Jurnal Ilmu Pertanian Indonesia (JIPI), Juli 2023
ISSN 0853-4217
EISSN 2443-3462
Vol. 28 (3) 361–369
http://journal.ipb.ac.id/index.php/JIPI
DOI: 10.18343/jipi.28.3.361

Characterization and Disease Severity of Pathogenic Microbes on 20 Red Chili Genotypes

(Karakterisasi dan Keparahan Penyakit dari Mikroorganisme Patogenik pada 20 Genotipe Cabai Merah)

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(Diterima November 2021/Disetujui April 2023)

ABSTRACT

Pathogenic microbes are the limiting factor in increasing red chili productivity. These pathogens cause decreasing yield of red chili up to 50–100%. This research aimed to characterize and evaluate disease severity on 20 red chili genotypes caused by pathogenic microbes. The research was arranged in Randomized Complete Block Design with three replications. The samples were 20 chili genotypes, namely UNIB K01, UNIB CGTS1, G35, G48, G56, G60, G67, G77, and G43 (developed by the University of Bengkulu researchers) and IPB C19, COPAY, IPB C495, IPB C14, DORSET NAGA, IPB C4, IPB PANJANG, LOKAL BENGKULU, SELOKA, SSP, and ANIES (developed by others). The results showed that four groups of pathogens attacked red chili, namely *Fusarium oxysporum*, which causes fusarium wilt disease; *Cercospora* sp., the cause of leaf spot disease; *Colletotrichum* sp. causes anthracnose; and virus groups. All tested red chili genotypes could be infected by these four pathogens in which the incubation period, disease incidence, and disease severity were insignificant. Of the nine genotypes developed by the University of Bengkulu researchers, the G35 genotype had the best potency to be developed as a disease-resistant genotype.

Keywords: Cercospora sp, Colletotrichum sp, Fusarium s, virus

ABSTRAK

Mikroorganisme patogenik merupakan faktor pembatas dalam peningkatan produktivitas cabai merah. Patogen tersebut menurunkan hasil cabai merah 50–100%. Tujuan penelitian ini adalah mencirikan dan mengevaluasi keparahan penyakit pada 20 genotipe cabai merah. Penelitian disusun dalam Rancangan Acak Kelompok dengan tiga ulangan. Perlakuannya adalah 20 genotipe cabai merah, yaitu UNIB K01, UNIB CGTS1, G35, G48, G56, G60, G67, G77, and G43 (dikembangkan oleh peneliti Universitas Bengkulu) and IPB C19, COPAY, IPB C495, IPB C14, DORSET NAGA, IPB C4, IPB PANJANG, LOKAL BENGKULU, SELOKA, SSP, and ANIES (dikembangkan oleh pihak lain). Hasil penelitian menunjukkan ada empat kelompok patogen yang menyerang cabai merah, yaitu layu fusarium oleh *Fusarium oxysporum*, bercak daun oleh *Cercospora* sp., antraknosa oleh *Colletotrichum* sp., dan virus. Semua genotipe cabai merah terinfeksi oleh keempat kelompok patogen dengan masa inkunasi, kejadian penyakit, dan keparahan penyakit yang tidak berbeda nyata. Dari 9 genotipe yang berasal dari Universitas Bengkulu, G35 merupakan genotipe yang berpotensi untuk dikembangkan sebagai genotipe tahan penyakit.

Kata kunci: Cercospora sp, Colletotrichum sp, Fusarium s, virus

INTRODUCTION

The need for chili from year to year continues to increase, and at certain times the need for chili is very high, but the national chili production is unable to meet market demand. The limiting factors for increasing the productivity of national chilies are pests, diseases, and weeds. Common diseases in chili plants can be caused by fungi, bacteria, nematodes, and viruses (Syukur *et al.* 2009). Some of the diseases that infect chili plants are fusarium wilt, anthracnose, bacterial wilt, spotting caused by *Xanthomonas campestris*, phytophthora leaf rot, Cercospora leaf spot, powdery mildew, root-knot nematodes, and mozaic caused by viruses. Anthracnose disease caused by the fungus *Colletotrichum* spp can cause a decrease in the yield of up to 75% (Semangun 2001). Chili plants affected by fusarium wilt disease caused by the fungus *Fusarium* sp. decrease in yield can reach 50% (Nugraheni 2010). The decrease in yield due to mosaic disease can reach 100% (Hartono 2003). The intensity of virus mosaic can range from 50 to 100%, while in red chilies, it can range from 20 to100%. As a result, the plant will continue to produce fruits, but the quality of the fruit will decline, and the fruit-picking period will be shorter. Whereas in

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red chilies, the intensity of the attack that reaches 100% will cause the plants not to produce fruit (Gunaeni *et al.* 2014).

Researchers at the University of Bengkulu have collected some chili genotypes from within and outside the country. In these new collections, there has never been any identification of diseases that can attack. Therefore, it is necessary to research to reduce the intensity of attacks on essential diseases of chili plant genotypes so that resistant varieties can be obtained. This study aims to identify and evaluate the level of attack of important chili plant diseases in Bengkulu on twenty chili genotypes.

