Conference Paper

Resistance Potential to Powdery Mildew (*Microsphaera diffusa* Cooke and Peck) of Several Yellow and Black Soybean (*Glycine max* (L.) Merr) Genotypes

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Abstract

Powdery mildew caused by *Microsphaera diffusa* has recently received more attention because of yield losses caused by the disease and has even been reported as a limiting factor on soybean production in a certain soybean plantation areas. The aim of the research was to examine resistance potential of several yellow and black soybean genotypes in order to develop powdery mildew-resistant soybean varieties. The experiment was conducted in rainy season of 2013 at the Ciparanje Experimental Station, Faculty of Agriculture, Universitas Padjadjaran, Jatinangor, West Java, using a Randomized Block Design with 61 soybean genotypes as treatments that replicated two times. Each genotype was planted in plot (5 m long) consisted of 25 plants from which 6 plants per plot were sampled randomly. The disease intensity and soybean yield were assessed. The result showed that 15 genotypes were not infected by the disease, namely UP-104, UP-106, UP-108, UP-111, UP-112, UP-113, UP-114, UP-125, UP-127, UP-130, UP-136, UP-137, Argomulyo, Arjasari and Mintani, whereas other 46 genotypes were infected with the highest disease intensity of around 40%. Genotypes showing resistance potential are considered as a potential source of resistance genes that valuable in the disease-resistant soybean breeding.

Keywords: Soybean; resistance; powdery mildew; *Microsphaera diffusa*.

1. Introduction

Soybean is one of important food crops in several countries including in Indonesia. Availability of soybean is very crucial since nearly 90% of soybean is used as raw material of processed food products and the need continues to increase [1, 2]. However, soybean production in Indonesia is reported to be considerably influenced by the presence of infectious diseases on soybean plants [3, 4]. One of the diseases on soybean that is begun to receive attention is powdery mildew caused by the fungus *Microsphaera diffusa* Cooke & Peck. The disease can cause early defoliation of soybean leaves that result in reduced weight of the seeds and pods ranging from 10% to 90% depending on the phase of plant development, environment condition and soybean varieties [5].

Since the first report of powdery mildew disease incidence on soybeans in Japan [6, 7], this disease has become a limiting factor in all the soybean production regions worldwide. In Indonesia, the powdery mildew was first reported in soybean plants in the area of Muneng-Probolinggo, East Java, and at present has attracted considerable attention because of high losses in grain yield [8]. Symptoms of the disease are in the form of white patches of mycelium and conidia of fungi growing on plants, especially on the upper surface of the leaves that are then enlarged and covered the entire surface of the leaf [9]. Other symptom mentioned by Grau [10] is the emergence of patches of green and yellow islands on leaves. Powdery mildew disease can lead to high yield losses. Disease that occurs can lead to the decline in the quantity, weight and physical quality of seeds and reduce germination of seeds [11, 12]. Rahayu [8] mentioned that a decrease in germination in plants infected by powdery mildew disease ranges between 50 and 52%. Yield loss due to infection of *M. diffusa* in some countries has been reported to reach 30% when *M. diffusa* infects at the beginning of plant growth in some susceptible varieties [13]. Powdery mildew disease was also reported in Brazil (the second world's largest soybean exporter country) where the disease occurred throughout the planting area of soybean with yield losses up to 40% [14].

Infection of powdery mildew disease is known to be influenced by resistance of soybean varieties that even in a different variety there are possibilities of different development and progression of the disease symptoms [8, 9, 14]. It is reported that soybean resistance against powdery mildew is an inherited resistance that is controlled by dominant genes with different effects on the level of intensity and severity of the disease [15, 16]. Other studies have shown that symptoms of powdery mildew infection can disappear and vulnerable when the plants are young and reappear when the plants are mature [14]. Powdery mildew disease management is still depending on the use of varieties that are considered to be resistant to the disease due to consideration of inefficient and ineffective of chemical control [17]. The aim of this study was to select soybean genotypes that have potential resistance to powdery mildew disease.

2. Materials and Methods

The research was conducted at the Ciparanje Experimental Station, Faculty of Agriculture, Universitas Padjadjaran from April to July 2013. The materials used were 61 genotypes of soybeans (collection of the Laboratory of Plant Breeding, Universitas Padjadjaran) consisted of 39 black soybean genotypes (including 3 released varieties) and 22 yellow soybean genotypes (including 10 released varieties). The experiment method was a randomized block design (RBD) with 61 genotypes as treatments that were repeated twice. Each genotype was planted on an extending plot to a length of 5 m consisted of 25 plants with plant spacing of 20 cm in one plot while the distance within plots was 70 cm. As many as six plants per plot were taken as sample plants that determined systematically namely the 3rd, 7th, 11th, 15th, 19th and 23rd of the planted plants. The sample plants were scored for the disease according to 0-to-5 grade scale, as follows 0 = no leaf symptoms, 1 = 10% of the leaf surface with symptoms, 2 = 11 to 25% of the leaf surface with symptoms, 3 = 26 to 50% of the leaf surface with symptoms, 4 = 51 to 75% of the leaf surface with symptoms, 5 = more than 75% of the leaf surface with symptoms [14]. The score was used to calculate the intensity of the disease [18].

