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EFFECT OF DIFFERENT INORGANIC NITROGEN SOURCES ON YIELD AND QUALITY OF FCV TOBACCO IN NORTHERN LIGHT SOILS OF ANDHRA PRADESH

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Flue-cured Virginia tobacco is grown in an area of 28, 000 ha in Northern Light Soils (NLS) region of Andhra Pradesh under irrigated condition. Diammonium phosphate (DAP) and calcium ammonium nitrate (CAN) were the two important nitrogen sources widely used in the fertiliser schedule of Northern Light Soils. As per the Govt. of India's policy, production of CAN is restricted. To find out an alternative cheaper nitrogen source to CAN for FCV tobacco in NLS and to study the effect of different nitrogen sources on yield, chemical composition and quality parameters of cured leaf, a field experiment was conducted for two consecutive years (2014-15 and 2015-16) during rabi at CTRI Research Station Jeelugumilli, West Godavari district, Andhra Pradesh. Twelve treatment combinations of Urea, Ammonium Sulphate (AS), Potassium Nitrate (KNO_3) and Calcium Nitrate (CN) were compared with DAP + CAN (Recommended Dose), and 20-20-0, urea and AS combinations (Interim Fertiliser schedule recommended) in randomized block design with three replications. Based on the two years yield and chemical analysis for quality and nutrient composition it can be concluded that different sources of nitrogen (urea/AS)as basal dose and their combinations (AS/urea/urea+AS/ urea+AS+KNO_3/ urea+AS+CN) as top dressing did not significantly influence the yield parameters (green leaf yield, cured leaf yield and grade index), quality parameters (nicotine, reducing sugars and chlorides) and also nitrogen composition of FCV tobacco in NLS of Andhra Pradesh. Hence any of these nitrogen fertiliser sources or their combinations can be used for FCV tobacco grown in Northern Light Soils.

Key Words: FCV tobacco, Inorganic nitrogen, Northern Light Soils.

INTRODUCTION

Tobacco, one of the important high value commercial crops in India, is valued for its potential to generate farm income and employment to farmers and farm labours, and revenue to the government. It is grown in an area of 0.450 M ha in the country. With a production of 761 M kg India ranks second in the world tobacco production, after China and tobacco made a significant contribution of Rs. 28,712 crore to Indian economy in terms of excise revenue (Rs. 22,737 crore) and export earnings (Rs. 5,975 crore). The unique feature of Indian tobacco production is different tobacco types *viz.*, Flue-cured Virginia (FCV), *Bidi*, *Hookah*, Chewing, Cigar-wrapper, Cheroot, Burley, Oriental, HDBRG, *Lanka, Pikka, Natu* etc. are grown in the country, FCV and Burley tobaccos being the main exportable types.FCV tobacco is grown mainly in the states of Andhra Pradesh and Karnataka. In Andhra Pradesh, FCV tobacco is grown under four different tobacco zones of which NLS is one of the important zones where FCV tobacco is grown under irrigated conditions in light textured soils. Tobacco produced from this zone is semi flavourful, heavy bodied with balanced chemistry.

Nitrogen has a more pronounced effect on the growth and quality of tobacco than any other essential element. Soil nitrogen regime affects plant development more than any other nutrient from seedling stage through the time of final harvest. Soil nitrogen must be sufficient during early and mid-season growth stages to ensure vigorous, but not excessive growth, and it should be nearly depleted by flowering for the plant to mature and ripen properly ensuring a quality leaf. In general, as total N in the plant increases, above the amount required for maximum growth, quality of flue-cured tobacco tends to decrease (Parker, 2009). Diammonium phosphate (DAP) and Calcium Ammonium Nitrate (CAN) were the two important sources of nitrogen being widely used by the farmers along with potassium sulphate. DAP is applied as basal dose where as CAN is applied as top dressing at 23-30 and 40-45 days after planting. In view of the restrictions imposed by Govt. of India on production and supply of CAN,it is imperative to find out a viable alternative fertiliser package in NLS of Andhra Pradesh with other fertiliser nitrogen sources available *viz.*, urea, AS and CN.

