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Effect of leguminous green leaf manures and leaf extract on growth, yield, quality and economics of bhendi [*Abelmoschus esculentus* (L.) Moench] cv. Arka Anamika

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ABSTRACT

Bhendi [*Abelmoschus esculentus* (L) Moench] is one of the most commonly grown tropical vegetable crops. Its growth, yield and quality are highly influenced by the application of fertilizers and agrochemicals. An investigation was carried out to study the performance of bhendi (*Abelmoschus esculenstus*) cv. Arka Anamika under "*Vrkshayurvedic Farming*" with incorporation of different green leaf manures and seed soaking along with foliar sprays of different green leaf extracts on growth, yield, quality and economics. Among the treatment combinations, *Albizia lebbeck* [green leaf manure]+ *Annona squamosa* [seed soaking along with foliar sprays] was recorded the highest performance of growth parameters, yield and quality characters. This treatment also recorded highest net profit and benefit cost ratio. Treatment with only organic manure also resulted in improvement in fruit quality over application of only chemical fertilizer but had lesser effect on productivity.

Key words: Economics, Green leaf manure, Growth, Quality, Yield.

INTRODUCTION

Okra (*Abelmoschus esculentus* L. Moench) is an important vegetable crop and is grown widely in various parts of India throughout the year. It is a cheap and nutritious vegetable. Tender green fruits are cooked in curry and are also used in soups. Okra requires heavy dosage of nutrients *i.e.*, inorganic fertilizers. To reduce the cost of inorganic fertilizers and source to supplement the nutrients, organic manures (green manure and green leaf manures) opens new vistas to reduce the inorganic fertilizer requirement. The yield parameters *viz.*, number of flowers, number of fruits, fruit length, fruit girth and fruit weight play major role in yield enhancement. Similarly growth parameters determine the yield and quality of bhendi. Kavitha *et al*. (2005) reported that application of panchagavya and moringa leaf extract along with recommended dose of fertilizers (RDF) recorded highest number of bulbs, bulb yield plant^{-1} and yield plot^{-1} (8.6kg) compared to control (2.9kg). Christopher Lourduraj *et al*. (2005) reported that application of neem cake+ panchagavya in bhendi, increased the number of fruits plant^{-1} (10.66), fruit girth (6.20cm), fruit length (16.06cm), fruit weight (16.06g) and fruit yield (9.25t ha^{-1}). With this background the per cent studies were carried out.

MATERIALS AND METHODS

The field experiments were carried out at Agricultural College and Research Institute, Madurai during 2006-2007 in bhendi cv. Arka Anamika. The field experiment was laid out in a split plot design of four main and five sub plot to a total of twenty treatment combinations with three replications. The details of the treatments are mentioned hereunder;

Main plot (Basal application of leguminous green leaf manure)

M_1 : *Albizia lebbeck*
M_2 : *Delonix regia*
M_3 : *Gliricidia sepium*
M_4 : *Leucaena leucocephala*

Green leaves from the above leguminous tree species were collected and incorporated to the field @ 10t ha^{-1} during field preparation and allowed 45 days into the soil for decomposition process.

Sub-plot (seed treatment and foliar spray of fresh leaf extract)

S_1 : *Alangium salvifolium*
S_2 : *Annona squamosa*
S_3 : *Aegles marmelos*
S_4 : *Morinda tinctoria*
S_5 : *Ocimum sanctum*

The leaf extract of the above species were prepared separately by grinding fresh leaves with distilled water at 1:1 proportion and kept for 6 hours and the extract was filtered to serve as a stock. Bhendi seeds were soaked in 5 per cent solution for 30 minutes. The soaked seeds were dried

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under shade before sowing. Five per cent of leaf extract prepared from stock solution was sprayed twice *viz.*, 25 and 45 days after sowing. Two control plots *viz.*, absolute control (C_1) and recommended dose of inorganic NPK (40:50:30) alone (C_2) were also maintained. Biometric observations *viz.*, growth parameters (plant height, number of leaves and number of branches plant^{-1}), quality parameters (crude fibre, vitamin C and crude protein contents of the fruit), yield parameters (number of flowers, number of fruits, fruit length, fruit girth, fruit weight, number of seeds fruit^{-1} and yield ha^{-1}) and also cost benefit ratio were recorded. The collected data were subjected to statistical analysis as per Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Growth parameters: The results of the present investigation showed that significant difference was observed for plant height, leaves plant^{-1} and branches plant^{-1} due to the application of leguminous green leaf manure and foliar sprays of tree leaf extracts.

