Infestation of *Dendrophthoe pentandra* (L.) Miq. on Various Canopy Shading and Plants Diversity in Purwodadi Botanic Garden, Indonesia: A study on *Cassia fistula* L.

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Abstract. Mistletoe *Dendrophthoe pentandra* (L.) Miq. is a parasitic plant commonly found parasitizing and infesting medicinal plants such as *Cassia fistula* L. This research aimed to investigate the infestation of *D. pentandra* on *C. fistula* on various trees canopy shading, infested host number, and plant diversity. The study was conducted in Purwodadi Botanic Garden which is located in Purwodadi, Pasuruan, East–Java, Indonesia from January to March 2020. Data collection was conducted by explorative and descriptive methods in each block location in the garden. Sampling plots were determined by the purposive sampling method using 20 × 20 m plot^{-1} in each block where the tree of *C. fistula* found. The canopy shading was categorized as: open (iv) = light interception > 90 %, rather open (iii) = light interception = 60 % to 90 %, rather shady (ii) = light interception 30 % to 60 %, shady (i) (light interception < 30 %). The result showed that the infestation of *D.pentandra* was affected significantly by the plant canopy shading and the infested host number in the blocks. The highest infestation of mistletoe *D. Pentandra* on *C. fistula* was found in the open canopy and the highest infested host plants in the block III.D with the parasite number 13 plant^{-1}. The tree plant diversity in the blocks tend to have negative correlation to the infestation of *D. pentandra* on *C. fistula* with r= –0.18.

Keywords: Golden shower tree, Malayan mistletoe, medicinal plant, purging cassia, shoot parasitic plant

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1 Introduction

Mistletoe is a shoot parasitic plant commonly found parasitizing wild and cultivated plants. Some species of the mistletoes have special characteristics for compatibility or specificity to their hosts determined by chemical, physiological and physical processes at the mistletoe–host interface [1]. They live and only found on some or particular plant species as hosts such as *Viscum articulatum* Burm. f. on *Dendrophthoe pentandra* (L.) Miq. [2], *Arceuthobium minutissimum* Hook. f. on *Pinus wallichiana* A.B. Jacks. [3] *and Viscum combreticola* Engl. on *Combretum erythrophyllum* (Burch.) Sond. [4]. The other mistletoes parasitize many tree species [5] such as *Cassytha filiformis* L.(26 species) [6], *Tapinanthus globifer (*A. Rich.) Tiegh. (22 species) [7], and *Viscum rotundifolium* L.f. (six species) [4]. *D. pentandra* parisitized 86 plant species in Purwodadi Botanic Garden, East Java, Indonesia [2].

D. pentandra belongs to the family Loranthaceae growing and broadly distributes from eastern India eastwards throughout Indochina; Malesia: Sumatra, Peninsular Malaysia, Singapore, Borneo, Java, Papua, rare in the Philippines (Palawan, Luzon) and western Lesser Sunda Islands (Bali, Sumba, Flores) [8]. It is a common mistletoe parasitizing on cultivated plants in Purwodadi Botanic Garden and fruit plants in East Java such as *Cassia fistula* L.*, Swietenia macrophylla* King*, Mangifera indica* L.*, Citrus hystrix* DC.*, Syzygium samarangensis* (Blume) Merr. & L.M. Perry, and *Annona squamosa* L. [2, 9]. *D. pentandra* has potential used for medicinal plants as antioxidant, antidiabetes [10] and antibacterial [11].

Parasitization and infestation of mistletoes will reduce growth and development of the host plants because they absorb water and nutrients from their hosts. A study reported that parasitization an infestation of the mistletoe inhibited the growth of mango (*Mangifera indica* L.), citrus (Citrus spp.), nutmeg (*Myristica fragrans* Houtt.), avocado (*Persea americana* Mill.), sandalwood (*Santalum album* L.), neem (*Azadirachta indica* A.Juss.), and camphor trees (*Cinnamomum camphora* (L.) J.Presl.) [12]. A study reported that the parasitic plant caused stunted growth, mortality, and reduced yield of citrus, *i.e*. 65 %, 55 %, and 95 % respectively in Central Ghana [13]. Infestation and distribution the mistletoes on the host plants depended on biotic and abiotic factors such as infested host plants, dispersers, plants diversity, compatibility between host and parasite, and light interception in the plant canopy layers. Birds have important role on the dispersal of seeds mistletoes such as the seeds *D. pentandra* at Purwodadi Botanic Garden

D. pentandra is a hemiparasitic plant that needs light for its growth and development [3, 7]. Hemiparasite has green leaves and produces its own photo assimilates and obtaining water and nutrients through its haustoria from its hosts [14]. Light is also needed for seeds germination for this parasite. Thus, canopy shading by neighbor treesor in the trees will affect light interception by tree canopy layer, seeds germination and the growth of the parasite. A study also reported that shady condition limits the development of *Agelanthus natalitius* (Meisn.) Polhill & Wiens such as seed germination and seedling growth [4].

