Agric Res J **60** (2) : 177-181, *April* 2023
DOI No. 10.5958/2395-146X.2023.00028.5

RESPONSE OF VEGETABLE INTERCROPS ON THE PERFORMANCE OF CHEWING TOBACCO (*Nicotiana rustica* L.) BASED INTERCROPPING SYSTEM

Jalpa Panchal[1]*, K M Gediya[2] and J N Patel[3]

Bidi Tobacco Research Station, Anand Agricultural University, Anand - 388 111, Gujarat

ABSTRACT

A field experiment was conducted at Bidi Tobacco Research Station, Anand Agricultural University, Anand to find out suitable chewing tobacco based intercropping system for three years during 2017-18 to 2019-20. Total eight treatments viz.T_1: Sole chewing tobacco (*Nicotiana rustica* L.), T_2: Chewing tobacco + Cabbage (*Brassica oleracea*) (1:2), T_3: Chewing tobacco + Onion (*Allium cepa* L.) (1:2), T_4: Chewing tobacco + Garlic (*Allium sativum* L.) (1:3), T_5: Chewing tobacco + Radish (*Raphanus sativus* L.) (1:3), T_6: Chewing tobacco + Fenugreek (*Trigonella foenum-graecum*) (1:3), T_7: Chewing tobacco + Spinach (*Spinacia oleracea* L.) (1:3) and T_8: Chewing tobacco + Coriander (*Coriandrum sativum* L.) (1:3) were tested in randomized block design with four replications. Cured leaf yield of tobacco was significantly higher with sole cropping of chewing tobacco (3.79 t/ha) followed by chewing tobacco + onion, chewing tobacco + garlic, chewing tobacco + fenugreek and chewing tobacco + coriander intercropping systems. Tobacco leaf equivalent yield (TLEY) was significantly higher with chewing tobacco + garlic intercropping system of 4.86 t/ha followed by chewing tobacco + radish (4.49 t/ha) and chewing tobacco + onion (4.16 t/ha) than sole chewing tobacco (3.89 t/ha) and other intercropping systems. Increase in mean TLEY was 28% over sole chewing tobacco. Chewing tobacco + garlic intercropping system realized maximum gross returns (₹ 2.43 x 10^3/ha) and net returns (₹ 1.67 x 10^3/ha) with higher BCR value of 3.21. It was concluded that chewing tobacco + garlic (1:3) was an economically viable chewing tobacco based intercropping system which obtained higher TLEY and net returns.

Keywords: Chewing tobacco, Economics, Intercropping, Tobacco Leaf Equivalent Yield, Vegetable crops

Tobacco is an important commercial crop which is traded for its quality leaves and quoted as golden leaf in the world market. India is the 2nd largest producer of tobacco grown in 0.45 M ha with approx. 750 M kg of tobacco leaf production. In Gujarat, tobacco especially chewing type is a remunerative *rabi* cash crop mainly grown in middle Gujarat districts viz. Anand and Kheda as well as north Gujarat districts viz. Banaskantha, Sabarkantha, Mahesana and Patan. Chewing tobacco is also known as calcutti and *rustica* tobacco. It is mostly cultivated either as monoculture or in sequence with paddy in middle Gujarat. During the initial period of tobacco growth, the crop canopy is less which allows sufficient sunlight to reach the soil surface between the rows which facilitates growing short duration intercrops like vegetables in between the rows of chewing tobacco to get more productivity per unit area and time. Vegetable crops are successfully grown in this region with high net profit due to having good marketing potential.

Intercropping is a technique studied by agro-ecologists in which two or more species are planted together to improve agricultural systems. The concept of intercropping enhances the productivity and profitability per unit area and time through efficiently use of natural resources besides assuring insurance against failure of one or the other crops. Earlier studies by Prajapati *et al.* (2016) revealed that garlic and spinach would be a profitable intercrops in middle Gujarat. In Bihar, garlic intercropped with tobacco recorded maximum cured leaf yield, net returns and benefit cost ratio (Singh *et al*., 1998). The present study was taken up with a view to find out some remunerative and compatible vegetable intercrop with high monetary value and having less competition with the main crop tobacco.