The treatment, M_4 (*Leucaena leucocephala*) recorded highest plant height (130.88cm) compared to M_2 (*Delonix regia*) (120.92cm). The highest number of leaves plant^{-1} (36.35) was obtained in M_1 (*Albizia lebbeck*) and the least (29.28) was observed in M_4 (*Leucaena leucocephala*). More number of branches plant^{-1} (1.77) was recorded in M_3 (*Gliricidia sepium*) and the least number of branches plant^{-1} (1.24) was recorded in M_4 (*Leucaena leucocephala*). Among the different foliar spray treatments, the highest plant height (130.42cm), number of leaves plant^{-1} (34.58) and number of branches plant^{-1} (1.82) was recorded in S_2 (*Annona squamosa*) and the lowest plant height (121.32cm) and number of leaves plant^{-1} (27.79) was recorded in S_5 (*Ocimum sanctum*). The lowest number of branches plant^{-1} (1.53) was recorded in S_3 (*Aegles marmelos*) at harvest stage of the crop (Table1).

The interaction effect was significant and the treatment combinations, M_1S_2 (*Albizia lebbeck* + *Annona squamosa*) recorded the highest plant height of 141.50cm, highest number of leaves (40.67) and number of branches plant^{-1} (2.13). The treatment M_1S_5 (*Albizia lebbeck* + *Ocimum sanctum*) recorded the lowest plant height (111.10cm) and M_4S_5 (*Leucaena leucocephala* + *Ocimum sanctum*) registered lowest number of leaves plant^{-1} (21.73). The lowest number of branches plant^{-1} (1.13) was recorded in M_4S_1 (*Leucaena leucocephala* +*Alangium salvifolium*). This might be due to the bio stimulant activity and consistent supply of nutrients to the plants by the decomposed green leaf manures (Prakash and Bhushan, 2003). This would have provided the nutrition for increasing the cell division and elongation and there by improved the plant height (Tripathi *et al*., 2000). During green leaf manure decomposition, high concentration of organic acids, phenolic substances and other organic compounds are released which could influence the

Table 1: Effect of leguminous green leaf manures and leaf extracts on plant height (cm), number of leaves and number of branches plant^{-1} in bhendi cv. Arka Anamika

Green leaf incorporation	Plant height (cm)						Number of leaves plant^{-1}						Number of branches plant^{-1}					
	S_1	S_2	S_3	S_4	S_5	Mean	S_1	S_2	S_3	S_4	S_5	Mean	S_1	S_2	S_3	S_4	S_5	Mean
M_1	133.23	141.50	128.00	126.50	111.10	128.07	36.33	40.67	37.87	33.33	33.53	36.35	1.53	2.13	1.40	1.60	1.80	1.69
M_2	116.03	118.67	120.53	126.53	122.83	120.92	29.40	34.93	32.27	33.27	31.67	32.31	1.87	1.67	1.60	1.40	1.73	1.65
M_3	125.87	127.40	135.83	123.03	126.43	127.71	34.80	33.73	34.80	36.07	34.27	34.73	1.60	1.67	1.47	2.07	2.07	1.77
M_4	134.27	134.10	131.07	130.07	124.90	130.88	30.73	33.53	33.00	27.40	21.73	29.28	1.13	1.33	1.20	1.33	1.20	1.24
Mean	127.35	130.42	128.86	126.53	121.32	126.89	32.82	35.72	34.48	32.52	30.30	33.17	1.60	1.82	1.53	1.59	1.58	1.59
Control plots																		
C_1			101.00						19.75						1.07			
C_2			146.65						43.00						3.00			
	M		**S**		**M x S**		**M**		**S**		**M x S**		**M**		**S**		**M x S**	
SEd	2.472		2.765		5.529		1.597		1.307		2.832		0.134		0.096		0.217	
CD (0.05)	6.048		5.632		11.716		3.909		2.663		6.139		0.327		0.195		0.476	

growth (Diekmann and De Datta, 1992). Similar observations were supported by Kavitha *et al*. (2005).

