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Occurrence of Mistletoe (*Dendrophthoe curvata* Blume Miq.) and its impact on growth and yield on Noni plantations

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Abstract

Noni (*Morinda citrifolia* Linn.) is also known as Indian Mulberry belongs to Rubiaceae family. Locally known as Lorang, Burmaphal, Pongeephal and Suraogi by the tribals of Andaman and Nicobar Islands. Recently this noni tree attain important because of its fruit juice medicinal and nutritional value. Many factors affecting the yield of noni fruit among them recently we have identified the parasite plants affect the growth and yield of the Noni plantations. Mistletoe (*Dendrophthoe curvata* Blume Miq.) belongs to *Loranthaceae* family cause variable damages: morphological, technological, ecological and socio-economic. A field assessment of the incidence and severity of the mistletoe in five Noni plantations (CIARI and APDC Port Blair) were conducted. The results revealed that, high incidence and severe infestation of Noni by the mistletoe. This obligate parasite attacks Noni trees as early as four to seven years after planting and causes severe damage by retarding growth and causing yield loss. Out of 6500 individuals 735 individuals were parasitized. The mean DBH of healthy trees ranged from 9.86 cm to 12.23 cm and the infected tree was 7.02 cm to 8.65 cm. The severity index (%) was ranged from 4.05 to 6.4 % and the higher in CIARI, Port Blair plantation. These findings were used for defining conservation plans for Noni trees. However, Mistletoe impact on Noni tree needs to be investigated physiologically in order to judge more completely parasite effect on Noni tree.

Keywords: Loranthus infestations, Morinda citrifolia, habitat management, Andaman and Nicobar Islands, parasite

Introduction

Morinda citrifolia, known commercially as noni or Indian Mulberry belongs to the family Rubiaceae, grows widely throughout the Bay Islands and is one of the most significant sources of traditional medicines for the aboriginals of bay Islands. This small evergreen tree or shrub is native of India, Southeastern Asia (Indonesia) to Australia, and now has a pantropical distribution (Singh *et al*., 2005[a]). Today, Noni grows in most regions of the South Pacific, India, the Caribbean, South America and the West Indies. Noni's broad proliferation gives testimony to its value to traditional cultures. In Andaman and Nicobar Islands, it is widely found throughout the coastal region and along the fences and the roadside. Due to its adaptability to wide range of environmental conditions, the Noni plant grows even in infertile, acidic, alkaline, sea inundated land and also prefers to grow even in the dry and wet areas. The tropical humid climate is very much suitable for its cultivation. It can also be called as Kalpavriksha as its every part has commercial importance.

The interesting fact is that the tribes i.e. Nicobari tribes of these islands have very long association with this plant, as they have been using different parts as medicine for different purposes. The leaves made into paste with the leaves of *Tylophora tenuissima* and coconut oil are rubbed on body by them for relieving pain during fever (Dagar and Singh, 1999). The *Morinda citrifolia* is gaining popularity among the farmers and local communities due to its good market value, and is also gaining more significant importance because of tolerant to salinity and brackish water (Singh *et al*., 2005[b]). *Morinda citrifolia* is naturalized in almost all parts of the islands, as it grows in dry to wet and in sea level of about 1500 feet elevation (Nelson, 2003). Noni is noted for its extremely wide range of environmental tolerances. Despite its ecological and economic importance Noni is susceptible to attack by a specific parasitic plant *Dendrophthoe curvata* Blume Miq. is identified and severe infestation was recorded.

Parasitic plants are a taxonomically diverse group of angiosperms that rely partially or completely on host plants for carbon, nutrients and water, which they acquire

by attaching to host roots or shoots using specialist structures known as haustoria and by penetrating host xylem and or forming close connections with phloem. The site of attachment to the host classifies the parasite as either a root or shoot parasite, whereas the presence or absence of functional chloroplasts defines the parasite further as being either hemiparasitic or holoparasitic, respectively (Musselman & Press, 1995).

Although parasitic plants in natural habitat in these islands have been reported, the association between parasitic flowering plants and *Morinda citrifolia* trees is less studied. Therefore, we aimed to identify the parasitic species, quantify levels of infections, and describe the association of tree characteristics with infection of *Dendrophthoe curvata* Blume Miq. in Noni plantations.

