Effect of Gibberellin Doses on the Morphologhy of Soybean Strains Infected with *Bemisia tabaci*

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Abstract

This study aimed to determine the effect giberelin doses on the morphology of several soybeans strains (UM.4-1, UM.7-2, UM.2-4, UM.7-6, UM.6-2 , Gumitir and Wilis) which have been attacked by Bemisia tabaci. Research was conducted at Research Station, Indonesian Legume and Tuber Crops Research Institute, Malang. The design of the study was a complete split plot randomized block design. Spraying gibberellin on 35 days old (35 HST) after-planting soybean with variation dose of giberellin were 0 ppm, 25 ppm, 50 ppm and 75 ppm. Morphological observation was carried out on leaf length, leaf width, leaf area, ratio of leaf, petiole length, leaf shape, color of hipocotyl, rod coat color, the color of ripe pods and flower color. Data were analyzed using 2 ways Anova. The results showed that there was a difference in treatment's effect against leaf width, leaf ratio, leaf area and petiole length of soybeans but no effect of dose variation on soybean leaf length. There is the effect of the combination treatment (soybean strains and dosage) of the leaf width, leaf ratio, leaf area and petiole soybeans but there is no effect of combination treatment on soybean leaf length. There is the influence of lines on the leaf width, leaf area and ratio, but there is no influence on the long soybean lines of soybean leaf and petiole).

Keywords: *Gibberelin, Bemisia tabaci, Morphology, Soybean*

1. INTRODUCTION

Soybean is a popular source of food, in Indonesia the main source of vegetable nutrition after rice is obtained from soybeans (Wahyu et al., 2013). The high demand for soybean consumption in Indonesia is not balanced with the amount of production. It is estimated that in 2015-2019 the balance of supply and demand for soybean in Indonesia has increased deficit where demand is greater than the existing supply. The shortage of soybean supply in 2016 is estimated to reach 1.61 million tons, by 2017 at 1.83 million tons and by 2019 the shortage of soybean supply is estimated to reach 1.93 million tons (Riniarsih, 2015). The lack of soybean supplies is due to the decrease of soybean production caused by pest attack (Wahyu et al., 2013; Sulistyo & Marwoto, 2011; Chamzurni et al., 2011). One of the pests that cause the decrease of soybean production because of damage caused is *Bemisia tabaci* (kutu kebul) (Sulistyo & Marwoto 2011; Zubaidah et al., 2009; Marwoto & A. Inayati, 2011).

Bemisia tabaci is the most dangerous insect infecting in the tropics and subtropics (Alemandri, 2012). *Bemisia tabaci* can cause damage to the host plant directly and indirectly. Directly, when the insect pierces and sucks directly the liquid from the host plant resulting in malformations until the death of the plant. Indirectly, caused by the accumulation of sooty dew which later became the living medium of the fungus (Sulistyo & Marwoto, 2011; Hirano et al., 2000). The effects of subsequent damage from *Bemisia tabaci* attacks can occur from the transmission of the virus it carries

(Oliveira et al., 2001; Brito et al., 2012; Arifin, without years; Sulistyo & Marwoto, 2011).

The tick (kutu kebul-in local name) is the vector of CpMMV virus (Sulistyo & Marwoto, 2016; Muniyapa, 1983). The soybean infected with CpMMV virus will show some morphological damages. The phenomenon can be identified with leaf spot, necrosis of leaf bone, chlorosis (Brito et al., 2012), leaf malformation in which the leaves of the plant are curly and small, yellowish and show mosaic symptoms in leaves (Arifin, no year). Efforts were made to reduce the impact of soybean damage due to virus attacks, such as the reduction of kebul infestation by integrated pest control techniques (Marwoto & Inayati, 2011) and the seeking of superior CpMMV resistant strains through genetic improvement (Zubaidah et al., 2010). The next effort that can be done to optimize the growth of soybean plants is by utilizing the role of growth hormone, one of the hormones such as gibberellin. Gibberellin is responsible for leaf development (Wheeler et al., 2015; Marth et al., 1956), leaf formation and expansion (King, 2011), as well as elongation of petioles (Marth et al., 1956). It is important to distinguish the optimal dose of gibberellin hormone in plants, proper hormone concentration greatly affects the given response (Biroc, 1975).

