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Effect of composted coir pith, nitrogen and irrigation on chewing tobacco (*Nicotiana tabacum*)

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ABSTRACT

A field experiment was conducted from 2001-02 to 2003-04 at Vedasandur to study the effect of coconut (*Cocos nucifera* L.) coir pith compost at three levels (10.0, 12.5 and 15.0 t/ha) in comparison with municipal compost at 25 t/ha, three levels of irrigation (0.5, 0.75 and 1.0 ETc) and three levels of nitrogen (50, 75 and 100 kg N/ha) on the yield and quality of chewing tobacco (*Nicotiana tabacum* L.). The yields of first-grade leaf and total cured-leaf of chewing tobacco with municipal compost at 25 t/ha were comparable with that of composted coir pith at 10 t/ha. Irrigation at 1.0 ETc significantly increased the yields of first-grade leaf and total cured leaf by 19 and 17% respectively compared with that at 0.5 ETc. Nitrogen at 100 kg/ha significantly increased the yield of first-grade leaf and total cured leaf by 15 and 19% respectively than at 75 kg N/ha. Water-use efficiency was higher with 0.5 ETc and 100 kg N/ha. Net returns increased by 4% with composted coir pith at 10 t/ha than with municipal compost at 25 t/ha, 12% with 1.0 ETc than with 0.5 Etc, and 6% with 100 kg N/ha over 50 kg N/ha. Soil available P, lamina P and K uptake were higher with municipal compost at 25 t/ha than composted coir pith at 10 t/ha. Soil-organic C and nutrient uptake of lamina improved with 1.0 ETc and 100 kg N/ha than with 0.5 ETc and 50 kg N/ha, respectively. Nicotine increased with 0.5 ETc and decreased with 1.0 ETc. Composted coir pith at 10 t/ha, irrigation at 1.0 ETc and nitrogen 100 kg/ha were found optimum for increased yields of first-grade leaf and total cured leaf, net returns and benefit : cost ratio.

Key words: Chewing tobacco, Composted coir pith, Irrigation, Nitrogen

Chewing tobacco (*Nicotiana tabacum* L.) is one of the major cash crops of Tamil Nadu. The crop requires about 20 irrigations each of 25 to 30 mm and higher dose of organic manure (25 t/ha as municipal compost). Sankara Reddy and Yellamanda Reddy (2002) reported water requirement of 400–600 mm to tobacco. As water has became a prime natural resource recently for assured crop production and as day-by-day competition for water increases from domestic to agricultural industries, there is a need to use the irrigation water judiciously in scientific manner. In flue cured virginia (FCV) tobacco, irrigation scheduling at 1.0 IW : CPE ratio up to 75 days and 0.8 IW : CPE ratio up to harvest recorded significantly higher leaf yields (Krishna Reddy *et al.*, 2000). As abundant quantities of coir pith from coconut are available in Tamil Nadu and its compost contains higher N (1.04%) in addition to improving the soil physical conditions of the soil, an attempt was made to use this as an alternative to municipal compost, which contains enormous weed seeds, indecomposable materials like polythene sheets, plastics and glass pieces, whose availability too is diminishing day by day. In view of little information available on the effect of composted coir pith (CCP) in combination with irrigation and nitrogen on the yield, quality (chewability) and economics of chewing tobacco, the present investigation was undertaken.

MATERIALS AND METHODS

A field experiment was conducted during the winter (*rabi*) season of 2001-02 to 2003-04 at Vedasandur to study the effect of composted coir pith, nitrogen and irrigation on chewing tobacco. The soil was sandy gravelly with alkaline pH (8.3), low in organic C (0.45%), available N (210 kg/ha) and available P (6.5 kg/ha) and medium in available K (275 kg/ha). The maximum temperature was 34.1, 34.8 and 34.4°C during 2001-02, 2002-03 and 2003-04 respectively and the corresponding minimum temperature was 22.4, 22.3 and 22.9°C. The treatments consisted of three levels of composted coir pith (CCP), viz. 10.0, 12.5, 15.0 t/ha and the present practice of 25 t/ha of mu-

