

Yield, quality and economics of FCV tobacco (*Nicotiana tabacum*) in relation to preceding crops and nitrogen fertilization in Vertisols

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ABSTRACT

A field experiment was conducted during 2001-02 and 2002-03 at Rajahmundry in Andhra Pradesh with six treatments during rainy (*kharif*) season, viz. blackgram [*Vigna mungo* (L.) Hepper], rice (*Oryza sativa* L.), soybean [*Glycine max* (L.) Merr.], maize (*Zea mays* L.), green-leaf manuring with pillipesara [*Vigna trilobata* (L.) Verdc.] and fallow; and three N levels of 30, 45 and 60 kg N/ha, applied to FCV tobacco in winter (*rabi*) season. Short-duration maize and rice could successfully be grown before *rabi* tobacco, taking advantage of south-west monsoon rains. Among the cropping systems, green-leaf manuring-tobacco recorded significantly higher cured leaf (1.92 t/ha), bright leaf (0.88 t/ha) and grade index (1.39) of tobacco followed by fallow - tobacco, whereas lowest values of these yields were recorded in soybean-tobacco. Application of 60 kg N/ha offered significantly higher cured-leaf yield and grade index, and was comparable with that of 45 kg N/ha in respect of bright-leaf yield. Interaction effects of cropping systems and N levels revealed that FCV tobacco preceded by maize, blackgram, rice and soybean responded up to 45 kg N/ha, whereas tobacco preceded by green leaf manuring and fallow responded up to 60 kg N/ha in the production of bright leaf. Maize - tobacco system recorded higher tobacco leaf-equivalent yield (2.25 t/ha). The chemical quality parameters of leaf like reducing sugars, nicotine and chlorides were within the acceptable range. Maize - tobacco and green leaf manuring - tobacco systems recorded higher net returns, whereas benefit : cost ratio was higher with green leaf manuring-tobacco and fallow-tobacco. Minimum broomrape (*Orobanche cernua* Loeffl) infestation of 1.75% was recorded in FCV tobacco succeeding maize. It was concluded that maize - tobacco accrued higher monetary returns, followed by green leaf manuring-tobacco system compared with fallow - tobacco.

Key words : Broomrape, Cropping systems, Economics, FCV tobacco, Leaf quality, Nitrogen, Preceding crops, Soil fertility

In the flue-cured Virginia (FCV) tobacco (*Nicotiana tabacum* L.) growing rainfed vertisols of northern Andhra Pradesh, fertility status of soil and annual rainfall of 1,100 mm received through south-west and north-east monsoons provide ample scope for crop intensification through cultivation of a number of rainy season (*kharif*) crops preceding tobacco. Tobacco-based cropping systems have been advocated in various types of tobacco (Singh *et al.*, 2000; Kasturi Krishna *et al.*, 2004), and different *kharif* crops exert variable influence on the yield and quality of succeeding FCV tobacco. It is necessary to assess the requirement of nutrients, especially N for FCV tobacco-based cropping systems. The infestation of broomrape (*Orobanche cernua* Loeffl) an important total root parasite in tobacco, may be reduced with crop rotation (Krishnamurthy *et al.*, 1994). Hence this study was made

to evaluate the productivity, quality and economics of FCV tobacco as influenced by preceding crops and nitrogen levels applied to FCV tobacco and to find out the most viable and remunerative preceding crop to FCV tobacco.

MATERIALS AND METHODS

A field experiment was conducted during 2001-02 and 2002-03 at the CTRI Farm, Katheru in Andhra Pradesh. The soil was clayey, slightly alkaline (pH 8.3), low in available N (177 kg/ha) and organic C (0.48%), medium in available P (22.5 kg/ha) and high in available K (484 kg/ha). The field capacity and permanent wilting point were 35 and 12% on weight basis. The experiment was laid out in a split-plot design replicated thrice. The *kharif* season crops of blackgram [*Vigna mungo* (L.) Hepper], rice (*Oryza sativa* L.), soybean [*Glycine max* (L.) Merr.], maize (*Zea mays* L.), Pillipesara [*Vigna trilobata* (L.) Verdc.] green leaf manuring (GLM) and fallow formed

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the main plots, and three N levels applied to FCV tobacco during winter (*rabi*) season (30, 45 and 60 kg N/ha) formed sub-plots. The rainfed *kharif* crops were sown during second fortnight of July and harvested at physiological maturity. The packages of practices followed for *kharif* crops are given below:

