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Evaluation of Organic and Inorganic Fertilizers on Chemical and Biochemical Quality Constituents of Burley Tobacco

K SIVA RAJU[1], D DAMODAR REDDY[2], S KASTURI KRISHNA[3], C CHANDRASEKHARA RAO[3]* AND H RAVISANKAR[3]

ABSTRACT

A field experiment was conducted to study the effect of organic and inorganic manures viz., four formulations of organic manures (neem cake, pongamia cake, filter press cake, poultry manure, FYM and vermicompost in different ratios) and two levels of inorganic nitrogen fertilizers (120 and 160 kg N /ha) on chemical and biochemical quality constituents of burley tobacco. Cured leaf samples from bottom, middle and top leaf positions in different treatments were analysed for chemical and biochemical quality constituents. Total chlorophylls, carotenoids and nitrate nitrogen varied from 0.116 to 0.388, 0.161 to 0.531, 3.87 to 8.06 mg/g, respectively. Chlorophylls and carotenoids were higher in manure treatments compared to inorganic treatments. Polyphenols viz., chromogenic acid and rutin ranged from 0.58 to 3.89 mg/g and 0.94 to 2.85 mg/g respectively. Polyphenols were less with organic manures compared to inorganic manures. Proline content varied from 0.506 to 3.7 mg/g. Organic manures showed higher proline compared to inorganic Nitrogen. Chemical quality parameters viz., nicotine, reducing sugars and chlorides ranged from 0.4 to 1.73%, 0.49 to 1.93% and 0.39 to 2.84% respectively. Reducing sugars content is high with organic manure application compared to inorganic nutrients. Manure treatments not only increased the content of carotenoids, proline, reducing sugars, chlorophyll, and free fatty acids which play an important role in the quality of tobacco but also decreased the levels of polyphenols and nitrate nitrogen, which are negatively correlated with the quality of tobacco. Among the different organic manures, manure A (neem cake, pongamia cake, filter press cake, poultry manure, FYM and vermicompost in the ratio of 2:2:2:2:1:1) showed superiority followed by Manure C (neem cake, pongamia cake, filter press cake, poultry manure, FYM and vermicompost in the ratio of 1.5:1.5:5:2:1:2) in their influence on chemical quality parameters of Burley tobacco.

KEYWORDS

Organic and inorganic fertilizers, Quality, Burley tobacco

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INTRODUCTION

Tobacco is one of the important high value commercial crops grown in an area of 0.45 million ha producing 804 million Kg cured leaf. About fifteen tobacco types are being cultivated in diverse agro-climatic conditions which are broadly classified as Flue-cured Virginia (FCV) and non-FCV types based on method of curing. Based on their usage in the end product, they are classified as cigarette and non-cigarette types. Burley tobacco is a cigarette type mainly used in blending of cigarette mixtures, grown mostly in Andhra Pradesh. Apart from climate, burley tobacco leaf chemical quality parameters are significantly influenced by the type and quantum of organic and inorganic nutrients applied. The organic fertilisers besides providing nutrients, improves the nutrient use efficiency by reducing the leaching losses and improving the soil physical and biological environment, especially in light soils (Giridhar *et al*, 2003). Organic manures are reported to improve the body, aroma, pliability, and other quality parameters of tobacco besides lowering the harmful carcinogenic constituents like tobacco specific nitrosamines (TSNA) and enhance fertilizer use efficiency (Singh *et al*, 2002). Nitrogen through organic source helps in preventing quick ripening of tobacco by maintaining continuous availability during the crop growth period. Integrated use of inorganic and organic fertilisers is important to maintain and sustain a higher crop productivity and soil fertility. In tobacco, combination of organic and mineral fertilizers improves the tobacco yield and quality (Tursic *et al*, 2004). Among the different nutrients, nitrogen plays an important role on yield and quality improvement of tobacco. Nitrate form of nitrogen influences the health-related smoke constituents in leaf which increase with nitrogen fertilization (Raju *et al*, 2003; Chandrasekhararao *et al*, 2013). Chemical quality parameters viz., nicotine, reducing sugars and chlorides and biochemical constituents viz., pigments, starch, petroleum ether extractives, polyphenols, free amino acids and free fatty acids are some of the main constituents responsible for aroma and quality of tobacco and these parameters are influenced by quantity

[1] Principal Scientist (Retd), Central Tobacco Research Institute, Rajahmundry, Andhra Pradesh, India
[2] Director, Central Tobacco Research Institute, Rajahmundry, Andhra Pradesh, India
[3] Principal Scientist, Central Tobacco Research Institute, Rajahmundry, Andhra Pradesh, India
*Corresponding author email: ccsrao30@gmail.com

and source of manures, leaf position on stalk, climatic conditions, cultural practices, genotypes and method of curing. The present investigation was planned to study the integrated nutrient management with different organic manures on biochemical and quality parameters of Burley tobacco.