MATERIALS AND METHODS

In order to findout an alternative cheaper fertiliser schedule in place of CAN, a field experiment was conducted at ICAR- CTRI Research Station Jeelugumilli, during 2014-15 and 2015-16 crop seasons with 12 treatment combinations. The experimental site is located at 17.21^0 N, 81.13^0E, with an average rainfall of 1100 mm. Soils were sandy loams (sand 84%, silt 5%, clay 11%), acidic (pH 5.5), low in soluble salts (EC 0.06 dSm^{-1}), chlorides (31 ppm), organic carbon (0.4%,) available nitrogen(72 kg/ha), available potassium (71 kg/ha) and high in available phosphorus (35 kg/ha).The treatments include Urea and AS as basal dose with Single superphosphate (SSP) and Sulphate of potash (SOP) as phosphorus and potassium sources, followed by Urea, Urea + AS, AS, Urea + AS + KNO_3, Urea + AS +CN in second split and in third split AS was given uniformly. These ten treatment combinations were compared with DAP + CAN + SOP (Recommended Dose), and 20-20-0, SSP, Urea, AS and SOP combinations (Interim Fertiliser schedule recommended). Nitrogen was applied in three splits (1:3:1.5) at 10, 25-30 and 40 days after planting. Initially nitrogen is applied in the form of DAP (22.5 kg N) along with Potassium sulphate. In the second dose CAN (65 kg N) is applied along with SOP. CAN (32.5 kg N) was exclusively applied in the third dose. Phosphorus@ 60 kg P_2O_5 ha^{-1} was applied through SSP/DAP and potassium @ 120 kg K_2O/ha was applied through SOP. All the package of practices were followed in raising the crop with test variety *Kanchan*. Tobacco being a multi harvested crop, pick wise green leaf yield, cured leaf yield and grade index were recorded and were summed –up for total yield. Pick wise cured leaf samples were collected and grouped position wise (P, X, L and T). These samples were dried, powdered and analysed for quality parameters *viz.*, nicotine and reducing sugars (Harvey *et al.*, (1969). Leaf samples were digested using the triacidmixure and analysed for nitrogen, phosphorus and potassium. Leaf samples from X position were analysed for nitrate nitrogen (Broaddus *et al.*, 1965)

RESULTS AND DISCUSSION

Yield Parameters

Pooled analysis of the two years (2014-15 & 15-16) yield data revealed that seasons significantly influenced the yield (Table 1). The yield parameters in 2015-16 were significantly higher than 2014-15 indicating the favourable weather in 2015-16 compared to 2014-15. Application of urea or AS did not show significant differences in green leaf yield, cured leaf yield and grade index compared to DAP or 20-20-0 as basal dose. Among the top dressers also application of urea/ AS, or their combination (50+50), or inclusion of KN or CN did not show significant differences in yield parameters. However, addition of nitrate form-N along with ammonical form-N as top dressers showed higher yield compared to ammoniacal fertilisers alone (Table 1). Linda Williams and Miner (1982) reported that yield and grade index of FCV tobacco were increased 26 and 20%, respectively by urea compared to $NaNO_3$ when excess rainfall occurred shortly after planting. Apparently, N from urea was still present as NH_4^+-N and remained within the root zones while N from $NaNO_3$ moved below the root zone, urea resulted in a 7% higher yield. Under conditions of adequate and well-distributed rainfall, both N sources had similar effects on tobacco. In tropical conditions, where nitrification is likely to be more rapid and leaching is more prevalent, there was no significant treatment effects from the different sources of nitrogen *viz.*, urea, ammonium nitrate (AN), chilean potassium nitrate (CPN) and calcium nitrate (CaN) as basal dressing on the yield and quality with a small trend in the order CaN>AN>CPN>Urea. Cost-wise the use of granulated urea, entail greater savings compared with the current recommended source (Wan Azman et.al. 1996). Tisdale, *et al.*1952, reported that various nitrogen sources, including sodium nitrate, ammonium nitrate and urea, had no effect on the yield or value of tobacco. Similarly, Mc Cantsand Woltz (1976) concluded that the relative response of tobacco to application

