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Susceptible Phase of Chili Pepper Due to Yellow Leaf Curl Begomovirus Infection

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***Abstract*— One of the factors that affect the severity of plant diseases caused by virus is the time of Begomovirus infection. There is a tendency that the younger the plants are infected, the greater the damage caused by the Begomovirus infection will be. This study aimed to reveal the exact time of Begomovirus infection for the purpose of resistance plant selection and to determine the onset of Begomovirus infection which resulted in the most devastating damage to the plant. The study was conducted in a factorial randomized completely block design with two factors. The first factor was 5 chili pepper genotypes and the second factor was the infection at three phases of the plant with no infection as a control treatment. The results showed that the screening for resistant and susceptible Begomovirus infection on pepper genotypes was very effective when it was done during cotyledon phase/two leaf using individual transmission method. Genotype UNIBC GTS1 was the most susceptible to infection of Begomovirus because it had the highest disease intensity, the fastest incubation period, small plant dry weight and fruit weight per plant. In contrast, genotype IPBC 12 was the most resistant genotypes. It had lower disease intensity and long incubation period. However, despite this resistant characteristic, the weight of fruit per plant of IPBC 12 genotype was not significantly different from the susceptible genotype. Genotype IPBC 14, despite having high disease intensity, could produce the highest fruit weight per plant compared to other genotypes. The infection of Begomovirus on susceptible genotype UNIB, C GTS1 at various phases of the plant growth, led to the pepper fruit become shorter, lower plant dry weight, smaller numbers of fruits and fruit weight per plant. While the resistant genotypes IPBC 12 had low dry weight when infected by Begomovirus in the phase of cotyledon.**

***Keywords*– Begomovirus; resistance; susceptible; chili pepper**

I. INTRODUCTION

Yellow leaf curl Begomovirus is a virus that causes much damages to various cultivated crops. In Indonesia, the disease was first reported to infect chili by [1]. Infection of Begomovirus had been reported in legumes [2], cassava [3], cotton [4] cucumber [5], tomatoes [6] and pumpkin in Cameroon [7]. In addition to infecting the crop, this virus could also infect weeds [8]. The virus also infected tobacco plant in Indonesia and caused harvest failure [9]. Epidemic diseases were largely influenced by the active role of the insect vector of Bemisia tabaci viruliferous. It was reported that the tail of whiteflies was capable of transmitting the virus and caused infection [10]. According to [11], the intensity of Begomovirus infection in cayenne pepper in areas of Sleman, Bantul, Kulon Progo and Gunung Kidul reached 100%, whereas infection intensity in large chili pepper was sporadically around 10-35%. Yield losses due to *B. tabaci* and yellow leaf curl disease on red chili pepper plants ranged from 20% to 100% [12].

Reference [13] reported that the infection of PepYLCV on chili caused yellow symptoms. According to [14], Begomovirus symptoms on pepper caused variations in symptoms of yellow mosaic; leaf edges curved upward, smaller leaf size, and dwarf symptoms. Reference [15] reported symptoms of tomato plants infected with this virus was a dwarf plant, direction of branch and leaf stalks tended to be upright, the child leaves were small and shrunken, and often showed the hollow at the edge of the leaf (leaf curl) with or without the color yellow. Reference [16] suggested

that Begomovirus infection symptoms in pepper varied depending on the varieties, such as yellowing leaf, curly leaf, curved leaf downward and upward and dwarf plants. Symptoms of infection Begomovirus in tobacco plants formed young leaves bones more clear (vein clearing) [17], leaves bones thickening and rolled leaves. Further infection of Begomovirus could lead to smaller and bright yellow leaves and stunted plants.

