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EFFECT OF INTERCROPPING OF GRAIN LEGUMES ON THE YIELD AND QUALITY OF FLUE-CURED TOBACCO (*NICOTIANA TABACUM* L.) IN VERTISOLS.

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ABSTRACT

Field experiments conducted from 1982-1983 to 1984-1985 at the Central Tobacco Research Institute, Rajahmundry revealed that tobacco + pigeonpea either 1:1 or 2:1, tobacco + chickpea 1:1 and tobacco+pigeonpea either 1:1 or 2:1, tobacco+chickpea 1:1 and tobacco+*mung* 1:2 as additive series resulted in cured leaf and total bright leat equivalent (TBLE) production as that of sole tobacco. Nitrogen fertilizer upto 20 kg.ha^{-1} remarkably increased the cured leaf and bright leaf production over no N. Applied N showed no effect on grain yield of legumes. Intercropping tobacco with chickpea either in 1 : 1 or 2:2, pigeonpea in 1:1 or *mung* in 2:2 pattern maintained similar leaf quality in terms of sugar/nicotine ratios as sole tobacco. Tobacco manufacturing quality components such as equivalent moisture content (EMC) filling value and pore volume remained unaltered by intercropping with grain legume. Increasing N fertilizer increased the leaf nicotine content and decreased the reducing sugar and sugar:nicotine ratio. Land equivalent ratios and the total economic productivity was higher when tobacco was intercropped with pigeonpea in 1:1 or 2:1 pattern.

KEYWORDS: Tobacco, Intercropping, Yield, Tobacco Quality.

India produced 109.4m.kg of virginia tobacco on 1.3m.ha with a productivity of 842 kg.ha^{-1} in 1984-1985. Tobacco in India is grown on vertisols during post rainy season (October to February) utilising the conserved soil moisture. The productivity of Indian Flue-cured tobacco is lower and is often not commensurate with the inputs applied. There is a growing need to devise strategies which would accrue higher profits without substituting the principal tobacco crop. Since tobacco is planted in relatively wider rows, the interspaces can be put to more efficient use by growing short duration low-growing grain legumes and such a practice is reported to ensure better utilisation of land and solar energy (Willey 1979). The prospects of profitably growing short duration mustard and chickpea (Raghavaiah *et al.* 1986) and snapbean (Parbo and Maguslong, 1985) in association with flue-cured tobacco were reported. Natarajan and Willey (1980) suggested better utilization of above-and below ground resources by component crop in a sorghum legume intercropping system. Intercropping ensures better interception of photosynthetically active radiation (PAR) and higher radiation conversion efficiency (Marshall and Willey, 1983) and thus the non-competitive influence of morphologically diverse crops can be better exploited (Trendbath 1979). It is, therefore, logical to evaluate the performance of various proportions of tobacco crop and intercrop under various N regimes.

MATERIALS AND METHODS

Investigations were made during the post rainy seasons of 1982 to 1984 at Rajahmundry (17° 2' 40' N, 81° 46' 25" E) situated in the coastal tropical belt of India. The soil of the experimental site was a clay loam (coarse sand 1.5%, fine sand 17.0%, silt 22.5 % and clay 56.5% in 0 to 22.5 cm soil layer) of pH 7.5, low in N (Organic carbon 0.28%) and medium to high in available P (13.44 kg.ha^{-1}) and K (386.4 kg.ha^{-1}).

There were nine tobacco-grain legume treatments based on row arrangement (Table 1) which formed the main plots and three levels of

N (0, 20 and 30 kg.ha^{-1}) constituted the sub plots replicated thrice in a split plot design. A basal dose of 50 kg.ha^{-1} each of P_2O_5 and K_2O together with N treatment was applied at transplanting as single superphosphate, potassium sulphate and ammonium sulphate. Tobacco crop was planted on 8 November 1982, 17 November 1983 and 1 November 1984 according to row proportions. The four grain legume crops were grown alone at their recommended row distances for calculation of land equivalent ratios (LER). Tobacco cultivar Jayasri, *urdbean* cv. T9, *mung* cv. Pusa-baisakhi, Chickpea cv. Jyothi and pigeonpea cv. LRG-30 were used. After harvest, the leaf was cured in flue curing barns, bulked and graded as per the standard grading system.

