Influence of attack intensity of Sucking Pod (*RiptorusLinearis*), to the Yield of Superior Soybean Varieties in Drought Stress Condition

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**Abstract.** The objective of this investigation is to determine the influence of attack intensity of pod sucking pest, to the yield of superior varieties of soybean in drought stress conditions. The research has been carried out in the greenhouse of the Faculty of Agriculture, University of Mataram. Experiments have been designed by using completely randomized design with treatment consist of eight soybean varieties namely Anjasemoro, Panderman, Burangrang, Lawit, Argomulyo, Kaba, Tanggamus and Grobogan. The parameters measured were: 1) starting time of flowering age, 2) Attack intensity3) plant resistance; 4) plant height; 5) number of pods; 6) number of seeded pods; 7) number of empty pods because of pests; 8) the number of empty pods because of drying; 9) the number of seeds per plant; 10) weight of 100 seeds; 11) and grain yield per plant; 12) water needs. Data analysis of the studies were performed using ANOVA on the significance level of 5 percent, continued by Honestly Significant Difference (HSD) 5%. The results showed that 1) the decrease of weight 100 seeds of each varieties are proportional to the intensity of pest attacks *Riptortuslinearis*. Burangrang (moderate resistance), the intensity of attack is 22.35%, the decrease of product is 27% followed by Anjasemoro (moderate resistance), the intensity of the attacks 29.07%, the decreased of product is 31.01%; Grobogan (moderate susceptible), the intensity of attack is 37.88%, the decreased of product is 35.71%; Argomulyo (moderate susceptible), the intensity of attack is 38.32%, the decrease of product is 40.98%; Panderman (very susceptible), the intensity of the attacks 72.87%, the decreased of product is 60.02%; Kaba (very susceptible), the intensity of attack is 85.77%, the decreased of product is 64.92%; Tanggamus (very susceptible), the intensity of attack is 86.87%, the decrease of product is 67.40%, and Lawit (very susceptible), the intensity of attack is 89.41%, the decrease of product is 68.03%. 2) Varieties with a higher level of resistance and produced the highest weight of 100 seeds. Varieties with a higher level of resistance and produced the highest weight of 100 seeds is Burangrang 7.57 g followed by Anjasemoro 6.23 g; Grobogan 6.04 g; Argomulyo 5.76 g; Panderman 4.39 g; Kaba 2.14 g; Tanggamus 2.08 g and Lawit 1.95 g.
1. Introduction

Soybean is a secondary crop that has many benefits, one of which is a source of protein that has a high value of nutrition, it makes soybean a priority commodity to be developed after paddy and corn. The demand for soybean increase every year, however the increase of demand is not compensated with the production so the needs are not fulfilled. Riniarsi et al reported the number of soybean production in Indonesia from 2013 to 2015 tends to increase from 779,992 tons in 2013 to 963,183 tons in 2015 [1]. Despite the increase of production, it still cannot meet the consumption needs in Indonesia. This can be seen from the amount of Indonesian soybean imports from 2013 to 2015 which raised sharply from 1,785,385 tons to 6,416,821 tons. For this reason, extra efforts are needed to increase the national production through accelerating the increase in productivity and expanding the cultivation.

The increasing of production through accelerating the productivity can be held through the use of superior varieties obtained by assembling new variety with high product rate, drought tolerant, and resist to pest attack. Kisman (2008) stated that there were 42 soybean accessions obtained in several regions in West Nusa Tenggara which could be used as source of drought tolerant genes and resist to pest attack [2]. Increasing the production could be achieved through expansion of planting area in dry land. The potential of dry land in West Nusa Tenggara is quite wide reach up to 626,034.6 ha or approximately 31% of total area in West Nusa Tenggara. Increasing the productivity of soybean on dry land often has obstacles in form of abiotic factors for instance drought conditions and biotic factors in form of pest attack such as sucking pod (Riptortus linearis). According to Bray (2002), the decline of plant product per area due to the drought condition that reach 50-80% compared in a normal condition [3]. Tropical area with dry condition that have a high level of pest attack especially the main pests (Riptortus linearis) become one of the reason the low productivity of soybean with 79% damage rate [4]. Experiment on morphological resistance in several soybeans with superior varieties against sucking pod (Riptortus linearis). In drought stress condition the experiment has been carried out to determine the resistance of these varieties to the sucking pod. Thus, data and information will be obtained about the relationship between the level of plant resistance and the yield obtained on soybean that grown on dry land.