One of the factors that affect the severity of disease caused by viral infection is the time of infection. Tomato plants infected with the virus at the age of 20 days after planting will result in 92% yield loss, but the loss of yield dropped to 74% when infection occurs in old plants of 35 days after planting [18]. There is a tendency that the younger plants infected with the virus, the greater the damage. Alternaria solani infection on tomato plants is more common in older leaves than young leaves because the old leaf contains less nitrogen than young leaves [19]. For other pathogens, such as Cucumber mosaic virus, inoculation time on pepper plants showed no difference in the level of infection intensity both on young plants and mature plants [20]. Reference [21] suggests that there is a tendency if cultivars are resistant or susceptible to the vegetative phase also tend to be more resistant or susceptible to the generative phase. Reference [22] suggests that the disease severity indicates that the younger the age of the infected plants, the faster progression of the disease, whereas the older the plant when the initial infection, the slower the development of bacterial leaf blight in rice plants. On the contrary, reference [23] suggests that the plant stadia affect the severity of the disease, most of the rice varieties that are resistant to the bacterial leaf blight when the vegetative phase change to be very vulnerable on the generative phase. Virus infection can occur in certain phases of the plant, possibly due to its physical defense and biochemical changes that occur in plants.

For pepper plant, there has been no such information on that matter. Therefore research on the vulnerable phase of pepper plants from Begomovirus infection is indispensable. This study was conducted to obtain information regarding (1) the onset of Begomovirus infection for the purpose of resistance plant selection, (2) current Begomovirus infection that causes the most devastating damage.

II. Materials and Methods

A. Materials

The experiment was conducted at the Cikabayan greenhouse, Bogor Agricultural University, Indonesia. The planting material used was four chili genotypes collection of Breeding Team of Genetics and Plant Breeding Section, Department of Agronomy and Horticulture, Bogor Agricultural University and 1 chili genotype collection of the Division of Plant Breeding, Faculty of Agriculture, University of Bengkulu (UNIB). The plant material of the IPB Breeding Team come from locals and the introduction of the Asian Vegetable Development Research Center (AVRDC), which had been strained and derived from Breeding Division of the Faculty of Agriculture UNIB. Chili genotypes used were IPBC 10, IPBC 12, IPBC 14, IPBC 18 and UNIBC GTS1 selected based on the degree of resistance to Begomovirus, from resistant to very susceptible [16]. The experiment was arranged in a factorial randomized completely block design with two factors and three replications. Each replication consisted of three plants. The first factor was the age of the plant when inoculation, consisted of D2 = two-leaf plants (cotyledons) phase, D4 = four-leaf plant phase, and D6 = six-leaf plant phase. The second factor was five genotypes of chili which were IPBC 10, IPBC 12, IPBC 14, IPBC 18 and UNIBC GTS1. Control was a plant without inoculation (D0).

Source of inoculums was Begomovirus isolates 'Segunung' maintained on tomato plants which were a collection of Plant Virology Laboratory, Department of Plant Protection, Faculty of Agriculture, Bogor Agricultural University.

Imago whiteflies were used as vectors derived from the cotton crop in the greenhouse experiment station Cikabayan of Plant Protection Department, Faculty of Agriculture, IPB. Imago was grown on the cotton crop and allowed to lay eggs in insect resistant confinement. Stadia whiteflies used in transmission was the imago.

Nursery media used sterile soil, manure and rice husk at a weight ratio of 2:1:1 [24]. Plants germinated in the seedling tray until the age of 10 days and then transplant to polyethene bags measuring 30 x 40 cm. Inoculums source was prepared for the acquisition of whiteflies, by way of at the tip of branches covered with mica such a way that covered the branches and insects B. tabaci adults put into it to get the 24-hour feeding period of inoculums. Inoculation was made on the state of the plants according to treatments. Inoculation was done by covering the plant with plastic cups, then whiteflies that had obtained a period of 24-hour acquisitions was taken using a glass pipette and put into each individual plant as many as 10 heads per plant and left for 48 hours to get the feeding period inoculation (Fig. 1). After that, the insects were sprayed with water mixed with detergent and plants kept in the greenhouse until showing the infection symptoms.

B. Methods

Variables measured was the intensity of the disease, the incubation period, the numbers of fruit per plant, fruit weight per plant, fruit length and dry weight of the plant. The intensity of the disease (IP) used to determine the severity of the Begomovirus infection on chili genotype tested using formula ([25]; [26]; [27]).

$$IP = [\Sigma (ni \times zi) / (N \times Z) \times 100\%$$

with i: 0-5, ni = number of symptomatic plants to the value of a particular score,

zi = value symptom score, N = the total number of plants were observed, and

Z = the value of the highest symptom scores.