When absolute control compared with M_1S_2, M_1S_2 showed an increase in the plant height, number of leaves plant^{-1} and number of branches plant^{-1}, while the control recorded the lowest height and number of leaves per plant, since there was no external application of organic and inorganic nutrients. Comparing the inorganic fertilizer treatments with M_1S_2, M_1S_2 showed a decrease in height, number of leaves plant^{-1} and number of branches plant^{-1}. This might be due to the higher availability of nutrients at the vicinity of root zone of the crop in turn resulted in growth of the plants (Thilakavathy, 1998). Similar observations were recorded by Rajasekar (1995).

Yield parameters: The incorporation of green leaf manures had significant effect on number of flowers plant^{-1}, number of fruits plant^{-1}, fruit length, fruit girth, fruit weight, fruit yield plant^{-1}, number of seeds fruits^{-1}, seed weight plant^{-1}, yield plot^{-1} and fruit yield ha^{-1} in Bhendi. More number of flowers plant^{-1} (29.38), fruits plant^{-1} (28.63), longest fruit length (18.09cm), heaviest fruit (16.06g), highest fruit yield plant^{-1} (371.61g), highest number of seeds fruit^{-1} (54.32), highest seed weight plant^{-1} (121.73g), highest plot yield 4.36kg, highest fruit yield of 11.62t ha^{-1} was recorded in M_1 *(Albizia lebbeck*) and also the highest fruit girth (7.12cm) was recorded in M_4 (*Leucaena leucocephala*). The least number of flowers plant^{-1} (27.52), number of fruits plant^{-1} (27.03), lowest fruit; weight (14.59g) lowest fruit yield plant^{-1} (325.25g) , lowest number of seeds fruit^{-1} (49.39), lowest seed weight plant^{-1} (104.03g), lowest plot yield (3.86kg), lowest fruit yield of 10.28t ha^{-1} was recorded in M_4 (*Leucaena leucocephala*). Shortest fruit length (15.59cm) and fruit girth (6.34cm) was recorded in M_2 (*Delonix regia*). The application of leaf extract through seed treatment and foliar sprays had significant effect on number of flowers plant^{-1}, number of fruits plant^{-1}, fruit length, fruit girth, fruit weight, fruit yield plant^{-1}, number of seeds fruits^{-1}, seed weight plant^{-1}, yield plot^{-1} and fruit yield ha^{-1} in bhendi. Among the sub plot treatments, S_2 observed highest number of fruits plant^{-1}(28.07), longer fruit length (17.51cm), highest fruit yield plant^{-1} (364.71 g) and highest fruit yield ha^{-1} (11.84 t ha^{-1}), highest seed weight plant^{-1}(115.79g), highest plot yield (4.44kg). S_4 (*Morinda tinctoria*) recorded the highest number of flowers plant^{-1} (28.68). S_1 (*Alangium salvifolium*) recorded the highest fruit girth (6.91cm), number of seeds fruit^{-1} (52.77) and S_3 (*Aegles marmelos*) recorded highest fruit weight (16.23g). The lowest number of flowers plant^{-1} (27.41), number of fruits plant^{-1} (26.69), shortest fruit length (15.78cm), lowest fruit weight (14.82g), lowest fruit yield plant^{-1} (303.18g), lowest seed weight plant^{-1} (103.78g) and lowest number of seeds fruit^{-1} (49.32) were recorded in S_5 (*Ocimum sanctum*). The lowest fruit girth (6.41cm) was recorded in S_4 (*Morinda tinctoria*). S_1 (*Alangium salvifolium*) recorded the lowest plot yield (3.92kg) and fruit yield ha^{-1} of 10.46t (Table2, 3, 4 and 5).

