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ALTERNATE HOST PLANTS FOR *Spodoptera frugiperda* (LEPIDOPTERA: NOCTUIDAE) IN GUNUNGKIDUL AND SLEMAN REGENCIES, YOGYAKARTA, INDONESIA

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ABSTRACT

Spodoptera frugiperda is a polyphagous insect originating from the Americas and has been found attacking maize in Indonesia. The purpose of this study was to determine the plants that could be alternative hosts for *S. frugiperda* in Gunungkidul and Sleman Regencies, Yogyakarta, Indonesia. This research was conducted in November 2021 - May 2022. Samples were taken around corn plantations in all sub-districts in Gunungkidul and Sleman Regencies. Two villages were taken from each sub-district using simple random sampling. In each of the village, one corn planting area was selected for a purposive sampling location. The criteria for the host plants taken were plants with attack symptoms from *S. frugiperda.* The alternative host plant species obtained consisted of 21 plant species in Gunungkidul Regency and 20 plant species in Sleman Regency. The plant families whose members of the species were most frequently attacked by *S. frugiperda* from the two Regencies were Fabaceae (8 species) and Poaceae (7 species). The conclusion of this study is that *S. frugiperda* has attacked other crops besides maize in Gunungkidul and Sleman districts, with the most attacked plants were the Fabaceae and Poaceae families.

Keywords: Alternative host, Fabaceae, Poaceae, *Spodoptera frugiperda*

ABSTRAK

Spodoptera frugiperda merupakan serangga polifagus yang berasal dari benua Amerika dan telah ditemui menyerang jagung di Indonesia. Tujuan kajian ini adalah untuk mengenalpasti tanaman yang boleh dijadikan perumah alternative kepada *S. frugiperda* di Kabupaten

Gunungkidul dan Sleman, Yogyakarta, Indonesia. Kajian ini telah dilakukan dari November 2021 – Mei 2022. Sampel diambil di sekitar kebun jagung di seluruh daerah di Kabupaten Gunungkidul dan Sleman. Dua buah kampung telah diambil dari setiap mukim menggunakan persampelan rawak mudah. Di setiap kampung, satu kawasan tanaman jagung telah dipilih untuk lokasi persampelan bertujuan. Ciri bagi tumbuhan perumah yang diambil adalah tumbuhan yang mempunyai gejala serangan daripada *S. frugiperda*. Spesies tumbuhan perumah alternatif yang diperoleh terdiri dari 21 spesies tumbuhan di Kabupaten Gunungkidul dan 20 spesies tumbuhan di Kabupaten Sleman. Famili tumbuhan yang ahli spesiesnya paling kerap diserang *S. frugiperda* daripada dua Kabupaten itu ialah Fabaceae (8 spesies) dan Poaceae (7 spesies). Kesimpulan kajian ini ialah *S. frugiperda* telah menyerang tanaman lain selain jagung di daerah Gunungkidul dan Sleman, dengan tanaman yang paling kerap diserang adalah dari famili Fabaceae dan Poaceae.

Kata Kunci: Perumah alternatif, Fabaceae, Poaceae, *Spodoptera frugiperda*

INTRODUCTION

Spodoptera frugiperda J. E. Smith or also known as the Fall Army Worm (FAW) is a polyphagous insect originating from the Americas (Montezano et al. 2018). Until now, *S. frugiperda* has spread to various parts of the world (Lubis et al. 2020). *Spodoptera frugiperda* was found in Indonesia in early 2019 and attacked corn plants in the Pasaman area, West Sumatra (Sari et al. 2021), and also early report in East Malaysia (Mohammed et al. 2021). Until now, *S frugiperda* has been reported to have spread to other areas in Indonesia, such as Lampung, Aceh, Riau, Jambi, Bengkulu, South Sumatra, Bandung, Sumedang, Garut and Yogyakarta, especially in Sleman, Bantul and Gunungkidul regencies (Maharani et al. 2019; Nurkomar et al. 2021).

