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by Bambang Supeno

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Relationship between Soybean Pod Morphological Characteristics with Population and Attack Intensity of Pod Sucking Pest *Riptortus linearis* F. (Hemiptera: Alydidae)

Tantawizal[1], Muhammad Sarjan[2], Bambang Supeno[3], Baku Aloy Patu[4], Baiq Nurul Hidayah[5]

[1,5]Assessment Institute for Agricultural Technology (*Balai Pengkajian Teknologi Pertanian*), West Nusa Tenggara, Indonesia. Jalan Raya Peninjauan, Narmada, Lombok Barat, West Nusa Tenggara 83371 Indonesia

[2,3]Post-graduate studies, University of Mataram, Jalan Pendidikan No. 37 Mataram 83125, West Nusa Tenggara, Indonesia

[4]Student at Post-graduate studies, University of Mataram, Jalan Pendidikan No. 37 Mataram 83125, West Nusa Tenggara, Indonesia

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Corresponding Author: **Tantawizal**

ABSTRACT

Pod sucking pest, *Riptortus linearis*, is one of the important pests on soybeans which cause high yield losses. This study aimed to determine the relationship between soybean pod morphological characteristics with population and attacking intensity of the pod sucking pest *R. linearis*. The research method used was descriptive exploratory in the field with five soybean varieties, namely: Detap-1 (V1), Dega-1 (V2), Anjasmoro (V3), Biosoy (V4), and Dena-1 (V5). Research was conducted from September to December 2020 in Setanggor Village, West Praya District, Central Lombok Regency, West Nusa Tenggara Province, Indonesia. Results showed that the highest population of *R. linearis* was in the Dena-1 variety (1.9 individuals/plant), followed by Detap-1 (1.7 individuals/plant), Anjasmoro (1.6 individuals/plant), Dega (1 individual/plant) and Biosoy (0.9 individual/plant). Two morphological characteristics of soybean pods that had a correlation with the attacking intensity of *R. linearis* were trichome density (TD) and trichome length (TL). The lowest attacking intensity was on Biosoy variety (26.08% b, TD:1000.7 (10,000 m2 (10 x 4) and TL: 71.78 μm followed by Dega-1 (27.98% ab, TD:1044.04 (10,000 m2) (10 x 4) and TL: 70.70 μm, Detap-1 (36.36% ab TD: 944.14 (10,000 m2 (10 x 4) and TL: 72.86 μm, Dena-1 (35.02 % ab TD: 957.55 (10,000 m2 (10 x 4) and TL: 73.11 μm and the highest is Anjasmoro (37.56% a TD: 955.24 (10,000 m2 (10 x 4) and TL: 74.67 μm. Furthermore, the correlation analysis showed that the denser and longer the pod trichomes, the lower the attacking intensity of the pod sucking pest *R. linearis*.

KEYWORDS: Characteristics, Pod, Riptortus Linearis, Soybean

I. INTRODUCTION

Soybean (*Glycine max* (L.) Merr) is one of the strategic food crop commodities in Indonesia after rice and corn, which serves as a source of vegetable protein, raw material for various food processing industries and animal feed. In addition, the vegetable protein content in soybean is very important for improving human nutrition, which is safe and relatively cheaper than animal protein [1]. In 2018, the average soybean demand per capita in 2013-2017 is 6.59 kg/capita/year, and continues to increase along with population growth [2]. This causes soybean demand to continue to increase far beyond domestic production. In 2018 the national soybean production was 982,598 tons and had not been able to meet national needs so that the government imported 2,585,809 tons of soybeans [2].

The low domestic soybean production is caused by the low interest of farmers in growing soybeans, low soybean productivity, low adoption of soybean cultivation technology, underdeveloped partnerships, as well as pest and disease attacks [3], the use of low-quality and uncertified varieties, technology cultivation is still traditional, and pest and disease control is not yet integrated [4]. The use of soybean varieties that are not suitable for agroecosystem conditions and poor seed quality and control of plant pest organisms are not optimal are obstacles in increasing soybean productivity at the farmer level [4]. There are 15 main pests on soybean plants that have an impact on soybean productivity, one of which is the pod sucking pest *R. linearis* [5]. Pod sucking pests *R. linearis* can cause seed damage up to 79% [6]. Yield loss reaches 80% even total losses if not controlled [7]. The area of *R. linearis* pest attack in 2018 on soybean plants in West Nusa Tenggara Province was reported to be 111 ha and in Central Lombok Regency an area of 10.10 ha [8].