C. fistula belongs to the family Leguminosae which has been cultivated and conserved in Purwodadi Botanic Garden. It is planted in several blocks location in the garden and various light interceptions also to be a dominant host for *D. pentandra*. It has potential as a medicinal plant containing various pharmacological compounds which have activities as antimicrobial, antifungal, antipyretic, analgesic, larvicidal, anti-inflammatory, antioxidant, antitumor, hepatoprotective, hypoglycemic activities, antidiabetic activity, and laxative properties [15].

Investigation the infestation of *D. pentandra* on *C. fistula* on various neighbour trees canopy shading, host infested number and plant diversity is interesting because there is no

information about this study, especially in Indonesian Botanic Gardens. It use and important to cultivate and control mistletoes for developing *C. fistula* as medicinal plant. This research aimed to investigate the infestation of *D. pentandra* on *C. fistula* in various trees canopy shading and infested host number in Purwodadi Botanic Garden.

2 Materials and methods

2.1 Time and location

The research was conducted in Purwodadi Botanic Garden (Figure 1) from January to March 2020. The garden is located in Purwodadi District, Pasuruan Regency, East Java Province, Indonesia at about 300 m asl with an area of 85 ha [16]. Climate data from climate station in Purwodadi Botanic Garden during 2014 to 2019 was recorded average of precipitation, rainy day, relative air humidity (RH), minimum and maximum temperature, *i.e.* 2 232 mm yr^{-1}, 152 d yr^{-1}, 74.33 %, 20.37 °C, and 30.82 °C, respectively (Table 1).

Table 1. Climate data in Climate Station of Purwodadi Botanic Garden during 2014 to 2019

Year	Precipitation (mm yr^{-1})	Rainy day (d yr^{-1})	RH (%)	Minimum temperature (°C)	Maximum temperature (°C)
2014	1 676	157	72.66	20.30	30.68
2015	1 568	141	74.64	19.89	30.28
2016	3 134	162	74.45	20.27	30.29
2017	3 554	193	72.45	20.45	31.32
2018	1 939	143	75.07	20.62	31.66
2019	1 564	115	76.71	20.70	30.70
Average	2 239	152	7.433	20.37	30.82

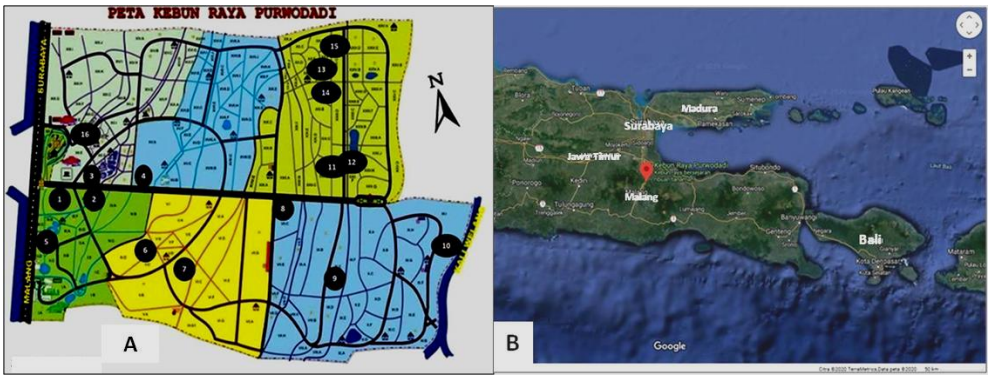

Fig 1. Research location: A. Map of Purwodadi Botanic Garden; B. = Location of Purwodadi Botanic Garden; sampling plot location

2.2 Data collection and analysis

Data collection was conducted by explorative and descriptive methods in any block locations in the garden. Sampling plots were determined by the purposive sampling method using 20 m × 20 m in each block where the tree of *C. fistula was* found. There were 16

blocks determined and 18 plots made where *C. fistula* found (III.C, III.D, III.E, V.D, VI.B, IX.B, IX.C, XI.I, XII.F, XIII.D, XV.A, XX.F, XX.G, XIV.C, XXII.D, XXII.E) (Figure 1). Tree species in each plot and block were invented, identified, and counted their species and specimen numbers.

