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Resistance Level of Soybean Genotypes against Pod Sucking Bug (*Riptortus linearis* F. Hemiptera: Alydidae)

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ABSTRACT

Background: Pod sucking bug (*Riptortus linearis* F. Hemiptera: Alydidae) is one of the major insect pest in soybean that cause yield loss up to 79%. This study was carried out to identify the level of resistance to pod sucking bug on soybean genotypes.

Methods: Field research was conducted at Muneng Experimental Farm, Probolinggo, East Java, Indonesia in the Dry Season (March-June) 2019. A randomized block design repeated two times were used on a total of 16 soybean genotypes included two varieties (Anjasmoro and Gema) as check. The experiment consisted of two growing environments namely controlled environment (P1): two insecticides with active ingredients Deltamethrin and Fipronil were applied to soybean crops alternately; and uncontrolled environment (P0): no insecticide was applied to soybean crops Observations were recorded on the intensity of borer attack and dry seed weight.

Result: In uncontrolled environment (P0), the percentage number of infected seed to healthy seed was higher than that in controlled environment (P1). The mean effectiveness of control of pod sucking was 35% which was based on infestation intensity of seed number/plant infected in in two environments. The total seed weight/plant in controlled environment (P1) was 95% higher than that in uncontrolled environment (P0). Based on infestation intensity in uncontrolled environment (P0), five genotypes (G1 to G5) were categorized as resistant against pod sucking bug while the check varieties Anjasmoro and Gema were categorized as moderate resistant and susceptible, respectively.

Key words: Genotypes, Pest, Pod sucking bug, Resistance, Soybean.

INTRODUCTION

In Indonesia, soybean (*Glycine max*) is the third strategic food crops after rice and maize. The soybean productivity is low due to biotic stress such as pests and diseases infestations that reduce the quantity and quality of crop yields. As much as 15-20 per cent of soybean production is lost directly or indirectly by pest each year (Rustam, 2016).

Two major soybean pests that damage soybean pods and resulting in yield reduction are pod borer (*Etiella zinckenella* Treitschke) and pod sucking bug (*Riptortus linearis* Hemiptera: Alydidae). These two pests showed a significant positive correlation value each other, indicating that they had the same preference for soybean pods (Suhartina *et al*., 2022). Damage by pod borer is resulted from the larvae boring into mature pods and seeds (Rahman *et al*., 2017). Pod sucking bug causes soybean seed become defleted, wrinkled and cannot be consumed resulted in yield loss more than 75% (Sari and Suharsono, 2011; Motaphale *et al*., 2016; Adie *et al*., 2022). The suitability of using resistant genotypes with other control components in pest management is a long-term problem solving due to its economically sound and easy to use (Soundararajan *et al*., 2013).

Several factors that involved in the mechanism of soybean resistance to pod sucking bug (*R. Linearis)* have been identified using resistant and susceptible soybean genotypes. The use of the resistant genotypes of soybean is one of the ideal methods to control soybean pod sucking bug since it stabilizes the yield and has significant advantages over the use of chemical insecticides. It is also proved to be environmentally friendly, minimize the production costs, does not involve the transfer of new technologies and is considered compatible with other control methods used in insect management (Suharsono and Sulistyowati, 2012).

The soybean breeding at ILETRI selected 14 promising high yielding soybean lines that have not been evaluated yet on their resistance level to major pests and disease.

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This study was aimed to identify the level of resistance against pod sucking bug on soybean genotype.

MATERIALS AND METHODS

Study area

Field research was conducted at Muneng Experimental Farm, Probolinggo, East Java Province, Indonesia with an altitude of 10 meters above sea level at the coordinates of 7°48′7.2″ South Latitude and 113°9′32.4″ East Longitude. The research was conducted during the Dry Season (March-June 2019).

A total of 16 soybean genotypes with two check varieties Anjasmoro and Gema were used in this study. The gnotypes were derived from the Indonesian Legumes and Tuber Crops Research Institute (ILETRI), Malang, East Java Province, Indonesia. Pedigrees of all soybean genotypes tested are shown in Tabel 1.

Methods

The experiment consisted of two growing environments, namely P1 (controlled environment) and P0 (uncontrolled environment). In controlled environment (P1), two insecticides with active ingredients Deltamethrin and Fipronil were applied to soybean crops alternately. Spraying of the two insecticides was carried out once a week starting from 30 days after planting until harvest time. In uncontrolled environment (P0), no insecticide was applied to soybean crops. The study was conducted using a randomized block design and repeated four times.