Soybean genotype resistance criteria was determined use modified disease resistance criteria set by Gonçalves et al. [14] as well as based on a general criteria for plant disease resistance [19, 20]. Thus in this study, any genotype that classified as 'Resistant' (scale grades of 0 to 3) or 'Susceptible' (scale grades of 4-5) according to Gonçalves et al. [14] was divided into scale grades as follows: 0 = immune, 1-2 = resistant, 3 = moderately resistant, 4 = moderately susceptible, and 5 = susceptible.

3. Results and Discussion

The experiment was carried out in February up to May with the average rainfall of 319 mm/month. This rainfall condition is considered has benefited the growth of soybean plants during the trial where sufficient soil water affected excellent soybean plant growth. High rainfall will automatically lead to the availability of water in the soil. On the other hand, this condition might also provide high environmental humidity that can favour the development of the powdery mildew pathogen. However, it is reported that conidia of *M. diffusa* can be easily carried by rain water thus delaying secondary spread of this fungus in the rainy period. In the time of the trial period, the relative humidity was ranging from 90.43 to 91.05%. This relatively high humidity condition is considered supported the development of the disease and the infection during the trial. Grau [10] mentioned that cold temperature with high humidity can generate the development of

Table 1: Disease intensity of powdery mildew at 11 weeks after planting and resistance criteria of soybean genotypes.

Genotype	Disease intensity (%)	Resistance criteria	Genotype	Disease intensity (%)	Resistance criteria
UP 137	0.00	Immune	UP 107	5.00	Resistant
UP 119	1.67	Resistant	UP 124	18.33	Resistant
Burangrang	15.00	Resistant	Panderman	8.89	Resistant
UP 123	16.67	Resistant	Cikuray Balitkabi	12.78	Resistant
Mutiara	10.00	Resistant	UP 154	38.89	Moderately resistant
UP 126	28.33	Moderately resistant	UP 160	10.56	Resistant
Malika	10.56	Resistant	UP 102	13.33	Resistant
UP 135	36.67	Moderately resistant	UP 152	5.00	Immune
UP 115	27.78	Moderately resistant	UP 129	20.00	Resistant
UP 144	10.56	Resistant	UP 130	0.00	Immune
UP 110	3.34	Resistant	UP 128	5.00	Resistant
Argomulyo	0.00	Immune	UP 132	5.00	Resistant
Arjasari	0.00	Immune	UP 149	3.34	Resistant
UP 109	5.56	Resistant	UP 116	3.34	Resistant
UP 131	5.00	Resistant	UP 134	5.56	Resistant
UP 141	38.89	Moderately resistant	UP 158	10.00	Resistant
Wilis	6.67	Resistant	UP 118	10.00	Resistant
Kaba	10.00	Resistant	Grobogan Balitkabi	3.34	Resistant
UP 146	20.00	Resistant	UP 108	0.00	Immune
UP 133	10.00	Resistant	UP 136	0.00	Immune
UP 100	3.34	Resistant	UP 125	0.00	Immune
UP 111	0.00	Immune	UP 157	5.56	Resistant
UP 112	0.00	Immune	Detam 1	5.56	Resistant
UP 148	25.56	Moderately resistant	UP 104	0.00	Immune
UP 106	0.00	Immune	UP 120	5.00	Resistant
UP 122	1.67	Resistant	Mintani	0.00	Immune
UP 113	0.00	Immune	UP 101	14.45	Resistant
UP 121	1.67	Resistant	UP 127	0.00	Immune
Bromo	5.56	Resistant	UP 114	0.00	Immune
Manglayang	21.67	Resistant	UP 117	10.00	Resistant
UP 103	5.00	Resistant			

Resistance criteria are according to Gonçalves et al. (2002) with slight modification.

powdery mildew disease. Furthermore, Mignucci [21] stated that high humidity greatly benefits the development of powdery mildew disease on soybean plants and started at around 80% of humidity the disease has a greater development.

The weather conditions, including low temperature, high humidity and moderate rainfall intensity are also reported to greatly affect the severity of the infection and the spread of powdery mildew disease [12]. Temperature that favours the development of powdery mildew is ranging from 18 to 24°C. The optimum temperature for the development of disease in susceptible plants is 18°C, while the development of the disease is inhibited and the infection of the pathogen is relatively low at 30°C [15, 22]. The maximum and minimum air temperatures during the trial period ranged from 28.3 to 29°C and 14.5 to 15°C. Comparing between temperatures during the trial and optimum temperatures for the disease progression, it is estimated that powdery mildew disease might develop but not optimum due to high temperatures during the trial period.