D. pentandra in plots and its host plants in the blocks was counted to know their relation to the parasite infestation and prevalence. Infested host prevalence by parasite shows the proportion between the infected host and the total host number. The neighbor tree canopy shading around and the top canopy of *C. fistula* in each plot location were categorized qualitatively as : open (iv) = light interception > 90 %, rather open (iii) = light interception = 60 % to 90 %, rather shady (ii) = light interception 30 % to 60 %, shady (i) (light interception < 30 %). Infested host by *D. pentandra* in the blocks was categorized as : 0 = not found; 1 = too little (1 to 2 host); 2 = little (3 to 4 host); 3 = lot (5 to 6 host); 4 = too lot (> 6 host). Vegetation analysis was conducted to count the index of Important Value (IVI), Shannon diversity (H'), domination (C), and evenness (e'). These parameters were counted according to [6, 17–19]. Data were analyzed by Microsoft excel and non-parametrical statistics using MINITAB 13 program. Kruskal × Wallis test was used to determine differences between tree canopy shading, host-infested plants, and the number of parasites. Pearson correlation test (r) was used to know the correlation between Shannon diversity and the number of parasites; the number of tree species and the number of parasites the te number of tree specimens and the number of parasites.

3. Results and discussion

3.1 Tree plant diversity and composition

The results showed that there were 63 species, 55 genera and 20 families of tree plant species found around *C. fistula* in all plots in the garden (Table 2). There were six species dominating around *C. fistula* such as *S. macrophylla*, *Jacaranda obtusifolia* Bonpl., *Samanea saman* (Jacq.) Merr., *and Terminalia microcarpa* Decne. with IVI 29.45, 26.48, 19.87, and 15.49, respectively.

The highest plant diversity (H') was reached in the plot in block III.C (2.41) and the lowest was in XII.F (0.88) (Table 3). Plant diversity in all block locations was high (H'= 3.157) (Table 3).

Table 2. Relative density (RD), relative frequency (RF), relative domination (RDom) and important value index (IVI) of the plant species around *C. fistula* L. in Purwodadi Botanic Garden

No.	Species	Family	RD	RF	RDom	IVI
1	*C assia fistula* L.	Leguminosae	18.11	20.00	13.47	51.58
2	*Swietenia macrophylla* King.	Meliaceae	8.64	6.67	14.15	29.45
3	*Jacaranda obtusifolia* Bonpl.	Bignoniaceae	19.75	5.83	0.90	26.48
4	*Samanea saman* (Jacq.) Merr.	Leguminosae	3.29	3.33	13.25	19.87
5	*Terminalia microcarpa* Decne	Combretaceae	2.06	2.50	10.93	15.49
6	*Ceiba pentandra* (L.) Gaertn.	Malvaceae	2.47	2.50	5.08	10.05
7	*Diospyros malabarica* (Desr.) Kostel.	Ebenaceae	4.53	3.33	2.17	10.03
8	*Enterolobium cyclocarpum* (Jacq.) Griseb	Leguminosae	1.23	1.67	6.75	9.65
9	*Pterocarpus indicus* Willd.	Leguminosae	2.06	2.50	3.97	8.53
10	*Wrightia arborea* (Dennst.) Mabb	Apocynaceae	2.47	1.67	0.73	4.87

(Continued on next page)