MATERIALS AND METHODS

This work was carried out in the Plant Protection Laboratory, Faculty of Agriculture and the Agronomy Experimental Field, Department of Agroecotechnololy, Faculty of Agriculture, Bengkulu University. The materials used were 20 chili genotypes consisting of nine varieties belonging to the University of Bengkulu (UNIB K01, UNIB CGTS1, G35, G48, G56, G60, G67, G77, and G43) and eleven varieties from outside the University of Bengkulu (IPB C19). COPAY, IPB C495, IPB C14, DORSET NAGA, IPB C4, IPB Panjang, Local Bengkulu, SELOKA, SSP, and ANIES), manure, and PDA media as the isolation media. The design used was a completely randomized block design, with 3 replications with a single factor. Each genotype was planted in rows, consisting of 10 plants per replication, with 4 samples.

Seeding was carried out by planting seeds in seedling media in the form of a ratio between soil media:cow manure:rice husk of 2:1:1. Preparation of planting land was carried out by cultivating the soil and making a plot measuring 1.2 m × 5.5 m. The spacing used is 60 cm × 50 cm, with each row consisting of 10 plants. Planting was carried out after the chili plants were 3 weeks-old by transferring them to the planting medium. Each hole was planted with 2 seeds and given Furadan 5–10 seeds per planting hole. Then the plant hole was closed. Maintenance includes watering, maintenance, fertilizing, replanting, and controlling weeds mechanically. Fertilization was done after the plants were 4 days-old using 5 g of NPK fertilizer/plant.

The variables observed were disease symptoms, incubation period, and disease incidence. Disease symptoms were observed daily by observing the emergence of symptoms on the parts of the chili plants (stems, leaves, and fruits) attacked by pathogens. Isolation and identification of pathogens were carried out using tissue implantation methods. Observation of the incubation period was carried out daily by observing the emergence of disease symptoms in the parts of the plants (stems, leaves, and fruits) attacked by pathogens. Observations on disease incidence were made on plant parts, namely on the leaves, stems, and fruit, since the beginning of the plant part being attacked. Observations were made once a week using the following formula:

$$P = a / N \times 100\%$$

Where:
P = Disease incidence
a = Infected plants in each treatment
N = All plants observed in each treatment

Disease severity was carried out after planting until the 6th harvest on the affected parts of the plant, namely the leaves, stems, and fruit, using the formula:

$$I = \frac{\sum(n \times V)}{Z \times n}$$

Where:
I = Disease severity
n = Number of infected plants
v = The observed plant scale value
N = Number of plants observed
Z = The highest scoring value

For fusarium wilt, the following scoring was used (Sugiharso 1983):

Scoring	Disease symptoms
0	No symptom
1	If one leave wilt
2	If more than one leaves wilt
3	If more than one leaves wilt except for shoots
4	If the plant is completely wilt
5	If the plant dies

For the cercospora spot disease, the scoring (Roziq *et al.* 2013) was used:

Scoring	Disease symptom
0	No leaf spot on leaves
1	There is a spot between > 0–10%
2	There are spots between > 10–20%
3	There are spots between > 20–40%
4	There are spots between > 40–60%
5	There are spots > 60%

For the viral scoring disease, the scoring (Sulyo & Duriat 1997) was used:

Scoring	Disease symptom
0	Asymptomatic
1	Plants show mild mosaic symptoms or mesh-like
2	Plants show yellow mosaic symptoms and leaves are still healthy
3	Plants show heavy yellow mosaics
4	Plants show whole yellow leaves, concave wrinkled, stunted plant
5	Symptoms of severe mosaic, necrosis of dead stems and plants

The data were analyzed statistically using analysis of variance with a level of 5%, and were further tested using Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Four primary diseases attack chili plants in the field: fusarium wilt, leaf spot disease, fruit rot disease, and viral diseases. All of the genotypes tested could be attacked by the four pathogens in the field (Table 1). This phenomenon follows the report of Gratitude *et al.* (2009) that the diseases that often attack chili plants are fusarium wilt, leaf spot, fruit rot, chlorosis or viral jaundice, and bacterial wilt. Diseases commonly found in chili plants are diseases caused by pathogens. The causes of disease in chilies are relatively similar, only different quantitatively and qualitatively according to the conditions of the growing environment.

Fusarium Wilt

Fusarium wilt disease is indicated by the occurrence of wilting in the plant's older leaves and spreads to the younger ones. Withered yellowing of the plant leaves remains attached to the plant stem. The plant stems will remain hard and green on the outside, but in the plant's vascular tissue, discoloration occurs in the form of a narrow brown wound (Figure 1).

