EFFECT OF METHODS OF IRRIGATION AND DATES OF PLANTING ON THE YIELD, ECONOMICS AND WATER USE EFFICIENCY OF HYBRID CHEWING TOBACCO (*NICOTIANA TABACCUM* L.)

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Field experiments were conducted in a strip plot design at the experimental farm of ICAR-CTRI-Research Station, Vedasandur, Tamil Nadu during 2013-14 and 2014-15 with four main plot treatments *viz.*, Drip fertigation with 100% RDN (Recommended dose of Nitrogen @ 125 kg/ha), Drip irrigation with 100% RDN (Soil applied), Alternate furrow irrigation and furrow irrigation and three sub-plots with different dates of planting *viz.* October 1st fortnight, November 1st fortnight and December 1st fortnight with 3 replications. Drip treatments *viz.* Drip fertigation with 100% RDN and drip irrigation with soil applied 100 % RDN recorded significantly higher first grade leaf yield (FGLY) and Total cured leaf yield (TCLY) over the alternate furrow and furrow irrigation methods. The increase in FGLY and TCLY was 9 and 10 % respectively with drip irrigation+100% RDN, soil applied, over the furrow irrigation. Water saving in drip treatments was 61% over the furrow irrigation. Planting hybrid chewing tobacco during October1st fortnight increased the FGLY and TCLY by 64 and 34 % over the December 1st fortnight planting. Water use efficiency (WUE) was higher with drip treatments (23.6-23.7 kg/ha-mm) and October 1st fortnight planting (20.6 kg/ha-mm). Drip irrigation+100% RDN soil applied and October 1st fortnight plant increased the net return and B:C ratio. Higher residual soil NPK and lamina NPK uptake was recorded with drip treatments and planting the hybrid chewing tobacco during October 1st fortnight. It could be concluded that drip fertigation with 100% RDN and October 1st fortnight planting could be recommended for chewing tobacco in Tamil Nadu for higher yield , net returns and water use efficiency.

INTRODUCTION

Tobacco (*Nicotiana tabaccum* L.) is very sensitive to environmental condition and grown in wide range of ecological zone and thus a number of factors like cultivars, plant density, nutrient and water management practices are involved in tobacco yield. Therefore a better crop growth can be ensured with the appropriate coordination of different agronomic practices and judicious use of various inputs. Among this planting time is important to explore the potential of a cultivar or a hybrid in the region. The cultivar or a hybrid selection is also a key management component in any cropping system, even more critical is date of planting for tobacco production. In Tamil Nadu, chewing tobacco is grown in area 0f 10000-15000 ha. Generally farmers cultivate the cultivars released by this Research Station. Most of the cultivars yield ranged between 3500-4000 kg/ha of cured leaf yield. Hybrids are preferred by the farmers in any crops due to high yield potential, higher response to fertilizer and water management. Generally, the tobacco grown areas of Tamil Nadu are drought prone, where the water availability is restricted to 3-4 months. Under this condition, water saving methods viz., drip irrigation, alternate furrow irrigation etc., gains importance to improve the productivity, WUE and to save the depleting ground water. Indiscriminate use of water through conventional method with only 60% application efficiency may cause serious threat to available ground water resources. The nutrient use efficiency (NUE) in drip irrigation would be higher >90% and relatively less leaching loss <10% resulting in higher productivity in agricultural crops (Sankaranarayanan *et al.*, 2010). Irrigation at 1.0 IW/CPE ratio increased the productivity, profitability, better chewing quality and lamina chemical quality in chewing tobacco as compared to 0.75 and 0.5 IW/CPE ratio (Kumaresan *et al.*, 2008). As in chewing tobacco less work was done on methods of irrigation and dates of planting in hybrid chewing tobacco, the present study was taken up.

Key words: Drip fertigation, First grade leaf yield, Total cured leaf yield, Water use efficiency.

