The pattern of germination of teak mistletoe seeds in relation with parasitism

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Abstract. The objectives of this research are to test the initial viability and germination pattern of teak mistletoe seeds, namely Dendrophthoe pentandra and Macrosolen tetragonus in association with parasitism. Research results showed that the pattern of D. pentandra germination was different from that of M. tetragonus. The germination process of D. pentandra showed incomplete development of germination morphology, marked by an absence of development or growth of hypocotyl and cotyledon. Parasitism was more dominant in D. pentandra, supported by the fact that the sum of mean germination day (RH) in the stem of teak seedling was faster (17.54±2.77 days), as compared with that of M. tetragonus (35.13±1.76 days), although mortality of M. tetragonus seedlings was very low (±3%), whereas that of D. pentandra was fairly high (±34%). It was related to the life cycle of M. tetragonus, which was longer than that of D. pentandra. In the attachment of seeds in the standing tree stems, it was proven that the germination percentage (%K) of D. pentandra (38.5%) was higher than that of M. tetragonus (11.1%). Seed germination of D. pentandra from bird feces also showed that %K (46.4%) was higher than seed attachment in tree stem, including M. tetragonus. It was supposed that there was a correlation between the easiness of germination and parasitism character in teak mistletoes. It was considered that parasitism of D. pentandra was more prominent than that of M. tetragonus in a teak host.

1. Introduction

Based on the results of the study, it was found that there were three types of mistletoes infecting teak trees, i.e., Dendrophthoe pentandra, Macrosolen tetragonus, and Viscum articulatum as hyperparasite, which have caused impaired teak growth and decreased teak fruit production in Padangan Clonal Seed Orchard (CSO) [1]. It was reported that teak mistletoe had reduced fruit and seed production of teak under the limit average of it per tree amount of 500 grains equivalent weight 0.5 kg [2]. One of the biological aspects of these mistletoes in teak trees is the autotrophic period of their life cycle, and it seems that this is the best period to apply several control methods in regards to their physical features (mechanical), biological agents, silvicultural measures, and chemical features [3].
2. Method

2.1. Research site
The research was conducted at the seed testing laboratory, the nursery of Puslitbang Perhutani Cepu, and teak stands in the Padangan CSO area for approximately nine months, from February until October 2015.

2.2. Research procedure
Approximately as many as 500 grains of the ripe mistletoe fruits in yellowish-green color from each type were collected of *D. pentandra* and *M. tetragonus* in the Padangan CSO. The fruit dimensions, including the length and width, were measured using the digital calipers, and the mistletoe fruits were stored in the refrigerator no later than 2-3 days after being removed from the trees so that the germination test could be immediately conducted.

2.2.1. The germination test method in the germinator and greenhouse. Since the standard test for germination of parasitic species as a parasitic plant has not yet been stipulated [6], in this study, the testing procedure was applied by adjusting the ISTA provisions and supporting references, i.e. [7, 8]. The seeds were germinated on a media of fine sand and tested by the test method on paper (UDK) using straw paper. Due to the limited availability of seeds in certain fruiting seasons, the sand media germination test was only carried out on *D. pentandra*, and the test method on paper (UDK) was carried out on *D. pentandra* and *M. tetragonus*.

a. Test on paper (UDK) (vigor test)
The straw paper was first sterilized using an oven at 100 °C for ± 24 hours. To prevent the growth of fungi, bacteria, and other microorganisms that might affect the germination of mistletoe seeds, especially for the types of mistletoes in this study, the straw paper was not used, and the tubs were moistened with water. The straw paper was cut to the same size as the petri dish (cp) (±9 cm in diameter), and 3-4 sheets of straw paper were arranged at the bottom of the petri dish. The seeds were removed from the exocarp and the fleshy layer of the mistletoe fruits by squeezing the tip of the fruit using fingers [7, 8], and then...
the seeds attached to the viscin were directly placed with the help of tweezers onto the surface of the parchment paper on each side (cp) as many as 4-5 seeds. There were four replications, and in each replication, there were six seeds (cp), so the number of seeds tested was equal to (5 cp x 4 seeds)+(1 cp x 5 seeds) = 25 seeds, with a total of 4 replications x 25 of 100 seeds. Each petri dish was appropriately labeled and immediately inserted into the germinator.

Observations on the seed germination process in sand and UDK media were carried out every day for ± two months to observe the development of the seed structure in the germination process, including the root system, shoots, cotyledons, terminal buds, and other seed structures [9].