The isolation results showed that the Fusarium fungus had circular colonies and spread in all directions with cotton-shaped mycelium (Figure 2A). The character shown by this fungus follows the Domsch (1980) finding that the fungus *Fusarium* sp. has a mycelium shaped like a thread (cotton), a white surface, and over time will turn cream or pale yellow. Nugraheni (2010) stated that the morphology of *Fusarium* sp. shows hyphae spreading in all directions to form cotton-like mycelium. The mycelium cultures showed varied pigmentation and colony color, ranging from white and reddish to purple, fawn, and dark brown. Culture of *Fusarium* sp on the PDA media will produce clumps, sparse or numerous mycelium that is white to pale purple or usually produces pale to dark purple or dark red pigments in the agar medium, but there are also colorless isolates.

This fungus has macroconidia that are crescent-shaped and divided, about 2–5 blocks (Figure 2B). Feriansyah (2014) reports that *F. Oxysporum* consists of macroconidia, microconidia, clomidospores, and mycelium. Macroconidia are crescent-shaped, whereas microkinidia are oval or ovoid. Macrokinidia found in this fungus have 2–5 blocks with a size of 25–35 × 3.5–4.4 μm. The microconidia in *F. Oxysporum* have one or two ovoid-shaped cells, and macroconidia have two to five crescent-shaped septums. In addition, thick-walled chlamydospores are formed in older mycelium (Semangun 2007). The fungus *F. Oxysporum* is saprophytic and parasitic and is found everywhere. This fungus can live a long time in the soil in the form of chlamydospores which can last for years (Sujatmiko *et al.* 2012). According to Karima and Nadia (2012), *Fusarium* sp. can also produce cellulolytic and pectolytic enzymes that degrade cell walls and membranes in plant tissue so that they can cause damage and disease in host plants.

Leaf Spot

Leaf spot disease in chili plants has early symptoms in the form of small round leaf spots and chlorosis. Then necrosis will occur until a hole forms (Figure 3). Based on these symptoms, this leaf spot disease is thought to be caused by the pathogen *Cercospora* sp.

According to Semangun (2001), the symptoms of leaf spots caused by the fungus *Cercospora* sp. are round, small, and chlorotic spots. The patches can be broad, and the center is pale to white with a darker edge. The spots caused by this fungus are 0.25 cm or more. The spots resemble frog eyes, so this disease is often called frog eyes. Old patches can have holes, and the holes that arise can be up to 0.5 cm wide. If there are many spots on the leaves, the leaves will turn

Table 1 The major diseases infect 20 chili genotypes

Genotypes	Major diseases			
	Fusarium wilt	Cercopsora leaf spot	Anthracnose	Viral diseases
UNIB K01	+	+	+	+
IPBC19	+	+	+	+
COPAY	+	+	+	+
UNIB CG151	+	+	+	+
IPBC495	+	+	+	+
IPBC14	+	+	+	+
IPBC4	+	+	+	+
DORSET NAGA	+	+	+	+
IPB	+	+	+	+
IPB PANJANG	+	+	+	+
LOKAL BENGKULU	+	+	+	+
G35	+	+	+	+
ANIES	+	+	+	+
SELOKA	+	+	+	+
G48	+	+	+	+
G56	+	+	+	+
G60	+	+	+	+
G67	+	+	+	+
G77	+	+	+	+
G43	+	+	+	+

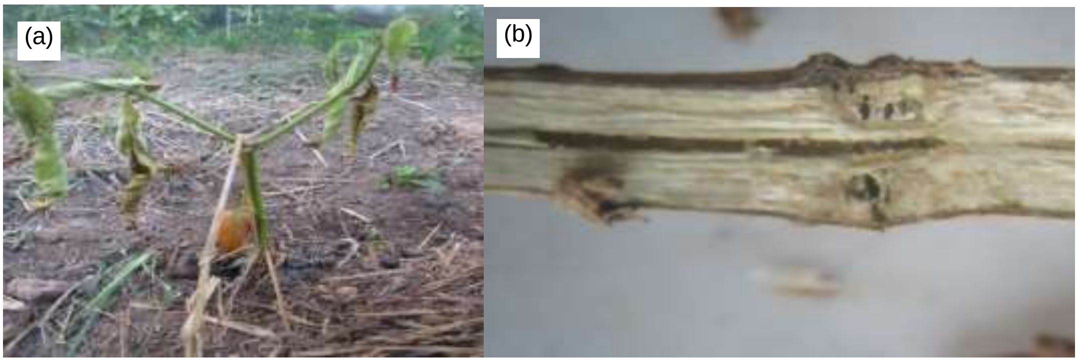

Figure 1 Symptoms of fusarium wilt disease. A = Symptoms of fusarium wilt in the field, B = Discolorosis of plant vascular tissue affected by fusarium.