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nicipal compost (MC), with three irrigation levels based on ETc (consumptive use of water), viz. 0.50, 0.75 and 1.0, and three levels of N, viz. 50, 75 and 100 kg/ha. Raw coir pith was composted as per the method suggested by Balasubramanian *et al.* (1995). The composted coir pith contains 1.04% N, 0.06% P and 1.0% K. Municipal compost contains 0.5% N, 0.08% P and 0.90% K. For irrigation treatments, the irrigation water (IW) is fixed as 30 mm, which is optimum for chewing tobacco. The crop was irrigated every time at 1.0 IW : CPE ratio, viz. for every 30 mm evapo-transpiration (CPE). The consumptive use of water (ETc = ET x Kp x Kc) and irrigation water requirement (WR = ETc - ER) for each irrigation was calculated as per Training Manual, FAO, 24(1986) and 56(1998), where Kp, ET, Kc and ER are pan-evaporimeter constant (0.70), cumulative pan evaporation, crop factor and effective rainfall respectively. The Kc values for different growth stages of the crop are given in Table 1. The required water was applied through Parshall flume. In total 13, 16 and 13 irrigations were given to the crop during 2001-02, 2002-03 and 2003-04 respectively. The corresponding total quanta of water irrigated were 112.0, 137.3 and 79.1 mm at 0.5 Etc; 174.3, 211.7 and 118.6 mm at 0.75 Etc; and 236.9, 285.7 and 159.0 mm at 1.0 ETc. Nitrogen was applied in two equal splits through ammonium sulphate as the first dose on 45th day and urea as second dose on 60th day. A common dose of 44 kg P/ha was applied through single super phosphate mixed with 2.5 t municipal compost applied basal to all the treatments. Topping was done at 60th day by retaining 12 leaves on the plant and the suckericide (Decanol @ 6%) was applied at leaf axils @ 5 ml/plant. The crop was harvested at 120 days, sun-cured, bulk-fermented, stripped and graded. The other cultural practices recommended by CTRI Research Station, Vedasandur were followed for raising the crop. The experiment was conducted in split-plot design with levels of CCP and municipal compost in main plots, irrigation levels in sub-plots, and nitrogen levels in sub-sub-plots with three replications. The variety of chewing tobacco used was 'Meenakshi'. The yields were recorded after grading. Leaf samples were collected and the lamina was analysed for nicotine, reducing sugars and chlorides by auto-analyser method developed at Central Tobacco Research Institute, Rajahmundry. The soil sample drawn from 0-22.5 cm depth was analysed for organic C (Walkley and Black's method), available P (Olsen's method), available K (1.0 N neutral ammonium acetate extractant method) and chlorides (titration of soil water with standard silver nitrate method). Economics was calculated as per the cost of inputs and the price of cured leaf realized. The quality in terms of chewability was evaluated by various parameters, viz. body of the leaf (10), aroma (10), whitish incrustation (10), taste(10), pungency (10), saliva secretion (10), retention of pungency (10), stiffness in mouth, totaling to 80 (Palanichamy and Nagarajan, 1999). Samples of the cured leaves were given to three tobacco chewers and scores were recorded. A score of 60 and above was considered to indicate preferably the better quality for chewing purposes.

RESULTS AND DISCUSSION

Growth, yield and chewing quality of leaf

Levels of composted coir pith and municipal compost @ 25 t/ha did not influence the leaf length, width and stem girth of chewing tobacco. Irrigation at 1.0 ETc significantly increased the growth attributes than at 0.5 ETc. Since the consumptive use of water of the crop at 1.0 ETc is higher (264.4 mm) than of 0.5 ETc (132.2 mm), the physiological process of plants might be at its best for increasing the water content of the plants, the water potential of the plant, which in turn eases the availability of water to the plant cells, leads to higher cell enlargement and transpiration rate, resulting in increased growth attributes. Growth attributes were lower with 0.5 ETc. Lower water regimes of the soil ceased the cell elongation and division (Reddy *et al.*, 2001), perhaps leading to lower growth attributes. Nitrogen levels did not influence the growth attributes.