MATERIALS AND METHODS

The field experiment was conducted at experimental farm at ICAR- CTRI Research station, Vedasandur (latitude 10° 32'N longitude 77° 57') during 2012-2014. The treatments comprised of four irrigation methods viz. Drip fertigation +100% RDN, Drip+100% RDN soil applied, Alternate furrow irrigation and Furrow irrigation in main plots and three dates of planting viz. October 1st fort night, November 1st fort night and December 1st fort night, in sub plots. The experiment was conducted in a strip plot design three replication. Experimental soils are sandy loam (Alfisol) alkaline (pH 8.1), low in available N (210 kg/ha), P (6.5kg/ha) and medium in available K (275 kg/ha) status. Ridges and furrows were formed at a spacing of 90 cm and 45 days old seedlings were planted at a spacing of 75 cm. Phosphorus @21.8 kg P/ha as super phosphate was mixed with 2.5 t/ha of sieved farm yard manure and spot applied before transplanting the seedlings. Potassium @ 41.6 kg K/ha was applied at 45 days through muriate of potash. In the drip treatments, drippers were kept near the root zone of the seedlings and the pressure was maintained at 1.5 kg/cm^3. The daily pan evaporation rate (USWB class-A), rain fall, and effective rain fall during the crop period for the year 2013-14 and 2014-15 are given in Table 1. Effective rainfall was calculated by following a water balance sheet method for all the three seasons. Water requirement at different crop growth stages was calculated by the following equation

Water Requirement (WR) or ETc (lpd) = CPE x Kp x Kc x Wp x S

Where, ETc- Crop evapo transpiration; lpd - liters/day; CPE- Cummulative pan evaporation (mm); Kp-Pan factor (0.7); Kc- Crop coefficient; Wp – Wetting area Percentage (80%); S - Crop spacing (0.9 m x 0.75m). The Kc values were 0.4, 0.8, 1.15 and 0.90 for initial stage (1-25 days), Crop development stage (26-60 days), mid season stage (61-85 days) and late season stage (86-120 days) for all the three seasons. Three flood irrigations @ 30 mm, were given to all the treatments at the initial stage of the crop (0-25 days) during the three seasons for seedlings establishment. The quantum of water used in drip irrigation is given in Table 2. The recommended dose of fertilizer, 125:21.8:41.5 kg NPK/ha was given to the crop. Nitrogen in the form of urea was given through ventury as per the fertigation treatments in two splits at 45 and 60 days. Potassium was applied near the root zone as Muriate of potash at 45 DAT for the fertigation treatments. The N and K fertilizers were placed near the root zone where drip irrigation was followed. Surface irrigation was given as per 1.0 IW/CPE ratio. Parshall flume was kept and furrow irrigation was given as per the pan evaporation data. In the alternate furrow irrigation, the alternate furrows were irrigated during every irrigation. Weeding was done by hand hoeing at 20 days after transplanting. At 40 days earthing up operations were done with spade. Five plants from the net plot area were selected at random and tagged. The tagged plants were used for recording the growth parameters like leaf length and width.. The crop was harvested by stalk cut method at 120 days. The first grade leaf yield (FGLY) and total cured leaf yield (TCLY) were recorded after sun curing and standard fermentation process. Leaf samples collected after fermentation and bulking were chopped, air dried and then oven dried at 65± 5° C until attaining constant weight. The leaf samples were used for estimating lamina chemical quality viz., nicotine, reducing sugars (Harvey *et al.*, 1969) and chlorides (Hanumantha Rao *et al.*, 1980). The soil samples at 0 – 22.5 cm and 22.5 – 45 cm were analyzed for available N, P_2O_5 and K_2O as per the standard procedures. Chewing tobacco hybrid (VDH-3) 'Kamatchi', a sun cum and smoke cured type of tobacco with medium inter nodal length (5.5 to 6.0 cm diameter) and with ovate, moderately puckered leaf surface having prominent mid rib and venation was used for the study. The quality in terms of chewability was evaluated (Palanichamy and Nagarajan, 1999) viz., body of the leaf (10), aroma (10), whitish incrustation (10), taste (10),pungency (10), saliva secretion (10), retention of pungency (10),stiffness in the mouth (10), totaling to 80. A score of 60 and above was considered to indicate preferably the better quality for chewing purposes. Economics were calculated based on the cost of inputs and the price of cured leaf realized.

