Evaluation of roadside green belt trees damaged by mistletoes parasite plant in Medan Merdeka Road, Central Jakarta, Indonesia

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Abstract. This research was conducted to evaluate tree species attacked by mistletoes, the damage scale and eventually propose maintenance of host tree. Research was undertaken during February – August 2016 to observe all trees in Medan Merdeka Road in Central Jakarta. Research results showed only one species of mistletoes of Dendrophthoe pentandra L. was found. Total number of trees in the research site was 557 trees that consisted of 19 species, however only four species were attacked by mistletoes. The highest number of trees attacked by mistletoes was Swietenia mahogani (L.) Jacq (268 trees), followed by Bauhinia purpurea L. (21 trees), and Cordia sebestana L. (5 trees) and Pterocarpus indicus Willd (1 tree). The damage scale of Swietenia mahogani consisted of 26 trees of severely worse, 14 trees of worse, 29 trees of moderate, 71 trees of light, and 128 trees of very light damage. The damage scale of Pterocarpus indicus was one tree of very light damage. The damage scale of Bauhinia purpurea was 19 trees of very light and two trees of light damage. In Cordia sebestana there were two trees of very light damage and three trees of light damage. Type of maintenance ranged from light pruning for trees of light damage to heavy pruning for trees of severely worse damage.

1. Introduction
Roadside greenery is important element of urban green open space system. It is not just spread in overall part of city following the road network, but it also connected to other bigger greeneries such as city park, river bank greenery and urban forest. Trees as an elements of roadside greenery contribute to create a comfort and attractive roadscape if the trees grow and develop normally without any damage caused by insect, disease, or parasite plant.

Roadside greenery is part of road, which was planted in the right way. In the city area, trees are allowed to be cultivated in median of road [1]. One of strategic roads in Central Jakarta, Indonesia, is Medan Merdeka Road, because the road location along the border of National Monument Park and also connected to the government buildings surrounding the road. The road has four sections, namely North, East, South and West of Medan Merdeka Road. The road consisted of six lanes, median and pedestrian paths. Only East Medan Merdeka Road, which does not have a median. Furthermore trees of road greenery are planted at the side of pedestrian path and median. Part of these greeneries were attacked by mistletoes, therefore it sparked a problem of physical and visual characteristics of host trees that will gradually continue to decrease.
Mistletoes seeds are spread by bird, which are included in family of Dicacedae, especially *Dicaeum* spp. Distribution of seed from host plant to other host plants was made easier by their sticky seeds [2]. Mistletoes generally attack twig and branch of host tree and very rarely attack plant stems [3].

Mistletoes are hemi parasitic flowering plants that absorb water and nutrient from host trees, than proceed in photosynthesis in their leaves. Mistletoes attack host tree by means of organ like root called haustoria [2]. Besides absorbing mineral, haustoria also absorbs organic substances from host trees. Nutrients, water and photosynthate, which come from proximal (before haustoria) of branch mostly flows to mistletoes, hence only very few or no flowing to distal (after haustoria) part branch, so it caused distal part of branch gradually become degenerated or dead [3].

This research aimed to analyze which species of trees attacked by mistletoes, and to analyze the damage scale caused by mistletoes in Medan Merdeka Road in Central Jakarta, Indonesia. Finally this research would propose a recommendation in removing mistletoes from the roadside greenery.

2. Research method

2.1. Observation plot
Research was conducted in Medan Merdeka Road, which consisted of three sections, North Medan Merdeka Road, West Medan Merdeka Road and South Medan Merdeka Road in Central Jakarta, Indonesia, throughout February – August 2016. In order to describe vegetation composition in research site, observation plots were set six in North Medan Merdeka Road, and ten both in West and South Medan Merdeka Road.

2.2. Assessment roadside tree damage
Photos of tree canopy attacked by mistletoes were taken in observation plots. By using Adobe Photoshop, grid lines were made in the photo by creating vertical and horizontal lines (figure 1). Then, grids containing mistletoes and total grid covered the tree canopy were calculated. Percentage of tree damage was calculated using formula below (equation 1), and category of damage was classified using table 1 and figure 2.

\[
R \text{ (Tree damage)} = \frac{\text{Number of grid containing mistletoe}}{\text{Total grid covering tree canopy}} \times 100\%
\]

![Figure 1. Illustration of grids created in the tree photo.](image)

![Figure 2. Classification of tree damaged by mistletoes: (a) very light, (b) light, (c) moderate, (d) worse, and (e) severely worse.](image)
Table 1. Classification of host tree damage.

