# Arthropods, Pests, and Diseases of Jack Bean (*Canavalia Ensiformis*) in Upland and Dry Climate Areas

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**Abstract.** Jack bean (*Canavalia ensiformis*) is one of the potential crops in tropical areas. Arthropods, plant pests, and microorganisms were observed in Jack bean crop ecosystems. The aims of this study were to observe the presence of arthropods in Jack bean plants in dry land and dry climate area, and disease symptoms caused by microorganisms. This research was conducted at Muneng experimental station Probolinggo, using a diagonal sampling method, with yellow trap, pitfall trap, and swapping net. Symptom variation, arthropod diversity, pest attack intensity, and disease incidence were recorded. The results showed that the types of arthropods, pests, and diseases that infect and the incidence of pest and disease attack on each accession do not differ between accessions. The highest number was recorded in the sweeping net with 12 families, followed by the pitfall trap with 4 families, while in yellow traps there were 3 families. Two insects as plant pest organisms were *Liriomyza* sp and *Maruca* sp with attack rates up to 70% and 80% respectively, while jack bean diseases were wilting and mosaic with 25% and 40%. It is necessary to identify the pathogens that caused the diseases in more detail and to study the proper management of pests to reduce yield loss.

## 1 Introduction

Jack bean (*Canavalia ensiformis*) is a tropic legume plant that has a large seed size and potential food source[1]. *Canavalia* spp contains 17%-30% protein and 24%-68% carbohydrates, and very low-fat of 0.2% in fresh seeds. Other components such as potassium, calcium, and iron are also at high quantity values[1,2]. The presence of this toxic alkali causes the seeds to undergo processing first before consumption. Jack bean is used as food, medicine, and animal feed. Low-fat content provides the potential nutrition for food fortification enthusiasts with low-fat and high protein content[2].

Jack bean is rarely reported to be infected with pathogens and attacked by pests. *Platiprosopus acutangulus* is one of the insect pests that are quite wary because it can attack in the vegetative phase and can cause serious losses, while in storage warehouses,

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pest attacks can be caused by *Tricorinus tabaci*[2]. Pathogenic infections in jack beans that have been reported are pod rot caused by *Fusarium solani* infection[3] and Potyvirus group infection[4].

In Indonesia, upland is the second largest suboptimal land (10.8 million ha), after wetland (133.7 million ha)[5]. The use of upland in dry climate areas can face some problems, which are climate change include short rainy periods with high intensity, or rainfall in the dry season that is low with a longer duration[6]. These anomalies can affect the presence of pests and pathogens that cause plant diseases[7]. Maintaining arthropod diversity in a cropping agroecosystem help increase soil and plant richeness which ultimately affects plant health and field productivity[8]. This study aims to observe the presence of arthropods and plant-disturbing organisms in jack bean plants applied in upland and dry climate areas. Pest information will be taken into consideration in crop cultivation and proper management of the jack bean pest in upland and dry climate areas in Indonesia.

# 2 Materials and Methods

## 3.1 Materials

The experiment used three jack bean accessions, namely a) Accession MLGCE 0003/original Wonogiri, b) MLGCE 001/original Gunung Kidul, and c) MLGCE 002/CE 7 which was repeated five times. The insect traps used are pitfall, yellow trap and insect net.

## 3.2 Time and Place

The experiment was carried out at the installations research and assessment of agriculture technology (IPPTP) Muneng Probolinggo in June 2021. The observations were made in jack bean planting, with upland and dry climate land type.

## 3.3 Observations

Observations were made to see the diversity of arthropods, pest attacks, and pathogenic infections in jack bean plants. The sampling pattern for observing arthropod diversity was carried out diagonally, using yellow traps, pitfalls, and swapping nets. Yellow traps and pitfalls were installed diagonally on each accession plot and repeated five times, while insect nets swung 12 times in double swings/accession tiles while walking around the sample swath, which was repeated five times each.

## 3.4 Data Analysis

The attack of pests and pathogenic infections is observed by conducting a description of symptoms and attack intensity. The intensity of attacks using the following formula:

Attack Intensity (%) (1)

AI = Attack Intensity (%)
n1 = Number of plants with scale of damage
Vi = Sample damage scale value
Z = Highest damage scale value

N = Number of jack beans plants observed

The observation data contain arthropod diversity, types of pests and diseases, description of symptoms, and intensity of attacks in vegetative and generative growth phases.

