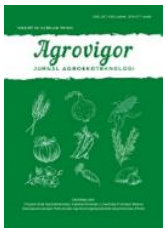
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Article

Diseases in mung bean with the spreading and dibbling planting system in Banyumas Regency, Central Java, Indonesia

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ABSTRACT

Mung bean is Indonesia's important legume crop after soybean and peanut, and it can be grown as a primary crop or an intercrop. The purpose of this study was to compare disease development and yield on mung bean fields grown under a spreading and dibbling cropping system in Kedungwringin Village, Jatilawang District, Banyumas Regency, Central Java. Data was collected from farmers through interviews and weekly disease observation in six mung bean fields. The type of disease, disease incidence, and severity were also determined using data obtained directly from the field. The study discovered five fungi and virus: powdery mildew (Erysiphe sp.), stem rot (Sclerotium rolfsii), leaf rust (Uromyces sp.), leaf spot (Cercospora sp.), and yellow mosaic disease (Begomovirus). The incidence of such diseases was ranging from 1% up to 85%, with the yellow mosaic disease having a very low incidence. There is no significant difference of disease intensity on both system. Leaf spot was the major disease with severity increasing gradually from 11.11% to 43.17%. Several insect pests and predators were discovered in fields. Considering the higher pod production in response to the disease occurrence, the dibble cropping system is recommended as the better mung bean farming strategy.

INTRODUCTION

Mung bean (*Vigna radiata* L.) is globally recognized as an essential component of the legume commodity chain, often ranking third in importance after soybean and peanut. As an inexpensive, high-quality source of plant protein, dietary fiber, and essential minerals, its production is vital for food security and nutritional stability, particularly across Asia. In Indonesia, primary mung bean-producing centers include Central Java, West Nusa Tenggara, South Sulawesi, and East Java (Trustinah *et al.* 2014). Globally, production is led by countries like India, which boasts an annual output of 1.5 - 2 million tons from 3 - 4 million hectares (Pandey *et al.*, 2018). Despite its nutritional importance, Indonesia's national production has faced challenges, showing a decline from 241.334 tons in 2017 to 234.718 tons in 2018 (BPS 2018), a decrease of 2.74%. This sustained low productivity necessitates imports and undermines efforts toward food self-sufficiency.

This decline is driven by a complex interaction of limiting factors cutting across genetic, environmental, and management deficiencies. These factors include poor seed quality, unsuitable timing and location for cultivation, and inadequate nutrient management leading to suboptimal nutrient availability and uptake. Furthermore, the overall health of agricultural soils is declining, worsening the vulnerability of the crop. These challenges are amplified by the growing threat of global climate change, which introduces multiple abiotic stresses such as higher ambient temperatures, increased humidity, unpredictable flooding and drought events, salinity stress, and elevated CO_2 levels. On a field scale, a suboptimal cropping system and the influence of both biotic (pests and diseases) and abiotic stresses are closely related to the persistently low mung bean yield (Pandey *et al.* 2018).

Pest and disease attacks represent a major biological threat across all growing seasons. The mung bean cropping system is associated with a wide variety of pests, including the bean fly (*Ophiomyia phaseoli*), various pod-sucking bugs (*Nezara viridula*, *Piezodorus hybneri*, *Riptortus linearis*), whitefly (*Bemisia tabaci*), and the pod borer weevil (*Apion clavipes*) (Indiati and Rahayu 2017). Disease pressure is equally severe, with reported infections including fungal pathogens like leaf spot (*Cercospora canescens*), powdery mildew (*Erysiphe polygoni*), and root and stem rot (*Rhizoctonia solani*), as well as bacterial leaf blight (*Xanthomonas phaseoli*). The most devastating biological constraint, however, is the Mung bean yellow mosaic virus (MYMV), transmitted by the whitefly vector. While fungal and bacterial infections can cause significant yield losses ranging from 40% to 60% viral infections, particularly MYMV, are capable of inflicting total loss, reaching 100% of the potential yield. These statistics emphasize the critical economic impact that disease management failures have on national mung bean productivity.