Municipal compost 25 t/ha and levels of composted coir pith did not influence the first grade-leaf yield (FGLY) and total cured leaf yield (TCLY). Irrigation levels significantly influenced the FGLY and TCLY during 2001-02 and 2003-04. However, during 2002-03 irrigation levels did not influence the cured leaf yield. Irrigation at 1.0 ETc significantly increased the FGLY and TCLY by 23% and 22% than at 0.5 ETc during 2001-02 (Table 2). During 2003-04, both FGLY and TCLY significantly increased by 26 % over 0.5 ETc. The mean data also showed a significant yield increase of 19% and 17 % of FGLY and TCLY respectively with 1.0 ETc over 0.5 ETc. Higher quantity of irrigation at 1.0 ETc enhanced the nutrient uptake which in turn enhanced the meristamatic activities and size of cells and functioning of protoplasm which consequently improved the leaf yield. Scheduling irrigation at 1.0 IW : CPE ratio gave substantially greater yields of chewing tobacco than 0.25, 0.50 and 0.75 IW : CPE ratios (CTRI, 1990).

Nitrogen @ 100 kg/ha significantly increased the FGLY than @ 50 kg N/ha. The yield increase was 11, 19 and 19% during 2001-02, 2002-03 and 2003-04 respectively. Similarly, the increase in yield of TCLY during 2001-02 and 2003-04 was 20 and 19% respectively. Nitrogen levels did not influence the TCLY during 2002-03. The mean data for FGLY and TCLY significantly increased by 15 and 19% respectively at 100 kg N/ha than of 75 kg N/ha. The increased availability and uptake of nutrients could be attributed for increased cured-leaf yield. Chewing tobacco responded to higher N fertilization (150 to 250 kg N/ha) under Bihar conditions (Singh *et al.*, 1999).

Interactive effect of levels of composted coir pith and irrigation was significant. Application of composted coir pith @ 12.5 t/ha at 1.0 ETc registered higher TCLY. The interactive effect of seasons, levels of composted coir pith and irrigation on TCLY was significant (Table 3). Application of composted coir pith at 12.5 t/ha under 1.0 ETc registered higher TCLY, followed by composted coir pith 15 t/ha under 1.0 ETc during 2001-02.

Preferable chewing quality score (>60 out of 80), viz. body of the leaf, aroma, whitish incrustation, taste, pungency, saliva secretion and retention of pungency were obtained with all the treatments.

Water-use efficiency and economics

Water-use efficiency (WUE) varied from 13.8 to 14.4 kg/ha-mm with municipal compost and levels of composted coir pith (Table 4). As the yield variation is non-significant, the variation in WUE is less among the levels of compost. It is obvious that WUE is the function of the ratio of economic produce (TCLY) to the consumptive use of water (mm), the production of cured-leaf yield/mm of water used decreased with increase in water supply, and the relative increase in total cured leaf was not in proportion to the increase in consumptive use of water, thereby resulting in decreased WUE under 1.0 ETc. Nitrogen 100 kg/ha increased the WUE owing to increased TCLY caused by increased uptake of N.

The cost of cultivation was higher with municipal compost @ 25 t/ha, irrigation at 1.0 ETc and nitrogen at 100 kg/ha. The cost involved in purchase, transport of municipal compost and the labour charges involved in weeding due to its application could be attributed to higher cost of cultivation. Increased cost of cultivation with 1.0 ETc and 100 kg N/ha is due to higher leaf yield, involving higher labour cost for the post-harvest operations like sun-curing, bulk-fermenting, turning, stripping, bulking and grading. Net returns increased by 4.0% with composted coir pith 10 t/ha compared with the municipal compost 25 t/ha; 12% with 1.0 ETc than with 0.5 ETc and 6% with 100 kg N/ha than with 50 kg N/ha. The benefit : cost ratio was higher with composted coir pith 10 t/ha, irrigation at 1.0 ETc and N 100 kg/ha.