2. RESEARCH METHOD

The design of this experimental research is Randomized Complete Block Design (RAKL) divided plot. The population of this study were soybeans of UM.4-1 strain, UM.7-2 strain, UM.2-4 strain, UM.7-6 strain, UM.6-2 strain, and 2 varieties of comparison, namely Gumitir and Wilis. Used in 4 variations of dose of gibberellin as treatment were 0 ppm, 25 ppm, 50 ppm and 75 ppm. The morphological characters observed in this study include leaf length, leaf width, leaf area, leaf ratio, petiole length, hypocotyl color, stem color, flower color, pod color and leaf shape. The research was conducted in June 2016 until September 2016. The experiment was conducted at Experimental Garden of Indonesian Legumes and Tuber (Balitkabi) Research Institute of Kendalpayak Malang Regency. Data were analyzed using 2 ways Anova. If significant, proceed with LSD test.

3. RESULT AND DISCUSSION

Based on analysis, result showed that there was influence of treatment difference to leaf width, leaf ratio, leaf area, and length of soybean petiole but no effect of dose variation to leaf length of soybean. There was influence of combination treatment (strain and dose) to leaf width, leaf ratio, leaf area and petiole but no effect on leaf length. There was influence of strain on leaf width, area and leaf ratio but there is no effect of strain on leaf length and petiole. Summary of Anava results can be seen in Table 1.

Table 1. Summary of F Test Results of Each Character
Description: * = p value <0.05

Character	F		
	Strain	Hormone	Combination
Length	1,566	0,611	1,177
Width	10,080*	19,357*	23,753*
Broad	6,198*	10,072*	13,756*
Ratio	15,856*	24,712*	29,986*
Petiole	1,590	8,271*	3,560*

The treatments were further differentiated using 5% LSD test, the result implied that the soybean leaf area of UM 4-1 strain is significantly more extensive than the other strains, UM 4-1 soybean leaves are significantly wider than the other strains and UM 4-1 soybean leaves significantly have a larger leaf ratio than other soybean strains. Summary of LSD test results on the treatment of strains on each character can be seen in Table 2.

Table 2. Summary of LSD Test Result on Treatment of Strains in Each Character

Strain	Leaf width	Leaf broad	Leaf ratio
1	11,87^{c}	85,297^{b}	1,706^{b}
2	4,187^{ab}	38,16^{a}	0,537^{a}
3	3,865^{a}	28,447^{a}	0,531^{a}
4	4,348^{ab}	31,558^{a}	0,608^{a}
5	4,092^{ab}	29,949^{a}	0,574^{a}
6	5,601^{b}	42,936^{a}	0,753^{a}
7	4,879^{ab}	41,019^{a}	0,598^{a}

Note: strain followed by the same notation means no significant difference.

A 5% LSD test of the treatment of variations in gibberellin dose in each character showed that soybean leaves without gibberellin (0 ppm) were significantly larger than gibberellin-supplied plant. The soybean leaf without the administration of gibberellin (0 ppm) has a significantly higher leaf ratio of soybeans given gibberellin with other doses. The soybean leaf without the administration of gibberellin (0 ppm) has significantly larger leaves than gibberellin-treated soybeans in other doses. Petiol treated with gibberellin at a dosage of 50 ppm was significantly lower than the other three treatments while the other three treatments had a mean length of the cortis which did not differ significantly from one another. A 5% LSD test result for the treatment of variation of gibberellin dose can be seen in Table 3 .

Table 3. Summary of 5% BNT Test Result for the Treatment of Gibberellin Dose Variation.