# 3 Results and Discussion

## 3.1 Arthropod Diversity in Jack Bean Plant

Observations on the three accessions showed that the different types of trapped arthropods did not differ between accessions (Accession MLGCE 0003/original Wonogiri, MLGCE 001/original Gunung Kidul, and MLGCE 002/CE 7). Field data show that the number of orders and families of insects trapped in each type of trap is different. Sweep net traps found 7 orders and 12 families, pitfall traps found 4 orders and 12 families, while yellow trap traps found 2 orders and 3 families. An overall of these three trappings show that the number of insects roles as a herbivore are 7 families (Aleyrodidae, Gryllotalpidae, Crysomelidae, Cicadellidae, Aphididae, Agromyzidae, and Phyralidae), insects roles as parasitoids are 3 families (Braconidae, Tachinidae, Ichneumonidae) and insects roles as predators are 5 families (Formicidae, Araneidae, Staphylinidae, Coccinelidae, Lilellulidae) (Table 1).

The highest number of trapped insects from the herbivorous group is from the Aleyrodidae family, the highest number of trapped insects from the predator group is from the Coccinelidae family, while the highest number of trapped insects from the parasitoid group is from the Braconidae family.

**Table 1**. Insect diversity in Jack bean

| **Number** | **Order** | **Insect Collection Method** | | | | | |
|---|---|---|---|---|---|---|---|
| | | ***Yellow trap*** | | ***Pit Fall*** | | ***Sweep Net*** | |
| | | **Family** | **Role** | **Family** | **Role** | **Family** | **Role** |
| 1 | Hymenoptera | Braconidae | Parasitoids | Formicidae | Predators | Braconidae | Parasitoids |
| | | Ichneumonidae | Parasitoids | - | - | Ichneumonidae | Parasitoids |
| 2 | Homoptera | Aleyrodidae | Herbivores | - | - | Aleyrodidae | Herbivores |
| 3 | Araneae | - | - | Araneidae | Predators | | |
| 4 | Orthoptera | - | - | Gryllotalpidae | Herbivores | | |
| 5 | Coleoptera | - | - | Staphylinidae | Predators | Staphylinidae | Predators |
| | | | | - | - | Coccinelidae | Predators |
| | | | | - | - | Crysomelidae | Herbivores |
| 6 | Hemiptera | - | - | - | - | Cicadellidae | Herbivores |
| | | | | - | - | Aphididae | Herbivores |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 7 | Odonata | - | - | - | - | Lilellulidae | Predators |
| 8 | Diptera | - | - | - | - | Agromyzidae | Herbivores |
| | | | | - | - | Tachinidae | Parasitoids |
| 9 | Pyralidae | - | - | - | - | Phyralidae | Herbivores |

The Aleyrodidae family consists of two subfamilies, namely Aleurodicinae and Aleyrodinae. This family is group of aphids which among them are important pests on horticultural and food crops. Members of the Aleyrodidae family includes *Aleurodicus dugesii* Cockerell, *Aleurodicus dispersus* Russell, *Trialeurodes vaporariorum* West, and *Bemisia tabaci* Genn,

*B. tabaci* is pest and viral vector that is often found in various bean plants, such as soybeans, mungbean and various other potential beans[9,10]. The abundance of various legume plants in IPPTP Muneng Probolinggo causes the cycle and development of pests to be uninterrupted, besides it the high of air temperature at the location (25 -33 $^0$C), is the optimum temperature for aphids development, such as *B. tabaci*. Bonaro et al[11] explained that the growth rate of this pest is influenced by environmental temperature. The increase in temperature from 17 $^0$C to 30 $^0$C will increase the population rapidly.

The population of Braconidae and Coccinellidae is higher than other predators and parasitoids insects. This is due to the availability of host insects as food and environment factors that support their development. Braconidae is known to be endoparasitoids in larvae of Lepidoptera, Coleoptera and Diptera[12,13], while Coccinellidae is known to be one of the predators of aphids on soybean plants[14].