Table 1. Requirement of consumptive use of water and irrigation water requirement for chewing tobacco under three schedules of irrigation

Crop growth stage	Cumulative evapo-transpiration (ET, mm)	Effective rainfall (ER, mm)	Crop factor (Kc)	Consumptive use of water (ETc = ET x Kp x Kc)			Irrigation-water requirement (WR = ETc - ER)		
				0.5 ETc (mm)	0.75 ETc (mm)	1.0 ETc (mm)	0.5 ETc (mm)	0.75 ETc (mm)	1.0 ETc (mm)
2001-02									
Initial	60.7	17.0	0.40	8.5	12.8	17.0			
Crop development	124.9	12.7	0.80	35.0	52.5	70.0	22.3	39.8	57.3
Mid-season	111.7		1.15	45.1	67.5	89.9	45.1	67.5	89.9
Late-season	141.9		0.90	44.6	67.0	89.4	44.6	67.0	89.7
Total	439.2	29.7		133.2	199.8	266.4	112.0	174.3	236.9
2002-03									
Initial	86.6	11.1	0.40	12.1	18.2	24.2	1.0	7.1	13.1
Crop development	136.0		0.80	38.1	57.2	76.2	38.1	57.2	76.2
Mid-season	145.6		1.15	58.6	87.9	117.1	58.6	87.9	117.1
Late-season	125.8		0.90	39.6	59.5	79.3	39.6	59.5	79..3
Total	494.0	11.1		148.4	222.8	296.8	137.3	211.7	285.7
2003-04									
Initial	59.3	16.6	0.40	8.3	12.4	16.6			
Crop development	100.2	55.2	0.80	28.0	42.1	56.1			0.9
Mid-season	100.0		1.15	40.3	60.4	80.5	40.3	60.4	80.5
Late-season	123.2		0.90	38.8	58.2	77.6	38.8	58.2	77.6
Total	382.7	71.8		115.4	173.1	230.8	79.1	118.6	159.0
Mean									
Initial	68.9	14.9	0.40	9.6	14.4	19.2			4.3
Crop development	120.3	22.6	0.80	33.7	50.5	67.4	11.1	27.9	44.8
Mid-season	119.1		1.15	47.9	71.8	95.8	47.9	71.8	95.8
Late-season	130.3		0.90	41.0	61.6	82.0	41.0	61.6	82.0
Total	438.6	37.5		132.2	198.3	264.4	100.0	161.3	226.9

Table 2. Growth, yield and quality score as influenced by composted coir pith (CCP), irrigation and nitrogen

Treatment	Leaf length (cm)	Leaf width (cm)	Stem girth (cm)	First-grade leaf (t/ha)				Total cured leaf (t/ha)				Quality score (out of 80)
				2001-02	2002-03	2003-04	Mean	2001-02	2002-03	2003-04	Mean	
CCP (t/ha)												
10.0	60.9	33.6	9.3	2.26	1.95	2.08	2.10	2.93	2.50	2.61	2.68	62
12.5	60.1	33.5	10.4	2.47	1.78	1.99	2.08	2.96	2.32	2.48	2.58	62
15.0	60.8	33.2	9.2	2.38	1.74	2.04	2.06	2.93	2.24	2.50	2.56	64
MC 25 t/ha	59.9	32.8	9.3	2.51	1.97	2.05	2.18	3.09	2.46	2.53	2.69	68
SEm±	1.6	1.3	0.2	0.1	0.09	0.05	0.06	0.12	0.09	0.05	0.05	
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	
Irrigation (ETc)												
0.50	57.0	31.2	9.1	2.21	1.75	1.76	1.91	2.78	2.26	2.21	2.42	60
0.75	61.0	33.7	9.4	2.29	1.97	2.15	2.14	2.78	2.55	2.59	2.64	64
1.00	63.3	35.0	10.2	2.72	1.86	2.22	2.27	3.39	2.32	2.78	2.83	64
SEm±	1.2	0.5	0.2	0.05	0.08	0.05	0.03	0.13	0.09	0.09	0.03	
CD (P=0.05)	2.98	1.42	0.5	0.41	NS	0.18	0.07	0.44	NS	0.30	0.08	
Nitrogen (kg/ha)												
50	60.3	33.3	9.4	2.25	1.72	1.83	1.94	2.69	2.19	2.28	2.39	60
75	60.9	33.4	9.3	2.47	1.82	2.12	2.14	3.01	2.35	2.58	2.65	66
100	60.1	33.3	10.0	2.50	2.04	2.17	2.24	3.23	2.60	2.72	2.85	66
SEm±	0.9	0.7	0.1	0.07	0.06	0.05	0.03	0.08	0.05	0.05	0.03	
CD (P=0.05)	NS	NS	NS	0.21	0.17	0.16	0.07	0.23	NS	0.16	0.08	

