Current Progress of Research on Soybean Diseases in Indonesia

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ABSTRACT

Recent field surveys indicated that the major soybean disease in Indonesia are soybean stunt, peanut stripe, cowpea mild mottle, bacterial blight, bacterial pustule, rust, and anthracnose. In 1990-1999, research on soybean diseases have been done on the following aspects: (a) field surveys, (b) etiology of the diseases, (c) ecobiology of the pathogens such as strain identification, (d) development of techniques for detection of the pathogens from seeds and other plant parts, and (e) control of the diseases through development and screening of soybean genotypes resistant to the pathogens and biological control such as using antagonistic microbes. This paper is an overview of research progress on soybean diseases in Indonesia that have been done in the past ten years.

Key words: Current research, soybean diseases, Indonesia

INTRODUCTION

Soybean is the second most important food crop after rice. The crop is grown in all provinces of the country. Major soybean growing centers are found in Aceh, North Sumatera, Lampung, Java, Bali, West Nusa Tenggara, and South Sulawesi. The total national acreage of soybean crop in 1998 was 1,306,203 ha with an average yield of 1.209 t ha^{-1} and a total production of 1,474,313.42 t ha^{-1}.

One major constraint to soybean production was losses due to pests and diseases. Quantitative data on yield losses due to soybean diseases, however, are lacking. Research activities on soybean diseases has been done in the past decade, including those caused by viruses, bacteria, fungi, and nematodes.

This paper is an overview of research progresses on soybean diseases in Indonesia that have been done in the past ten years. These include the following aspects: (a) field surveys, (b) ecobiology of the pathogens, (c) development of techniques for detection of pathogen from soybean seeds, (d) development of techniques for detection of strains of the pathogens, (e) evaluation of soybean resistance to the diseases, (f) study on control of soybean diseases, and (g) molecular study of soybean pathogens.

DISEASE SURVEY

Virus Diseases

Roechan (1992) surveyed soybean viruses from Java, Lampung, and Bali. He observed several virus diseases of soybean and the most dominant diseases were soybean stunt, soybean dwarf, cowpea mild mottle, and peanut stripe. Rahamma (1997) reported that soybean mosaic is a major disease of soybean in South Sulawesi. Effectiveness of virus transmission was 73-100% by mechanical inoculation, 34% by seeds. Soybean and string bean were hosts of SMV. The younger the plant becomes infected the higher the soybeans yield loss. When infection occurred at 10-60 days, the yield losses range from 12-57% (Burhanuddin, 1997; Pakki *et al.*, 1997). SMV was seed transmitted. Seed transmission from seeds showing brown discoloration reached 21.2%, while those from visually clean seeds only 1.2%. The germination percentage of the discolored seeds was lower than the clean seeds.

At least four bacterial diseases were found on soybean in Indonesia, i.e. bacterial blight, bacterial pustule, bacterial spot, and wildfire (Machmud, 1992a, 1992b). Aini (1992) surveyed bacterial diseases of soybean in South Kalimantan and reported that only bacterial pustule was found in the area. Bacterial blight was severely distributed on soybean in West Sumatera, ranging from 1-18% (Marmaini *et al.*, 1996). Habazar and Rudolph (1996) surveyed bacterial blight distribution in various soybean production centers in West Sumatera, Lampung, Yogyakarta, East Java, and South Sulawesi. They found that the disease was found in all the surveyed areas.

Various fungal diseases were found in Indonesia, and the major fungal diseases were rust (*Phakopsora pachyrhizi)* and anthracnose (*Colletotrichum truncatum* var. *dematium*). Other fungal diseases commonly observed in the field were *Fusarium* wilt, sclerotial blight (*Sclerotium rolfsii*), Macrophomina stem blight (*Macrophomina phaseolina*), Cercospora leaf spot and blight (*C. kikuchii*), Alternaria leaf spot (*Alternaria* spp.), and damping-off (*Rhizoctonia* spp., *Pythium* spp., *F. oxysporum)*. Dharmaputra *et al.* (1997) reported that 23 fungal species were isolated from soybean cakes collected from 14 soybean mills and storage. *A. flavus* was consistently isolated from samples of the soybean cakes. Aflatoxins were isolated from five of the 14 samples at contents ranging from 7.9 to 34 ppb. There was a positive correlation between water contents and fungal growth (Dharmaputra *et al.*, 1997).

