Pest Diseases on Nutmeg (*Myristica fragrans* Houtt) and Its Damage Symptoms

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Abstract

Nutmeg plants (*Myristica fragrans* Houtt) in Indonesia are cultivated by smallholder plantations (98%) and the rest (2%) by large state plantations. In 2022, the area of nutmeg plantations in Indonesia will increase, but productivity per hectare will decrease. One of the causative factors is the attack of plant-disturbing organisms such as pests and diseases of nutmeg plants. The study aimed to determine the types of pests and diseases of nutmeg plants in the study area and to identify the symptoms of crop damage they cause. The results showed that nutmeg plants' pests were moths, grasshoppers, thrips, mealybugs, and fruit flies. The types of diseases found were wet fruit rot, dry fruit rot, and leaf spot disease. Damage intensity due to dry fruit rot disease reached 49.28%. Wet rot disease was only found in the Nutmeg Development Center in Bogor Regency with a damage intensity of 52.93%, while the intensity of damage due to leaf spot disease reached 48.08%.

Keywords*: Disease, Indonesia, Nutmeg, Pest, Plant*

INTRODUCTION

The nutmeg plant (*Myristica fragrans* Houtt) is a native Indonesian plant originating from the Maluku Islands. Indonesia is the largest nutmeg producer in the world (70%), where most of the nutmeg plantations in Indonesia are cultivated by smallholders (98%) and the rest (2%) by large plantations. The products of nutmeg that are traded on the world market are seeds, mace, and essential oils.

Based on statistical data for national leading plantations for 2020-2022, it is known that in 2021 the area of nutmeg plantations in Indonesia will reach 254,699 ha with a productivity of 454 kg/ha. In 2022 there will be an increase in the area of nutmeg plantations which will reach 272,114 ha, but the productivity will only be 432 kg/ha. One of the factors causing the decline in the productivity of nutmeg is due to attacks by plant-disturbing organisms (OPT) such as pests and diseases of nutmeg plants which are often found in the field. The existence of OPT if left unchecked will continue to affect the productivity of the plant. Pests and diseases can be a limiting factor for the growth and production of a plant. Pests such as insects, mites, and vertebrates can cause physical damage to plants. Meanwhile, diseases caused by fungi, bacteria, phytoplasmas, viruses, and nematodes can cause physiological disturbances in plants (Wiyono, 2007).

Important plant-disturbing organisms (OPT) in nutmeg plants that have the most potential to reduce production are fruit/seed borer (*Aeroceum fariculatus*), stem/branch borer (*Batocera herculles*), wet fruit rot (*Colletotrichum gloesporiodes*) and dry fruit rot (*Stigmina myristicae*) (Pusat Data dan Sistem Informasi Pertanian 2020). The results of the research by Pesireron *et al.,* (2019) show that the main pest in nutmeg plantations in Maluku is the stem borer (*Batocera herculles*) and the main disease is stem canker (*Phytophthora palmivora*).

However, in several areas of nutmeg development in Indonesia, including in West Java, there is not much information on the types of pests and diseases that attack nutmeg plants and how much damage they cause. Therefore, in this study, we will identify pests and diseases of nutmeg plants and the level of damage they cause in two areas in West Java, under different environmental conditions.

METHODOLOGY

Identification of Pests and Diseases of Nutmeg Plants

The research was conducted at the Ciapus Tamansari Nutmeg Farmers Garden, Bogor Regency, and at the Balittro Cicurug Experimental Garden, Sukabumi Regency. Site selection is based on different environmental and maintenance conditions. The observation sampling technique was carried out by determining simple random sampling (Simple Random Sampling). The number of sample plants is 10% of the plant population at each location. Observation of the sample was carried out in 5 repetitions. Observations were made by observing the physical changes caused by pests and diseases, such as the presence of hollow leaves, cut shoots, hollow stems, leaf spots, leaf rot, dead shoots, and other symptoms, as well as identifying the symptoms of the attack and assessing the level of damage to the nutmeg plants they caused.