Each soybean genotypes was planted in a plot of 4 m in length and 2 rows per treatment with a plant spacing of 40 cm × 15 cm, 2 plants per hole. Fertilizer application was 45 kg Urea/ha (20.7 kg N/ha) + 45 kg SP36 (16.2 kg P_2O_5/ha) + 50 kg KCl/ha (30 kg K_2O/ha) given during planting.

Data analysis

Observations were made on the intensity of pod sucking bug attack at harvest by counting the number of symptomatic pods and seeds affected in each genotype. The intensity of the pod was attacked in 5 sample plants at harvest, dry seed yields from 5 sample plants and the entire plot at harvest. The intensity of pod sucking attack at harvest is calculated according to the formula:

$$1 = \frac{a}{(a + b)} \times 100\%$$

Where,

I = intensity of plants or pods attacked.

a = Number of plants or pods attacked by bugs.

b = Number of healthy plants or pods.

The loss of seed yield due to pod sucking bugs were calculated according to the formula:

$$YL = \frac{YL1 - YL0}{YL1 \times 100\%}$$

Where,

YL = yield loss.

YL1 = yield of controlled plants (P1).

YL0 = yield of uncontrolled plants (P0).

The level of resistance of soybean of each genotype to pod sucking pest was categorized based on the mean of pod damage or seed damage (X) and the Standard Deviation method developed by Chiang and Talekar (1980) as follows:

1. Highly resistant (HR) : $X_i < (\bar{X} - SD)$
2. Resistant (R) : $(\bar{X} - 2SD) \leq X_i \leq (\bar{X} - SD)$ $\bar{X}$
3. Moderate resistant (MR) : $(\bar{X} - SD) \leq X_i \leq \bar{X}$
4. Susceptible (S) : $\bar{X} \leq X_i \leq (\; + SD)$
5. Highly susceptible (HS) : $X_i \geq (\bar{X} + 2SD)$

Where,

X_i = Pod damage or seed damage of each genotype.

$\bar{X}$ = Mean of pod damage or seed damage.

SD = Standard deviation.

Base on that formula, the genotype that had pod or seed damaged by insect numbers less than $\bar{X}$ - SD was considered highly resistant (HR), on the other hand, the genotype that had pod or seed damaged by insect numbers more than $\bar{X}$ + 2 SD was considered highly susceptible (HS).

RESULTS AND DISCUSSION

Number of infected seeds

The mean number of seed/plant infected by pod suckers (*Riptortus linearis*) is presented in Tabel 2. In controlled environment (P1), the mean number of seed/plant of healthy seed and infected seed were 363.5 and 581.0 seeds, respectively, or a total of 944.5 seeds. In uncontrolled environment (P0), the mean number of seed/plant of healthy seed and infected seed were 93.9 and 460.5 seeds, respectively, or a total of 554.4 seeds. This data indicated that the total seeds number in controlled environment (P1) was 70.4% higher than that in uncontrolled environment (P0).

In controlled environment (P1), mean number of seed/plant of healthy seed was 363.5 seeds which 38% lower than the infected seed (581.0 seeds). While in uncontrolled environment (P0), mean number of seed/plant of healthy seed was 93.9 seeds which 80% lower than the infected seed (460.5 seeds). This indicated that in uncontrolled environment (P0), the percentage number of infected seed to healthy seed was higher than that in controlled environment (P1).

The infestation intensity of seed/plants infected in controlled environment (P1) and in uncontrolled environment (P0) were 61.51% and 83.06%, respectively, suggested that infestation intensity of seed/plant infected in controlled environment (P1) was 26% lower than that in uncontrolled environment (P0). The mean effectiveness of control of od sucker was 35% which was based on infestation intensity of seed /plant infected in two environments (Tabel 2). This data suggested that, if there was no control, there would be a 65% reduction in number of seed /plant.

Based on infestation intensity in controlled environment (P1), there were three genotypes categorized as resistant (R) namely G1, G4 and G16 (Check variety Gema), six genotypes categorized as moderate resistant (MR) and seven genotypes (include G15 as check variety Anjasmoro) were categorized as susceptible (S). While in uncontrolled environment (P0), there were five genotypes categorized as resistant (R) namely G1 to G5, two genotypes as moderate resistant (MR) and nine genotypes (include G16 as check variety Gema) were categorized as susceptible (S) (Table 2).