MATERIALS AND METHODS

Field experiment was conducted during kharif at Burley Tobacco Research Centre, Kalavacharla, East Godavari district, Andhra Pradesh on, slightly acidic (pH 6.3) sandy loam soils with low insoluble salts (EC 0.12 dS/m), chlorides (44 mg/kg), organic carbon (0.22%), available nitrogen (155 kg/ha), available potassium (134 kg/ha) and medium in available phosphorus (22 kg/ha). Treatments consists of four organic manures mixtures equivalent to 30 kg N (organic manure A, B, C, D) along with 90 kg inorganic N and two inorganic nitrogen levels (120 and 160 kg N/ha) in Randomised Block Design (plot size of 5.4 m X 5.4 m) replicated three times**.** Organic manure mixtures were prepared by mixing neem cake, pongamia cake, filter press cake, poultry manure, FYM and vermicompost in different ratios viz., **A** manure (2:2:2:2:1:1), **B** manure (1.5:2:4.5:2:1:1.5), **C** manure (1.5:1.5:5:2:1:2) and **D** manure (1.5:1.5:3.5:1.5:2:5). The ratios of the individual organic manures were taken by considering their potential in providing nutrients/plant protection/plant growth substances however, the total nitrogen content supplied by the manure formulation was kept constant at 30 kg N/ha.

These manures mixtures were applied 15 days prior to planting. In the manured plots, 90 kg N was applied along with 50 kg K_2O/ha in two splits at 7-10 and 25-30 days after planting (DAP). Entire dose of P (50 kg P_2O_5/ha) was applied as basal dose along with first dose of N and K at 7-10 DAP. The N, P and K fertilisers were applied by dollop method (10 cm away from plant at 10 cm depth) through calcium ammonium nitrate, di-ammonium phosphate and potassium sulphate, respectively. Burley tobacco variety 'Banket A1' was grown with recommended package of practices. Matured leaves were harvested 7-8 times from 65 days onwards after planting and were air cured. Cured leaf samples were collected from bottom, middle and top positions, dried and powdered. The powdered samples were analysed for biochemical constituents viz., chlorophyll pigments, carotenoids (Hiscox and Iscrelston's, 1979), petroleum ether extractives (Andersen *et al*, 1977), free fatty acids (Chu *et al*, 1972), starch (Gaines and Meudt, 1968), polyphenols (Raju *et al*, 2005), nitrate nitrogen (Padmavathi, 2008) proline (Bates *et al*, 1973) and nicotine, reducing sugars and chlorides (Harvey *et al*, 1969). Solanesol in L position leaf was analysed by HPLC method (Kiran *et al*, 2008) and data were statistically analysed (Panse and Sukhatme, 1957).

RESULTS AND DISCUSSION

Influence of different organic manures, position of leaf on the plant on chemical and biochemical parameters is given tables 1-6**.**

Table 1: Effect of organic and inorganic treatments on burley tobacco pigments (mg/g)

Treatments	Chlorophyll a				Chlorophyll b				Total chlorophyll			
	Bottom	Middle	Top	Mean	Bottom	Middle	Top	Mean	Bottom	Middle	Top	Mean
Manure A	0.119	0.142	0.155	0.138	0.124	0.169	0.141	0.144	0.224	0.388	0.201	0.271
Manure B	0.067	0.095	0.108	0.092	0.068	0.133	0.117	0.106	0.139	0.232	0.230	0.200
Manure C	0.103	0.122	0.109	0.111	0.083	0.179	0.104	0.122	0.190	0.307	0.204	0.233
Manure D	0.065	0.126	0.083	0.091	0.069	0.116	0.099	0.094	0.145	0.163	0.164	0.157
120 kg N/ha	0.087	0.087	0.109	0.094	0.067	0.103	0.100	0.091	0.148	0.179	0.203	0.176
160 kg N/ha	0.067	0.097	0.109	0.091	0.054	0.115	0.065	0.078	0.116	0.202	0.198	0.172
Mean	0.084	0.111	0.112		0.077	0.135	0.104		0.160	0.245	0.200	