Other observations were made in the laboratory, by taking the types of pests that attack nutmeg plants and then identifying them from several literature sources, and then preserving them. The identification of disease-causing fungi is carried out by following several stages of implementation including harvesting diseased nutmegs, isolation, subculture, and then identification.

Damage Level Analysis

Identification of Pests and Diseases found, identified, recorded the type and number as well as indications of attack. Analysis of the level of damage was carried out by calculating the intensity of damage (IK) of nutmeg plants due to pests and diseases, using the formula proposed by Townsend & Heuberger (1968) in Karmanah *et al.* (2022) as follows:

DI = n/N x 100% .....(1)
(1) Diseases Incidence; n: number of plants affected by symptom, N: total number of plants.

The modified severity scale is based on Cristiane-Delmadi *et al.* (2018), namely disease intensity of 0% (healthy), >0 - 25% (mild), >25% - 50% (moderate), >50% - 75% (severe), and >75% (very severe).

RESULTS AND DISCUSSION

Identification of Pests and Diseases of Nutmeg Plants

The Nutmeg Development Center in Tamansari District has climatic conditions for an average daily temperature of 26.3^{o}C and an average relative humidity of 78.8%, while in Kp. Cicurug the average temperature is 26^{o}C each month, and humidity is 70%. The results of the inventory and identification showed that the pests found at the observation sites consisted of moths, grasshoppers, thrips, mealybugs, and fruit flies. The identified diseases are wet fruit rot, dry fruit rot, and anthracnose. The types of pests found are as follows:

A. Types of Moth Pests

Moths and butterflies belong to the order Lepidoptera. More than 90% of the order Lepidoptera are moth insects while the rest are butterflies (Sutrisno, 2010). According to Kalshoven (1981), moths are dark brown-gray, body length of 1.5-2 cm, and a wingspan of 3-3.8 cm (Figure 1a). Armyworm body color varies. The body of the late instar larvae is green-black with a black crescent mark on both sides of the 4th to 9th abdominal segments, which are located between two lateral and laterodorsal yellow longitudinal stripes.
The characteristics of the Lepidoptera order are: a) It has two pairs of wings with fine scales; b) Experiencing complete metamorphosis; c) The type of mouth in the larval stage is biting, while in the adult stage is sucking; d) The eyes are large facets.

B. Grasshopper (*Valanga nigricornis*)

The grasshoppers found in the field are as shown (Figure 1b). Grasshoppers belong to the order Orthoptera and the family Acrididae. The female imago has a body length of 58–71 mm and the male imago is 49–63 mm. Imago lays its eggs at a depth of 5–8 cm and is wrapped in a foam-like material. These insects generally lay eggs at the beginning of the rainy season and hatch early in the dry season (Dadang *et al.* 2007).
Members of this order generally have two pairs of wings. The forewings are narrower than the hindwings with thickened/hardened veins called tegmina. The hind wings are membranous and dilated with regular veins. During rest, the hind wings fold under the forewings. This insect has two (pair) compound eyes (facets), a pair of antennae, and three simple eyes (ocelli). Two pairs of wings and three pairs of legs are on the thorax. In the first segment (segment) of the abdomen, there is an auditory membrane called the tympanum. Spiracles which are external respiratory organs are found in

each abdominal and thoracic segment. The anus and external genitalia are found at the extremity of the abdomen (last abdominal segment), and the mouthparts are a biting-chewing type. Simple metamorphosis with development through three stages, namely egg-nymph-adult (imago) (Indartono 2006).

Figure 1a. Moth; 1b Grasshopper
(Source: Personal photo)

C. Thrips (Thrips Sp)

Thrips are the order Thysanoptera (Borror *et al.* 1996). The body is slender and flat, the imago is black and 1–2 mm long (Kalshoven 1981). The lower the temperature of an environment the color of the thrips will usually be darker. Male thrips are wingless, while the female has two pairs of fine, tufted wings.