In this experiment, it was carried out observations of the density of leaf trichome and palisade tissue. The data analysis was conducted on the analysis of variance, followed by Duncan Multiple and Dennett using software SAS 9.1.

III. Result and Discussion

There was a significant interaction between genotype and Begomovirus infection at various phases of the plant on the agronomic variables which were dry weight, fruit length, the

number of fruits and fruit weight per plant. On the contrary, there was no interaction between variable disease intensity and incubation period. For single treatment of chili genotype or Begomovirus infection at various phases of the plants showed significant differences in all disease and agronomic variables (Table 1). Interactions that occur indicated that variables of dry weight, fruit length, the number of fruits and fruit weight per plant influenced by a combination of chili genotype and Begomovirus infection in various phases of different plants. According to reference [28], all varieties of chili had a growth response against different viral infections. Reference [23] suggested there was significantly interaction between rice varieties and strains Xoo, on the severity of the infection of bacterial leaf blight. However, reference [22] showed that there was no interaction between pathogen inoculation treatment at different growth phases and rice varieties at the variable amount of rice panicle, but at the variable progression of the disease, there was significant interaction.

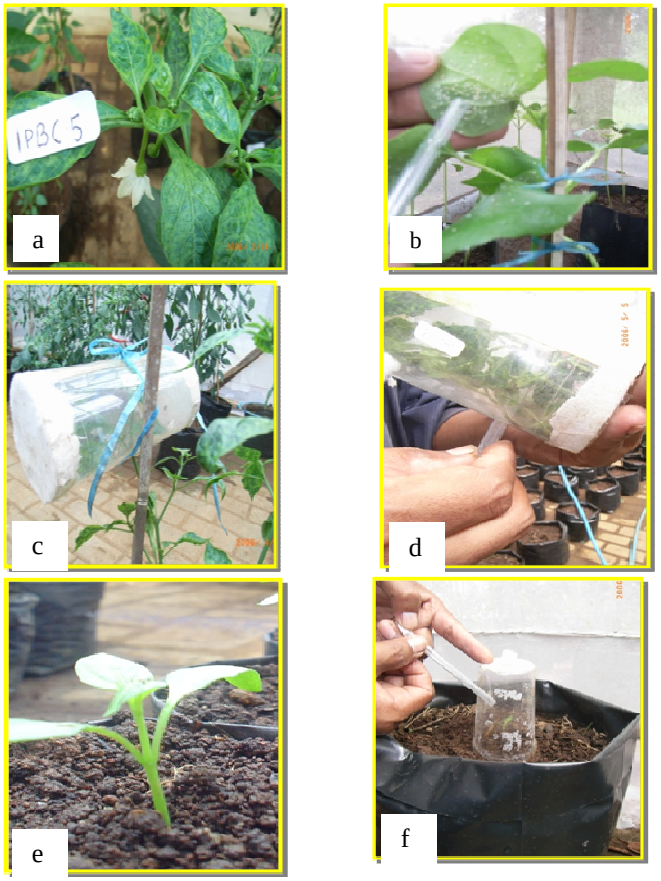

Fig. 1 Chili inoculation stages with individual transmission method using an insect vector B. tabaci (a) source of inoculums (b) imago of whiteflies (c) period of acquisition (d) taking insects for inoculation (e) plants to be inoculated (f) process of inoculation

A. Genotypes and Begomovirus Infection at Several Phases of Plant Growth Interaction

The infection of Begomovirus at UNIBC GTS1 susceptible genotype for dry weight of plants had not significantly different at various phases of the plant growth (Table 2). This genotype could be infected on all phases and caused severe damage, degraded plant growth, as indicated by the lowest weight of dry plant of 15.41 gram when infected on the phase of the cotyledons. On the other hand, IPBC 12 resistant genotype had the low dry weight of plant when infected in the phase of cotyledons, but the affected plants of leaves 4 and 6 did not show significantly different from the control (not infected plants). Generally, UNIBC GTS1 genotype showed the lowest of the dry weight of plants if infected by Begomovirus and most vulnerable phase was the phase of the cotyledons except on IPBC 10 genotype. Plants infected with the virus showed a decrease in a number of carbohydrates. This reaction could vary between cultivars. Reference [29] reported that the cotyledons of Cucurbita pepo infected with CMV caused a decrease in the rate of starch accumulation. While reference [29] suggested that the reaction of cultivars to CMV and ChiVMP was vary as indicated by the decreasing rate of plant height and number of branches.