| Score | Scale of damage | Description | Damage (%) |
|-------|----------------|-------------|------------|
| 1     | Very light     | Very few or no mistletoes covered canopy | R ≤ 20     |
| 2     | Light          | Few of mistletoes covered canopy       | 20 < R ≤ 40|
| 3     | Moderate       | Half of canopy is covered by mistletoe | 40 < R ≤ 60|
| 4     | Worse          | In general, canopy is covered by mistletoe | 60 < R ≤ 80|
| 5     | Severely worse | Most all canopy is covered by mistletoe | 80 < R ≤ 100|

2.3 Assessment damage of roadside green belt

Damage of roadside green belt was calculated based on the total score of all host tree damage compared to maximum damage score of roadside green belt. It was measured using formula below (equation 2), and scale of damage of roadside green belt was classified based on table 2.

\[
\text{Green belt damage} = \frac{\text{Total Score of all host tree damaged}}{\text{Number of tree x maximum damage score}} \times 100\%
\]  

Table 2. Classification of roadside green belt damage.

| No  | Scale of damage | Damage (%) |
|-----|----------------|------------|
| 1   | Very light     | J ≤ 20     |
| 2   | Light          | 20 < J ≤ 40|
| 3   | Moderate       | 40 < J ≤ 60|
| 4   | Worse          | 60 < J ≤ 80|
| 5   | Severely worse | 80 < J ≤ 100|

3. Research results and discussion

3.1. Diversity of plant in research site in Medan Merdeka Road

It was found that 110 trees consisting of 9 species of tree in North Medan Merdeka Road which only *Swietenia mahagoni* (L.) Jacq was attacked by mistletoes. In the case of West Medan Merdeka Road, it was spotted 227 trees consisting of 10 species, however only three species, namely *S. mahogani* (L.) Jacq., *Pterocarpus indicus* Willd., *Bauhinia purpurea* L., were parasited by mistletoe. In South Medan Merdeka Road, it was shown 220 trees consisting of 8 species, with only three species namely *S. mahogani* (L.), *B. purpurea* L., and *Cordia sebestana* L. were attacked by mistletoes. Therefore, in the research site, it was found 557 trees with 19 species (table 3).

3.2. Tree damage in roadside green belt

Species of host tree attacked by mistletoes and their damage scales are presented in table 4. Results of observation indicated only one of mistletoes species of *Dendrophthoe pentandra* (L.) Miq derived from family of Loranthaceae found in research plots. In the three sections of road, it was found 295 trees (53% of total tress) and four species of host trees were parasited by mistletoes, namely *S. mahagoni* L., *Pterocarpus indicus* Willd., *B. purpurea* L., and *C. sebestana* L.

Among of trees which were attacked by mistletoe, the highest number of host tree parasited by mistletoes was *S. mahagoni* L (90.8%), followed by *B. purpurea* L(7.1%), *C. sebestana* L (1.7%), and *P. indicus* Willd (0.03%). The highest percentage of *S. mahagoni* L attacked by mistletoes due to the roadside green belt mostly consisted of *S. mahagoni* L. In the contrary, among the other three host trees only few trees were attacked by mistletoes due to number of host trees was very few in research site and their branch and size was still small. It was also reported that the most susceptible hosts were the trees with greater abundances and larger sizes [4].
Table 3. Number of species in plot observation in 3 sections of Medan Merdeka Road.

| No. | Scientific name               | Section of road | Total |
|-----|-------------------------------|-----------------|-------|
|     |                               | North | West | South |     |
| 1   | *Swietenia mahogani* (L.) Jacq. | 71    | 171  | 131   | 373 |
| 2   | *Bauhinia purpurea* L.         | 0     | 2    | 48    | 50  |
| 3   | *Polyalthia fragrans* (Dalz.) Bedd. | 12    | 15   | 0     | 27  |
| 4   | *Pterocarpus indicus* Willd.   | 17    | 4    | 0     | 21  |
| 5   | *Roystonea regia* (Kunth.) O.F. Cook. | 0     | 6    | 11    | 17  |
| 6   | *Michelia champaca* L.         | 0     | 0    | 16    | 16  |
| 7   | *Minusops elengi* L.           | 0     | 11   | 0     | 11  |
| 8   | *Peronema canescens* Jack      | 0     | 9    | 0     | 9   |
| 9   | *Tamarindus indica* L.         | 3     | 2    | 2     | 7   |
| 10  | *Cordia sebestana* L.          | 0     | 0    | 5     | 5   |
| 11  | *Spathodea campanulata* Beauv. | 0     | 0    | 5     | 5   |
| 12  | *Polyalthia longifolia* (Sonnn.) Thwaites. | 0     | 4    | 0     | 4   |
| 13  | *Albizia chinensis* (Osbeck) Merr. | 3     | 0    | 0     | 3   |
| 14  | *Terminalia catappa* Linn.     | 0     | 3    | 0     | 3   |
| 15  | *Ficus benjamina* Linn.        | 0     | 0    | 2     | 2   |
| 16  | *Cassia fistula* L.            | 1     | 0    | 0     | 1   |
| 17  | *Ficus lyrata* Warb.           | 1     | 0    | 0     | 1   |
| 18  | *Plumeria alba* L.             | 1     | 0    | 0     | 1   |
| 19  | *Samanea saman* (Jacq.) Merr   | 1     | 0    | 0     | 1   |

