Tobacco Research 40 (1) : 11-16, 2014

EVALUATION OF FLUE-CURED TOBACCO GENOTYPES FOR NITROGEN-USE EFFICIENY

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(Received on 16th February, 2014 and accepted on 26th May, 2014)

Tobacco is very sensitive to nitrogen fertilization and leaf being the economic product, nitrogen plays a key role in realizing optimum yields and quality. The nitrogen use efficiency in Northern Light Soils (NLS) area seldom exceeds 50%, hence, identification of genotypes with higher nitrogen-use-efficiency (NUE) may be a promising strategy to reduce the application of N fertilizer. A field experiment was conducted during 2011-12 crop season at CTRI Research Station, Jeelugumilli to evaluate the flue-cured tobacco genotypes for nitrogen use efficiency. Treatments includes eighteen flue-cured tobacco genotypes (16/103, Mc Nair-12, CM-12, Kanchan, TOBIOS-2, RT-31-1, RT-40-1, RT-42-1, RT-46-1, RT-51-2, RT-52-3, RT-57-1, RT-62-1, RT-102-1, ABL-8-1, ABL-10-1, ABL-49-1 and NLSH-1) grown with (120 kg N/ha) and without N in three replications. Results revealed that flue-cured tobacco genotypes showed differential response to applied nitrogen. The cured leaf yield of genotypes without N application ranged from 744 to 1244 kg/ha with an average of 1006 kg/ha. The yield of 18 genotypes grown with N (120 kg N/ha) varied between 1606 to 2722 kg/ha with an average of 2370 kg/ha. The genotypes which produced higher yields than the average under no nitrogen and 120 kg N/ha were considered as genotypes with higher use efficiency and high yield potential respectively. Based on that criterion, the genotypes 16/103, RT-31-1, RT-52-1, RT-57-1, RT-62-1, ABL-8-1, ABL-10-1, ABL-49-1 and NLSH-1 have higher efficiency and the genotypes *viz.*, RT-57-1, RT-51-2, NLSH-1, ABL-8-1, RT-42-1, ABL-49-1, RT-62-1, RT-102-1 and RT-31-1 have high yield potential. The Agronomic use efficiency (AE) of the genotypes varied between to 5.74 to 15.14 kg/kg with an average of 13.37 kg/kg. The genotypes which showed more than average AE were considered as nitrogen responsive genotypes. The genotypes *viz.*, TOBIOS-2, RT-40-1, RT-42-1, RT-46-1, RT-51-2, RT-57-1, RT-62-1, RT-102-1, ABL-8-1, ABL-49-1 and NLSH-1 showed higher responsiveness to nitrogen. The genotypes which recorded higher yield under no nitrogen and 120 kg N/ha and more AE are considered as efficient and responsive genotypes with high yield potential. From this study it can be inferred that among the flue-cured tobacco genotypes evaluated, RT-51-2, RT-57-1, RT-62-1, ABL-8-1, ABL-49-1 and NLSH-1 can be selected as nitrogen use efficient genotypes with high yield potential.

Key words: FCV tobacco, Nitrogen use efficiency, Tobacco genotypes

INTRODUCTION

Crop productivity heavily depends on the use of inorganic nitrogenous fertilizers, as the nitrogen plays important role in all the plant activities. Farmers worldwide apply about 90 million tons of nitrogen fertilizers to crop plants and are projected to increase to 236 million tons by the year 2050. However, it is widely reported that the recovery of nitrogen fertilizer by crop plants is relatively low (Cassman *et al.*, 1988; Ram and Jhonson, 1999) owing to N losses through varied mechanisms. Further excess nitrogen use has been reported to cause an array of adverse environmental impacts. Consequently there has been a growing interest in developing management practices having potential to cut down N fertilizer usage and also to enhance NUE in agro ecosystem worldwide.