The only genus of nematodes reported from soybean was *Meloidogyne*. Four species of *Meloidogyne* were found in Indonesia, i.e. *Meloidogyne hapla, M. incognita, M. arenaria,* and *M. javanica* (Machmud, 1992b). Few researches had been done on soybean diseases caused by nematodes. A list of major diseases of soybean in Indonesia is shown in Table 1.

Table 1. Soybean diseases commonly found in the field

Disease	Pathogen
Viral diseases[1]	
Soybean mosaic	Soybean mosaic virus (SMV)
Soybean stunt	Soybean stunt virus (SSV)
Cowpea mild mottle	Cowpea mild mottle virus (CMMV)
Peanut stripe	Peanut stripe virus (PStV)
Bacterial diseases[2]	
Bacterial blight	*Pseudomonas s.* pv. *glycinea*
Bacterial pustule	*Xanthomonas c.* pv. *glycines*
Bacterial spot	*P. chicorii*
Wildfire	*P. syringae* pv. *tabaci*
Witches' broom	Phytoplasma
Fungal diseases[3]	
Rust	*Phakopsora pachyrhizi*
Anthracnose	*Colletotrichum truncatum* pv. *dematium*
Damping-off	*Rhizoctonia* spp., *Pythium* spp.
Fusarium wilt	*Fusarium oxysporum*
Sclerotial blight	*Sclerotium rolfsii*
Macrophomina leaf spot	*Macrophomina phaseolina*
Cercospora leaf spot	*Cercospora canescens*
	C. kikuchii
Purple blotch	*Alternaria* spp.
Alternaria leaf spot	
Nematode diseases	
Root knot	*Meloidogyne javanica. M. incognita, M. hapla*

Source: [1]Roechan, 1992; Burhanuddin, 1997; Rahamma, 1997; Pakki and Rahamma, 1997; [2]Rahayu, 1997; Rahayu and Iriani, 1991; [3]Sudarmadi and Iriani, 1997; Dahlan *et al.*, 1997

ISOLATIONS AND CHARACTERIZATIONS OF SOYBEAN PATHOGENS

Rahamma (1997) studied various aspects of soybean mosaic and its pathogen in South Sulawesi. Sumardiyono *et al.* (1997) isolated SMV from soybean seeds showing typical symptom of soybean mosaic collected from Gunungkidul, Yogyakarta. Different strains of the virus were found (Burhanuddin, 1997).

Study on virulence of *P. syringae* pv. *glycinea* on cultivar Wilis indicated that virulence of the isolates varied from high to low. Plants inoculated with *P. syringae* pv. *glycinea* at flowering stage produced seeds with high infection by pathogen (Machmud *et al.*, 1995b). Habazar and Rudolph (1996) identified *P. syringae* pv. *glycinea* isolates collected from different localities (West Sumatera, Lampung, Yogyakarta, East Java, and South Sulawesi) and their virulence to a set of seven differential soybean cultivars (Acme, Chippewa, Flambeau, Harosoy, Lindarin, Merit, and Norchief). They found out that the isolates were belonging to three different races, i.e. Race 4, Race 5, and Race 9. Majority of the *P. syringae* pv. *glycinea* from West Sumatera were of Race 4. In another study, Marmaini *et al.* (1996) also distinguished *P. syringae* pv. *glycinea* isolates from their collections using the same set of differential soybean varieties as those used by Habazar and Rudolph (1996). The grouped the isolates into four races named Race A, Race B, Race C, and Race D. The use of resistant varieties to control bacterial blight of soybean has been hampered by the presence of genetic variability of the pathogen.

Muhsin (1997) reported that brown discoloration could be used as an indicator of soybean seed infection by soybean stunt virus (SSV). Discolored seeds could produce infected plants. Intensities of discolored seeds were higher on plants infected at young ages than those at older ages. When plants were inoculated at 45 HST, the seed infections were low.