In uncontrolled environment (P0), the percentage number of infected seed to healthy seed was higher than that in controlled environment (P1). The mean effectiveness of control of pod sucker was 35% which was based on infestation intensity of seed number/plant infected in two environments.

Table 1: Pedigrees of all soybean genotypes test.

Code	Genotype pedigree
G1	G100H/9305//IAC100-271///Grob-36-2
G2	G100H/9305//IAC100-271///Grob-42-3
G3	Kaba/IAC100//Brg63///Grob-386-1
G4	Kaba/IAC100//Brg63///Grob-386-3
G5	Kaba/IAC100//Brg63///Grob-392-1
G6	G100H/9305//IAC100-271///Grob-434-2
G7	G100H/9305//IAC100-271///Argo-473-6
G8	G100H/9305//IAC100-271///Argo-477-4
G9	G100H/9305//IAC100-271///Argo-478-1
G11	G100H/9305//IAC100-271///Argo-494-1
G10	G100H/9305//IAC100-271///Argo-485-1
G12	G100H/9305//IAC100-271///Argo-803-1
G13	Anj/G100H-6
G14	Anj/G100H-21
G15	Anjasmoro (check variety)
G16	Gema (check variety)

Seed weight infected per plant

The mean of seed weight/plant infected by pod suckers (*Riptortus linearis*) is presented in Tabel 3. In controlled environment (P1), the mean of seed weight/plant of healthy seed and infected seed were 53.84 and 62.34 g, respectively, or a total of 116.18 g. In uncontrolled environment (P0), the mean of seed weight/plant of healthy seed and infected seed were 13.85 and 45.79 g, respectively, or a total of 59.64 g. This indicated that the total seed weight/plant in controlled environment (P1) was 95% higher than that in uncontrolled environment (P0).

In the present study, the percentage number of infected seed to healthy seed in uncontrolled environment (P0) was higher than that in controlled environment (P1). The mean effectiveness of control of pod sucking was 35% which was based on infestation intensity of seed number/plant infected in two environments. The total seed weight/plant in controlled environment (P1) was 95% higher than that in uncontrolled environment (P0). The study to pod sucking bug on soybean reported by Krisnawati *et al*. (2016; 2017; 2018) showed that a very high natural population of pod sucking bug was recorded in the field with the average number of damaged pod in full protection environment (L1) and insecticide control until 50 dap (L2), *i.e.* 41.45% and 60.16%, respectively. On

Table 2: Infestation intensity and effectiveness of control of pod sucker base on number of seed/plant infected in two environments in 2019.

Genotypes	P1 = Controlled environment			P0 = Uncontrolled environment[a)]			Effectiveness of pest control (%)
	Number of healthy seeds	Number of infected seeds	Infestation intensity (%)[b)]	Number of healthy seeds	Number of infected seeds	Infestation intensity (%)[b)]	
G1	411	341	45.34 (R)	141	341	70.70 (R)	56
G2	362	461	55.98 (MR)	195	491	71.58 (R)	28
G3	399	539	57.47 (MR)	159	502	75.87 (R)	32
G4	444	472	51.53 (R)	165	456	73.39 (R)	42
G5	476	626	56.82 (MR)	190	534	73.74 (R)	30
G6	402	623	60.78 (MR)	69	534	88.53 (S)	46
G7	426	480	52.98 (MR)	84	510	85.93 (S)	62
G8	521	597	53.43 (MR)	94	493	84.04 (S)	57
G9	295	695	70.18 (S)	53	436	89.17 (S)	27
G10	309	692	69.14 (S)	54	558	91.21 (S)	32
G11	304	530	63.54 (S)	82	396	82.94 (MR)	31
G12	307	647	67.84 (S)	67	453	87.10 (S)	28
G13	220	775	77.90 (S)	58	391	87.03 (S)	12
G14	292	643	68.73 (S)	32	426	92.96 (S)	35
G15[a)]	220	708	76.27 (S)	32	453	73.45 (MR)	23
G16[a)]	429	469	52.24 (R)	28	277	90.88 (S)	74
Mean	363.5	581.0	61.51	93.9	460.5	83.06	35
Stand. deviation			9.26			7.74	

Note: [a)]Check varieties (G15 = Anjasmoro; G16 = Gema).

