Study on different organic sources for yield parameters and insect pest population in betelvine

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Abstract: The study of different organic sources for yield parameters and insect pest population in betelvine revealed that Neem oil cake (2.8t/ha) was found superior for most of the growth and yield characters under study. The gross returns and B: C ratio were observed higher in Neem oil cake (2.8 t/ha). The lowest population of aphid, whitefly, mealy bug, leaf eating (caterpillar/plant), termite and green looper was observed in treatment Neem oil cake (2.8 t/ha) under study. Leaf yield/ha/year showed positive and significant correlation with number of shoot/vine, number of leaves per vine, number of laterals/vine, internodal distance, petiole length, leaf area, L/B ratio and survival percentage at genotypic and phenotypic level, whereas leaf yield/ha/year showed significant positive association with vine length, basal girth of vine, fresh weight of 100 leaves at genotypic level.

Keywords: Organic sources, betel leaf, Insect pest, correlation

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1. Introduction

Betel vine (*Piper betle* Linn.) is an evergreen, perennial, dioecious creeper cultivated mainly in South-East Asian countries, namely, India, Bangladesh, Sri Lanka, Malaysia, Singapore, Thailand, Philippines, Taiwan and Papua New Guinea for its leaves. In India, it is grown on a commercial scale as a cash crop in the states such as Assam, West Bengal, Bihar, Uttar Pradesh, Meghalaya, Orissa, Karnataka, Kerala, Andhra Pradesh, Madhya Pradesh, Tamil Nadu and Tripura. The cultivation of betel vine is known for its greater potential to generate income and employment. The importance of the leaves has been explained in relation to every sphere of human life, including social, cultural, religious, health and even day-to-day life, which is very much relevant even these days.

Organic farming avoids or largely excludes the use of synthetically produced fertilizer, pesticides, growth regulators and livestock feed additives to the maximum extent possible. Responses from betel vine growers and other studies have shown that organic manure in betel leaf is the best source of nutrients, quality and taste as compared to

chemical fertilizers. Farmers are not aware of the nutritional management of betel leaves cultivation that's why betel vine planting is currently not profitable. It is essential to evaluate the various organic manures and select the best combination for proper growth, leaf quality and yield.

2. Materials and Methods

The experiment was carried out in RBD with eight treatments and three replications under Bareja condition at RABL College of Agriculture and Research Station, Chhuikhadan, Dist- Khairagarh-Chhuikhadan-Gandai, Indira Gandhi Krishi Vishwavidyalaya during the year 2021-22. The treatments consist of various organic nutrient sources which were used in the present experiment. i.e. T_1 Karanj oil cake (3.5 t/ha), T_2 Neem oil cake (2.8 t/ha), T_3 Mustard oil cake (2.8 t/ha), T_4 Vermicompost (9.3 t/ha), T_5 Fresh Moringa leaf extract @ 25% dilution (3 spray), T_6 Poultry manure (2.3 t/ha), T_7 Vermi-wash @ 25% dilution (4 spray), and T_8 RDF (NPK::150:100:100 Kg/ha).

The experimental layout was made by preparation of ridges and furrow at a distance of 11m x 9 m by manually. Bareja structure was prepared by bamboo sticks, shade net, roop and khar. The cultivar of betelvine cv. Karapaku (Bangla paan) were used for planting. The total experiment area in Bareja was 99 sqm and the cuttings were planted at a distance of 1m between rows and 20cm between the plants. FYM (20t/ha) was used as a basal dose in each treatment. The observations on growth, yield and quality parameters of the betelvine were recorded by tagging five randomly selected plants leaving the border rows from each treatment and their average values were worked out. The number of incident of insect pest population in vine and soil was also recorded from randomly selected plants from all three replications were counted and mean value of insect were calculated. The collected data on different growth parameters were statistically analysed by adopting the procedures suggested Panse and Sukhatme (1995). Correlation coefficient analysis measures all possible combination between various characters at genotypic (g), phenotypic (p) and environmental levels with the help of formula suggested by Miller *et al*. (1958).