The results of the study by [9] showed that the morphological characteristics of soybean plants in the form of pod shell thickness had a strong relationship with the intensity of *R. linearis* attack, the higher the thickness of the pod shell, the lower the attack intensity. Furthermore, it was stated that the tight and long trichomes reduced the number of pod-sucking stylet puncture wounds [10]. Therefore, increasing productivity is achieved through the use of improved varieties obtained by assembling new improved varieties that are high yielding, drought tolerant and resistant to pest attack [11]. In addition, planting soybean varieties that are resistant to pests will reduce damage to crops and reduce the use of insecticides, thus providing economic, environmental and human health benefits [12].

This study aimed to determine the relationship between the morphological characteristics of the pods of several soybean varieties with the population and intensity of attack of the pod sucking pest *R. linearis*.

II. MATERIALS AND METHODS

This research was conducted from September to December 2020 in the rice fields of Setanggor Village, West Praya District, Central Lombok Regency, West Nusa Tenggara Province, Indonesia. The experimental design used was descriptive exploratory with five soybean varieties, namely Detap-1 (V1), Dega-1 (V2), Anjasmoro (V3), Biosoy (V4), and Dena-1 (V5), replicated 6 (six) times to obtain 30 experimental plots. The study was conducted at a central location for soybean production and there was or had been an attack by soybean pod sucking pests in the experimental site. Land preparation without tillage begins with cleaning weeds and the former base of the rice stalks, making drainage channels at the edges of the plots, each treatment plot covering an area of 4x5 m. Sowing was done by digging a depth of 2-3 cm, with a spacing of 40 x 20 cm, 2 seeds/hole, weeding was done at the age of 14 and 50 days after sowing (DAS), Fertilization using NPK Ponska fertilizer (200 kg/Ha) was applied at the age of 14 DAS by sowing between rows of plants, pest control was only conducted in the vegetative phase and irrigation was applied at the pre-planting, flowering phase at 5 week after sowing (WAS) and pod filling (9 WAS). Morphological characteristics of soybean plants observed were: (1) total number of pods, (2) number of filled pods, (3) number of infected pods, (4) productivity, (5) pod shell thickness, (6) pod trichome density and (7) pod trichome length. Observations were made at the age of 10, 11 and 12 WAS. Observation of parameters of pod shell thickness was observed using a micrometer screw, length and density of trichomes were observed using a Meiji binocular microscope with an area of 100 x 100 m^2 at a magnification of 10x4. The imago population of pod-sucking pests was carried out by catching imago using Sweep net with two swings on each treatment plot, while the intensity of attack was calculated using the attack intensity formula [13].

$$I = [a/(a+b)] \times 100\%$$

I = number of affected pods (%)
a = number of affected pods
b = number of uninfested pods

All data obtained were analyzed for variance, if the treatment had a significant effect, then it was continued with the honest real difference test with a level of 5%. Regression and correlation analysis are used to examine how the influence and how strong the influence between parameters.

III. RESULTS AND DISCUSSION

A. *Morphological Characteristics of Five New Improved Soybean Varieties, Populations and Intensity of Attacks of Pod Sucking Pests*

The average length of the trichomes of the five varieties tested increased along with the age of the plant, the results of the analysis showed that the difference in the length of the trichomes of the pods was only seen at the age of 11 WAS, with the longest size being Dena-1 (74.33 m) followed by Anjasmoro (67. 94 m), Detap-1 (67.60 m), Biosoy-1 (65.96 m) and the shortest Dega-1 (62.33 m). while the density of trichomes was not significantly different in the five varieties tested and three different ages of observation. Furthermore, the hardness/texture of soybean pods constantly from the three ages of observation showed that the Detap-1 variety had harder and thicker pods than the other four varieties (Table 1).