Among the interaction effect M_1S_2 (*Albizia lebbeck+ Annona squamosa)* recorded the highest number of flowers plant^{-1} (31.13), number of fruits plant^{-1} (30.73), fruit length (21.55cm), fruit girth (7.59cm), fruit weight (18.33g), number of seeds fruit^{-1} (59.20), fruit yield plant^{-1} (490.36g), seed weight plant^{-1} 144.09g, yield plot^{-1} (5.24kg) and yield ha^{-1} (13.96 t). M_3S_5 (*Gliricidia sepium + Ocimum sanctum*) recorded least number of flowers plant^{-1} (25.67), number of fruits plant^{-1} (24.95) and seed weight plant^{-1} 98.64g. The lowest fruit length (13.20cm) was recorded in M_4S_3 (*Leucaena leucocephala + Aegles marmelos*) and fruit girth (5.87cm) was recorded in M_3S_4 (*Gliricidia sepium + Morinda tinctoria*). M_4S_5 (*Leucaena leucocephala +Ocimum sanctum*) was recorded the lowest fruit weight (13.42g) at harvest of the crop. The lowest fruit yield plant^{-1} (282.85g) was recorded in M_2S_3 (*Delonix regia + Aegles marmelos*. M_3S_2 (*Gliricidia sepium + Annona squamosa*) recorded lowest number of seeds per fruit (47.27). The lowest yield ha^{-1} of 9.49t and lowest yield plot^{-1} of 3.56kg was recorded in M_3S_1 (*Gliricidia*

Table 2: Effect of leguminous green leaf manures and leaf extracts on number of flower plant^{-1} and number of fruits plant^{-1}in bhendi cv. Arka Anamika

Green leaf incorporation	Number of flower plant^{-1}						Number of fruits plant^{-1}					
	S_1	S_2	S_3	S_4	S_5	Mean	S_1	S_2	S_3	S_4	S_5	Mean
M_1	29.93	31.13	27.97	29.50	28.37	29.38	28.97	30.73	27.63	28.13	27.66	28.63
M_2	28.03	28.73	28.43	28.47	28.40	28.14	27.68	28.47	27.88	27.85	27.49	27.87
M_3	28.00	27.37	30.57	28.83	25.67	28.09	27.53	26.75	29.50	28.33	24.95	27.41
M_4	28.47	26.83	27.20	27.90	27.20	27.52	28.02	26.32	26.50	27.65	26.67	27.03
Mean	28.61	28.52	28.54	28.68	27.41	28.35	28.05	28.07	27.88	27.99	26.69	27.74
Control plots												
C_1			19.00						18.00			
C_2			33.00						32.00			
	M		**S**		**M x S**		**M**		**S**		**M x S**	
SEd	0.385		0.388		0.794		0.337		0.423		0.828	
CD(0.05)	0.942		0.790		1.693		0.824		0.861		1.742	

Table 3: Effect of leguminous green leaf manures and leaf extracts on fruit length (cm) fruit girth (cm) & number of seeds per fruit (numbers) in bhendi cv. Arka Anamika