The vulnerability of mung bean is structurally linked to its status within Indonesia's national agricultural priorities. Current national policies heavily prioritize staple commodities like rice, maize, and soybean, often through subsidized seed, fertilizer programs, and supported mechanization. As mung bean is not at the top of this priority list, concern and investment in the crop are generally lower. Consequently, farmers frequently relegate mung bean to a rotation crop, typically planted after the main rice harvest, primarily utilizing residual moisture and nutrients with minimal external inputs. This operational context forces farmers to adopt trial-and-error cropping system approaches, experimenting with various techniques to find the most optimum method considering their local microclimate and socioeconomic status. This long-term empirical process influences the field's established microflora and insect populations, directly impacting disease ecology.

Disease transmission and severity are fundamentally determined by environmental factors, including temperature, relative humidity, field sanitation practices, and weed management. In tropical and subtropical regions, the high prevalence of diseases leads to chronic yield loss. For farmers, the presence and severity of disease must be evaluated because it translates directly into economic losses. Crucially, plant cultivation practices, specifically the initial planting method, have a profound and immediate impact on both pest and disease intensity and, ultimately, final yield. Banyumas Regency, a significant contributor to mung bean production in Central Java, exhibits this challenge, with an average mung bean productivity recorded at a relatively low 0.86 tons per hectare in 2018 (Dinpertan KP Banyumas Regency 2019). Mung bean cultivation in this area currently employs two distinct planting methods: 1) Spreading (scattering seeds randomly across the field surface), and 2) Dibbling (placing seeds in holes or shallow trenches at specific, measured intervals). These two methods

represent evident differences in plant spacing, density, and light interception, factors that critically influence the microclimate within the canopy. Dibbling, by promoting lower density and greater spacing, typically enhances air circulation, which can suppress the onset and spread of humidity-dependent fungal diseases like powdery mildew and leaf spots. Conversely, the dense, randomized canopy created by the spreading method can trap humidity, creating an ideal environment for disease proliferation.

Despite the contrasting effects these two simple methods have on the crop's microenvironment and subsequent disease risk, there is a distinct lack of quantitative, locally validated information regarding their efficacy and efficiency. The knowledge gathered from a systematic observation and evaluation of these methods is therefore essential for farmers to establish the best planting and cultivation strategies for maximizing mung bean yield and profitability. As a result, this research was aimed to evaluate the disease mapping and harvest yield differences between the spreading and dibbling planting methods in Banyumas Regency as the basis for recommending the superior system for farmers to achieve higher, more sustainable mung bean productivity.

MATERIALS AND METHODS

Study site, field observation, and laboratory identification

Field observations and sampling for this study were conducted in mung bean cultivation areas within Kedungwringin village, Jatilawang District, Banyumas Regency, Central Java. A total of six established fields were utilized as replicate plots for the two distinct planting treatments: the farmer-standard Spreading method (plots S1, S2, and S3) and the Dibbling method (plots D1, D2, and D3), resulting in three replicates for each method. To gather essential background data, semi-structured interviews were concurrently held with participating farmers regarding the history of the land, specific cultivation practices, and any pest and disease control measures applied to the current crops. Following field work, laboratory analyses were conducted at the Plant Mycology Laboratory, Department of Plant Protection, Faculty of Agriculture, IPB University. Pathogen identification was performed through morphological characterization, involving the isolation and microscopic observation of fungal structures (spores, hyphae, and fruiting bodies) to confirm genus and species. Field-observed insect pests were similarly identified based on detailed morphological features and confirmed using established taxonomic keys and reference literature pertaining to major mung bean pests prevalent in tropical regions.

Disease incidence, disease severity, and yield estimation

Disease observation within the study was conducted across all six field replicates, with data collected from twenty sample plants in each plot. These plants were chosen using simple random sampling to ensure the representative nature of the disease data from both the spreading and dibbling treatments. The monitoring process spanned four critical stages of mung bean development, with weekly observations performed over the period from 5 to 8 weeks after planting (WAP). Concurrently with the disease assessments, ambient temperature and relative humidity measurements were systematically recorded weekly at the time of observation to correlate microclimatic factors with disease progression. Disease incidence (DI) and severity (DS) was calculated using the following formula (Cooke 2006):

$$\text{DI (\%)} = \frac{n}{N} \text{x } 100 \text{ \%}$$

with DI = disease incidence (%); n = number of symptomatic plants; N = total plants observed.

$$\text{DS (\%)} = \frac{\sum_{i=1}^{6} ni.vi}{N \text{ x } Z} \text{ x } 100\%$$

with DS = disease severity (%); ni = number of symptomatic plants in a scale; vi = disease severity scale; N = total plants observed; Z = maximum disease severity scale.

