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Evaluation of integrated nitrogen management on vine and leaf characters of betel vine (*Piper betle* L.) cultivars in new alluvial zone of West Bengal

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Abstract
The present study was executed to identify the suitable integrated nitrogen management on vine growth and leaf characters of betel vine (*Piper betle* L.) *cv*. Simurali Deshi, Simurali Bhabna and Halisahar Sanchi in new alluvial zone of West Bengal. The experiment was laid out in Randomized Block Design, replicated thrice with eight treatments of integrated nitrogen management. It was noted that treatments in combination with inorganic and organic sources of nitrogen produced better results than the treatments with sole application of organic source of nitrogen. Application of 100% recommended dose of nitrogen (200 kg/ha) in the form of mustard oil cake and urea in equal proportion (1:1) recorded the highest vine growth (273.57 cm/ year) in Simurali Deshi, leaf petiole length (8.04 cm) in Simurali Bhabna, intermodal length (4.88 cm) in Halisahar Sanchi, number of branches per vine (11.43) in Simurali Bhabna, leaf length (12.24 cm) in Simurali Bhabna, leaf breadth (10.05 cm) in Halisahar Sanchi, leaf area (106.34 cm^2) in Halisahar followed by application of nitrogen from cow dung manure and urea in 1:1 ratio (T_2).

Keywords: Simurali deshi, simurali bhabna, halisahar sanchi, mustard oil cake, cow dung manure, poultry manure, pond silt, urea

Introduction
The betel vine is an important medicinal and recreational plant in Southeast Asia. It is an evergreen, perennial climber with glossy heart shaped leaves which grows in tropics and subtropics. It is a member of *Piperaceae* family and its origin is in central and eastern Malaysia. Betel leaves are cultivated in the states of Assam, Andhra Pradesh, Bihar, Gujarat, Odisha, Karnataka, Madhya Pradesh, Rajasthan, West Bengal and Maharashtra. The guests are offered betel morsels (pan-supari) in the Indian subcontinent as a common courtesy. The betel leaves are mainly used for mastication purpose. Betel leaf stalk extract is found potent antimicrobial agent (Chanda *et al*., 2013) [3]. It is cultivated in an area of about 55000 ha in India providing livelihood to millions of people (Guha, 2006) [5]. It is a perennial source of employment (Prasad *et al*., 2003) [7]. India has exported 13195.43 MT of Betel Leaves to the world for the worth of Rs. 46.75 crores/ 6.74 USD Millions in 2018-19 (APEDA agriXchange) [1]. Since the green leaves constitute the economically relevant part of the plant, the nitrogen requirement of the crop is quite high (Saikia *et al*., 1995) [9]. In India most of the betel vine growers apply large amounts of organic manures mainly in the form of mustard oil cake (Sarkar *et al*., 1986) [10]. Lack of soil moisture (drought), insufficient water supply, occurrence of natural calamities, disease and pest attack, non-availability of skilled labour, high labour cost, lack of storage facilities, transportation facilities, large number of intermediaries, lack of export promotional activities etc. are some constraints of betel vine cultivation (Sahoo *et al*., 2017, Suranse and Bhople, 2004,) [8, 12]. Use of integrated nitrogen management with balanced organic and inorganic nitrogen sources can provide cost effective and environment friendly production tool. This present study assesses the effect of different integrated nitrogen management treatments in betel vine (*Piper betle* L.) cultivars in new alluvial zone of West Bengal.

Materials and Methods
The field experiment was carried out at Horticulture Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal. The experiment was laid out in Rnadomized Block Design, replicated thrice. Three cultivars of betelvine namely Simurali Deshi (V_1), Simurali Bhabna (V_2) and Halisahar Sanchi (V_3) were used. The eight treatments of integrated nitrogen management *viz.*, T_1 = Mustard oil cake (50%) + Urea (50%), T_2 = Cow

