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Performance of flue-cured virginia tobacco (*Nicotiana tabacum*)-based cropping systems under irrigated Alfisols of Andhra Pradesh

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ABSTRACT

A field experiment with flue cured virginia tobacco (*Nicotiana tabaccum* L.)-based cropping systems was conducted at Jeelugumilli, Andhra Pradesh, from 1997–98 to 1999–2000 to find out sustainable profitable production in irrigated Alfisols of Andhra Pradesh. The experiment comprised 10 cropping systems, i.e. fallow–tobacco, fallow–tobacco–groundnut (*Arachis hypogaea* L.) groundnut–tobacco, gingelly (*Sesamum indicum* L.)–tobacco, soybean [*Glycine max* (L.) Merr.]–tobacco, greengram–tobacco–sorghum [*Sorghum bicolor* (L.) Moench] (fodder), blackgram–tobacco–maize (*Zea mays* L.), maize–tobacco, sunnhemp (*in-situ* green manuring)–tobacco and sunnhemp (*in-situ* green manuring)–tobacco–groundnut. Sunnhemp (*in-situ* green manuring)–tobacco, sunnhemp (*in-situ* green manuring)–tobacco–groundnut, greengram–tobacco–sorghum (fodder) and blackgram–tobacco–maize cropping sequences recorded more yields of tobacco and proved more remunerative than other sequences. A preceding legume of green-manure crop resulted in relatively higher nitrogen and nicotine in succeeding tobacco. However, quality parameters of tobacco leaf in all the cropping sequences were within the acceptable limits.

Key words : Tobacco-based cropping systems, Productivity, Leaf chemistry, Economics to find out

Exportable quality flue-cured virgina (FCV) tobacco is grown under irrigated conditions in Alfisols of East Godavari, West Godavari and Khammam districts of Andhra Pradesh as monocrop. Tobacco-based cropping systems have been advocated in traditional black soils (Harishu Kumar *et al.*, 1992) and southern light soils of Andhra Pradesh (Singh and Srinivasulu, 1992). Tobacco-based cropping system studies conducted earlier with 1 year cycle in irrigated alfisols clearly showed the possibility of growing other crops preceding and succeeding tobacco involving oilseeds, pulses, foodgrains and fodder crops (CTRI, 1992). Hence, a study on tobacco-based crop sequences was undertaken with the objective of sustained profitable production in irrigated Alfisols of Andhra Pradesh without affecting the quality of tobacco.

MATERIALS AND METHODS

A field experiment was conducted at Research Station, Jeelugumilli, Andhra Pradesh, for 3 years from 1997–1998 to 1999–2000. The experiment was conducted in randomized block design with 10 cropping systems, replicated thrice (Table 1). Rainy season (*kharif*) crops were sown in the second week of June in all the years and harvested as and when they reached physiological maturity. Sixty days-old tobacco seedlings (cv. 'K 326') were planted during the winter (*rabi*) season in second week of October with 100 cm × 60 cm spacing in all the years. Nitrogen 100 kg/ha and potassium 120 kg K_2O/ha were applied in 2 equal splits at 7 to 10 and 35 to 40 days after planting. Phosphorus was applied 60 kg P_2O_5/ha at 7 to 10 days after planting. The crops were raised following recommended package of practices. Leaves were harvested as and when matured at 7–8 days interval by priming and cured in the barn. The data of green leaf and cured leaf were recorded and grade index was calculated. Cured leaf samples, collected from different plant positions viz. primings (P), lugs and cutters (X), leaf (L) and tips (T) were analysed for sugars and nicotine, chlorides and total nitrogen. Summer crops were raised in the third week of March in respective seasons. Economics of different crop sequences were worked out on the basis of input, output and prevailing market rates.

