Evaluation of Different Nutrient Management Options for Leaf Yield, Quality, and Economics of Betel Vine Cultivation

By Usha C. Thomas, S. Chandini, S. Anil Kumar, Allan Thomas, and T. Satyanarayana

Betel vine is one of the most profitable intercrops cultivated in the small holdings of Kerala. Complete reliance on chemical fertilisers without inclusion of organic sources of nutrients had some adverse effects on keeping quality and chewing properties of leaves, in addition to aggravating foliage diseases. Thus, a 2-year study was conducted in order to identify rational options for substituting chemical fertilisers with organic nutrient sources for improved productivity and better chewing quality of betel vine.

Betel vine (*Piper betel* L.), a native of Malaysia, is a perennial dioecious creeper that possesses a host of medicinal properties. Though the crop demands continuous care and monitoring by farmers, it is considered as one of the most profitable intercrops cultivated in the home gardens of Kerala.

Nitrogen plays a direct role on growth, yield, and keeping quality of betel vine leaves. A study conducted at College of Agriculture, Vellayani, showed that bulky organic manures can be partly replaced by chemical fertilisers without affecting the chewing quality of leaves (Chandini, 1989). Maiti et al. (1995) reported that application of 200 kg N/ha through a 1:1 ratio of organic and inorganic sources was the best way for obtaining higher yields of betel vine. Debanath et al. (1985) reported that integrated nutrient management (INM) is always advantageous from a long-term perspective both in terms of cost of production and soil health. Thus, a field study was undertaken in Thiruvananthapuram district at the College of Agriculture, Vellayani, to develop an INM practice for improved productivity and quality of betel vine.

Field experiments were conducted during the main planting season starting from June to August in 2001-02 and 2002-03. The soil was an acidic, red loam, low in available N and K, and medium in available P status. The most popular local cultivar (Cheelanthikarpuram) was selected for the study. Its leaves are dark green, broad, and coarse-textured with good storage quality. Chandini (1989) recommended that 60 kg N and 25 kg P_2O_5/ha, over a basal dose of 30 t/ha of FYM, was an acceptable rate of nutrients for this crop. Along with the results of Maiti et al. (1995) reported above, these results formed the basis for deciding N levels in this study.

The treatments involved two N levels (60 and 90 kg/ha), three organic sources: 1) poultry manure (PM), 2) farmyard manure (FYM), and 3) neem cake (NC) – a by-product obtained in the process of cold pressing Neem tree fruits and kernels. The treatments also included two source substitution ratios (1:1 and 2:1). Phosphorus was applied as Mussoriephos (20% P_2O_5) rock phosphate at 30 and 45 kg P_2O_5/ha and K was applied as potassium chloride (KCl) at 60 and 90 kg K_2O/ha to maintain a uniform treatment ratio of 2:1:2. Both fertilisers and manures were applied in equal splits, at monthly intervals after establishment, as surface bands. A brief description of treatments, arranged in a randomised block design with three replications, is given in **Table 1**. Observations were collected on growth and yield parameters for both years and were analysed using standard statistical tools.

Abbreviations: N = nitrogen; P = phosphorus; K = potassium; lakh = 100,000; CD = Critical Difference, equivalent to Least Significant Difference; INR = Indian rupee currency code (47 INR = approximately 1 USD).

Table 1. Treatment details imposed in the experiment.

Treatments	Manure: Source	Manure: kg N/ha	Manure: t/ha	Urea, kg N/ha
T_1	Poultry	30	2.5	30
T_2	Poultry	40	3.3	20
T_3	Farmyard	30	7.5	30
T_4	Farmyard	40	10	20
T_5	Neem cake	30	2	30
T_6	Neem cake	40	2.7	20
T_7	Poultry	45	3.7	45
T_8	Poultry	60	5	30
T_9	Farmyard	45	11.2	45
T_{10}	Farmyard	60	15	30
T_{11}	Neem cake	45	3	45
T_{12}	Neem cake	60	4	30
T_{13}		Farmer practice[1]		

[1]Farmer practice includes 60 t of farmyard manure, 25 t of green manure, and 10 t of wood ash/ha.
P_2O_5 was applied at either 30 or 45 kg/ha, and K_2O at 60 or 90 kg/ha, to maintain a uniform NPK ratio of 2:1:2.

Table 2. Nutrient composition (%) of organic amendments used in the field experiment.

Source	N	P_2O_5	K_2O
Farmyard manure	0.4	0.3	0.2
Poultry manure	1.2	0.63	0.7
Neem cake	1.5	1.0	1.4
Green manure	2.1	0.6	1.0
Wood ash	0.15	2.15	3.0

Across treatments, the average leaf yield increased from 13.8 to 23.7 lakh/ha as the amount of N provided by treatments increased from 60 to 90 kg/ha (**Table 3**). The leaf yield during both years of study revealed that NC + urea applied in a 2:1 ratio (T_{12}) recorded the highest marketable leaf yield compared to other combinations of sources followed by NC + urea applied in a 1:1 ratio (T_{11}). The higher leaf yield with NC over the other two sources could be attributed to its better mineralisation rate and a higher N content (**Table 2**). Regardless, it is inferred that application of 90 kg N/ha through NC and urea in a 2:1 or

1:1 substitution ratio is the best N management schedule for achieving higher leaf yield in betel vine.