2. Methodology

This study was conducted in the greenhouse of the Faculty of Agriculture, University of Mataram. The method used is the experimental method with completely randomized design consist of 8 treatments of soybean varieties namely: Anjasmoro, Panderman, Burangrang, Lawit, Agromulyo, Kaba, Tanggamus and Grobogan. Each treatment was repeated 3 times, so 24 experimental units were obtained. The sucking pod (Riptortus linearis) maintenance is carried out before planting. The mature insect (imago) are taken from the field and placed on breeding media. The pest (Riptortus linearis) infested into the experimental plants was the first generation imago that resulted from rearing. The dried soil sifted and cleaned from dirt. The soil was entered in a plastic with a diameter of 20 cm and separated at 25 cm between the pots. The day before planting, the fertilized urea was mixed in the soil, SP-36 an KCL at a dose of 1/3 of the total that is 50-75 kg of urea, 75-100 kg SP-36 and 50-75 kg KCl. In each pot, two soybean seeds were planted 2 cm deep. After one-week planted, thinning process is carried out by leaving one healthy plant on each pot. Examination, drought stress treatment on soybean starts from 5 weeks after planted (MST) until the harvest stage. Drought stress treatment 60% field capacity carried out by giving water to the pot once a day or once every two days by using weighing method, as used by Hapsoh [5]. Sucking pod infestation was treated with the direct infestation method by using 5 Riptortus linearis on the soybean plant filling phase, then the plant covered with tile and metal frame in a circle with diameter of 40 cm and a height of 120 cm. To find out the attack level on pods, the intensity formula was used according to Fattah [5].

\[ I = \frac{a}{a+b} \times 100\% \]

Where: \( I \) = intensity of pest attack (%), \( a \)=the number of parts of infected plant, \( b \) = number of plants part that are not infected. The criteria of soybean resistance to sucking pod according to Akib and Baco (1985) [5].
Table 1. Criteria of pest Attack Intensity

| No. | Endurance Plant criteria | Pod Attack Percentage (%) |
|-----|--------------------------|---------------------------|
| 1.  | Very resistance          | 0 – 10                    |
| 2.  | Resist                   | 11 – 30                   |
| 3.  | Moderate Sensitive       | 31 – 50                   |
| 4.  | Sensitive                | 51 – 70                   |
| 5.  | Very Susceptible         | 75 – 100                  |

Observation variables include: number of pods, number of seeded pods, number of empty pods due to pests, number of empty pods due to drought, number of planting seeds, weight of 100 seeds, crop yields, trichome density, trichome length, pod skin thickness, plant height, flowering age, intensity of attack, the resistance to pod sucking pests, and water needs.

Data Analysis. Data were analyzed by variance analysis (ANOVA) at the 5%. The treatment showed a significant difference continued by HSD 5% analysis.

3. Result and Discussion

The observation showed that the infected pods will become reddish yellow, deflated then become blackish brown because of the damage of the tissue. After that the pods dried and fell due to the cessation of the photosynthesis to the pods and seeds. The pods structure that is soft makes the pod pests penetrate the stylet. The pest attack could cause the new seeds stopped developing due to the liquid inside the seed absorbed.