RESULTS AND DISCUSSION

Crop yields

Blackgram, groundnut and maize recorded better yields than other rainy season (*kharif*) crops (Table 4). Sunnhemp gave 54,226 to 54,603 kg green matter/ha, which was incorporated into the soil during the last week of August (T_9 and T_{10}). The study revealed that short-duration *kharif* crops successfully be grown before winter (*rabi*) tobacco taking the advantage of south-west monsoon rains.

Significant differences were observed in FCV tobacco yields succeding *kharif* crops (Table 2).Tobacco grown after green-manuring recorded significantly higher yields of green leaf, cured leaf and grade index of tobacco than other sequences but on a par with blackgram–tobacco–maize and greengram–tobacco–fodder sorghum sequences. The cured leaf yields of tobacco grown after green-manuring were higher by 21.8 to 23.2% over fallow–tobacco. The improvement in yields of tobacco in sunnhemp *in–situ* green manuring sequences could be due to the build up of soil organic matter and nutrients in balanced form in the soil [Collins and Hawks (Jr) 1993] and also due to the resulting favourable soil conditions. Earlier workers also observed the beneficial effect of sunnhemp *in-situ* incorporation on improving succeeding tobacco yield (CTRI, 1992). Groundnut–tobacco and gingelly–tobacco sequences also produced higher yields of 21.5–22.0 q/ha of cured leaf and recorded better grade index than fallow–tobacco. Increase in yields of tobacco preceded by groundnut and gingelly over fallow–tobacco may be ascribed to the addition of organic matter besides conservation of nutrients and rain water due to green cover of the crops as the soils are sandy with low organic matter. The earliest recommendation in irrigated alfisols of Andhra Pradesh was gingelly–tobacco rotation (Naidu and Krishnamurthy, 1998). Soybean–tobacco sequence gave tobacco yields similar to fallow–tobacco sequence. Soybean being an exhaustive crop due to its high protein and oil content might have depleted most of the available soil nitrogen and to some extent to other nutrients thereby reducing the succeeding tobacco yields. Maize–tobacco sequence recorded the lowest tobacco yield that could be attributed to the exhaustive nature of the preceding maize crop.

Quality characters of tobacco

Nitrogen, nicotine, sugars and chlorides in leaf are important quality parameters and are reported to be influenced by the preceding crops.

Table 1. Tabacco-based crop sequences

Crop sequences	Rainy-season	Winter-season	Summer
T_1	Fallow	FCV tobacco	
T_2	Fallow	FCV tobacco	Groundnut
T_3	Groundnut ('JL 24')	FCV tobacco	
T_4	Gingelly ('Gowri')	FCV tobacco	
T_5	Soybean ('JS 335')	FCV tobacco	
T_6	Greengram ('ML, 267)	FCV tobacco	Sorghum (fodder)
T_7	Blackgram ('LBG 20')	FCV tobacco	Maize
T_8	Maize ('Kanchana')	FCV tobacco	
T_9	Sunnhemp (*in-situ* GM)	FCV tobacco	
T_{10}	Sunnhemp (*in-situ* GM)	FCV tobacco	Groundnut

Details of treatments are given in Table
GM, Green-manure

Table 2. Yield characters of tobacco as influenced by different crop sequences

Treatment	Green leaf (kg/ha)				Cured leaf (kg/ha)				Grade index			
	1997–98	1998–99	1999–2000	Pooled	1997–98	1998–99	1999–2000	Pooled	1997–98	1998–99	1999–2000	Pooled
T_1	15,050	12,977	14,472	14,167	2,067	1,854	1,896	1,940	1,532	1,390	1,329	1,417
T_2	15,730	12,719	13,888	14,112	2,189	1,804	1,846	1,946	1,590	1,380	1,311	1,427
T_3	16,900	13,880	15,609	15,463	2,414	1,955	2,074	2,148	1,719	1,449	1,503	1,557
T_4	17,471	15,271	15,772	16,172	2,385	2,121	2,121	2,209	1,692	1,592	1,517	1,600
T_5	14,718	13,223	14,916	14,326	2,058	1,889	1,979	1,975	1,555	1,436	1,404	1,465
T_6	17,123	16,020	16,902	16,684	2,439	2,,225	2,243	2,302	1,742	1,736	1,649	1,710
T_7	17,466	15,804	17,250	16,840	2,461	2,195	2,305	2,320	1,768	1,713	1,683	1,721
T_8	13,283	12,670	15,166	13,706	1,876	1,810	1,959	1,881	1,371	1,338	1,351	1,353
T_9	18,004	16,430	17,669	17,369	2,504	2,282	2,301	2,362	1,846	1,781	1,714	1,780
T_{10}	18,398	16,270	17,120	17,261	2,627	2,260	2,284	2,390	1,898	1,764	1,690	1,783
CD (P=0.05)	2,545	1,055	1,850	1,032	364	143	227	141	291	107	155	108