TABLE I
CENTRAL SQUARES OF CHILI GENOTYPE, BEGOMOVIRUS INFECTIONS AT VARIOUS PHASES OF THE PLANTS AND THEIR INTERACTIONS ON ALL OBSERVED VARIABLES

Variables	Genotype	Phase of Plant Growth	Interaction
Disease intensity (%)	2474.555**	5361.648**	320.053 tn
Incubation period (days)	349.391*	6319.355**	144.479 tn
Dry weight (gram per plant)	969.176**	288.947**	128.256 *
Fruit length (cm)	25.865**	9.457**	3.703**
Number of fruit	24515.773**	48326.457**	4400.352**
Fruit weight per plant (gram)	19267.207**	136045.974**	10912.329**

Note: (*) significantly difference at 5%, (**) very significantly difference at 1%, (tn) no difference.

TABLE II
DRY WEIGHT OF THE CHILI GENOTYPE INFECTED BY BEGOMOVIRUS AT 3 PHASES OF PLANT GROWTH

Genotype	Phase of Plant Growth			
	D0	D2	D4	D6
UNIBC GTS1	21.83c A	15.41 c A	20.22 c A	20.11 c A
IPBC12	44.64 a AB	19.48 b C	46.42 a A	39.28 a B
IPBC14	36.76 ab A	16.89 bc B	25.03 bc AB	25.47 bc AB
IPBC18	21.93c A	15.10 c A	17.08 c A	16.87 c A
IPBC10	37.43 ab AB	42.10 a A	29.32 b B	32.33 ab B

Note: D0 (control= no infection of Begomovirus), D2 (infected at cotyledons phase), D3 (infected at 4-leaf phase), D4 (infected at 6-leaf phase). Numbers in a row followed by same small letter indicated not significantly different, numbers in a column followed by same capital letter indicated not significantly different at 5% DMRT test.

Begomovirus infection on chili pepper could cause inhibition the development of chili fruit length. Fruit length of control treatment of susceptible genotype C UNIB long GTS1 was 9.15 cm (Table 3). Begomovirus infection at cotyledon phase caused fruit length of chili only 3.62 cm and

not significantly different from fruit length of 4-leaf and 6-leaf phase. Begomovirus infection caused shorter fruit length, especially the susceptible genotype. Conversely, for the resistant genotypes IPBC 12, Begomovirus infection at the cotyledons, 4-leaf and 6-leaf phase did not affect significantly different in chili fruit length. Reference [22] reported that the development of bacterial leaf blight affected by the life phase of the plant, and the disease was usually more prevalent in rice which moved at a younger age. Furthermore, reference [21] suggested that the pathogen infection that occurred at the end of growth did not significantly reduce yield, but if it happened at vegetative phase, it greatly significantly reduce the yield.

TABLE III
FRUIT LENGTH OF THE CHILI GENOTYPE INFECTED BY BEGOMOVIRUS AT 3 PHASES OF PLANT GROWTH

Genotype	Phase of Plant Growth			
	D0	D2	D4	D6
UNIBC GTS1	9.15 a A	3.62 cd C	4.75 bc B	4.28 bc BC
IPBC12	4.43 c A	4.73 bc A	3.89 cd AB	4.40 ab A
IPBC14	6.97 b A	5.49 b BC	5.75 a B	5.42 a BC
IPBC18	7.13 b A	7.14 a A	5.45 b B	5.13 ab B
IPBC10	2.71 d A	2.64 d AB	2.42 e B	2.63 d AB

Note: D0 (control= no infection of Begomovirus), D2 (infected at cotyledons phase), D3 (infected at 4-leaf plant phase), D4 (infected at 6-leaf plant phase). Numbers in a row followed by same small letter indicated not significantly different, numbers in a column followed by same capital letter indicated not significantly different at 5% DMRT test.