RESULTS AND DISCUSSION

Growth attributes and yield

Irrigation methods significantly influenced the growth attributes viz. leaf length, leaf width and dry matter production (DMP). Significantly higher leaf length and width were recorded with drip irrigation+100% RDN, soil applied over alternate furrow irrigation. The higher frequency of irrigation and increased availability of soil moisture under drip irrigations led to effective absorption and utilization of nutrients and better proliferation of roots resulting in higher leaf length and width. The drip irrigation +100% RDN, soil applied was comparable with drip fertigation+100% RDN and furrow irrigation. Alternate furrow irrigation recorded the lowest leaf length, leaf width and DMP. The FGLY significantly increased with drip irrigation + 100 % RDN over alternate furrow irrigation. The FGLY with drip irrigation+100% RDN, soil applied was comparable with drip fertigation+100% RDN and furrow irrigation (Table. 2). The FGLY increase was 26 % over the alternate furrow irrigation. The increased leaf length and width increased the FGLY. Kumaresan *et al.*, (2013) reported an increased FGLY of 11-14 % with drip irrigation in chewing tobacco. The TCLY significantly increased with drip irrigation+100% RDN, soil applied over the furrow and alternate furrow irrigation. The TCLY with drip irrigation+100% RDN soil applied and drip fertigation+100% RDN were comparable. The TCLY increase with drip irrigation+100% RDN soil applied over alternate furrow and furrow irrigation was 25 and 11 % respectively. The increased yield in drip irrigation might be due to the fact that frequent watering resulted in higher water potential thus minimizing fluctuation in soil moisture in effective root zone, which holds promise for increase in crop yields (Hanson *et al.*, 1997). In FCV tobacco, Deo Singh and Sannibabu (2005) recorded an increased cured leaf yield and net returns with drip at alternate days over the surface irrigation. Alternate furrow irrigation recorded the lowest FGLY and TCLY. The lower yield could be attributed to inefficient use of irrigation water, deep percolation and uneven distribution of irrigation water. The soil moisture fluctuation from field capacity to different degrees of dryness between irrigation could reduced the yield of crops (Yellamanda Reddy and Sankara Reddy, 2010).

Planting the hybrid chewing tobacco at October 1st fort night significantly increased the Dry matter production (DMP), FGLY and TCLY. The FGLY and TCLY increase with October 1st fort night was 64% and 39% respectively over the December 1st fortnight planting. The ideal climatic condition prevailed during the crop period increased the leaf length, leaf width there by FGLY and TCLY. The lower yield with November 1st fortnight planting and December 1st fortnight planting could be attributed to the higher temperature and lower rainfall during the crop period.

Preferable quality score (> 60) was recorded with drip treatments followed by furrow irrigation. The water in small quantities wetted the root zone, the ideal climate condition improved the microclimatic condition which increased the lamina expansion, thickness of leaf acceptable chewing quality parameters thereby quality scores. Planting chewing tobacco hybrid during October 1st fortnight recorded a high score followed by November 1st fort night planting.

Water use, water saving and WUE

The quantum of water used was higher with furrow irrigation (480 ha-mm) followed by alternate furrow irrigation (306 ha-mm). Drip treatments recorded the lowest quantum of water use (183 ha-mm). The water use efficiency as measured by quantity of water needed (in ha-mm) to produce an unit quantity (1 kg) of cured leaf was higher (32.1 – 32.4 kg/ha-mm) in drip treatments and lower with furrow irrigation (8.37 kg/ha-mm). The water saving was around 62 % with drip treatments as compare to the furrow irrigation.

The dates of planting influenced the quantum of water used. The higher quantum of water was used during December 1st fort night planting (318 ha-mm) followed by November 1st fort night planting (302 ha-mm) and October 1st fort night planting (227 ha-mm). The higher quantum of water used in the December 1st fortnight and November 1st fortnight could be attributed to the

increased temperature, low rainfall there by high PAN evaporation and more irrigation during the crop period. Higher WUE (34.9 kg/ha-mm) was recorded with October 1st fort night planting. Higher cured leaf yield coupled with less quantum of water used increased the WUE. The lowest WUE was recorded with December 1st fortnight planting (12.5 kg/ha-mm). The lower cured leaf yield with higher quantum of water used reduced the WUE. The water saving was 61% with the drip treatments

Economics

The cost of cultivation was higher (Rs.1,04,700/ha) with the drip treatments. The cost of drip matertials increased the cost of cultivation for drip treatments (Table 3). Drip treatments increased the net return and B:C ratio. The net return with drip treatments varied between Rs. 1,38,800 to 1,56,000/ha with the B:C ratio of 2.32 to 2.49.

