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EFFECT OF INTERCROP POPULATION AND LEVELS OF FERTILIZER ON THE YIELD, SYSTEM PRODUCTIVITY, ECONOMICS, MICROBIAL POPULATION IN CHEWING TOBACCO (*NICOTIANA TABACCUM* L.) + ANNUAL *MORINGA* (*MORINGA OLEIFERA* L.) INTERCROPPING SYSTEM

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A field experiment was conducted during 2012-15 at Research station of ICAR-Central Tobacco Research Institute,Vedasandur, Tamil Nadu ,to study the effect of intercrop population and fertilizer levels in a chewing tobacco (*Nicotiana tabaccum* L.) + Annual *Moringa* (*Moringa oleifera* L.) intercropping system. Annual *moringa* was planted as an intercrop in chewing tobacco at 100, 75, and 50% plant population. Different fertilizer levels viz.125, 100 and 75% RDF were applied to chewing tobacco as well as for annual *moringa*. The experiment was conducted in a strip plot design with 3 replications. The levels of intercrop population in chewing tobacco did not affect the growth and yield of chewing tobacco. The fertility levels 125 and 100% RDF recorded a comparable growth and yield of chewing tobacco. The FGLY recorded with 125 and 100 % RDF was 2.94 and 2.86 t/ha respectively. The TCLY recorded with 125 and 100% RDF was 3.51 and 3.43 t/ha respectively. The chewing quality scores were not altered by different levels of intercrop population or fertility levels. Annual *Moringa* at 100% population significantly increased the pod yield by 56.3% over the other population levels. The Annual *Moringa* with yield with respect to 125 and 100% RDF are comparable. The pod yield recorded at 125 and 100% RDF was 3.92 and 3.6 t/ha respectively. Annual *Moringa* 100% population recorded higher system productivity (7.15 t/ha), LER (1.06), TEY (4.57 t/ha) and net returns (Rs. 2,02,700/ha). The RDF 100% is sufficient for increased system productivity, LER, system economics and net returns. The residual soil organic-C status varied between 0.44 to 0.48%, soil available P between 9.89-10.9 kg/ha, soil available K between 294 to 318 kg/ha at different levels of intercrop and fertility levels. The RDF at 100% is sufficient for higher lamina NPK uptake and lamina chemistry. Annual *Moringa* 100% population intercropped with chewing tobacco increased the microbial population and dehydrogenase activity.

Keywords: Tobacco, Hybrid, Phenotypic stability

INTRODUCTION

Chewing tobacco (*Nicotiana tabaccum*) is one of the commercial crops grown in an area of about 10,000 to 15,000 ha in Tamil Nadu. Annual *moringa* (*Moringa oleifera*) is grown throughout Tamil Nadu as a pure crop and also as an intercrop in chillies, tobacco, onion etc. Since the growth, habit of the crops viz., Tobacco and annual *moringa* varied, farmers cultivate chewing tobacco intercropped with annual *moringa*. Intercropping increases not only productivity per unit area but also the net returns. Earlier studies revealed that *aggregatum* onion would be a profitable intercrop in chewing tobacco Kumaresan *et al.*, 2019. Tobacco equivalent yield was higher with chewing tobacco + Annual *moringa* intercropping system as compared to many other crops grown in *rabi* season Kumaresan and Rao , 2013). Intercropping has been recognized as a potential beneficial system of crop production and evidences indicate that it can provide substantial yield advantage over sole crop (Seth et. al. 2016).The existing nutrient management practices are based on individual crop and very little information is available on nutrient management in intercropping systems. Heavy indiscriminate application of fertilizer not only impairs ground water quality but also have deleterious effects on the environment through gaseous emissions. (Rajendra Prasad, 2009). Hence the present study was conducted to study the effect of intercrop population and fertilizer levels in a chewing tobacco + Annual *Moringa* intercropping system.