2.2.2. Germination test method by attaching seeds to teak seedlings. The variety clone teak seedlings of ten months of age (PHT 1 for D. pentandra and PHT 2 for M. tetragonus) were prepared and grown in polybags. As many as 120 seedlings were prepared for each. The sample design for each type of mistletoe was four replications, and each replication contained 30 samples. In each teak seedling sample, one mistletoe seed was attached directly to the seedling stem manually, and the position could be at the bottom, in the middle, or on the top of the seedling stem, using the natural viscin that surrounded the mistletoe seeds [10, 11]. After the attachment, the suitability of germination (fate) of the seeds was monitored every day for ±3 months until the mistletoe seedlings grew well. The individual mistletoe seeds were categorized as germinated or sprouts if the tip of the radicle began to appear, and the hypocotyl was grown until it was attached to the host branch [7]. Following this, it developed into a seedling form if the first pair of small leaves appeared [8].

2.2.3. Germination test method by attaching seeds to the teak trees. Five teak trees of range from 20 to 30 years of age and 25 to 40 cm dbh were identified for each species of D. pentandra and M. tetragonus, and the growth of small branches/young twigs/juveniles appeared. The sample seeds were manually attached to each sample tree at the top, middle, and bottom canopy, and as many as two seeds were deposited in each area. There were six seeds in each sample tree, with a total of 30 seeds of the germination test sample for each mistletoe. After the attachment, the suitability of germination of the seeds (fate) was observed every seven days for D. pentandra and two days for M. tetragonus based on the orientation of the initial study on the developmental time of the seed germination process of the mistletoe species in teak. The observation time was ± 1.5 to 2 months until the mistletoe seedlings grew well.

2.2.4. Test method for germination of mistletoe seeds from bird defecate (Roxburgh 2007). In this study, an inventory of sample trees was carried out where seeds of the natural mistletoe (D. pentandra) were found from bird defecate, marked by five representative trees. In each sample tree at the top, middle, and bottom of the canopy, as many as 1 or 2 seeds were observed for the germination process. Observation of the seeds’ suitability of germination (fate) was monitored every seven days, and the observation time was ±3 months until the mistletoe seedlings grew well.

2.3. Data analysis
The observational data were processed by tabulation, and the physiological quality parameters of the seeds were calculated using the Czabazor equation with the result of % K (percentage of sprouts), NK (sprout value), RH (average number of days to germinate) in reference to [12, 13, 14, 15, 16].

\[
\text{Percentage of germination phase (%K)}
\]
\[
\text{\% K} = \frac{\text{The sum of seed germinate}}{\text{The sum of seed sown}} \times 100\% 
\]

Value of germination (NK)
Equation 1:
NK₂ = PV x MDG

\[ PV = \frac{\% \text{ germination in day to} - i}{\text{The sum of day that need}} \]  

The peak value of germination, took the biggest value

MDG = \[ \frac{\% \text{ germination in the final observation}}{\text{the time of observation}} \]

MDG = Value of the average value germination daily

Equation 2:

\[ NK₂ = \frac{\sum RH}{N} \times \% K \times 10 \]  

RH = The sum of average germination daily

N = The sum of seeds that germinated

The sum of average germinate daily (RH)

\[ RH = \frac{n_1 \times h_i + n_2 \times h_2 + \cdots + n_i \times h_i}{n_1 + n_2 + \cdots + n_i} \]

hi = \[ \sum \text{seed germinate in day to-i, } \]

ni = day to-i

3. Results and discussions

3.1. Mistletoe seed germination test results

The recapitulation of the calculation of the percentage of germination (%K), germination value (NK), the average number of days of germination (RH) from the germination of teak mistletoe seeds in several germination methods is presented in Table 1. The graph of the trend of the percentage of sprouts is presented in figure 1.

| No | Mistletoe species | Method of germination | Time of observation | %K | NK₁ | NK₂ | RH |
|----|------------------|-----------------------|---------------------|----|-----|-----|----|
| 1a | MT (Macrosolen tetragonus) | Direct test (UDK) | T₆₀ | 39.00±23.64 | 1.56±1.02 | 1.62±1.37 | 10.10±2.71 |
| 1b | MT | Attached on seedling (PHT2) | T₇₀ | 93.85±3.13 | 1.38±0.39 | 11.71±1.28 | 35.13±1.76 |
| 1c | MT | Attached on tree | T₆₀ | 11.10 | 0.02 | 1.64 | 40.33 |
| 2a | DP (Dendrophthoe pentandra) | Attached on seedling (PHT1) | T₇₀ | 64.58±14.05 | 2.26±1.35 | 3.90±1.34 | 17.54±2.77 |
| 2b | DP | Attached on tree | T₆₀ | 38.50 | 0.26 | 7.10 | 47.30 |
| 2c | DP | Bird defecate | T₆₀ | 46.40 | 0.50 | 3.94 | 24.00 |