Table 2. Intensity of pest pod (*RiortusLinearis*) attack on each variety at age 10 week after planting (WAP), 11 WAP, and 12 WAPgk/mdgk/dm

| No  | Variety   | Attack intensity (%) on age |
|-----|-----------|----------------------------|
|     |           | 10 MST | 11 MST | 12 MST |
| 1.  | Anjasmoro | 26.31 e) | 27.14 e | 29.07 d |
| 2.  | Panderman | 42.63 c  | 49.65 c | 72.87 b |
| 3.  | Burangrang| 17.69 f  | 20.79 f | 22.35 e |
| 4.  | Lawit     | 70.29 a  | 72.17 a | 89.41 a |
| 5.  | Argomulyo | 35.83 cd | 37.54 d | 38.32 c |
| 6.  | Kaba      | 44.79 c  | 52.91 c | 85.77 a |
| 7.  | Tanggamus | 54.89 b  | 64.21 b | 86.87 a |
| 8.  | Grobogan  | 31.92 de | 36.67 d | 37.88 c |

HSD Value 0.05 = 8.13, 6.39, 7.60

*) the number followed by the same letter in one column are not significant different based on HSD 5%

The attack intensity of each variety is different and increases depending on the age of the plant. This is because each variety has a different resistance to the attack of *R. linearis*. The mechanism of plant resistance to pests occurs because of the differences in morphology between each variety. The sucking pod with sucking and piercing mouth types will give a different response to the pod morphology that prevent the activity of pests in sucking the pod. With a different response, the level of pests attacks on plants will be different. This is consistent with Smith (1989) idea which stated that one of the mechanism of plant resistance against pests is antixenosis, specifically resistance related to insect’s behavior caused by the shape of plant morphology (length and feather density, and plant tissue thinness) [6].
Fig 1. Graph intensity of pod pest attack (*R. linearis*) at age 10 WAP, 11 WAP, and 12 MST

There was an increase of attack intensity in all varieties, because at age 10 to 12 plant week after planting the soybean pod still formed due to the emerge of flowers that are not simultaneous so the establishment and filling of the pods continue to occur. This is beneficial for pests because the availability of food during this period is always available. Chattopadhyay (1981) in Marwoto et al. (2005) emphasized that abundant of food availability is one factor that emerge pest attacks. According to Metcalf and Luckman (1975), the crop damage will increase along with biomass [7].

**Table 3.** Average of attack intensity of Sucking Pod (*Riptortus linearis*), Number of Pods, Number of filled Pods, Amount of Planting Seed yield

| No | Varieties     | Intensity of attack (%) | The number of Pods | The number of Filled pods | Number of seeds per plant | Seed results (gr) |
|----|---------------|-------------------------|--------------------|---------------------------|----------------------------|-------------------|
| 1  | Anjasmoro     | 29.07 d                 | 43 b               | 30 b                      | 63 b                       | 3.92 c            |
| 2  | Panderman     | 72.87 b                 | 45 b               | 19 d                      | 41 d                       | 1.89 d            |
| 3  | Burangrang    | 22.35 e                 | 35 d               | 26 c                      | 54 c                       | 4.09 d            |
| 4  | Lawit         | 89.41 b                 | 41 c               | 7 f                       | 16 e                       | 0.31 f            |
| 5  | Argomulyo     | 38.32 c                 | 32 e               | 20 d                      | 43 d                       | 2.48 d            |
| 6  | Kaba          | 85.77 a                 | 45 b               | 7 f                       | 18 e                       | 0.38 f            |
| 7  | Tanggamus     | 86.87 a                 | 26 f               | 9 e                       | 19 e                       | 0.40 f            |
| 8  | Grobogan      | 37.88 c                 | 60 a               | 39 a                      | 84 a                       | 5.07 a            |

| No | Varieties     | Intensity of attack (%) | The number of Pods | The number of Filled pods | Number of seeds per plant | Seed results (gr) |
|----|---------------|-------------------------|--------------------|---------------------------|----------------------------|-------------------|
| 1  | Anjasmoro     |                         |                    |                           |                            |                   |
| 2  | Panderman     |                         |                    |                           |                            |                   |
| 3  | Burangrang    |                         |                    |                           |                            |                   |
| 4  | Lawit         |                         |                    |                           |                            |                   |
| 5  | Argomulyo     |                         |                    |                           |                            |                   |
| 6  | Kaba          |                         |                    |                           |                            |                   |
| 7  | Tanggamus     |                         |                    |                           |                            |                   |
| 8  | Grobogan      |                         |                    |                           |                            |                   |