[b)]HR = Highly resistant; R = Resistant; MR = Moderately resistant; S = Susceptible; HS = Highly susceptible.

Tabel 3: Infestation intensity and effectiveness of control of pod sucker base on seed weight/plant infected in two environments. Muneng, 2019.

Genotypes	P1 = Controlled environment[a)]			P0 = Uncontrolled environment[a)]			Effectiveness of pest control (%)
	Healthy seeds weight/ plant (g)	Infected seeds weight/ plant (g)	Infestation intensity (%)	Healthy seeds weight/ plant (g)	Infected seeds weight/ plant (g)	Infestation intensity (%)	
G1	70.57	46.15	39.54	24.86	38.17	60.56	53.16
G2	56.00	51.83	48.07	27.80	50.11	64.32	33.81
G3	56.69	59.08	51.03	21.84	48.27	68.85	34.91
G4	67.91	57.48	45.84	22.17	51.17	69.77	52.20
G5	63.15	59.53	48.52	24.84	48.42	66.09	36.21
G6	61.96	70.71	53.30	10.68	59.12	84.70	58.92
G7	59.72	48.44	44.79	11.63	50.10	77.52	73.09
G8	69.93	59.21	45.85	12.86	52.21	80.24	75.00
G9	46.13	76.01	62.23	8.03	41.30	83.72	34.53
G10	43.71	70.90	61.86	7.84	53.30	87.18	40.92
G11	42.18	54.52	56.38	11.75	42.77	78.45	39.14
G12	43.13	65.05	60.13	8.95	47.37	84.11	39.88
G13	38.76	84.24	68.49	10.34	40.41	79.63	16.26
G14	42.68	66.96	61.07	4.63	43.34	90.35	47.94
G15 [a)]	33.76	75.79	69.18	5.50	49.37	89.98	30.06
G16 [a)]	65.11	51.60	44.21	7.95	27.28	77.43	75.14
Mean	53.84	62.34	53.66	13.85	45.79	76.77	43.07

[a)]Check varieties (G15 = Anjasmoro; G16 = Gema).

mung bean, Indiati *et al*. (2021) reported that control application (L1) reduced pod damage by 48.50% and increased mung bean seed yield by 25%, compared to without control (L2).

The different level of resistance of genotype could be determined by different morphological characters. Plant morphological structures play a leading role in plant protection against insect pests as the first line of defense. Resistance to pod sucking pests associated with pod morphological factors (antixenosis) as well as antibiosis factors (War *et al*. 2012).

Soybean morphological characters occured on leaves, stem and pod surface varied upon the variety which is the phenotypic characteristics. It was found that these characteristics has significant role on defense mechanism of soybean against pod feeding the insects. The resistance of soybean to pod sucking bug *Riptortus linearis* was controlled by pod wall thickness and trichome density.

The different response of genotype to pod insect attack could be influenced by pod morphology (wall thickness of pods, number of pods/cluster, angle between pods in one cluster, trichome pods, length, density and position of trichome pods, pod length and pod width) and content of compounds or plant nutrients (Halder and Srinivasan, 2007; Sunitha *et al*., 2008). Crop damage was indirectly influenced by the high frequency of probing and oviposition (Herlina *et al*., 2021). The thickness of the pod walls of the pegeon peas, the angle between the pods and the width of the pods showed a negative correlation with pod damage (Halder and Srinivasan, 2011). The level of damage of soybean pod due to pod sucking bug followed the morphological characteristics on pods as number of trichomes, wide surface pod and number pod per nodes (Hendrival *et al*., 2013; Jat *et al*., 2021; Krisnawati *et al*., 2022). The denser and longer trichomes on pods along with harder pod shells acts as a physical barrier in antixenosis resistance of soybean to the pod sucking bug (Suharsono and Sulistyowati, 2012).

CONCLUSION

Based on infestation intensity of seed number/plant infected in two environments, the mean effectiveness of control of pod sucking was 35%. The total seed weight/plant in controlled environment (P1) was 95% higher than that in uncontrolled environment (P0). Based on infestation intensity in uncontrolled environment (P0), five genotypes (G1 to G5) were categorized as resistant level against pod sucking bug, while the check varieties Anjasmoro and Gema were categorized as moderate resistant and susceptible levels, respectively. The resistant genotypes could be used as a genetic source in the improvement of soybean resistance to pod sucking bug.

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