Green leaf incorporation	Fruit length (cm)						Fruit girth (cm)						Number of seeds fruit^{-1} (numbers)					
	S_1	S_2	S_3	S_4	S_5	Mean	S_1	S_2	S_3	S_4	S_5	Mean	S_1	S_2	S_3	S_4	S_5	Mean
M_1	16.92	21.55	16.73	18.27	17.00	18.09	7.00	7.59	6.65	6.20	6.52	6.79	55.07	59.20	52.53	53.60	51.20	54.32
M_2	15.67	16.67	14.37	16.40	14.83	15.59	6.33	6.53	6.03	6.31	6.50	6.34	54.13	50.67	54.40	50.93	50.47	52.12
M_3	17.57	15.17	19.70	16.73	15.11	16.85	6.95	6.59	5.99	5.87	6.67	6.41	51.33	47.27	51.87	49.73	47.33	49.51
M_4	16.60	16.67	13.20	15.97	16.17	15.72	7.35	6.75	7.08	7.27	7.16	7.12	50.53	48.80	49.47	49.87	48.27	49.39
Mean	16.69	17.51	16.00	16.84	15.78	16.56	6.91	6.87	6.44	6.41	6.71	6.67	52.77	51.48	52.07	51.03	49.32	51.33
Control plots																		
C_1			11.03						5.50						40.00			
C_2			21.73						7.95						59.85			
	M		**S**		**M x S**		**M**		**S**		**M x S**		**M**		**S**		**M x S**	
SEd	0.433		0.586		1.134		0.212		0.159		0.354		1.156		0.932		2.029	
CD (0.05)	1.059		1.193		2.377		0.519		0.323		0.774		2.829		1.899		4.404	

Table 4: Effect of leguminous green leaf manures and leaf extracts on seed weight plant^{-1}(g), fruit weight (g) and fruit yield plant^{-1} in bhendi cv. Arka Anamika

Green leaf incorporation	Seed weight plant^{-1} (g)						Fruit weight (g)						Fruit yield plant^{-1}					
	S_1	S_2	S_3	S_4	S_5	Mean	S_1	S_2	S_3	S_4	S_5	Mean	S_1	S_2	S_3	S_4	S_5	Mean
M_1	112.57	144.09	123.39	118.63	109.99	121.73	15.48	18.33	16.83	15.20	14.47	16.06	391.79	490.36	283.87	359.25	332.81	371.61
M_2	112.20	114.53	112.09	107.15	107.65	110.73	15.09	15.15	16.08	14.29	17.08	15.54	390.80	310.94	282.85	374.30	295.28	330.83
M_3	115.17	100.36	120.69	112.24	98.64	109.42	15.11	14.97	17.58	15.72	14.31	15.54	359.53	340.53	420.65	298.31	291.54	342.11
M_4	110.92	104.20	103.79	112.24	98.83	104.03	14.89	15.54	14.43	14.71	13.42	14.59	359.53	317.02	350.58	360.23	293.09	325.25
Mean	112.72	115.79	114.99	110.11	103.78	111.48	15.14	15.99	16.23	14.98	14.82	15.43	361.87	364.71	334.49	348.02	303.18	342.45
Control plots																		
C_1			90.65						11.05						255.30			
C_2			145.27						19.20						501.00			
	M		**S**		**M x S**		**M**		**S**		**M x S**		**M**		**S**		**M x S**	
SEd	3.396		4.132		8.135		0.148		0.284		0.529		0.604		0.533		1.129	
CD(0.05)	8.310		8.418		17.152		0.363		0.579		1.095		1.479		1.086		2.433	

Table 5: Effect of leguminous green leaf manures and leaf extracts on plot yield (kg) and yield ha^{-1} (t) in bhendi cv. Arka Anamika

Green leaf Incorporation	Plot yield (kg)						Yield ha^{-1} (t)					
	S_1	S_2	S_3	S_4	S_5	Mean	S_1	S_2	S_3	S_4	S_5	Mean
M_1	4.08	5.24	4.21	4.36	3.91	4.36	10.87	13.96	11.22	11.62	10.42	11.62
M_2	4.21	4.35	4.52	4.13	4.01	4.24	11.24	11.61	12.06	11.01	10.68	11.32
M_3	3.56	4.07	4.73	4.23	4.41	4.19	9.49	10.85	12.60	11.28	11.75	11.19
M_4	3.83	4.10	3.88	3.74	3.74	3.86	10.22	10.92	10.34	9.96	9.96	10.28
Mean	3.92	4.44	4.33	4.11	4.01	4.16	10.46	11.84	11.56	10.97	10.70	11.10
Control plots												
C_1			1.95						5.50			
C_2			6.00						14.75			
		M	**S**		**M x S**			**M**		**S**		**M x S**
SEd		0.088	0.154		0.289			0.236		0.410		0.771
CD(0.05)		0.216	0.313		0.599			0.577		0.836		1.599