3. Results and Discussion

Data regarding survival percentage has been presented in Table 1. The survival percentage ranged from 61.19-83.16% with an average of 73.24% and recorded significant maximum value (83.16 %) in treatment T_2 Neem oil cake (2.8 t/ha) which was found statistically similar with treatment T_1 Karanj oil cake (3.5 t/ha) (80.08) and T_3 Mustard oil cake (2.8 t/ha) (78.03 %). The maximum survival percentage might be due to neem oil cake and karanj oil cake etc. facilitates cell expansion and elongation, resulting in improved root and shoot development, which promotes and encourages betelvine survival. This has a positive impact on plant health and growth, as it increases the availability of nutrients and assimilates. Similar result obtained by Sivashankara *et al.* (2000). Vine length affects the yield and other important yield contributing traits. The data recorded significant highest vine length (4.71m) in treatment T_2 Neem oil cake (2.8 t/ha), while significantly lowest vine length were found in treatment T_8 RDF (NPK::150:100:100 Kg/ha) of (3.60 m) (Table 1). The increased vine length might be due to enhanced uptake of nutrients from soil resulting in assimilation of carbohydrates and other metabolic activity which led to an increase in various plant

metabolites responsible for vine length. Similar result was also reported by Preethy *et al.* (2016).

The highest number of leaves /vine (79.24) was noted in treatment T_2 Neem oil cake (2.8 t/ha), while lowest number of leaves/ vine (55.61) was observed in treatment T_8 RDF (NPK::150:100:100 Kg/ha). The reason behind use of 100 % organic manure are availability of nutrient elements such as NPK and Ca and Mg, and their interaction is helpful to increase the no. of leaves per vine by activating the enzymatic activities which promotes cell mitosis, division and elongation as also observed by Dasgupta and Sarkar (2017). On other hand, the higher number of shoot/ vine (6.00) was also observed in treatment T_2 Neem oil cake (2.8 t/ha), which was statistically similar with treatment T_1 Karanj oil cake (3.5 t/ha) (5.70), (Table 1). Application of organic manure might increase the uptake of all the plant nutrients and micro nutrient enhance various mechanisms (photosynthesis, cell division) thus, consequently improve plant growth as described by Khattak *et al.* (2011).

Table 1 showed that the highest number of laterals /vine (12.30) was recorded in treatment T_2 Neem oil cake (2.8 t/ha), which was statistically similar with treatment T_1 Karanj oil cake (3.5 t/ha) (11.55), while significant minimum number of laterals/vine (6.45) was noted in treatment T_8 (RDF NPK::150:100:100 Kg/ha). The organic manure plays a predominant role on plant growth and development, as it is a constituent of all proteins and protoplasm of living cells. Organic manure application can stimulate plant vegetative and reproductive growth and cause increased in plant growth due to reasons such as having macro and micronutrients, protease, amylase, cytokinin and auxin as reported by Mahalakshmi *et al.*, (2019).

Table 1: Effect of different organic nutrient sources on various growth parameters.

Tr. No.	Treatments	Survival Percentage	Vine length (m)	No of leaves/vine	Number of shoot/vine	No. of laterals/vine
T_1	Karanj oil cake (3.5 t/ha)	80.08	4.63	68.69	5.70	11.55
T_2	Neem oil cake (2.8 t/ha)	83.16	4.71	79.24	6.00	12.30
T_3	Mustard oil cake (2.8 t/ha)	78.03	4.52	57.66	5.15	10.75
T_4	Vermicompost (9.3 t/ha)	75.12	4.34	67.77	4.40	9.85
T_5	Fresh Moringa leaf extract @25% dilution (3 spray)	67.00	3.80	64.59	3.50	7.50
T_6	Poultry manure (2.3 t/ha)	69.30	4.02	64.31	3.17	8.10
T_7	Vermi-wash @ 25% dilution (4 spray)	72.07	4.20	60.26	4.02	9.08
T_8	RDF (NPK::150:100:100 Kg/ha)	61.19	3.60	55.61	3.00	6.45
SEm (±)		2.52	0.24	2.34		0.24
CD (5%) =		7.63	0.73	7.11		0.72
CV (%) =		5.95	9.82	6.27		9.41

The maximum petiole length (12.00cm) and intermodal distance (6.50cm) was observed in treatment T_2 Neem oil cake (2.8 t/ha) (Table 2). These might be due to effective utilization of growth resources, availability of major nutrients to plants further resulting in elevation of physiological and biochemical processes due to use of organic

manure, which allowed the crop to grow to their higher in intermodal distance. Similar results in China aster were also observed by Bar and Pariari (2020).