Number of species: 9

Total of trees: 557

Mistletoes seeds are dispersed by birds which consume mistletoes fruits including within family of Dicacedae, especially *Dicaeum* spp [3]. Mistletoes attacked host tree in branch part, then in the point of branch, which was infected by mistletoes, there was a swelling form called houstoria. Nutrients and photosynthate, which came from proximal part of branch, flow mainly to mistletoe instead of to distal part of branch [3]. It caused obstruction in distal part of branch growth, then distal part of branch gradually dead.

Table 4. Number of host trees attacked by mistletoes and their damage scale.

| Scientific name | Local name   | Damage scale | Total | %  |
|-----------------|--------------|--------------|-------|----|
|                 |              | Very light | light | Moder-| Worse| Severely worse|       |
| *S. mahogani*   | Mahoni       | 128        | 71    | 29   | 14  | 26          | 90.8  |
| (L.) Jacq.      |              |             |       |      |     |             |       |
| *P. indicus*    | Angsana      | 1          | -     | -    | -   | 1           | 0.03  |
| Willd.          |              |             |       |      |     |             |       |
| *B. purpurea*   | B. kupu-kupu | 19         | 2     | -    | -   | 21          | 7.1   |
| L.              |              |             |       |      |     |             |       |
| *C. sebestana*  | Jatimas      | 2          | 3     | -    | -   | 5           | 1.7   |
| L.              |              |             |       |      |     |             |       |
| Total           |              | 150        | 76    | 29   | 14  | 26          | 295   |
| %               |              | 50.8       | 25.8  | 9.8  | 4.7 | 8.8         |       |

Table 4 displays the damage scale of host trees in three sections of the street. Half of attacked host trees (50.8%) were in very light damage scale. However there are host trees in critical condition,
because among *S. mahogany*, which were attacked by mistletoes, there were 14 trees (5.2%) and 26 trees (9.7%) in worse and severely worse damage scale, respectively. Physical characteristic of trees in condition of worse or severely worse significantly decreased, than their ecological and aesthetical function also decreased. Without adequate maintenance, the trees with worse and severely worse damage scale will totally be damaged.

In the case of *P. indicus*, there was only one tree with very light damage scale. Then, there were 19 trees (90.4%) of *B. purpurea* were attacked mistletoes with very light damage scale, and 2 trees (9.5%) with light damage scale. In the case of *C. sebestana* there were 2 trees (40%) and 3 trees (60%) with very light and light damage scale, respectively.

### 3.3. Tree damage in each road section

Table 5 enlisted number and percentage of trees damage scale in each section of road. In general, half (43.4-55.8%) of trees in each section of road were in very light damage condition. However trees with the highest percentage of worse and severely worse condition were found in North Medan Merdeka Road, followed by South Medan Merdeka and West Medan Merdeka Road. In North Medan Merdeka Road, it was measured 13.8% and 28.3% trees in the damage scale of worse and severely worse, respectively.

#### Table 5. Tree damage scale in roadside green belt of Medan Merdeka Road.

| Section of Street | Very Light | Light | Moderate | Worse | Severely worse | Total | Very Light | Light | Moderate | Worse | Severely worse | Percentage |
|-------------------|------------|-------|----------|-------|---------------|-------|------------|-------|----------|-------|---------------|-------------|
| North Medan Merdeka Utara | 23 | 5 | 4 | 6 | 15 | 53 | 43.4 | 9.4 | 7.5 | 13.8 | 28.3 |
| West Medan Merdeka | 63 | 33 | 10 | 4 | 3 | 113 | 55.8 | 29.2 | 8.8 | 7.2 | 2.7 |
| South Medan Merdeka | 64 | 38 | 15 | 4 | 8 | 129 | 49.6 | 29.5 | 11.6 | 8.1 | 6.2 |
| Total | 150 | 76 | 29 | 14 | 26 | 295 | 50.8 | 25.8 | 9.8 | 4.7 | 8.8 |

Damage scale of overall roadside green belt in each sections of road is presented in table 6 where percentage of green belt damage was based on ratio of sum of all tree damage scores compared to the maximum damage score of all trees in roadside green belt (table 6).