Molecular techniques had been used to study genetic variability of soybean pathogens, particularly *Xanthomonas compestris* pv. *glycines*. Rukayadi (1995) reported at least 17 *X. compestris* pv. *glycines* strains differing in their genotype characteristics were found in Java. Analysis of genomic DNA from *X. compestris* pv. *glycines* was done by Rosana (1994) and (Rukayadi, 1995; 1998). Rosana (1994) also analyzed genomic DNA from *P. syringae* pv. *glycinea*.

TECHNIQUES FOR DETECTION OF SOYBEAN PATHOGENS

Production of Viral and Bacterial Antigens and Antibodies

In an effort to develop techniques for detection of soybean pathogens from soybean seeds and other plant parts using serological techniques, such as the ELISA technique, research has been done on purification of the virus and bacterial pathogens that will be used as source of antigens for the production. Purification of soybean viruses has been successfully done on SSV and PStV, but not with the SMV (Machmud *et al.*, 1995a). Bacterial pathogens have been easily isolated from plant samples.

Productions of viral and bacterial polyclonal antibodies (pAb) have been done successfully for SSV, PStV, *P. syringae* pv. *glycinea*, and *X. compestris* pv. *glycines* (Machmud *et al.*, 1995a; Sumaraw, 1997). The pAb to SSV and PStV were produced on rabbit by injecting purified virus intramuscularly at one week interval. Titer of the pAbs obtained was 1260. The pAbs to *P. syringae* pv. *glycinea*, and *X. compestris* pv. *glycines* were also produced on rabbit. Immunizations were done by injecting glutaraldehyde fixed whole cell antigen by a combination of intravenal and intraperitoneal injection techniques. Polyclonal Ab for the bacterial pathogens was produced at a titer of 5120. In another effort, Sumaraw (1997) also produced pAb to *P. syringae* pv. *glycinea* by injecting heat-killed bacterial cells. The pAb titer obtained was only 2560.

Adoption of ELISA Techniques and Development of ELISA Kits

In efforts to apply the ELISA techniques for detection and identification of soybean pathogens, two ELISA techniques have been adopted, i.e. Nitrocellulose Membrane-ELISA (NCM-ELISA or Dot blot ELISA) and Double Antibody Sandwiched–ELISA (DAS-ELISA). The NCM-ELISA was adopted for detection of SSV, while the DAS-ELISA was adopted for SSV and PStV. DAS-ELISA technique was applicable to detect SSV from seed coat, cotyledon, and embryo. The technique was applicable to evaluate resistance of soybean cultivars based on number of virus particles in the plant. The indirect ELISA technique was used to detect *P. syringae* pv. *glycinea,* and *X. compestris* pv. *glycines* from infected soybean plant parts, particularly from seeds.

CONTROL OF SOYBEAN DISEASES

Various components for integrated disease control of soybean diseases have been studied including (a) development of resistant cultivars to major diseases, (b) production of clean or healthy seeds, (c) biological control, (d) chemical control, and (e) cultural control.

Host Resistance

Growing resistant cultivars is the most effective and economical way to control soybean diseases. Laboratory and field trials have been done to evaluate resistance of various soybean genotypes for resistance to major diseases. Burhanuddin (1997) evaluated resistance of soybean genotypes to SMV and reported that genotypes AGS 222, AG2102, MLG 2742, and AGS 129 were resistant to SMV. Asadi *et al.* (1998) evaluated more than 1000 soybean germplasm for resistance to SSV and CMMV using artificial inoculation and NCM-ELISA techniques. Five genotypes (Lompobatang, Mlg 2521, B3570, Engopa 305, UFV-10-1) were resistant to both SSV and CMMV, while Taichung was resistant only to SSV (Table 2).

Resistances of soybean genotypes to bacterial diseases have also been evaluated. Machmud *et al.* (1995b) reported that cultivar Wilis was more resistant to bacterial blight than Galunggung and Orba. Habazar and Rudolph (1996) evaluated resistance of 11 soybean cultivars against *P. syringae* pv. *glycinea* Race 4 using artificial inoculation technique and showed that two cultivars, Lokon and Orba, were resistant to the pathogen, while Wilis was susceptible (Table 3). Budiman (1997) also evaluated resistance to bacterial blight of 40 soybean genotypes by artificial inoculation in the glasshouse. The result showed that variety Lokon and line MSC 8613-5-1 were resistant to the disease, while seven other genotypes were moderately resistant.