Details of treatments are given in Table 1

Table 3. Chemical composition of tobacco leaf lamina (pooled) in different plant positions as influenced by different crop sequences

Treatment	Total nitrogen (%)				Nicotine (%)				Reducing sugars (%)				Chlorides (%)			
	P	X	L	T	P	X	L	T	P	X	L	T	P	X	L	T
T_1	1.79	1.87	2.20	2.33	1.35	1.59	2.51	2.69	9.97	14.30	12.84	8.73	0.58	0.61	0.67	0.75
T_2	1.85	1.93	2.25	2.37	1.41	1.67	2.57	2.77	9.97	13.49	12.61	8.65	0.56	0.55	0.67	0.71
T_3	1.99	2.07	2.39	2.52	1.49	1.76	2.66	2.88	9.44	13.60	12.24	8.30	0.55	0.61	0.67	0.77
T_4	1.73	1.81	2.15	2.28	1.31	1.54	2.45	2.64	10.16	14.56	13.01	8.94	0.56	0.58	0.67	0.71
T_5	1.93	2.01	2.35	2.48	1.46	1.69	2.63	2.80	9.45	13.88	12.38	8.65	0.58	0.62	0.72	0.71
T_6	2.04	2.13	2.47	2.60	1.51	1.75	2.72	2.90	9.24	13.75	11.92	8.32	0.66	0.67	0.67	0.72
T_7	2.02	2.11	2.44	2.57	1.52	1.77	2.72	2.92	9.27	13.66	11.91	8.23	0.58	0.63	0.63	0.75
T_8	1.71	1.80	2.14	2.26	1.27	1.51	2.29	2.52	10.33	14.87	13.16	9.07	0.59	0.61	0.68	0.71
T9	2.08	2.16	2.50	2.63	1.57	1.81	2.72	2.96	9.21	13.33	11.96	7.66	0.55	0.58	0.62	0.76
T_{10}	2.10	2.21	2.55	2.68	1.59	1.88	2.79	3.01	8.87	13.05	11.44	7.53	0.65	0.57	0.66	0.71
CD (P=0.05)	0.08	0.12	0.12	0.13	0.11	0.12	0.17	0.21	NS	NS	0.95	0.92	NS	NS	NS	NS

P, Primings (first and second harvest from bottom); X, lug and cutters (third and fourth harvest); L, leaf (firth to 10th harvest); T, tips (11th and 12th harvest)