Crop	Variety	Seed rate (kg/ha)	Spacing (cm)	Fertiliser dose (N+P+K kg/ha)
Blackgram	'LBG 20'	20	30 × 10	25 + 21.8 + 00.0
Maize	'GSF 2' (hybrid)	20	60 × 25	60 + 17.5 + 33.3
Upland rice	'MTU 1006'	80	20 × 15	60 + 34.9 + 33.3
Soybean	'JS 335'	60	30 × 10	30 + 26.2 + 33.3
Tobacco	'VT-1158'	28,571 pl/ha	70 × 50	As per treatment

The total rainfall received during the cropping period of 2001-02 and 2002-03 was 625 and 520 mm, respectively. The soil-moisture content after *kharif* crops was 26.8, 30.0 in blackgram, 26.0, 30.6 in rice, 24.0, 28.0 in soybean, 26.0, 29.2 in maize, 27.5, 32.0 in green leaf manuring, and 27.2 and 31.6% in fallow plots in 0-15 and 15-30 cm layers, respectively before planting tobacco. The FCV tobacco was planted in first fortnight of November. The recommended cultural and manurial schedules were followed to raise different *kharif* crops and FCV tobacco received N as per treatment by adopting plant row plough furrow method, 15 days before planting. FCV tobacco crop was grown with residual soil moisture only. Tobacco leaves were harvested on maturity at 7-8 days intervals by priming and cured in the flue-curing barn. About 2-3 matured leaves were harvested at each time and on an average, 7 primings were done to complete the harvesting of tobacco. After curing and bulking, leaf was graded on the basis of colour and blemish. The data of cured leaf and bright leaf were recorded and grade index were calculated as per the formula suggested by Gopalachari (1984). Observations on broomrape infestation and fresh weight were taken at 90 days after planting and presented on percentage basis as given by Krishnamurthy *et al.* (1994). The tobacco leaf-equivalent yield was computed by converting the yield of *kharif* crops to tobacco yield, based on their market prices. Soil samples collected at pre-sowing and post-harvest were analysed for organic C, and available N, P and K contents. Economics was calculated on the basis of prevailing market cost of inputs and market price of the produce.

RESULTS AND DISCUSSION

Preceding crops

Maize, rice and soybean performed better than blackgram in both the years (Table 1). In blackgram luxuriant vegetative growth was observed but pod formation and pod filling were very poor, leading to very low yields.

Table 1. Tobacco leaf yield, economics and soil fertility as influenced by various preceding crops and N levels

Treatment	Kharif crop yield (t/ha)	Tobacco yield (t/ha)			Grade index	Tobacco leaf-equivalent yield (t/ha)	Economics (Rs/ha × 10 ³)		B : C ratio	Soil chemical constituents									
		Cured leaf	Bright leaf	Grade			Cost of cultivation	Gross returns		Net returns	Organic C (%)	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)					
<i>Cropping system</i>																			
Blackgram - tobacco	0.39	1.56	0.61	1.05	1.82	37.87	49.19	11.32	1.30	0.54	186	21.75	496						
Rice - tobacco	2.38	1.47	0.59	1.01	2.00	42.36	54.00	11.64	1.27	0.47	174	23.75	478						
Soybean - tobacco	1.99	0.88	0.31	0.55	1.58	36.00	42.76	6.76	1.19	0.49	180	18.54	476						
Maize - tobacco	4.30	1.29	0.52	0.91	2.25	42.58	60.68	18.10	1.43	0.47	174	22.25	473						
GLM - tobacco		1.92	0.88	1.39	1.92	33.86	51.87	18.01	1.53	0.50	184	24.42	491						
Fallow - tobacco		1.85	0.83	1.32	1.85	32.86	49.82	16.96	1.52	0.50	178	23.53	483						
SEm±		0.03	0.01	0.02	0.04					0.02	7.2	1.52	11.4						
CD (P=0.05)		0.09	0.04	0.07	0.11					0.05	NS	4.51	NS						
<i>N level (kg/ha)</i>																			
30		1.37	0.56	0.94	1.72	36.02	46.48	10.46	1.29	0.49	178	24.01	468						
45		1.53	0.64	1.06	1.92	37.59	52.39	14.80	1.39	0.50	183	21.57	483						
60		1.59	0.67	1.11	1.93	39.16	55.29	16.13	1.41	0.49	178	21.54	497						
SEm±		0.02	0.01	0.01	0.02					0.01	5.1	1.07	8.0						
CD (P=0.05)		0.06	0.02	0.03	0.05					NS	NS	NS	22						

The short-duration *kharif* crops, viz. maize and rice, could be grown successfully before *rabi* tobacco, taking the advantage of south-west monsoon rains.