Cured leaf samples were collected from each treatment after compositing all grades and primings in proportion to the weights of individual grades from each priming. Each sample was made into two subsamples after removing mid-rib. One subsample was used for the determination of equilibrium moisture content (Chakraborthy *et al*.1967), filling value, shattering index (Artho *et al.* 1963) and pore volume (Chakraborthy and Ramachandrudu, 1967). The second subsample was dried in an oven at 60°C, powdered to 60 mesh size and analysed for nicotine and reducing sugars (Harvey *et al.* 1969).

The total economic productivity of the intercropping system was evaluated as follows in terms of tobacco equivalents (t.ha^{-1})

$$\text{Tobacco equivalent for intercrop} = \frac{Yi \times Pi}{Pt}$$

Where Yi = Seed yield of intercrop
Pi = Price per tonne of intercrop
Pt = Price per tonne of tobacco

The rainfall received during 1982-1983, 1983-1984 and 1984-1985 was 175.7, 323.9 and 181.8 mm, respectively.

RESULTS AND DISCUSSIONS

Effect on tobacco yield

Growing various grain legumes in association with flue-cured tobacco did not significantly affect the yield of cured leaf (except in 1984-1985), bright grade production and total bright leaf equivalent (TBLE) during three years of experimentation. Data over the years revealed that tobacco + pigeonpea 1:1 or 2:1, tobacco+ chickpea 1:1 and tobacco+ *mung* 1:2 resulted in similar cured leaf yield as that of sole tobacco. The TBLE also followed similar trend. Bright grade production tended to improve by intercropping with pigeonpea or chickpea in 1:1 pattern or with pigeonpea in 2:1 pattern.

The conceptual degree of association between base crop of tobacco and intersown crops would be in the order of 1:2>1:1> 2:2> 2:1 patterns. As the degree of association between base crop and intercrops of *urdbean* and *mung* was more, tended to decrease, and TBLE tended to decrease and cured leaf yield and intercrop yield tended to increase and vice versa. In case of pigeonpea and chickpea intercropping, however, as the area of contact between component crops increased the yield of flue-cured tobacco and intersown crops tended either to increase or remain unaffected, indicating a possible beneficial effect of these legumes.

It is evident from Table 2 that the land equivalent ratios (LER) were greater in 1982-1983 and 1984-1985 than those in 1983-1984. The greater quantum of post planting rain received during the latter year possibly brought down the yield of tobacco resulting in lower LER values. It can be seen that tobacco + pigeonpea 1:1 or 2:1 and tobacco + *mung* 1:2 systems are more stable over the years in respect of their productivity. The total economic productivity of the intercropping systems expressed in terms of tobacco equivalent (t.ha^{-1}) was higher when tobacco was intercropped with pigeonpea either in 1:1 or 2:1 pattern.

ffect of nitrogen

Fertilizer N at 20 kg.ha^{-1} brought about a :markable increase in cured leaf and bright leaf :oduction (Table 1), growth and yield charac- rs of flue cured tobacco over no N. There was no marked improvement in yield or yield characters due to further increments of N upto 30 kg.ha^{-1}. The TBLE was unaffected by N fertilizer except in 1983-1984, where beyond 20 kg.ha^{-1} substantially decreased the TBLE. Applied N had no effect on grain yield of legumes.

Effect on chemical and manufacturing quality characteristics

Intercropping tobacco with pigeonpea or chickpea decreased the nicotine content of leaf as compared to sole crop of tobacco, while it increased with *urdbean* intercropping (Table 3). The reducing sugar content of tobacco leaf was not much altered by intercropping with grain legumes. By and large, the sugar:nicotine ratios were greater in relatively dry seasons than in wet season which received higher post-planting rain. Intercroppping tobacco with chickpea either in 1:1 or 2:2, pigeonpea in 1:1 or *mung* in 2:2 pattern maintained similar sugar:nicotine ratios as sole tobacco.

Increasing N increased the nicotine content and decreased the reducing sugar content and sugar:nicotine ratio of tobacco leaf. This corroborates with the findings of Aromin *et al.* (1985) who reported a decrease in quality index with increase in N level.

Manufacturing quality components such as equilibrium moisture content (EMC) filling value and pore volume were unaffected by intercropping tobacco with grain legumes and were within the acceptable limits. The shatterability indices, however, were slightly lower that the acceptable limits in all the treatments (Raghavaiah *et al.* 1986; Gopalachari 1971).