dung manure (50%) + Urea (50%), T_3 = Poultry manure (50%) + Urea (50%), T_4 = Pond silt (50%) + Urea (50%), T_5 = Mustard oil cake (100%), T_6 = Cow dung manure (100%), T_7 = Poultry manure (100%) and T_8 = Pond silt (100%). The soil of the experimental site is sandy loam in texture having good drainage and water holding capacity and slightly acidic in nature and moderate soil fertility status. Recommended dose of fertilizers for betel vine is 200:100:100 kg NPK/ha, N applied in the form of urea, mustard oil cake, cow dung manure, poultry manure and pond silt, P_2O_5 applied in the form of single super phosphate and K_2O applied in the form of sulphate of potash. In all the nitrogen sources P_20_5@ 100 kg/ ha and K_20 @ 100 kg/ ha were applied from inorganic sources during April considering the amount present in the respective organic manures to be applied. Then different combinations of nitrogenous fertilizer were applied in different nitrogen sources in three split doses during April, July and September. Vine characters *viz.,* vine length was recorded at monthly interval, number of branches/vine/year was counted at a regular interval as the total number of branches emerged out from the main vine of the plant throughout the year and all the branches were removed immediately leaving the main stem to maintain the uniformity of growth and internodal length were measured in centimetre (cm) during the peak period of growth *i.e.* July to September with the help of a measuring scale. Leaf characters *viz.,* leaf length, leaf breadth, and internodal length were recorded during July to September with the help of measuring scale. Leaf area was recorded using Licor electronic portable leaf area meter.

Results and Discussions

Vine growth characters

Data presented in table-1, showed that the application of nitrogen from mustard oil cake and urea in 1:1 ratio (T_1) produced highest increment in vine length throughout the growing period in all the three cultivars with the values of 273.57 cm in Simurali Deshi (V_1), 265.86 cm Simurali Bhabna (V_2) and 254.63 cm in Halisahar Sanchi (V_3). The lowest increment in vine length were observed 183.51 cm in Simurali Deshi (V_1), 179.43 cm in Simurali Bhabna (V_2) and 168.97 cm in Halisahar Sanchi (V_3) when 100% nitrogen was applied from Pond silt. In relation to increment in vine length/ year Simurali Deshi (V_1) performed the best (221.54 cm) followed by Simurali Bhabna (V_2) (211.39 cm) and Halisahar Sanchi (V_3) (201.09 cm). The best performance (264.69 cm) was shown with the application of nitrogen from mustard oil cake and urea at 1: 1 ratio. Saikia *et al.,* (1995) [9] and Maiti *et al.,* (1995) [6] reported highest vine length with application of 200 kg nitrogen/ hectare in the form of mustard oil cake and urea (1:1). Dey *et al.* (2003) [4] also found that highest increment of vine/ month (24.80cm) was recorded with mustard oil cake+ urea at 1: 1 ratio. Nitrogen being the main constituent of protein and nucleic acid, which greatly influences the cell division, cell elongation and cell enlargement and thereby it could increase the vine length. The reason for better growth and development under this treatment could be attributed to increased availability of nitrogen to the plants initially through inorganic fertilizer and later by organic sources *i.e.* mustard oil cake, matching to the need of plants throughout the cropping season.

Combination of mustard oil cake (50%) and urea (50%) produced maximum number of branches (11.44 branches/ vine/ year) in Simurali Bhabna (V_2) followed by Simurali Deshi (V_1) (10.83 branches/ vine/ year) and Halisahar Sanchi (V_3) (9.36 branches/ plant/ year) and lowest number of branches/ vine were produced in Halisahar Sanchi (V_3) (5.46 branches/ vine/ year) from T_8 *i.e.* pond silt (100%). All-over among the cultivars Simurali Bhabna (V_2) produced highest (7.35 branches/vine/ year) numbers of branches followed by Simurali Deshi (V_1) (7.01 branches/ vine/ year) and Halisahar Sanchi (V_3) (6.91 branches/ vine/ year). Overall performance of branch production was better when nitrogen was supplied as a combination of mustard oil cake (50%) and urea (50%). Dey *et al.,* (2003) [4] reported that mustard oil cake 50% + urea 50% found to be superior to produce maximum number (12.62) of branches/ plant.