Tobacco is very sensitive to nitrogen fertilization and leaf being the economic product, nitrogen plays a key role in realizing optimum yields and better quality. At present recommended rate of N for tobacco in irrigated Alfisols is 120 kg/ha. But use efficiency of N in this area seldom exceeds 50%. Identification of genotypes with higher NUE either in strict physiological sense such as increased carbon gain per unit plant nitrogen or in agronomic sense as greater dry matter production per unit plant nitrogen applied may be a promising strategy to reduce the use of N fertilizer and in turn environmental pollution. Therefore, an attempt has been made to evaluate flue-cured tobacco genotypes for nitrogen use efficiency.

MATERIALS AND METHODS

Field experiment was carried out during 2011-12 crop season at CTRI Research Station, Jeelugumilli to evaluate the flue-cured tobacco genotypes for nitrogen use efficiency. The soil of the experimental field is slightly acidic in reaction with low soluble salts, chlorides and nitrogen. The experiment was laid out with two levels of nitrogen (0, 120 kg N/ha) and eighteen flue-cured tobacco genotypes (16/103, Mc Nair-12, CM-12, Kanchan, TOBIOS-2, RT-31-1, RT-40-1, RT-42-1, RT-46-1, RT-51-2, RT-52-3, RT-57-1, RT-62-1, RT-102-1, ABL-8-1, ABL-10-1, ABL-49-1 and NLSH-1) in three replications. Among the genotypes selected, 16/103, Mc Nair-12, CM-12 and Kanchan are released varieties of flue-cured tobacco grown in irrigated Alfisols of Andhra Pradesh and remaining were advanced breeding lines for higher yield and quality. The tray seedlings of 18 genotypes were planted in the experimental plot and grown using recommended package of practices. At 60 days after planting net photosynthetic rate was recorded using portable photosynthesis system (LICOR-6400 model) and estimated the total chlorophyll content (Hiscox and Israelstam, 1979). Plants were topped at flower bud initiation stage and suckers were controlled using decanol. After attaining maturity, leaves were harvested and the harvested leaf was cured in barn. Cured leaf yield and shoot biomass were recorded. Grade index was calculated from cured leaf yield and grade points of different grades at different plant positions. Representative leaf and stem samples were processed and analysed for total nitrogen (AOAC, 1950). Nutrient uptake was computed from biomass and nitrogen content. From the data nitrogen use efficiency parameters *viz.*, Agronomic efficiency {(Cured leaf yield with N application – Cured leaf yield without N application)/N applied}, Physiological efficiency {(Shoot biomass with N application – Shoot biomass without N application)/(N uptake with N application – N uptake without N application)}, and Recovery efficiency [{(N uptake with N application – N uptake without N application)/N applied} * 100], were computed. The data were analysed statistically using statistical package MSTATC.

RESULTS AND DISCUSSION

Effect of applied nitrogen on net photosynthetic rate, chlorophyll content, yield, nitrogen content and uptake, and nitrogen use efficiency in different genotypes was discussed.

Photosynthetic rate and chlorophyll content

Nitrogen application increased the photosynthetic rate and chlorophyll content in all the genotypes. Among the genotypes grown with N, the net photosynthetic rate measured at 55 days after planting ranged from 20 to 26.5 mmol/m/s. Among the genotypes ABL-10-1, RT-51-2, ABL-8-1, NLSH-1, RT-62-1, RT-51.1, RT-52-3, RT-46-1, RT-31-1 recorded higher rate of net photosynthetic rate compared to other genotypes in N supplied condition and RT-31-1, RT-102-1, TOBIOS-2, 16/103, ABL-8-1, RT-62-1 recorded higher pn under without N treatment. The total chlorophyll content increased with increased N application and it varied between 1.97 to 3.12 mg/g f.wt among the genotypes with N application and it varied between 0.631 to 1.479 mg/g f.wt. Greater chlorophyll content was recorded in ABL-49-1 followed by RT-46-1. The reduction in chlorophyll content due to nitrogen stress ranged from 38 to 77% among the genotypes.