Imago *R. linearis* was allowed to come and choose freely soybean varieties without control, the results obtained were that *R. linearis* imago was found in all varieties tested with varying populations. The distribution of imago populations was even in all treatments because *R. linearis* had very high flight power, strong [14], as well as the availability of food, if food is available in the plantation, the *R. linearis* pest is able to breed throughout the year [7].

The results showed that the largest population of *R. linearis* was at the age of 11 WAS and decreased at the age of 12 WAS, this was because at the age of 12 WAS the soybean pod skin had begun to harden so that the stylet had difficulty in shaving the pods so that *R. linearis* did not like it. At the 10 WAS the highest population was in the Dena-1 variety (0.97 individual/plant) and the lowest was in the Biosoy-1 variety (0.40 individual/plant), at 11 WAS the highest was Detap-1 (1.52 individuals/plant) and the lowest was Anjasmoro (0.90 individual/plant), and at the age of 12 WAS the highest was Anjasmoro (1.30 individuals/plant) and the lowest was Biosoy-1 (0.65 individual/plant) (Table 1).

R. linearis attack on soybean pods was found starting at the age of 9 WAS or the pod formation phase, but at this phase the intensity of attack was still very low, this was because the seeds were not fully formed so they were not favored by sucking pests. This is in accordance with the results of research by [15] which stated that *R. linearis* did not like soybeans in the pod formation phase (R3-R4). Attacks that began to be found at the age of 10 WAS and continued to increase with increasing soybean biomass, this was in accordance with the results of [7] which states that the availability of abundant food is one of the factors for the emergence of pest attacks. Meanwhile, it was stated that crop damage will increase in tandem with the increase in soybean biomass [7]. The intensity of *R. linearis* attack increased with increasing plant age, at 10 WAS (14.99 - 22.71%), 11 WAS (25.26 - 32.43%) and 12 WAS (26.08 - 37.56%).

At the age of 10 WAS the affected soybean pods showed dry and fallen symptoms. The fall of the pods was caused by the cessation of the food supply to the pods due to damaged seed tissue [16], then at the age of 11 WAS the infected pods showed symptoms in the form of seeds becoming deflated and then drying, at this age according to Sunarno, (2017) is the most preferred phase by *R. linearis* and caused the highest damage and yield loss [14]. Meanwhile, at the age of 12 WAS or the ripening phase of the seeds and some of the seeds have started to harden, *R. linearis* is less favored by the plant's tolerance to pests and the pods have begun to harden so that it interferes with the stylet nymph or imago of *R. linearis* at the time of shearing and sucking liquid soybean pods [17]. Symptoms of the attack in the form of puncture marks on the brown seeds that damage the quality of the seeds. The results of the analysis showed that from the three ages of observation, the significant effect of soybean varieties was only seen at the age of 12 WAS where the lowest intensity was found in the Biosoy-1 variety (26.08%), followed by Dega-1 (27.08%), Dena-1 (35.02%), Detap-1 (36.36%) and the highest intensity was Anjasmoro (37.56%) (Table 1).

Tabel I. Morphology of five soybean varieties, population and intensity of pod sucking pest *R. linearis* at three different ages

