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JOURNAL OF SCIENTIFIC ACHIEVEMENTS

VOLUME 2, ISSUE 3, MARCH 2017, PAGE: 13–18

RESEARCH ARTICLE

Impact of Nutrient Management on Yield and Quality of Betel Leaf

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Abstract

The experiment was conducted at Spices Research Centre, Shibganj, Bogra, Bangladesh during kharif season 2013-14 and continued in 2014-15 to determine optimum dose of N, P and K in combination with organic & inorganic source and to assess the effect of N, P and K on the yield and quality of betel leaf. The land was medium high and the soil was silty loam in texture. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Different fertilizer doses viz. N = 0, 50, 100, 150 kg ha^{-1}, P = 0, 22, 44 kg ha^{-1} and K= 0, 21, 42 kg ha^{-1} were considered as treatment. The treatment combinations were $T_1 = N_0P_0K_0$, $T_2 = N_0P_{22}K_{21}$, $T_3 = N_{50}P_{22}K_{21}$, $T_4 = N_{100}P_{22}K_{21}$, $T_5 = N_{150}P_{22}K_{21}$, $T_6 = N_{150}P_{44}K_{21}$, $T_7 = N_{150}P_{44}K_{42}$, $T_8 = N_{100}P_0K_{21}$, $T_9 = N_{100}P_{44}K_{21}$, $T_{10} = N_{100}P_{22}K_0$ and $T_{11} = N_{100}P_{22}K_{42}$. The total amount of N as per treatment was top dressed in 8 equal splits at 45 days' interval. The sources of N were 50% from Urea and 50% from mustard oil cake. Betel leaf advanced line BL-018 was used as a test crop. The highest leaf yield (59000 bira ha^{-1} in 2013-14 & 142200 bira ha^{-1} in 2014-15) was obtained from the treatment $T_{11} = N_{100}P_{22}K_{42}$ which was identical to $T_9 = N_{100}P_{44}K_{21}$ (55370 bira ha^{-1} in 2013-14 & 123500 bira ha^{-1} in 2014-15) and $T_4 = N_{100}P_{22}K_{21}$ (51590 bira ha^{-1} in 2013-14 & 120600 bira ha^{-1} in 2014-15). The lowest leaf yield (26030 bira ha^{-1} in 2013-14 & 57090 bira ha^{-1} in 2014-15) was recorded from $T_1 = N_0P_0K_0$ (1 bira= 80 leaves). It was concluded that $N_{100}P_{22}K_{42}$, $N_{100}P_{44}K_{21}$ and $N_{100}P_{22}K_{21}$ kg ha^{-1}may be the good alternative for betel leaf cultivation where 50% N was supplied from urea and 50% from mustard oil cake. Among them $N_{100}P_{22}K_{42}$ kg ha^{-1}would be the best due to less disease infestation, higher productivity and higher economic return.

Keywords: Betel leaf, Fertilizer, Organic source, Yield, Quality.

Citation to This Article: Fahim AHF, Naher MS, Wadud MA, Sarker R, Alam MJ. Impact of Nutrient Management on Yield and Quality of Betel Leaf. Journal of Scientific Achievements, Mar 2017; 2 (3): 13-18.

1. INTRODUCTION

The deep green heart shaped leaves of betel vine are popularly known as Paan in Bangladesh. The scientific name of betel vine is *Piper betle* L. It belongs to the family Piperaceae (7). Betel vine is a dioecious (male and female plants are different), shade loving perennial root climber. About 100 varieties of betel vine are found around the world (6, 8, 9). The most probable place of origin of betel vine is Malaysia (2). It is widely cultivated in moist tropical and subtropical regions of Asia and the Pacific, for its leaves which are mainly used for chewing. It is cultivated in small holdings commonly known as Baroj in Bangladesh. The crop demands constant care.

Yield and quality of betel leaf can be increased by proper nutrient management. Moreover, nutrient availability throughout the crop growth period from the applied sources has considerable importance. The crop is usually manured with heavy doses of organic manures especially mustard oil cake in Bangladesh. The farmers are reluctant to use commercial fertilizers as they fear that the quality of the leaves may be affected by the use of fertilizers. The organic manures can be partly replaced by chemical fertilizers without affecting the chewing quality of leaves (1). 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 the experiment was taken to determine the optimum dose of N, P and K in combination with organic and inorganic source and to assess the effect of N, P and K on yield and quality of betel leaf.