Yield parameters

Nitrogen stress reduced cured leaf yield and grade index in all the genotypes (Table 1). Genotypes showed differential response to nitrogen. Among the genotypes, cured leaf yield ranged between 1606 to 2722 kg/ha with 120 kg N/ha and 744 to 1244 kg/ha without N application. Previously cultivated varieties *viz.*, Mc-Nair-12, CM-12, 16/103 recorded significantly less yield compared to Kanchan (variety in vogue) and advanced breeding lines evaluated. The cured leaf yield of Kanchan is on a par with RT-46-1, RT-52-3, RT-40-1, RT-31-1, Rt-102-1, TOBIOS-2 and ABL-10-1. The lines RT-57-1, RT- 51-2, NLSH-1, ABL-8-1, RT-42-1, ABL-49-1 and RT-62-1 recorded higher cured leaf yield compared to Kanchan. Breeding lines RT-46-1 and RT—52-3 recorded yield at a par with RT-62-1and ABL-49-1 and lesser yields compared to other advanced breeding lines. Advanced breeding lines RT-57-1 recorded higher yield compared to RT-46-1, RT-52-3, RT-40-1, RT-31-1, RT-102-1, TOBIOS-2, ABL-10-1, RT-62-1 and on a par with RT-51-2, NLSH-1, ABL-8-1, ABl-49-1 and RT- 42-1. The interaction effect between genotypes and nitrogen was significant. Among the genotypes evaluated RT-57-1, RT-51-2, NLSH-1, ABL-8-1, RT-42-1, ABL-10-1, TOBIOS-2 and RT-102-1 recorded significantly higher yield compared to Kanchan and advanced breeding lines RT-46-1, RT-52-3, RT-40-1 are at a par with N application. Without N application, RT-57-1 and RT-51.2 recorded higher yield compared to other genotype. But the reduction in yield due to N application is low in previously cultivated varieties *viz.*, 16/103, CM-12 and Mc Nair-12 (40.46 - 42.90%) followed by ABL-10-1, RT-31-1, RT-62-1 and high in presently cultivated variety Kanchan and other advanced breeding lines (57.01-69.8%). Sisson *et al.* (1991) also reported that breeding

Table 1: Effect of nitrogen on yield characters (kg/ha) of flue-cured tobacco genotypes

Genotype	Cured leaf yield			Grade index		
	120 kg N/ha	0 kg N/ha	Mean	120 kg N/ha	0 kg N/ha	Mean
16/103	1708	1017	1363	1101	768	935
Mc Nair-12	1606	917	1262	1144	692	918
CM-12	1668	964	1316	1119	729	924
Kanchan	2214	944	1579	1616	707	1161
TOBIOS-2	2517	992	1755	1851	782	1317
RT-31-1	2463	1136	1800	1693	871	1282
RT-40-1	2367	1002	1684	1774	755	1265
RT-42-1	2603	786	1695	1913	597	1255
RT-46-1	2271	744	1508	1487	577	1032
RT-51-2	2709	1103	1906	1821	864	1343
RT-52-3	2328	975	1651	1629	742	1186
RT-57-1	2722	1014	1868	1975	772	1374
RT-62-1	2545	1114	1830	1673	820	1246
RT-102-1	2504	986	1745	1674	763	1218
ABL-8-1	2669	1047	1858	1634	771	1203
ABL-10-1	2520	1244	1882	1778	998	1388
ABL-49-1	2545	1094	1820	1860	873	1366
NLSH-1	2701	1036	1869	1902	782	1342
Mean	2370	1006		1647	770	
	SEm±	**CD (P=0.05)**		**SEm±**	**CD (P=0.05)**	
Nitrogen (N)	**94**	**574**		**49**	**300**	
Genotype (G)	**70**	**196**		**61**	**174**	
N X G	**99**	**277**		**88**	**24**	

for improved yield and quality of flue-cured tobacco cultivars has indirectly led to improvement in nitrogen use efficiency.