HSD Value 0.05 7.60 1.90 1.97 3.10 0.16

*) the number followed by the same letter in one column are not significant different based on HSD 5%
Fig 2. The relationship between the attack intensity of pods sucking pests (*R. linearis*) with the amount of Pods.

\[ y = -0.0114x^2 + 1.2616x + 14.28 \]
\[ R^2 = 0.1748 \]

Fig 3. The relationship between the attack intensity of pods sucking pests (*R. linearis*) with the amount of filled Pods.

\[ y = 55.49e^{-0.02x} \]
\[ R^2 = 0.798 \]

Fig 4. The relationship between the attack intensity of pods sucking pests (*R. linearis*) with the number of seeds per plant.

\[ y = 112.0e^{-0.01x} \]
\[ R^2 = 0.793 \]
Fig 5. The relationship between the attack intensity of pods sucking pests (*R. linearis*) with the seed yield per plant.

Fig 5 above shows that the intensity of attack does not show a close relationship with the amount of pods. The different attack intensity in variety with varying number of pods depends on the potential yield. In Fig 3, 4, and 5 shows that the intensity of attack has a linear relationship with the number of filled pods, the number of seeds of crops and the yield of crop seeds. The higher the intensity of the attack and the number of filled pods, then the number of crop seeds and crop yields will be lower vice versa. This is because the pod damage caused by high attack intensity that results a fewer number of filled pods than pods damage caused by low attack intensity. The number of filled pods that produce a small number of seeds per plant planting and grain yield per plant.

Table 4 shows the attack intensity give a different effect on the weight of 1000 seeds and the number of empty pods due to the pest attack. The higher attack intensity the smaller the weight of 100 plant seeds.

Table 4. The average attack intensity of pods sucking pests (*R. Linearis*), weight of 100 seeds and amount of empty pods because of pests

| No | Varieties | Attack intensity | Weigh of 100 seeds | The number of empty pods caused by pest |
|----|-----------|------------------|-------------------|----------------------------------------|
| Pests                        |
| 1. | Anjasmo   | 29.07 d          | 6.23 b            | 6.00 f                                  |
| 2. | Panderman | 72.87 b          | 4.39 e            | 16.00 c                                 |
| 3. | Burangrang| 22.35 e          | 7.57 a            | 5.00 f                                  |
| 4. | Lawit     | 89.41 a          | 1.95 g            | 26.00 b                                 |
| 5. | Argomulyo | 38.32 c          | 5.76 d            | 8.00 e                                  |
| 6. | Kaba      | 85.77 a          | 2.14 f            | 28.00 a                                 |
| 7. | Tanggamus | 86.87 a          | 2.08 f            | 13.00 d                                 |
| 8. | Grobogan  | 37.88 c          | 6.04 e            | 9.00 e                                  |
| Control                        |
| 1. | Anjasmo   | 9.03 d           |                   |                                        |
| 2. | Panderman | 10.98 a          |                   |                                        |
| 3. | Burangrang| 10.37 b          |                   |                                        |
| 4. | Lawit     | 6.10 f           |                   |                                        |
| 5. | Argomulyo | 9.76 c           |                   |                                        |
| 6. | Kaba      | 6.10 f           |                   |                                        |
| 7. | Tanggamus | 6.71 e           |                   |                                        |
| 8. | Grobogan  | 10.98 a          |                   |                                        |

| HSD Value 0.05 | 7.60 | 0.18 | 2.15 |

*) the number followed by the same letter in one column are not significant different based on HSD 5%
Table 5. Decrease in production of several varieties soybean due to the attack of Pod Sucking Pests