Mustard oil cake 50% + urea 50% (T_1) was found to be superior for maximum internodal length resulting 4.88 cm in Halisahar Sanchi (V_3), 4.44 cm in Simurali Bhabna (V_2) and 4.36 cm in Simurali Deshi (V_1). The lowest internodal length of 4.22 cm in Simurali Deshi (V_1), 4.25 cm in Simurali Bhabna (V_2) and 4.69 cm in Halisahar Sanchi (V_3) was obtained with pond silt 100% (T_8). Among all varieties Halisahar Sanchi (V_3) showed the highest internodal length of 4.77 cm and mustard oil cake 50% + urea 50% (T_1) obtained the best result (4.56 cm) among all the treatments. Dey *et al.,* (2003) [4] reported that maximum internodal length (5.17 cm) was observed in treatment receiving 50% mustard oil cake + 50% urea. Sengupta *et al.,* (2004) [11] also recorded maximum (5.54 cm) internodal length with the application of mustard oil cake + urea at 1: 1 ratio.

The reason behind those observations may be that urea hastened decomposition of mustard oil cake by providing a part to the microorganism to mobilize nitrogen slowly and progressively from the organic sources. This promoted to attain faster growth rate at early period, which reflected on overall impact of vine and leaf yield. The application of organic manures and inorganic fertilizers in combination lowered the C: N ratio thereby favoring microbial decomposition which in turn contributed to the higher uptake of nitrogen along with other nutrients, leading to higher level of photosynthetic pigments. This resulted in higher vegetative growth and ultimately higher leaf yield (Arulmozahiyan *et al.,* 1998; Dey *et al.,* 2003) [2, 4].

Leaf characters

The data in table-2, indicated that the combination of mustard oil cake (50%) and urea (50%) produced highest leaf length in Simurali Bhabna (V_2) (12.24 cm) followed by Halisahar Sanchi (V_3) (12.11 cm) and Simurali Deshi (V_1) (11.84 cm). Application of cowdung manures (50%) + urea (50%) resulted 12.04 cm, 12.02 cm and 11.64 cm leaf length from Simurali Bhabna (V_2), Halisahar Sanchi (V_3) and Simurali Deshi (V_1) respectively. Lowest size leaf length was observed when nitrogen was applied in the form of pond silt (100%) and the leaf lengths were 10.44 cm in Simurali Deshi (V_1), 10.96 cm in Halisahar Sanchi (V_3) and 11.03 cm in Simurali Bhabna (V_2). Among the three cultivars, highest leaf length was found in Simurali Bhabna (V_2, 11.64 cm) followed by Halisahar Sanchi (V_3, 11.55 cm) and Simurali Deshi (V_1, 11.26 cm). Similar results also reported by Dey *et al.* (2003) [4].

Mustard oil cake (50%) + urea (50%) is one of the treatment combination which produced maximum leaf breadth in Halisahar Sanchi (V_3) (10.05 cm), Simurali Bhabna (V_2) (8.86 cm) and Simurali Deshi (V_1) (8.34 cm) while minimum leaf breadth was produced with pond silt (100%) as nitrogen sources and the values were of 7.43 cm in Simurali Deshi (V_1), 7.88 cm in Simurali Bhabna (V_2) and 8.94 cm in

Halisahar Sanchi (V_3). Among the cultivars, Halisahar Sanchi (V_3) produced maximum leaf breadth (9.41 cm). Among all of the treatment combinations, highest leaf breadth (9.08 cm) was found from mustard oil cake (50%) and urea (50%). Dey *et al.* (2003) [4], has reported that there was a very little significant variation among different nitrogen sources though Oil cake 50% + Urea 50% (T_5) produced highest leaf breadth.

Maximum leaf area (106.34 cm^2) was observed in T_1 receiving nitrogen from 50% mustard oil cake and 50% urea in Halisahar Sanchi (V_3), in Simurali Deshi (V_1) it was 105.64 cm^2 and in Simurali Bhabna (V_2) it was 100.09 cm^2; while in T_8 (pond silt 100%) minimum leaf area was found in Simurali Bhabna (V_2) 92.29 cm^2, in Simurali Deshi (V_1) 95.91 cm^2 and in Halisahar Sanchi (V_3) it was 96.59 cm^2. Among the cultivars Simurali Deshi (V_1) showed a leaf area of 98.11 cm^2, Simurali Bhabna (V_2) of 98.43 cm^2 and in Halisahar Sanchi (V_3) it was 99.46 cm^2 and overall highest leaf area (104.03 cm^2) was found with mustard oil cake (50%) and urea (50%). The results regarding this character in this experiment indicates that different sources of nitrogen have effect on leaf area of betelvine but there were no significant variations in case of cultivars and that may be due to the genetical effect. In an experiment Dey *et al.* [4] in 2003 also observed that maximum leaf area (107.93 cm^2) was exhibited by mustard oil cake 50% and urea 50% as nitrogen source. Increased growth could be correlated to suitable combination of organic and inorganic source of nutrients *i.e.* combination of mustard oil cake and urea (T_1) which ensured readily availability of nutrients for initial requirement through inorganic source and slow pace as long term availability through organic source.