The findings of the present investigation suggest that by intercropping flue-cured tobacco with pigeonpea, the total economic productivity of the system can be increased, as the growth pattern of component crops differed in scale resulting in temporal separation of their demands on resources. Temporal complementarity can result in substantial yield advantages (Willey 1979).

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Table 1. **Flue-cured tobacco yield ($t.ha^{-1}$) as affected by intercropping and N fertilizer**

Treatments	Cured leaf yield ($t.ha^{-1}$)				Bright leaf yield ($t.ha^{-1}$)				TBLE ($t.ha^{-1}$)			
	1982-'83	1983-'84	1984-'85	Pooled	1982-'83	1983-'84	1984-'85	Pooled	1982-'83	1983-'84	1984-'85	Pooled
Intercropping												
Tobacco sole crop 80 x 60 cm	1.60	1.56	2.01	1.72	0.53	0.34	0.79	0.55	0.91	0.68	1.19	0.93
Tobacco + *urd* 1 : 2	1.21	1.24	1.61	1.35	0.34	0.38	0.65	0.46	0.63	0.75	0.95	0.74
Tobacco + *mung* 1 : 2	1.38	1.30	1.97	1.55	0.32	0.33	0.75	0.47	0.63	0.59	1.15	0.79
Tobacco + Pigeonpea 1 : 1	1.74	1.41	1.59	1.58	0.47	0.40	0.80	0.56	0.89	0.69	1.05	0.88
Tobacco + Chickpea 1 : 1	1.60	1.45	1.63	1.56	0.50	0.40	0.80	0.56	0.85	0.70	1.06	0.87
Tobacco + *Urd* 2 : 2	1.33	1.38	1.69	1.47	0.39	0.35	0.74	0.49	0.67	0.75	1.05	0.79
Tobacco + *mung* 2 : 2	1.46	1.36	1.70	1.51	0.50	0.39	0.70	0.53	0.84	0.67	1.00	0.84
Tobacco + pigeonpea 2 : 1	1.53	1.41	1.77	1.57	0.45	0.42	0.81	0.56	0.79	0.71	1.12	0.88
Tobacco + chickpea 2 : 2	1.42	1.43	1.48	1.44	0.36	0.37	0.67	0.47	0.72	0.66	0.91	0.76
SEm	0.149	0.083	0.139	0.092	0.078	0.052	0.097	0.054	0.083	0.054	0.109	0.059
CD (5%,	NS	NS	0.296	0.186	NS	NS	NS	NS	NS	NS	NS	0.119
Nitrogen ($kg.ha^{-1}$)												
0	1.51	1.28	1.60	1.46	0.46	0.44	0.77	0.56	0.82	0.70	1.04	0.85
20	1.41	1.44	1.74	1.53	0.42	0.39	0.78	0.53	0.74	0.69	1.09	0.84
30	1.50	1.46	1.81	1.59	0.41	0.29	0.69	0.47	0.76	0.61	1.04	0.80
SEm	0.040	0.037	0.078	0.036	0.026	0.020	0.047	0.022	0.027	0.022	0.057	0.025
CD (5%)	NS	0.014	0.159	0.073	NS	0.058	NS	0.044	NS	0.061	NS	NS

Table 2. Seed yield of legumes and Land Equivalent Ratio as affected by intercropping and N fertilizer

