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Long-term study on invasive behavior of *Myroxylon balsamum* in the Udawattakele forest reserve, Kandy, Sri Lanka

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Key words: Invasive species, *Myroxylon*, Udawattakele forest.

Abstract

The objective of this study was to estimate the changes in the vegetation structure and species composition of the Udawattakele forest reserve due to *Myroxylon balsamum* invasion during the twelve year period from 1998 to 2010. Species composition of the upper story and under story were evaluated through measuring Relative Importance Value (RIV) of species in the *Myroxylon* invaded parts of the forest, initially in 1998 and then in 2010. A map was drawn to show the distribution and abundance of *Myroxylon* in the Udawattakele forest reserve. Germination of *Myroxylon* seeds were evaluated under different light intensities. Results showed that seeds of *Myroxylon* are able to germinate under a wide range of conditions from full sunlight to complete darkness. The results of the forest inventory showed that *Myroxylon* invasion has caused significant reduction in the species diversity in the forest. *Myroxylon* dominates the under story even when a few mother trees occur in the over story due to its prolific self-regenerating ability. Further, it was found that, *Myroxylon* had infested some new areas of the forest during the 12 year period between 1998-2010. Hence control measures have to be applied without any delay. The over story species composition and diversity of the *Myroxylon* invaded areas of the forest has not changed significantly (P=0.05) during the 12 year period. However, species diversity of the under story has increased (P=0.05). This was caused mainly due to self-thinning of *Myroxylon* and arrival of Mahogany, another species spreading rapidly in the Udawattakele forest reserve.

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Introduction

Udawattakele forest borders the town limits of Kandy and it covers an extent of 86.25 ha (Survey General's Department, 1982). It is classified as a wet semi-evergreen forest. Udawattakele has been declared as a Reserved Forest in 1856 and in 1938 as a Wild Life Sanctuary. Twenty hectare out of the forest was planted to enrich the forest during 1922-1929 period (Karunarathna, 1986). Udawattakele is rich in flora and fauna. *Myroxylon balsamum* (balsam tree), belongs to family Fabaceae is native to moist or dry forests in southern Mexico to Panama up to elevation of 600 m. It has been introduced to Sri Lanka as a wind break species in 1870 by the British. *Myroxylon* has been reported in Udawattakele forest before 1922 (Karunarathne, 1986). Trees taller than 20m produce larger quantity of seeds. Flowering season of *Myroxylon* is from July to September every year. Flowers are self-pollinated (Dasanayake and Fosberg, 1983). Pods are lance (samara) shaped. These winged indehiscent fruits are straw coloured when ripened. After ripening pods are dispersed with the aid of wind and runoff water.

Vegetation studies conducted at Udawattakele by Hitinayake and Senadhera (Senadheera, 1997) has reported that *Myroxylon balsamum* has become invasive in some parts of the forest. In Sri Lanka 25% of flora are exotic in origin. About 1-3% of naturalized exotic species have become invasive in behavior (Bambaradeniya, 2000). Among the all identified invasive plants 13 species are considered of national significance that need attention in terms of their threat to the ecosystems and control (MoFE, 1999). Certain species among them have received some attention of the researchers in past. They are *Salvinia molesta, Echornia crassipes, Mimosa pigra, Parthenium hysterophorus, Prosopis juliflora* and *Myroxylon balsamum* (Marambe, 1999; Amarasinghe, 1999; Wedathanthri and Hitinayake, 1999; Hitinayake *et al*., 2000; Pushpakumara *et al.,* 2000, Costa *et al.,* 2001; Marambe 2008).

The objective of this study was to evaluate the changes in the vegetation of the Udawattakele forest reserve due to *Myroxylon* invasion during the twelve year period from 1998 to 2010.

The specific objectives were to identify the changes in species composition and diversity due to *Myroxylon* invasion in the *Myroxylon* occupied regions of the Udawattakele forest during twelve year period from 1998 to 2010, to identify the distribution and the direction of spread of *Myroxylon balsamum* in the Udawattakele forest and to study the germination of *Myroxylon* under different light intensities.

Materials and methods

The study was conducted in the Udawattakele forest reserve. Latitude is 7.8° N, 82° E and Altitude is 540-645m. The climate is tropical wet midlands and the forest is located within the WM3 agro ecological region. Mean annual rainfall and average temperature is ranging from 22-27°C and 2500-3000mm, respectively. Reddish Brown Latosolic (RBL) and Red-yellow Podzolic soils are the major soil groups found in this region (Punyawardena, 2008). The climatic conditions could be classified as tropical wet midlands.