sepium +Alangium salvifolium). The high values registered in vrkshayurvedic farming may be due to the mineralization, solubilization and availability of all the nutrients to the crop for the entire growth period in addition to the improvement in soil physio-chemical properties that could have enhanced the growth and yield attributes (Pandey *et al*., 2006). These findings are in line with the findings of Kavitha *et al*. (2005) and Christopher Lourduraj *et al*. (2005). Moreover Increase in the availability of nutrients improved the synthesis and translocation of metabolites to various reproductive structures of the plant (VijayKumar and Singh 2006). Similar observations were recorded by Patel *et al*. (2003) in cluster bean. The yield increase might also be due to more foliage resulting in better harvesting of light energy, higher photosynthesis activity, translocation and accumulation of photosynthates to different parts of the plant (Sanker *et al*., 2001). Similar observations were recorded by Ragupathi and Thamburaj (1997) in bhendi.

The absolute control was compared with interaction effect, in which M_1S_2 (*Albizia lebbeck + Annona squamosa*) showed an increase in yield parameters. This might be due to low level of nutrients in the soil. Hence the utilization to would have been also on the lower side.

The recommended dose of inorganic fertilizers (C_2) recorded highest values for yield characters than the treatments involved in green leaf manures and leaf extracts. By application of inorganic fertilizers, the higher dose of nitrogen application lead to higher uptake of nutrients which would have helped to produce more vegetative growth and more number of flowers plant^{-1} by which the effective conversion of carbohydrate to reproductive (economic) part might have increased the yield. Application of phosphorus influenced the root growth in a positive manner which would have helped in better absorption and translocation of nutrients from source to sink of plants. Better root growth would have helped better synthesis of cytokinin which would have helped to divert photo assimilates to more yield attributes (Singh and Maurya, 1992). These nutrients being important constituents of neucleotides, proteins, chlorophyll and enzymes, involved in various metabolic processes and have direct impact on vegetative and reproductive phases of plants (Sharma and Sharma, 2004). Increased fruit length and fruit girth of bhendi was due to the application of nitrogen, phosphorus and potassium fertilizers (Pandey and Singh, 1979). The increase in fruit weight (Dinesh Sharma *et al*., 2001), fruit length, fruit diameter (Shanthi and Vijayakumar, 2005).

Quality parameters: The quality decides the market price and high crude protein and vitamin-C coupled with low crude fibre would be as ideal vegetable. The highest crude fibre (7.81 per cent) was recorded in M_4 (*Leucaena leucocephala*). The highest crude protein (12.86 per cent) was recorded in M_3 (*Gliricidia sepium*) and vitamin-C (12.48mg / 100g) was

recorded in M_1 (*Albizia lebbeck*). The lowest crude fibre (7.46 per cent) was recorded in M_1 (*Albizia lebbeck*). M_2 (*Delonix regia*) was recorded the lowest vitamin-C (10.89mg /100g). The lowest crude protein (10.73 per cent) was recorded in M_4 (*Leucaena leucocephala*). The application of leaf extract through seed treatment and foliar sprays had a significant effect on crude fibre, vitamin-C and crude protein in Bhendi. Among the treatments, S_5 (*Ocimum sanctum*) recorded highest crude fibre (7.86 per cent). S_2 (*Annona squamosa*) recorded highest Vitamin- C (11.89mg / 100g) and crude protein (12.83 per cent). The lowest crude fibre (7.24 per cent) was recorded in S_2 (*Annona squamosa*), the lowest Vitamin- C (11.09mg / 100g) was recorded in S_1 (*Alangium salvifolium*) and S_5 (*Ocimum sanctum*) had the lowest crude protein (11.51 per cent) (Table 6).