TABLE IV
NUMBERS OF FRUITS OF THE CHILI GENOTYPE INFECTED BY BEGOMOVIRUS AT 3 PHASES OF PLANT GROWTH

Genotype	Phase of Plant Growth			
	D0	D2	D4	D6
UNIB C GTS1	95.88 c A	5.50 b B	11.66 b B	9.77 b B
IPBC12	93.22 c A	13.22 b B	18.00 b B	16.88 b B
IPBC14	130.16 b A	19.22 b B	32.66 b B	31.11 b B
IPBC18	66.66 c A	12.22 b B	13.88 b B	10.88 b B
IPBC10	319.50 a A	75.66 a B	69.72 a B	73.88 a B

Note: D0 (control= no infection of Begomovirus), D2 (infected at cotyledons phase), D3 (infected at 4-leaf plant phase), D4 (infected at 6-leaf plant phase). Numbers in a row followed by same small letter indicated not significantly different, numbers in a column followed by same capital letter indicated not significantly different at 5% DMRT test.

Begomovirus infection of all chili plant genotypes at the cotyledon, 4-leaf plant and 6-leaf plant phases led to low numbers and the weight of fruit that could be harvested on both susceptible and resistant genotypes (Tables 3 and 4). In susceptible genotypes UNIB C GTS1, numbers of fruits per plant control (uninfected) was 96 fruits with a weight of 230.32 grams of fruit per plant, while Begomovirus infection at the time of the cotyledons phase caused the number of fruits per plant chilies dropped to 6 fruits (4.70 grams), and it was not significantly different from the numbers of fruits from infected plants at 4-leaf and 6-leaf plant phase. Reference [13] stated that the highest chili yields obtained from healthy crops were 16.01 ton per hectare, but crop production dropped to 3.07 ton per hectare when showed symptoms of yellow leaf virus infection. Reference [31] suggested that the weight value of each panicle rice varieties varied greatly with regard to the intensity of the disease. The intensity of low disease usually was followed by high grain weight, but that was not always the case. According to [32], varieties or strains that showed good appearance and high yield potential can be recommended to be released even though the disease is a high intensity with expectations in the field later are tolerant.

TABLE V
WEIGHT OF FRUITS OF THE CHILI GENOTYPE INFECTED BY BEGOMOVIRUS AT 3 PHASES OF PLANT GROWTH

Genotype	Phase of Plant Growth			
	D0	D2	D4	D6
UNIBC GTS1	230.32 c A	4.70 c B	13.50 c B	11.39 bc B
IPBC12	206.80 c A	36.59 b B	28.03 bc B	31.37 ab B
IPBC14	386.32 a A	45.61 b BC	77.82 a B	73.48 a B
IPBC18	276.57 b A	48.39 a B	34.98 b B	33.45 ab B
IPBC10	38.59 d A	40.18 b A	38.66 b A	41.11 ab A

Note: D0 (control= no infection of Begomovirus), D2 (infected at cotyledons phase), D3 (infected at 4-leaf plant phase), D4 (infected at 6-leaf plant phase). Numbers in a row followed by same small letter indicated not significantly different, numbers in a column followed by same capital letter indicated not significantly different at 5% DMRT test.

1) Genotype Treatments

Genotype treatments had a significant effect on the variable intensity of the disease, the incubation period, dry weight of the plant, fruit length, numbers and weight of fruit crops (Table 6). UNIB C GTS1 variety was the most susceptible to infection of Begomovirus because it had the highest disease intensity of 43.22 percent, with the fastest incubation period of 26 days, small dry weight of plant (19.37 grams), the numbers of fruit (30 fruits) and fruit weight as low as 64.98 grams per plant. In contrast, IPBC 12 genotype was the most resistant genotypes which had a lower disease intensity of 10.46 percent and the longest incubation period of 36 days (Table 6). However, despite this resistant genotype, the weight of fruit per plant of IPBC 12 genotype was not significantly different from the susceptible genotype. Genotype IPBC14, despite having the disease intensity as high as 27.83 percent, could produce the highest fruit weight per plant of 145.28 grams per plant compared to other genotypes. According to [27], commercial chili cultivars if inoculated with CMV and ChiVMV response differently ranging from tolerant to very vulnerable, none of them was resistant cultivars. Reference [16] suggested that resistance of chili genotypes to infection of Begomovius varied. IPBC 12 was resistant genotype, IPBC 14 and IPBC 15 were moderately resistant while UNIBC GTS1 was susceptible genotype.