Materials and Methods

The study was carried out during the rainy season of 2016 in five Noni plantations of ICAR-CIARI Garacharma farm (Block-1, Block-2), ICAR-CIARI Sippighat Horticulture farm (Block-3, Block-4) and APDC plantation, Mithakhari (Block-5). The study area is characterized by a pronounced warm and humid tropic type of climate. The temperatures ranges from 23° to 32° C and the mean relative humidity is 78% with an annual rainfall ranging from 300 to 380 cm. Descriptive survey and field assessment were carried out by random sampling method. We have estimated three separate localities, in which five Noni plantations were selected each of 1000 m^2.

To assess the effect of parasites we have randomly selected 50 plants per plot from center of the plantations and intermediate in orchards *viz.* tree height, diameter at breast height (DBH), severity index (%) were recorded within each study plot. The mortality percentage, numbers of main and secondary branches and locations of parasitic plant infection with respect to the branches of each tree were also recorded.

Parasite infection severity rating of 0 to 5 was adopted for scoring the number of mistletoe per plant as indicated below:

0 - No incidence (no mistletoe)

1 - 1-5 per plant

2 - 6-10 per plant

3 - 11-15 per plant

4 - 16-20 per plant

5 - > 20 per plant

The severity indices (SI) for the mistletoe' infestations of the *Morinda citrifolia* plants were assessed using the formula below (Galanihe *et al*., 2004).

$$SI\ (\%) = \{(P \times Q)\}/\ (M \times N)] \times 100$$

Where P = severity score, Q = number of infected plants having the same score; M = total number of plants observed, N = maximum rating scale number.

Per cent mistletoe incidence in an orchard was also calculated using the formula:

$$\%\ \text{Incidence (orchard)} = \frac{\text{Number of plants with mistletoe infestation}}{\text{Total number of plants assessed in an orchard}} \times 100$$

The proportional presence of parasitic plants was calculated for *Morinda citrifolia* host trees. Independent sample t-test or mean was used to compare the proportion of infected and non-infected sample trees as a function of DBH, height, number of main branches, total yield Kg per plant. Where the overall ANOVA detected significant difference at 0.05 level.

The alternate hosts to the mistletoe observed around the study area were identified and recorded. Data were presented as frequency distributions and percentages by using Statistical Product for Service Solutions software version 14.0 (SPSS V14.0).

Results and discussion

The results indicated a significant impact of mistletoe on the growth and yield parameters of noni viz., tree height (m), number of branches and DBH (cm) growth (table 1). Among the 6500 individual plants of *Morinda citrifoila*

observed on five blocks of different localities, 11.3% of trees (735 trees) were infested by *Dendrophthoe curvata.* The infection intensity of infected plant was significant as compared to the healthy plants. Relationship among individual characteristics (Diameter at Breast Height, tree height and number of branches) of healthy and infected tree with infection intensity was analysed by 'students t' test. Among the blocks the highest level of growth reduction due to the parasite infection was observed in block 3 (tree height and number of branches) and maximum DBH reduction was observed in Block1when compared to healthy plants. The competition between mistletoe and noni for nutrients was the primary reason for reduction of tree growth which was similar to the reports published by Ohene, (2011). He further reported that mistletoe infestation caused drastic growth retardation, yield loss and subsequent killing of the citrus plants in Ghana. The average mean fruit yield of the infected plants was 14.4 kg plant^{-1} and the healthy plant mean yield was 20.12 kg plant^{-1}. It clearly showed that the infected tree fruit yield was reduced up to 38 % compared to the healthy plants. This agrees with the findings of Osman *et al.*, (2007) who reported decrease in fruit yield upto 95 % due to the prevalence of mistletoe on the citrus orchards in Sudan.