Table1: Effect of different inorganic nitrogen sources on yield (kg/ha) parameters

Treatments	Green leaf yield	Cured Leaf yield	Grade index
Urea+ Urea + AS	12646	2066	1444
Urea + Urea + AS +AS	11297	2086	1444
Urea+ AS + AS	11214	2008	1352
Urea+ Urea + AS+ KNO_3 + AS	11830	2086	1473
Urea + Urea + AS + CN + AS	12402	2129	1499
AS + Urea + AS	11763	2116	1447
AS + Urea + AS + AS	12107	2015	1403
AS + AS + AS	10934	1926	1331
AS + Urea + AS + KNO_3 + AS	12361	2121	1460
AS + Urea + AS + CN +AS	11817	2071	1415
DAP + CAN + CAN	11778	2186	1459
20:20 + Urea + AS	11986	2038	1426
SEASON MEANS			
2014-15	9162	1996	1558
2015-16	11573	2144	1300
SEM±			
SEASONS	281	83.20	73.63
TREATMENTS	377	94.6	82.5
S X T	533	125.2	113.5
CD at 5%			
SEASONS	1106	326	289
TREATMENTS	NS	NS	NS
S X T	NS	NS	NS
CV% (A)	14.3	16.0	21.5
CV% (B)	7.80	12.0	14.6

of the ammonium and nitrate forms depended on the extent and speed with which the ammonium was converted to nitrate, which is depend upon the environmental conditions for biological nitrification. Tobacco Research Board (1986 e) observed no differences in the yield, grade index and concentration of reducing sugars, total alkaloids and total nitrogen between different sources *viz.*, sodium nitrate, ammonium nitrate and urea. Bangarayya and Sarma, 1975 reported that, relative efficiency of ammonium nitrate, calcium ammonium nitrate, potassium nitrate, ammonium sulphate nitrate, calcium nitrate and ammonium sulphate was about the same with regard to yield and quality of FCV tobacco

Chemical quality parameters

The role of nitrogen in the development and quality of tobacco is of major importance with respect to time of absorption, form of nitrogen absorbed, rate of application, concentration in the leaf and numerous other aspects. In the cured leaf, nicotine content was low compared to reducing sugars. Different nitrogen sources and their combination as top dressers did not show any significant differences in nicotine and reducing sugars. Nicotine in lamina increased and reducing sugars decreased with increase in plant position. Total alkaloids in leaf, reducing sugars, were affected by application rate and timing of nitrogen. In general, as rate of applied nitrogen increased, alkaloid levels increased and reducing sugars decreased. Application of urea and ammonium sulphate as basal dose is at par with recommended practice (RP) of diammonium phosphate (DAP) and complex fertiliser 20-20-0 as interim recommendation (IFR) application in terms of its effect on nicotine and reducing sugars. Both these sources showed higher nicotine in all plant positions compared to RP and IFR. Among the two basal sources, nicotine content was higher with