Disease severity for Cercospora leaf spot (*Cercospora* sp.) as the major disease observed was assessed on a modified 1-to-6 scale based on the percentage of symptomatic leaf area. A score of 1 represented a very mild infection, affecting 1%-10% of the leaf area. As the infection progressed, the scores were defined as follows: score 2 for 10%-30% infection, score 3 for 30%-50%, score 4 for 50%-70%, score 5 for 70%-80%, and the highest score of 6 for plants showing more than 80% of their leaf area with symptoms. This standardized scoring system was adapted from the methods described by Manandhar *et al.* (2016) and Sarker *et al.* (2017). Based on these severity observations, the area under the disease progress curve (AUDPC) was subsequently determined using the trapezoidal integration method as outlined by Cooke (2006).

$$AUDPC = \frac{\sum_{i=1}^{6}(X_{i+1} + X_i)}{2} . (t_i + 1 - ti)$$

with X_{i+1} = disease severity at present observation; X_i = disease severity at the previous observation; $t_{i+1} - t_i$ = observation time interval.

Pathogen propagules were observed directly by excising small, symptomatic portions of infected leaves collected from the field. A sterile needle was used to carefully detach the diseased tissue, which was then immediately mounted onto a glass slide with a drop of sterile water. Microscopic examination for the morphological characteristics of the causal agents (such as fungal spores, conidiophores, or mycelium) was conducted using a light microscope at 40 x 10 magnification and confirmed through the use of established morphological key references.

Data analysis

All quantitative data, including disease incidence, disease severity, AUDPC, and harvest yield, were first organized and compiled using Microsoft Excel 2010 before statistical testing. The non-parametric data for disease incidence, disease severity, and AUDPC were analyzed using the Mann-Whitney U test at a 5% significance level. Conversely, the data for harvest yield were subjected to a parametric analysis using an independent samples t-test at a 5% significance level. Both comparative tests were executed using SPSS 16.0 software to evaluate significant differences between the spreading and dibbling cultivation methods.

RESULTS AND DISCUSSION

General conditions of the mung bean cultivation in Banyumas Regency

Banyumas Regency is located astronomically between 7°15′05″ and 7°37′10″ South Latitude and 108°39′17″ and 109°27′15″ East Longitude, and it consists of 27 sub-districts. The mung bean fields used for the research are located in Kedungwringin Village, Banyumas Regency, Central Java. This location is at an elevation of 21 meters above sea level (BPS Banyumas Regency 2021). The average daily temperature in the observation fields ranged from 27-30 °C, with an average daily relative humidity of 74%-82%. These are the favorable conditions both for plant growth and for disease development. The mung beans were grown in paddy fields as a rotation crop after two consecutive rice plantings.

The observed mung bean plots ranged in size from 525 to 700 m^2. The farmers used two planting methods: spreading and dibbling. The seeds were a local variety from previous harvesting season. The planting pattern was typically monoculture, except for one spreading plot (S3) which was intercropped with sweet potatoes. The dibbling plots had a consistent planting distance of 30 x 30 cm, while the spreading plots had variable spacing. Irrigation was provided by a technical irrigation system. The majority of farmers did not apply fertilizer or perform any weeding or pest and disease management. However, in two of the dibbling plots (D1 and D2), farmers applied Gandasil fruit and leaf fertilizer at three weeks after planting. The general conditions of the observed fields are detailed in Table 1.

Diseases in mung bean fields

There are five diseases discovered in this study, i.e. powdery mildew, stem rot, rust, leaf spot and yellow mosaic. The most dynamic incidence level was observed at 7 weeks after planting (Table 2). The diseases caused by fungi were clarified through microscopic observation and the infective structures i.e. conidia, infective mycelia, uredospores, conidiophores were observed confirming the causal agents of the symptomatic diseases (Figure 1). The infection of yellow mosaic virus did not have the microscopic or serological confirmation, but the significant reduction of pod size was confirmed as the direct impact of this viral diseases. Based on Table 1, yellow mosaic virus has the lowest disease incidence. Meanwhile, Cercospora leaf spot was the major diseases in mung bean on this research. Considering the yield loss risk due to the high incidence, the severity of the leaf spot disease was measured (Figure 2).