#### Table 6. Damage category of roadside green belt.

| Section of Road | Total Score | Maximum Score | % Damage | Category of Damage |
|-----------------|-------------|---------------|----------|-------------------|
| North Medan Merdeka Utara | 144 | 550 | 26.2 | Light |
| West Medan Merdeka Barat | 190 | 1135 | 16.7 | Very light |
| South Medan Merdeka | 240 | 1100 | 21.8 | Light |
| Total | 574 | 2785 | 20.6 | |

The highest value of roadside green belt damage was found in North Medan Merdeka, followed by South Medan Merdeka and West Medan Merdeka. Value of greenbelt damage ranged from 16.7% in West Medan Merdeka Road, 21.8% in South Medan Merdeka Road, and the highest value 26.2% in North Medan Merdeka Road. Therefore, category of green belt damage was very light in West Medan Merdeka Road, and light in both North and South Medan Merdeka Road.
The damage value in West Medan Merdeka Road was the lowest (16.7%). It appeared due to among 227 trees, there were 113 trees attacked by mistletoes. In South Medan Merdeka Road, among of 220 trees, there were 129 trees attacked by mistletoes, and in North Medan Merdeka Road, among 110 trees, there were 71 trees attacked by mistletoes which 15 trees with severely worse damage.

3.4. Recommendation

Good physical characteristic of trees attacked by mistletoes gradually decreases, therefore maintenance to remove mistletoes is necessary. Without adequate maintenance, the damage stage will increase to worse condition. Maintenance type for each category of damage is shown in table 7.

Maintenance type is selected depends on damage stage. Trees with very light damage stage is maintained by cutting the small branch to remove houstoria of mistletoes while trees with light and moderate damage were supposed to do light pruning by removing more branches which contain houstoria of mistletoes and to prune other healthy branches to maintain balance of canopy shape. Furthermore trees with worse to severely worse damage stage are supposed to do heavy pruning by removing all branches including main branches and also to prune to maintain canopy shape. Removing mistletoes is not only important to maintain the host trees but also to reduce bird food, hence eventually reduced population of birds distributing the seed of mistletoe. It was reported that bird species richness was associated with number of mistletoes plants [5].

| Stage | Damage stage | Maintenance type* |
|-------|--------------|------------------|
| 1     | Very light, $R \leq 20$ | $v$ |
| 2     | Light, $20 < R \leq 40$ | $v$ |
| 3     | Moderate, $40 < R \leq 60$ | $v$ |
| 4     | Worse, $60 < R \leq 80$ | $v$ |
| 5     | Severely worse, $80 < R \leq 100$ | $v$ |

*Notes: (a) cutting of mistletoes haustoria, (b) light pruning by pruning the selected branches; (c) heavy pruning by pruning many branches; and (d) pruning most of host tree canopy which was parasited by mistletoe.

4. Conclusion and Suggestion

Quality of trees as element of roadside green belt in Medan Merdeka Road in Central Jakarta decreased due to parasite plant of mistletoes. There were 557 trees found in all sampling plots in North, West and South sections of Medan Merdeka Road which 295 trees (52.96%) were parasited by mistletoes. It was found that the only one species of mistletoes of *D. pentandra* (L.) Miq attacked 4 species of host trees, namely *S. mahagoni* L., *P. indicus* Willd, *B. purpurea* L., and *C. sebestana* L.

Trees, which were attacked by mistletoes consisted of *S. mahagoni* L (90.8%), *B. purpurea* L (7.1%), *C. sebestana* L (1.7%), and *P. indicus* Willd (0.03%). The damage scale varied among the trees which were attacked by mistletoes. Half of host trees (50.8%) were in very light damage scale, followed by light damage scale (25.8%), moderate damage scale (9.8%), severely worse damage scale (8.8%), and worse damage scale (4.7%).

Generally greenbelt damage was categorized as very light in West Medan Merdeka, and light in North and South Medan Merdeka Road. However among of *S. mahagoni* there were trees in worse and severely worse damage stage, which were distributed in North, West and South section of Medan Merdeka Road. Finally maintenance is needed, because without removing mistletoes, the damage scale may increase to worse and severely worse scale.
References
[1] PU 2012 Guidance for Planting of Trees in Road Network. Availableon (http://www.pu.go.id/uploads/services/info20130422141127.pdf) (Accesed 15 Mei 2016) (In Indonesian)
[2] Widyastuti S M, Sumardi and Harjono 2005 Forest Pathology (Yogyakarta: Gadjah Mada University Press) (In Indonesian)
[3] Sunaryo E, Rachman E and Uji T 2006 The Damage of Plant morphology Caused by Mistletoes (Loranthaceae and Viscaceae) in Purwodadi Botanical Garden Berita Biologi 8(2) 129–139 (In Indonesian)
[4] Limon M P D, Santana Z C, Balanos M E Q 2016 Mistletoes infection in an urban forest in Mexico City Urban For. Urban Green. 17 126–134
[5] Zuria I, Castellanos I and Gates J E 2014 The influence of mistletoes on birds in an agricultural landscape of central Mexico Acta Oecol. 61 51–56