## 3.2Pests on Jack Bean Plants

i.*Liriomyza* sp. The attacks give characteristic symptoms. On healthy leaves, there are no traces of roasting (Figure 1a), while on affected leaves, there will be traces of rouse with various intensities of attack, ranging from low attack intensity (Figure 1b), medium (Figure 1c), and high. Symptoms of liriomyza attacks on jack bean plants are white roasting strips on the leaf surface. The number of scraping marks varies depending on the number of slitting larvae. In further attack conditions, brownish discoloration will be found in the grooves of the former roasting (Figure 1d). At the level of heavy infestation, the affected leaves will easily turn yellow, dry out and fall off.

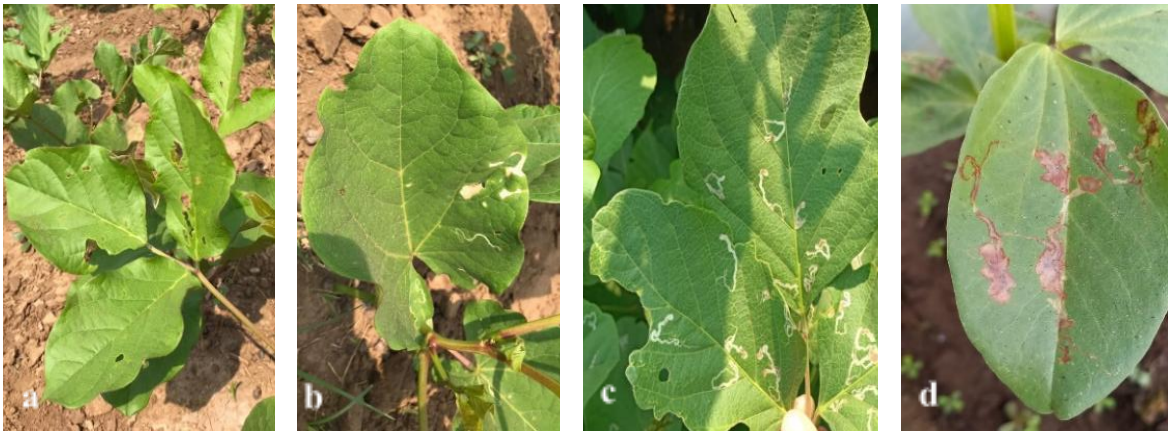

**Fig.1**. Symptoms of Liriomyza sp attack on Jack bean plants. a) leaves without attack symptoms, b) leaves with mild attack symptoms, c) leaves with moderate attack symptoms, and c) advanced attack symptoms.

Liriomyza attacks have been seen in vegetative phase with a low attack rate. Symptoms are found on the lower leaves near the soil surface. The attack rate of Liriomyza on each accession (Accession MLGCE 0003/original Wonogiri, MLGCE 001/original Gunung Kidul, and Accession MLGCE 002/CE 7) in both vegetative and generative phases is no different. Observations in the vegetative phase found an average attack of 20%, while the highest severity in generative phase, was found to reach 70% with an average attack of 42-44% (Figure 2).

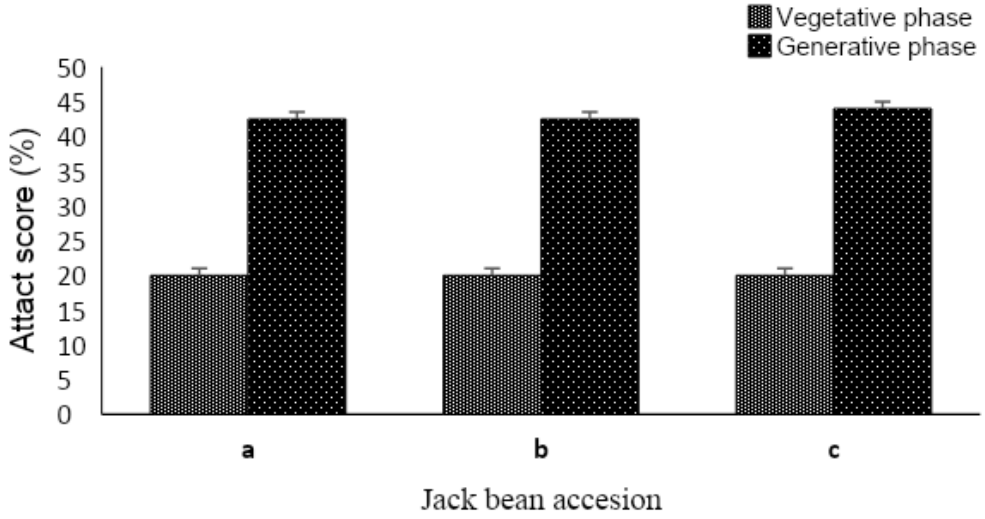


**Fig.2**. *Liriomyza* sp attack on jack bean plants, a) Accession MLGCE 0003/original Wonogiri, b) MLGCE 001/original Gunung Kidul, and c) Accession MLGCE 002/CE 7.

