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Chapter

Symptoms of Damage to Soybean Varieties Due to Major Pest Attacks in South Sulawesi, Indonesia

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Abstract

South Sulawesi Province is one of the centers for soybean development in Indonesia. The varieties that are widely planted by farmers in South Sulawesi include Anjasmoro, Argomulyo, Grobogan, Gema, Dering-1, and Burangrang. These varieties have different levels of seed yield and damage levels. This paper aims to provide an overview and information about the types of soybean varieties, the level of pest damage, and the types of pests that cause damage to soybean varieties developed by farmers in South Sulawesi Province. The method used is to collect various information in the form of secondary data and primary data from research results related to soybean varieties, types of pests that damage soybean plants and the level of damage caused by soybean pests in South Sulawes. The results obtained provide information that the highest level of leaf damage caused by *Spodoptera litura* F. occurred in the Anjasmoro variety 10.94–32.69% followed by Argomulyo 10.16–26.17% and Grobogan 8.61–24.81%. The highest level of pod damage due to pod sucking was found in Burangrang varieties, namely 13.20%, Gema 12.51%, Dering 10.5%, Argomulyo 9.40%, Grobogan 8.50%, and Anjasmoro 7.70%. The level of fruit damage caused by the fruit borer *Etiella zinckenella* T., the highest occurred in Detam-1 15.71%, Ring 14.50%, Burangrang 10.60%, Gema 10.0%, Argomulyo 8.20%, Grobogan 7.10%, and Anjasmoro 6.70%. The rate of soybean yield loss caused by *S. litura* F. was the highest at Anjasmoro 8.97%–11.29%, then Grobogan 7.88–12.80%, and Argomulyo 6.77–14.90%. Meanwhile, the percentage of seed yield loss caused by the attack of the pest *Nezara viridula* L. ranged from 10.0–41.0% for all varieties. Likewise with *Riptortus linearis* F., the percentage of soybean seed loss caused ranged from 15 to 79% for all varieties.

Keywords: Soybean, varieties, symptoms, damage, main pests

1. Introduction

Soybean has a strategic position as a source of vegetable protein and functional food that has been affordable to all levels of society. Soy products such as tempe, tahu, soy milk, soy sauce, chips and so on are needed every day of the year. To meet the demand for raw materials for the processing industry, Indonesia needs around

2.2 million tons of soybean raw materials per year. Meanwhile, domestic soybean production is currently only able to meet 30–40% of national needs [1].

The national soybean productivity achieved by farmers in Indonesia only reaches 1.80 t / ha, while the potential national soybean productivity can reach 2.5 t/ha [2]. One of the factors causing low soybean productivity is the high pest attack. Pest attacks on soybean plants can reduce yields up to 80%, even puso if no control measures are taken [1]. According to Oerke [3], the loss of soybean yields due to pest attacks can reach 26–29%.

In the tropics, there are about 60 types of insects that can cause significant leaf damage in soybeans [4]. Meanwhile in India, there are about 150 species of insects that can cause serious damage to soybeans from planting to harvest [5].

Pests on soybean plants are classified into pests that destroy leaves and pests that destroy pods. Pests that destroy soybean leaves include whitefly (*Bemisia tabaci* G.), aphids (*Aphis glycines*), red mites (*Tetranychus cinnabarinus*), soybean green leaf-hoppers (*Empoasca* spp.), Armyworms (*S. litura*), jengkal caterpillars (*Chrysodeizis chalcites*), rollers. Leaf (*Omiodes indicata*), and soy beetle (*Phaedonia inclusa*). In principle, leaf damage caused by pests can interfere with the photosynthesis process [6]. Meanwhile, pests that destroy soybean pods include pod suckers *Nezara viridula, Reptortus linearis*, and *Piezodorus rubrofasciatus*. For pod borer, among others, *Etiella zinckenella* and *Heliothis armigera* [7].