Quality of Marketable Leaves

Increasing levels of N application had a significant impact on keeping quality of betel vine leaves, as did the substitution of organic nutrient sources with urea. Farmer practice (FP), with its sole organic N source, provided superior leaf keeping quality followed by NC + urea, and FYM + urea – both applied in a 2:1 ratio at 90 kg/ha total N **(Table 3)**. These observations support the findings of Mandal et al. (1994), who determined that complete reliance on chemical fertilisers without organic input could produce adverse effects through an aggravation of foliage diseases. Supplying N completely through chemical fertilisers generally led to a more rapid release rate for N, producing more succulent leaves and therefore a shorter shelf life. It followed that substitution of inorganic sources with organic fertilisers helped to reduce the N supply rate and provide more appropriate quantities throughout the crop's growth stages.

Sugar and essential oil content are important parameters determining leaf quality in betel vine. Results of the study showed significant influence of INM on essential oil content. Application at 90 kg N/ha (T_7 to T_{12}) recorded the highest essential oil content over N applied at 60 kg/ha (T_1 to T_6) **(Table 3)**. Rahman et al. (1990) reported an increase in essential oil content in coriander seeds with increasing N application from 0 to 60 kg/ha. A comparison among organic sources found equivalent results during 2 years of study if all three sources were applied in a 2:1 combination with urea at a total N rate of 90 kg/ha. Thus, no source had an adverse impact on sugar and oil content and either of the sources can safely be used to substitute, preferably in 2:1 ratio at higher rates of N application, with commercial fertiliser.

Table 3. Effect of different integrated nutrient management options on yield and quality of betel vine.

Treatments	Marketable leaf yield, lakh/ha	Keeping quality, days for 50% rotting of leaves	Essential oil content, mg/g dry weight	Total sugar, %
T_1	14.52	14.0	0.44	20.68
T_2	12.02	15.7	0.42	20.73
T_3	14.42	15.7	0.45	21.60
T_4	13.95	13.5	0.44	22.75
T_5	15.17	15.3	0.44	23.35
T_6	12.78	14.6	0.46	22.46
T_7	18.67	15.5	0.52	26.54
T_8	20.13	16.7	0.51	27.59
T_9	20.96	14.5	0.51	26.90
T_{10}	24.68	18.0	0.57	29.13
T_{11}	27.30	13.0	0.55	28.55
T_{12}	30.72	18.0	0.55	29.22
T_{13}	19.27	20.5	0.55	25.40
CD	4.88	3.4	0.04	2.53

Economics of Cultivation

The economics of cultivation were evaluated both in terms of benefit-to-cost ratio (BCR) and net income. Treatments providing 60 kg N/ha generated less favorable economic indicators compared to plots receiving 90 kg N/ha. During the first year, a highest BCR (and income) was obtained with the 2:1 ratio of NC + urea and by NC + urea in 1:1 substitution during the second year – both at 90 kg N/ha **(Table 4)**. This yearly difference follows the observed yield trends. The expenditure for initial crop establishment was higher in the first year than in the second, as was the cost of cultivation, and these factors were reflected in generally lower values for BCR and net income during the first year.

Table 4. Effect of different integrated nutrient management options on economics of betel vine.

Treatments	Net income, INR/ha Ist year	Net income, INR/ha 2nd year	Net income, INR/ha Average	B:C ratio Ist year	B:C ratio 2nd year	B:C ratio Average
T_1	28,587	66,493	47,540	1.27	1.75	1.51
T_2	8,488	20,593	14,541	1.07	2.21	1.64
T_3	51,188	51,393	51,291	1.49	1.59	1.54
T_4	46,088	25,693	35,891	1.41	1.27	1.34
T_5	3,545	58,150	30,848	1.41	2.09	1.75
T_6	15,131	32,564	23,848	1.52	1.02	1.27
T_7	51,638	101,943	76,791	1.44	2.01	1.73
T_8	114,888	44,293	79,591	1.85	1.39	1.62
T_9	76,588	126,993	101,791	1.65	2.28	1.97
T_{10}	99,288	147,093	123,191	1.78	2.3	2.04
T_{11}	105,424	151,429	128,427	2.32	2.91	2.62
T_{12}	132,002	145,807	138,905	2.4	2.63	2.52
T_{13}	92,088	110,593	101,341	1.92	2.34	2.13
CD	-	-		0.04	0.01	

Summary

The results of the present study revealed that the integration of organic sources of nutrients with urea gave the highest yield and strengthens the concept of an integrated plant nutrient management system. It is inferred from this study that application of NC + urea in 1:1 or 2:1 ratios can be considered as economically viable options although an adequate total N rate is critical. The appropriate substitution ratio would be dependent on the regional availability of the source. BC-SA

Dr. Usha Thomas is Assistant Professor, Department of Agronomy, Dr. Chandini, Dr. Kumar, and Dr. Allan Thomas are scientific staff working at College of Agriculture, Vellayani, Thiruvananthapuram, Kerala. Dr. T. Satyanarayana is Deputy Director, IPNI South Asia Programme, South India and Sri Lanka, located at Secunderabad; e-mail: tsatya@ipni.net.

References

Chandini, S. 1989. PhD Thesis, Kerala Agricultural University, Thrissur. p.130.
Debanath, P.K., K. Sengupta, C. Sengupta, and B.N. Chatterjee. 1985. Indian Fmg 25 (7):22-23.
Maiti, S.A.S., K. Kadam, L.K. Sengupta, J.N. Punekar, L. Das, S.R. Biswas, and K.M. Reddy. 1995. J. Pln. Crops 23:122-125.
Mandal, B.K., S.K. Choudhuri, K. Sengupta, and B. Dasgupta. 1994. Indian J. Agric. Sci. 64:297-301.
Rahman, O., S.H.C. Babu, and S.N. Rao. 1990. J. Agric. Sci. 100:251-253.