\( (R. \text{linearis}) \)

| No  | Varieties | Attack Intensity | Weigh of 100 seeds | Decreasing of production | Decrease percentage |
|-----|-----------|------------------|--------------------|--------------------------|--------------------|
| 1.  | Anjasmoro | 29.07 d          | 9.03 d             | 6.23 b                   | 2.81               | 31.01              |
| 2.  | Panderman | 72.87 b          | 10.98 a            | 4.39 e                   | 6.59               | 60.02              |
| 3.  | Burangrangi | 22.35 e        | 10.37 b            | 7.57 a                   | 2.80               | 27.00              |
| 4.  | Lawit     | 89.41 a          | 6.10 f             | 1.95 g                   | 4.15               | 68.03              |
| 5.  | Argomulyo | 38.32 c          | 9.76 c             | 5.76 d                   | 4.00               | 40.98              |
| 6.  | Kaba      | 85.77 a          | 6.10 f             | 2.14 f                   | 3.96               | 64.92              |
| 7.  | Tanggamus | 86.87 a          | 6.38 b             | 2.08 f                   | 4.63               | 67.40              |
| 8.  | Grobogan  | 37.88 c          | 10.08 a            | 6.04 c                   | 4.94               | 35.71              |

HSD Value 0.05 7.60 0.18

*) the number followed by the same letter in one column are not significant different based on HSD 5%

The relationship between attack intensity and the weight of 1000 seeds and the number of empty pods due to pest attack is shown in Fig 6.

\[ y = -0.0006x^2 - 0.008x + 7.47 \]
\[ R^2 = 0.9597 \]

Fig 6. Graph relationship between attack intensity of pods sucking pests (Riptortus linearis) with weight of 100 seeds

Fig 6 shows that the attack intensity and weight of 100 seeds have a non-linear relationship. This is because of the pests suck the seeds liquid and will affect the growth and development of the seed. The infected pods will produce lower seed weight and reduce the quality compared to the pods that are not infected [8][9]. Some other study also showed that the attack of R.linearis is truly harmful. Prago and Suharsono (2005) reported that pod sucking pests could cause damage up to 79% [4].

\[ y = 0.167x^{0.978} \]
\[ R^2 = 0.870 \]

Fig 7. The relationship between attack intensity of the Pods sucking Pests (Riptortus linearis) with the Amount of Empty Pods due to Pests
Fig 7 shows that the attack intensity has a linear relationship with the number of empty pods due to pest attacks. This is because the attacked pods during the filling period (young pods) will damaged, deflated, dried, and fell off. According to Tengkano (1985), the Imago *R. Linearis* will impacted the entire growth stage of soybean pods, it caused varies damages depends on the frequency of attack and the age of pods [9].

Table 6. The average of water needs, character of morphological pods, intensity of *Riptortus linearis*, Productivity and Plant Resistance

| No. | Varieties   | Water needs (Litre) | Morphological Charater | Attack Intensity (%) | Weight of 100 seeds | Resistance Criteria |
|-----|-------------|---------------------|------------------------|---------------------|---------------------|---------------------|
| 1.  | Anjasmoro   | 2.97 c *)           | 0.72 ab                | 1.29 b              | 29.07 d             | 6.23 b              | Moderate Resistant  |
| 2.  | Panderman   | 3.73 b              | 0.61 b                 | 1.28 b              | 72.87 b             | 4.39 c              | Very Susceptible    |
| 3.  | Burangrang  | 2.80 e              | 0.83 a                 | 1.59 a              | 22.35 e             | 7.57 a              | Moderate Resistant  |
| 4.  | Lawit       | 4.00 a              | 0.65 b                 | 1.27 b              | 89.41 a             | 1.95 g              | Very Susceptible    |
| 5.  | Argomulyo   | 2.90 c              | 0.73 b                 | 1.24 b              | 38.32 c             | 5.76 d              | Moderate Susceptible|
| 6.  | Kaba        | 3.93 ab             | 0.63 b                 | 1.26 b              | 85.77 a             | 2.14 f              | Very Susceptible    |
| 7.  | Tanggamus   | 3.93 ab             | 0.63 b                 | 1.24 b              | 86.87 a             | 2.08 f              | Very Susceptible    |
| 8.  | Grobogan    | 2.88 c              | 0.73 ab                | 1.26 b              | 37.88 c             | 6.04 c              | Moderate Susceptible|