Table 4. Economic viability of various tobacco-based cropping systems

Treat-ment	Yield (kg/ha)			Cost of cultivation (Rs/ha)				Gross returns (Rs/ha)				Combined net returns (Rs/ha)	Benifit: cost ratio
	Rainy season	Winter	Summer	Rainy season	Winter	Summer	Total	Rainy season	Winter	Summer	Total		
T_1		1,940			57,270		57,270		77,600		77,600	20,330	1.35
T_2		1,946	1,237		57,336	8,916	66,252		77,840	12,370	90,210	23,158	1.36
T_3	1,212	2,148		7,960	58,458		66,418	12,120	85,920		98,040	31,622	1.48
T_4	323	2,209		4,006	59,129		63,135	5,168	88,360		90,528	27,393	1.43
T_5	957	1,975		5,824	56,555		62,379	7,656	79,000		86,656	24,227	1.39
T_6	755	2,302	42,796	5,010	60,152	55100	70,662	13,590	92,080	10,699	116,369	45,707	1.65
T_7	1,300	2,320	39,166*	5,148	60,350	8,765	74,263	23,400	92,800	19,583	135,783	61,520	1.83
T_8	48,777*	1,881		8,520	55,521		64,041	24,388	75,240		99,628	35,587	1.56
T_9	54,226	2,362		2,400	60,812		60,812		94,480		94,480	33,668	1.55
T_{10}	54,603	2,390	1208	2,400	61,120	8,916	70,036		95,640	12,080	107,720	37,684	1.54

*Cobs

Market prices of grain: Groundnut (pods), Rs 10/kg; gingelly, Rs 16/kg, soybean, Rs 10.kg; greengram, Rs 15/kg; blackgram, Rs 18/kg; tobacco cured leaf, Rs 40/kg

Higher values of nicotine and nitrogen in leaf were recorded in all the plant positions in the cropping sequences involving *in-situ* green–manuring and leguminous crops preceding tobacco (Table 3). This trend could be attributed to higher organic matter and residual nitrogen in these crop sequences (Gopalachari, 1984). Lowest values of nicotine and total N in tobacco leaf were found in maize–tobacco sequence due to the exhaustive nature of preceding maize crop. Significant differences were not observed in reducing sugars concentration of leaf in P and X positions; however, significant differences in reducing sugar concentration of leaf were observed between treatments in L and T positions. Reducing sugar concentration in leaf was lower in the crop sequences wherever *in-situ* green-manuring was done or the *kharif* crop was a legume. Higher levels of reducing sugars in tobacco leaf in L and T positions were recorded in maize–tobacco sequences. Lower levels of sugars are associated with higher levels of nitrogen (Gopalachari, 1984). Chloride concentration in leaf was not altered by any of the crop sequences and it was well with in the normal limits of a good quality leaf.

The leaf quality was significantly influenced by variable climatic conditions during the course of study. Lower levels of nitrogen and nicotine and higher levels of reducing sugars in leaf were obtained in 1998–99 season due to higher amount of rainfall (251 mm) and more number of rainy days (19 days) during crop growth period compared to the other 2 seasons. The study also revealed that total nitrogen and nicotine levels gradually increased with leaf position from P to T. Reducing sugars increased from P to X position and thereafter decreased gradually up to T position in all the crop sequences (Table 3). Distribution of nitrogen, nicotine and reducing sugars in different plant positions (Gopalachari, 1984) followed the normal trend in all the crop sequences. All the chemical quality parameters were within the desirable levels in all the plant positions.

Economics

Gross returns, combined net returns and benefit : cost ratio were higher for blackgram–tobacco–maize and greengram–tobacco–sorghum (fodder) sequences. (Table 4). This can be attributed to additional monetary benefits from both *kharif* and summer crops and higher net returns from tobacco. Maize–tobacco and sunnhemp (green manuring)–tobacco followed next in order with benefit : cost ratio of around 1.55. Superior benefit : cost ratio in maize–tobacco cropping sequence was possible owing to high monetary returns from maize in spite of lower returns from tobacco. Sunnhemp (green-manuring)–tobacco sequences (T_9 and T_{10}) were better in terms of soil health as green-manuring improves soil organic matter, moisture holding capacity and physical condition of the soil.

Green manure (sunnhemp) or blackgram or greengram in *kharif* followed by tobacco (cv. 'K 326') in *rabi* and fodder sorghum/maize (cobs)/groundnut in summer would be profitable crop sequences in tobacco growing irrigated alfisols of Andhra Pradesh. The crop sequence with 300% cropping intensity will provide employment throughout the year and also give extra monetary benefit to the farmer.

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