Mustard oil cake 50% + Urea 50% (T_1) was found to be the best resulting 8.04 cm in Simurali Bhabna (V_2) and 7.74 cm in Halisahar Sanchi (V_3), 4.99 cm in Simurali Deshi (V_1) in production of petiole length. The lowest petiole length of 4.34 cm in Simurali Deshi (V_1), 7.46 cm in Simurali Bhabna (V_2) and 7.08 cm in Halisahar Sanchi (V_3) was obtained with application of poultry manure as nitrogen source 100% (T_7). The overall result showed that the maximum petiole length (6.92 cm) was obtained with application of mustard oil cake (50%) and urea (50%) and minimum petiole length (6.29 cm) was obtained when 100% nitrogen was applied from poultry manure. Among the cultivars, Simurali Bhabna (V_2) produced maximum petiole length of 7.79 cm and Simurali Deshi (V_1) produced minimum petiole length of 4.66 cm. Dey *et al.* (2003) [4] also found that, Mustard oil cake 50% + Urea 50% to be superior for petiole length resulting 9.25 cm in Bangla, 8.93 cm in Aima and 5.89 cm in Haldia. In another experiment Sengupta *et al.*, (2004) [11] recorded maximum (5.54cm) petiole length with the application of mustard oil cake + urea at 1: 1 ratio.

Maximum leaf growth was recorded when organic and inorganic nitrogen was applied in equal proportion. This might be due to maximum utilization of nitrogen from inorganic and organic sources. Urea is a water soluble fertilizer, and prone to high leachability in the soil. Therefore, if nitrogen was applied fully through urea, then leaching loss was more and plants could not utilize nitrogen totally. On the other hand, the utilization of nitrogen was found better when it was applied with a combination from both the sources. Although on the basis of content and utilization of nitrogen, organic manures are less efficient than the inorganic fertilizers, combined use of those sources was considered to be superior to use of either organic or inorganic nitrogen alone. The superiority of combination, but nitrogen through inorganic source might be due to added advantage of organic nutrients, which besides supplying all the essential nutrients, also improves physical conditions of soil in respect of granulation, friability, porosity and water holding capacity which enable the crop to utilize nutrients and water more efficiently especially under light textured loamy sand soils (Yadav, 2005) [13].

Table 1: Effect of treatments on vine growth characters of betel vine

Treatments	Vine length (cm)	Number of branch /vine/year	Internodal length (cm)
T_1	264.69	10.543	4.56
T_2	224.17	7.844	4.48
T_3	217.70	6.887	4.51
T_4	209.66	6.573	4.45
T_5	217.52	6.933	4.49
T_6	194.19	6.293	4.45
T_7	185.47	5.851	4.42
T_8	177.30	5.8	4.39
CD	5.493	0.183	0.01
S.Em(±)	1.924	0.064	0.004
V_1	221.54	7.01	4.28
V_2	211.39	7.35	4.36
V_3	201.09	6.91	4.77
CD	3.364	0.112	0.006
S.Em(±)	1.178	0.064	0.002
T_1 V_1	273.57	10.833	4.36
T_2 V_1	232.84	8.107	4.30
T_3 V_1	229.48	6.637	4.32
T_4 V_1	215.89	6.15	4.27
T_5 V_1	227.18	6.587	4.29
T_6 V_1	210.49	5.753	4.28
T_7 V_1	199.31	5.88	4.24
T_8 V_1	183.51	6.14	4.22
T_1 V_2	265.86	11.437	4.44
T_2 V_2	225.99	7.203	4.40
T_3 V_2	212.59	6.733	4.43
T_4 V_2	203.55	6.78	4.38