2. MATERIALS AND METHODS

This experiment was conducted by establishing a new Baroj in Spices Research Centre, Shibganj, Bogra, Bangladesh during kharif season 2013-14 and continued in 2014-15. The experimental site represents agro-ecological zone (AEZ)-26 recognized as "Level Barind Tract" and situated at 24°51′ North latitude and 89°22 East longitude under Bangladesh (4). The soil of the experimental field belongs to Grey Terrace Soil under AEZ 26. It was developed from Madhupur Clay and silty loam in texture. Organic matter content of the soil was low (1.02%). The soil was acidic in nature (pH 5.7).

At first the land was deeply ploughed and filled with the top soil collected from another source in mid-February, 2013. The additional soil was silty loam in texture. Then the structure of the Baroj was made maintaining row to row distance 60 cm. Each of the rows was 3.5 m long. One bed contained two rows. So that, the area of each bed was 4.2 m^2. The experimental field was laid out in Randomized Complete Block Design (RCBD) with three replications. The pits were made on 11 March, 2013, maintaining 40 cm apart between the centers of two pits. The size of each pit was 20cm × 20cm × 20 cm. The pits were dug and exposed for a week for solarization to destroy soil born insects, pests and pathogens. The pits were fertilized with P and K as per treatment as basal dose with a common dose of cow dung 15 t ha^{-1}. The amount of P and K was calculated by omitting the amount which was supplemented by top dressing of mustard oil cake. No urea was applied as basal dose. Then the applied fertilizers were mixed well with the soil and the pits were filled with that soil mixture.

The cuttings of betel vine were collected from the old Baroj of Spices Research Centre, Shibganj, Bogra, Bangladesh. Betel leaf advanced line BL-018 was used as planting material. The cuttings were planted in the pits in 11 April, 2013 about one month after pit preparation. The pits were irrigated once per day for one month using water cane. Further, no irrigation was given for the consequent year. The total amount of N as per treatments was top dressed in 8 equal split at 45 days' interval (ie. 45, 90, 135, 180, 225, 270, 315 and 360 days after planting). The sources of N were 50% from Urea and 50% from Mustered oil cake. During second year TSP and MOP was top dressed into two equal splits, 1st at the beginning of the year and 2nd was top dressed 6 months after 1st top dress just before earthing up. Different cultural practices such as staking ie. supporting with bamboo sticks, trailing ie. tying of the vine with the support using straw rope and training ie. removal of partial vine were done at 15 to 20 days after lowering of vine.

Harvesting was done when the vines attended about 1.5 to 2 m in height. After harvesting, coiling of vine was done and data on vine length (cm), total number of leaf per bed and leaf weight (g) were taken each time. Twenty leaves per plot were taken from each bed as test sample to measure leaf length (cm), leaf breadth (cm), petiole length (cm), petiole diameter (mm) and moisture content (%). Also data on disease incidence (%), leaf crispiness and pungency were recorded. Four times spray with Ripcord @ 1ml L^{-1} was done for controlling white fly after harvesting during kharif season. Ridomilgold @ 2g L^{-1} was applied three times during the rabi season for controlling vine rot disease during rabi season. The collected data were analyzed by MSTAT-C statistical package and mean values were analyzed by Duncan's Multiple Range test (5).

2.1 Organoleptic test

Leaf crispiness and pungency were recorded by organoleptic test. Twenty people were selected to test the entire sample and their opinions were noted. Crispiness was classified as very crispy, crispy, moderate & low and pungency was classified as very pungent, pungent, moderate & low.

Table 1. Analytical data of the soil used for baroj

Texture	p^H	OM	Ca	Mg	K	Total N	P	S	B	Zn	Cu	Mn	Mo
		%	(meq/100g soil)			%				(µg/g soil)			
Sandy loam	6.0	1.58			1.15	0.08	21.78	5.87	0.09			-	-
Critical level	-	-	2.0	0.8	0.20	-	14	14	0.2	2.0	0.2	1.0	0.1

3. Results and Discussion

3.1. Effects on yield and yield contributing characters

The effect of N, P and K on the yield and yield contributing characters of betel leaf are presented in Table 2. All the parameters except petiole diameter (mm) and inter node distance (cm) varied significantly due to different treatment combination in both the years.

