	0.32	0.3	
0.16																
CD 5%	NS	NS	NS	NS	NS	NS	65.0	85	47	0.09	0.09	0.06	0.95	1.00	0.32	
N levels (kg/ha)																
N ₁₀₀	11158	12553	11856c	1996	2228	2112c	1225	1616	1421	5.59	5.63	5.61	61	72	66.9	
N ₁₁₅	13637	15159	14397b	2219	2451	2335b	1407	1827	1617	6.15	6.19	6.17	63	75	69.0	
N ₁₃₀	15437	17072	16254a	2338	2570	2454a	1452	1882	1667	6.61	6.65	6.63	62	73	67.7	
SEm ±		286	325	216	43.74	48.8	32.77	27.2	35.41	22.31	0.04	0.04	0.03	0.34	0.3	
0.20																
CD 5%	838	952	599	128	143	91	79.62	104	62	0.10	0.11	0.07	1.00	1.00	0.56	
Topping																
T ₂₄	13454	14902	14178	2153	2370	2261	1333	1731	1532	6.22	6.26	6.24	62	73	67.2	
T ₂₆	13367	14952	14160	2216	2463	2339	1390	1819	1605	6.01	6.05	6.02	63	74	68.3	
SEm ±		233	265	177	35.7	39.8	26.75	22.2	28.91	18.21	0.03	0.03	0.02	0.32	0.3	
0.16																
CD 5	NS	NS	NS	NS	NS	NS	74	NS	NS	50	0.09	0.09	0.06	0.95	1.00	
NS																
Seasons																
2012-13			13411			2185			1362			6.11			62.3	
2013-14			14928			2416			1775			6.16			73.4	
SEm ±				195			27.4			17.01			0.02			
0.1																
CD 5%			764			108						NS			0.4	
Interactions																
CD 5%			NS			NS						NS			NS	

Table 2: Effect of nitrogen and topping on nicotine and reducing sugars of FCV tobacco cv.LT-Kanchan (2012-14 pooled)

Treatment	Nicotine (%)				Reducing sugars (%)			
	P	X	L	T	P	X	L	T
Variety								
JS-117	1.21	1.62	2.34	3.80	15.08	17.92	18.84	14.13
Kanchan	1.37	1.59	2.50	2.52	15.49	17.73	18.74	14.82
SEm ±	0.01	0.01	0.01	0.01	0.04	0.05	0.10	0.06
CD (P=0.05)	0.03	0.02	0.03	0.03	0.12	0.10	0.27	0.28
N levels (kg/ha)								
N ₁₀₀	1.14	1.54	2.29	3.10	16.43	19.14	20.00	15.63
N ₁₁₅	1.29	1.46	2.43	3.22	15.22	17.71	18.68	14.39
N ₁₃₀	1.43	1.82	2.52	3.33	14.19	16.63	17.68	13.41
SEm ±	0.01	0.01	0.01	0.01	0.04	0.06	0.12	0.08
CD (P=0.05)	0.03	0.03	0.03	0.03	0.12	0.18	0.33	0.21
Topping								
T ₂₄	1.32	1.71	2.47	3.02	15.52	17.91	19.02	14.67
T ₂₆	1.25	1.50	2.38	3.15	15.04	17.74	18.56	14.28
SEm ±	0.01	0.01	0.01	0.01	0.04	0.05	0.10	0.06
CD (P=0.05)	NS	0.02	0.03	0.03	0.12	0.10	0.27	0.28
Seasons								
2012-13	1.15	1.58	2.68	3.20	17.29	19.80	18.20	12.86
2013-14	1.42	1.63	2.16	3.12	13.27	15.85	19.37	16.09
SEm ±	0.012	0.01	0.02	0.03	0.04	0.04	0.09	0.10
CD (P=0.05)	0.05	0.02	0.04	0.10	0.16	0.14	0.38	0.39

Table 3: Effect of nitrogen and topping on reducing sugars/ nicotine and chlorides of FCV tobacco cv.LT-Kanchan (2012-14 pooled)

Treatment	Reducing sugars/ Nicotine				Chlorides (%)			
	P	X	L	T	P	X	L	T
Variety								
JS-117	12.76	11.19	8.23	5.01	0.59	0.55	0.62	0.70
Kanchan	12.29	10.71	7.61	4.86	0.58	0.54	0.60	0.69
SEm $\pm$		0.10	0.06	0.07	0.03	0.01	0.01	0.010.01
CD (P=0.05)		0.34	0.20	0.13	0.09	0.02	0.03	0.020.02
N levels (kg/ha)								
N ₁₀₀	15.05	12.71	8.92	5.29	0.63	0.59	0.65	0.74
N ₁₁₅	12.24	10.81	7.83	4.89	0.58	0.55	0.61	0.70
N ₁₃₀	10.28	9.33	7.02	4.33	0.54	0.51	0.57	0.65
SEm $\pm$		0.12	0.08	0.09	0.04	0.01	0.01	0.010.01
CD (P=0.05)		0.34	0.21	0.22	0.10	0.02	0.02	0.020.03
Topping								
T ₂₄	12.34	10.75	7.88	4.95	0.60	0.56	0.62	0.71
T ₂₆	12.71	11.15	7.97	4.93	0.57	0.54	0.60	0.69
SEm $\pm$		0.10	0.06	0.07	0.03	0.01	0.01	0.010.01
CD (P=0.05)		0.34	0.20	0.13	0.09	0.02	0.05	0.020.02
Seasons								
2012-13	15.34	12.72	6.81	3.40	0.72	0.61	0.70	0.76
2013-14	9.71	9.18	9.04	6.47	0.44	0.49	0.51	0.64
SEm $\pm$		0.13	0.07	0.05	0.03	0.01	0.02	0.010.01
CD (P=0.05)		0.49	0.27	0.19	0.13	0.04	0.08	0.030.02

leaves). Chlorides were well within the acceptable limits of good quality in all the treatments. Topping significantly increases the concentration of nicotine in leaves and the earlier the plants are topped the greater the increase (Marshall and Seltzmann, 1964; Elliot, 1966). Leaves from topped plants have a higher concentration of starch than untopped plants, which results in an increased reducing sugar concentration in the cured leaves (Crafts - Brandner, 1991).

Seasons

Higher nicotine in P and X position and higher reducing sugars in L and T position was recorded in second season than first season, while higher nicotine in L position and higher reducing sugars in P and X position was recorded first season (12-13). than second season due to seasonal variation.

Conclusion

From the pooled results, it can be concluded that the LT Kanchan performed on a par with control cv. Kanchan with regard to green leaf yield and cured leaf yield. A nitrogen dose of 115 kg N/ha and topping at 26 leaves are optimum for optimum yield.

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