The characteristics of the imago are winged insects, the body and legs are brown with alternating yellow, the second antenna segment is brown, the third, fourth and fifth segments are yellow, the sixth segment is brown and yellow, the seventh and eighth segments are brown, the head is elongated, not wide, the antenna consists of eight segments, and the last abdominal segment is shaped like a tube (tubular). The imago is inside the leaf roll, together with the eggs and larvae, and more active than the larvae. Imago with a length of 2 - 2.5 mm, and a width of approximately 0.3 mm.

These pests reproduce by parthenogenesis or can produce eggs without going through marriage first. Thrips eggs are oval, laid separately on the surface of plant parts, or inserted into plant tissue by egg-laying tools. Eggs are laid on the inside of the leaf tissue, then the nymphs that come out suck the leaf mesophyll tissue so that some spots are transparent and dry. The eggs produced can reach 80-120 eggs. After 6–8 days the eggs hatch into a transparent white first instar (Indartono 2006).

Figure 2. Thrips and Attack Symptoms
(Source: Personal photo)

D. Mealybugs (*Hemiptera*)

Bedbugs belong to the order Hemiptera and the Pseudococcidae family, namely insects that resemble flour. The characteristics of this pest are that it has a white body

and yellow wax, the body is covered with white flour, the edges of the body are like small threads, and on the tail, it has 2 threads that are longer than the other threads around the body.
This pest is polyphagous, female imago can produce 200-450 eggs within a few hours. While the change in shape from egg to nymph lasts 4-9 days. Males will become adults within 20–60 days after the nymphs hatch and female adults need only 20–45 days to complete their nymph period. Female imago can live for 1-2 months, while males only 1-3 days. Apart from copulation, the reproduction of this pest can be carried out by parthenogenesis by female imago (Kalshoven 1981).

Figure 3. Mealybugs and Attack Symptoms
(Source: Personal photo)

E. Fruit flies (*Tephritidae*)
Fruit flies belong to the order Diptera, family Tephritidae, subfamily Dacinae, and genus Tribe dacini. Worldwide, the Tephritidae family numbers approximately 4000 species and is grouped into 500 genera. This number is the largest among the economically important Diptera order insects. Morphologically, Tribe dacini is divided into three genera, namely Bactrocera, Dacus, and Monacrostichus (White *et al*. 1992). The Tephritidae family is easily recognized from the shape of the imago with the characteristic wing veins that have various beautiful patterns. Tephritidae fruit flies are often found perching on leaves or flowers during the day.

Figure 4. Fruit Flies
(Source: Personal photo)

Pest Attack Symptoms
Based on the observations made, several pests have been found, which generally come from the class of insects (insects) as shown in Table 1:

Table 1. Pests on nutmeg plants found at the study site

No	Pests	Part of the plant	Attack Symptoms
1	Ngengat	Stem	There were no signs of an attack
2	Belalang	Leaves	Locust on the edge of the leaf due to bites
3	Thrips	Leaves	Attack primordia leaves and young leaves by rolling the leaves eventually difficult to open
4	Leaf mealybug	Leaves	Leaves curl, apical shoots grow abnormally
5	Leaf Fruit	Flies	There were no signs of attack

There were moths and fruit flies at the study site, but no indications of attack symptoms were found on the nutmeg plants. It is likely that insects only need shelter, lay eggs, and nutrients that can be obtained from plants. The tendency of insect pests to choose plants as hosts is largely determined by the properties contained in these plants. If the plants have the properties favored by insect pests, then there is a tendency for the plants to suffer more severe damage.

Types of Diseases

The results of an inventory and identification of diseases on nutmeg plantations at the study site showed that there were disease attacks caused by 3 types of fungi, namely wet fruit rot, dry fruit rot, and anthracnose on leaves. This indicated that these three diseases had the potential to reduce nutmeg production in the District Nutmeg Development Center and KP Cicurug.

A. Wet Fruit Rot

The cause of this disease is caused by the fungus *Colletotrichum gloeosporioides*. In general, symptoms begin to appear at the base of the fruit, the part of the fruit that turns brown. The development of the fungus under optimum conditions causes the spots to spread rapidly to almost the entire fruit, the fruit is brown as if it had been boiled. According to Barnett (1999, the conidia of the fungus *C. gloeosporioides* are single-celled, ovate, or oval.