Dominance and Diversity of Myroxylon

A vegetation survey was conducted in the Udawattakele forest in 1998, where nine sample plots were sampled in six *Myroxylon* occupied regions. Study was repeated in 2010 (i.e. same areas were sampled) to study the changes in vegetation. Comparison was done using "t test". Plots were located randomly and number of plots was decided based on the extent of the region. 10m x 10m plots were used for understory measurements and 10m x 15m plots were used for over story measurements. In each plot following measurements were done to estimate the Relative Importance Value and Diversity Index to estimate the species dominance and diversity of vegetation in the *Myroxylon* invaded parts of the forest.

Frequency of Individuals

Frequency of individuals belong to different species in each plots was counted and classified to height classes, below 0.5m, between 0.5-2.0m, between 2-3m, between 3-10m, between 10-20m and more than 20m. Height of the individuals below 3m was considered as understory and more than 3m was considered as over story.

Tree Height

The clinometer was used to measure the angles in a vertical plane upward or downward from the horizontal. The measuring tape was used to measure the base distance. The following formula was used to calculate the tree height.

Tree height = Tan slope angle in degrees x Base distance (m)

Diameter at Breast Height of Tree (DBH)

The diameter tape was simply a measuring tape with a hook on one end for implanting in the bark and graduations scaled to read in units of diameter instead of circumference, when tape was wrapped around the tree (Myers 1980). It measures in units multiplied by л (which is the ratio of the circumference of a circular object to its diameter, approximately = 3.1416) (Forest Inventory manual). The diameter of a tree trunk is measured at 1.3m above the ground level (measured in cm).

Crown Diameter (CD)

The measuring tape was used to measure the crown diameter of tree species. This was done by measuring the diameter of shadow of the tree crown at mid-day. The value was measured in meter (m). The following indices were calculated to interpret the dominance and diversity:

Diversity Index

The following formula was used to calculate the diversity index Myers and Shelton (1980); Muller-Dombois and Ellanberg (2003):

$$\text{Diversity index} = \frac{\text{Total number of species recorded}}{\text{Log of total number of individuals counted}} \times 100$$

Relative Importance Value (RIV)

Following standard equations were used to calculate the RIV of species Myers and Shelton (1980); Muller-Dombois and Ellanberg (2003):

(A) Relative frequency =

$$\frac{\text{Individuals from species A}}{\text{Total number of all individuals}} \times 100$$

(B) Relative Basal Area =

$$\frac{\text{Cumulative DBH of individual of species A}}{\text{DBH of all individuals}} \times 100$$

(C) Relative Crown Diameter =

$$\frac{\text{Crown diameter of individual species A}}{\text{Crown Diameter of all individuals}} \times 100$$

Relative Height =

$$\frac{\text{Height of individuals of species A}}{\text{Height of all individuals}} \times 100$$

$$\text{RIV} = \frac{(A) + (B) + (C) + (D)}{4} \times 100$$

Distribution and abundance of *Myroxylon* in the Udawattakele forest reserve were marked in a map of Udawattakele after the first study done in 1998. It was updated after the second study to show the distribution and abundance of *Myroxylon* at different parts of the forest.

Spread of Myroxylon

In selected two plots, center of the plots were marked. From the center point, four pathways were marked away with 90° angle in to each. Along those four pathways 10m x 10 m sub plots were located with 5m intervals between each plots until the *Myroxylon* plants are absent along the path. In each plot, number of *Myroxylon* plants and their DBH were recorded and categorized in to five DBH classes. Those are below 5 cm, between 5-10 cm, between 10-20 cm, between 20-40 cm and above 40cm.

Germination of Myroxylon

Light requirement for germination of *Myroxylon* seeds were examined through an experiment conducted at Agricultural Experimental Station, Dodangolla, Kundasale under control conditions. Germination of *Myroxylon* seeds were evaluated under four different light levels (full sunlight, 70% and 35% light and complete dark conditions). Number of germinated seeds was counted in each bed at the end of every week. Chi-square tests were performed to examine the association between germination and light levels.

Results and discussion

Germination of Myroxylon Seeds

Analysis of data using Chi-square test indicated that there are no association between germination rate and light level (Table 1). This indicates that seeds of *Myroxylon* are able to germinate under wide range of light conditions that is full sunlight, full dark condition and levels in between these two extremes.