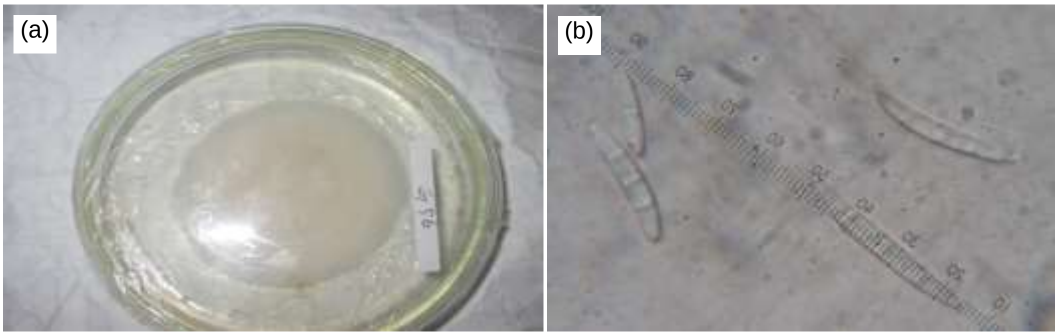

Figure 2 Colonies and macroconidia of the fungus *Fusarium* sp. A = 7 days-old colony and B = Macroconidia (magnification 400×).

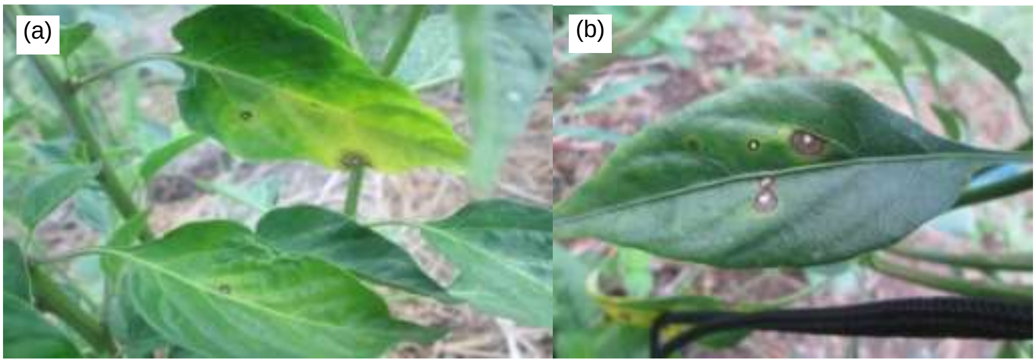

Figure 3 Early and advanced symptoms of leaf spot disease in chili plants. A = early symptoms, B = advanced symptoms.

yellow quickly and fall or fall immediately without turning yellow first. Leaf spots, petiole, but sporadic spots appear on fruit. Setiadi (2011) states that Cercospora leaf spot disease symptoms are marked by the presence of pale-colored spots, which are initially small, eventually gradually getting more expansive. On the edge of the leaf, there is a spot darker than the spot in the middle. In addition, there are frequent tears in the center of the spot. If it is like this, the leaves will immediately fall. Although sometimes it does not fall right away, it changes color to yellowish before finally falling. Cercospora leaf spots can cause defoliation. Circular oblong (hollow) spots with the center drying dark gray with brown edges and the leaves becoming old (yellowing) prematurely (Kementerian Pertanian 2015).

Microscopically, this pathogen has a dull white mycelium color, branched hyphae, is not straight, insulated, and is slightly dark in color. The macroscopic and microscopic characteristics of *Cercospora* sp. can be seen in Figure 4. It has dark conidiophores with conidia produced sequentially in end cells experiencing new growth. Conidia are hyaline to dark, elongated, and multicellular (Barnett 2000). This disease can occur in young plants in the nursery, although it tends to be more common in older plants. Many attack during the dry season (Semangun 2004).

Anthracnose

Another disease found in the experimental field was rot. Symptoms of fruit rot are caused by the fungus *Colletrotrichum* sp. This fungus is latent or can attack young fruit before it is ripe and also ripe or red fruit

(Figure 5). This pathogen attacks plants in generative phases and occurs mainly in the dry season with good drainage and controlled weed cultivation (Semangun 2004).

Microscopically, the fungus *Colletotrichum* sp. has gray or dark white colonies and is not insulated with unbranched conidifors and crescent-shaped, non-insulated, hyaline-shaped conidia (Figure 6). *C. capsici* produces spores in the form of cylindrical conidia, hyaline with a blunt tip and bent like a crescent moon (Sulastri *et al.* 2010). According to Semangun (2004), this species has many aservuius scattered under the

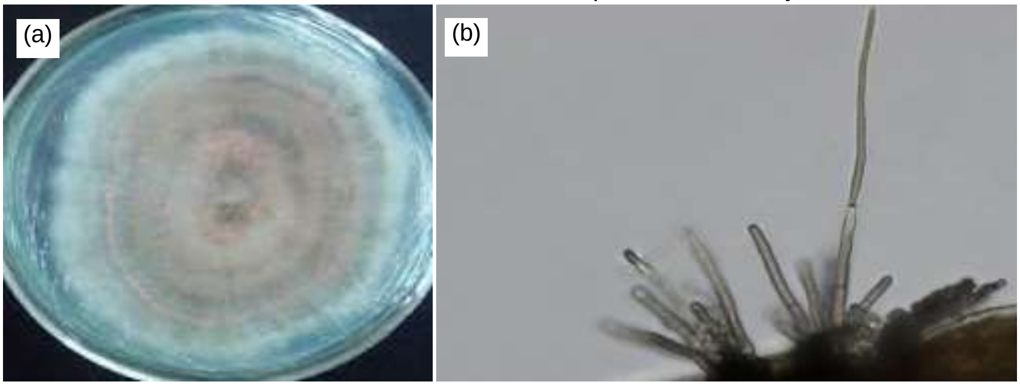

Figure 4 Colonies and conidia of the fungus *Cercospora* sp. A = 10 day-old colony, B = Conidia (magnification 400×).