MATERIALS AND METHODS

The study was conducted during *rabi* season from 2012-13 to 2014-15 at ICAR- Central Tobacco

Research Institute, Research Station, Vedasandur (Latitude 10^0 32' N Longitude $77^0$57'). The soil of the experimental site was alfisols with alkaline pH (8.1), low organic C (0.40%), low in available nitrogen (210 kg/ha.), P (6.5 Kg/ha.) and medium in available K (275 kg/ha.). The main plot treatments comprised of different levels of inter crop population (Annual *Moringa*) in chewing tobacco viz., 100, 75 and 50 %. The sub plots comprised of different levels of recommended fertilizer dose for chewing tobacco and Annual *Moringa* viz., 75, 100 and 125% RDF for both chewing tobacco and Annual *Moringa*. The experiment was conducted in a strip plot design with three replication. A separate plot of pure stand of tobacco and annual *moringa* was maintained to work out the land equivalent ratio (LER). The land equivalent ratio was worked out as follows,

$$LER = \frac{Yab}{Yaa} + \frac{Yba}{Ybb}$$

Where Yab, yield of crop 'a' grown with crop 'b'; Yba, yield of crop 'b' grown with crop'a'; Yaa, yield of crop 'a' in pure stand; Ybb, yield of crop 'b' in pure stand. The chewing tobacco was planted in ridges and furrows at a spacing 90 cm x 75 cm. The 100, 75 and 50 % population of annual *moringa* was 2000, 1500 and 1000 plants/ha. The recommended dose of fertilizer for chewing tobacco and annual *moringa* was 125 +50 + 50 and 90+ 30 + 60 kg/ha; $N+P_2O_5+K_2O$ respectively. The fertilizer for annual *moringa* was applied after the harvest of chewing tobacco. Weeding was done manually at 20 days after transplanting. At 40 days, earthing-up operations were done by spade. Five plants from the net plot area were selected at random and tagged. The tagged plants were used for recording the leaf length and width. Leaf samples were collected after fermentation and bulking. The crop was harvested by stalk cut method at 120 days. The rhizosphere soil (0 to 15 cm) at 110 days was collected and analysed for fungi, bacteria, actinomycetes, Phosporus solubilising bacteria (PSB) and Dehydrogenase activity as per standard procedures. The first-grade leaf yield (FGLY) and total cured leaf yield (TCLY) were recorded after sun curing and standard fermentation process. The leaf samples collected were chopped, air-dried and then oven dried at $65+5^0$ 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 drawn after harvest of annual *moringa* from 0-22.5 cm depth was analyzed for available N, P and K as per the standard procedures.

Chewing tobacco 'Abirami' was used for planting is a sun-cum-smoke cured tobacco with a medium inter nodal length (5.5 to 6.0 cm diameter) and leaf with ovate, moderately puckered surface having prominent mid-ribs and venation. The package of practices for chewing tobacco was followed as per the recommendation of ICAR-CTRI Research station , Vedasandur. The Annual *Moringa* variety used with experiment was PKM1. The package of practices for chewing tobacco was followed as per the recommendation of Tamil Nadu Agricultural University, Coimbatore.The quality in terms of chewability was evaluated by the method suggested by 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 was calculated as per the cost of inputs and the price of cured leaf realized. The total rainfall received was 462.4, 25.6 and 82.4 mm during the crop seasons of 2012-13, 2013-14 and 2014-15, respectively.

RESULTS AND DISCUSSION

Growth, yield and chewability of tobacco

The different levels of intercrop population did not affect the leaf length, leaf width, dry matter production (DMP), first grade leaf yield (FGLY) and total cured leaf yield (TCLY). This indicated that there is no competition for the chewing tobacco and annual *moringa*. As the annual *moringa* growth is slow with less foliage in the initial stages up to 4 months, the competition for moisture, nutrients and sunlight is very less. Hence, the growth and yield of tobacco did not get affected.

The levels of fertilizer significantly influenced the growth and yield of tobacco. Leaf length, leaf width ,dry matter production ,FGLY and TCLY of tobacco significantly increased with 125% RDF when compared to 75% RDF. The RDF at 125 and 100% are comparable (Table 1). The FGLY recorded with 125% RDF and 100% RDF was 2.94 and 2.86 t/ha respectively. The TCLY recorded with 125 and 100 % RDF were 3.51 and 3.43 t/ha respectively. The increased leaf length, leaf width, DMP might be owing to better availability of nutrients during all the crop growth stages which might have resulted in more N absorption by the roots for the synthesis of protoplasm responsible for rapid cell division consequently increasing the FGLY and TCLY.

Chewing quality scores were tested in composite samples in different treatments. Preferable chewing quality scores >60 out of 80 were recorded with all the intercropping treatments. The chewing quality scores were also found to be better with respect to varied fertility levels. This indicated that there is no influence of intercrop population and fertilizer levels. However, the chewing quality score was higher with 100 and 125% RDF as compared to 75%RDF.