S. litura F. armyworms is one of the important pests on soybeans in the world, including in Indonesia. In India, *S. litura* F is one of the important pests of soybeans [8]. A part from soybeans, in India, *S. litura* F. is also an important pest of tobacco with a damage rate of around 25–50% [9]. In Asia, *S. litura* F. is also an important pest and is a polyphagous which can attack about 122 species from 44 plant families [10]. In Bangladesh, about 15–20% of the total soybean production has decreased due to *S. litura* F attacks [11]. In Brazil, *S. Litura* F. can destroy soybean leaves by about 35% [12]. Rao et al. [13], *S. litura* F. can cause about 35–50% yield loss in tobacco. In cotton, in India, *S. litura* can result in 25.8–100% yield loss [14].

In Indonesia, armyworms, *S. litura* F. are important pests that eat soybean leaves compared to other pests such as jengkal caterpillars (*Chrysodeixis chalcites*), *Heliothis armigera*, leaf-rolling caterpillars (*Lamprosema indica*). Armyworms, *S. Litura* F. is a type of polypagus pest that attacks various types of plants, including soybeans. This is according to Santi and Krisnawati [15], in Indonesia, *S. Litura* F. is an important pest on soybeans with a leaf damage rate of around 70%. According to Adie et al. [16], soy-bean yield losses due to armyworm attack can reach 80% in Japan, 90% in America, and 23–45% in Indonesia. Meanwhile, according to Marwoto and Suharsono [17], the yield loss due to *S. litura* F. armyworm attacks in Indonesia can reach 80%.

R. linearis F. is an important pest of soybean in South Sulawesi. Yield losses due to pod sucking pests were 79% [18]. Both nymphs and imago suck the seed fluid by sticking their stylet which causes damage to the pods. The degree of damage due to *R. linearis* F. varies, depending on the stage of development of pods and seeds. The attack in the seed filling phase will cause the seeds to turn black and rot, at the ripening phase the pods will wrinkle the seeds and in the old pods before harvesting will cause the seeds to become hollow [18].

2. Soybean varieties developed by farmers in South Sulawesi

2.1 Anjasmoro variety

The Anjasmoro variety has a purple hypocotyl color, purple epicotyl color, white stem coat color, purple flower color, yellow seed coat color, light brown ripe pods, and yellowish brownish hilarity of seeds. This variety also has oval leaf shape, wide leaf size, deterministic growth type, flowering age 35–39 days, pod ripe age 82–92 days, plant height 64–68 cm, number of branches 2–5 branches, has a large seed size (weight of 100 seeds 14.8–15.3 g). The seeds contain 41.8–42.1% protein, 17.2–18.6% fat content, and are not resistant to falling. Anjasmoro variety is moderate to leaf rust, and the pods do not break easily [19]. Meanwhile, according to Hendrival et al. [6], Anjasmoro variety has 83.38 pods, 24.69 empty pods, 173.27 seeds per plant and 3.81–9.39% *S. litura* F. attack.

2.2 Argomulyo variety

Argomulyo variety has purple hypocotyl, brown fur color, purple flower color, yellow seed coat, bright white hilarity of seeds, deterministic growth type, flowering age 35 days, age at harvest 80–82 days, plant height 40 cm, number of branches per plant 3–4 stems from the main stem, has a large seed size (weight 100 seeds 16.0 g), has a seed yield of 1.5–2.0 t ha $^{-1}$, has a protein content of 39.4%, contains fat, 20.8%, has a fall resistance property [19]. In addition, the Argomulyo variety is tolerant of leaf rust disease and this variety is suitable for soy milk as raw material. Meanwhile, according to Poniman et al. [20], the Argomulyo variety had the number of pods filled with 79.00, the weight of 100 seeds was 15.38 g, and the percentage of pod damage caused by pod borer attack was 13.11%.

2.3 Grobogan variety

According to the description of the soybean variety [19], the Grobogan variety has a determinitic growth type, purple hypocotyl color, purple epicotyl color, brown stem coat color, purple flower color, dark brown pod color, lanceolate leaf shape and hilarity brown seed color, plant height 50–60 cm, flowering age 30–32 days, mature pods 76 days, have large seed size (weight 100 seeds, 18 g), potential seed yields 3.40 t/ha, and an average seed yield of 2.77 t ha^{-1}. The seeds have a fat content of 18.4% and a protein content of 43.9%. It is well adapted to several different growing environmental conditions, has pods that are not easily broken, and at harvest 95–100% of the leaves are shed (**Figure 1**).