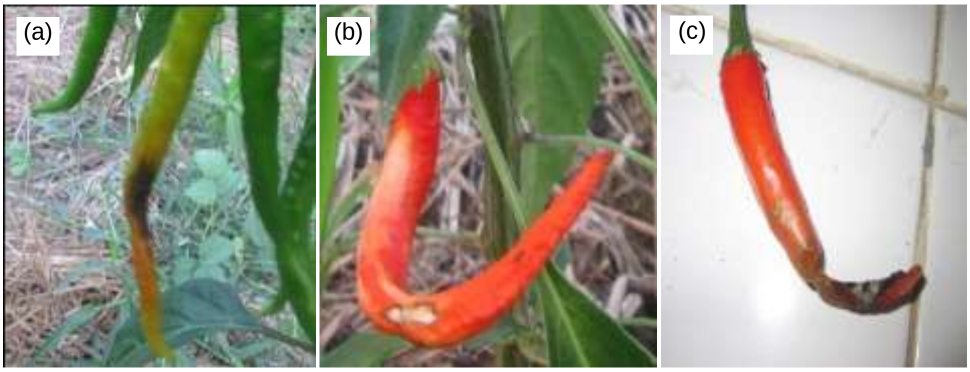

Figure 5 Symptoms of anthracnose in chilies. A = anthracnose symptoms in the young fruit, B = early symptoms of anthracnose in old fruit, C = advanced symptoms.

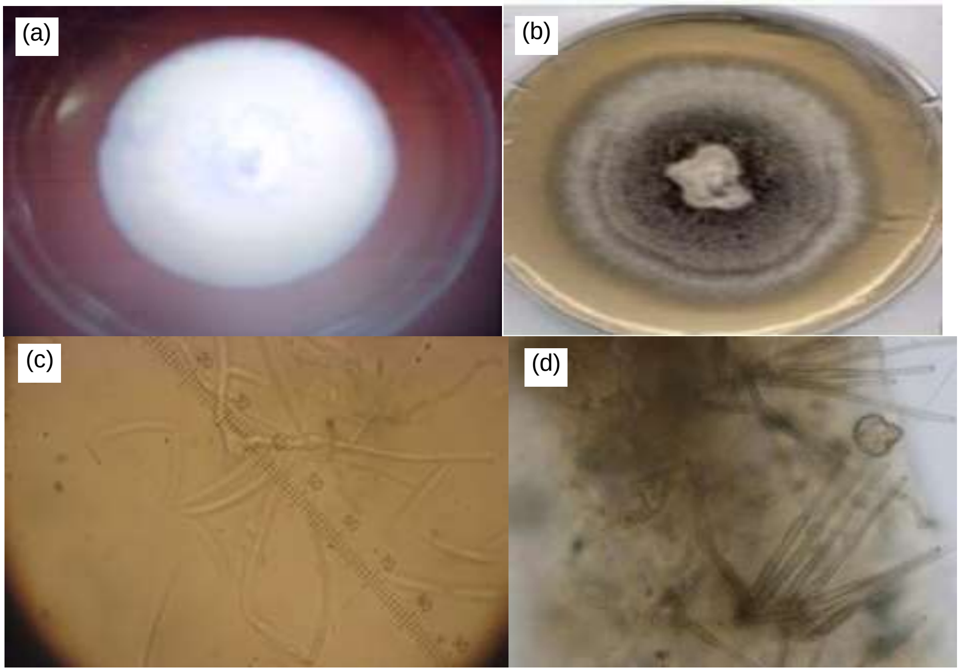

Figure 6 Colonies and conidia of *Colletotricum* sp. A = Colony aged 7 days, B = Colony aged 14 days, C = Conidia (magnification 400×), d = setae *Colletotricum* sp.

cuticula or on the surface. It has a seta with dark brown color, insulated, stiff, tapering upwards, with a size of 75–100 × 2–6.2 μm. Conidia hyalum, tubular 18.6–25.6 × 3.5–5.3 μm, the edges are blunt or bent like a sickle. Many fungi form sclerotium in diseased plant tissue or in culture media. Sudirga (2016) suggests the general characteristics of fungi from the genus Colletotrichum are that they have insulated and branched hyphae and produce transparent and elongated conidia with rounded or tapered ends of 10–16 μm and 5–7 μm wide with black conidial mass. The subsequent development is that hyphae will release protease, cellulase, and pectinase enzymes, causing damage to the cell wall structure. The fungus *C. capsici* forms many acervuli in culture media (Semangun 2001).