	Chlorophyll a SEm±	Chlorophyll a CD 5%	Chlorophyll b SEm±	Chlorophyll b CD 5%	Total chlorophyll SEm±	Total chlorophyll CD 5%
Leaf position	0.002	0.005	0.001	0.005	0.006	0.019
Treatments	0.002	0.008	0.002	0.007	0.009	0.026
Treatments x Leaf position	0.004	0.013	0.004	0.012	0.018	0.056

Chlorophylls

Chl a, Chl b contents and Total chlorophyll (Tchl) contents varied from 0.065 to 0.155 mg/g, 0.054 to 0. 179 mg/g and 0.116 to 0.388 mg/g respectively among the different treatments and leaf positions (Table 1). Chlorophyll a (Chl a), chlorophyll b (Chl b) and total chlorophyll contents were significantly higher in manure A and manure C compared to other treatments. Middle position leaves recorded maximum and significantly higher levels of chl b (0.135 mg/g) and Tchl pigments (0.245 mg/g) compared to bottom and top position leaves. Tobacco from organic manure treatments showed higher levels of Chl b when compared to inorganic nitrogen treatments. Tobacco from manure A, manure B and manure C showed higher levels of Chl compared to nitrogen 120 and 160 kg N/ha. C Chandrasekhararao *et al* (2013) reported the increase in Chlorophyll a, Chl b and total chlorophyll content with increase in leaf position from bottom to top on stalk and decrease with increase in nitrogen levels. Court and Hendel (1982) reported that Chlorophyll a and b concentrations in the cured leaf were at about 1% of the amount measured at harvest.

Carotenoids

Carotenoid content varied from 0.161 to 0.531 mg/g among the different treatments and leaf positions (Table 2). Carotenoid pigments were significantly higher in manure A compared to other treatments and it was minimum in 160 kg N/ha. Tobacco from manure treatments showed higher levels of carotenoids compared to nitrogen treatments. Middle position leaves showed significantly higher levels of carotenoids compared to bottom and top position leaves. Break down of the chlorophyll pigments was one of the important biochemical transformations during curing to get desired colour of the tobacco. The degradation products of carotenoids include a number of aroma compounds in tobacco. The chemical breakdown products of pigments during the curing have been reported to give rise numerous flavour components and improves the colour of the cured leaf (Hong-Zhi *et al*, 2012). Carotenoids are precursors to many of the volatile aroma components of tobacco in addition to major colour pigments (red-orange to yellow).

Starch

Starch present in the mature leaves is hydrolysed to reducing sugars during curing, the level of which has a profound influence upon tobacco quality. Starch content varied from 0.116 to 0.399 mg/g among different treatments and leaf positions (Table 2). Maximum starch content (0.399 mg/g) recorded in 120 kg N/ha whereas it was minimum in manure B. Lower levels of starch were recorded in manure treatments compared to 120 and 160 kg N/ha. Decrease in starch accumulation with increase in nitrogen application in FCV tobacco was reported (Chandrasekhararao *et al*, 2013). The starch content increased significantly with increase in leaf position on the stalk and decreased from middle to top position on the stalk (Court and Hendel, 1982). They also reported that with increase in nitrogen from 120 to 200 kg /ha, the starch content was decreased, and lowest content was observed in 200 kg /ha. FCV tobacco with starch content below 5% was regarded as good quality character.

Table 2: Effect of organic and inorganic treatments on carotenoids, starch and nitrate nitrogen in burley tobacco (mg/g)

Treatments	Carotenoids				Starch				Nitrate nitrogen			
	Bottom	Middle	Top	Mean	Bottom	Middle	Top	Mean	Bottom	Middle	Top	Mean
Manure A	0.259	0.531	0.388	0.392	0.266	0.116	0.215	0.199	3.87	4.94	5.25	4.69
Manure B	0.175	0.427	0.414	0.338	0.150	0.183	0.200	0.178	4.12	5.23	6.51	5.29
Manure C	0.233	0.418	0.457	0.369	0.306	0.299	0.333	0.312	4.34	5.42	5.53	5.09
Manure D	0.186	0.379	0.350	0.332	0.200	0.366	0.383	0.316	4.48	5.55	5.86	5.29
120 kg N/ha	0.176	0.379	0.366	0.307	0.399	0.316	0.333	0.349	4.82	5.83	5.92	5.52
160 kg N/ha	0.161	0.431	0.406	0.305	0.306	0.320	0.326	0.317	4.27	5.25	8.06	5.84
Mean	0.198	0.427	0.396		0.271	0.266	0.298		4.31	5.37	6.18	
		SEm±		CD 5%		SEm±		CD 5%		SEm±		CD 5%
Leaf position		0.005		0.016		0.003		0.010		0.047		0.132
Treatments		0.008		0.023		0.005		0.014		0.067		0.187
Treatments x Leaf position		0.014		0.040		0.008		0.024		0.117		0.325