Spodoptera frugiperda has the main host for this pest in the form of corn (*Zea mays* L.) (Caniço et al. 2021). Economic Injury Level (EIL) of *S. frugiperda* in corn plant as many as 0.2 - 0.8 larvae/plant can reduce maize production by up to 20 - 50% (Nonci et al. 2019). Moreover, According to Jaramillo-Barrios et al. (2019), EIL of *S. frugiperda* in corn plant in Colombia as many as 1.9 to 2.6 larvae per 10 plants. *Spodoptera frugiperda* has also been reported to cause losses to corn farming reaching 8.3 – 20.6 million tonnes/year or the equivalent of US$ 2.5 – 6.2 billion per year in Africa and Europe (FAO & CABI 2019). Reports of reduced yields due to this pest attack have been reported in several countries, such as Ethiopia and Kenya (32 - 47%) (Groote et al. 2020; Kumela et al. 2019), Zimbabwe (32 - 48%) (Baudron et al. 2019), Ghana (22 - 67%) (Day et al. 2017), India (33%) (Balla et al. 2019) and Indonesia 60% (Lubis et al. 2020). In addition Megasari and Khoiri (2021) reports thaht attacks of *S. frugiperda* in corn plants in Tuban Regency ranged from 40 - 100% in Tuban Regency, East Java. *Spodoptera frugiperda* is known to have more than 350 alternative host plants for survival (Caniço et al. 2021). Alternative hosts are used by *S. frugiperda* as a place to find nutrients (Karkee et al. 2017; Kumar et al. 2021) and defend against natural enemies (Saeed et al. 2015). Plants that are known to be used as alternative hosts by *S. frugiperda* include cabbage, cassava, tomatoes and beans (Caniço et al. 2021). According to Nurkomar et al. (2021), these insects will still be found in the Special Region of Yogyakarta area. Even though crop rotation always occurs so that corn plants are not always available in the field. So it is possible for *S. frugiperda* to have another host besides corn to survive during the absence of the corn plant. Therefore, it is important to conduct this research to find out which plants can be alternative hosts for *S. frugiperda*, especially in Gunungkidul and Sleman Regencies, Yogyakarta, Indonesia.

MATERIALS AND METHODS

The materials used in this study were intact plants and leaves from plants attacked by *S. frugiperda* which were characterized by the presence of egg packets, dirt marks, and *S. frugiperda* on plants other than corn plants in Gunungkidul and Sleman Regencies, Yogyakarta, Indonesia.

Sampling Locations

Samples were taken around corn plantations in 18 sub-districts in Gunungkidul Regency and 17 sub-districts in Sleman Regency. Global Positioning System (GPS) of each location in two regencies showed in Table 1.

Table 1. Coordinate of each sampling location in Gunungkidul and Sleman Regencies, Yogyakarta, Indonesia

No.	Regencies	Sub- District	Village	Coordinate
1	Sleman	Berbah	Tegaltirto	S07°49.109'E110°26.3293'
			Kalitirto	S07°48.082' E110°27.258'
		Kalasan	Tirtomartani	S07°45.672' E110°27.897'
			Purwomartani	S07°45.096' E110°27.837'
			Selomartani	S07°43.737' E110°28.227'
		Ngemplak	Wedomartani	S07°43.745' E110°25.135'
			Bimomartani	S07°42.044' E110°27.507'
		Prambanan	Madurejo	S07°47.176' E110°28.450'
			Bokoharjo	S07°46.541' E110°29.474'
		Ngaglik	Donoharjo	S07°48.937' E110°22.640'
			Sukoharjo	S07°42.386' E110°25.892'
		Pakem	Pakembinangun	S07°40.882' E110°24.386'
			Hargobinangun	S07°40.241' E110°25.182'
		Cangkringan	Argomulyo	S07°39.424' E110°27.920'
			Wukirsari	S07°40.405 E110°26.096
		Sleman	Trimulyo	S07°40.564' E110°21.578'
			Pandowoharjo	S07°41.829' E110°21.716'
		Turi	Bangunkerto	S07°39.261' E110°21.239'
			Donokerto	S07°39.931' E110°21.858'
		Mlati	Sendangadi 1	S07°43.947' E110°21.254'
			Sendangadi 2	S07°44.328' E110°21.363'
		Tempel	Margoadi	S07°42.355' E110°19.998'
			Tambakrejo	S07°40.626' E110°18.542'
			Pondokrejo	S07°40.335' E110°18.445'
		Depok	Condong catur	S07°45.102' E110°24.568'
			Maguwoharjo	S07°45.436' E110°25.715'
		Moyudan	Sumber Rahayu	S07°47.981' E110°14.677'
			Sumbersari	S07°47.434' E110°15.650'
		Minggir	Sendang Agung	S07°43.787' E110°14.398'