Tobacco grown after green-leaf manuring recorded significantly higher yields of cured leaf, bright leaf and grade index of tobacco compared with other sequences and was comparable with fallow – tobacco sequence. The blackgram - tobacco sequence recorded significantly higher tobacco - leaf-yields when compared with rice-tobacco and maize - tobacco sequences. In general, tobacco yields were lower following a *kharif* crop than sole tobacco, as tobacco was raised entirely on residual soil moisture. The lower yields in tobacco succeeding *kharif* crops could be due to partial utilization of stored soil moisture by *kharif* crop and thus reducing the available residual moisture to tobacco.

Significantly lower tobacco cured leaf yields were obtained in soybean - tobacco sequence, and the yields were reduced by 54.2 and 52.4% when compared with green

leaf manuring - tobacco and fallow - tobacco sequences, respectively. Soybean owing to its high protein and oil content might have depleted most of the available nutrients (especially soil available P) and soil moisture, thereby reducing the succeeding tobacco yields. After soybean, establishment of tobacco was difficult and hence led to decreased yield compared with sole tobacco (Harishu Kumar *et al.*, 1992).

Maize - tobacco recorded significantly higher tobacco leaf - equivalent yield, which was 14.7 and 17.8% more than under green leaf manuring - tobacco and fallow –tobacco, respectively. Tobacco leaf - equivalent yield was also 4.0 and 7.5% more in rice - tobacco than in green leaf manuring-tobacco and fallow - tobacco, respectively.

N level

There were significant differences in cured-leaf and bright-leaf yields and grade index due to levels of N (Table 1). Progressive and significant increase in cured-leaf and bright-leaf yields and grade index was noticed with increase in N level from 30 to 60 kg N/ha. The improvement in cured leaf yield with application of 45 and 60 kg N/ha was significantly higher by 0.16 (11.7) and 0.22 t/ha (16.1%), respectively when compared with application of 30 kg N/ha. The 15 kg N increment from 30 to 45 kg resulted in 160 kg increase in cured-leaf yield, but its further increase from 45 to 60 kg/ha produced 60 kg increase only in cured leaf. This follows the Mitscherlich's equation, which states that the increase in growth with each successive addition of element in question was progressively smaller. Bright leaf yield with application of 45 and 60 kg N/ha was significantly higher by 80 (14.3) and

Table 2. Interaction effect of cropping system and N level on bright-leaf yield (t/ha)

Cropping system	N level (kg/ha)		
	30	40	60
Blackgram - tobacco	0.54	0.63	0.65
Rice - tobacco	0.54	0.62	0.62
Soybean - tobacco	0.25	0.32	0.35
Maize - tobacco	0.48	0.54	0.54
GLM - tobacco	0.78	0.89	0.96
Fallow - Tobacco	0.74	0.85	0.90
SEm±		0.02	
CD (P=0.05)		0.04	

Table 3. Effect of preceding crops and N levels on broomrape infestation in tobacco and chemical quality parameters of tobacco-cured leaf

Treatment	Broomrape infestation (%)	Fresh weight of broomrape (g/100 tobacco plants)	Chemical quality parameters			
			Nicotine (%)	Reducing sugars (%)	Reducing sugars : nicotine	Chlorides (%)
<i>Cropping system</i>						
Blackgram - tobacco	8.75	327	2.80	14.24	5.08	1.19
Rice - tobacco	5.04	517	2.48	14.40	5.81	0.92
Soybean - tobacco	7.25	296	2.84	14.20	5.00	1.11
Maize - tobacco	1.75	113	2.40	14.45	6.02	0.91
GLM - tobacco	18.74	1,158	2.50	14.51	5.80	0.81
Fallow - tobacco	21.54	1,485	2.50	14.57	5.83	0.81
SEm±	1.64	40	0.12	0.80	0.50	0.21
CD (P=0.05)	5.10	124	0.33	NS	NS	NS
<i>N level (kg/ha)</i>						
30	10.18	529	2.43	14.82	6.10	0.88
45	10.32	580	2.54	14.45	5.67	0.96
60	11.03	839	2.72	13.92	5.12	1.04
SEm±	1.15	28	0.08	0.56	0.35	0.15
CD (P=0.05)	NS	77	NS	NS	NS	NS

110 kg (19.6%), respectively when compared with that of 30 kg N/ha. Grade index with 45 and 60 kg N/ha was significantly higher by 120 (12.8) and 170 kg (18.1%), respectively than with 30 kg N/ha.