Dates of planting significantly influenced the net return and B:C ratio. Planting the hybrid tobacco during October 1st fort night increased the net returns (Rs. 1,62,400/ha) over the December 1st fort night planting. Similar trend was observed with the B: C ratio also. The higher cured leaf with October 1st fortnight planting significantly increased the net return and B:C ratio.

Soil residual fertility status

The soil residual fertility status viz. available NPK increased as compared to initial soil fertility status. Soil available N was significantly higher with drip treatments (142.4 to 143.2 kg/ha) as compared to furrow irrigation (127.2 kg/ha) in the soil depth 0- 22.5 cm (Table 3). Similar trend was observed at lower depth, 22.5 to 45 cm also. Higher soil available N in the drip treatments could be attributed to less leaching of N in drip treatments. The soil available N was higher in the first depth (0-25 cm) as compared to the lower depth (22.5-45 cm). The different methods of irrigation did not influence the available P_2O_5 at both the soil depths. Higher available P_2O_5 was recorded in the first soil depth as compared to the lower soil depth. The available P_2O_5 at the first depth ranged from 24.4 to 31.7 kg/ha and the lower depth ranged from 11.3 to 17.3 kg/ha. The available K_2O is higher with drip treatments in both the soil depths as compared to furrow and alternate furrow irrigation. The increased K_2O in drip treatments could be attributed to less leaching effects.

The dates of planting significantly influenced the soil available N and K_2O. Lower available N and K_2O was recorded with October 1st fort night planting. The higher uptake of N and K_2O by the crop and leaching effect by the rain fall during the crop period decreased the available N and K_2O. The available N ranged between (502-542 kg/ha). Higher available N and K_2O was recorded with the first depth as compared to second depth. Available P_2O_5 was not significantly influenced by the dates of planting.

Nutrient uptake and lamina chemistry

The nutrient uptake viz., N, P and K were higher with the drip treatments followed by furrow irrigation. As nutrient uptake is a function of the DMP and nutrient content, increase in these factors are responsible for higher NPK uptake. The increased lamina yield increased the N, P and K uptake. Lower NPK uptake was record with alternate furrow irrigation.

Planting in October 1st fortnight significantly increased the NPK uptake. The higher dry matter production of the lamina and nutrient content increased the NPK uptake.

Lamina chemistry viz. nicotine and reducing sugars were not significantly influenced by the methods of irrigation and dates of planting. The chloride content was higher (5.83%) with furrow irrigation followed by alternate furrow irrigation and drip treatments. The higher quantum of water used in the furrow and alternate furrow irrigation increased the Chloride content of the lamina. Planting chewing tobacco during December 1st fortnight recorded higher chloride content. Higher quantum of water used for irrigation during the crop period increased the chloride content in the lamina. Lesser chloride content was recorded in October 1st fortnight. The rainfall during the crop period reduced the quantum of water used, thereby reduced lamina chloride content. It could be concluded from the study that drip fertigation

with 100% RDN and October 1st fortnight planting increased the cured leaf yield, net return and water use efficiency.

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Table 1: Cumulative pan evaporation, rain fall and effective rainfall under various irrigation treatments at different crop stages

Crop stages	CPE (mm)						Rain fall (mm)						Effective Rain fall (mm)					
	2013-14			2014-15			2013-14			2014-15			2013-14			2014-15		
	D1	D2	D3	D1	D2	D3	D1	D2	D3	D1	D2	D3	D1	D2	D3	D1	D2	D3
0-25days	113.6	65.7	65.5	55.7	38.1	37.5	40.4	25.4	15.6	367.4	31.4	93.2	14	6	0	0	8	50
26-60 days	97.9	92.9	125.6	66.9	68.4	100.9	34.2	49.8	0	35.6	93.2	4.2	8	20	0	17	50	0
61-85 days	62.4	88.8	123.0	37.4	73.8	94.2	15.6	0	0	67.0	0	0	0	0	0	3	0	0
80-120 days	161.6	123.0	152.4	120.9	104.5	107.7	0	3.6	3.6	26.2	4.2	0	0	0	0	5	0	0
Total	435.5	370.4	466.5	280.9	284.8	340.3	90.2	78.8	19.2	496.2	128.8	97.4	22	26	0	25	58	50

D1-October 1st fortnight planting; D2-November 1st fortnight planting;D3-December 1st fortnight planting

Table 2: Growth, yield and Water use efficiency as influenced by irrigation methods and dates of planting.