Doses	Width	Broad	Ratio	Petiole
0 ppm	8,536^{b}	62,022^{b}	1,207^{b}	10,989^{b}
25 ppm	4,435^{a}	34,155^{a}	0,587^{a}	10,968^{b}
50 ppm	4,212^{a}	34,422^{a}	0,575^{a}	9,582^{a}
75 ppm	5,013^{b}	39,341^{a}	0,661^{a}	10,639^{b}

Note: A string followed by the same notation means no significant difference

The 5% LSD test result on the combination treatment of the strains with variation of gibberellin dose showed that soybeans from UM 4-1 strains treated without gibberellin (0 ppm) had significantly larger leaves than other soybeans. Soybean from UM 4-1 strains without gibberellin (0 ppm) treatment had leaves significantly larger than other soybeans. The soybean of UM 4-1 strains treated without gibberellin (0 PPM) has leaves that significantly have a larger leaf ratio than other soybeans. Soybeans from the UM 7-6 strain with a 25 ppm gibberellin treatment had significantly longer petioles than other soybeans. Summary of 5% LSD test results on combination treatment can be seen in table 4.

Table 4. Summary of 5% BNT Test Result For Combination Treatment on Each Character.

Strain*Doses	Width	Broad	Ratio	Petiole
UM 4-1 (0 ppm)	34,533^{Bb}	240,077^{Bb}	5,080^{Bb}	12,242^{Ab}
UM 7-2 (0 ppm)	4,092^{Aa}	31,222^{Aa}	0,558^{Aa}	10,216^{Aab}
UM 2-4 (0 ppm)	3,555 ^{Aa}	25,152^{Aa}	0,505^{Aa}	11,882^{Aab}
UM 7-6 (0 ppm)	4,000^{Aa}	26,63^{Aa}	0,610^{Aa}	9,245^{Aa}
UM 6-2 (0 ppm)	4,250^{Aa}	33,092^{Aa}	0,555^{Aa}	11,116^{Aab}
Gumitir (0 ppm)	4,117^{Aa}	33,729^{Aa}	0,518^{Aa}	11,233^{Aab}
Wilis (0 ppm)	5,200^{Aa}	43,953^{Aa}	0,630^{Aa}	10,945^{Aab}
UM 4-1 (25 ppm)	4,600^{Aa}	36,834^{Aa}	0,545^{Aa}	9,073^{Aa}
UM 7-2 (25 ppm)	4,518^{Aa}	38,606^{Aa}	0,549^{Aa}	11,032^{Aab}
UM 2-4 (25 ppm)	4,383^{Aa}	35,195^{Aa}	0,599^{Aa}	10,692^{Aab}
UM 7-6 (25ppm)	4,372^{Aa}	30,967^{Aa}	0,618^{Aa}	13,055^{Bb}
UM 6-2 (25 ppm)	4,417^{Aa}	31,184^{Aa}	0,630^{Aa}	10,658^{Aab}
Gumitir (25 ppm)	4,933^{Aa}	39,462^{Aa}	0,634^{Aa}	11,875^{Aab}
Wilis (25 ppm)	4,208^{Aa}	30,213^{Aa}	0,588^{Aa}	10,383^{Aa}
UM 4-1 (50 ppm)	4,408^{Aa}	31,175^{Aa}	0,628^{Aa}	8,992^{Aab}

UM 7-2 (50 ppm)	3,563^{Aa}	47,138^{Aa}	0,452^{Aa}	8,227^{Aa}
UM 2-4 (50 ppm)	3,483^{Aa}	23,131^{Aa}	0,527^{Aa}	10,425^{Aab}
UM 7-6 (50 ppm)	4,983^{Aa}	39,079^{Aa}	0,643^{Aa}	9,008^{Aab}
UM 6-2 (50 ppm)	3,525^{Aa}	23,128^{Aa}	0,547^{Aa}	10,733^{Aab}
Gumitir (50 ppm)	4,517^{Aa}	33,345^{Aa}	0,632^{Aa}	11,267^{Aab}
Wilis (50 ppm)	5,000^{Aa}	44,247^{Aa}	0,592^{Aa}	8,218^{Aa}
UM 4-1 (75 ppm)	4,342^{Aa}	36,312^{Aa}	0,55^{Aa}	9,475^{Aa}
UM 7-2 (75 ppm)	4,55^{Aa}	36,242^{Aa}	0,588^{Aa}	9,683^{Aa}
UM 2-4 (75 ppm)	4,017^{Aa}	30,321^{Aa}	0,540^{Aa}	11,658^{Aa}
UM 7-6 (75 ppm)	4,07^{Aa}	29,796^{Aa}	0,567^{Aa}	11,57^{ABa}
UM 6-2 (75 ppm)	4,164^{Aa}	32,478^{Aa}	0,561^{Aa}	11,655^{Aa}
Gumitir (75 ppm)	8,73^{Aa}	64,756^{Aa}	1,21^{Aa}	10,12^{Aa}
Wilis (75 ppm)	5,133^{Aa}	45,597^{Aa}	0,590^{Aa}	10,325^{Aa}