Viral Diseases

The chili plant samples in the field showed some symptoms of virus infection in the form of chlorosis on the shoots, dark and light green mosaics on the leaves, and around the leaf bones that were greener than the laminae, and the fruit shape was sometimes imperfect so that production and quality were low. Symptoms of viral disease in chili plants initially appear on young leaves or shoots in the form of yellow spots around the leaf bones, with further symptoms of yellowing of older plant leaves. Color changes in the leaves of chili plants that are attacked by viruses are caused by chlorosis or inhibition of leaf chlorophyll growth (Figure 7).

Several types of viruses often attack chili plants, namely cucumber mosaic virus (CMV), tobacco etch virus (TEV), chili veinal mottle virus (ChiVMV), and Begomovirus. The yield reduction of chili plants can reach 50% if the chili plants are attacked by CMV at weeks 5–7 after planting (Semangun 2007). The difference in symptom varies in one area and/or different areas is caused by many factors, such as the possibility of different virus strains, processing and maintenance of the planting area, and environmental conditions (Trisno *et al.* 2010). The findings by Subekti *et al.* (2006) showed that CMV and ChiVMV infection in triangular Tit chili caused the incidence of disease, up to 60–100%. Plants infected by the CMV will be dwarfed in growth. This observation is in line with the report of Taufik *et al*. (2005), stating that the CMV causes inhibition of height increase in chili plants. In addition, Trisno *et al*. (2010) work shows that chili plants attacked by Begomovirus could reduce yields by 50–85%.

Table 2 shows the recapitulation of the *F* test results on the variables of the incubation period, disease incidence, and disease severity of the four primary diseases in 20 chili genotypes. Cercospora leaf spot disease has different incubation periods in 20 genotypes of chilies, but anthracnose, fusarium disease, and viral diseases were not significantly different. The percentage of viral disease attacks in all genotypes of chili plants was different, while fusarium disease, anthracnose disease, and leaf spot disease showed no significant difference. The intensity of leaf spot disease was significantly different for 20 genotypes. However, the intensity of fusarium wilt, anthracnose, and viral disease was not significantly different for all chili plant genotypes.

The incubation period is when a disease begins, or symptoms first appear. The incubation period for leaf

Table 2 Variables of major diseases on 20 chili genotypes

Variables	$F_{calculated}$
Incubation period	
Fusarium wilt	1.049^{ns}
Cercospora leaf spot	3.269*
Anthracnose	0.692^{ns}
Viral diseases	0.828^{ns}
Disease incidence	
Fusarium wilt	0.936^{ns}
Cercopora leaf spot	1.259^{ns}
Anthracnose	0.644^{ns}
Viral disease	3.789*
Disease severity	
Fusarium	1.554^{ns}
Cercospora leaf spot	2.192^{ns}
Anthracnose	0.815^{ns}
Viral disease	3.549*

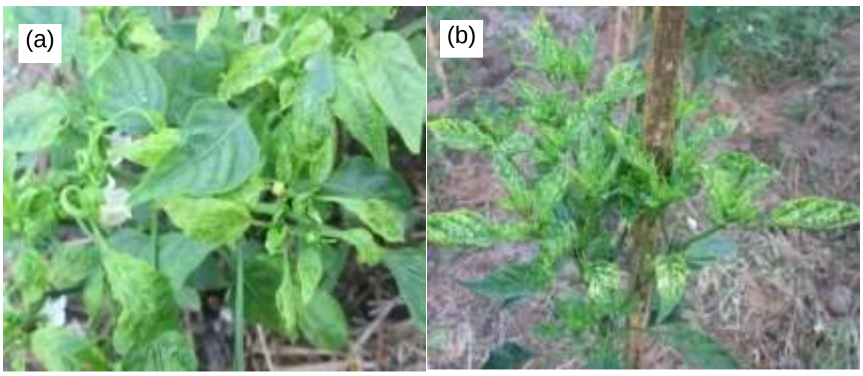

Figure 7 Symptoms of viral diseases in chilli plants. A = leaf curl due to virus attack, B = mosaic on leaves, chlorosis with the leaf bone looks greener than lamina.

Table 3 Incubation period of the primary disease on 20 chili genotypes

Genotypes	Incubation period (days)			
	Fusarium wilt	Cercospora leaf spot	Anthracnose	Viral diseases
UNIB K01	30.67	20.80[ab]	22.0000	58.14
IPB C19	20.00	20.19[ab]	23.3333	61.05
COPAY	29.30	19.33[ab]	23.3333	55.83
UNIB CG151	29.83	17.60[ab]	23.8333	57.16
IPB C495	23.50	20.00[ab]	24.5567	52.36
IPB C14	32.27	19.71[ab]	24.8333	51.11
DORSET NAGA	7.67	16.47[ab]	46.5000	57.10
IPB	30.05	18.33[ab]	46.6667	60.83
IPB PANJANG	33.17	18.33[ab]	47.0000	55.02
LOKAL BENGKULU	28.33	19.47[ab]	47.3333	54.05
G35	17.50	14.33[b]	47.5000	54.75
SELOKA	19.55	17.60[ab]	47.8333	59.56
SSP	30.67	21.40[ab]	48.3333	58.11
ANIES	16.77	21.40[ab]	48.3333	60.36
G48	33.50	20.60[ab]	49.8333	56.55
G56	19.94	19.73[ab]	52.3333	56.47
G60	19.27	19.13[ab]	69.6667	56.64
G67	21.69	22.87[a]	74.3333	62.19
G77	30.17	22.67[a]	75.8900	62.45
G43	31.44	22.20[ab]	76.0000	60.55