Among the treatment combinations, M_2S_5 (*Delonix regia+ Ocimum sanctum*) recorded highest crude fibre (8.48 per cent), M_1S_2 (*Albizia lebbeck +Annona squamosa*) recorded the highest Vitamin- C (14.10mg /100g), crude protein (14.27 per cent) and lowest crude fibre (6.17 per cent) was recorded in M_1S_2 (*Albizia lebbeck +Annona squamosa*). The lowest Vitamin- C (10.18mg /100g) was recorded in M_3S_1 (*Gliricidia sepium + Alangium salvifolium*). M_4S_5 (*Leucaena leucocephala + Ocimum sanctum*) recorded the lowest crude protein (10.07 per cent). The quality and suitability of a vegetable for consumption, in a crop like bhendi is judged based on the crude fibre content of the fruits and the organic manuring considerably decreased the crude fibre content (Mani and Ramanathan, 1981). The highest level of ascorbic acid content may be due to the action of macro and micronutrients and also the growth hormones released from the added manures (Tien *et al*., 1989). Similar findings were reported by Randhawa and Bahil (1976) and Hanchinamani (1983) in bhendi. Apart from this, the presence of phenols, protein and flavonoids in the leaf extracts would have promoted the nutrient uptake and ultimately increased the quality (Tripathy *et al*., 2000).

The absolute control (C_1) recorded 9.32 per cent crude fibre. When it was compared with M_1S_2 (*Albizia lebbeck +Annona squamosa*) it showed a decrease in crude fibre (3.15 per cent) and the recommended dose of inorganic fertilizers (C_2) recorded crude fibre of 10.72 per cent. However there was a decrease in crude fibre content of 4.55 per cent for M_1S_2 (*Albizia lebbeck +Annona squamosa*) than C_2 at harvest stage. The absolute control recorded the lowest quality of bhendi due to non- availability of nutrients and soil reserve alone acts as the only source of nutrients.

The absolute control (C_1) recorded 8.15mg /100g of Vitamin- C. and crude protein of 9.61 per cent. When it was compared to M_1S_2 (*Albizia lebbeck +Annona squamosa*) this treatment showed an increased Vitamin- C of 5.95mg / 100g and protein by 4.66 per cent. The recommended dose of inorganic fertilizers (C_2) recorded (13.85mg/100g) of

Table 6: Effect of leguminous green leaf manures and leaf extracts on crude fibre (per cent), crude protein (per cent) and vitamin-C (mg/100 g)in bhendi cv. Arka Anamika

Green leaf incorporation	Crude fibre (per cent)						Crude protein (per cent)						Vitamin-C (mg/100 g)					
	S_1	S_2	S_3	S_4	S_5	Mean	S_1	S_2	S_3	S_4	S_5	Mean	S_1	S_2	S_3	S_4	S_5	Mean
M_1	7.33	6.17	8.24	8.31	7.24	7.46	12.50	14.27	12.85	11.78	11.94	12.67	11.87	14.10	12.15	11.83	12.45	12.48
M_2	7.33	7.55	8.40	7.06	8.48	7.77	12.32	12.56	11.09	13.24	11.95	12.23	10.19	11.18	10.30	12.03	10.79	10.89
M_3	8.39	7.78	6.65	7.20	7.87	7.58	13.22	13.36	13.57	12.07	12.08	12.86	10.18	10.52	13.49	11.87	11.45	11.50
M_4	7.97	7.46	7.76	8.05	7.84	7.81	10.60	11.13	10.78	11.09	10.07	10.73	12.15	11.77	11.43	10.23	10.33	11.18
Mean	7.76	7.24	7.76	7.66	7.86	7.65	12.16	12.83	12.07	12.05	11.51	12.12	11.09	11.89	11.85	11.49	11.26	11.52
Control plots																		
C_1				9.32						9.61						8.15		
C_2				10.72						11.00						13.85		
	M		**S**		**M x S**		**M**		**S**		**M x S**		**M**		**S**		**M x S**	
SEd	0.089		0.147		0.277		0.423		0.249		0.615		0.182		0.164		0.345	
CD(0.05)	0.219		0.299		0.577		1.036		0.509		1.373		0.445		0.334		0.742	