No.	Regencies	Sub- District	Village	Coordinate
		Godean	Sidoagung	S07°46.340' E110°17.957'
			Sidomoyo	S07°44.851' E110°19.238'
		Seyegan	Margoagung	S07°42.894' E110°17.545'
			Margomulyo	S07°43.480' E110°18.454'
		Gamping	Balecatur	S07°48.421' E110°17.584'
			Trihanggo	S07°44.766' E110°19.965'
		Patuk	Ngoro-oro	S07˚50.062' E 110˚31.750'
			Putat	S07˚52.270' E 110˚31.169"
		Playen	Gading	S07˚57.071' E 110˚32.873"
			Plembutan	S07˚58.604' E 110˚32.506"
		Paliyan	Grogol	S07˚59.229' E 110˚32.159"
			Sodo	S07˚59.949' E 110˚33.791"
		Panggang	Giriwungu	S08˚01.306' E 110˚25.531"
			Girisuko	S08˚00.531' E 110˚25.187"
		Gedangsari	Ngalang	S07˚52.949' E 110˚34.763"
			Hargomulyo	S07˚49.632' E 110˚35.514"
		Wonosari	Siraman	S07˚58.473' E 110˚35.632'
			Kepek	S07˚57.455' E 110˚35.850"
			Gari	S07˚55.396' E 110˚36.317"
		Saptosari	Jetis	S08˚02.325' E 110˚29.564"
			Kepek	S08˚02.629' E 110˚30.999"
		Nglipar	Karangtengah	S07˚54.707' E 110˚36.531"
			Kedung Keris	S07˚53.726' E 110˚37.000"
		Semin	Beji	S07˚52.454' E 110˚43.504"
2	Gunungkidul		Semin	S07˚51.808' E 110˚44.094"
		Ngawen	Kampung	S07˚51.058' E110˚41.583"
			Watusigar	S07˚51'56.5"E110˚41'31.6"
		Karangmojo	Gedangrejo	S07˚56.615' E110˚40.933"
			Gedangrejo 2	S08˚00.446' E110˚38.909"
			Bejiharjo	S07˚57'09.0" E110˚37'20.7"
		Semanu	Semanu	S08˚02.541' E110˚38.819"
			Ngeposari	S08˚04.637' E110˚39.422"
		Tepus	Sumberwungu	S08˚07.062' E110˚41.624"
			Giripanggung	S07˚56.631' E110˚41.046"
		Tanjungsari	Kemadang	S08˚07.361' E110˚33.266"
			Kemiri	S08˚08.070' E110˚35.634"
			Ngestirejo	S08˚05.847' E110˚33.284"
		Purwosari	Girijati	S08˚01'20.6"E110˚20'31.7"
			Giripurwo	S08˚01'16.7"E110˚24'35.0"
		Ponjong	Sidorejo	S07˚59'59.7"E110˚42'04.1"
			Kuwon	S08˚00'22.1"E110˚43'09.5"
		Girisubo	Ngrombo	S08˚08'13.6"E110˚42'08.6"
			Jepitu	S08˚08'54.4"E110˚43'45.3"

No.	Regencies	Sub- District	Village	Coordinate
		Rongkop	Pringombo	S08˚06'30.5"E110˚45'34.3"
			Petir	S08˚07'25.9"E110˚45'48.5"

Two villages were taken from each sub-district using the simple random sampling method. Each village took one piece of land around the corn plantations which was used as the sampling location. The location of the sampling area was purposively around the 14-21 days old corn field and not yet flowering.

Symptoms Identification

The criteria for alternative host plants taken were those with symptoms of attack by *S. frugiperda*, characterized by bite marks from *S. frugiperda* (Figure 1a), the presence of feces (Figure 1b) and up to the presence of egg packets on the leaves (Figure 1c) (Kumar et al. 2022; Supartha et al. 2021). In addition to taking samples of alternative host plants, abiotic parameters were measured at each sampling location and coordinate points were taken.