Intercrop yield and system productivity

Annual *moringa* at 100% population significantly increased the pod yield over the 75 and 50% population. The pod yield increase with 100% population over 75 and 50% population was 56.3 and 26.3%, respectively. The higher population of Annual *moringa* could be attributed for increased pod yield of annual *moringa*.

The intercrop pod yield significantly increased with 125% RDF (3.92 t/ha) as compared to the 75% RDF (2.56 t/ha.). The pod yield with respect to 100% RDF (3.6 t/ha) and 125% RDF (3.92 t/ ha) are comparable. The increased available NPK at 125 and 100% RDF could be attributed to higher DMP, better nutrient uptake thereby higher pod yield.

The system productivity significantly increased when 100% of Annual *Moringa* was intercropped in chewing tobacco followed by 75% of annual *moringa* intercrop. The system productivity with 100 and 75% of annual *moringa* intercropping was 7.15 and 6.44 t/ha respectively.

Table 1: Effect of intercrop and fertilizer levels on the growth, yield, system productivity and LER of chewing tobacco+ Annual *moringa*. (pooled data of 3 years)

Treatments	Growth attributes			Cured leaf yield		Inter crop yield	Chewing quality	System productivity	LER
	Leaf length (cm)	Leaf width (cm)	DMP (t/ha)	FGLY (t/ha)	TCLY (t/ha)	(t/ha) (Out of 80)	scores	(t/ha)	
Intercrop population									
100%	72.9	42.6	6.59	2.73	3.40	3.75	63	7.15	1.06
75%	72.4	42.8	6.99	2.81	3.41	3.03	62	6.44	0.86
50%	72.1	42.9	7.03	2.87	3.46	2.40	63	5.86	0.70
S.Em	1.00	0.90	0.03	0.04	0.03	0.30	-	0.30	-
CD at 5%	NS	NS	NS	NS	NS	1.10	-	1.00	-
Fertilizer levels									
75%RDF	70.4	40.8	6.47	2.65	3.25	2.56	62	5.81	0.68
100%RDF	73.8	42.7	6.95	2.86	3.43	3.64	63	7.07	1.31
125%RDF	74.2	44.8	7.19	2.94	3.51	3.92	64	7.43	1.14
SEm	0.10	0.10	0.20	0.03	0.05	0.42	-	0.12	-
CD at 5%	0.30	0.30	0.68	0.10	0.16	1.20	-	0.30	-
Sole tobacco	72.4	42.5	6.68	2.79	3.38	-	-	-	-
Sole Annual *moringa*	-	-	-	-	-	3.54	-	-	-

Table 2: Effect of intercrop and fertilizer levels on the tobacco equivalent yield (TEY), System economics and residual soil fertility status. (pooled data of 3 years)

Treatments	TEY (t/ha)	System economics		Residual soil fertility status					
		Net return	B:C	OC%		P(kg/ha)		K(kg/ha)	
		(Rs x 10^3)	ratio	0-22.5 cm	22.5-45 cm	0-22.5 cm	22.5-45 cm	0-22.5 cm	22.5-45 cm
Intercrop population									
100%	4.57	202.7	1.87	0.44	0.29	9.94	8.20	294	323
75%	4.36	194.3	1.78	0.48	0.34	10.84	8.45	302	335
50%	4.21	184.0	1.76	0.48	0.35	10.94	10.5	318	353
S.Em	0.12	4.20	0.03	0.01	0.01	0.30	0.70	6.62	9.10
CD at 5%	0.30	16.0	0.10	0.03	0.03	1.00	2.10	22.4	28.0
Fertilizer levels									
75%RDF	4.05	185.5	1.76	0.44	0.28	9.89	8.3	298	334
100%RDF	4.57	192.2	1.79	0.46	0.34	10.45	8.3	305	343
125%RDF	4.74	209.4	1.90	0.46	0.35	10.89	10.6	318	356
SEm	0.18	6.20	0.03	0.01	0.01	0.30	0.70	5.42	6.46
CD at 5%	0.60	22.0	0.13	0.03	0.03	1.00	2.20	18.5	20.2
Sole tobacco	-	127.0	1.93	-	-	-	-	-	-
Sole Annual *moringa*	-	9.58	0.49	-	-	-	-	-	-