AS in the lower leaf position (P position), later nicotine values were higher with urea in upper position leaves (X,L and T). Application of nitrogen in the ammonical form or replacement of a part of nitrogen with nitrate form has not shown any significant differences in the nicotine content of cured leaf in different plant positions compared to the recommended practice of CAN as a top dressing. However, application of nitrate form nitrogen in the top dresser showed higher values of nicotine compared to ammoniacal nitrogen in the top position leaves (X,L and T). In the lower leaves (P and X) urea as a basal dose showed higher reducing sugars where as in top position leaves lower values of reducing sugars were observed with urea compared to ammonium sulphate.(Table 2 & 3).Chandrasekhararao, *et al.*, 2005 reported that application of calcium nitrate as basal or top dresser did not significantly influence the nicotine and reducing sugar content compared to DAP and CAN as basal dresser and AS and CAN as top dressers. Similarly, Parker, (2009), evaluated nitrogen source *viz.*,calcium nitrate, ammonium nitrate, and urea ammonium nitrate (UAN) and rates on yield and quality of modern Flue-Cured tobacco cultivars and reported no significant effect on yield, grade index, total alkaloids, total reducing sugars, or leaf colour

Leaf Nitrogen

Application of urea or AS as a basal dose did not significantly influenced total nitrogen and nitrate content in the lamina, compared to the recommended practice of DAP or interim fertiliser recommendation 20-20-0. However, higher total nitrogen and lower nitrate nirogen were observed with application of urea compared AS. Replacing a part of nitrogen with nitrate form in the top dressing did not show any significant differences

Table 2: Effect of different inorganic nitrogen sources on lamina nicotine (%) in different leaf positions

TREATMENTS	P	X	L	T
Urea+ Urea + AS	1.388	1.156	1.481	1.921
Urea + Urea + AS +AS	1.521	1.366	1.568	2.086
Urea+ AS + AS	1.525	1.166	1.713	2.191
Urea+ Urea + AS+ KNO_3 + AS	1.451	1.330	1.700	2.211
Urea + Urea + AS + CN + AS	1.406	1.301	1.803	2.383
AS + Urea + AS	1.418	1.086	1.365	1.858
AS + Urea + AS + AS	1.370	1.123	1.571	1.891
AS + AS + AS	1.233	1.136	1.458	1.911
AS + Urea + AS + KNO_3 + AS	1.576	1.371	1.710	2.240
AS + Urea + AS + CN +AS	1.386	1.093	1.446	1.825
DAP + CAN + CAN	1.328	1.351	1.635	2.073
20:20 + Urea + AS	1.330	1.181	1.495	2.181
SEASONS MEAN				
2014-15	0.659	0.653	0.951	1.324
2015-16	2.163	1.790	2.206	2.805
SEm ±				
SEASONS	0.02	0.02	0.06	0.04
TREATMENTS	0.07	0.08	0.11	0.14
S X T	0.10	0.11	0.16	0.19
CD at 5%				
SEASONS	0.08	0.09	0.23	0.15
TREATMENTS	NS	0.21	NS	NS
S X T	NS	NS	NS	NS
CV% (A)	8.62	11.7	22.7	11.3
CV% (B)	12.8	15.1	17.4	16.3

Table 3: Effect of different inorganic nitrogen sources on lamina reducing sugars (%) in different leaf positions (%)

TREATMENTS	P	X	L	T
Urea+ Urea + AS	18.66	22.15	21.96	17.94
Urea + Urea + AS +AS	15.82	19.88	21.60	17.61
Urea+ AS + AS	15.66	20.68	21.40	16.87
Urea+ Urea + AS+ KNO_3 + AS	17.28	22.31	22.28	18.93
Urea + Urea + AS + CN + AS	16.72	20.60	20.26	15.96
AS + Urea + AS	17.15	21.25	22.44	19.20
AS + Urea + AS + AS	18.56	22.21	21.65	18.56
AS + AS + AS	16.09	20.29	21.64	18.19
AS + Urea + AS + KNO_3 + AS	14.95	19.41	20.03	17.16
AS + Urea + AS + CN +AS	15.65	21.02	22.95	19.75
DAP + CAN + CAN	16.85	19.49	21.71	19.54
20:20 + Urea + AS	16.34	21.74	21.69	17.23
SEASONS MEAN				
2014-15	18.90	20.82	21.11	20.05
2015-16	14.38	21.02	22.16	15.77
SEm ±				
SEASONS	0.49	0.68	1.00	0.58
TREATMENTS	0.58	0.78	0.78	0.71
S X T	0.82	1.10	1.10	1.01
CD at 5%				
SEASONS	1.92	NS	NS	2.29
TREATMENTS	1.61	NS	NS	1.97
S X T	2.28	NS	NS	NS
CV% (A)	17.58	19.36	27.65	19.51
CV% (B)	8.57	9.14	8.80	9.73