Table 3. Interaction between seasons, compost and irrigation on total cured-leaf yield (t/ha)

Season	CCP at 10.0 t/ha			CCP at 12.5 t/ha			CCP at 15.0 t/ha			MC at 25 t/ha		
	0.5 ETc	0.75 ETc	1.0 ETc	0.5 ETc	0.75 ETc	1.0 ETc	0.5 ETc	0.75 ETc	1.0 ETc	0.5 ETc	0.75 ETc	1.0 ETc
2001-02	2.73	2.83	3.23	2.69	2.64	3.54	2.90	2.48	3.43	2.79	3.12	3.36
2002-03*	2.52	2.60	2.37	2.13	2.40	2.41	2.15	2.49	2.09	2.23	2.73	2.41
2003-04	2.17	2.78	2.88	2.16	2.59	2.67	2.29	2.43	2.79	2.24	2.55	2.79
Mean	2.48	2.74	2.83	2.33	2.54	2.87	2.44	2.46	2.77	2.42	2.80	2.85
SEm±						0.10 (0.06)						
CD (P=0.05)						0.29 (0.17)						

* Data in parentheses refer to mean data

Residual soil fertility

The soil-nutrient status analysed at the end of every season showed improvement in available P with municipal compost 25 t/ha and composted coir pith 15 t/ha (Table 5) than with other levels of composted coir pith. Higher dose of composted coir pith and municipal compost with basal P could be attributed to its increased availability. The organic C significantly improved with 1.0 ETc than with 0.5 Etc. Nitrogen 100 kg/ha significantly improved the organic C status of soil over the initial status and 50 kg N/ha. Soil chlorides significantly increased at 1.0 ETc. Since the quantum of irrigation water in this treatment is more compared with 0.5 and 0.75 ETc and the irrigation water contains chlorides, there was an increased chloride content in the soil.

Nutrient uptake by lamina and chemical quality

The P and K uptake by the lamina was significantly higher with municipal compost 25 t/ha than with composted coir pith 10 t/ha (Table 5). Irrigation of the crop with 1.0 ETc significantly increased the N and P uptake of than with 0.5 ETc. Nitrogen at 100 kg/ha increased the N, P and K uptake by the lamina. As the nutrient uptake is the function of the lamina yield and nutrient content, increase in these factors is responsible for the increased N, P and K uptake.

The levels of composted coir pith did not influence the chemical quality of chewing tobacco, but the levels of irrigation had significant influence. The nicotine content increased and reduced sugars decreased with 0.5 ETc than with 1.0 ETc. As nicotine is synthesized in the roots of tobacco plant at moisture-stress condition, the root growth is more, resulting in increased synthesis of nicotine and leading to increase in lamina nicotine. In FCV tobacco, Reddy *et al.* (2001) reported increased nicotine content

Table 4. Water-use efficiency and economics as influenced by levels of composted coir pith, irrigation and nitrogen (mean data of 3 years)