Tabel 2. Continued

No.	Species	Family	RD	RF	RDom	IVI
11	*Madhuca longifolia* (J. Konig ex L.) J.F.Macbr.	Sapotaceae	1.23	1.67	1.80	4.70
12	*Lagerstromea loudonii* Teijm&Binn.	Lytheraceae	0.82	1.67	1.74	4.23
13	*Lagerstroemia duperiana* PierreexGagnep	Lytheraceae	0.82	1.67	1.72	4.21
14	*Mangifera indica* L.	Anacardiaceae	1.23	1.67	0.50	3.40
15	*Metroxylon sagu* Rotb.	Arecaceae	2.06	0.83	0.49	3.38
16	*Syzygium sexangulatum* (Miq.) Amsh.	Myrtaceae	0.82	1.67	0.72	3.21
17	*Livistona rotundifolia* (Lam.) Mart.	Arecaceae	1.23	1.67	0.12	3.02
18	*Gliricidea sepium* (Jacq.) Walp.	Leguminosae	0.82	1.67	0.47	2.96
19	*Diospyros celebica* Bakh.	Ebenaceae	1.23	0.83	0.71	2.78
20	*Kigelia africana* (Lam.) Benth.	Bignoniaceae	0.41	0.83	1.52	2.76
21	*Eucalyptus globulus* Labill.	Myrtaceae	0.82	0.83	1.09	2.75
22	*Parkia timoriana* (DC) Merr.	Leguminosae	0.41	0.83	1.44	2.68
23	*Miliusa horsfieldii* (Bennett) Baill. ex Pierre	Annonaceae	1.65	0.83	0.14	2.62
24	*Streblus asper* Lour.	Moraceae	1.65	0.83	0.12	2.60
25	*Peltophorum pterocarpum* (DC) K.Heyne	Leguminosae	0.41	0.83	1.24	2.48
26	*Roystonea regia* (Kunth) O.F. Cook.	Arecaceae	0.82	0.83	0.77	2.42
27	*Caryota rumphiana* Mart.	Arecaceae	0.82	0.83	0.73	2.39
28	*Acacia oraria* F.Muell.	Leguminosae	1.23	0.83	0.28	2.35
29	*Ficus callosa*Willd.	Moraceae	0.41	0.83	1.05	2.30
30	*Aleurites moluccana* (L.) Willd.	Euphorbiaceae	0.41	0.83	1.02	2.26
31	*Voacanga* sp.	Apocynaceae	0.82	0.83	0.51	2.17
32	*Tectona grandis* L.f.	Verbenaceae	0.41	0.83	0.92	2.16
33	*Adonidia merrillii* (Becc.) Becc.	Arecaceae	1.23	0.83	0.08	2.15
34	*Firmiana malayana* Kosterm.	Sterculiaceae	0.82	0.83	0.46	2.12
35	*Spathodea campanulata* L. Beauv.	Bignoniaceae	0.41	0.83	0.79	2.04
36	*Albizia chinensis* (Osbeck) Merr.	Leguminosae	0.41	0.83	0.76	2.01
37	*Eucalyptus alba* Reinw. Ex Blume	Myrtaceae	0.41	0.83	0.76	2.01
38	*Delonix regia* (Hook.) Raf.	Leguminosae	0.41	0.83	0.73	1.98
39	*Bombax ceiba* L.	Malvaceae	0.82	0.83	0.28	1.94
40	*Cinnamomum verum* J. Presl.	Lauraceae	0.41	0.83	0.59	1.84
41	*Cinnamomum camphora* (L.) J.Presl.	Lauraceae	0.41	0.83	0.52	1.76
42	*Albizia procera* (roxb.) Benth.	Leguminosae	0.41	0.83	0.49	1.74
43	*Areca macrocalyx* Zippex Blume	Arecaceae	0.82	0.83	0.06	1.71
44	*Alstonia scholaris* (L.) R.Br.	Apocynaceae	0.41	0.83	0.47	1.71
45	*Erytrina variegata* L.	Leguminosae	0.41	0.83	0.47	1.71
46	*Vitex pinnata* L.	Verbenaceae	0.41	0.83	0.47	1.71
47	*Elaeis guinensis* Jacq.	Arecaceae	0.41	0.83	0.42	1.67
48	*Plumeria alba* L.	Apocynaceae	0.41	0.83	0.28	1.53
49	*Kopsia arborea* Blume	Apocynaceae	0.41	0.83	0.20	1.44
50	*Pimenta dioica* (L.) Merr.	Myrtaceae	0.41	0.83	0.20	1.44
51	*Anadenathera peregrina* (L.) Speg	Leguminosae	0.41	0.83	0.18	1.43
52	*Anthochepalus* sp	Rubiaceae	0.41	0.83	0.18	1.43
53	*Dehaasia* sp	Lauraceae	0.41	0.83	0.18	1.43
54	*Plumeria rubra* L.	Apocynaceae	0.41	0.83	0.18	1.43
55	*Syzygium acuminatissimum* (Blume) DC	Myrtaceae	0.41	0.83	0.18	1.43
56	*Actinoritis callapparhia* (Blume) H. Wendl and Drune ex Scheff.	Arecaceae	0.41	0.83	0.13	1.37