Nitrate-N

Nitrate nitrogen content varied from 3.87 to 8.06 mg/g among the different treatments and leaf positions (Table 2). Tobacco from manure A treatment showed minimum content of nitrate nitrogen whereas it was maximum in 160 kg N/ha. Manure treatments showed lower levels of nitrate nitrogen compared to 120 and 160 kg N/ha. Nitrate nitrogen content increased with increase in application of nitrogen from 120 to 160 kg N/ha and also increased significantly with increase in leaf position on the stalk (bottom to top). Maximum nitrate nitrogen content (8.06 mg/g) recorded in top position tobacco from 160 kg N/ha whereas it was minimum in bottom position tobacco from manure A (3.87 mg/g). Wide variation in nitrate content of cured tobacco as influenced by genotype, cultural practices and curing method was reported (Raju *et al*, 2003). Nitrate nitrogen in tobacco has a great influence on tobacco specific nitrosamines. C Chandrasekhararao *et al* (2013) reported that nitrate nitrogen content increased with increase in nitrogen up to 180 kg N/ha in all leaf positions whereas there was a marginal decrease at 200 kg N/ha in FCV tobacco. Accumulation of higher levels of nitrate nitrogen in air-cured burley tobacco genotypes was a genetic factor (Raja-Rao and Suryanarayana, 1988).

POLYPHENOLS

Chlorogenic acid: Major phenols in tobacco are chlorogenic acid and rutin which play an important role on quality of tobacco. Chlorogenic acid content varied from 0.58 to 3.89 mg/g among the different treatments and leaf positions (Table 3). Tobacco from manure A showed minimum chlorogenic acid content (1.27 mg/g) whereas it was maximum in 120 kg N/ha. The chlorogenic acid content increased significantly from bottom to top position on the stalk in all treatments. Inorganic nitrogen showed higher chlorogenic acid compared to organic treatments.

Rutin: Rutin content varied from 0.94 to 2.85 mg/g among the treatments (Table 3). Tobacco from 120 kg N/ha showed maximum rutin content. Manure treatments showed significantly lower levels of rutin compared to nitrogen treatments. Phenolic constituents in the tobacco are effected by genotypes, fertilizers, curing method and leaf position on the stalk (Raju *et al*, 2005; Chandrasekhararao *et al*, 2013). Lower levels of polyphenols are preferred in FCV tobacco as more attention has been diverted towards their role as precursors of dihydroxybenzene compounds of tobacco smoke (Snook and Schlozheuer, 1988). Catechol, one of the most potent cocarcinogens found in cigarette smoke condensate is a major pyrolitic product of chlorogenic acid and rutin. Significant variations in the phenol content in six varieties of FCV tobacco was reported (Raju *et al*, 2005).

Table 3: Effect of Organic and inorganic treatments on polyphenols and proline in burley tobacco (mg/g)

Treatments	Chlorogenic				Rutin				Proline			
	Bottom	Middle	Top	Mean	Bottom	Middle	Top	Mean	Bottom	Middle	Top	Mean
Manure A	0.78	1.36	1.69	1.27	0.94	1.47	1.88	1.43	1.96	2.00	3.70	2.55
Manure B	0.58	2.51	2.66	1.91	0.95	1.71	1.76	1.47	0.70	1.33	2.03	1.36
Manure C	1.25	1.72	3.43	2.13	1.51	1.67	2.3	1.82	1.56	2.02	2.07	1.88
Manure D	0.86	1.06	2.16	1.36	1.17	1.33	1.65	1.38	0.76	2.00	2.83	1.86
120 kg N/ha	1.11	3.72	3.89	2.91	1.61	2.22	2.85	2.22	0.70	1.86	1.91	1.49
160 kg N/ha	0.70	2.78	3.87	2.45	1.40	2.15	2.62	2.05	0.506	0.87	1.98	1.11
Mean	0.881	2.19	2.95		1.26	1.17	2.17		1.03	1.68	2.42	