Figure 1. Symptoms of *S. frugiperda* attack on alternative hosts; (A) bite mark on *Pennisetum purpureum*, (B) Feces on *Allium fistulosum,* and (C) Egg packet on *Arachis hypogaea* leaves

Alternate Host Sampling

Sampling was carried out directly every two months from October to November 2021. The intended direct collection is by coming to the area around the corn plantations in Gunungkidul and Sleman Regencies. Sampling of infected plants was carried out by looking for plants around the corn field with a sampling radius of 5 - 10 m. The plants that taken were those with attack symptoms of *S. frugiperda* on these plants. Samples were taken mechanically by hand. The sample in the form of a whole plant is then preserved by making it into herbarium.

Plant Sampel Identification

The plant samples that have been obtained are then identified by comparing the plants obtained using a Herbarium at the Ecology and Systematics Research Laboratory, Ahmad Dahlan University, Yogyakarta. Plant samples of unknown species were identified using plant

identification book references from Sastrapradja and Johar (1981), Naidu (2012), and Lavelle (2020).

Data Analysis

The analysis used in this study was a quantitative and descriptive analysis used to describe alternative hosts, the number of alternative hosts, and the most commonly used plants as well as the forms of attack on each of the alternative hosts of *S. frugiperda* obtained at the sampling location.

RESULTS

The results of research conducted in 18 sub-districts in Gunungkidul Regency and in 17 sub-districts in Sleman Regency found 15 plant families that have been used as alternative hosts by *S. frugiperda* (Table 2). The plant families whose members were most frequently attacked by *S. frugiperda* were Fabaceae (8 species) and Poaceae (7 species). The plant families whose members of the species were the least attacked by *S. frugiperda* were Brassicaceae, Commelinaceae, Heliconiaceae, Liliaceae, Myrtaceae, Oxalidaceae, Solanaceae and Talinaceae (1 species).

Table 2. Alternate host plants of *S. frugiperda* in Gunungkidul and Sleman Regencies

No	Family	Species
1	Asteraceae	*Chromolaena odorata*
		Elephantopus scaber
		Acmella paniculate
		Sphagneticola trilobvignata
2	Brassicaceae	*Brassica rapa*
3	Commelinaceae	*Commelina benghalensis*
4	Convolvulaceae	*Ipomoea reptans*
		Ipomea batatas
5	Euphorbiaceae	*Acalypha indica*
		Euphorbia heterophylla
6	Fabaceae	*Arachis hypogaea*
		Pisum sativum
		Phaseolus vulgaris
		Vigna radiate
		Bauhinia purpurea
		Flemingia lineata
		Vigna unguiculata
		Clitoria ternatea
7	Heliconiaceae	*Heliconia* sp.
8	Liliaceae	*Allium fistulosum*
9	Myrtaceae	*Syzygium myrtifolium*
10	Oxalidaceae	*Oxalis barreliere*
11	Poaceae	*Pennisetum purpureum*
		Imperata cylindrica
		Panicum repens
		Eleusine indica
		Setaria barbata

No	Family	Species
		Brachiaria sp.
		Oryza sativa
12	Solanaceae	*Physalis angulate*
13	Talinaceae	*Talinum paniculatum*
14	Urticaceae	*Parietaria judaica*
		Laportea interrupta
15	Zingiberaceae	*Boesenbergia pandurata*

The results of this study also found that almost all alternative host plants found, both in Sleman and Gunungkidul Regencies, had a type of attack in the form of bite marks from *S. frugiperda*. Only 2 plants were not found in the form of bite marks, namely *Acalypha indica* and *Parietaria judaica* (Table 3).

Table 3. *Spodoptera frugiperda* attack type on the alternative host plants in Sleman and Gunungkidul regency

No	Plant species	Attack type from *S. frugiperda*		
		Bite marks	Egg mass	Dirt
1	*Acalypha indica*	-	√	-
2	*Allium fistulosum*	√	-	√
3	*Arachis hypogaea*	√	√	-
4	*Bauhinia purpurea*	√	-	-
5	*Boesenbergia pandurata*	√	-	-
6	*Chromolaena odorata*	√	√	-
7	*commelina benghalensis*	√	-	-
8	*Elephantopus scaber*	√	-	-
9	*Flemingia lineata*	√	-	-
10	*Imperata cylindrical*	√	-	-
11	*Ipomea batatas*	√	-	-
12	*Ipomoea reptans*	√	-	-
13	*Laportea interrupta*	√	-	-
14	*Panicum repens*	√	-	-
15	*Parietaria judaica*	-	√	-
16	*Pennisetum purpureum*	√	√	√
17	*Phaseolus vulgaris*	√	-	-
18	*Physalis angulate*	√	-	-
19	*Pisum sativum*	√	-	-
20	*Vigna cylindrica*	√	-	-
21	*Vigna radiate*	√	-	-