Table 1. Comparative quantitative analysis of effected and healthy Noni plants

Name of Noni plantation			Tree height (m)	No. of Branches	DBH (cm)	Total Yield (Kg/plant)
Block-1	Healthy plant	Mean	4.48	23.6	10.45	17.6
		SE	0.19	1.69	0.42	0.92
	Infected plant	Mean	3.72	16.8	8.88	10.8
		SE	0.19	0.86	0.26	0.58
	Probability		0.005	0.001	0.003	0.002
Block-2	Healthy plant	Mean	5.68	18.6	10.6	15.2
		SE	0.47	1.96	0.61	1.15
	Infected plant	Mean	3.92	13.6	7.1	10.6
		SE	0.13	0.92	0.20	0.67
	Probability		0.015	0.03	0.003	0.000
Block-3	Healthy plant	Mean	7.76	39.6	12.23	22.6
		SE	0.29	2.48	0.50	1.07
	Infected plant	Mean	6	29.4	8.56	17.2
		SE	0.20	1.63	0.31	0.96
	Probability		0.002	0.009	0.001	0.011
Block-4	Healthy plant	Mean	6.48	31.4	9.85	21.2
		SE	0.23	0.97	0.40	1.35
	Infected plant	Mean	5.00	23.6	8.17	15.0
		SE	0.08	0.92	0.37	1.0
	Probability		0.001	0.001	0.03	0.019
Block-5	Healthy plant	Mean	6.94	34.8	10.37	24.0
		SE	0.33	2.13	0.63	1.41
	Infected plant	Mean	5.8	27.0	8.64	18.4
		SE	0.34	0.70	0.26	1.28
	Probability		0.02	0.008	0.01	0.035

(*SE: standard error; p: probability of Student's t test comparing the two paired sampled Noni trees*).

Further the study revealed that maximum frequency of 30 with the 60% mistletoe attack was observed in the noni trees in the age of 5-8 years (Table 2). The parasite attach will be having a devastating effect on Noni fruit production. This is a clear indication of the threat of the mistletoe to the noni industry in India. Asare *et al*., (2013) reported that mistletoe attacked citrus at 6 to 10 years of the plant age.

Table 2. Age at which mistletoe attacks on Noni plants

Age	Frequency	Percentage
1 - 4	16	32
5- 8	30	60
Any age	4	8
Total	50	100.0

All the five noni plantations assessed had incidence of mistletoe infestation, with percentage incidence ranging from 16 – 21% per plantation. The level of infestation was also very high in the various plantations (Table 3) with the severity indices ranging between 4.05 % and 6.4 %, (level of infestation ranging from 5 to over 20 mistletoe parasite per plant. Most of the noni plantation showed drastic drop in yield (Table 4) when attacked by the mistletoe. This indicated that the parasite is highly prevalent in the area and the infection level was moderate but given the climatic conditions it suggested that the parasite poses a serious threat to the growth and yield of the noni and other plantations. This finding agrees with the report of the prevalence of mistletoe on the citrus in the Eastern Region of Ghana (Ohene, 2011). An urgent control of the parasite is therefore quite imminent in order to save the noni industry in the country.

Table 3. Percentage incidence and severity of mistletoe infestations

Orchard	% Incidence of mistletoe	Severity index (%)
Block-1	16.66	4.46
Block-2	18.75	4.68
Block-3	21.33	6.4
Block-4	16.21	4.05
Block-5	17.4	4.09

(*Parasite severity index was based on 1 to 5 severity scale where 1 denotes 1 – 5 parasites per plant, and 5 denotes more than 20 parasites per plant*)

Table 4. Economic damage of mistletoe on Noni

Damage	Frequency	Percentage
Stunted growth	28	54.9
Mortality	0	0
Reduced yield	22	43.1
Total	50	100

Several alternate hosts were identified during the study. Among the 6 alternate hosts identified, Cashew was the most frequent (30%), whereas Malayan rose apple and Rudraksh were less frequent, each forming only 5% (Table5). The numerous alternate hosts identified near the noni plantation might have at least, in part, been responsible for the high incidence and severity of the parasite recorded. The parasite could easily be dispersed from any of the alternative hosts into the noni plantations by birds and other dispersal agents. A considerable damage caused to perennial crops such as citrus, cocoa, avocado, coffee, cola, sheanut and rubber through the activities of mistletoe has also been reported by Irvine (1961). Effective control of the mistletoe and constantly monitoring its infestation is, therefore, very essential in order to save noni plantations.

Table 5. Alternate hosts observed by the authors during field assessment

Alternative host	Frequency of observation	Percentage
Magnifera indica	4	20.0
Malayan Rose apple	1	5.0
West Indian Cherry	4	20.0
Sapota	4	20.0
Cashew	6	30.0
Rudraksh	1	5.0
Total	20	100

Conclusion

It is evident from the study that there is a high incidence and severity of mistletoe infestation in the study area, with a consequent growth reduction and yield loss. Farmers should therefore be encouraged to remove the parasite from their plantation at the earliest to avoid its multiplications. However, majority of the farmers do not

have standard pruner for efficient and regular pruning. The interaction among mistletoes and their dispersal birds and hosts may play an important role for some of the host tree species. Mistletoe species can be serious pests in natural forests and plantations or they can be threatened species themselves in their limited natural areas of distribution.