As the system productivity was worked out based on the economic yield of tobacco and annual *moringa*, the economic yield of annual *moringa* at 100% level was higher which in turn increased the system productivity. The system productivity significantly increased with 125% RDF (7.43 t/ha) as compared to 100% RDF (7.07 t/ha). The increase in system productivity with 125% RDF over 100% RDF was 5%. The 75 % RDF recorded the lowest system productivity (5.81 t/ha). Increased nutrient availability at 125% RDF might have increased the yield of tobacco and *moringa* thereby system productivity. Annual *moringa* (100%) population intercropped in chewing tobacco recorded a LER of 1.06.The RDF more than 100% recorded a LER values of 1.31 to 1.14.

TEY and System economics

With Intercropping of annual *moringa* at 100% population followed by 75% of population (4.30 t/ha) increased the tobacco equivalent yield (TEY) 4.57 t/ha, The lower TEY (4.21 t/ha) were recorded with 50% population of annual *moringa*. The RDF at 125% significantly increased the TEY (4.74 t/ha.) as compared to 75% RDF (4.05 t/ha.). The TEY with 125 and 100% RDF are comparable (Table 2). Annual *moringa* with 100% population intercropped with chewing tobacco significantly increased the net return (' 2,02,700/ha) over 50% annual *moringa* population as intercrop. The higher yield with *moringa* and tobacco increased the net returns. The net return with 100% and 75% of annual *moringa* population was comparable. Higher net returns of ' 2,09,400/ha was recorded with 125% RDF applied to tobacco and annual *moringa* followed by 100% RDF (' 1,92,200/ha). The higher yield with *moringa* and tobacco increased the net returns. The 75% RDF applied to tobacco as well as annual *moringa* recorded the lowest net return of ' 185500/ha. The B:C ratio significantly increased with 100% annual *moringa* population intercropped with chewing tobacco. Application of 125% RDF for chewing tobacco and annual *moringa* increased the B:C ratio as compared to the other levels of RDF.

Soil residual fertility status

Soil organic C status in the first depth increased (0.44 to 0.48%) as compared to initial soil fertility status(0.40%). The organic C percentage was higher (0.44 – 0.48%) with the first soil depth (0-22.5 cm) as compared to the second depth (22.5 – 40 cm). The organic C significantly increased (0.48%) with annual *moringa* at 100% population as compared to 50% annual *moringa* population. Similar trend was observed in the second depth also. The addition of leaf litters from annual *moringa* could be attributed for increased organic matter thereby organic C. In a chewing tobacco based cropping system, Kumaresan *et al.*(2008) reported an increased soil organic C as compared to sole tobacco.

Fertilizer levels significantly increased the OC status at first soil depth. The RDF at 125% significantly increased the OC % (0.46%) as compared to the 75% RDF (0.44%). Similar trend was observed with second depth also.

Soil residual P status was higher (9.89- 10.9 kg/ha) with the first soil depth as compared to the second soil depth (8.2 to 10.6 kg/ha). As the applied P is fixed in the top soil, the P status in first depth was more as compared to the second depth. Soil P was significantly higher (10.9 kg/ha) with 50% annual *moringa* population as compared to 100% annual *moringa* population. Similar trend was observed in second depth also. The less P uptake due to less plant population could be attributed for higher available P. The RDF at 125% significantly increased the soil residual P (10.8 kg/ha) as compared to 75% RDF. The higher dose of P added through 125% RDF increased the residual P status. The residual soil P with 125% RDF and 100% RDF are comparable. Similar trend was observed with second depth also. The higher dose of P and degradation of organic matter resulted in increased available P. The organic materials form a cover on sesquioxide and thus release the phosphate-fixing capacity of the soil (Das *et al.*, 2004).

The soil residual K increased (294-356 kg/ha) as compared to initial K fertility status (275 kg/ha). The cumulative effect of K applied to tobacco and *moringa* resulted in increased residual K status. The residual K was higher (323-356 kg/ha) with the second depth as compared to the first depth. Since the K is a mobile element , the K applied on the top soil might have moved to the second depth thereby increased residual soil K. In the first soil depth, soil residual K was significantly higher (318 kg/ha) with 50% annual *moringa* population as compared to 100% annual *moringa*

Table 3: Effect of intercrop and fertilizer levels on the tobacco lamina nutrient uptake and lamina chemistry.