The fungus *Colletotrichum gloeosporioides* usually has a septa mycelium, is colorless, and darkens when old. The mycelium forms masses of thick-walled cells with fruiting bodies, called acervuli. Usually, these acervuli are in the host tissue just below the epidermal cells. This fungus has conidia which are short, oval, and colored while the conidiophores are short, and between the two they produce a black hair-like set

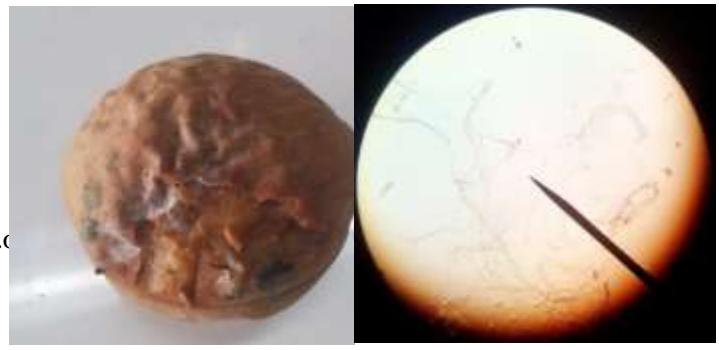

Figure 5.a) Disease symptoms and b) Konidia *Colletotrichum gloeosporioides*
(Source: Personal photo)

The pathogen *C. gloeosporioides* requires free water or relative humidity above 95% for conidia germination and appressorium formation. However, conidia can survive for 1-2 weeks at humidity as low as 62% and then germinate at 100% humidity. In general, infection occurs at temperatures between 20-30°C, and among variations in this temperature range is the optimal temperature for germination requirements and formation of appressorium between *C. gloeosporioides* isolates from different locations (Arauz, 2000).

B. Dried Fruit Rot
Dry fruit rot is caused by *Stigmina myristicae*. The initial symptoms of diseased fruit are first visible small round spots, with a diameter of approximately 0.3 cm. This part is blackish brown and settles (concave) then forms a black mass which dries and hardens (mummification process). According to Opete (2011), the sporodochium of the fungus measures 48-152 μm and is brown-green-black. Conidiophores grow on the upper stromal cells like a tube, clear to brown, conidia are 3-11 in sections, club-shaped upside.
According to Semangun (2008), infected nutmegs start at the age of 4-6 months. This disease is spread throughout the area in the observation plots such as those in the Nutmeg Development Center in Bogor Regency and KP. Cicurug.

Figure 6. a) Disease symptoms and b) Konidia *Stigmina myristicae*
(Source: Personal photo)

C. Leaf Spot
In general, leaf spot disease that attacks nutmeg plants is often also called anthracnose. This disease is caused by the fungus *Colletotrichum sp*. In these fungal colonies conidia are formed with the characteristics of being elliptical, two-celled, and rounded at the ends. Such conidial morphology is characteristic of the fungus *Colletotrichum sp*. (Barnett, 1999).

According to Semangun (2008) on young leaves, the disease can cause the death of leaves or part of the leaf blade. This symptom is often referred to as leaf blight, but for mature leaves, the disease can cause patches of necrosis (dead tissue) that are irregularly limited. These spots can later become holes. Severely affected leaves fall easily, so the branches of the plants become bare (Sunanto, 2002). Characteristic of anthracnose are spots on the leaves. Oval or irregular spots on the leaf surface. Under humid conditions, the patches expand and are irregular in necrotic areas (Singh, 1998).

Figure 6. a) Disease symptoms and b) Konidia *Colletotrichum* sp
(Source: Personal photo)

D. Symptoms of Disease Attack

The results of observations in the field showed that the nutmeg plants at the Bogor Regency Nutmeg Development Center and the Cicurug Experimental Garden (KP) indicated that they were attacked by an infection that causes a disease that attacks nutmeg fruit and leaves, several types of diseases attack nutmeg plants but the most found namely wet fruit rot disease, and dry fruit rot and leaf spot. The disease symptoms found in the observation plots are shown in Table 2.