3.1.1. Vine length per year

Vine length per year varied significantly due to different treatment combinations. The longest vine per year was recorded from $N_{100}P_{22}K_{42}$ (4.867m in 2013-14 & 14.34m in 2014-15) which was identical to $N_{100}P_{44}K_{21}$ (4.443m in 2013-14 & 12.76m in 2014-15) and $N_{100}P_{22}K_{21}$ (4.417m in 2013-14 & 12.73m in 2014-15) but differed significantly from other treatments. The shortest vine per year was obtained from $N_0P_0K_0$ (2.317m in 2013-14 & 4.466m in 2014-15), followed by $N_0P_{22}K_{21}$ (2.730m in 2013-14 & 6.699m in 2014-15).

3.1.2. Leaf length

Leaf length was markedly influenced by the treatment combinations during 2013-14 and 2014-15. The longest leaf was recorded from the treatment $N_{100}P_{22}K_{42}$ (15.25 cm in 2013-14 & 17.79 cm in 2014-15) which was identical to $N_{100}P_{44}K_{21}$ (15.10 cm in 2013-14 & 16.33 cm in 2014-15) and $N_{100}P_{22}K_{21}$ (14.62 cm in 2013-14 & 16.23 cm in 2014-15). The shortest leaf was obtained from $N_0P_0K_0$ (8.183 cm in 2013-14 & 4.217 cm in 2014-15) which was identical to $N_0P_{22}K_{21}$ (8.597 cm in 2013-14 & 5.127 cm in 2014-15).

3.1.3. Leaf breadth

Different treatments had significant effect on leaf breadth in both years. The widest leaf was recorded from the treatment $N_{100}P_{22}K_{42}$ (15.59 cm in 2013-14 & 17.45 cm in 2014-15) which was identical to $N_{100}P_{44}K_{21}$ (15.44 cm in 2013-14 & 16.03 cm in 2014-15) and $N_{100}P_{22}K_{21}$ (15.35 cm in 2013-14 & 15.08 cm in 2014-15). The narrowest leaf was obtained from $N_0P_0K_0$ (7.851cm in 2013-14 & 4.787 cm in 2014-15).

3.1.4. Petiole length

Petiole length was varied significantly due to different treatments during 2013-14 & 2014-15. The longest petiole was recorded from the treatment $N_{100}P_{22}K_{42}$ (12.08 cm in 2013-14 & 11.59 cm in 2014-15) which was identical to $N_{100}P_{44}K_{21}$ (12.01 cm in 2013-14 & 11.18 cm in 2014-15) and $N_{100}P_{22}K_{21}$ (11.28 cm in 2013-14 & 9.62 cm in 2014-15). The shortest petiole was obtained from $N_0P_0K_0$ (6.528 cm in 2013-14 & 2.560 cm in 2014-15).

3.1.5. Leaf yield (t ha^{-1})

The highest leaf yield (t ha^{-1}) was recorded from the treatment $N_{100}P_{22}K_{42}$ (9.880 t ha^{-1} in 2013-14 & 19.60 t ha^{-1} in 2014-15) which was identical to $N_{100}P_{44}K_{21}$ (9.510 t ha^{-1} in 2013-14 & 17.09 t ha^{-1} in 2014-15) and $N_{100}P_{22}K_{21}$ (9.217 t ha^{-1} in 2013-14 & 16.58 t ha^{-1} in 2014-15). The lowest leaf yield was obtained from $N_0P_0K_0$ (3.963 t ha^{-1} in 2013-14 & 7.532 t ha^{-1} in 2014-15) followed by $N_0P_{22}K_{21}$ (4.403 t ha^{-1} in 2013-14 & 9.611 t ha^{-1} in 2014-15).

3.1.6. Leaf yield (bira ha^{-1})

Leaf yield (bira ha^{-1}) was markedly influenced by different treatment combinations in both years. The highest leaf yield (bira ha^{-1}) was recorded from treatment $N_{100}P_{22}K_{42}$ (59000 bira ha^{-1} in 2013-14 & 142200 bira ha^{-1} in 2014-15) followed by $N_{100}P_{44}K_{21}$ (55370 bira ha^{-1} in 2013-14 & 123500 bira ha^{-1} in 2014-15) and $N_{100}P_{22}K_{21}$ (51590 bira ha^{-1} in 2013-14 & 120600 bira ha^{-1} in 2014-15). The lowest leaf yield was obtained from $N_0P_0K_0$ (26030 bira ha^{-1} in 2013-14 & 57090 bira ha^{-1} in 2014-15).