As notes, the germination on fine sand media and using straw paper in the germinator for D. pentandra was unsuccessful because a total of 100 seeds and 200 seeds, respectively, could not grow or the structure of the seeds (embryo) including radicles, plumules, cotyledons did not show the process of development/growth of sprouts into seedlings. So that, those data are not presented in table 1. Table 1 shows that through the direct test (UDK), the percentage of germination (%K) in M. tetragonus was
only 39.0±23.6%, and the average number of germination days (RH) was 10.1±2.7 days. For the treatment of the seed attachment in teak seedlings (PHT 2) for *M. tetragonus*, the %K was higher (93.9±3.1%), but the RH (35.1±1.8 days) was slower than that of *D. pentandra* in teak seedlings (PHT 1) of % K (64.6±14.1%) and RH (17.5±2.8 days).

A mistletoe germination test was also carried out on standing trees against *D. pentandra* and *M. tetragonus*, but on *M. tetragonus* it was not possible to observe the germination process of the seeds from the bird dropping because it was challenging to find/identify the defecate. In table 1, *D. pentandra*, through the germination test of bird defecate obtained (%K) 46.4% and RH of 24.0 days, indicating that they could germinate more and faster than the same seeds which were attached on trees where the values of (%K) 38.5% and RH of 47.3 days were obtained. For the treatment of the attachment of *M. tetragonus* seeds to the teak trees, the %K was lower (11.10%), but the RH of 40.33 days was slightly faster than that of *D. pentandra*, but the %K was lower, and the RH was slower than those of the seed germination of *D. pentandra* from the bird defecate.

The results of the *M. tetragonus* germination test on straw media in the germinator showed a downward trend movement by 39% of the sprout percentage (table 1). The result of this germination also showed that seed vigor was seed viability which showed the ability of seeds to grow normally under sub-optimum conditions, including adjustment to the straw paper media that was not humidified based on the reference from [9]. In comparison, the results of this study were lower than those of the germination test under optimum conditions for the mistletoe *Ligustrum lucidum* W.T. Aiton (Oleaceae) and *Handroanthus chrysotrichus* Mart. Eex DC. (Bignoniaceae) was conducted in a germination chamber (Model MDG2000, Seedburo Company, USA). By putting them under continuous light and constant temperature (25 °C) [17], the percentages of germination for seeds taken from bird defecate by viscin treatment were obtained, i.e. (89.5±9.3)% and (92.0±9.3)% with t14=0.537, p>0.05, respectively.

![Figure 1](image-url)

**Figure 1.** The percentage value of germination of mistletoe seeds on the teak trees from the beginning to the end of the observations

Figure 1 shows that in UDK, *M. tetragonus* began to germinate on the 3rd day, and on the 30th day, there was no increase in %K, which was marked by a horizontal line. In the germination test on PHT2 teak seedlings, *M. tetragonus* began to germinate on day 18 later than *D. pentandra*, which began to germinate on day 10 and days 65 to 70, these two types of mistletoes did not experience an increase in
%K. In the germination test on teak tree branches/twigs, *D. pentandra* began to germinate on the 37th day later than *D. pentandra*, which began to germinate on the 22nd day, and on days 44 to 56, the % K of these two types of mistletoes did not increase. Based on the germination test, the seeds of *D. pentandra* from the bird defecate began to germinate on the 18th day faster than the seeds from the attachment treatment of *D. pentandra* and *M. tetragonus* 44th day, there was no increase in their percentage (%K).

After the treatment (attachment) of mistletoe seeds on small branches/twigs of standing teak trees, it turned out that *M. tetragonus* had a lower germination percentage (%K) (11.1%) than *D. pentandra* (38.5%) (table 4.1). Compared to the report of [18], the successes of germination for *A. flavida* (96.9%) and *P. tetrapetala* (97.4%) were significantly higher than those of the two types of mistletoes on the teak trees. This was due to, among other things, the intensity of light and humidity that were not suitable for the germination of mistletoe seeds on small branches/twigs on standing teak trees and the micro temperature range that was very extreme (high) at the time of observations.