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Tabel 2. Continued

No.	Species	Family	RD	RF	RDom	IVI
57	*Lannea coromandelica* (Houst.) Merr.	Anacardiaceae	0.41	0.83	0.13	1.37
58	*Morinda citrifolia* L.	Rubiaceae	0.41	0.83	0.13	1.37
59	*Maniltoa rosea* (K.Schum) Meeuwen	Leguminosae	0.41	0.83	0.06	1.30
60	*Syzygium nervosum* A.Cunn. ExDC.	Myrtaceae	0.41	0.83	0.05	1.29
61	*Cassia leptophylla* Vogel	Leguminosae	0.41	0.83	0.03	1.27
62	*Dysoxylum* sp.	Meliaceae	0.41	0.83	0.02	1.26
63	*Mischocarpus* sp.	Sapindaceae	0.41	0.83	0.02	1.26

Table 3a. Vegetation analysis of tree plant species and host of *D. Pentandra* in block locations of *C. fistula* in Purwodadi Botanic Garden

No	Block	Canopy shading	Plot number	Index			Host in block
				Domination C**)	**EvennessE' **)**	Diversity H'**)	
1	XXII. D	2	1	0.14	0.98	2.04	0
2	XXII. E	2	1	0.24	0.94	1.50	1
3	XX. G	2	1	0.16	0.94	1.95	0
4	XX. F	2	2	0.22	0.97	1.55	0
5	XIII. D	2	1	0.25	1.00	1.38	1
6	IX. B	3	1	0.20	1.00	1.61	2
7	IX. C	3	1	0.28	0.96	1.32	2
8	XI. I	3	2	0.32	0.95	2.17	0
9	III. C	3	1	0.10	0.94	2.41	2
10	XXIV. C	1	1	0.32	0.84	1.35	0
11	VI. B	1	1	0.16	0.97	1.88	1
12	III. D	4	2	0.37	0.81	1.12	4
13	III. E	4	2	0.45	0.85	1.65	4
14	XII. F	4	2	0.52	0.63	0.88	3
15	XV. A	4	1	0.28	0.96	1.33	3
16	V. D	4	2	0.23	0.85	1.77	2
Total number in all plots in the blocks				0.09	0.78	3.21	

Note :*) = *C. fistula*, **) = tree plant species

Table 3b. Vegetation analysis of tree plant species and host of *D. Pentandra* in block locations of *C. fistula* in Purwodadi Botanic Garden

No	Block	Host prevalence*)	Parasite number	Species number		Specimen number	
				Plot	Block	Plot	Block
1	XXII. D	0.00	0	8	67	8	143
2	XXII. E	0.00	0	5	29	10	56
3	XX. G	0.00	0	8	63	13	114
4	XX. F	0.00	0	5	56	22	76

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Table 3b. Continued

No	Block	Host prevalence*)	Parasite number	Species number		Specimen number	
				Plot	Block	Plot	Block
6	IX. B	2.27	9	4	14	5	18
7	IX. C	0.00	0	4	53	6	67
8	XI. I	0.00	0	10	36	12	50
9	III. C	2.27	6	13	15	18	15
10	XXIV. C	0.00	0	5	5	16	50
11	VI. B	0.00	0	7	11	9	35
12	III. D	27.27	13	4	57	23	75
13	III. E	20.45	7	7	5	12	35
14	XII. F	13.64	5	4	6	10	22
15	XV. A	2.27	4	4	20	6	50
16	V. D	0.00	0	8	67	23	55

Note :*) = *C. fistula*, **) = tree plant species

Plant diversity in the plots in the blocks is categorized to be low (H' < 1), moderate (1 < H' < 2), and high (H' > 2) [19]. This variation is caused by the difference of species and specimen number in the plots. The lowest of H' (0.88) in block XII.F is caused by the lowest species and specimen number in the plot (Table 3). In contrast, the highest H' (2.41) in III.C is caused the highest species and specimen number in the plot (Table 3). Plant diversity in all plots in the blocks around *C. fistula* is high (H' > 3). It is caused by many species and specimen number of trees, *i.e.* 63 species and 203 specimens, respectively. Actually, plant diversity in the garden is very high. It is related to the function of the garden for plants conservation, especially plants from dry lowland area in Indonesia. Purwodadi Botanic Garden has collected living plant 1 925 species, 928 genera and 175 family in the garden [16]. It is not included plants for reforestation, road side evenue, forested area and wild plants.