HSD Value 0.05

0.05 0.24 0.08 0.13 7.6

*) the number followed by the same letter in one column are not significant different based on HSD 5%

TPS: Tick of Pod Skin
LPT: Length of Pod Trichoma

Table 6 shows that the total water demand in eight varieties are diverse. Burangrang with the smallest water needs were not significantly different from Anjasmoro, Argomulyo and Grobogan varieties with the highest pod skin thickness, not significantly different from Argomulyo and Grobogan with the largest trichome pod length and have a different from other varieties. The Burangrang variety received the less attack intensity with the highest weight of 100 seeds compared to other varieties with moderate resistant category. This means that the Burangrang is the most resist variety due to 60% drought in field capacity by producing the thickest pods skin and the longest trichome. The pods morphology lead to the resist of Burangrang variety compared to other varieties, followed by Anjasmoro and Grobogan respectively. Pods sucking pests attack also affect the plant resistance, there are some varieties resistance criteria which are categorized by pest attack given by Akib and Baco (1985) [5]. Based on the intensity of pest attack on eight soybean varieties there were several resistance criteria in the order from the largest intensity to the lowest respectively: very susceptible consist of four varieties *i.e* Lawit (89%), Tanggamus (86.87%), Kaba (85.77%) and Panderman (72.87%), moderate susceptible consist of two varieties *i.e* Argomulyo (38.32%) and Grobogan (37.88%), and moderate resistance consist of Anjasmoro (29.07%) and Burangrang (22.35%).

4. Conclusion

Based on the observation and discussion that have been carried out in this study, there are two conclusion obtained as follows:

1. The decrease of the 100 seeds yield of each soybean is linear with the intensity of *Riptortus linearis* attack. Varieties with the lowest percentage of attack intensity and yield reduction is Burangrang (moderate resistance) with 22.35% of attack intensity, decrease in yield 27% followed by Anjasmoro (moderate resistance) with 29.07% of attack intensity, decrease in yield 31.03%; Grobogan (moderate susceptible) with 37.88% attack intensity, decrease in yield 35.71%; Argomulyo (moderate susceptible) with 38.32% attack intensity and 40.98% of yield
reduction; Panderman (very susceptible) with 72.87% of attack intensity and 60.02% of yield reduction; Kaba (very susceptible) with 85.77% of attack intensity and 64.92% of yield reduction; Tanggamus (very susceptible) with 86.87% of attack intensity and 67.40% of yield reduction; and Lawit (very susceptible) with 89.41% of attack intensity and 68.03% of yield reduction;

2. Soybean varieties with higher level of resistance produce higher weight of 100 seeds. The most resistance varieties with the highest weight of 100 seeds are Burangrang 7.57 gr followed by Anjasmoro 6.23 gr; Grobogan 6.04 gr; Argomulyo 5.76 gr; Panderman 4.39 gr; Kaba 2.14 gr; Tanggamus 2.08 gr and Lawit 1.95 gr respectively.

3. Recommendations
There are several recommendations based on the observations, discussions and conclusions:
1. Further research is needed with more varied varieties of soybeans under different stresses condition.
2. For developing soybean in dryland, it is recommended to conduct field research using resistant varieties such as Burangrang and Anjasmoro.

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