Differences in resistance in both genotypes (IPBC 12 and UNIB C TS1) to infection of Begomovirus apparently attributed to differences in morphology and biochemical

changes in plants. Morphological differences may be related to the differences in numbers of trichome and density of palisade between the genotypes. Trichome and palisade cell of UNIBC GTS1 and IPBC12 genotype showed the difference. UNIBC GTS1 genotype had numbers of trichome slightly higher compared to IPBC 12 genotype (Fig. 2). Palisade cell of IPBC 12 was denser compared to UNIBC GTS1 genotype (Fig. 3). Whiteflies insects sucked plant fluids by means of perched on plant leaves and then put down and struck their stylet. Furthermore, the stylet was penetrated pass the epidermis and palisade. Trichome of leaves became one of the things that were hindered that process. Subsequently, the dense palisade of the cell was also one of the barrier penetration processes. This may be the cause that IPBC12 genotype has a higher level of resistance than UNIBC GTS1 genotype. The composition and length of palisade cells and the high density of trichome were a structural barrier to the vector B. tabaci and Begomovirus [33]. Reference [12] suggested that the Martha tomato variety has secretion and density of trichome high enough to be effective in reducing populations of B. tabaci. Reference [34] suggested that the intensity of the disease caused by infection of Begomovirus closely related to the density of trichome of leaves. Reference [35] reported that chili plants which accumulate salicylic acid tended to be more resistant to pathogen infection. While [36], suggested cultivars of pigeon pea plant resistance to pod borer related to trichome density, which resistant plants had a density of trichome C-type (short, non-glandular) but low density of trichome A-type (long, glandular). Reference [37] suggested that trichome contained in wild species of Lycopersicon showed plant resistance to insects. Glandular trichome also showed a negative effect on the insect. Resistance to Arthropods associated with a high density of trichome in Lycopersicon. According to [22] level of resistance of rice varieties to leaf, blight bacteria were thought to be influenced by the structure of the surface morphology of leaves. Cisantana rice variety has smooth surface leaves so as to have lower disease severity compare to other varieties. Resistant genotypes increased the content of salicylic acid on pepper infected by Begomovirus [35].

TABLE VI
DISEASE INTENSITY AND AGRONOMIC VARIABLES OF THE CHILI GENOTYPE TREATMENT INFECTED BY BEGOMOVIRUS

Genotype	IP	MI	BRANG	PJBH	JMBH	BBBH
UNIBC GTS1	43.22a	26.50b	19.37c	5.46b	30.70c	64.98c
IPBC18	37.97ab	22.61b	17.74c	6.22a	25.91c	98.35b
IPBC14	27.83b	25.44b	26.04b	5.91ab	53.29b	145.82a
IPBC10	14.05c	30.08ab	35.31a	2.60d	134.69a	76.01cb
IPBC12	10.46c	36.63a	37.46a	4.37c	35.33c	75.70cb

Note: Numbers in a row followed by same small letter indicated not significantly different at 5% DMRT test. IP = disease intensity (%), MI = incubation period (days), BRANG = dry weight of plant (gram per plant), PJBH = fruit length (cm), JMBH = numbers of fruit (fruit), BBBH = fruit weight per plant (gram)

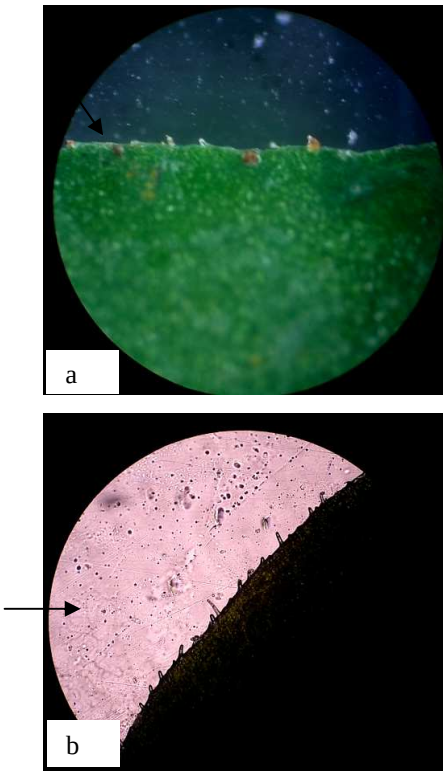

Fig. 2 Trichome of chili leaf at cotyledons phase of UNIB C GTS1 genotype (a) dan IPBC12 (b) magnified 10x