Table 2 expressed that the significantly higher value of L/B ratio (1.54) was observed in treatment T_2 Neem oil cake (2.8 t/ha), which was found non-significant with treatment T_1 Karanj oil cake (3.5 t/ha) (1.47) and T_3 Mustard oil cake (2.8 t/ha) (1.36), while the maximum fresh weight of 100 leaves (267.03 g) was noted in treatment T_1 Karanj oil cake (3.5 t/ha). The organic manure fertilizer of soil as evidenced from higher organic C status in organic plots in the present study might have resulted in the formation of stable soil aggregates with the resultant slight increase in fresh weight of 100 leaves in betelvine. Similar result was also reported by the Moutusi *et al*.(2003).

Significant variation was recorded for leaf yield / vine /year and are presented below in Table 2. In the study, the maximum leaf yield/vine/year (63.39) and leaf yield / ha /year (1584733.33) was recorded in treatment T_2 Neem oil cake (2.8 t/ha). Umesha *et al.* (2011) and Hegde *et al.* (2012) observed that the availability of primary and secondary plant nutrient elements such as NPK and Ca and Mg, and their interaction is helpful to increase leaf yield / vine of betelvine and enhanced uptake of nutrients from soil resulting in assimilation of carbohydrates and other metabolic activity which led to an increase in various plant metabolites responsible for leaf yield.

Table 2: Effect of different organic nutrient components on betel leaf yield components.

Tr. No.	Treatments	Petiole length (cm)	Internodal distance (cm)	L/B ratio	Fresh weight of 100 leaves(g)	Leaf yield / vine /year (on number basis)	Leaf yield / ha /year (on number basis)
T_1	Karanj oil cake (3.5 t/ha)	11.45	6.35	1.47	267.03	54.95	1373800.00
T_2	Neem oil cake (2.8 t/ha)	12.00	6.50	1.54	255.00	63.39	1584733.33
T_3	Mustard oil cake (2.8 t/ha)	10.60	6.20	1.36	250.00	46.13	1153200.00
T_4	Vermicompost (9.3 t/ha)	9.70	6.05	1.29	248.10	54.22	1355400.00
T_5	Fresh Moringa leaf extract @ 25% dilution (3 spray)	8.00	5.00	0.99	235.00	51.67	1291733.33
T_6	Poultry manure (2.3 t/ha)	8.40	5.30	1.05	240.15	51.45	1286200.00
T_7	Vermi-wash @ 25% dilution (4 spray)	9.00	5.80	1.16	242.00	48.21	1205200.00
T_8	RDF (NPK::150:100:100 Kg/ha)	6.50	4.50	0.72	225.00	44.49	1112133.33
SEm (±)		0.37	0.19	0.06	7.26	1.87	46882.26
CD (5%) =		1.12	0.58	0.18	22.03	5.69	142202.64
CV (%) =		6.74	5.78	8.69	5.13	6.27	6.27

Economics is the most important aspect of any research upon which the recommendation depends and tests the feasibility of the technology. Until and unless a farmer is well convinced about a purposeful gain from a particular package of practices, he would not be willing to adopt the same. The data pertaining to cost of cultivation (Rs. ha^{-1}), gross return (Rs. ha^{-1}), net return (Rs. ha^{-1}) and B: C ratio as affected by different treatments presented in Table 3. The maximum total cost of cultivation Rs 492991.60 ha^{-1} were calculated for treatment T_1 Karanj oil cake (3.5 t/ha) followed by T_3 Mustard oil cake (2.8 t/ha) (464991.60) and highest gross return Rs 1584733.33 ha^{-1} was obtained in treatment T_2

Neem oil cake (2.8 t/ha) followed by Rs 1373800.00ha^{-1} obtained in T_1 Karanj oil cake (3.5 t/ha). On other hands, the highest net return Rs 923741.73 ha^{-1} was obtained in treatment T_5 Fresh Moringa leaf extract at 25% dilution (3 spray) followed by Rs 910208.40 ha^{-1} obtained in T_6 Poultry manure (2.3 t/ha). Data revealed that highest B:C Ratio 2.63 was obtained in treatment T_2 Neem oil cake (2.8 t/ha) followed by 2.51 obtained in T_5 Fresh Moringa leaf extract at 25% dilution (3 spray).