Table 1. Mean germination percentages of *Myroxylon* seeds under different light levels.

Weeks after planting	Mean germination	SE	H_0	H_1
1	7.95 %	1.50	Acc.	Rej.
2	27.27 %	2.44	Acc.	Rej.
3	69.31 %	3.86	Acc.	Rej.
4	79.16 %	2.98	Acc.	Rej.

Key: SE- Standard error; H_0: No association between germination and light levels; H_1:There is an association between germination and light levels; Acc. – Accepted; Rej. – Reject

Distribution of Myroxylon

The distribution of *Myroxylon* at Udawattakele forest in 2010 is shown in the Fig. 1. There are 18 prominent *Myroxylon* patches found in the forest. These patches are located along the roads and footpaths of the forest. Highly varied topographical conditions were observed with the different *Myroxylon* patches. South-east part of the forest has been severely infested by *Myroxylon*. Solitary invaded patches in the south-eastern part have a tendency to link together to form larger patches. Invasion is beginning at some areas in the northern part and southern part of the forest. Some individual *Myroxylon* plants which have not established in to dense stands can be seen in the western and northwestern parts of the forest. Therefore there is a risk of *Myroxylon* being invaded in to the other areas of the forest.

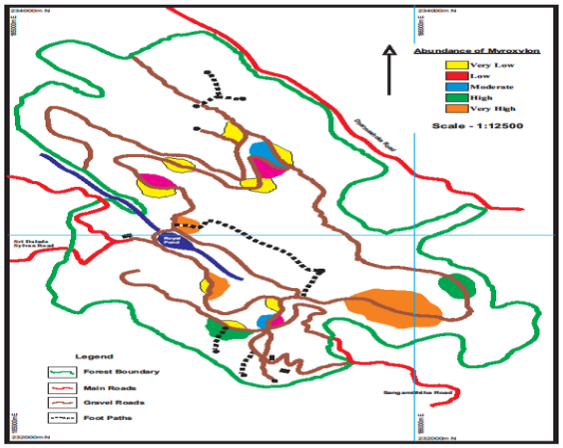


Fig. 1. Distribution and abundance of *Myroxylon* in the Udawattakele forest reserve (Abundance rating: Very low-less than 10%, Low-11%-25%, Moderate-26%-50%, High-51%-75%, Very high-more than 76%).

Dominance and Diversity of Species in the Myroxylon Invaded Areas

Height Class Distribution of Myroxylon

Individuals of *Myroxylon* recorded at Udawattakele forest, both in the over story and under story were categorized in to different height classes.

Overstory of the Forest

Mean number of *Myroxylon* individuals per plot in the 3-10 m height classes is about 38 (89%). In 10-20 m and above 20 m height classes it is 1.2 (3%) and 3.3 (8%), respectively. *Myroxylon* trees taller than 20 m are the most prolific seed producers and mother plants. Only one or two such mother plants were recorded in most plots except 2, 3 and 8 which had many (4-15) *Myroxylon* mother plants.

Understory of the Forest

Results show that mean number of *Myroxylon* individuals per plot below 0.5 m are 2601 (75%). The mean number of individuals of 0.5-2 m height class is 480 (14%). 372 (11%) is the mean number of individuals per plot in the height class 2-3 m. The results shows that under story of most plots are dominated by individuals of below 50 cm height class.

Species Dominance

Overstory of the Forest

Species composition and dominance in the *Myroxylon* invaded parts of the forest was evaluated by computing the relative importance value (RIV). The comparison of RIV values recorded in study in 1998 and 2010 are given in the Table 2.

This shows that *Myroxylon* is the most dominant species and its dominance is more than 50% in all plots except 5, 6 and 7. Relative rarity (abundance) of *Myroxylon* was identified using a rating scale based on the RIV. Mahogany, Jak, Pihimbiya, Ratagoraka, Alstonia, Bala and Waldel were the subdominant species recorded in the over story. The results also indicates that abundance of *Myroxylon* have increased in the plots 2 and 3 from high to very high, in the plot 6 from low to moderate and plot 8 moderate to very high. Only reduction is observed in the plot 5, where abundance has reduced from moderate to low.

Pooled t test shows that the changes in RIV in the upper story during 1998-2010 period (Table 2.) *Myroxylon* invaded plots in Udawattakele forest is not significant (Pr> | t | = 0.9544).