Fig. 3 Section of chili leaf at cotyledons phase of UNIB C GTS1 genotype (a) and IPBC12 genotype (b) magnified 40x, arrow pointed palisade cell of leaf

2) Begomovirus Infection Treatments at Several Phase of Plant Growth

Treatment of infection of Begomovirus at several phases of plant growth showed significant influence on disease and agronomic variables (Table 7). Plants at cotyledons phase showed the highest disease intensity value, although not significantly different from the four-leaf plants, but significantly different with six-leaf plants. This means that the cotyledon phase of chili pepper is very vulnerable to Begomovirus infection transmitted by whiteflies. Plants that were infected by Begomovirus at cotyledon phase showed the lightest of plant's dry weight, decreased by 32.965% compared to healthy plants (control). Furthermore, the affected plants at cotyledon phase reduced fruit length by 22.368%, numbers of fruit by 82.166% and fruit weight per plant by 83.014% compared to control (Table 8).

Observation of leaf trichome at cotyledon phase of IPBC 12 genotype showed a smaller number than the six-leaf plant phase (Fig. 4). The density of palisade visually did not show differences (Fig. 5). Reference [35] suggested that the intensity of the disease caused by infection of Begomovirus was positively correlated with the density of trichome. Reference [12] suggested that the Martha tomato variety had secretion and density of trichome high enough to be effective in reducing populations of B. tabaci. According to [22], the severity of the disease was suspected because of the structure of the leaf surface. The younger the age of the infected plants the faster disease progression of bacterial leaf blight in rice and vice versa. Slowing the pace of development in the generative phase allegedly caused a layer of wax and cuticle thickness of the epidermis cells that had been perfect so as to increase the resistance of plants. Reference [21] suggested each plant had a different response to pathogen infection, caused by differences in morphology, genetics of plants and their secondary metabolic content in plants.

TABLE VII
DISEASE INTENSITY AND AGRONOMIC VARIABLES OF CHILI PEPPER INFECTED BY BEGOMOVIRUS AT PHASES OF PLANT GROWTH

Phase	IP (%)	MI	BRANG	PJBH	JMBH	BBBH
D2	41.88a	27.49c	21.80c	4.72b	25.16b	38.68b
D4	38.04a	47.44a	27.80ab	4.45b	29.18b	38.16b
D6	26.90b	38.08b	26.82bc	4.37b	28.51b	35.09b
D0	0.00c	0.00d	32.52a	6.08a	141.08a	227.73a

Note: Numbers in a row followed by same small letter indicated not significantly different at 5% DMRT test. IP = disease intensity (%), MI = incubation period (days), BRANG = dry weight of plant (gram per plant), PJBH = fruit length (cm), JMBH = numbers of fruit (fruit), BBBH = fruit weight per plant (gram).

TABLE VIII
PERSENTAGE OF DECREASING VALUE OF AGRONOMIC VARIABLES OF CHILI PEPPER INFECTED BY BEGOMOVIRUS AT 3 PHASES OF PLANT GROWTH

Phase	BRANG	PJBH	JMBH	BBBH
D2	32.964	22.368	82.166	83.014
D4	14.510	26.809	79.316	83.243
D6	17.527	28.125	79.791	84.591

Note: BRANG = dry weight of plant (gram per plant), PJBH = fruit length (cm), JMBH = numbers of fruit (fruit), BBBH = fruit weight per plant (gram)

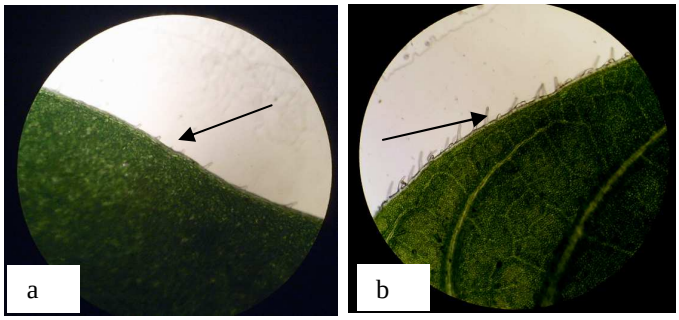

Fig. 4. Trichome of chili leaves of IPBC 12 genotype at cotyledons phase (a) and trichome of chili leaves at six-leaf plant phase (b)