Table 3: Assessment of Benefit: Cost ratio among different organic manures

Tr. No.	Treatments	Cost of cultivation	Leaf yield / ha / year	Gross return (Rs/ha)	Net return (Rs/ha)	B:C ratio
T_1	Karanj oil cake (3.5 t/ha)	492991.60	1373800.00	1373800.00	880808.40	1.79
T_2	Neem oil cake (2.8 t/ha)	436991.60	1584733.33	1584733.33	1147741.73	2.63
T_3	Mustard oil cake (2.8 t/ha)	464991.60	1153200.00	1153200.00	688208.40	1.48
T_4	Vermicompost (9.3 t/ha)	445991.60	1355400.00	1355400.00	909408.40	2.04
T_5	Fresh Moringa leaf extract @ 25% dilution (3 spray)	367991.60	1291733.33	1291733.33	923741.73	2.51
T_6	Poultry manure (2.3 t/ha)	375991.60	1286200.00	1286200.00	910208.40	2.42
T_7	Vermi-wash @ 25% dilution (4 spray)	392991.60	1205200.00	1205200.00	812208.40	2.07
T_8	RDF(NPK::150:100:100 Kg/ha)	362576.60	1112133.33	1112133.33	749556.73	2.07

Selling Price = Rs. 1.00 /leaf

Results pertaining to the studies on the incidence of major and minor insect pest in betelvine observed during different standard with respect to average data have been presented in Table 4. The lowest population of aphid (3 leaves/plant) (1.33), whitefly (no./plant) (1.56), mealy bug (colonies/ vine) (2.78), leaf eating (caterpillar/plant) (0.70), termite(workers /plant) (1.24) and population of green looper (upper leaves/plant) (0.84) was observed in treatment T_2 Neem oil cake (2.8 t/ha) under study.

Table 4: Insect pests population on different treatments in betel vine during 2021-22

Tr. No.	Treatments	Insect pest population (overall mean)					
		Aphid (3 leaves/plant)	Whitefly (No./plant)	Mealy Bug (colonies/vine)	Leaf Eating (Caterpillar/ plant)	Termite (Workers /plant)	Green Looper (upper leaves/ plant)
T_1	Karanj oil cake (3.5 t/ha)	2.67 (9.29)	3.00 (9.96)	2.56 (9.02)	1.09 (5.93)	2.00 (8.06)	1.34 (6.50)
T_2	Neem oil cake (2.8 t/ha)	1.33 (6.40)	1.56 (6.96)	2.78 (9.48)	0.70 (4.68)	1.24 (6.27)	0.84 (5.20)
T_3	Mustard oil cake (2.8 t/ha)	2.22 (8.34)	3.67 (11.04)	4.33 (11.97)	1.56 (7.16)	3.18 (10.25)	1.62 (7.23)
T_4	Vermicompost (9.3 t/ha)	4.33 (11.92)	3.33 (10.41)	4.56 (12.27)	1.94 (7.97)	3.18 (9.85)	1.88 (7.86)
T_5	Fresh Moringa leaf extract at 25% dilution (3 spray)	4.33 (12.00)	3.22 (10.21)	4.33 (11.93)	2.00 (8.09)	1.93 (7.96)	2.00 (7.97)
T_6	Poultry manure (2.3 t/ha)	4.66 (12.45)	2.66 (9.35)	3.89 (11.34)	2.77 (9.57)	3.26 (10.38)	1.75 (7.51)
T_7	Vermi-wash at 25% dilution (4spray)	3.22 (10.21)	3.66 (11.01)	5.67 (13.72)	2.22 (8.54)	3.03 (9.96)	2.04 (8.01)
T_8	Control (NPK::150:100:100 Kg/ha)	3.89 (11.15)	3.44 (10.69)	5.00 (12.89)	3.09 (10.11)	4.33 (12.00)	2.87 (9.65)
	CD (5%) =	2.14	N/A	0.89	0.68	1.63	N/A
	SEm (±)	0.70	0.43	0.29	0.22	0.53	0.43
	SEd (±)	0.99	0.61	0.41	0.31	0.75	0.61
	CV (%)	36.28	24.18	12.19	19.98	33.35	41.39