Table 2. RIV and abundance rating of *Myroxylon* in the over story.

Plot no.	RIV% and abundance rating of *Myroxylon*				Other species (in the order of importance)
	In 1998		In 2010		
1	100	Very high	80.90	Very high	Mahogany, Pihimbiya
2	51.16	High	97.05	Very high	Jak
3	60.38	High	87.65	Very high	Jak, Ratagoraka, Mahogany
4	55.46	High	73.22	High	Pihimbiya, Ratagoraka
5	28.55	Moderate	15.78	Low	Mahogany, Bala
6	15.84	Low	26.00	Moderate	Alstonia, Mahogany, Bala, Ratagoraka
7	24.21	Low	13.55	Low	Mahogany, Waldel
8	49.98	Moderate	76.83	Very high	Jak
9	68.75	High	62.33	High	Pihimbiya, Mahogany, Ratagoraka
Mean	50.48	-	59.26	-	
SE	8.56	-	10.73	-	

Key: Botanical names are given in Appendix 01. Abundance rating: Very low-less than 10%, Low-11%-25%, Moderate-26%-50%, High-51%-75%, Very high-more than 76%.

Understory of the Forest

Since most of the individuals in the under story are of same size Relative Frequency was used to estimate the dominance of *Myroxylon*. The composition of under story in the *Myroxylon* invaded parts of forest are given in Table 3. The results also indicate that dominance of *Myroxylon* in the under story is much higher when compared to the over story (See Table 2).

The results shows that abundance of *Myroxylon* have reduced significantly (P=0.05). When't test' was performed it showed that the difference among the 1998 and 2010 values of relative frequency of *Myroxylon* in the under story (Table 3) is significant (Pr> | t | = 0.023). In plots 6 and 8 abundance rating has reduced from very high to high.

Myroxylon shows very high or high abundance rating in all plots although there is a reduction from 1998 to 2010. Hence still there is a high risk that these areas of the forest will become more *Myroxylon* dominant as time progresses.

Reduction of *Myroxylon* abundance can be attributed largely to the in transpacific competition of *Myroxylon* and competition sets in by other species such as Mahogany (Pushpakumara and Hitinayake, 2001). The results also show that Mahogany has become the next most dominant species in the Udawattakele forest (Table 3). Mahogany is found co-dominant in 05 out of 09 plots. The only exceptions are plot numbers 1, 2, 3 and 4.

Table 3. Relative Frequency % of *Myroxylon* in the understory of *Myroxylon* invaded areas of Udawattakele forest.

Plot no.	RIV % and abundance rating of *Myroxylon*				Other species (in the order of importance)
	In 1998		In 2010		
1	99.95	Very high	95.00	Very high	Pihimbiya, Ratagoraka, Mahogany
2	99.86	Very high	98.54	Very high	Bala, Philodendron
3	99.96	Very high	97.40	Very high	Wewal, Mora, Mahogany
4	99.95	Very high	100	Very high	No
5	85.84	Very high	87.40	Very high	Mahogany, Kududawla, Kithul
6	99.95	Very high	75.80	High	Mahogany, Mora, Alstonia
7	99.95	Very high	93.06	Very high	Mahogany, Wewal, Kududawla
8	99.78	Very high	71.80	High	Mahogany, Pihimbiya, Bala
9	100	Very High	76.67	Very High	Mahogany, Pihimbiya
Mean	98.36	-	88.41	-	-
SE	1.57	-	3.64	-	-

Key: Botanical names are given in Appendix 01. Abundance rating: Very low-less than 10%, Low-11%-25%, Moderate-26%-50%, High-51%-75%, Very high-more than 76%.

Species Diversity

Diversity of species in the over story and under story of the *Myroxylon* invaded patches were analyzed and given in the Table 4 and 5.

Overstory of the Forest

The't test' showed that the difference between mean Diversity Index values estimated in 1998 and 2010 for the over story of *Myroxylon* invaded areas of Udawattakele forest (Table 4) is not significant (Pr> | t | = 0.8701). High variation is apparent when consider the changes in Diversity Index values of individual plots.

The Diversity Index value has decreased in 04 plots and increased in 05 plots over the 12 year period. Further, no clear pattern emerges when Diversity Index values of individual plot are compared between 1998 and 2010.

The results clearly shows that species diversity of the *Myroxylon* invaded parts of the forest have reduced due to the high presence of *Myroxylon*.