In 1991, Aini (1992) evaluated resistance of a number of soybean cultivars to bacterial pustule under semi-field condition in South Kalimantan. She found that Lokon and Orba were resistant to the disease. Dirmawati (1996) evaluated resistance of five improved soybean cultivars to bacterial pustule in Yogyakarta and reported that cultivars Malabar and Cikurai were resistant with yield losses ranging from 13-17%. In another trial, Rahayu (1997) reported that three soybean genotypes, i.e. Lokon, Wilis, and MSC 6813-6-8, were moderately resistant to bacterial pustule in East Java.

Table 2. Reactions of selected soybean genotypes to SSV and CMMV as identified using the NCM-ELISA and artificial inoculation techniques

Cultivar	Reaction to	
	SSV	CMMV
Galunggung	-	MR
Lompobatang	R	R
Mlg2379	S	-
Mlg2521	R	R
Acc2120	MR	-
C-3-01-1278-c-Pop	MR	-
B3892	S	-
B3900	S	MR
Mlg2778	S	-
Xw-61	S	-
Hitam Lokal	S	S
B3570	R	R
Mlg2551	S	-
Mlg2611	S	-
No,483Si	S	-
AGS85	MR	-
Engopa 305	R	R
UFV-10-1	R	R
Taichung	R	MR

Notes: R = resistant; MR = moderately resistant, and S = susceptible

Source: Asadi *et al.*, 1998

Table 3. Bacterial blight intensity and reaction of soybean cultivars to *P. syringae* pv. *glycinea* Race 4 by artificial inoculation technique

Cultivar	Disease intensity (%)	Varietal reaction
Orba	96.5	S
Singgalang	81.2	S
Lokon	71.6	S
Krakatau	67.8	S
Tampomas	64.7	S
Cikurai	51.8	S
Kipas Putih	20.1	MR
Kerinci	18.3	MR
Raung	15.1	MR
Lumajang Bewok	9.6	R
Wilis	8.6	R

Notes: R = resistant, MR = moderately resistant, S = susceptible

Source: Habazar and Rudolph, 1996

Hardaningsih (1997) studied soybean resistance to rust (*P. pachyrhizi*) and reported that rust symptom on soybean leaves appeared 8 days after inoculation. There was a positive correlation between number of pustule per leaf and number of uredospores per pustule. Cultivars Kerinci, Wilis, and Malabar have a degree of resistance to rust. Sulistyorini *et al.* (1997) evaluated resistance of soybean genotypes and found that cv. Raung was resistant to anthracnose.

Biological Control

Suwanto (in Rukayadi, 1995) using antagonistic strains of *P. fluoresces*, did research on biological control of bacterial pustule. They found that isolates *P. fluorescens* B29 and B39 were good competitors for nutrition and space against *Xcg* (Khaeruni, 1998; Nawangsih, 1997; Rukayadi, 1995).

Sudjadi *et al.* (1999) screens a large number of phylosphere and rhizosphere microbes to look for chitinolitic microbes antagonistic to soybean rust. Among several antagonistic bacteria isolated, only one isolate were selected based on its high chitinolitic activity against *P. pachyrhizi*, the soybean rust pathogen. Further study is in progress. Dahlan *et al.* (1997) two fungal antagonists *(Cunninghamella* spp. and *Pennicillium* spp.) effective against *F. oxysporum* that cause damping-off.

Chemical Control

Chemicals have been used to control soybean diseases, particularly those caused by fungal pathogens. A bactericide with an active ingredient oxolinic acid had been proven effective against both bacterial blight and bacterial pustule.

Integrated Disease Management

Roechan (1992) studied various aspects of virus disease control in soybean. Rahamma (1997) reported that control of SMV may be done by growing resistant varieties (AGS 222), AG2102, MLG 2742, and AGS 129), virus free seeds, growing soybean, planting time.

Aini (1992) studied integrated control technique for bacterial diseases of soybean in South Kalimantan. Growing healthy seeds of resistant cultivars, good cultural techniques such as proper plant spacing, crop sanitation, and crop rotation, and time of planting reduced disease intensity in the field and improved soybean yield.

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