All possible phenotypic and genotypic correlation coefficient between leaf yield and its components was calculated and is given in (Table 5). For most of the characters genotypic correlation coefficient was found higher than phenotypic correlation coefficient indicating a strong inherent association among various characters. Similar findings were observed by Mohanty (2003) and Singh (2009). Leaf yield/ha/year showed positive and significant correlation with number of shoot/vine (0.736 and 0.570), number of leaves per vine (1.00 and 1.00), number of laterals/vine (0.699 and 0.629), internodal distance (0.694 and 0.469), petiole length (0.780 and 0.558), leaf area (0.732 and 0.690), L/B ratio (0.699 and 0.684) and survival percentage (0.813 and 0.496) at genotypic and phenotypic level. On other hand leaf yield/ha/year showed significant positive association with vine length (0.943), basal girth of vine (0.957), fresh weight of 100 leaves (0.820) at genotypic level.

Table 5: Genotypic and phenotypic correlation coefficients between different

		VL	NSPV	NLPV	BGV	NOLPV	ID	PL	LA	FW100L	LBR	LY
SP	P	0.797**	0.919**	0.496*	0.946**	0.865**	0.971**	0.964**	0.851**	0.790**	0.802**	0.496*
	G	1.210**	1.016**	0.813**	1.074**	1.080**	0.994**	1.019**	1.079**	1.064**	1.123**	0.813**
VL	P		0.762**	0.295	0.763**	0.695**	0.765**	0.812**	0.727**	0.537**	0.688**	0.295
	G		1.197**	0.943**	1.311**	1.297**	1.233**	1.184**	1.246**	1.441**	1.296**	0.943**
NSPV	P			0.570**	0.844**	0.965**	0.902**	0.956**	0.957**	0.683**	0.875**	0.570**
	G			0.736**	1.143**	1.004**	0.959**	1.008**	1.016**	1.155**	1.020**	0.736**
NLPV	P				0.343	0.629**	0.469*	0.558**	0.690**	0.382	0.684**	1.000**
	G				0.957**	0.699**	0.694**	0.780**	0.732**	0.820**	0.699**	1.000**
BGV	P					0.741**	0.916**	0.883**	0.749**	0.712**	0.676**	0.343
	G					1.265**	1.086**	1.134**	1.242**	1.201**	1.313**	0.957**
NOLPV	P						0.883**	0.915**	0.970**	0.658**	0.913**	0.629**

	G						1.031**	1.041**	1.011**	1.178**	1.031**	0.699**
ID	P							0.951**	0.863**	0.786**	0.836**	0.469*
	G							0.982**	1.015**	1.054**	1.075**	0.694**
PL	P								0.919**	0.786**	0.884**	0.558**
	G								1.041**	1.095**	1.055**	0.780**
LA	P									0.616**	0.951**	0.690**
	G									1.231**	1.003**	0.732**
FW100L	P										0.591**	0.382
	G										1.257**	0.820**
LBR	P											0.684**
	G											0.699**

*5% level of significant
**1% level of significant
SP-Survival percentage
PL-Petiole length(cm)
VL-Vine length (m)
LA-Leaf area(cm^2)
NSPV-Number of shoot/vine
FW100L-Fresh weight of 100 leaves(g)
NLPV-Number of leaves per vine
LBR-L/B ratio
BGV-Basal girth of vine(mm)
LY-Leaf yield/ha/year
NOLPV-Number of laterals/vine
ID-Internodal distance(cm)

4. Conclusion

The growth and yield parameters were found significantly superior in treatment Neem oil cake (2.8t/ha) for most of the characters *i.e.* survival percentage, vine length, number of shoot/vine, no. of leaves /vine, basal girth of vine, no. of laterals /vine, internodal distance, petiole length, leaf area, fresh weight of 100 leaves, leaf yield / vine /year, leaf yield / ha /year and L/B ratio. The cost of cultivation, gross returns, net returns and B: C ratio were found maximum in treatment T_1 Karanj oil cake (3.5 t/ha), T_2 Neem oil cake (2.8 t/ha), T_5 (Fresh Moringa leaf extract @ 25% dilution (3 spray) and T_2 Neem oil cake (2.8 t/ha) respectively.