Table 4 Disease incidence of the primary diseases on 20 chili genotypes

Genotypes	Deases incidence (%)			
	Fusarium wilt	Cercospora leaf spot	Anthracnose	Viral diseases
UNIB K01	23.33	35.00	15.00	23.33[ab]
IPB C19	20.00	41.67	13.33	21.67[ab]
COPAY	25.00	40.00	13.33	18.33[a]
UNIB CG151	19.44	31.67	16.67	28.89[ab]
IPB C495	16.67	35.00	3.33	21.67[ab]
IPB C14	18.33	40.00	8.33	23.33[ab]
DORSET NAGA	25.00	38.33	5.00	31.11[ab]
IPB	26.11	36.67	6.67	22.77[ab]
IPB PANJANG	23.33	36.67	8.33	19.44[a]
LOKAL BENGKULU	13.33	35.00	8.33	18.33[a]
G35	20.57	26.67	5.00	26.67[ab]
SELOKA	25.00	33.33	5.00	27.50[ab]
SSP	18.33	36.67	10.00	25.00[ab]
ANIES	21.11	32.77	5.00	32.23[ab]
G48	18.33	32.22	8.33	20.00[ab]
G56	20.00	30.00	10.00	20.00[ab]
G60	20.00	34.44	8.33	22.77[ab]
G67	26.11	30.55	6.67	22.22[ab]
G77	28.33	32.22	8.33	37.78[b]
G43	18.33	31.66	10.00	21.67[ab]

spot disease significantly differs from the incubation period for other diseases that attack chili plants. The leaf spot disease incubation period differed for each plant genotype observed (Table 5). The shortest average incubation period occurred in G35 variety (14.33 days), while the most prolonged incubation period is in G67 variety (22.87 days). The G67 variety is similar to the G77 variety (22.67 days). Chili varieties G67 and G77 are the best varieties because these two varieties have the most prolonged leaf spot incubation period.

The disease incidence of virus infection data on chili plants shows that Local Bengkulu (18.33%), Kopay (18.33%), and IPB Panjang (19.44%) were the genotypes with the lowest percentage of attack. In comparison, the highest percentage of virus attack values occurred in genotype G77 (37.78%). It indicates

Tabel 5 Disease severity of the primary diseases on 20 chili genotypes

Genotypes	Disease severity (%)			
	Fusarium wilt	Cercospora leaf spot	Anthracnose	Viral disease
UNIB K01	9.52	14.18	14.18	27.73[ab]
IPB C19	4.82	12.79	9.90	8,09[b]
COPAY	5.96	8.50	8.50	22.10[ab]
UNIB CG151	5.44	8.94	8.94	27.22[ab]
IPB C495	8.59	9.29	9.29	16.01[ab]
IPB C14	9.28	9.90	9.90	17.63[ab]
DORSET NAGA	4.58	11.75	11.75	10.52[ab]
IPB	7.8	8.33	8.33	9.64[ab]
IPB PANJANG	7.51	6.07	6.07	9.76[ab]
LOKAL BENGKULU	9.52	12.19	12.19	9.53[ab]
G35	6.38	7.76	7.76	7.79[b]
SELOKA	7.03	9.37	9.37	12.68[ab]
SSP	8.71	7.40	7.40	13.45[ab]
ANIES	7.91	8.66	8.66	10.52[ab]
G48	5.65	9.99	9.99	19.61[ab]
G56	7.65	8.96	8.96	19.31[ab]
G60	6.78	11.89	11.89	9.31[ab]
G67	6.44	13.11	13.11	36.68[b]
G77	6.20	12.97	12.97	26.99[ab]
G43	8.16	11.68	11.68	10.49[ab]

that the G77 genotype is a genotype susceptible to viral disease.

The disease severity of virus infection in G35 (7.79%) and IPBC19 (8.09) was the genotype that had the lowest disease severity, while the highest disease severity was genotype G67 (36.68%). It shows that the genotypes G35 and IPBC19 had the best capability to resist virus infection.

The disease severity was a variable that affected crop production. High disease severity can cause a decrease in crop production. The disease incidence and severity can show plants' resistance to pathogens. The results showed that each plant genotype showed different disease resistance. It follows the statement of Dewi *et al*. (2014) that several environmental and genetic factors can cause differences in plant resistance. Ganefianti *et al*. (2008) found that the greater the disease incidence, the higher the disease severity. However, this had yet to prove in this study, which could be due to differences in the genotype of the plants used.