Note: A string followed by the same notation means no significant difference

Qualitative data of leaf shape, flower color, cooking pod color, color of stem hair, and hypocotyl color obtained through direct observation. A summary of the qualitative data of each character can be seen in table 5.

Table 5. Summary of Qualitative Observation Results Morphological Character.

Strain	Flwer	Ripe Pod	Stem hairs	Hypo-cotyl	Leaf shape
1	Purple	Brown	Brown	Purple	Oval
2	Purple	Brown	Brown	Purple	Oval
3	Purple	Brown	Brown	Purple	Oval
4	Purple	Brown	Brown	Purple	Oval
5	Purple	Brown	Brown	Purple	Oval
6	Purple	Brown	Brown	Purple	Oval
7	Purple	Brown	Brown	Purple	Oval

Differences of the soybean strains used in this study showed significant results in influencing the characteristics of leaf width, leaf area, leaf ratio and long petiol daun. Different strains affect differently on the performances of plant (Hakim, 2012). This study showed there was no variation in flower color, hypocotyl color, stem hairs color, pods color, and leaf shape. The doses of hormone applied on the B. tabaci infected strains significantly effect on the leaf width, leaf broad, leaf ratio and length of petiole. However it showed no effect on leaf length. It can be infered that giberelin enhance the growth of soybean.

Gibberellin is a plant hormone that stimulates growth and development, GA stimulates the process of seed germination, causing the transition from meristem to shoot growth, from young leaves to mature leaf stages, leaf extension and vegetative growth (Gupta et al., 2013). Gibberellin administration on some plant species may provide a positive effect in affecting leaf area, width and leaf ratio than plants not given gibberellin, gibberellin-supplied plants also show better elongation and thickening of petiole than plants not given gibberellin (Marth et al. 1956). Gibberellin stimulates cell division and extension but, the GA mechanism in the plant or target tissue to initiate its action is not known clearly (Gupta et al., 2013).

Gibberellin may increase the carbon fixation, thus affecting leaf development (Brian, 1959). The hormonal treatment has no effect on the length of the soybean leaf, this may be due to the different responses of each part or plant species. Not all plant species respond to gibberellin in promoting growth, and the effects of different plants can be better or worse than others (Brian, 1959). Combination treatment between various strains of soybean infected by Bemisia tabaci with dose-varying gibberellin showed that strain 4-1 significantly had the width, broad and ratio of leaves better than the other strains without treatment of gibberellin. These results show that the soybean strain can grow optimally with gibberellin produced within its own body. It is known that plants are naturally capable of producing gibberellin hormone although tt is very difficult to know the levels of gibberellin present in plants (Gupta et al., 2013; Kimball, 1983; Riley, 1987).

The 5% LSD test result on the combination treatment of the length of the petiol showed that the UM-7-6 strain had the best length at a 25% hormone dose. This suggests that applications at very small doses of gibberellin can have a profound effect (Riley, 1987). Giving too frequent and repeated doses of gibberellin causes abnormal extension of the leaves, petiole and shows symptoms of chlorosis and the plant becomes weak (Rappaport, 1957).

4. CONCLUSION

The conclusion of this research is (1) there is influence of strain to leaf area, leaf width, leaf ratio and petiole length, but no effect to leaf length. (2) There is influence of gibberellin hormone doses on leaf area, leaf width, leaf ratio and length leaf petiole, but no effect on leaf length, flower color, hypocotyl color, mature pod color, stem color and leaf shape. (3) There is influence of combination of treatment (strain and doses) on leaf area, leaf width, leaf ratio and the length of petiole, but no effect on the length of the leaves.

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