Symptoms of powdery mildew disease were firstly observed in generative period of soybean plants at 9 weeks after planting. Typical symptom of the disease was the presence of white patches on the leaf surface (Fig. 1a). These patches initially formed small round colonies but then coalesced to form larger colonies and conclusively covered the entire surface of the leaves. The disease symptoms were also found on leaf petioles and stems (Fig. 1b). The disease has previously reported to infect the soybean plants in the generative phase (R2-full bloom soybean growth stage) as observed in this study. A previous study confirmed the infection of the disease occurred in about two months after planting [8]. There was a tendency that disease infection especially occurred on soybean plants that were grown in the outer edge of the plots.

The powdery mildew disease intensity was varied among the 61 genotypes where 46 genotypes showed to be infected by the disease and 15 genotypes indicated no visible symptoms (Table 1). The highest disease intensity of 38.9% was demonstrated by the genotypes of UP-154 and UP-141. In the case of powdery mildew, the percentage of disease intensity about 40% can already be categorized as high disease intensity [14]. In that condition, soybean plants can experience leaf dryness and premature fall. Within the 46 infected genotypes, 6 genotypes were categorized as 'moderately resistant' and 40 genotypes were included in 'resistant' while 15 other genotypes were classified as 'immune'. With this result, there were several genotypes that have potential to be developed as resistant soybean genotypes to the powdery mildew, especially the 15 genotypes that showed immune reaction.

Generally, the intensity of the disease was increasing in subsequent observations. However, there was a situation of a decreased or even recovery from symptom appearance. The condition is presumed due to several factors including the resistance

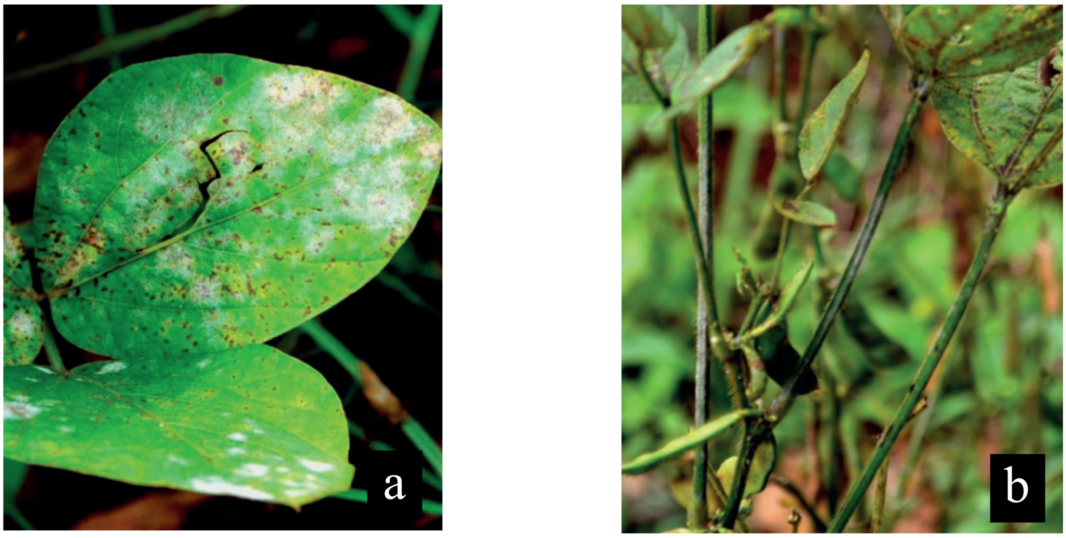

Figure 1: Powdery mildew disease symptoms on soybean plants. (a) Layers of mycelium and powdery conidia on leaf surface of UP-148 genotype. (b) Infection of powdery mildew disease on leaf petioles in UP-103 genotype.

characteristics of the genotypes or the environmental conditions that changed and affected the disease progression as reported in some previous studies [14, 23].

The incidence and development of powdery mildew during the trial had been affected by environmental factors such as rainfall, humidity, and temperature as mentioned earlier in this section. Nevertheless, the resistant reaction showed by some soybean genotypes in this study was considered due to genetic characteristics since as can be seen in Fig. 2, eventhough environmental factors were similar, two different genotypes planted side by side showed different resistant reactions.

In this study, the soybean yield was recorded showing the two highest grain weight resulted in the genotypes of Mutira dan Detam 1 (87.2 g and 86.8 g, respectively) while the lowest grain weight was performed by the genotype of UP-148 with 20.35 g of grain weight. Those genotypes either with the highest or the lowest grain weight were classified into 'resistant' criteria. It is considered that genetic factors and physiological and physical characteristics of seeds are determinant aspects of the quality of the seeds together with environmental factors will determine the growth and the production of soybean plants in the field.

4. Conclusion

This study found that 15 genotypes were not infected by the disease, namely UP-104, UP-106, UP-108, UP-111, UP-112, UP-113, UP-114, UP-125, UP-127, UP-130, UP-136, UP-137, Argomulyo, Arjasari and Mintani, whereas other 46 genotypes were infected with the highest disease intensity of around 40%. Genotypes showing resistance potential

Figure 2: Two different soybean genotypes grown side-by-side within the same plot demonstrated different levels of powdery mildew disease infection to confirm more possibility of genetically resistance to the disease.

are considered as a potential source of resistance genes that valuable in the disease-resistant soybean breeding.

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