MATERIALS AND METHODS

An experiment was carried out for three consecutive years from 2017-18 to 2019-20 at Bidi Tobacco Research Station, Anand Agricultural University, Anand, Gujarat to study feasibility and economic viability of chewing tobacco based intercropping system. The soil type of experiment was loamy sand in texture and slightly alkaline in reaction. Total annual rainfall of 726.8, 937.2 and 1305 mm were recorded for years 2017-18, 2018-19 and 2019-20, respectively as against the normal rainfall of the region is about 862 mm. There were eight treatments viz.T_1: Sole chewing tobacco (*Nicotiana rustica* L.), T_2: Chewing tobacco + Cabbage (*Brassica oleracea*) (1:2), T_3: Chewing tobacco +

*Corresponding author : jalpanchal1623@aau.in
Date of receipt: 23.07.2021, Date of acceptance: 30.04.2023

Onion (*Allium cepa* L.) (1:2), T_4: Chewing tobacco + Garlic (*Allium sativum* L.) (1:3), T_5: Chewing tobacco + Radish (*Raphanus sativus* L.) (1:3), T_6: Chewing tobacco + Fenugreek (*Trigonella foenum-graecum*) (1:3), T_7: Chewing tobacco + Spinach (*Spinacia oleracea* L.) (1:3) and T_8: Chewing tobacco + Coriander (*Coriandrum sativum* L.) (1:3) were evaluated in a randomized block design (RBD) with four replications. Individual plots measured 3.6 x 5.4 m. Castor cake @ 1 tone/ha and Vermicompost @ 2 tone/ha were applied one week before transplanting. The fertilizer dose for chewing tobacco was 200-0-0 NPK kg/ha. No additional fertilizer applied for intercrops. Nitrogen was applied in four equal splits; 1st as basal just prior to transplanting through ammonium sulphate and remaining three splits as top dressing through urea, each at 30 days interval after transplanting. Tested varieties were Gujarat Calcutti 1, Golden acre, Gujarat white onion 1, Gujarat garlic 10, Pusa rashmi, Gujarat fenugreek 2, All green and Gujarat coriander 2 for chewing tobacco, cabbage, onion, garlic, radish, fenugreek, spinach and coriander, respectively. 45 days old healthy chewing tobacco seedlings were transplanted as main crop with spacing 60 x 45 cm during 2nd fortnight of October and intercrops were sown/transplanted in between two tobacco rows within 15 to 20 days after planting of chewing tobacco. Chewing tobacco plants were topped at bottom stage retrieving 17-18 leaves per plant. All crops were raised with assured irrigation using flood method. Incidence of pests and diseases was kept under control by adopting recommended plant protection measures. Tobacco leaf samples were collected and analyzed for nicotine and reducing sugar contents (Harvey *et al*., 1969) and chloride content (Murthy *et al*., 1962). Data on yield and yield components were recorded and analyzed statistically. Economics of tobacco and different intercropping systems were calculated based on the prevailing market price.

Formula to calculate Tobacco Leaf Equivalent Yield (TLEY) =

$$TLEY = \frac{\sum Yi \times Pi}{P(t)}$$

Where; TLEY - Tobacco Leaf Equivalent Yield
Yi - Yield of inter crop (kg/ha)
Pi - Prevailing market price of respective inter crop (₹/kg)
Pt - Prevailing market price of tobacco (₹/kg)

RESULTS AND DISCUSSION

Tobacco growth

The pooled data over three years of the experimentation showed that leaf length and dry weight per unit leaf area measured at harvest were found significant (Table 1). Chewing tobacco + fenugreek gave maximum leaf length as compared to chewing tobacco + cabbage and chewing tobacco + onion but it was at par with sole tobacco and rest of chewing tobacco based intercropping systems. While, sole tobacco cropping gave maximum dry weight per unit leaf area as comparable with others except chewing tobacco + onion intercropping system. Moreover, there were no any significant differences found between different chewing tobacco based intercropping systems with regard to leaf width and plant height. Kumaresan and Damodar Reddy (2020) also gave same findings that different levels of annual moringa intercrop population did not affect the leaf length, leaf width of chewing tobacco.