	SEm±	CD 5%	SEm±	CD 5%	SEm±	CD 5%
Leaf position	0.784	0.217	0.064	0.177	0.047	0.13
Treatments	0.110	0.307	0.90	0.250	0.066	0.18
Treatments x Leaf position	0.192	0.532	0.156	NS	0.115	0.32

Proline: Proline content varied from 0.506 to 3.7 mg/g among the different treatments and leaf positions (Table 3). Tobacco from manure A showed maximum proline content while it was minimum in 160 kg N/ha. Tobacco from manure treatments showed higher levels of proline over the nitrogen treatments and its content decreased significantly with increase in nitrogen application from 120 to 160 kg N/ha. Proline content increased significantly with increase in leaf position from bottom to top on the stalk. Increase in proline content in FCV tobacco with increase in nitrogen application from 40 to 120 kg/ha and with increase in leaf position on the stalk from bottom to top was reported (Chandrasekhararao *et al*, 2013). Transformation of leaf proteins into free amino acids and ammonia during curing contribute significantly to flue-cured tobacco quality. Higher levels of free amino acids are preferred in FCV tobacco as they react with free sugars at high temperatures to form amadori compound responsible for flavour. Burley tobacco contain 3-4% proteins whereas FCV tobacco contains 15-20% of that of Burley (Weybrew *et al*, 1966).

Table 4: Effect of Organic and inorganic treatments on chemical quality parameters inburley tobacco (%)

Treatments	Nicotine				Reducing sugars				Chlorides			
	Bottom	Middle	**Top**	**Mean**	**Bottom**	**Middle**	**Top**	**Mean**	**Bottom**	**Middle**	**Top**	**Mean**
Manure A	0.66	1.43	1.65	1.24	1.06	1.04	1.93	1.34	0.70	1.20	2.41	1.43
Manure B	0.58	1.55	1.46	1.20	0.55	1.44	1.63	1.21	0.56	1.91	2.57	1.68
Manure C	0.59	1.61	1.59	1.26	1.25	1.48	1.57	1.43	0.63	2.31	2.38	1.77
Manure D	0.40	1.73	1.57	1.23	1.11	1.43	1.64	1.39	0.44	2.06	2.84	1.78
120 kg N/ha	0.49	1.42	1.67	1.19	0.49	1.42	1.67	1.19	0.39	1.63	2.12	1.38
160 kg N/ha	0.55	1.44	1.63	1.20	0.73	1.13	1.16	1.00	0.54	1.59	2.80	1.64
Mean	0.54	1.53	1.59		0.86	1.32	1.60		0.54	1.78	2.52	
		SEm±		**CD 5%**		**SEm±**		**CD 5%**		**SEm±**		**CD 5%**
Leaf position		0.008		0.023		0.016		0.045		0.045		0.12
Treatments		0.012		0.033		0.023		0.064		0.064		0.17
Treatments x Leaf position		0.020		0.057		0.040		0.112		0.112		0.31

Chemical Quality Parameters

Nicotine content varied from 0.4 to 1.73% among the different treatments and leaf positions (Table 4). Tobacco from manures A and C showed significantly higher levels of nicotine compared to the nitrogen treatments. Nicotine content significantly increased with increase in leaf position from bottom to top on the stalk. Reducing sugar (RS) content varied from 0.49 to 1.93% among different treatments and leaf positions (Table 5). Tobacco from manure C showed maximum content of RS (1.43%) whereas it was minimum in 120 kg N/ha. Manure treatments showed higher levels of RS over the nitrogen treatments. Chloride content varied from 0.39 to 2.84% among the different treatments (Table 4). Tobacco from manure D showed maximum chloride content (1.78%) whereas it was minimum in 120 kg N/ha. Chloride content increased with increase in leaf position from bottom to top on the stalk. Maximum chloride content (2.84%) recorded in top position leaf in manure D, whereas it was minimum in bottom position leaf in 120 kg N/ha. In FCV tobacco, generally, carbohydrates fraction was more (reducing sugars; 8.6 – 27.0%) when compared to the air-cured burley tobacco, which contains lower levels of free sugar. Nicotine, sugars, sugar/nicotine and chlorides in the leaf are important chemical quality parameters in FCV tobacco. Application of organic and inorganic fertilizers (30% organic manure and 70% inorganic fertilizer) increased yield of FCV tobacco and nicotine content of upper tobacco leaves (Tursic *et al*, 2004). Lower levels of chlorides (<1%) are desired in cigarette tobaccos as their content has negative correlations with burning rate.