Treatment	Seed yield ($t.ha^{-1}$) of legumes				Land Equivalent Ratio (LER) Based on cured leaf tobacco.							
	1982-'83	1983-'84	1984-'85	Average	1982-'83		1982-'84		1984-'85		Average	
Intercropping												
Tobacco sole crop 80 x 60 cm	—	—	—	—	1.00	(1.60)	1.00	(1.56)	1.00	(2.01)	1.00	(1.72)
Tobacco + *urd* 1: 2	0.28	0.15	0.21	0.21	1.23	(1.33)	1.04	(1.30)	1.20	(1.70)	1.15	(1.44)
Tobacco + *mung* 1 : 2	0.24	0.08	0.04	0.12	1.61	(1.51)	1.03	(1.34)	1.12	(1.99)	1.25	(1.61)
Tobacco + Pigeonpea 1 : 1	0.38	0.22	0.56	0.38	1.42	(1.99)	1.10	(1.55)	1.13	(1.96)	1.21	(1.83)
Tobacco + Chickpea 1 : 1	0.17	0.08	0.39	0.21	1.16	(1.69)	1.00	(1.49)	1.09	(1.84)	1.08)	(1.67)
Tobacco + *urd* 2 : 2	0.11	0.08	0.20	0.13	1.01	(1.37)	1.01	(1.41)	1.22	(1.77)	1.08	(1.51)
Tobacco + *mung* 2 : 2	0.08	0.05	0.03	0.05	1.35	(1.50)	0.99	(1.38)	0.94	(1.71)	1.09	(1.53)
Tobacco + pigeonpea 2 : 1	0.30	0.14	0.50	0.31	1.22	(1.73)	1.02	(1.50)	1.18	(2.10)	1.14	(1.77)
Tobacco + chickpea 2 : 2	0.10	0.08	0.45	0.21	0.97	(1.47)	0.99	(1.47)	1.06	(1.73)	1.00	(1.55)
Nitrogen ($kg.ha^{-1}$)												
0	0.20	0.11	0.29	0.20								
20	0.20	0.09	0.30	0.19								
30	0.22	0.11	0.30	0.21								
Sole legumes												
urd	0.58	0.60	0.52	0.56								
mung	0.32	0.40	0.28	0.33								
Pigeonpea	1.11	1.08	1.62	1.27								
Chickpea	1.06	0.98	1.36	1.13								

Figures in parenthesis are tobacco equivalents ($t.ha^{1}$).

Rates per tonne (Rupees) of urd = 4,000/-, mung = 5,000/-, pigeonpea = 6,000/-, chickpea = 5,000/-, tobacco = 9,000/-.

Table 3. Chemical and manufacturing quality characteristics of flue-cured tobacco as affected by intercropping with grain legumes and N fertilizer (Mean values of three seasons).

Treatment	Chemicalquality/characteristic			Manufacturing quality parameters			
	Nicotine (%)	Reducing sugars (%)	Sugar/ nicotine	EMC (%)	Filling Value(cc.g^{-1})	Shattering index (%)	pore volume (ml.g^{-1})
Intercropping							
Tobacco sole crop 80 x 60 cm	2.24	11.8	5.12	15.23	3.69	2.98	0.1401
Tobacco + *urd* 1: 2	2.39	11.53	4.68	16.31	3.76	2.86	0.1546
Tobacco + *mung* 1: 2	2.23	10.68	4.64	15.63	3.99	2.90	0.1404
Tobacco + pigeonpea 1 : 1	2.17	11.42	5.10	16.02	4.05	2.80	0.1415
Tobacco + chickpea 1 : 1	2.16	11.43	5.10	15.42	3.82	2.86	0.1335
Tobacco + *urd* 2 : 2	2.28	10.84	4.56	15.77	3.84	2.81	0.1449
Tobacco + *mung* 2 : 2	2.13	11.06	5.05	14.71	3.82	2.90	0.1327
Tobacco + pigeonpea 2 : 1	2.26	10.84	4.65	15.83	3.81	2.83	0.1392
Tobacco + chieckpea 2 : 2	2.13	11.42	5.23	15.58	3.94	2.86	0.1178
Nitrogen (kg / ha^{-1})							
0	2.09	11.39	5.28	15.71	3.75	2.91	0.1420
20	2.24	11.39	5.28	15.71	3.75	2.91	0.1420
30	2.32	10.92	4.57	15.44	3.89	2.84	0.1352

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EFFECT OF PRODUCTION FACTORS ON GROUNDNUT YIELD

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ABSTRACT

The results of a field experiment conducted during the special seasons (April-May) of 1987, 1988 and 1989 at Agricultural Research Station, Aliyarnagar to find out the optimum production factors for rainfed groundnut revealed that the selection of improved variety JL 24, adoption of a spacing of 15 x 15 cm, providing one supplemental irrigation between 50 to 90 days and fertillizing the crop with 15N, 30P, 45K, kg.ha^{-1} resulted in the highest pod yield, net returns and cost benefit ratio.

KEYWORDS : Ground nut, Production factor Fertilizer, Spacing variety population, irrigation.

Groundnut, the most important oilseed crop of India is mostly grown as a rainfed crop. Non doption of improved agronomic package of practices is one of the main reasons for the low production and productivity of this crop. Experimental evidences suggest that with the adoption of improved package of practices, the yield can be increased by 110 per cent. The exclusion of protective irrigation and fertilisation from the package of practices, brought in increases of only 61 and 64 per cent over control (Saini, 1984). An investigation on the effects of differ-