OEPPP/EPPO,[15] report that more than 300 species of *Liriomiza* spp are reported in the world. Liriomiza is a polyphage insect found infecting vegetable groups of the families Cucurbitaceae, Leguminosae, Fabaceae, Solanaceae and Brassicaceae. Liriomyza is commonly found in vegetable plants, including *L. sativae* and *L. trifolii* species found in legume families such as yardlong beans[16]. In Indonesia, this pest is not classified as the main pest on food crops, but in this study found a fairly high attack rate on jack bean plants. Liriomiza attacks have been reported caused high yield losses in potato crops. Its existence and attacks found on the jack bean plant are important information in the sustainability of its management.

The *Liriomyza* population and diversity in the field are influenced by various factors such as host availability and climate. The influence of changes in enviroment temperature greatly affects the development and spread of liriomyza. The appropriate temperature for its development is at 28 $^{0}$C-29 $^{0}$C[17]. Crop rotation is one of the important tecniques to prevent high pest infestation, by limiting the availability of food for pests.

i.*Maruca sp.* Observations in the generative phase found an attack by pests *Maruca* sp. *Maruca* sp is found on the petals in the flower strands (Figure 3a). Larvae obtain food by sucking flower which causes flowers dry and fall off (Figure 3b). This causes, the flowers not be able to develop into pods, so that crop production decreases.

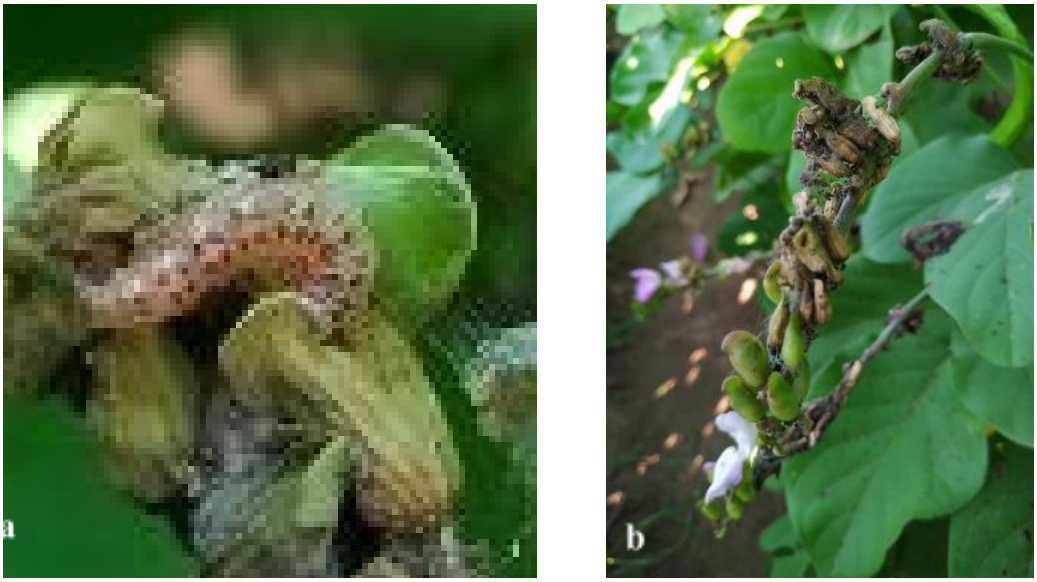


**Fig.3**. *Maruca* sp attack on jack bean plant at 12 WAP, a) larvae on flowers, b) flower strands affected by Maruca

Maruca's attack rate on Accession MLGCE 0003/original Wonogiri, MLGCE 001/original Gunung Kidul, and Accession MLGCE 002/CE 7) is no different. Observations at 12 weeks after planting (WAP) show that the average affected plant ranges from 52-54% (Figure 4). The maximum temperature conditions during the day and minimum temperature at night, effect the development of pests. In the generative phase of the plant, the attack rate reaches > 80%.