Table 2. Effect of N, P and K on the yield and yield contributing characters of betel leaf during 2013-2014 and 2014-15

Treatments	Vine length year^{-1} (m)		Leaf length (cm)		Leaf breadth (cm)		Petiole length (cm)	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
$T_1 = N_0P_0K_0$	2.317 d	4.466 e	8.183 c	4.217 d	7.851 c	4.787 c	6.528 e	2.560 c
$T_2 = N_0P_{22}K_{21}$	2.730 cd	6.699 de	8.597 c	5.127 d	8.183 c	5.753 c	7.093 de	2.620 c
$T_3 = N_{50}P_{22}K_{21}$	3.487 bc	7.567 cd	11.94 b	10.25 bc	11.94 b	10.57 b	8.370 bc	6.340 b
$T_4 = N_{100}P_{22}K_{21}$	4.417 a	12.73 a	14.62 a	16.23 a	15.35 a	15.08 a	11.28 a	9.620 a
$T_5 = N_{150}P_{22}K_{21}$	3.573 b	9.863 bc	12.29 b	11.01 bc	12.29 b	10.65 b	8.693 bc	6.740 b
$T_6 = N_{150}P_{44}K_{21}$	3.607 b	9.936 bc	12.49 b	11.51 bc	12.49 b	11.15 b	8.930 bc	7.047 b
$T_7 = N_{150}P_{44}K_{42}$	3.630 b	10.31 b	12.75 b	12.27 b	12.75 b	11.31 b	9.273 b	7.093 b
$T_8 = N_{100}P_0K_{21}$	3.333 bc	7.644 cd	11.53 b	9.773 c	11.53 b	9.647 b	7.983 cd	6.093 b
$T_9 = N_{100}P_{44}K_{21}$	4.443 a	12.76 a	15.10 a	16.33 a	15.44 a	16.03 a	12.01 a	11.18 a
$T_{10} = N_{100}P_{22}K_0$	3.540 bc	7.813 cd	12.14 b	10.83 bc	12.14 b	10.55 b	8.513 bc	6.720 b
$T_{11} = N_{100}P_{22}K_{42}$	4.867 a	14.34 a	15.25 a	17.79 a	15.59 a	17.45 a	12.08 a	11.59 a
Level of significance	*	**	*	**	*	**	*	**
CV (%)	9.04	10.57	5.41	8.40	8.87	12.09	5.12	13.88

In a column, means followed by the same letter did not differ significantly. 1 bira = 80 leaves, NS = Non significant, * = 5% level of significance, ** = 1% level of significance. 50% N applied from mustard oil cake.

3.2. Effects on leaf quality

The organoleptic test showed that the treatments had marked influence on the quality of betel leaf which is described below.

3.2.1. Crispiness

In case of treatment $N_{100}P_{44}K_{21,}$ 18.18% respondents in 2013-14 and 19.23% respondents in 2014-15 said that leaf was very crispy, 27% in 2013-14 & 30.17% in 2014-15 said crispy, 18.18% in 2013-14 & 20.16% said medium and 36.37 in 2013-14 & 30.44% in

2014-15 said low (Figure 1 & 2). In case of $N_{100}P_{22}K_{42}$, 5.35% respondent in 2014-15 said that the leaf was crispy, 63.64% in 2013-14 & 62.64% in 2014-15 said moderate and 36.36% in 2013-14 & 32.01% in 2014-15 said low. But they did not prefer the leaves collected from $N_0P_0K_0$ (where no fertilizer was applied) due to its low crispiness.