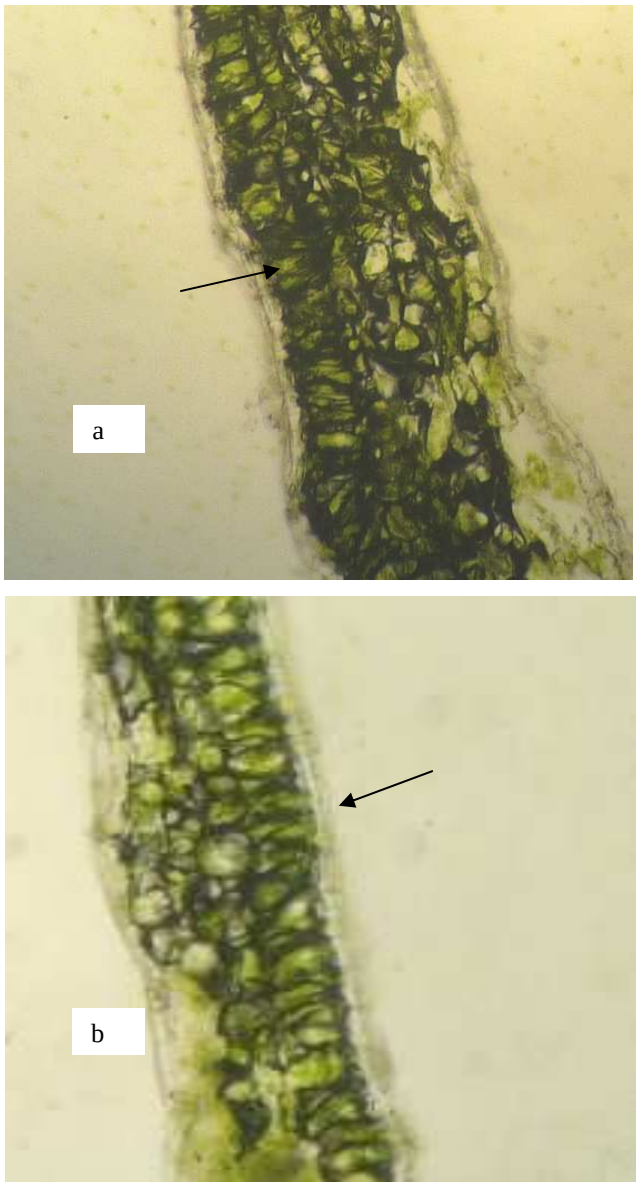

Fig. 5 Section of chili leaf at cotyledons phase of IPBC 12 genotype (a) and at six-leaf plant phase (b) magnified 40x, arrow pointed palisade cell of leaf

IV. CONCLUSIONS

Screening of chili pepper genotypes that resistant and susceptible for infection of Begomovirus was very

effectively done at the phase of the cotyledons using individual transmission method.

UNIB C GTS1 genotype is the variety that is most vulnerable to infectious diseases Begomovirus because it has the highest intensity of 43.22 percent, with the fastest of the incubation period of 26 days, the plant dry weight of 19.37 gram, the numbers of the fruit of 30 fruits and low fruit weight of 64.98 gram per plant. In contrast, genotype IPBC 12 is the most resistant genotypes, have a lower disease intensity of 10,46 percent and the long incubation period of 36 days. However, despite these resistant IPBC 12 genotype, the weight of fruit per plant was not significantly different from the susceptible genotype. IPBC14 genotype, despite having the disease intensity of 27.83 percent, can produce the highest fruit weight per plant of 145.28 grams per plant compared to other genotypes.

Begomovirus infection on susceptible UNIBC GTS1 genotype at several phases of the plant growth causes the chilies into a shorter, lower plant dry weight, the smaller numbers and weight of fruits per plant, while the resistant IPBC 12 genotype have low dry weight of plant when infected on cotyledons phase.

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