The genotypes which produced higher yields than the average under no nitrogen and recommended dose of nitrogen were considered as genotypes with higher use efficiency and high yield potential respectively. The average cured leaf yield of genotypes was 1006 and 2370 kg/ha, under 0 and 120 kg N/ha respectively. Based on that criterion, the genotypes 16/103, RT-31-1, RT-52-1, RT-57-1, RT-62-1, ABL-8-1, ABL-10-1, ABL-49-1 and NLSH-1 have higher use efficiency and the genotypes *viz.*, RT-57-1, RT-51-2, NLSH-1, ABL-8-1, RT-42-1, ABL-49-1, RT-62-1, RT-102-1 and RT-31-1 have high yield potential. The genotypes which produced higher than the average cured leaf were considered as genotypes with high yield potential. Effect of Nitrogen, genotype and

Table 2: Effect of nitrogen on cured leaf N and shoot N uptake of flue-cured tobacco genotypes

Genotype	Nitrogen (%)			N uptake (kg/ha)		
	120 kg N/ha	0 kg N/ha	Mean	120 kg N/ha	0 kg N/ha	Mean
16/103	2.26	2.02	2.14	51.30	23.77	37.54
Mc Nair-12	2.54	2.15	2.35	50.83	22.08	36.46
CM-12	2.59	1.88	2.23	54.32	20.55	37.44
Kanchan	2.72	2.00	2.36	70.70	21.52	46.11
TOBIOS-2	2.32	1.78	2.05	68.33	18.86	43.60
RT-31-1	2.80	1.97	2.39	81.08	25.08	53.08
RT-40-1	2.37	1.88	2.13	66.13	20.71	43.42
RT-42-1	2.26	1.76	2.01	72.23	15.34	43.79
RT-46-1	2.61	2.29	2.45	70.43	19.74	45.09
RT-51-2	2.42	1.90	2.16	77.53	22.69	50.11
RT-52-3	2.91	2.24	2.57	79.33	23.36	51.35
RT-57-1	2.79	2.02	2.41	85.53	22.52	54.03
RT-62-1	2.53	1.89	2.21	82.04	23.78	52.91
RT-102-1	2.56	1.69	2.13	74.94	19.95	47.45
ABL-8-1	2.42	1.78	2.10	80.39	21.76	51.08
ABL-10-1	2.45	1.87	2.16	75.14	26.16	50.65
ABL-49-1	2.94	1.97	2.45	88.51	23.67	56.09
NLSH-1	2.39	2.01	2.20	81.24	23.02	52.13
	2.55	1.95		72.78	21.92	
	SEm±	**CD (P=0.05)**		**SEm±**	**CD (P=0.05)**	
Nitrogen (N)	**0.08**	**0.48**		**2.81**	**17.0**	
Genotype (G)	**0.11**	**0.32**		**82.80**	**7.86**	
N X G	**0.16**	**0.45**		**3.96**	**11.11**	

their interactions were found to be significant and found similar trend like that of cured leaf yield. Grade index recorded is 67-77% of the cured leaf.

Nitrogen concentration and uptake

Influence of nitrogen on leaf nitrogen content and shoot nutrient uptake are given in Table 2. Application of nitrogen increased the leaf nitrogen content and it varied among the genotypes. Nitrogen content of cured leaf varied from 2.26 to 2.94% with a mean of 2.55% under N applied condition and it was between 1.69 to 2.29% with a mean of 1.95% under without N application. Nitrogen uptake increased due to N application and it ranged from 50.83 kg/ha to 88.5 kg/ha and 15.34 kg/ha to 26.6 kg/ha, with and without N respectively. The reduction in nitrogen uptake ranged from 53.67% to 78.76% among the genotypes.