DISCUSSIONS

Research that conducted in Gunungkidul and Sleman Regencies found that the Fabaceae and Poaceae families were the plants most widely used by *S. frugiperda* as host plants. Members

of the Fabaceae family are widely used by *S. frugiperda* as alternative hosts in this study because these plants grow close to maize which is the main host of *S. frugiperda*. According to Capinera (2020), *S. frugiperda* can attack other plants if these plants grow near corn plants. In addition, several members of the Fabaceae family such as peanuts, beans and peas were deliberately planted close to corn fields because they could sincrease nutrient availability in soil, especially nitrogen. In addition, the Fabaceae family has indole-type volatile compounds that can attract *S. frugiperda* to lay their eggs on these plants. According to Zevallos et. al. (2016), the volatile compounds responded by female *S. frugiperda* namely (Z)-3-hexenyl acetate, (E)-β-ocimene, b-linalool, indole, (E)-b-farnesene and TMTT.

The Poaceae family is the next family whose members of the species are most attacked by *S. frugiperda* in this study. The large number of Poaceae families that were attacked by *S. frugiperda* in this study was because the Poaceae family was the main host of *S. frugiperda* (Rwomushana 2019). The species members of the Poaceae family obtained in this study were mostly weeds, except for rice (*O. sativa*). The number of weeds attacked by *S. frugiperda* in this study was due to the fact that many weeds grow around the corn plants.

The families whose members of the species were least attacked by *S. frugiperda* in this study were Brassicaceae, Euphorbiaceae, Heliconiaceae, Myrtaceae, Oxalidaceae, Solanaceae and Talinaceae. According to Syahrawati et. al. (2018), taste, smell, nutritional content and appropriate morphological structure will influence *S. frugiperda* in selecting host plants. The choice of host plants by females of *S. frugiperda* is related to the need for insects to eat, reproduce and lay their eggs (Syahrawati et. al. 2018). Number of members of this family that were attacked by *S. frugiperda* could also be due to the incompatibility of the criteria for members of that family as hosts for *S. frugiperda*. As in the Euphorbiaceae and Solanaceae families. The Euphorbiaceae family itself contains sap in members of its species (Karimi et al. 2009; Morah & Okoi 2016) and the Solanaceae family has fine hairs (trichomes) on the leaves of members of its species (Kariyat et al. 2018; Kumar et al. 2017). This may cause difficulty to consume by *S. frugiperda*. Other families whose members of the species were found to be slightly attacked by *S. frugiperda* in this study were Heliconiaceae and Myrtaceae. Few members of the Families Heliconiaceae and Myrtaceae were attacked by *S. frugiperda* because members of these families were rarely found around the maize fields at the study.

The Talinaceae is the next family whose members are rarely attacked by *S. frugiperda* in this study. This is because members of this family have thick leaf morphology, making it difficult for *S. frugiperda* (Naidu 2012). The last family whose members are rarely attacked by *S. frugiperda* is Oxalidaceae. This is because there is a content of oxalic acid in the Oxalidaceae family (Sa et al. 2019) which is a toxic compound for insects because it can inhibit feeding activity (Rademacher et al. 2017; Shi et al. 2013).

This study found many types of plants, but the type of garden that was most widely used as an alternative host in this study was *Pennisetum purpureum*. *Pennisetum purpureum* or elephant grass is a type of grass that has been used as animal feed by farmers in DI Yogyakarta. Apart from being used as animal feed, this plant is also used as a trap crop for *S. frugiperda* (Lestari 2020). This plant serves to attract *S. frugiperda* female moths to lay their eggs on this plant, so that *S. frugiperda* do not lay their eggs on corn plants. Females of *S. frugiperda* were laying eggs on elephant grass because the nutritional content of elephant grass was not much different from the nutritional content of corn leaves. The nutritional content of elephant grass leaves are: 6.26% crude protein; crude fat 2.06%; crude fiber 32.60%; ash 9.12%; 0.46% calcium and 0.37% phosphorus (Fathul et al. 2013). While the nutritional