It can be seen that plots which are having high diversity have only few *Myroxylon* trees in the over story. Some plots such as plot number 2 have recorded very low species diversity values as its over story is dominated by *Myroxylon* replacing most other species (Table 4). Results also show that density of individuals has increased during the 12 year period.

Table 4. The Diversity index computed for over story vegetation of the *Myroxylon* invaded parts of the Udawattakele forest.

Plot no.	Number of species	Total number of individuals	Diversity index
1	4 (1)	13 (16)	3.60 (0.83)
2	2 (5)	183 (16)	0.88 (4.16)
3	12 (5)	95 (29)	6.06 (4.27)
4	7 (7)	59 (19)	3.95 (4.79)
5	12 (10)	25 (20)	8.58 (7.87)
6	9 (18)	18 (18)	7.16 (13.84)
7	6 (3)	19 (17)	4.70 (2.40)
8	3 (5)	18 (24)	2.38 (4.06)
9	5 (3)	21 (15)	3.78 (2.17)
Mean	6.66 (6.33)	50.11 (19.33)	4.57 (4.93)
SE	-	-	0.79 (1.29)

Key: The values recorded during 1998 vegetation survey are given in the parenthesis.

Understory of the Forest

The results show that species diversity is largely dependent on the frequency of *Myroxylon*. Plot number 01 showed the highest species diversity (3.60) where 13 other species are present (Table 5). The lowest diversity (0.27) is recorded for the plot number 4 where under story is totally dominated by *Myroxylon* individuals.

A "t test" was performed to compare the Diversity Index values for 1998 and 2010 (Table 5). It showed that mean difference between two periods is significant (Pr> | t | = 0.0026).

It was found that the diversity index value for under story at present is higher than the value in 1998. This indicates that during the above period under story species diversity has significantly increased and *Myroxylon* dominance has reduced. The results show that density of *Myroxylon* individuals have decreased in all the plots by more than 50%. Also the number of species has increased more than two folds in all plots except plot number 4. This reduction in *Myroxylon* seedling density has been most likely caused by the in transpacific competition, in transpacific competition from species such as Mahogany and arrival more species.

Table 5. The Diversity index computed for under story vegetation of the sample plots located in the *Myroxylon* invaded parts of the Udawattakele forest during 1998 and 2010.

Plot No.	Total number of species	Number of individuals of *Myroxylon*	Number of individuals of other species	Total number of Individuals	Diversity index
1	14 (6)	7425 (15142)	396 (7)	7821 (15149)	3.60 (1.43)
2	9 (5)	5950 (14543)	88 (20)	6038 (14563)	2.38 (1.20)
3	6 (2)	3268 (14761)	15 (5)	3283 (14766)	2.27 (0.48)
4	1 (2)	4412 (9675)	0 (4)	4412 (9679)	0.27 (0.50)
5	9 (7)	2790 (6015)	413 (993)	3203 (7008)	2.56 (2.08)
6	9 (2)	2725 (9040)	869 (4)	3594 (9044)	2.53 (0.50)
7	7 (2)	1583 (9108)	118 (5)	1701 (9113)	2.16 (0.50)
8	6 (2)	1450 (2733)	590 (6)	2040 (2739)	1.81 (0.58)
9	4 (1)	1475 (2834)	450 (0)	1925 (2834)	1.21 (0.28)
Mean	7.22 (3.22)	3453 (9317)	327 (116)	3780 (9433)	2.09 (0.84)
SE	-	-	-	-	0.31 (0.20)

Key: The values recorded during 1998 vegetation survey are given in the parenthesis.

Diversity index values indicate that over story diversity is higher when compared to the under story. This shows that *Myroxylon* is getting established in the under story. Hence it can be said that these parts of the forest will be gradually taken over by the *Myroxylon* including over story in the long run. These results reiterate the fact that species diversity of both over story and under story of Udawattakele will continue to decline due to *Myroxylon* invasion.

Direction of Spread of Myroxylon

Myroxylon plants which belong to different DBH classes were found in subplots located within the four directions (south, north, east and west) of sampling plots. According to the results obtained, the highest numbers of *Myroxylon* plants around the centre of an invaded plot are belong to the DBH class below 5 cm (Annexure 2).

Almost in all the DBH classes, *Myroxylon* plant spread is less towards the west direction compared to the other directions. There is a trend in plants to spread towards the east direction compared to the other directions. Within 25 m distance from the centre of a *Myroxylon* invaded plot at least single *Myroxylon* seed producer can be found.