Powdery mildew. Symptoms of powdery mildew first appeared on young plants as grayish-white spots on the upper leaf surface. These spots clustered together, forming island-like structures on the leaves. In the reproductive phase, the disease symptoms were often associated with leaf spot, leading to an overlap of the two diseases. Severe infections resulted in stunted growth and the drying of leaves. This disease is caused by the fungus *Erysiphe* sp. The pathogen's signs were observed as clusters of conidia and conidiophores on both the upper and lower leaf surfaces.

Table 1. General conditions of mung bean crops in the observation fields

Field Information	Plot 1 (D1)	Plot 2 (D2)	Plot 3 (D3)	Plot 1 (S1)	Plot 2 (S2)	Plot 3 (S3)
Area (m^2)	525	525	700	700	700	700
Topography	Flat	Flat	Flat	Flat	Flat	Flat
Planting system	Monoculture	Monoculture	Monoculture	Monoculture	Intercropped with sweet potatoes	Monoculture
Seed source	Previous harvest	Previous harvest	Previous harvest	Previous harvest	Another farmers	Previous harvest
Planting distance (cm)	30 x 30	30 x 30	30 x 30	-	-	-
Plant Density	Moderate	Moderate	Moderate	High	Moderate	Moderate
Fertilization	Gandasil (at 3 WAP)	Gandasil fruit and leaf once at 3 WAP	Not done	Not done	Not done	Not done
Weed Presence	High	Moderate	Moderate	High	Moderate	Moderate
Disease control	Not done	Not done	Not done	Not done	Not done	Not done
Rice straw application	Returned to the field	Returned to the field	Burned	Returned to the field	Returned to the field	Returned to the field

Table 2. The disease incidence at 7 weeks after planting on both spreading and dibbling cropping system

Diseases	Disease incidence in cropping system-i (%)[a]	
	Spreading	Dibbling
Powdery mildew	8.33a	6.67a
Stem rot	3.33a	3.33a
Rust	3.33a	1.67a
Leaf spot	85.0a	63.3a
Yellow mosaic	1.67a	1.00a

[a]Means followed by the same letter is not significantly different by Mann-Whitney U test at α 0.05

The conidia were cylindrical, singular, and measured 6–51 × 13–22 µm, while the conidiophores were elongated and flexible with a cylindrical base. Conidia act as the primary source of inoculum and are spread by wind.The first symptoms of powdery mildew appeared at 6 WAP. The highest disease incidence reached only 8.33% in spreading plots. There was no significant difference in disease progression between the two methods. However, disease progression was slower in the dibbling plots, possibly because shade from nearby tahiti apples trees reduced direct sunlight, which, according to Giertych and Suszka (2010), can inhibit the development of powdery mildew.

Stem rot. Symptoms of stem rot were observed during the generative stage of the plant. The signs included a white, fuzzy mycelium visible on the soil surface and at the base of the stem, accompanied by a softening of the stem tissue. Advanced symptoms caused wilting, preventing the plants from producing pods and eventually leading to plant death. The pathogen responsible for stem rot is the soil-borne fungus *Sclerotium rolfsii*, which thrives in optimal temperatures of 21-30 °C and high humidity. The fungus forms a survival structure called a sclerotium to withstand unfavorable environmental conditions.

Based on the disease progression graph, stem rot appeared at 7 WAP with the highest average disease incidence was 3.33%, with no significant difference between the two planting methods. The low incidence was likely due to the fact that symptoms were only found in plots D3 and S1 when the plants were already producing pods, so they were harvested before the infection could spread widely. The higher incidence in spreading plots compared to dibbling plots may be due to the higher

plant density from the spreading technique. According to Jaccoud-Filho *et al.* (2016), high plant population density can increase the incidence and severity of stem rot.