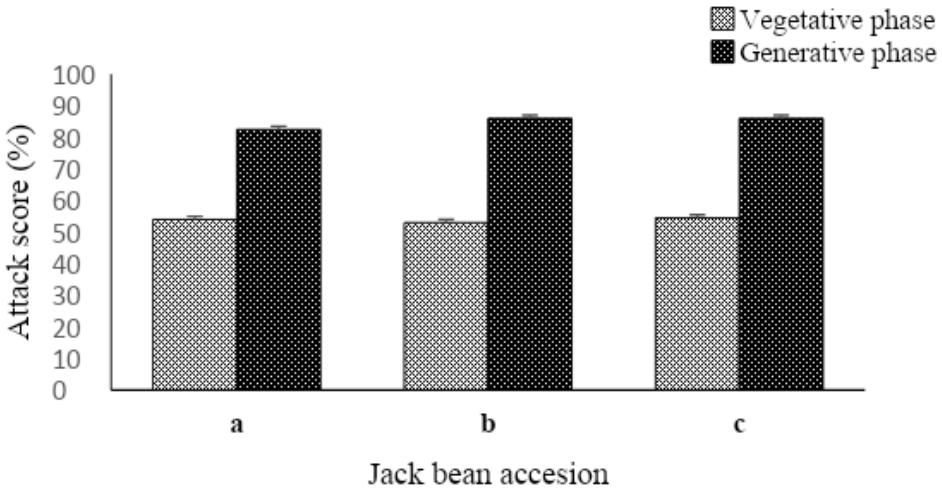


**Fig4**. *Maruca* sp pest attack on jack bean plants, a) Accession MLGCE 0003/original Wonogiri, b) MLGCE 001/original Gunung Kidul, and c) Accession MLGCE 002/CE 7.

The research in IPPTP Muneng Probolinggo shows that this plant can be attacked by *Maruca* sp with a fairly high attack rate (>80%). Indiati et al[18] reported that *Maruca* sp is one of the main pests on mungbean plants in IPPTP Muneng Probolinggo. Pod borer larval are commonly found on flower buds, flowers, and pods. The attacks caused flowers failed develop into pods and yield loss. This research was carried out in the dry season where there were jack bean plants, mungbean, soybeans and various other beans. The host availability and the suitability between pest and host caused attack incidence. Reports on

*Maruca* sp on jack bean plants are currently not available, so this research result can be information for proper pest management.

*Maruca* sp are known to be the main pests on legume food crops on Asia and Africa. This pest is polyphagous with the main host on legumes with yield loss rate can reach 72%. Until now, there have been no resistant varieties of *Maruca* sp in various plant such as cow pea, mungbean, and long beans[19,20]. Attacks in the pod-filling phase lead to high yield losses of more than 80%[21]. Therefore, control of these pests needs to be part of crop cultivation planning.

## 3.3 Diseases of Jack Bean Plant

This study also observed diseases in jack bean plants. The results showed that there were symptoms that pointed to pathogenic infection, namely mosaic stripes and wilting. The description of the symptoms that occur is as follows:

### *3.3.1 Mosaic and Mottle*

Mosaic symptoms were found at 12 WAP, along with an increase in whitefly populations. Mosaic symptoms in infected plants give them distinctive features compared to healthy plants (Figure 5). The criteria symptoms found in jack beans are striped mosaic leaves, wrinkled, abnormal and curly, stunted plants, abnormal fruits, and not producing pods. The rate of attack between accessions did not differ in the two observations. The incidence of striped mosaic infection in plants in the vegetative phase is (20 - 25%) which is randomly distributed in each plot, while in the generative phase ranges from (39 - 47%) in each infected individual (Figure 6).

**Fig.5**. a) Healthy leaves and pods; b) Symptoms of leaf mosaic, striped, blister-like, and wrinkled leaves; c) abnormal curling leaves and stunted plants; d) abnormal pods/curling.