Table 2. Continued

Treatments	Petiole diameter (mm)		Internode distance (cm)		Leaf yield			
					t ha^{-1}		000' bira ha^{-1}	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
$T_1 = N_0P_0K_0$	3.028	3.453	5.910	6.243	3.963 d	7.532 e	26.03 e	57.09 e
$T_2 = N_0P_{22}K_{21}$	3.250	3.539	6.527	5.940	4.403 cd	9.611 de	28.33 de	73.43 de
$T_3 = N_{50}P_{22}K_{21}$	3.160	3.657	5.757	6.590	6.903 b	11.22 cde	32.75 cde	88.60 cd
$T_4 = N_{100}P_{22}K_{21}$	3.190	3.960	5.643	6.010	9.217 a	16.58 ab	51.59 ab	120.60 ab
$T_5 = N_{150}P_{22}K_{21}$	3.400	3.812	5.553	5.837	6.227 b	12.16 cd	36.85 cde	102.90 bc
$T_6 = N_{150}P_{44}K_{21}$	3.447	3.832	6.173	6.203	6.430 b	12.24 cd	38.22 cd	105.60 bc
$T_7 = N_{150}P_{44}K_{42}$	3.647	3.901	6.120	6.153	7.363 b	13.76 bc	42.86 bc	107.40 bc
$T_8 = N_{100}P_0K_{21}$	3.333	3.618	6.363	5.853	5.820 bc	9.613 de	29.95 de	75.78 de
$T_9 = N_{100}P_{44}K_{21}$	3.250	3.726	6.327	6.470	9.510 a	17.09 ab	55.37 a	123.50 ab
$T_{10} = N_{100}P_{22}K_0$	3.487	3.734	6.023	5.923	6.377 b	11.65 cd	36.42 cde	92.64 cd
$T_{11} = N_{100}P_{22}K_{42}$	3.417	3.436	6.437	5.840	9.880 a	19.60 a	59.00 a	142.20 a
Level of significance	NS	NS	NS	NS	*	**	*	**
CV (%)	6.99	6.83	9.32	8.55	9.80	11.86	11.65	9.38

In a column, means followed by the same letter did not differ significantly. 1 bira = 80 leaves, NS = Non significant, * = 5% level of significance, ** = 1% level of significance. 50% N applied from mustard oil cake.

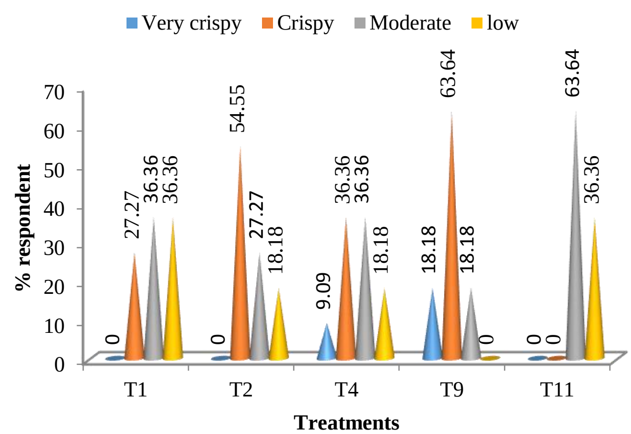


Figure 1. Effect of N, P and K on the crispiness of betel leaf during 2013-2014.

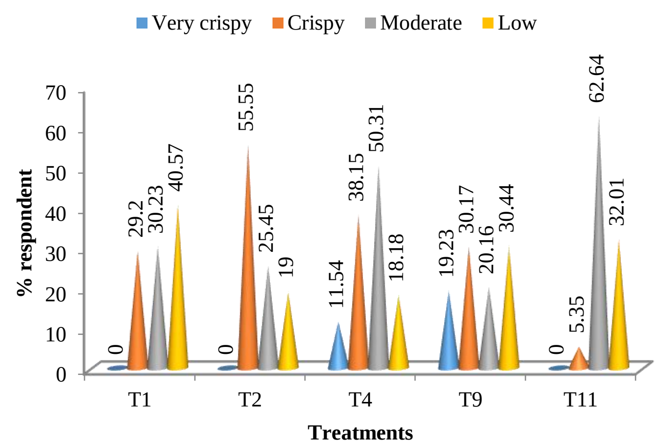
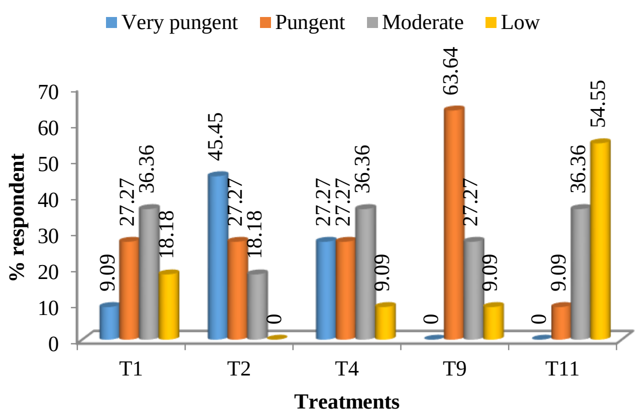
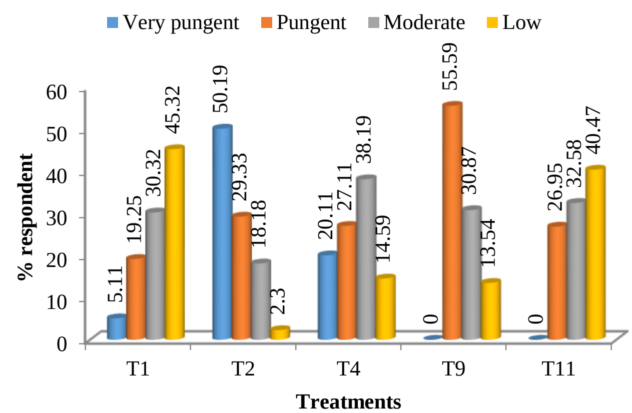