Thus, in summary, the results of the mistletoe seed germination tests for *D. pentandra* and *M. tetragonus* through the treatment (attachments) on seedling stems showed (%K) in the range of ±(65–94%), while in standing teak tree trunks, a value of ±(11-39%) was obtained. The treatment technique (attachment) on seedling stems obtained higher germination capacity than on teak tree stems. This is because the environmental conditions in the nursery such as temperature, light, relative humidity are stable or not fluctuated, and maintenance support (watering) is a factor that supports/increases the success of germination, while in the forest environment, there are fluctuating environmental conditions that can reduce the success of germination. For the validity of the results of this study, it is necessary to increase the number of samples of mistletoe seeds and standing host trees in the growing environment and observations in different seasons.

In comparison, seed germination of (*D. pentandra*) from bird defecate attached to small branches/twigs had (%K) (46.4%) greater percentage than that of the seeds attached manually to *D. pentandra* (38.5%) and *M. tetragonus* (11.1%) (table 1). These results confirm the report of [19], which showed that gut-passed seeds had a higher germination rate and seedling development than those of seeds from fruits obtained by manual fruit pulp removal. In many types of mistletoe, this can be explained by the presence of physical and chemical scarification by digestive enzymes or washing of the seminal covering accelerated relaxation of dormancy due to incorporation, gas exchange, or release of inhibitors in the testa teguments. According to [20] and [21], the seeds of the mistletoe are not known to form dormancy, so they germinate immediately after being released from the exocarp and have no seed coats [22]. Thus, scarification and seed dormancy did not affect the germination of the *P. calyculatus* seeds [8], and presumably, it also occurred in the seeds of *D. pentandra* and *M. tetragonus* mistletoes in this study. In addition, the gut-passed condition might aid in separating seeds from fruit pulp and assimilation of large amounts of lipids that inhibit *P. calyculatus* germination [23].

Compared to the result of the study by [8], the percentage of K (%K) of *Psittacanthus calyculatus* seeds was obtained. The seeds were attached manually to the complete factorial research design consisting of a combination treatment of the host provenance (the host trees where the mistletoe fruits were harvested) with the host fate (the host trees where the mistletoe seeds were attached). There were three types of host trees tested, namely, *Prunus serotina* (Ps) and *Crataegus pubescens* (Cp) as common hosts and *Salix bonplandiana* (Sb) as rare hosts for the *P. calyculatus* mistletoe. The results of (%K) showed that the percentages of the treatment combinations of Ps with Ps; Ps with Cp; Ps with Sb were 50%, 40%, and 40% more, respectively; Cp with Ps; Cp with Cp; Cp with Sb were 60%, 50%, 60%, respectively; Sb with Ps; Sb with Cp; Sb with Sb were 20, 70, 70%, respectively, and they found to be higher than that (%K) of seeds of *D. pentandra* (38.5%) and *M. tetragonus* (11.1%) except for host provenance with host fate (Sb with Ps) lower (20%) than (%K) for *D. pentandra*.

It also was reported [8] that (%K) of seeds of *Psittacanthus calyculatus* were derived from bird defecate in the combination of host provenance and host fate (Ps with Ps; Ps with Cp; Ps with Sb) with the results of more than 90%, 80%, and 70 %, respectively; (Cp with Ps; Cp with Cp; Cp with Sb) 80, 90, and 90%, respectively; (Sb with Ps; Sb with Cp; Sb with Sb) 40%, 40%, and 100%, respectively,
and the K value was significantly higher than that (%K) of *D. pentandra* seeds from bird defecate (46.4%).

3.2. *The stages of the germination process of mistletoe seeds on teak trees*

The results showed that generally, the shoot grew at the tip of the green round seeds on day 1, bud enlargement on days 3 to 5, and finally, the tip of the seed turned black from the 25th day to the 69th day (figure 2).

![Figure 2](image_url)

**Figure 2.** The stages of development of *D. pentandra* seed germination on the straw paper media, (a) growth of green shoots at the tip of the seeds, (b) enlargement of shoots, (c) shoot tips growing bigger and rounded, (d) shoot tips beginning to dry out, (e) and death of shoot, and seeds were mostly black.

Based on figure 2 of *D. pentandra*, the shoot grew at the tip of the green round seeds on day 1, shoot enlargement occurred on days 3 to 4, and seed tips were blackened on days 21 to 73 (figure 2). However, for *M. tetragonus*, it turned out that there was an early germination process that met the criteria for the germination process, which can be described in an outline of the stages of the mistletoe germination process referring to [17], modified, and personal observations as described in table 2.