(pooled data of 3 years)

Treatments	Tobacco lamina nutrient uptake(kg/ha)			Lamina chemistry		
	N	P	K	Nicotine (%)	Reducing sugars (%)	Chlorides (%)
Intercrop population						
Tobacco + Annual *moringa* (100%)	76.5	5.09	45.62	2.76	3.56	5.10
Tobacco +Annual *moringa* (75%)	76.0	5.37	46.81	2.80	3.48	5.12
Tobacco +Annual *moringa* (50%)	75.0	5.19	43.85	2.82	3.50	5.14
S.Em	1.03	0.19	2.10	0.06	0.06	0.06
CD at 5%	NS	NS	NS	NS	NS	NS
Fertilizer levels						
75%RDF	74.1	4.62	44.5	2.60	3.60	5.10
100%RDF	77.7	5.50	48.6	2.72	3.48	5.20
125%RDF	77.9	5.56	51.8	2.86	3.36	5.10
SEm	1.00	0.26	2.13	0.06	0.06	0.06
CD at 5%	3.00	0.90	7.00	0.24	0.22	NS
Sole tobacco				2.78	3.50	5.10
Sole Annual *moringa*						

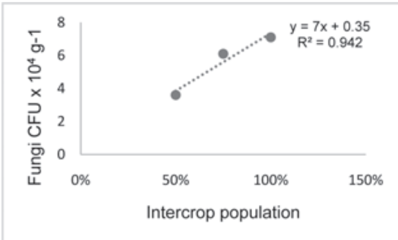

Fig.1: Intercrop population Vs Fungi population

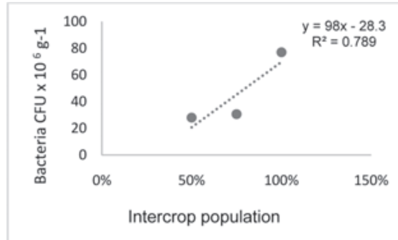

Fig. 2: Intercrop population vs Bacteria population

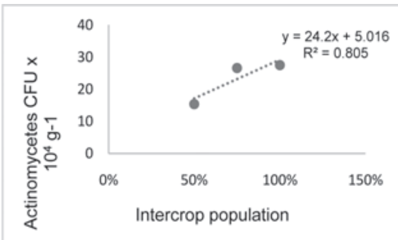

Fig.3: Intercrop population vs Actinomycetes population

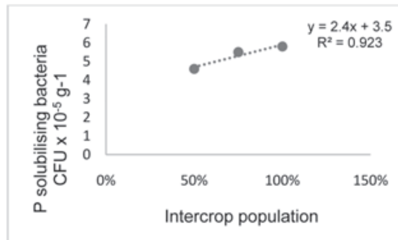

Fig.4: Intercrop population vs PSB population

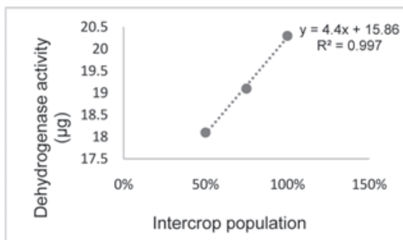

Fig. 5: Intercrop population vs Dehydrogenase activity

population. The less population thereby less uptake could be attributed for increased residual K status. The RDF at 125% significantly recorded higher residual K (318 kg/ha) as compared to 75% RDF. The soil residual K with 125% RDF and 100% are comparable. Similar trend was observed with the second depth also.Higher availability of K could be ascribed to addition of K to the available pool of soil through organic and inorganic sources besides the reduction in K fixation and release of K due to interaction of organic matter with clay (Katkar *et al.*, 2002).

Nutrient uptake and Lamina chemistry of tobacco

Lamina NPK uptake of tobacco was not significantly influenced by levels of intercrop population. The NPK uptake recorded with 125 and 100% RDF was comparable. Lamina chemistry viz., nicotine, reducing sugars and chlorides were not significantly influenced by the intercrop population. Nicotine content was significantly higher (2.86%) with 125% RDF over 100% RDF.As N is positively correlated to Nicotine the higher dose of N increased the Nicotine content in the lamina. Reducing sugars was significantly higher with 75% RDF (3.60 %) followed by 100% and 125 % RDF. Increased Nicotine content in the lamina decreases the reducing sugars. Giridhar *et al.* (1998) reported an increase in N content in tobacco leaves increased the nicotine content and decreased the reducing sugars. The chloride levels in the lamina did not show significant difference (Table 3).