CONCLUSION

Four primary diseases are found in the field: fusarium wilt, cercosporin leaf spot, anthracnose, and viral disease. The 20 genotypes of chili can be infected by the four primary diseases, with incubation, disease incidence, and disease severity not significantly different. Of the nine chili genotypes developed by researchers at the University of Bengkulu, the G35 genotype has the potential to be developed as a major disease-resistant genotype.

REFFERENCES

Kementerian Pertanian. 2015. Produktivitas cabai besar dan cabai rawit 2011–2015. [internet] [Diakses pada 29 Maret 2017]. Tersedia pada: http://www.pertanian.go.id. Kementrian Pertanian RI.

Barnett HL, Hunter BB. 2000. *Illustrated Genera of Imperfect Fungi*. Edisi ke-3. Buergess Publishing Company.

Dewi AA, Ainurrasjid D, Saptadi. 2016. Identifikasi ketahanan tujuh genotipe cabai rawit (*Capsicum frutescens* L.) terhadap patogen penyakit. *Jurnal Produksi Tanaman.* 4(3): 174–176.

Domsch KH, Gams W, Anderson TH. 1980. *Compendium of Soil Fungi*. V1. IHW-Verlag. 305–799 p.

Ferryansyah. 2014. Pengujian konsentrasi kultur filtral jamur *Fusarium oxysporum* pada resisten tanaman kentang (*Solanum tuberosum)* terhadap penyakit layu Fusarium. [Skripsi]. Bengkulu (ID): Universitas Bengkulu.

Ganefianti DW, Sujiprihati S, Hidayat SH, Syukur M. 2008. Metode penularan dan uji ketahanan genotipe cabai *(Capsicum* spp.) terhadap Begomovirus. *Aktaagrosia.* 11(2): 162–169.

Gunaeni N, Kirana R, Sofiari E. 2014. Keragaan derajat toleransi beberapa galur cabai merah *(Capsicum annuum* L.) terhadap penyakit virus kuning keriting di daerah endemi. *Agrin.*18.

Nugraheni ES. 2010. Karakteristik biologi isolate-isolat *Fusarium* sp pada tanaman cabai merah (*Capsicum annum*) asal Boyolali. [Skripsi]. Surakarta (ID): Universitas Sebelas Maret.

Semangun H. 2001. *Pengantar Ilmu Penyakit Tanaman*. Yogyakarta (ID): Gajah Mada University Press.

Semangun H. 2004. *Penyakit-Penyakit Tanaman Hortikultura di Indonesia*. Yogyakarta (ID): Gajah Mada University Press.

Setiadi. 2011. *Bertanam Cabai*. Jakarta (ID): Penebar Swadaya.

Subekti D, Hidayat SH, Nurhayati E, Sujiprihati S. 2006. Infeksi *Cucumber Mosaic Virus* dan *Chili Veinal Mottle Virus* terhadap pertumbuhan dan hasil tanaman cabai. *Hayati*. 13(2): 53–57. https://doi.org/10.1016/S1978-3019(16)30381-3

Sudirga KS. 2016. Isolasi dan identifikasi jamur *Colletotrichum* spp. isolat Pcs penyebab penyakit antraknosa pada buah cabai besar (*Capsicum annuum*) di Bali. [Skripsi]. Denpasar (ID): Universitas Udayana.

Sujatmiko B, Sulistyaningsih E, Murti RH. 2012. Studi ketahanan melon (*Cucumis melo* L.) terhadap layu fusarium secara *in-vivo* dan keikatannya dengan asam salisilat. *Jurnal Ilmu Pertanian.* 15(2): 1–18.

Sugiharso B. 1983*. Dasar-dasar Perlindungan Tanaman*. Departemen Ilmu Hama dan Penyakit Tanaman. Bogor (ID): IPB Press.

Syukur M, Sujiprihati S, Koswara, J. 2009. Ketahanan terhadap antraknosa yang disebabkan oleh *Colletrichum acutaum* pada beberapa genotipe cabai (*Capsicum annum* L.) dan korelasinya dengan kandungan kapsaicin dan peroksidase. *Jurnal Agronomi Indonesia*. 37(3): 233–239.

Taufik M, Hidayat SH, Suastika G, Sumaraw SM, Sujiprihatin S. 2005. Kajian *plant growth promoting Rhizobacteria* sebagai agens proteksi *cucumber mosaic virus* dan *chilli veinal mottle virus* pada cabai. *Hayati* 12(4): 139–144. https://doi.org/10.1016/S1978-3019(16)30341-2

Trisno J, Hidayat SH, Jamsari, Habazar T, Manti I. 2010. Identifikasi molekuler Begomovirus penyebab penyakit kuning keriting pada tanaman cabai (*Capsicum annum* L.) di Sumatra Barat. *Jurnal Natur Indonesia*. 13(1): 41–46. https://doi.org /10.31258/jnat.13.1.41-46