Effect of Organic and inorganic treatments on chemical quality parameters in Burley tobacco

Petroleum ether extracts

Petroleum ether extractives (PEE) varied from 4.80 to 7.14% among different treatments and leaf positions (Table 5). Tobacco from manure A showed maximum PEE whereas it was minimum in 160 kg N/ha. The PEE content decreased with increase in applied nitrogen from 120 to 160 kg N/ha. Tobacco from manure treatments showed significantly higher levels of PEE over the nitrogen treatments. Middle and top position leaf showed significantly higher levels of PEE compared to bottom position leaves.

Table 5: Effect of Organic and inorganic treatments on PEE, acid value and solanesol in burley tobacco

Treatments	PEE (%)				Value (μmole/g)				Solanesol (%)
	Bottom	Middle	Top	Mean	Bottom	Middle	Top	Mean	Middle
Manure A	6.21	6.81	6.75	6.59	13.73	13.15	14.27	13.72	0.75
Manure B	4.96	7.14	6.79	6.29	17.75	12.68	13.76	14.73	0.70
Manure C	5.67	7.11	6.92	6.56	15.09	11.39	13.00	13.16	0.75
Manure D	4.87	6.66	6.38	5.97	12.94	10.65	11.96	11.85	0.60
120 kg N/ha	4.80	6.75	6.14	5.89	14.92	9.97	12.42	12.44	0.50
160 kg N/ha	4.98	5.62	6.24	5.61	16.22	11.18	12.69	13.36	0.55
Mean	5.24	6.68	6.53		15.10	11.50	13.01		-
		SEm±		**CD 5%**		**SEm±**		**CD 5%**	
Leaf position		0.08		0.24		0.161		0.44	
Treatments		0.125		0.34		0.228		0.63	
Treatments x Leaf position		0.217		NS		0.395		1.09	

Table 6: Effect of organic manures on soil enzymes

Treatment	Enzyme activities before applying manures			Enzyme activities during growth period		
	Dehydrogenase*	Acid phosphatase**	Alkaline phosphata se **	Dehydrogenase	Acid phosphatase	Alkaline phosphatase
Manure A	0.124	32.56	23.26	0.178	60.36	50.26
Manure B	0.110	29.24	19.88	0.182	56.28	46.28
Manure C	0.112	33.46	23.24	0.196	68.56	54.24
Manure D	0.098	27.28	21.66	0.186	55.23	51.66
120 kg N/ha	0.090	27.34	19.20	0.156	42.36	40.24
160 kg N/ha	0.112	27.66	23.08	0.150	41.96	42.34

*change in OD; ** μ PNP/ g soil

Acid value, an indirect method of estimation of free fatty acid content varied from 9.97 to 17.75 μmole/g (Table 5). Chandrasekhararao *et al* (2013) reported increase in PEE content with increased application of nitrogen from 40 to 120 kg/ha and decreased with further increase in nitrogen levels. (Raju and Sarala, 2013) reported lower levels of crude lipids in bottom leaves and increase in the leaves ascending stalk position and higher levels of PEE are positively correlated with aroma in FCV tobacco. Solanesol content in middle leaf position varied from 0.50 to 0.75% among different treatments (Table 5). Tobacco from manure A and C showed maximum solanesol content whereas it was minimum in 120 kg N/ha.

Soil enzymes

The activity of soil enzymes dehydrogenase, acid and alkaline phosphatases were estimated before the application of organic manures and during the growth period (Table 6). The activities of the enzymes were higher in the organic manure treated plots compared to the inorganic nitrogen applied plots.

CONCLUSION

The present study showed that the manure treatments variably affected biochemical composition of burley tobacco. Manure treatments increased the content of carotenoids, proline, petroleum ether extractives, reducing sugars and free fatty acids which play a role in improving quality of tobacco. In contrast, the levels of polyphenols and nitrate nitrogen that are correlated with the quality of tobacco decreased with the manure treatments. Improvement in soil activity was observed with the application of manures as reflected by increased soil enzyme activities. Hence, it is recommended to replace 25% nitrogen coming from inorganic fertilisers with suggested best organic manure mixtures/formulations from the study to enhance the yield and quality of Burley tobacco while practicing integrated nutrient management.

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