Figure 2. Effect of N, P and K on the crispiness of betel leaf during 2014-2015.

3.2.2. Pungency

In case of treatment $N_{100}P_{44}K_{21}$, 63.64% respondents in 2013-14 & 55.59% respondents in 2014-15 said pungent, 27.27% in 2013-14 & 30.87% in 2014-15 said moderately pungent and 9.09% in 2013-14 & 13.54% in 2014-15 said less pungent. In case of $N_{100}P_{22}K_{42}$, 9.09% in 2013-14 & 26.95% in 2014-15 said pungent, 36.36% in 2013-14 & 32.58% in 2014-15 said moderate and 54.55% in 2013-14 & 40.47% in 2014-15 said low. In case of $N_0P_{22}K_{21}$, it was found that 45.45% respondent in 2013-14 & 50.19% in 2014-15 said very pungent and could not eat at all. It indicates that the application of P and K fertilizer in absence of N increases the leaf pungency.





3.2.3. Leaf moisture content (%)

The treatments had no significant effect on the leaf moisture content (%) in both years (Figure 5 & 6). That means the combine application of organic and inorganic fertilizer does not differ with the leaf moisture content that of the sole application of organic fertilizer.

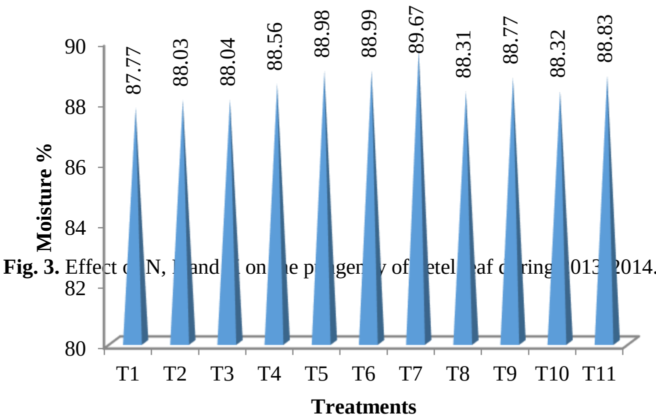


Fig. 5. Effect of N, P and K on the leaf moisture content of betel leaf during 2013-2014.

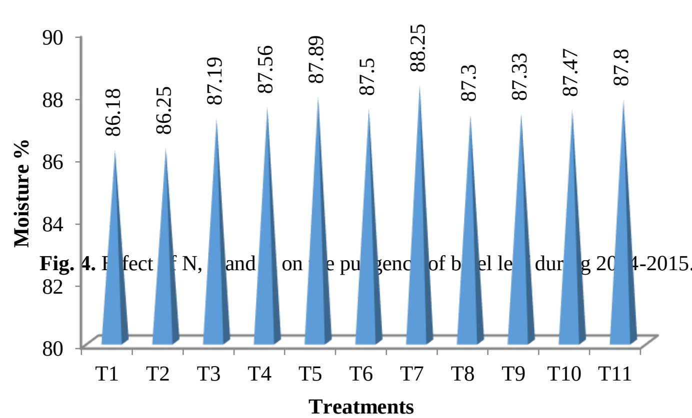


Fig. 6. Effect of N, P and K on the leaf moisture content of betel leaf during 2014-2015.