The lowest population of aphid (3 leaves/plant) (1.33), whitefly (no./plant) (1.56), mealy bug (colonies/ vine) (2.78), leaf eating (caterpillar / plant) (0.70) , termite(workers /plant) (1.24) and population of green looper (upper leaves/plant) (0.84) was observed in treatment T_2 Neem oil cake (2.8 t/ha) under study. Leaf yield/ha/year showed positive and significant correlation with number of shoot/vine (0.736 and 0.570), number of leaves per vine (1.00 and 1.00), number of laterals/vine (0.699 and 0.629), internodal distance (0.694 and 0.469), petiole length (0.780 and 0.558), leaf area (0.732 and 0.690), L/B ratio (0.699 and 0.684) and survival percentage (0.813 and 0.496) at genotypic and phenotypic level, whereas leaf yield/ha/year showed significant positive association with vine length (0.943), basal girth of vine (0.957), fresh weight of 100 leaves (0.820) at genotypic level.

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References

[1] Bar A, Pariari A 2020. Evaluation of integrated nitrogen management on vine and leaf characters of betel vine (*Piper betle* L.) cultivars in new alluvial zone of West Bengal. Journal of Pharmacognosy and Phytochemistry. 9(3): 2192-2196.

[2] Dasgupta B, Sarkar S 2017. Changes in crop canopy architecture on the incidence of major foliar diseases of betelvine (*Piper betle* L.). Journal of Applied Horticulture. 19(2): 135-138.

[3]Dutta B, Bandyopadhyay AK, Sultana S, Mondal A, Rudra BC, Das G 2020. The effects of biofertilizers, organic and inorganic nutrient sources on growth parameters and yield of *Piper betle* L. (Betlevine) under Gangetic alluvial soil of West Bengal. International Journal of Plant & Soil Science. 32(6): 90-95.

[4]Hedge NK, Patil S, Shasidar, VS 2012. Effect of organic nutrition on the performance of Betel vine (*Piper betle* L.). Indian Journal of Agricultural Sciences. 42: 367 – 397.

[5]Khattak A, Izahar A, NA Fazal W, Habib R 2011. Effect of different amended organic media on the growth and development of *vanica rosea* 'victory'. Sarhad Journal Agriculture. 27(2): 201-205.

[6] Mahalakshmi M, Chitra R, Jansi Rani P, Janaki D 2019. Effect of organic manures and nutrients on growth and yield of betelvine (*Piper betle* L.). International Journal of Chemical Studies.7(3): 288-291.

[7] Miller PJ, Willianis JC, Robinson HF, Comostock RE 1958. Estimates of genotypic and environmental variance and covariance in upland cotton and their implication in selection. Agronomy Journal. 50: 126-131.

[8] Mohanty BK 2003. Variability, heritability, correlation and path coefficient studies in tomato. Indian Journal of Agricultural Research. 37(1): 68-71.

[9] Moutusi Dey, Pariari A, Sharangi AB, Chatteijee R 2003. Response of different nitrogen sources on growth and yield of betelvine *(Piper betle* L). South Indian Horticulture. 51(1/6): 244-248.

[10] Panse VG, Sukhatme PV 1995. Statistical Methods for Agricultural Workers. ICAR, New Delhi.

[11] Preethy TT, Aswathi KK, Nisha Jayarajan Mannambeth, Asha V Pillai 2016. Spectrum of variation in land races of different Morphological characters of betel vine. International Journal of Current Research. 8(03): 28164-208170.

[12] Singh AK 2009. Genetic variability, heritability and genetic advance studies in tomato under cold arid region of Ladakh. Indian Journal of Horticulture. 66(3): 400-403.

[13] Shivashankara KS, Mithila J, Satyabrata Maiti 2000. A new method of vegetative propagation in betelvine. Journal of Plantation Crops. 28:91-98.

[14] Umesha K, Murthy G, Smita GR 2011. Environmental conditions and type of cuttings on rooting and growth of vanilla (*Vanilla planifolia* Andrews). Journal of Tropical Agriculture. 49(1-2): 121-123.