Therefore, in addition to immediate interception of the infection through pruning of infected branches, better understanding is needed of the ecophysiology of the mistletoe/host-association and its relation to environmental factors during periods of drought stress. Further study is also needed on the dissemination of mistletoe by birds.

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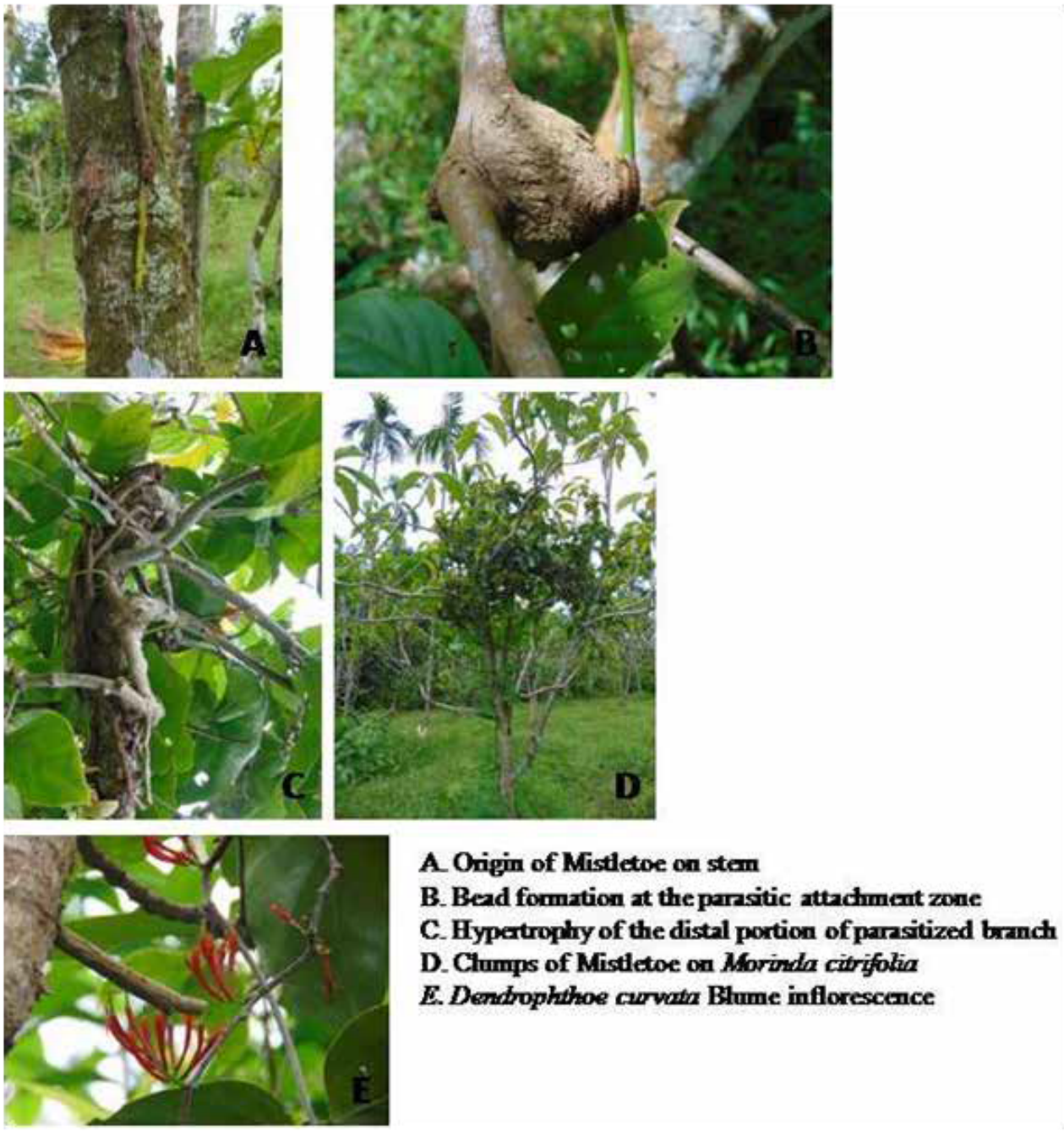

Fig 1. *Dendrophthoe curvata* Blume infections on Noni plantation