Tobacco cured leaf yield

Cured leaf yields of chewing tobacco exhibited marked variation due to varying canopy and growth habits of intercrops but the differences were statistically significant during 2017-18, 2018-19 and 2019-20 years and also in pooled data over the three years (Table 2). Significantly higher CLY of tobacco (2.75, 3.87, 4.74 and 3.79 t/ha) was exhibited in sole cropping of chewing tobacco followed by chewing tobacco + onion, chewing tobacco + garlic, chewing tobacco + coriander and chewing tobacco + fenugreek intercropping systems during the period of investigation and on pooled basis also. It was due to mono-cropping and fully utilization of space and nutrients without any crop interference. This is in conformity with the findings of Biradar *et al*. (2020) who reported that sole pigeon pea recorded significantly higher seed yield as compared to pigeon pea + foxtail millet (1:2) intercropping system. Increased CLY of tobacco with garlic intercropping due to low canopy structure of garlic was reported by Krishna Reddy *et al.* (2016), Singh *et al.* (2013), Singh *et al.* (2010) and Murthy and Rao (2002). As per pooled of three years results, significantly lower CLY of tobacco (2.51 t/ha) was observed in chewing tobacco + cabbage followed by chewing tobacco + spinach (2.63 t/ha) and chewing tobacco + radish (2.67 t/ha) intercropping systems due to high canopy crops than rest of intercrops.

Intercrop yield

The yields of different intercrops grown with chewing tobacco were relatively lower as compared to their potential yield as sole crops. The reduction in the yields of intercrops may be attributed to their reduced plant population rather than depression effects expected on account of competition between base crop and intercrop components. Similar results have been reported for intercrops of finger millet and blackgram that seed yields of component crops were low as compared to their respective sole crop (Chandra *et al.,* 2013). Competition among base crop and intercrop components for solar radiation, nutrients and moisture

Table 1. Morphological characters of chewing tobacco as influenced by different cropping systems at harvest [Pooled over three years data].

Treatments	Leaf length (cm)	Leaf width (cm)	Plant height (cm)	Dry weight per unit leaf area (mg/cm^2)
T_1 : Sole chewing tobacco	34.97	33.55	41.45	10.22
T_2 : Chewing tobacco + Cabbage (1:2)	32.69	32.36	42.12	8.55
T_3 : Chewing tobacco + Onion (1:2)	33.95	31.76	39.98	9.57
T_4 : Chewing tobacco + Garlic (1:3)	35.48	32.99	42.57	8.94
T_5 : Chewing tobacco + Radish (1:3)	35.53	33.80	41.82	8.62
T_6 : Chewing tobacco + Fenugreek (1:3)	36.59	32.76	44.53	8.84
T_7 : Chewing tobacco + Spinach (1:3)	35.89	33.70	42.63	8.55
T_8 : Chewing tobacco + Coriander (1:3)	36.42	33.01	42.10	9.34
S. Em. $\pm$	0.77	1.07	1.05	0.4
C. D. at 5%	2.18	NS	NS	1.0

Table 2. Cured Leaf Yield (CLY) of chewing tobacco, inter crop yield, Tobacco Leaf Equivalent Yield (TLEY) and economics as affected by different cropping systems [Pooled over three years data].

Treatments	CLY of chewing tobacco (t/ha)	Yield of inter Crop (t/ha)	TLEY (t/ ha)	Gross returns (x 10^3 ₹/kg)	Total cost (x 10^3 ₹/kg)	Net returns (x 10^3 ₹/kg)	BCR
T_1 : Sole chewing tobacco	3.79	--	3.79	189.78	60.57	129.21	3.13
T_2 : Chewing tobacco + Cabbage (1:2)	2.51	7.90	3.30	165.23	85.70	79.53	1.93
T_3 : Chewing tobacco + Onion (1:2)	3.50	3.30	4.16	208.29	74.29	133.99	2.80
T_4 : Chewing tobacco + Garlic (1:3)	3.50	1.70	4.86	243.23	75.74	167.48	3.21
T_5 : Chewing tobacco + Radish (1:3)	2.67	18.20	4.49	224.96	74.44	150.52	3.02
T_6 : Chewing tobacco + Fenugreek(1:3)	3.44	4.80	3.92	196.40	75.38	121.02	2.61
T_7 : Chewing tobacco + Spinach (1:3)	2.63	10.91	3.72	186.22	69.48	116.75	2.68
T_8 : Chewing tobacco + Coriander(1:3)	3.47	2.62	3.99	199.84	73.76	126.08	2.71
S. Em. +	0.13	--	0.23	--	--	--	--
C. D. at 5%	0.37	--	0.71	--	--	--	--

Prevailing market price (₹/kg)**:** Chewing tobacco: 50.1, Cabbage; 5, Onion: 10, Garlic: 40, Radish: 5, Fenugreek: 5, Spinach: 5, Coriander: 10

might have also contributed to some extent. However, the intercrops performed well and the yields of intercrops were relatively higher during years 2018-19 and 2019-20 compared to 2017-18.