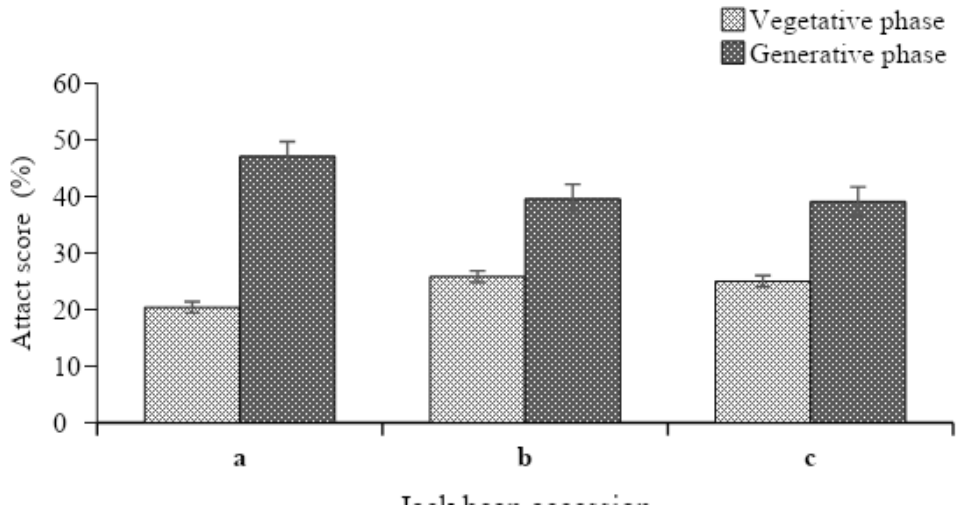


**Fig.6**. Incidence of striped mosaic disease in jack bean in the vegetative and generative phases of plants, a) Accession MLGCE 0003/original Wonogiri, b) MLGCE 001/original Gunung Kidul, and c) Accession MLGCE 002/CE 7

Viral infections in jack beans plants have been reported in several countries including *Canavalia mosaic potyvirus* in Nigeria[22], *Yambean mosaic virus* in Brazil[23] and *Bean common mosaic virus* (BCMV) in Indonesia[24]. Damayanti[26] report the first information of BCMV infection in Indonesia, with characteristic mosaic that have similarities symtomps with this finding in IPPTP Muneng Probolinggo, namely light green and dark green mosaics with clear boundaries, and vein banding. BCMV is a group of Potyviruses that can be carried by seeds (seed borned) and also reported to be carried by vectors including *Aphis fabae*, *Aphis craccivora*, *Acyrthosiphon pisum*, *Macrosiphum euphorbiae* and *Myzas persicae*[25]. Therefore, proper disease management and guarding against the spread of seed-borne viruses and planting material between regions is essential.

### *3.3.2. Wilt Disease*

Symptoms of wilting are found in fields with a very low percentage of incidence. The infection is not found in all plant blocks. The incidence of disease in the field is only found in accession b (MLGCE 001 / original Gunung Kidul) with an incidence rate of < 5%. Symptoms of wilting also appear by the presence of white fungal hyphae at the plant stem (Figure 7). Teixeria et al[26] reported pod rot infection in *C. ensiformis* caused by *Fusarium solani*, while pathogenic fungal infection in *Canavalia gladiata* species in China has been reported by Shi et al.,[27] in the form of stem rot symptoms caused by *Colletotrichum truncatum*.


**Fig.7**. Symptoms of wilting in jack beans plants, a) the leaves of the oldest plants turn yellow and the plant tans dry out and die, b) signs of infection at the base of the plant stem (white fungal hyphae).

The potential infection found in the field is information on good plant cultivation management to avoid fungal infections. Information on identifying plant-disturbing organisms in sword koro is still minimal, so the results of this study can be preliminary information about its management. Pests and pathogens can disrupt crop productivity and food availability. Therefore consideration is needed in a policy discussion on proper pest management.

## 4 Conclusion

Arthropods on jack bean in upland and dry climate areas in Muneng Probolinggo consist of 7 families of herbivorous groups (Aleyrodidae, Gryllotalpidae, Crysomelidae, Cicadellidae, Aphididae, Agromyzidae, and Phyralidae), 3 families of parasitoid insects (Braconidae, Tachinidae, Ichneumonidae) and 5 families of predatory insects (Formicidae, Araneidae, Staphylinidae, Coccinelidae, Lilellulidae). The main pest attacks on jack bean are *Liriomyza* sp, and *Maruca* sp, while diseases on Jack bean are striped mosaic disease and wilting. The types of arthropods, pests, and diseases that infect and the level of pest and pathogen attack on each accession do not differ between accessions. It is necessary to identify precisely the pathogen that causes the disease and assess the appropriate management of pests to reduce yield loss.

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