In reference to table 2, the final germination stage of *M. tetragonus* seeds through the direct test (UDK) only reached the initial formation process of haustorium attached to the base of straw paper, followed by the drying of the seeds. In this case, it had not reached the next germination stage, as non-parasitic plant sprouts are generally characterized by the appearance of fully open cotyledons and the emergence of leaf shoots and first leaf [9]. Therefore, to obtain the results of a complete germination process, further germination tests were carried out by attaching *D. pentandra* mistletoe seeds to teak seedlings (PHT 1) and those of *M. tetragonus* to teak seedlings (PHT 2). The results obtained showed complete seed germination until it reached the seedling stage. A simple grouping of the criteria for the germination process of mistletoe seeds in teak seedlings that can distinguish the stages of the germination process refers to [8], modified, and personal observations by authors as described in tables 3 and 4.

For the treatment (attachment) of mistletoe seeds on teak seedlings, it turned out that *M. tetragonus* tended to have a higher percentage of germination than that of *D. pentandra*. As described in the germination stages (tables 3 and 4), *M. tetragonus* reached its early germination stage (I) (2-5 days) earlier than *D. pentandra* (4-17 days). The time in reaching the early germination stage in *M. tetragonus* was considered to correspond to the initial germination time (±1 week) after treatment (attachment) of *Phoradendron affine* seeds that infected *Spathodea campanulata* P. Beauv. (Bignoniaceae) [17].

In the subsequent germination growth, hypocotyl in *D. pentandra* appeared with upright characteristics and encouraged the opening of two cotyledons as in *P. affine*, but the development of *D. pentandra* cotyledons was not perfect. *M. tetragonus* formed a different germination pattern, and it was
seen that the hypocotyl growth was curved in a semicircle or more towards the attachment of the bark surface to the initial formation of the haustorium disk. The occurrence of curvature of the hypocotyl stem is presumably due to more rapid longitudinal growth in the middle than at the bottom (base) and tip areas. He [24] stated that phylogenetically one of the characters found in parasitic plants, both hemiparasitic and holoparasitic, is the decline in the development process of cotyledons. This is in accordance with the observation report of [25] and the report of this study for the germination character, especially for *D. pentandra* rather than for *M. tetragonus*. The longitudinal growth character is supported by a bending mechanism caused by the uneven distribution of growth regulators and is considered to end when the hypocotyl curvature reaches a semicircular or circular form, as stated by [26]. Johri and Bhatnagar stated that several members of Loranthaceae that experienced a decline in cotyledon growth included *Amylotheca* van Tiegh., *Elytranthe* Bl., *Lepeostegere* Bl., *Macrosolen* (Blume) Rechb., and *Nuytsia* R. Br. He [24] also stated that several other genera such as *Amyema*, *Barathranthus* (Karth.) Miq, *Dendrophthoe* Mart, and *Helicanthes* Dans had the experience that one of their cotyledon pieces did not develop, which simulated the group to become a pseudo-monocotyl.

In the continuation of the germination stage II (mid-period), it turned out that *M. tetragonus* required 3–18 days faster than *D. pentandra* (9–49 days), and it was also faster than *P. affine*, which required a much more extended period (7 months) [17]. At the normal germination stage (III), the opposite results were obtained. *D. pentandra* germinated after 10 to 64 days, marked by the first pair of leaves' appearance, which was relatively faster than *M. tetragonus* which reached its normal germination in 19 to 68 days. Meanwhile, *P. affine* required a relatively longer time (+2 months) than the other two types of teak mistletoes to reach normal germination.

| Stages | The early germination criteria | Picture |
|--------|-------------------------------|---------|
| I (2-6;23;50 days) | The brown/green seeds were interspersed with white/green stripes, the outer skin began to peel, shoots of prospective stems (plumula, hypocotyl) grew from the tip of the seeds, and the tips became rounded and yellow. | ![plumula](image1) |
| II (3-13;20 days) | The hypocotyl grew long, and the yellow-headed tip as the haustorium disk initiation also grew b. | ![hypocotyl](image2) |
| III(4-15; 20-29 hari) | Hypocotyl with the yellow head at the tip growing elongated curved which tended to move downwards to attach to the base of the straw paper forming the early growth of the haustorium disk c. | ![growth](image3) |

a plumula is the first bud of an embryo, the hypocotyl is the embryonic part or part below the cotyledon and above the radicle (but sometimes it covers it), the embryonic stem of a seed (Little and Jones 1996; Norton et al. 2002); b special roots of parasitic vascular plants that can penetrate and absorb food and other elements from the infested tissue; c Early growth of the haustorium disk as a protrusion (protrusion) of the radicle, visible green shoots are considered to be the germination characteristics [17].