Tobacco leaf equivalent yield (TLEY)

Chewing tobacco based vegetable intercropping systems significantly influenced tobacco leaf equivalent yield (TLEY) in years 2017-18, 2018-19 and 2019-20 as well as in pooled data over the three years (Table 3). During 2017-18, chewing tobacco + radish gave higher TLEY over rest of intercropping systems except, chewing tobacco + garlic. Whereas during 2018-19 and 2019-20, chewing tobacco + garlic recorded higher TLEY. It was closely followed by rest of intercropping systems except, chewing tobacco + cabbage during 2019-20. Chewing tobacco + garlic recorded significantly higher mean TLEY as 4.86 t/ha closely followed by chewing tobacco + radish and chewing tobacco + onion intercropping systems as 4.49 and 4.16 t/ha, respectively. These three intercropping systems increased mean TLEY by 28% (1.07 t/ha), 18% (0.70 t/ha) and 10 % (0.37 t/ha) respectively, as compared to that of sole tobacco. This might be mainly due to higher CLY of tobacco obtained in chewing tobacco + garlic. Earlier studies revealed that aggregatum onion would be a profitable intercrop in chewing tobacco (Kumaresan *et al*., 2019). However, the lowest mean TLEY was registered in chewing tobacco + cabbage intercropping as 3.30 t/ha. This was remained at par with sole tobacco cropping and chewing tobacco intercropped with spinach, fenugreek and coriander.

Table 3. Quality parameters of chewing tobacco as influenced by different cropping systems [Pooled over three years data].

Treatments	Nicotine (%)	Reducing sugar (%)	Chloride (%)
T_1 : Sole chewing tobacco	4.36	4.64	1.23
T_2 : Chewing tobacco + Cabbage (1:2)	3.64	4.55	1.23
T_3 : Chewing tobacco + Onion (1:2)	4.00	4.54	1.31
T_4 : Chewing tobacco + Garlic (1:3)	4.21	4.69	1.51
T_5 : Chewing tobacco + Radish (1:3)	3.97	4.74	1.36
T_6 : Chewing tobacco + Fenugreek (1:3)	3.86	4.80	1.34
T_7 : Chewing tobacco + Spinach (1:3)	4.11	4.57	1.40
T_8 : Chewing tobacco + Coriander (1:3)	3.92	4.62	1.44
S. Em. ±	0.14	0.08	0.06
C. D. at 5%	NS	NS	NS

Quality parameters

Pooled over three years data (Table 4) revealed that quality parameters viz. nicotine, reducing sugar and chloride contents were not significantly influenced by the different chewing tobacco based intercropping systems. Similar results were reported by Kumaresan and Damodar Reddy (2020) and Krishna Reddy *et al.* (2016).

Economics

The intercropping system chewing tobacco + garlic realized maximum gross returns (₹ 243.23 x 10^3/ha) and net returns (₹ 167.48 x 10^3/ha) with higher BCR value of 3.21. This was 30% higher net returns gained as compared to sole chewing tobacco cropping. This might be due to the resultant effect of higher TLEY recorded in chewing tobacco + garlic ultimately resulted into the highest net realization and BCR value. Atik Ahamad *et al*. (2017) reported higher net returns in pigeonpea + urdbean intercropping system than sole crop of pigeonpea. Besides, chewing tobacco + cabbage recorded minimum gross returns (₹165.23 x 10^3/ha) and net returns (₹ 79.53 x 10^3/ha) with lower BCR value of 1.93.

Based on the findings in this study, we propose an economically viable chewing tobacco based intercropping system is chewing tobacco + garlic in 1:3 row proportion gave higher tobacco leaf equivalent yield and net returns.

Authors' contribution

Conceptualization of research work and designing of experiment (JP, KMG); Execution of field/lab experiments and data collection (JP, KMG); Analysis of data and interpretation (JP, KMG); Preparation of manuscript (JP, KMG, JNP).

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