Conclusions

Study clearly shows that *Myroxylon* invasion has caused significant reduction of species diversity in the *Myroxylon* invaded areas. However, study revealed that during past 12 years (1998-2010) *Myroxylon* invasion has caused no significant impact on the composition and diversity of the overs tory in the *Myroxylon* invaded areas of the forest. During the above period under story species diversity has significantly increased and *Myroxylon* dominance has reduced.

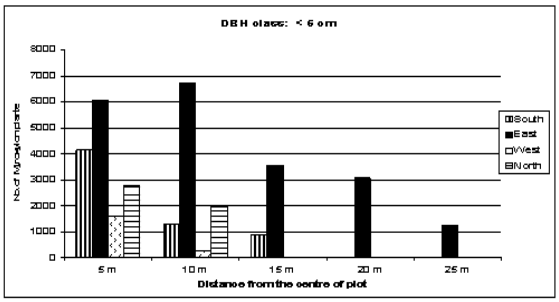
Some of these changes can be attributed to the in transpacific competition of *Myroxylon* and site-specific competition sets in by other species such as Mahogany.

Results also reveal that *Myroxylon* has spread to new areas in the forest during that period causing reduction in biodiversity. Therefore monitoring and taking necessary action to control the regeneration and spreading of *Myroxylon* in Udawattakele forest reserve is strongly recommended. Uprooting seedling bank, collecting and destroying seeds and thinning mother trees in the upper story could be done to control the invasion of *Myroxylon* in the Udawattakele forest reserve. Further research studies to understand dynamics of the *Myroxylon* seedling bank, competition between Mahogany and *Myroxylon* occurring at some parts of the forest is proposed. The present study also indicates that *Myroxylon* is a useful species that could be used to revegetate the degraded lands in the mid country wet zone of Sri Lanka.

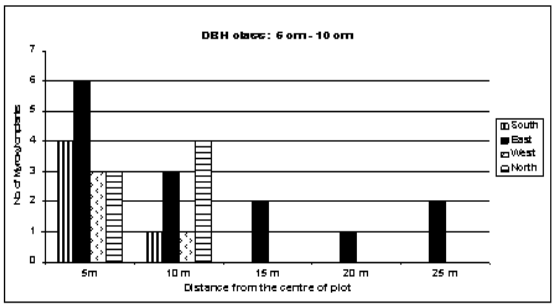
Annexure 1. A checklist of trees and plants found at Udawattakele forest reserve.

No.	Botanical Name	Common name
1	*Acronyhia pendunculata*	Ankenda
2	*Adenanthera pavonina*	Madatiya
3	*Agloanema commutatum*	
4	*Albizia flacataria*	Rata Mara
5	*Alelurites moluccans*	Tel- Kekuna
6	*Alstonia macrophylla*	Hawari- Nuga
7	*Anamirta cocculus*	Thiththa wel
8	*Aporosa lindleyana*	Kebella
9	*Ardisia missoionis*	
10	*Artocarpus altilis*	Rata-Del
11	*Artocarpus heterophyllus*	Jak
12	*Artocarpus nobilis*	Wal- Del
13	*Bambusa* sp.	
14	*Calamus thwaitesi*	Wewal
15	*Cananga adorata*	Wal-Sapu
16	*Carallia brachiata*	Davata
17	*Caryota urens*	Kithul
18	*Castilla elastica*	Panama rubber
19	*Cinnamomum verum*	Kurundu
20	*Dichapetalum helferianum*	
21	*Drynaria quercifolia*	
22	*Elaeocarpus serratus*	Weralu
23	*Entada zeylanica*	Pus- wel
24	*Eugenia malaccensis*	Jambu
25	*Euphorbia longana*	Mora
26	*Fagraea ceilanica*	Etamburu
27	*Ficus fergusoni*	Nuga
28	*Filicium decipiens*	Pihimbiya
29	*Flacourtia ramonthi*	Uguressa
30	*Garcinia tinctoria*	Rata goraka
31	*Garcinia quaesita*	Goraka
32	*Glycosmis mauritiana*	Dodan-pana
33	*Gmelina arborea*	Ethdemata
34	*Ichnocarpus frutescens*	Kiri-wel
35	*Macaranga peltata*	Kenda
36	*Mangifera indica*	Mango
37	*Mangifera zeylanica*	Etamba
38	*Meksua ferrea*	Na
39	*Michelia champaka*	Gini-sapu
40	*Micromelum minutum*	Wal-karapincha
41	*Mkurraya panaiculata*	Etteria
42	*Myristica dactyloides*	Malalboda
43	*Myroxylon balsamum*	Kattakumanjal
44	*Neolitsea cassia*	Kududawla
45	*Nothopegia beddomei*	Bala
46	*Pagiantha dichotoma*	Divi-kaduru
47	*Pavetta indica*	Pawatta
48	*Philodendron* sp.	
49	*Piper sylvestre*	Wal- gammiris
50	*Pongamia pinnata*	Karanda
51	*Psidium guajava*	Pera
52	*Pterocarpus indica*	
53	*Pterospermum canescens*	Welang
54	*Samanea saman*	Mora
55	*Sansevieria zeylanica*	
56	*Schleichera oleosa*	Kon
57	*Semecarpus obscura*	Badulla
58	*Solanum nigrum*	Kalukamberiya
59	*Spathodea campanulata*	
60	*Sterculia balanghas*	Nava
61	*Swietenia macrophylla*	Mahogany
62	*Syngonium podophyllum*	Wel-kohila
63	*Syzygium caryophyllatum*	Dan
64	*Syzygium firmum*	Wal- jambu
65	*Terminalia catappa*	Kottan
66	*Terminalia bellirica*	Bulu
67	*Vitex pinnata*	Milla