The plant species in all the plots is only 63 species or 3.27 % of plant species cultivated in the garden. The most dominant species around *C. fistula* is *S. macrophylla* with IVI 29.45 (Table 2). This species is to be dominant in the garden planted for reforestation, road side evenue and arboretum. It is also found growing wild in the garden. Reforestation with *S. macrophylla* was conducted for soil and water conservation for many years ago and also to be used as shading and climbing place for particular plants collection such as rattans. *Pterocarpus indicus* Willd. and *S. saman* were also planted for the same as function as *S. macrophylla* in the garden. The distribution of *S. macrophylla* in the garden have potential to be broad because it has samara seed type which has potential to disperse by wind far from the main plant. Therefore, their seedlings can be almost found in almost areas in the garden.

The plants domination index in all plots in the blocks are relatively low (C < 0.5) except in XII.F was moderate (0.75 > C > 0.5) [19]. It is indicate that there is no domination particular plant species around *C. fistula*. It is also shown by evennes index (e') in all plots > 0.75, except in XII.F.= 0.63. The e' > 0.75 shows that the ecosystem in the plots is stable [19]. In contrast, 0.5 < e' < 0.75 such as in XII.F is moderate which shows the ecosystem less stable [19].

Plant diversity, domination, and evennes in all blocks has not significant correlation with parasite number of *D. pentandra* infestation on *C. fistula* in given areas with r = –0.17 and *P*–value = 0.53; r = 0.26 and *P*–value = 0.34 ; r = –0.37 and *P*–value = 0.17, respectively (Table 4). The correlation between species number and specimen number in all plot site locations and parasite number infesting *C. fistula* also not significant with r = –0.079; *P*–value = 0.771 and r = –0.385; *P*–value = 0.141, respectively. However, there

are a tendency of negative correlation between plant diversity, plant species and specimen number with parasite number infestation on *C. fistula*, *i.e.*, r = –0.169, r = –0.079, and r = –0.385 respectively. Other study also reported that the infested and prevalence of the parasite (*D. pentandra*) in a community with higher plant species richness (16.5) and diversity index (2.27) is lower (1.8) than those in community with low richness (3.5) and diversity index (0.8) *i.e.*1.8 (high diversity) and 6.3 (low diversity), respectively [5]. It may also relate to the canopy shading caused by the high richnessand diversity of plants will inhibit distribution, infestation and population of the mistletoes.

The occurrence of infected hosts whether *C. fistula* or other plant species is important for the distribution and infestation of *D. pentandra* on *C. fisutla*. There is positive and significant correlation between the number of infested plant number by *D. pentandra* and the parasite number on *C. fistula* with r = 0.817 and *P*-value = 0.000 (Table 4). Kruskal–Wallis test also showed that there is a significant difference between the number of infested plants and the number of *D. pentandra* infesting on *C. fistula* with *P*-value = 0.018 (Table 4). It indicates that infested hosts by the parasite have important role on the distribution and infestation of the parasite *D. pentandra* on *C. fistula*. A study also reported a significant relationship between the abundance of indvidual hosts and mistletoe infection in the plantation [5].

Birds distribute seeds of the parasite in given infested plant or to other uninfested plants after perching, excreting and depositing the seeds on the branches and twigs. There were specialist and generalist birds which have important role on the seeds mistletoe dispersal such as *D. pentandra*. The birds from genera Dicaeum such as *Dicaeum concolor* Jerdon, 1840, "flower pecker" is categorized as specialist mistletoes, whereas yellow-vented bulbul (*Pycnonotus xanthopygos* Hemprich. & Ehrenberg 1833) as generalist frugivorous [5]. Yellow–vented bulbul "trucukan" (*Pycnonotus goavier* Scopoli 1786) and "kutilang" (*Pycnonotus aurigaster* Vieillot 1818) as frugivorous birds were also found in the garden as fruits eater such as the fuits of mistletoes. They will disperse and distribute the seeds of mistletoes to new host plants which far from the main host because they able tomove and fly more far than the specialist birds. The specialist birds (flower peckers) are nomadic birds and they move and fly no far, efectively 1 m to 10 m, so they will be intensiving the seeds dispersal on infested plants or other hosts near them [10]. Consequently, this species may have a short dispersal range and may contribute to the smaller scale of agregation in the plantation. In contrast, the dietary generalist yellow–vented bulbul' trucukan" (*P. goavier*) "kutilang" (*P. aurigaster*) as reported on *Pycnonotus jocosus* Linnaeus 1758 is more likely to visit uninfected trees for social interactions and self– maintenance activities, such as preening [20]. They tend to spend more time foraging on mistletoe fruits and usually fly long distances. These dietary generalists are more likely to establish new infections through long distance seed dispersal. Therefore, it indicate that mistletoe specialist and generalist dispersers provide different quantity and the quality of dispersal for mistletoes.