Rust. Symptoms of rust were found when plants were flowering and already had pods. The disease manifests as brown, raised pustule-like spots on the upper and lower leaf surfaces, surrounded by a yellow *halo*. These spots give the infected leaves a rough texture. The pathogen's presence reduces pod quality and quantity by disrupting photosynthesis. Symptoms on pods included raised brown spots on their surface. This disease is caused by the fungus *Uromyces* sp., with species such as *U. appendiculatus* and *U. phaseoli* reported to infect mung beans. The disease signs were observed as round oval, golden-yellow urediniospores. The pathogen is spread by wind and insects. Ideal conditions for uredospore germination are temperatures of 16-24 °C and high humidity.

The first symptoms appeared at 6 WAP in the spreading plots and 7 WAP in the dibbling plots. The average incidence started at 1.67% and 3.33% by the observation on dibbling and spreading plot, respectively, with no statistically significant difference between the two planting methods. The low incidence was likely because symptoms were only found in plots D1 and S1. While the high humidity from rainfall supported the disease, the observed temperature of 27-30 °C was higher than the optimal temperature for uredospore development, which likely kept the severity from increasing further.

Leaf spot. Symptoms of leaf spot were first found on the earliest leaves. The spots were dark brown, irregularly shaped, and had a grayish-white center, scattered across the upper leaf surface. The disease infected all plant growth stages and spread to other parts of the plant, including the pods, causing the leaves to dry up. On older plants, these symptoms were often accompanied by other diseases, leading to mixed infections. Leaf spot in mung beans is caused by the fungus *Cercospora* sp. The signs of the disease are long, septate conidia and conidiophores. The conidia are hyaline, straight or slightly curved, and contain 6-12 septa, while the conidiophores are yellowish-brown, straight or slightly curved, and unbranched. Conidia are crucial for the spread of the pathogen as they serve as the primary source of inoculum. Symptoms appeared early, at 5 WAP. The average disease incidence reached 85% in the spreading plots and 63.33% in the dibbling plots. The rapid and widespread infection suggests that the local seed variety used was highly susceptible to leaf spot. Furthermore, the use of self-produced seeds, which may be a mix of strains or varieties, can lead to lower quality seeds.

Despite the high incidence, the disease severity was relatively low. The highest average severity was up to 40% on both plots at 8 WAP, with no significant statistical difference between the two methods. The observed temperature (27-30 °C) was higher than the optimal range (20-26 °C) for the pathogen's conidia production, which likely kept the severity in check. This indicates that while the disease was widespread, it did not significantly impact the mung bean yield. Using superior, disease-resistant varieties is recommended to mitigate the problem.

Yellow mosaic. Another disease found was yellow mosaic, with symptomatology is highly related to the diseases commonly caused by the genus *Begomovirus*. This virus is transmitted by the whitefly vector (*Bemisia tabaci*). Further identification is needed to determine the specific virus species. Symptoms included yellow-green leaf mottling, stunted plant growth, and malformed pods that were small and empty. The incidence of yellow mosaic was very low, infecting only one to five plants per plot, and it did not spread throughout the entire crop. Therefore, it can be considered a minor disease at this location.

Non-disease causal agents: pests and predators. Several pests and predators were observed, including the hornworm (*Agrius convolvuli*), cabbage looper (*Chrysodaiexis chalcites*), bean fly (*Ophiomyia phaseoli*), green stink bug (*Nezara viridula*), leaf roller (*Lamprosema indicata*), and whitefly (*Bemisia tabaci*). Predators found included the rove beetle (*Paederus fuscipes*), dragonfly (*Orthetrum sp.*), spider (*Oxya javanus*), and ladybird beetle (*Micraspis lineata*). Pests attack plants from the seedling to the reproductive stages. The presence of some pests can increase disease incidence and plant damage both directly and indirectly, as feeding wounds can serve as entry points for pathogens.

Area under disease progress curve and harvest data

Harvesting was done early due to the onset of the rainy season and the opening of irrigation channels for the next rice planting cycle. As a result, many unripe pods were harvested, leading to reduced yield and lower seed quality. Furthermore, pathogen infections caused some pods to be malformed, small, or empty, which negatively

impacted the selling price. Farmers harvested by manually picking mature pods or by uprooting the entire plant to pick the pods at home. Mature pods, which are black, were then sun-dried until they cracked open.