The death time of *D. pentandra* sprouts from the 41 seeds (34.2%) occurred after 12-100 days, while for *M. tetragonus*, the sprouts from the four seeds (3.3 %) died relatively faster, i.e., between 48 and 68
days. This indicates that the number of dead seeds of *M. tetragonus* was less than that of *D. pentandra*, but the time for *D. pentandra* to die was slightly longer than that of *M. tetragonus*. It took a longer time for *P. affine* to die (3 months) compared with the two types of mistletoes in teak trees. The very low mortality of *M. tetragonus* sprouts indicated a longer expected sprout growth than that of *D. pentandra*. This is in accordance with the analogy of sprouting to plant growth reported by [18], stating that the mortality of the mistletoe plant (establishment) in *Alepis flavida* was high (±70%) while that for *P. tetrapetala* was very low. This indicated that the growth process to become a parasitic plant in *Peraxilla tetrapetala* was slower than that of *A. flavida*.

It should be noted that in this study, *D. pentandra*, which was attached to teak seedlings, did not show any fallen sprouts, but nine seeds of *M. tetragonus* (7.5%) fell down. The sample of parasitic seed sprouts fell from their attachment to the teak seedling stems, and this was due to the disruption of stem flow from rainwater, watering, or other disturbances.

**Table 3.** The stages of the *D. pentandra* seed germination process using attachment on teak seedlings

| Stages | Criteria for the germination process |
|--------|--------------------------------------|
| I (4-17 days) | The fruit dimensions were (n=1246) (p=12.50±0.77 mm), and (l=6.82±0.31 mm) (a). The white/brown seeds had brown seeds and had white/brown seed heads, tips of the seeds were white with white strings (b), tips of the seeds were brown/green, marked by viscin starting to dry out (c) [7, 22, 17] pers. obs. |

**Explanation:**

II (9-49 days) | The tip of the seed was green, the cotyledons began to open from the endosperm [16] but could not develop completely (a), small leaf buds appeared with enlarged shoots as many as 1, 2, 3, ..., and the appearance of small/large leaves (b)

III (10-64 days) | Leaf shoots developed into the first pair of small leaves showing normal germination *a* followed by an increase in the number of leaves with various sizes of small, medium, and large (a, b, c)

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*a* [18]
Table 4. The stage of the germination process of *M. tetragonus* seeds by attaching them to the teak seedlings

| Stages          | Criteria for the germination process                                                                 |
|-----------------|-------------------------------------------------------------------------------------------------------|
| I (2-5 days)    | The fruit dimensions were \((n=157) \ (p=9.87\pm0.48 \ mm)\) and \((l=6.60\pm0.65 \ mm)\). Brown/green seeds interspersed with white/green stripes (a), the outer skin began to peel, shoots of prospective stems (plumula) from the tip of the seeds (b) grew fast. |
| II (3-18 days)  | Plumula grew lengthwise into hypocotyl, appeared at the yellow tip of the head as the initiation of the haustorium disk. It developed/grew curved with a yellow-headed tip, elongated and attached to the stem of the teak seedling forming the initial growth of the haustorium disk (a, b, c), the seeds appeared to be lifted apart from the attachment (d), hypocotyl shoots grew in two branches; followed by cotyledons starting to open from the endosperm [16], at the end of the hypocotyl, leaf buds began to grow (e). |
| III (19-68 days)| Leaf shoots eventually grew into the first pair of young leaves showing normal germination (a), followed by an increase in the number of leaves with various sizes of small, medium, and large (b). |
4. Conclusion

The percentage of the germination test (patch treatment) on teak seedlings for *M. tetragonus* (%K) (93.9±3.1%) is higher than that of *D. pentandra* with (%K) (64.6±14%). However, the percentage of the germination test (patch treatment) on the standing tree branches/twigs for *D. pentandra* through the seed germination test on the bird defaecate (%K) (46.4%) is higher than that of the patch treatment (%K) (38.5%) and that of *M. tetragonus* through patch treatment (%K) (11.1%). The germination pattern of *D. pentandra* is characterized by the absence of the development/growth of the hypocotyl and cotyledons; however, *M. tetragonus* is characterized by the development/growth of the two parts of the seed structure. This is thought to be related to the parasitic character of *D. pentandra*, which is more noticeable than *M. tetragonus*.

5. References

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