Table 2. Diseases of nutmeg plants found at the study site

No	Diseases	The disease is caused by	Part of the plant	Attack Symptoms
1	Wet Fruit Rot	*Colletotrichum gloeosporioides*	fruit	The fruit is blackish brown like it's been boiled
2	Dried fruit rot	*Stigmina myristicae*	fruit	Diseased fruit are first visible in small round spots
3	Leaf Spot	*Colletotrichum* Sp	leaves	Young leaves the disease can cause the death of leaves or part of the leaf blade

The types of disease on nutmeg plants found at both locations were dry fruit rot and leaf spot, but wet fruit rot was only found at the Nutmeg Development Center, Bogor Regency. Based on the results of observations, the level of damage caused by several diseases is shown in Table 3.

Table 3. The intensity of plant damage caused by several diseases

No	Location	The intensity of plant damage caused by several diseases (%)		
		Dried Fruit Rot (*Stigmina myristicae)*	Wet Fruit Rot (*Colletotrichum gloeosporioides*)	Leaf Spot (*Colletotrichum* Sp)
1	Tamansari	38,88	52,93	24,26
2	KP Cicurug	49,28	-	48,08

Based on Table 3, the intensity of damage to nutmeg due to dry rot disease caused by the fungus *Stigmina myristicae* was found in two study locations and reached 49.28% (relatively high). According to Lala *et al.,* (2011), *Stigmina myristicae* causes dried fruit rot disease of nutmeg and reduces fruit yields to 40-60% (in Tidore) and 40-50% (in Bengkulu, Padang, and Deli).

Wet fruit rot disease caused by the fungus *Gloeosporium sp*. is only found in Tamansari with a level of damage reaching 52.93% (classified as heavy damage). These results are not much different from the results of Purnama's study (2015), where this fungus also infected nutmeg nurseries in Tamansari District with the highest incidence reaching 52% and the highest severity of 18%. The intensity of damage to leaves due to anthracnose disease caused by Colletotrichum sp at the Cicurug KP location was quite high, reaching 48.08% and classified as moderate damage.

According to Semangun (2008), important diseases that attack nutmeg plants in Indonesia include dry fruit rot (*Stigmina myristicae*), wet fruit rot (*Colletotrichum gloeosporioides*.), unripe fruit split (physiological disease), fruit rot and leaf fall (*Phytophthora palmivora*). Research results from Karoho *et al*. (2016), in Kendahe District, Sangihe Islands Regency, showed that the cause of wet fruit rot was the fungus *Colletotrichum gloeosporoides*, while the cause of dry fruit rot was the fungus *Stigmina myristicae*.

The high level of damage caused by this disease is partly due to poor land sanitation, especially at the observation site of Tamansari farmers. It appears that many nutmegs have fallen and have been infected with the disease but are left scattered so that they become a source of inoculum in the spread of this disease. Other factors that trigger the spread of this disease are a) the condition of the plantation is shaded by trees and dense plant crowns so that the intensity of sunlight is low and causes high humidity; b) poor drainage where there is still stagnant water

CONCLUSION

The types of pests found on nutmeg plants are moths, grasshoppers, thrips, mealybugs, and fruit flies while the types of diseases found on nutmeg plants are wet fruit rot disease, dry fruit rot disease, and leaf spot disease. The highest damage intensity for dry fruit rot disease was in the KP. Cicurug location, which reached 49.28%, while for the Nutmeg Development Center, Bogor Regency, it reached 38.88%. Wet pod disease was only found in the Nutmeg Development location, Bogor Regency, with an intensity of damage reaching 52.93%. The highest damage intensity of leaf spot disease was at the KP. Cicurug location, reaching 48.08%. The high level of damage by disease is caused by poor land sanitation, shaded planting conditions so that the intensity of sunlight is low and humidity is high, and poor drainage.

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