Observation Age	**Varieties**	**Trichome length (μm)**	**trichome density (10.000 μm2 (10 x 4))**	**pod skin hardness (gr)**	**pod skin thickness (mm)**	**Population (tail/plant)**	**Attack intensity (%)**
10 MST	Detap-1	63,2	1078.16	501.33 a	0,52	0,97 ab	14.99
	Dega-1	60,64	1054.26	298.67 b	0,51	0,92 ab	22.71
	Anjasmoro	64,42	951.45	247.33 b	0,45	0,82 ab	15.56
	Biosoy-1	61,83	958.94	298.33 b	0,48	0,52 b	16.78
	Dena-1	64,96	997.15	239.00 b	0,46	1,40 a	15.92
BNJ 5%		0	0	97.71	0	0.75	0
11 MST	Detap-1	67,60 ab	981.19	572.00 a	0,62 a	1,52 b	31.08
	Dega-1	62,33 b	998.27	336.00 b	0,55 ab	0,90 b	26.87
	Anjasmoro	67,94 ab	811.61	377.33 b	0,53 b	1,35 ab	31.47
	Biosoy-1	65,96 b	968.25	216.33 b	0,56 ab	0,90 b	25.26
	Dena-1	74,33 a	987.07	251.33 b	0,51 b	1,80 a	32.43
BNJ 5%		7.60	0	113.02	0.08	0.58	0
12 MST	Detap-1	70,67	895.83	525.67 a	0,64 a	0,65 b	36,36 ab
	Dega-1	67,58	1138.49	279.67 b	0,58 ab	0,63 b	27,98 ab
	Anjasmoro	72,17	890.61	344.00 b	0,57 ab	1,30 a	37,56 a
	Biosoy-1	71,78	1003.66	262.00 b	0,60 ab	0,35 b	26,08 b
	Dena-1	76,83	1011.11	277.33 b	0,54 b	0,78 ab	35,02 ab
BNJ 5%		0	0	115.95	0.08	0.74	6.34

Notes: The average value followed by the same letter in the same column means that it is not significantly different in the Turkey's Test 5%

B. The Relationship between Population and Intensity of Soybean Pod Sucking Pest with Soybean Pods Characteristics (Trichome Length, Trichome Density and Skin Thickness of Soybean Pods).

The meaning of the correlation coefficient interval (r) is 0.00 – 0.199 (very weak), 0.20 – 0.39 (weak), 0.40 – 0.59 (moderate), 0.60 – 0.79 (strong) and 0.80 – 0.100 (very strong) [18]. Of the four parameters of the morphological characteristics of soybean pods observed, two parameters were weakly correlated (r = 0.20 – 0.39) with attack intensity, while the other two parameters were very weakly correlated, r = 0.00 - 0.19. Meanwhile, with the population of *R. linearis*, all the parameters of the soybean pods observed showed a very weak coefficient. The parameters that showed a correlation with the attack intensity of *R. linearis* that is trichome density (r = 0.20) (Table 2).

The trichome density of soybean pods showed a positive correlation with the intensity of attack intensity of *R. linearis* with a weak correlation coefficient, namely the density of trichomes (r = 0.20) where the denser (the smaller the distance between the trichomes) of soybean pods, the lower the intensity of attack (Figure 1). The results of other study stated that the density of the trichomes had a positive correlation with the intensity of the attack [19]. The results of other study also stated that soybean resistance to pod sucking pests *R. linearis* was influenced by the density and length of pod trichomes, soybean varieties with dense and long trichomes were less preferred and the attack rate of *R. linearis* was lower than soybean varieties that had more tenuous trichomes [20].

Tabel II. Correlation between Morphological Characteristics of Soybean with Imago Population and Attack Intensity of *R. linearis*.

	Trichome length	Trichome density	Pod texture	Skin thickness
Imago population (tail)	0.06	0,12	0.02	0,03
Attack intensity (%)	0.05	0,20	0.01	0,07

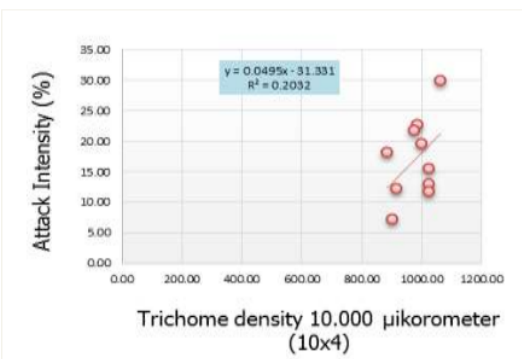

Figure 1. Correlation between trichome densities with attack intensity of *R. linearis*

Based on the correlation analysis between population and attack intensity of *R. linearis* showed that the presence of imago at different plant ages had a correlation with different soybean crop productivity, with a correlation coefficient value of r = 0.34, r = 00.5 and r = 0.05 at the age of 10, 11, and 12 WAS respectively, meaning that the presence of *R. linearis* imago on soybean plantations at the age of 10 WAS had the most effect on soybean productivity (Table 3). This is in accordance with the results of research by [19] which stated that *R. linearis* attacks at the age of 10 WAS were more sensitive and most preferred because the pods were young and the skin of the pods was still soft, making it easier for the stylet to pierce the soybean pods.