in total nitrogen content in leaf compared to ammoniacal form however application of nitrate nitrogen showed higher values of total nitrogen in leaf at different plant positions compared to ammoniacal form. Nitrate nitrogen content has not shown any significant differences with application of urea or AS as basal sources. Similarly application of nitrate form of nitrogen in top dressing also not shown any significant differences in nitrate nitrogen content in leaf. Dinesh Kumar *et al.*, 2013 reported that application of different N and K levels did not show any significant variation in leaf chemistry. Experiments conducted at CTRI RS Guntur indicated that DAP, large granular Urea, prilled urea and AS did not significantly influence nitrogen, nicotine and leaf burn. Chandrasekhararao *et.al.*, 2014 reported that Nitrate–N content increased with levels of nitrogen. The nitrate content increased from bottom to top position with increase in nitrogen application. Increased application of nitrogen increased the NR activity and accumulation of nitrate–N, thus a positive relationship was observed between NR activity and nitrate–N accumulation. Based on two years field experiments as evidenced from yield and chemical quality parameters, urea or ammonium sulphate were recommended as a basal sources of nitrogen along with recommended application of diamoniumphospahate. In the event of non availability of calcium ammonium nitrate, a combination urea and ammonium sulpahte (50: 50) or urea and ammoniumsulphate with potassium nitrate/calcium nitrate can be used as a source of nitrogen.

Table 4: Effect of different inorganic nitrogen sources on total nitrogen (%) and nitrate nitrogen (mg/g) in different leaf positions

	Total Nitrogen (%)				Nitrate Nitrogen (mg/g)
TREATMENTS	**P**	**X**	**L**	**T**	**X**
Urea+ Urea + AS	1.74	1.60	1.60	1.80	1.951
Urea + Urea + AS +AS	1.91	1.80	1.66	1.96	1.855
Urea+ AS + AS	1.81	1.72	1.73	1.92	2.101
Urea+ Urea + AS+ KNO_3 + AS	1.98	1.77	1.76	1.90	2.139
Urea + Urea + AS + CN + AS	1.86	1.79	1.70	2.14	1.775
AS + Urea + AS	1.91	1.63	1.57	1.76	1.999
AS + Urea + AS +AS	1.79	1.66	1.66	1.99	1.992
AS + AS + AS	1.82	1.71	1.61	1.73	2.175
AS + Urea + AS + KNO_3 + AS	2.00	1.87	1.74	1.91	1.917
AS + Urea + AS + CN +AS	1.85	1.71	1.66	1.81	2.066
DAP + CAN + CAN	1.84	1.72	1.63	1.92	2.032
20:20 + Urea + AS	1.82	1.59	1.52	1.90	2.209
SEASON MEANS					
2014-15	1.62	1.27	1.26	1.37	1.489
2015-16	2.10	2.16	2.04	2.42	2.546
SEM±					
SEASONS	0.05	0.04	0.05	0.02	0.21
TREATMENTS	0.07	0.07	0.07	0.09	0.16
S X T	0.09	0.10	0.07	0.12	0.23
CD at 5%					
SEASONS	0.19	0.17	0.18	0.09	0.81
TREATMENTS	NS	NS	NS	NS	NS
S X T	0.26	NS	NS	NS	NS
CV% (A)	15.85	15.4	16.7	7.38	61.06
CV% (B)	8.58	9.95	9.88	11.3	19.89

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