Interaction effects of preceding crops and N levels were significant for bright leaf production, wherein distinctly higher bright leaf was recorded in green leaf manure – tobacco system, which was comparable with fallow – tobacco receiving 60 kg N/ha (Table 2). Bright-leaf production with application of 60 and 45 kg N/ha, being at par, recorded substantially higher yield than 30 kg N/ha in tobacco succeeding other crops, whereas green leaf manure - tobacco and fallow – tobacco responded up to 60 kg N/ha. This was due to the residual effect of N left by the preceding crop to tobacco.

Broomrape incidence

Broomrape infestation in tobacco was significantly lower (1.75%) succeeding maize, but was higher (21.54%) in sole tobacco (Table 3). Cropping system plays a vital role on the incidence of broomrape, as root exudates of the preceding crops that act as trap crops might induce the germination of broomrape seed and thus reduce the inoculum potential (Krishnamurty *et al.*, 1994). Though increased N levels have no significant effect on broomrape infestation, fresh weight of broomrape increased significantly beyond 45 kg N/ha.

Leaf quality

The chemical quality parameters of leaf like nicotine, reducing sugars, reducing sugars : nicotine and chlorides were within the acceptable range (Table 3). Soybean - tobacco recorded significantly higher nicotine content followed by blackgram - tobacco, whereas maize - tobacco system recorded significantly lower values. Higher amount of organic C and residual N left by legumes might have resulted in increased N uptake by tobacco, resulting in higher nicotine accumulation in leaf. Higher nicotine in soybean - tobacco might be due to the concentration effect of nicotine as the tobacco cured leaf yields were lower in tobacco succeeding soybean. Similar observations were made by Harishu Kumar *et al.* (1992). Increasing N levels tended to increase the nicotine content but not significantly.

Reducing sugars decreased with increase in N level, but the differences were not discernible. The ratio of sugars : nicotine shows that tobacco in different treatments has balanced leaf chemistry. Leaf chloride content was unaffected either by preceding crop or N level and was well within the acceptable range. Usually leaf chlorides > 2.0% are not preferred, because the leaf absorbs more moisture, becomes pale and slick, which adversely affects the burning quality of leaf.

Soil-nutrient status

After 2 years of field experimentation, soil was analysed to study the effect of crop sequence on soil-fertility status (Table 1). Significantly higher organic C content was recorded in blackgram - tobacco compared with rice-tobacco, maize - tobacco and soybean - tobacco system. Significant differences in organic C content were not observed due to N levels. Differences were not significant for soil-available N and K in relation to different cropping systems. Significant available P depletion was noticed in soybean - tobacco, due to higher uptake by soybean grain. No significant differences in soil-available N and P were noticed due to N levels, but soil-K content was higher with 60 kg N/ha than with 30 kg N/ha.

Economics

Higher net returns of Rs 18,100 and Rs 18,010/ha were recorded in maize - tobacco and green leaf manuring – tobacco cropping systems, respectively (Table 1). Higher B : C ratio of 1.53 was obtained with green leaf manuring – tobacco, followed by fallow – tobacco sequence (1.52). The lowest net returns and B : C ratio were recorded in soybean – tobacco, because the yields of tobacco were low when it succeeded soybean. Application of 60 kg N/ha recorded higher net returns and B : C ratio than other levels. Maize - tobacco and green leaf manuring - tobacco recorded higher net returns with acceptable physical and chemical leaf quality. However, B : C ratio was higher with green leaf manuring - tobacco and fallow - tobacco.

It was concluded that maize - tobacco cropping system offered higher monetary returns, followed by green leaf manuring - tobacco compared with fallow - tobacco. A nitrogen dose of 45 kg N/ha would be sufficient for tobacco in maize - tobacco system.

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