content of corn leaves are: 5.56% crude protein; crude fiber 33.58%; 1.25% crude fat and 7.28% ash. The similarity in the nutritional content of these two plants is one of the factors that elephant grass is often attacked by *S. frugiperda* in this study. In addition to nutritional factors there are also other factors namely because elephant grass is commonly found around corn plantations and the morphology of elephant grass leaves also has similarities, namely the upper part of the epidermis is generally hairy. *Pennisetum purpureum* commonly found in 29°C and humidity of 65%. The temperature and humidity of *P. purpureum* commonly found also temperature and humidity that *S. frugiperda* can grow well. According to Plessis et al. (2020) armyworm *S. frugiperda* from egg to imago ranges from 26°-32°C. The higher the temperature will affect the speed of development of *S. frugiperda*. The highest larval survival is between 26^0C and 30^0C and the optimum temperature with the fastest larval development rate and the lowest larval mortality is 30^0C (Plessis et al. 2020).

The forms of attack identified in this study were egg packets, bite marks, and feces from *S. frugiperda* were recorded. The most common attack symptoms found in this study were bite marks and egg packets, while the least frequently found were feces marks. Bite marks are the most common attacks found in this study. This is because to choose a suitable host plant for larval development, *S. frugiperda* must first try to eat the plant (Altaf et al. 2022; Gatehouse 2002; Tiwari 2022). If the plant is not suitable for larval development, then *S. frugiperda* will leave the plant and only the larvae's bite marks will remain. According to Gatehouse (2002), physical characteristics of host plants can influence host-plant selection behavior. This is in accordance with the research of Trisyono et al. (2019) who obtained the results of many attacks from *S. frugiperda,* but only one *S. frugiperda* was found. According to Borkakati et al. (2019), there are ways of selecting hosts for insects, one of which is by tasting (*gustatory*). The tasting process makes the *S. frugiperda* continue to look for suitable hosts by tasting the plants, leaving bite marks. In addition to bite marks, there are also symptoms of an attack in the form of egg packets which are often found.

As stated by Montezano et al. (2018) and Borkakati et al. (2019), that host plants are not only used as a source of feed, but also used as a shelter from natural enemies and as a place to breed or lay eggs. The number of egg packets found in this study was made possible because the plants found in this study grew close to their main food source, namely corn plants. According to Ge et al. (2021), female moths from insect pests will lay eggs on plants adjacent to the main food source for their larvae, as well as female moths from *S. frugiperda* (Capinera 2017). In addition, the presence of volatile compounds released by plants will attract female moths to lay their eggs on these plants, especially in plant that *S. frugiperda* use as an alternative host plant (Rwomushana 2019). Volatile compounds that can attract moths to lay eggs include (Z)-3-hexenyl acetate, b-linalool, indole, (E)-b-farnesene and TMTT (Zevallos et al. 2016). The content of these compounds attracts female moths from *S. frugiperda* during the oviposition period to lay their eggs on certain plants (Zevallos et al. 2016). Apart from those that are found a lot, there is also an attack that is found the least, namely the form of the dirt marks attack.

Form of attack of *S. frugiperda* was the presence of larvae excrement on plants. This could be because *S. frugiperda* may have eaten (tasted) the plant. The existence of this feeding process will produce waste substances from the metabolic process of the larvae in the form of dirt. However, after trying to eat or taste, *S. frugiperda* feel unsuitable so they look for other hosts. According to Borkakati et al. (2019), compatibility in host selection can be done by way of host recognition, namely by the presence of taste and touch stimuli that will help insects recognize host compatibility.

CONCLUSION

Sympotms of *S. frugiperda* attack were found in two regencies in Yogyakarta, namely Gunungkidul and Sleman. Twenty one species of alternative host plats of *S. frugiperda* that consist of 15 families were found used by *S. frugiperda* as an alternative host in those regencies. Furthermore, the family of alternative host that used more as an alternative host plant by *S. frugiperda* was Fabaceae.

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My manuscript has no associated data.

Authors' Contributions
ITD and WA conceived this research, ILIP designed the experiments; ILIP, ITD and WA do the research and collect the samples from the field; ILIP, ITD and WA participated in the interpretation of the data; ITD and WA performed the plant identification; ILIP, ITD and WA wrote the paper and participated in the revisions of it. All authors read and approved the final manuscript.

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