Treatment	Consumptive use of water (mm)	WUE (kg/ha-mm)	Cost of cultivation ($\times 10^3$ Rs/ha)	Net returns ($\times 10^3$ Rs/ha)	Benefit : cost ratio
CCP (t/ha)					
10.0	198.6	14.43	30.9	32.4	2.05
12.5	198.6	13.75	31.0	30.2	1.97
15.0	198.6	13.78	31.5	29.0	1.92
MC 25 t/ha	198.6	14.40	32.6	31.1	1.95
Irrigation (ETc)					
0.50	132.6	18.31	29.2	28.0	1.96
0.75	198.6	13.31	30.2	32.1	2.06
1:00	264.7	10.70	31.5	35.5	2.13
Nitrogen (kg/ha)					
50	198.6	12.83	29.2	27.2	1.93
75	198.6	14.16	30.1	32.5	2.08
100	198.6	15.27	31.1	36.3	2.17

Cost of inputs: Municipal compost, Rs 292/t; composted coir pith, Rs 200/t; ammonium sulphate, Rs 5.47/kg; urea, Rs 4.42/kg; super phosphate, Rs 2.65/kg; suckericide (Decanol), Rs 190/kg

Sale price of tobacco/kg: 2001-02, Rs 24.50; 2002-03, Rs 23.25; 2003-04, Rs 23.00

Table 5. Effect of composted coir pith, irrigation and nitrogen on residual soil fertility, soil chlorides, lamina-nutrient uptake and chemical quality (mean data of 3 years)

Treatment	Residual soil fertility			Soil chlorides (ppm)	Lamina nutrient uptake			Lamina-chemical quality		
	Organic C (%)	Available P (kg/ha)	Available K (kg/ha)		N uptake (kg/ha)	P uptake (kg/ha)	K uptake (kg/ha)	Nicotine (%)	Reducing sugars (%)	Chlorides (%)
CCP (t/ha)										
10.0	0.45	9.9	313	177	49.7	3.89	42.6	2.90	0.38	5.02
12.5	0.44	10.7	317	164	48.0	4.21	56.7	2.63	0.31	5.14
15.0	0.48	11.5	323	161	47.3	4.89	60.0	2.62	0.38	5.30
MC 25 t/ha	0.48	12.0	324	181	50.0	4.96	61.9	2.91	0.37	5.12
SEm±	0.03	0.19	4.9	12.2	1.1	0.20	4.1	0.15	0.02	0.12
CD (P=0.05)	NS	0.46	NS	NS	NS	0.50	10.0	NS	NS	NS
Irrigation (ETc)										
0.50	0.45	10.7	316	151	44.8	4.36	52.9	2.93	0.33	4.48
0.75	0.46	11.0	320	180	48.9	4.51	54.3	2.74	0.37	4.90
1.00	0.47	11.3	321	182	52.5	4.74	58.7	2.63	0.39	6.06
SEm±	0.01	0.22	5.1	4.5	1.9	0.16	2.6	0.10	0.02	0.14
CD (P=0.05)	0.02	NS	NS	12.4	4.0	0.33	NS	0.21	0.04	0.30
Nitrogen (kg/ha)										
50	0.45	10.2	313	169	33.4	4.09	50.5	2.70	0.36	5.19
75	0.47	11.4	320	182	51.9	4.10	50.9	2.71	0.36	5.21
100	0.49	11.5	326	162	60.9	4.56	56.5	2.81	0.30	5.20
SEm±	0.01	0.20	3.7	4.5	0.9	0.13	2.2	0.12	0.01	0.06
CD (P=0.05)	0.02	0.39	7.5	NS	1.8	0.26	4.4	0.27	0.02	NS
Initial status	0.05	6.5	275							

and decreased reducing sugars at dry regimes. Nitrogen at 100 kg/ha significantly increased the nicotine content and decreased the reducing sugars than of 50 kg N/ha. As N has positive correlation with nicotine content, there was increased nicotine content at higher levels of N. An increase in N level decreases the starch accumulation in the leaf which in turn reduces the reducing sugar content. Kasturi Krishna *et al.* (2003) opined that nicotine content in FCV tobacco increased with higher N levels. Irrigation at 1.0 ETc significantly increased the chloride content of lamina than at 0.5 ETc owing to higher chloride content of the soil.

It was concluded that composted coir pith at 10 t/ha, irrigation at 1.0 ETc and 100 kg N/ha would be optimum for improved yield, net returns and B : C ratio of chewing tobacco.

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