Table 7: Effect of leguminous green leaf manures and leaf extracts on cost economics in bhendi cv. Arka Anamika

Treatments	Yield (t ha^{-1})	Gross income (Rs.)	Gross cost(Rs.)	Net returns(Rs.)	Benefit Cost Ratio
M_1S_1	10.87	70655	19000	51655	2.72
M_1S_2	13.96	90740	19000	71740	3.78
M_1S_3	11.22	72930	19000	53930	2.84
M_1S_4	11.62	75530	19000	56530	2.98
M_1S_5	10.42	67730	19000	48730	2.56
M_2S_1	11.24	73060	19000	54060	2.85
M_2S_2	11.61	75465	19000	56465	2.97
M_2S_3	12.06	78390	19000	59390	3.13
M_2S_4	11.01	71565	19000	52565	2.77
M_2S_5	10.68	69420	19000	50420	2.65
M_3S_1	9.49	61685	19000	42685	2.25
M_3S_2	10.85	70525	19000	51525	2.71
M_3S_3	12.60	81900	19000	62900	3.31
M_3S_4	11.28	73320	19000	54320	2.86
M_3S_5	11.75	76375	19000	57375	3.02
M_4S_1	10.22	66430	19000	47430	2.50
M_4S_2	10.92	70980	19000	51980	2.74
M_4S_3	10.34	67210	19000	48210	2.54
M_4S_4	9.96	64740	19000	45740	2.41
M_4S_5	9.96	64740	19000	45740	2.41
C_1	5.50	30250	12000	18250	1.52
C_2	14.75	81125	21000	60125	2.86

Vitamin- C and crude protein of 11.00 per cent. When it was compared with M_1S_2 (*Albizia lebbeck* +*Annona squamosa*), M_1S_2 showed an increase in Vitamin- C of 0.25 mg /100g and crude protein 3.27 per cent in Bhendi at harvest of the crop. The observed average quality of fruits in terms of crude protein, vitamin-C and crude fibre in the recommended dose of inorganic fertilizers may be due to the supply of macro nutrients alone and devoid of micronutrients and plant hormones.

Economics: The highest net returns of Rs.71,740 was recorded in M_1S_2 (*Albizia lebbeck*+ *Annona squamosa*) and the lowest net return of Rs.42,685 was obtained in M_3S_1 (*Gliricidia sepium* + *Alangium salvifolium*) and the absolute control (C_1) had net return of Rs.18,250 where as the recommended dose of inorganic fertilizers (C_2) gave a net return of Rs.60,125 (Table 7). This might be due to the availability of nutrient at lower cost through green leaf manure which minimized the expenditure on inorganic fertilizers (Patel *et al*., 2003).

The highest benefit cost ratio of (1:3.78) was obtained in M_1S_2 *(Albizia lebbeck*+ *Annona squamosa*) and the lowest benefit cost ratio of (1:2.25) was obtained in M_3S_1 (*Gliricidia sepium* + *Alangium salvifolium*). The absolute control (C_1) had benefit cost ratio of (1:1.52) and the recommended dose of inorganic fertilizers (C_2) showed benefit cost ratio of (1:2.86). This might be due to the cost incurred on the use of huge quantity of inorganic fertilizers alone without organics which ultimately reduced the quality of the produce also (Thilakavathy and Ramasamy, 1999). The absolute control recorded the lowest net return and benefit cost. This may be attributed to the lowest yield recorded in the control. The vrkshayurvedic farming with green leaf manure *Albizia lebbeck* @ 10t ha $^{-1}$ with 5 per cent leaf extract of *Annona squamosa* on seed soaking and foliar application may contribute a good quality vegetable bhendi without much compromise of yield.

CONCLUSION

Thus, it can be concluded that application of leguminous green leaf manures and tree leaf extracts given in the form of seed soaking and foliar sprays will increase the growth, yield, quality and economics of bhendi.

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