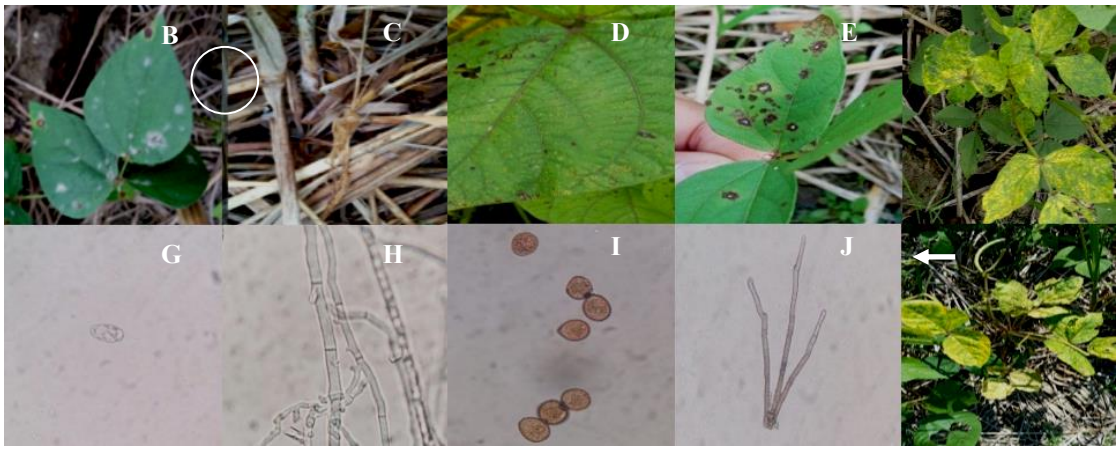


Figure 1. Diseases by pathogenic fungi and virus on mung bean, a. powdery mildew by *Erysiphe* sp., b. stem rot by *Sclerotium rolfsii*, c. rust by *Uromyces* sp., d. leaf spot by *Cercospora* sp., and e. yellow mosaic by Begomovirus. Belows are the pathogenic sign i.e. conidia of. *Erysiphe*, g. invasive mycelia and clamp connection of *S. rolfsii*, h. uredinospores of *Uromyces* sp., i. conidiophores of *Cercospora*, and j. smaller pods produced as a result of viral infection.

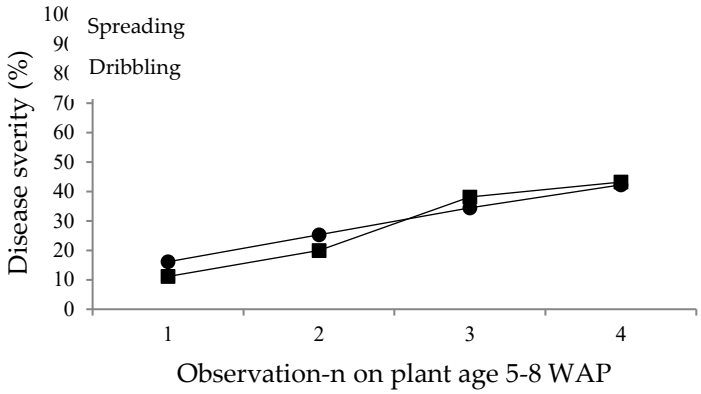


Figure 2. Disease progress of Cercospora leaf spot disease on mung bean

Table 3. The area under disease progress curve (AUDPC) value on mung bean and converted yield value

Cropping system	The AUDPC[a] value of disease incidence (unit)					Yield[b,c] (kg ha^{-1})
	Powdery mildew	Stem rot	Rust	Leaf spot	Yellow mosaic	
Spreading	15,83a	3,33a	6,67a	294,38a	1,34a	0,49a
Dribbling	14,17a	1,67a	3,33a	289,67a	0,90a	1,22b