3.2 Infestation and prevalence of *D. pentandra* on canopy shading

There is significant difference between the trees canopy shading and parasite infestation on *C. fistula* (Table 4). The most infestation of the parasite on *C. fistula* was found in open location III.D (Figure 2) with parasite population 13 parasites per plant. The infested host prevalence in this block also the highest, *i.e.* 27.27 %. (Table 3). There is not significant correlation between plant diversity on parasite infestation on the host (Table 4).

Table 4. Relationship between variables on infestation mistletoe *D.pentandra* on *C. Fistula* in various canopy shading, infested hosts and plant diversity in Purwodadi Botanic garden

Relationship of variables	**Kruskall Wallis Test**	**Pearson Correlation (r; P)**
Infested host parasite infesting	$P = 0.018$ (S)	–
Canopy shading parasite infesting	$P = 0.030$ (S)	–
Shannon diversity Index parasite number	–	r = –0.17; $P = 0.53$ (NS)
Domination index parasite number	–	r = 0.26; $P = 0.34$ (NS)
Evennesindexxparasitenumber	–	r = –0.37; $P = 0.17$ (NS)
Species number in plot parasite number	–	r = –0.08; $P = 0.77$ (NS)
Species number in plot (site) xparasitenumber	–	r = –0.19; $P = 0.49$ (NS)
Specimen number in plot xparasitenumber	–	r = –0.39; $P = 0.14$ (NS)
Infested hosts xparasitenumber	–	r = 0.82; $P = 0.00$ (S)

Note: (S) = significant on $\alpha = 0.05$; (NS) = not significant $\alpha = 0.05$

Figure 2. A. *Dendrophthoe pentandra* on *Cassia fistula* in block III.D; B. *Dendrophthoe pentandra*

Canopy shading by neighbor plants relate to light capturing by plants canopy and mistletoes life on branches and twigs. Canopy shading will affect to the growth, infestation and distribution of mistletoes [12, 21], especially for survival of hemiparasite such as *D. pentandra*. It need much light for its growth and development. Therefore, this parasite is commonly found in the top or outer plants canopy where much light intercepted by canopy layer. Light is needed by hemiparasite for photosyntesis to produce carbohydrate for supporting plant growth and development also seed germination. A study reported that light incidence limited the post–dispersal growth of the parasites, *i.e.* seed adhesion, seed germination, seedling establishment, and seedling survival [4, 5]. The seeds germination and seedlings growth and the survival of this parasite to be better on trees with more open

canopies (plantation) than shady canopy (forests) [5].

The infestation and prevalenceof *D. pentandra* on *C. fistula* in the open canopy such as in III.D is higher than those in too shady canopy such as XX.F (Table 3). It is caused or correlated to the number of deposited seeds and infection intensity of adult mistletoes such as reported by study, that deposited seeds, seed germination, and survival of *D. pentandra* in open canopy is higher than that in the shady canopy [5]. Table 4 shows that there is a significant different between canopy shading and the parasite number infesting on *C. fistula* with $P = 0.018$. It also shows that the highest number of parasite and prevalence was found in the open canopy (III.D), *i.e*. 13 parasites per plant and 27.27, respectively.

3 Conclusion

This research can be concluded that the infestation of *D. pentandra* (L.) Miq on *C. fistula* was affected significanly by the plant canopy shading and the infested hosts number. The highest infestation of *D. pentandra* on *C. Fistula* L. in Purwodadi Botanic Garden was found in the open canopy with the highest infested hostsnumber in the block III.D with the parasite number 13 plant^{-1}. The tree plant diversity in the blocks tend to have negative correlation to the infestation of *D. pentandra* on *C. fistula* with r = –0.18.

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