Nitrogen use efficiency

Nitrogen use efficiency of genotypes is expressed as agronomic efficiency (AE), Physiological efficiency (PE) and Recovery efficiency (RE). AE, PE and RE varied between 5.74 to 15.14 kg cured leaf per kg N applied, 32.84 to 47.20 kg/kg and 22.94 to 54.03%, respectively among the genotypes (Table 3). The higher AE recorded in RT-42-1 (15.4) followed by RT-57-1 whereas maximum RE recorded in NLSH-1, a

Table 3: Nitrogen use efficiency of different flue-cured tobacco genotypes

Genotype	Nitrogen use efficiency		
	Agronomic efficiency (kg cured leaf/kg N applied)	Physiological efficiency (kg/kg)	Recovery efficiency (%)
16/103	5.76	46.82	22.94
Mc Nair-12	5.74	42.61	23.96
CM-12	5.87	32.84	28.14
Kanchan	10.58	38.00	40.98
TOBIOS-2	12.71	42.87	41.23
RT-31-1	11.06	37.16	46.67
RT-40-1	11.38	43.59	37.85
RT-42-1	15.14	45.77	47.41
RT-46-1	12.73	45.85	42.24
RT-51-2	13.38	42.96	45.70
RT-52-3	11.28	37.27	46.64
RT-57-1	14.23	35.71	52.51
RT-62-1	11.93	37.76	48.55
RT-102-1	12.65	36.48	45.83
ABL-8-1	13.52	44.58	48.86
ABL-10-1	10.63	41.00	40.82
ABL-49-1	12.09	34.42	54.03
NLSH-1	13.88	47.20	48.52

hybrid followed by earlier cultivated variety, 16/103. Highest RE was observed in ABL-49-1 and RT-57-1. The AE and RE were low in earlier varieties *viz.*, 16/103, Mc-Nair and CM-13 compared to the variety in vogue (Kanchan) and advanced breeding lines. All the advanced breeding lines recorded more AE compared to presently cultivated variety Kanchan. Sifola and Postiglione (2003) reported that maximum value of Recovery Fraction (RF) and Agronomic Efficiency was 45 and 22% for irrigated and non irrigated treatments.

Genotypes which recorded greater efficiency values (AE, PE and RE) than average value of 18 genotypes are categorized as efficient. Based on that criteria, the genotypes, RT-42-1, RT-57-1, NLSH-1, ABL-8-1, RT-51-2, RT-46-1, TOBIOS-2, RT-102-1, ABL-49-1, RT-49-1, RT-62-1 and RT-40-1 recorded greater AE, NLSH-1, 16/103, RT-46-1, RT-42-1, ABL-8-1, RT-40-1, RT-51-2, TOBIOS-2, McNair-12 and ABL-10-1 recorded higher PE and ABL-49-1, RT-57-1, ABL-8-1, NLSH-1, RT-62-1, RT-42-1, RT-31-1, RT-52-3, RT-51-2, RT-102-1 and RT-52-3 recorded greater RE. Agronomic efficiency denotes the responsiveness of the genotypes to applied nitrogen. Genotypes which showed more AE also recorded higher RE. Previously cultivated varieties 16/103 and Mc Nair-12 showed better PE even though they recorded less AE and RE which states that these genotypes have utilised the nitrogen absorbed by the plant efficiently but not able to respond the applied nitrogen. Genotypes which showed more AE also recorded higher RE. So the genotypes which recorded higher AE were considered as responsive genotypes to nitrogen.

From the above results it can be inferred that the genotypes *viz.*, RT-51-2, RT-57-1, RT-62-1, ABL-8-1, ABL-49-1 and NLSH-1 recorded higher efficiency and responsiveness to nitrogen with high yield potential. These genotypes can be selected as nitrogen use efficient genotypes and they can be used to produce cultivars with higher NUE and also capable of producing higher yields.

ACKNOWLEDGEMENTS

Authors express their sincere thanks to T. Sreenu, Technical Assistant, CTRI, RS, Jeelugumilli and Smt D.V.L. Satyavathi, Assistant Chief Technical Officer for their services in conducting the experiment.

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