T_5 V_2	221.94	7.78	4.36
T_6 V_2	196.27	6.89	4.31
T_7 V_2	185.46	6.17	4.30
T_8 V_2	179.43	5.803	4.25
T_1 V_3	254.63	9.36	4.88
T_2 V_3	213.66	8.223	4.76
T_3 V_3	211.02	7.29	4.80
T_4 V_3	209.54	6.79	4.71
T_5 V_3	203.42	6.433	4.82
T_6 V_3	175.82	6.237	4.77
T_7 V_3	171.63	5.503	4.73
T_8 V_3	168.97	5.457	4.70
CD	9.515	0.317	0.018
S.Em(±)	3.332	0.111	0.006

Note: T_1 = Mustard oil cake (50%) + Urea (50%), T_2 = Cow dung manure (50%) + Urea (50%), T_3 = Poultry manure (50%) + Urea (50%), T_4 = Pond silt (50%) + Urea (50%), T_5 = Mustard oil cake (100%), T_6 = Cow dung manure (100%), T_7 = Poultry manure (100%), T_8 = Pond silt (100%), Simurali Deshi (V_1), Simurali Bhabna (V_2) and Halisahar Sanchi (V_3)

Table 2: Effect of treatments on leaf characters of betel vine

Treatments	Leaf length (cm)	Leaf breadth (cm)	Leaf area (cm^2)	Petiole length (cm)
T_1	12.06	9.08	104.03	6.92
T_2	11.90	8.89	99.98	6.79
T_3	11.31	8.50	98.71	6.69
T_4	11.15	8.38	97.34	6.51
T_5	11.96	8.74	98.31	6.80
T_6	11.62	8.55	99.17	6.49
T_7	11.06	8.15	96.88	6.29
T_8	10.81	8.08	94.93	6.41
CD	0.082	0.026	2.46	0.057
S.Em(±)	0.029	0.009	0.862	0.02
V_1	11.26	7.90	98.11	4.66
V_2	11.64	8.33	98.43	7.79
V_3	11.55	9.41	99.46	7.39
CD	0.05	0.016	N/A	0.035
S.Em(±)	0.017	0.006	0.528	0.012
T_1 V_1	11.84	8.34	105.64	4.99
T_2 V_1	11.64	8.24	101.34	4.83
T_3 V_1	11.05	7.98	97.00	4.67
T_4 V_1	10.92	7.83	96.78	4.60
T_5 V_1	11.96	7.96	96.44	4.90
T_6 V_1	11.27	7.93	94.35	4.45
T_7 V_1	10.96	7.46	97.41	4.34
T_8 V_1	10.44	7.43	95.91	4.49
T_1 V_2	12.24	8.86	100.09	8.04
T_2 V_2	12.04	8.68	97.36	7.96
T_3 V_2	11.50	8.24	102.58	7.86
T_4 V_2	11.26	8.20	99.63	7.70
T_5 V_2	12.10	8.50	98.39	7.94
T_6 V_2	11.84	8.37	102.78	7.78
T_7 V_2	11.12	7.93	94.33	7.46
T_8 V_2	11.03	7.88	92.29	7.60
T_1 V_3	12.11	10.05	106.34	7.74
T_2 V_3	12.02	9.74	101.24	7.59
T_3 V_3	11.38	9.28	96.55	7.55
T_4 V_3	11.26	9.10	95.62	7.24
T_5 V_3	11.83	9.77	100.10	7.56
T_6 V_3	11.74	9.34	100.37	7.24
T_7 V_3	11.10	9.05	98.89	7.08
T_8 V_3	10.96	8.94	96.59	7.15
CD	0.141	0.045	4.262	0.098
S.Em(±)	0.049	0.016	1.492	0.034

Note: T_1 = Mustard oil cake (50%) + Urea (50%), T_2 = Cow dung manure (50%) + Urea (50%), T_3 = Poultry manure (50%) + Urea (50%), T_4 = Pond silt (50%) + Urea (50%), T_5 = Mustard oil cake (100%), T_6 = Cow dung manure (100%), T_7 = Poultry manure (100%), T_8 = Pond silt (100%), Simurali Deshi (V_1), Simurali Bhabna (V_2) and Halisahar Sanchi (V_3)

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