[a]Measured in 5-8 weeks after planting; means followed by same letters are not significantly different by Mann-Whitney U test at α 0.05 . [b]Measured on the 20 observed yield per field and converted based on the population number of mung bean in one hectare; t-test α 0.05

lternatively, seeds were separated by threshing (beating or stepping on the pods). After separation, the seeds were sun-dried for 1-2 days. Seeds intended for the next planting season were dried longer to reach a moisture content of 9%-10% to prevent post-harvest pest infestation.The analysis showed that the number of pods in dibbling plots was significantly higher than in spreading plots, though the pod weight was not statistically different. This aligns with findings from Hossain *et al.* (2018), which state that dibbling yields significantly higher seed weight and number of pods than the spreading method. According to farmer interviews, spreading requires more seeds (5-6 kg) compared to dibbling (3 kg). As Almeida *et al.* (2020) noted, spreading uses more seeds and is harder to weed but requires less labor. The area under the disease progress curve (AUDPC) is a way to summarize disease progression over time into a single value. The AUDPC for leaf spot was the highest among all diseases, with a value of 294.38 in the spreading plots and 289.67 in the dibbling plots, confirming it as the most dominant disease. The dibbling plots had a lower AUDPC value than the spreading plots. The AUDPC values were inversely proportional to the total (Table 3).

Based on observations and interviews, several key issues were identified regarding how farmers in Kedungwringin Village cultivate mung beans. These farmers use a local seed variety from previous harvests and generally do not perform soil tillage, adequate irrigation, fertilization, weeding, or pest and disease control. Farmers typically use monoculture or polyculture cropping systems. In the polyculture system, they plant sweet potatoes on the bunds of the rice fields to maximize land use. Research shows that intercropping significantly boosts mung bean production because it leads to lower pest damage and an increase in natural enemies. The varying plant spacing in the spreading method, which depends on the farmer's skill, results in lower yields compared to the dibbling method. To achieve optimal growth, uniform planting distances are crucial for ensuring a higher amount of photosynthates are translocated to the seeds, maximizing production. Recommended planting distances for significant dry weight yields are 30 x 30 cm and 30 x 20 cm.

Since the seeds from previous harvests have unknown purity, health status, and susceptibility to pests and diseases, it's recommended that farmers use certified, healthy seeds to increase production. Several high-yielding varieties are recommended for mung bean production centers in Java, including Betet, Kenari, Kutilang, Murai, and Vima varieties. Proper irrigation is also vital, especially during the germination and reproductive phases when plants need sufficient water. In a technical irrigation system, farmers can flood the fields for 15-30 minutes until the land is sufficiently wet, then drain the water. Weeding is also essential to reduce competition with weeds, which can cause up to a 56% yield loss if left unchecked. Weeding is typically done 14-21 days after planting and can be influenced by the use of rice straw mulch, which can suppress weed growth by up to 61%.

Most farmers did not fertilize their crops, except for one who used Gandasil fruit and leaf fertilizer. While this type of fertilizer does not significantly affect plant height, its high phosphorus and potassium content significantly increases the number of fruits and fruit weight by boosting photosynthesis. It is also recommended to apply a basic fertilizer, such as 50 kg ha^{-1} of Urea, 50 kg ha^{-1} of KCl, and 75 kg ha^{-1} of TSP, to ensure plants have adequate nutrients. Finally, it is crucial for farmers to have a better understanding of important mung bean diseases so they can implement proper control measures. Recommended strategies include using certified seeds, planting with recommended spacing, regular weeding, removing diseased plants (roguing) when disease incidence is low, and using more environmentally friendly biopesticides. Implementing these proper cultivation practices can significantly increase mung bean production and lead to optimal yields.

CONCLUSION

Dibbling is a promising cultivation strategy for mung bean production in the study area. This strategy produced a considerably greater yield, despite the fact that disease incidences for the five examined diseases were not significantly different from those of the spreading method. This method, together with using certified seeds and frequent weeding, can reduce disease effect and increase yield. For example, a dibbling plot produces greater quantities, demonstrating that the plants may recover their normal state while combating disease progression. As a result, implementing a dibbling cropping system is an important step for farmers in order to increase mung bean productivity.

AUTHORS CONTRIBUTIONS

TAD and HSK designed the experiment. DKP conducted the farmers' interviews, data collecting, and analysis. TAD and HSK examined the microscopic structures of fungi and confirmed the viral symptoms. DKP, TAD, and HSK interpreted the results. DKP created the original manuscript. The authors of the manuscript responded and commented on the research flow, data analysis, and interpretation, as well as the manuscript's structure. All writers read and approved the final manuscript.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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