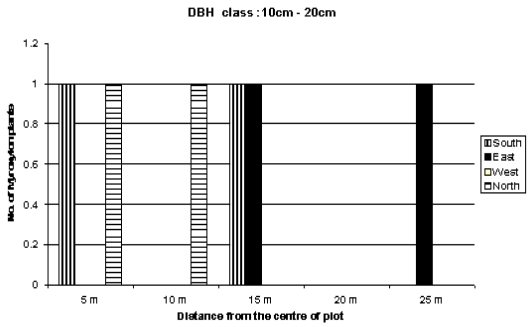
Annexure 2. Spread of *Myroxylon* plants in the sampling plots (distances from the centre of plot in four directions).



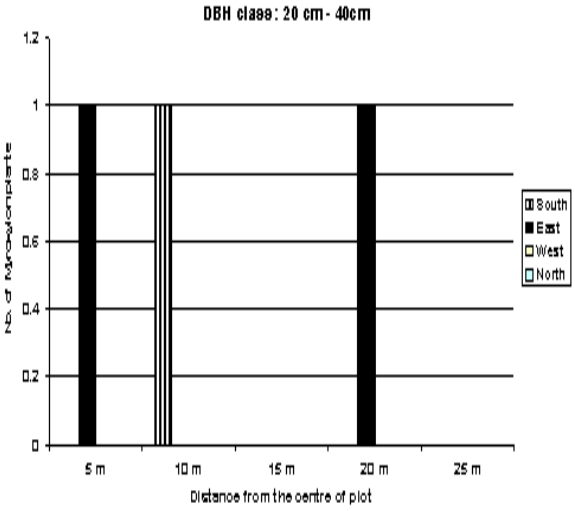
(A) DBH class < 5 cm



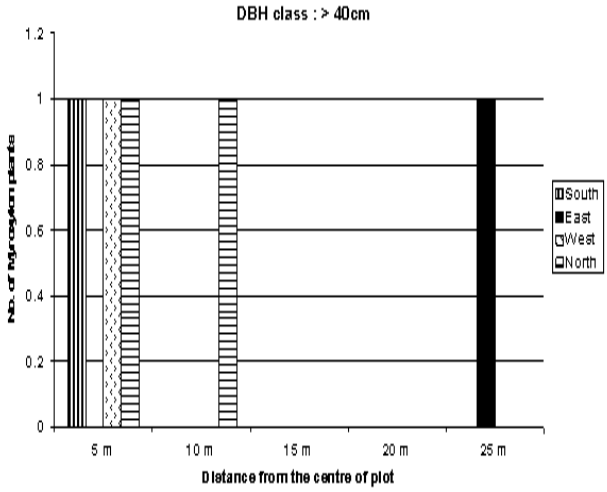
(B) DBH class 5-10 cm



(C) DBH class 10-20 cm



(D) DBH class 20-40 cm



(E) DBH class > 40cm

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