3.3. Effects on disease incidence

In both years, different treatments had significant effect on percent diseased vine per plot (Table 3). The higher percentage of diseased vine per plot was found in $N_{100}P_{22}K_0$ (39.66% in 2013-14 & 34.48% in 2014-15), followed by $N_0P_0K_0$ (27.38% in 2014-15) and the lower percentage of diseased vine per plot was recorded from $N_{50}P_{22}K_{21}$ (2.30% in 2013-14 & 6.91% in 2014-15) which was identical to $N_{100}P_{22}K_{42}$ (3.86% in 2013-14 & 8.62% in 2014-15) and $N_{100}P_{22}K_{21}$ (4.56% in 2013-14 & 8.28% in 2014-15). Which was statistically differs from other treatments. The data showed that the disease incidence was higher when no fertilizer (especially no K fertilizer) was applied. Perrenoud S. (1990) reported that, K has direct effects on attack severity on host: by effects on the internal metabolism of the plant affecting food supply for the pathogen; by modifying the microclimate through changes in habit, density of growth, etc. The leaf spot (%) and vine rot (%) were found non-significant during the study period.

Table 3. Effect of N, P and K on the disease incidence of betel leaf during 2013-2014 and 2014-15

Treatments	**Diseased vine/ plot (%)**		**% Leaf spot**		**% vine rot**	
	2013-14	**2014-15**	**2013-14**	**2014-15**	**2013-14**	**2014-15**
$T_1 = N_0P_0K_0$	24.61 b	27.38 ab	1.667	6.000	11.20	2.381
$T_2 = N_0P_{22}K_{21}$	15.88 c	21.05 bc	1.333	5.000	4.533	0.9527
$T_3 = N_{50}P_{22}K_{21}$	2.320 h	6.907 e	2.667	4.667	4.267	0.4763
$T_4 = N_{100}P_{22}K_{21}$	4.563 gh	8.620 de	2.000	5.333	5.733	1.905
$T_5 = N_{150}P_{22}K_{21}$	14.22 cd	18.09 c	1.000	3.333	1.467	2.381
$T_6 = N_{150}P_{44}K_{21}$	8.477 ef	15.72 cde	1.000	5.667	5.867	2.381
$T_7 = N_{150}P_{44}K_{42}$	11.85 de	16.66 cd	1.333	3.667	9.700	2.381
$T_8 = N_{100}P_0K_{21}$	14.99 cd	20.00 bc	2.000	6.333	8.400	2.381
$T_9 = N_{100}P_{44}K_{21}$	7.420 fg	15.71 cde	2.667	4.000	15.20	1.429
$T_{10} = N_{100}P_{22}K_0$	39.66 a	34.48 a	4.333	4.000	21.87	1.429
$T_{11} = N_{100}P_{22}K_{42}$	3.860 h	8.283de	4.000	5.333	15.47	0.4763
Level of significant	**	**	NS	NS	NS	NS
CV%	10.82	21.20	92.84	33.85	69.23	81.87

In a column, means followed by the same letter did not differ significantly. NS = Non significant, ** = 1% level of significance.

3.4. Economic performance

The economic performance of different treatment combination of N, P and K are presented in Table 7 and Table 8. The highest gross return (Tk. 885000 ha^{-1} in 2013-14 & Tk. 2133000 ha^{-1} in 2014-15), net return (Tk. 501645 ha^{-1} in 2013-14 & Tk. 1748284 ha^{-1} in 2014-15) and benefit-cost ratio (2.31 in 2013-14 % 5.54 in 2014-15) was obtained from $N_{100}P_{22}K_{42}$, followed by $N_{100}P_{44}K_{21}$ (gross return: Tk. 830550 ha^{-1} in 2013-14 & Tk. 1852500 ha^{-1} in 2014-15, net return: Tk. 445092 ha^{-1} in 2013-14 & Tk. 1465994 ha^{-1} in 2014-15 and benefit-cost ratio: 2.15 in 2013-14 & 4.79 in 2014-15) and $N_{100}P_{22}K_2$ (gross return: Tk. 773850 ha^{-1} in 2013-14 & Tk. 1809000 ha^{-1} in 2014-15, net return: Tk. 391235 ha^{-1} in 2013-14 & Tk. 1424914 ha^{-1} in 2014-15 and benefit-cost ratio: 2.02 in 2013-14 & 4.71 in 2014-15).

The lowest gross return (Tk. 390450 ha^{-1} in 2013-14 & Tk. 856350 ha^{-1} in 2014-15), net return (Tk. 66334 ha^{-1} in 2013-14 and Tk. 522050 ha^{-1} in 2014-15) and benefit-cost ratio (1.20 in 2013-14 & 2.56 in 2014-15) was obtained from $N_0P_0K_0$.