Treatments	Leaf length (cm)	Leaf width (cm)	DMP (kg/ha)	FGLY* (kg/ha)	TCLY** (kg/ha)	Quality score (out of 80)	Quantum of water used (ha-mm)	WUE (kg/ha-mm)	Water Saving (%)
Irrigation methods									
Drip fertigation+100% RDN	85.9	47.3	6571	3541	4316	66	183	23.6	62
Drip+100% RDN soil applied	89.9	45.3	5997	3542	4337	66	183	23.7	62
Alternate furrow irrigation	76.6	38.8	5547	2802	3469	58	306	11.3	36
Furrow irrigation	82.3	44.2	5663	3234	3909	62	480	8.14	-
SEm	3.20	2.20	260.0	59.0	75.0	-	-	-	-
CD at 5%	10.6	8.00	965.0	164.0	207.0	-	-	-	-
Dates of planting									
October 1st fort night	89.5	47.4	6738	4058	4669	66	227	20.6	-
November 1st fort night	86.6	45.3	6032	3313	3983	62	302	13.2	-
December 1st fort night	70.1	42.2	5064	2468	3371	56	318	10.6	-
SEm	6.10	1.30	370.2	79.0	61.0	-	-	-	-

Table 3: Effect of methods of irrigation and dates of planting on the economics and soil residual fertility status.

Treatments	Cost of cultivation (Rs. x10³/ha)	Net return (Rs. x10³/ha)	B:C ratio	Soil residual fertility status (kg/ha)					
				N		P_2O_5		K_2O	
				0-22.5 cm	22.5-45 cm	0-22.5 cm	22.5-45 cm	0-22.5 cm	22.5-45 cm
Irrigation methods									
Drip fertigation+100% RDN	104.7	138.8	2.32	143.2	140.8	28.4	11.3	539	394
Drip+100% RDN soil applied	104.7	156.0	2.49	142.4	142.4	24.4	14.4	530	398
Alternate furrow irrigation	96.0	127.0	2.32	128.4	121.3	28.6	17.3	509	378
Furrow irrigation	96.9	128.8	2.32	127.2	118.6	31.7	15.6	504	338
SEm	-	-	-	3.29	6.40	3.20	3.60	8.10	12.6
CD at 5%	-	-	-	14.00	20.2	NS	NS	28.0	40.0
Dates of planting									
October 1st fort night	100.4	162.4	2.62	131.0	119.3	33.7	15.8	502	354
November 1st fort night	100.7	141.5	2.41	136.2	132.5	25.1	13.6	538	369
December 1st fort night	100.8	109.5	2.09	142.0	140.6	26.8	17.4	542	433
SEm	-	-	-	3.10	5.20	4.20	3.00	10.6	20.4
CD at 5%	-	-	-	10.0	20.0	NS	NS	36.0	64.2

Table 4: Effect of methods of irrigation and dates of planting on the nutrient uptake, lamina chemistry and quality scores.

Treatments	Nutrient uptake (kg/ha)			Lamina chemistry (%)		
	N	P	K	Nicotine	Reducing sugars	Chlorides
Irrigation methods						
Drip fertigation+100% RDN	217	12.5	149	2.76	2.08	4.17
Drip+100% RDN soil applied	188	10.8	140	2.86	1.78	4.13
Alternate furrow irrigation	173	9.75	90	2.66	1.57	4.42
Furrow irrigation	187	10.2	136	2.36	1.44	5.83
SEm	10.1	0.60	14.6	0.46	0.30	0.36
CD at 5%	36.0	2.40	50.2	NS	NS	1.40
Dates of planting						
October 1st fort night	218	12.2	148	2.35	2.06	3.89
November 1st fort night	192	11.5	115	2.75	1.78	4.78
December 1st fort night	151	8.7	114	2.87	1.22	5.21
SEm	17.3	1.02	9.10	0.30	0.30	0.30
CD at 5%	56.0	3.00	30.0	NS	NS	1.20

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