Microbial population and Dehydrogenase activity

The microbial population increased with the higher plant population per unit area. The fungi population increased (7.1 CFU x 10^4 g^{-1}) with 100% intercropping situation (Fig. 1) showing a positive correlation(R^2=0.9423).The bacterial population increased (77.0 CFU x 10^6 g^{-1}) with 100% intercrop population(Fig. 2), showing positive correlation (R2=0.789). The 50 to 75 % of intercrop population did not increase the bacterial population. The actinomycetes increased (27.5 CFU x 10^4 g^{-1}) with 100% intercrop population (Fig. 3) showing positive correlation (R^2=0.805) .The phosphorus solublising bacteria increased (5.8 CFU x 10^{-5} g^{-1}) with 100% intercrop population (Fig. 4) followed by 75 and 50% annual *moringa* population, showing positive correlation (R^2=0.785). Dehydrogenase activity was higher 20.3 µ g with 100% annual *moringa* population (Fig. 5) followed by 75 and 50% population, showing positive correlation (R^2=0.838).The addition of organic manures and inorganic fertilizers for chewing tobacco increased the microbial population and dehydrogenase activity. Similar results were reported by Sneh Goyal et al.(1999).

It could be concluded from the study that 100% annual *moringa* as an intercrop in chewing tobacco with 100% RDF applied for chewing tobacco as well as for annual *moringa* increased the system productivity and net returns.

REFERENCES

Das, M, Anup Prasad and R.C. Gautam .2004. Residual effect of organic and inorganic sources of nitrogen applied to cotton 9Gossipium hirsutum) on succeeding wheat (*Triticum aestivum*). **Ind. J. Agron.** 49(3): 143-146.

Giridhar, K., D. Ramachandram and S. Ramesh .1998. Perfomance of FCV tobacco varieties with varying levels of nitrogen and spacings in KLS. **Tob. Res.** 24 (2): 89-92.

Hanumantha Rao, A., C.V.S.S.V. Gopalakrishna and B.V.V. Satyanarayanamurthy 1980. Determination of chlorides in tobacco by auto-analysis. **Tob. Res**. 7: 92-95.

Harvey, W. R., H.M. Stahr and W.C, Smith. 1969**.** Automated determination of reducing sugars and nicotine alkaloids on the same extract of tobacco. Tob. Sci. 13: 13-15.

Katkar, R. N., A.B. Turkhede, V. M. Solanke, S.T, Wankhede and M. R. Patil . 2002. Effect of integrated management of organic manures and fertilizers on soil properties of cotton. **J. Cotton Res. Develop.** 16(1): 89-92.

Kumaresan, M and C.Chandrasekara Rao (2013). Production potential and economic feasibility of chewing tobacco (*Nicotiana tabacum*)-based intercropping system. **Indian J. Agric. Res**., 47 (1): 66-72.

Kumaresan, M., P.Harishu Kumar, V.Krishnamurthy and R.Athinarayanan. 2008. Economic viability and residual soil-nutrient status in chewing tobacco (*Nicotiana tabacum*)-based cropping system. **Ind. J. Agron.** 53(4):290.

Kumaresan, M., D. Damodar Reddy and C. Chandrasekara Rao. 2019. ICAR –CTRI Research station , Vedasandur at a glance. Bulletin No.1. P: 15.

Palanichamy, K and K.Nagararajan.1999. Significant Research Achievements.(1948-1998).Central Tobacco Research Institute, Research Station, Vedasandur, Tamil Nadu.P:12.

Seth, M., J.P. Rameshwar Saini., R. P. Sharp and K.D. Sharma. 2016. Productivity and economics of wheat (*Triticum aestivum*)- Chick pea (*Cicer arietinum*) intercropping under irrigation and nutrient management. **Ind. J. Agron.** 61(3): 286-291.

Sneh Goyal, K.Chander, M.C.Mindra, K.K.Kapoor. 1999. Influence of inorganic fertilizers and organic amendments on soil organic matter and soil microbial properties under tropical condition. **Biol. Fertil. Soils**,29,196-200.