Table 4. Economic performance of different treatment combination of N, P and K on the yield of betel leaf during 2013-2014 and 2014-15

Treatments	Leaf yield (000' bira ha^{-1})		Gross return (Tk. ha^{-1})		Total cultivation cost (Tk. ha^{-1})		Net return (Tk. ha^{-1})		Benefit-cost ratio	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
$T_1 = N_0P_0K_0$	26.03	57.09	390450	856350	324116	334300	66334	522050	1.20	2.56
$T_2 = N_0P_{22}K_{21}$	28.33	73.43	424950	1101450	327700	337350	97250	764100	1.30	3.27
$T_3 = N_{50}P_{22}K_{21}$	32.75	88.60	491250	1329000	355157	360718	136093	968282	1.38	3.68
$T_4 = N_{100}P_{22}K_{21}$	51.59	120.60	773850	1809000	382615	384086	391235	1424914	2.02	4.71
$T_5 = N_{150}P_{22}K_{21}$	36.85	102.90	552750	1543500	410072	407454	142678	1136046	1.35	3.79
$T_6 = N_{150}P_{44}K_{21}$	38.22	105.60	573300	1584000	412916	409874	160384	1174126	1.39	3.86
$T_7 = N_{150}P_{44}K_{42}$	42.86	107.40	642900	1611000	413656	410504	229244	1200496	1.55	3.92
$T_8 = N_{100}P_0K_{21}$	29.95	75.78	449250	1136700	379771	381666	69479	755034	1.18	2.98
$T_9 = N_{100}P_{44}K_{21}$	55.37	123.50	830550	1852500	385458	386506	445092	1465994	2.15	4.79
$T_{10} = N_{100}P_{22}K_0$	36.42	92.64	546300	1389600	381875	383456	164425	1006144	1.43	3.62
$T_{11} = N_{100}P_{22}K_{42}$	59.00	142.20	885000	2133000	383355	384716	501645	1748284	2.31	5.54

Urea-Tk.16/kg, TSP-Tk. 22/kg, MoP-Tk. 15/kg, Mustard oil cake-Tk. 45/kg, Labour-Tk. 220/man day, Leas value-Tk. 50000/ha for 12 months, 1bira-Tk15.

CONCLUSION

From the above discussion it can be concluded that the treatments $N_{100}P_{22}K_{42}$, $N_{100}P_{44}K_{21}$ and $N_{100}P_{22}K_{21}$ kg ha^{-1} may be the good alternative for betel leaf cultivation where 50% N was supplied from urea and 50% from mustard oil cake. Among them $N_{100}P_{22}K_{42}$ kg ha^{-1} would be the best due to less disease infestation, higher productivity and higher economic return.

REFERENCES

1. Chandini S. PhD Thesis, Kerala Agricultural University, Thrissur. 1989; p.130.

2. Chattopadhyay SB, Maity S. Diseases of Betelvine and Spices. ICAR, New Delhi. 1967.

3. Debanath PK, Sengupta K, Sengupta C, Chatterjee BN. Indian Fmg. 1985; 25(7):22-23.

4. FAO (Food and Agricultural Organization). Food and Agricultural Organization of the United Nations, Rome, Italy. 1988.

5. Gomez KA and Gomez AA. Statistical procedures for agricultural research 2nd ed. John Wiley & Sons, New York; 1984. p. 146-184.

6. Guha P. Betel Leaf: The Neglected Green Gold of India. J Hum Ecol. 1997; 19(2):87-93.

7. Gunther E. The Essential Oils. D Van Nostrand & Co. Inc New York. 1952; 5:160-161.

8. Maity S. Extension bulletin: The betelvine. All India coordinated research project on betelvine, Indian Inst of Hort Res. Hessarghatta, Bangalore, India. 1989.

9. Perrenoud S. Potassium and Plant Health. Int Potash Inst. 2nd ed. CH 3048, Worblaufen Bern, Switzerland; 1990. 7 p. IPI Res Topics No. 3.

10. Samanta C. Paan chaser samasyabali-o-samavhana: Ekti samikkha (In Bengali): "A Report on the Problems and Solutions of Betel Vine Cultivation". A booklet published by Mr. H. R. Adhikari, C-2/16, Karunamoyee, Salt Lake City, Kolkata-64 (WB), India. 1994.