Damage caused by the attack of the pest *R. linearis* showed a correlation with the productivity of soybean plants, and attacks that occurred at the age of 10 WAS had the highest correlation with productivity with a correlation coefficient value of r = 0.40 (medium) compared to the age of 11 WAS was weak (r = 0.30) and 12 WAS was very weak (r = 0.19). *R. linearis* attack in the seed filling phase has the most impact on production loss, according to the results of research by [7] which said that *R. linearis* attack began to occur when the plant was 44 days old and the attack on the seed pod filling phase had the most impact on yield loss and quality. the resulting seeds. In line with the results of the study, it was stated that the investment/presence of *R. linearis* in the pod filling phase had the most effect on the intensity of pod damage compared to before and during flowering [21]. In addition, the most effective control efforts were carried out in the seed filling phase according to the research results of [21] which stated that the pest control of *R. linearis* in the seed pod filling phase was the most effective compared to the flowering phase or pod ripening.

Tabel III. Relationship between population and attack intensity of *R. linearis* with soybean productivity

Description	10 WAS	11 WAS	12 WAS
Population of *R. linearis*	0,34	0,05	0,05
Attacking Intensity (%)	0,40	0,30	0,19

C. Productivity

The results of the analysis showed that the treatment of soybean varieties had a significant effect on soybean productivity. Of the five varieties tested, the highest productivity was obtained in Dega-1 (0.5 t/ha) followed by Dena-1 (0.47 t/ha), Detap-1 (0.36 t/ha) Anjasmoro (0. 19 t/ha) and the lowest was Biosoy-1 (0.12 t/ha) (Figure 2). The low productivity of the soybean varieties tested was strongly influenced by the high intensity of *R. linearis* attack. In accordance with the results of [22] study which said soybean yield loss is closely related to the intensity of *R. linearis* pest attack where the higher the attack intensity, the higher the yield loss. Furthermore, the pod sucking pest *R. linearis* can cause seed damage up to 79%, and yield loss up to 80% and even total losses if not controlled [6,7].

Of the five varieties tested, the average attack intensity ranged from 26.08% - 37.56%, which means that according to the criteria for resistance. Of the five varieties tested, there were two varieties that were moderately resistant, namely Biosoy-1 and Dega-1 and there were three varieties that were somewhat sensitive, namely Dena-1 Detap-1 and Anjasmoro, and there were no varieties that were resistant to the attack of soybean pod sucking pests *R. linearis*.

In addition, differences in productivity between varieties are caused because each variety has different genetic yield potential which plays an important role in productivity [23] (Figure 2) . agronomic parameters that are closely related to the productivity of each soybean variety are the number of productive books, number of pods, seed size, and harvest index [24].

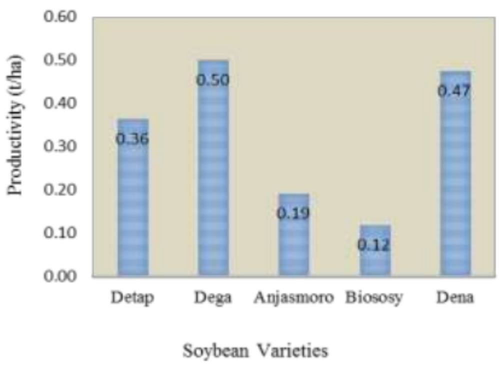

Figure 2. Productivity of each of soybean varieties during the field experiment which relatively low due to attack of *R. linearis*

IV. CONCLUSION

Of the four morphological characteristics of soybean varieties tested, one character was found that had a relationship with attack intensity, namely trichome density r = 0.2 (weak) the rest had a very weak relationship (r = 0.00 – 0.19) with the population and intensity of pest attack *R. linearis* and the intensity of the pest attack *R. linearis* greatly affect the yield loss of soybean varieties.

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