2.4 Burangrang variety

The Burangrang variety has purple hypocotyls, yellowish brown fur, purple flowers, yellow seeds, bright hilium seeds, oblong leaves, pointed tips, deterministic growth type, number of branches 1–2 branches, flowering age 35 days, pod age cook 80–82 days, plant height 60–70 cm, large seeds (weight of 100 seeds 16 g), seed yields range from 1.6–2.5 t ha^{-1}, have 39% protein content, 20% fat content, not

Figure 1.
Appearance of Grobogan (a), Argomulyo (b), and Anjasmoro (c) varieties. Source: Fattah et al. [21].

easy to fall down, tolerant of leaf rust disease. This variety is suitable for soy milk, tempe, and tahu [19].

2.5 Dering varieties

Dering variety has a deterministic growth type, flowering age 35 days after planting and 81 days after planting, plant height 57 cm, brown fur, oval leaf shape, purple hypocotyl color, purple epicotyl color, purple flower color, brown pod skin color., yellow seed coat color, dark yellow hilium seed color, white cotyledon color, resistant to falling, the number of branches 3–6 stems per plant [19]. Meanwhile, according to Poniman et al. [20], the Dering variety has medium seed size (100 seeds 10.7 g weight), the potential yield of seeds is 2.80 t ha^{-1}, the average seed yield is 2.0 t ha^{-1}, the seeds contain 34.2% protein and 17.1% fat content. Furthermore, it was said that the variety was resistant to pod borer (*E. zinckenella* T) and susceptible to armyworms (*S. Litura* F), resistant to leaf rust disease ((*Phakospscora pachithyzi* Syd) and tolerant to drought during the reproductive phase.

2.6 Gema varieties

According to Poniman et al. [20], the Gema variety has a deterministic type of growth with light brown coat color, purple cotyledon color, purple hypocotyl color, green epicotyl color, and white cotyledon color. Furthermore, it is said that this Gema variety has a plant height of 55 cm, has a medium seed size (100 seeds weight 11.90 g), a flowering age of 35 days, a harvest age of 73 days, a potential yield of 3.06 t ha^{-1}, an average seed yield. 2.47 t ha^{-1}, brown pod color, purple flower color, round seed shape, light yellow seed coat color, and brown hilium color. The seeds have a protein content of 39.07% and a fat content of 19.11%. The Gema variety is sensitive to leaf virus (CMMV) and moderate to rust disease [19]. In addition, these varieties are also somewhat susceptible to pod suckers, somewhat resistant to pod borer, and moderate to armyworm pests (**Figure 2**) [19].

2.7 Deja-2 varieties

The Deja-2 variety has a deterministic growth type, ± 37 days of flowering, ± 80 days of maturity, purple hypocotyl color, purple epicotyl color, green leaf color, purple flower color, brown coat color, light brown pod skin color, seed coat color. Yellow, yellow cotyledon color, brown hilum color, oval leaf shape, medium leaf size, 3 branches per plant, the number of pods per plant ±38 pods, ± 52.3 cm plant height, lying with resistance to collapse, pod breaking with the pods are not easily broken, the size of the seeds is large, the weight of 100 seeds is ±14.8 grams, the shape of the seeds is oval, the potential yield is 2.75 t ha^{-1}, the average yield is ±2.38 t ha^{-1}, the protein content is ±37.9%, fat content ±17.2%, susceptible to

Figure 2.
Appearance of Gema (a), Burangrang (b), and Dering (c) varieties. Source: Fattah et al. [21].

Figure 3.
Dena-1 (a), Deja-1 (b), and Dega-1 (c) varieties. Source: Fattah et al. [21].

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armyworm pests, mildly resistant to pod borer, somewhat resistant to pod suckers, and somewhat resistant to leaf rust disease (**Figure 3**) [19].

2.8 Dena- 1

According to the description of the soybean variety [19], the Dena-1 variety has a deterministic growth type, purple flower color, purple fur color, purple hypocotyl color, green epicotyl color, and yellow-yellowish pod skin color. Flowering age 33 days, pod ripe age 78 days, oval leaf shape, number of branches 12 branches per plant, growth type determinant, flowering age ± 33 days, maturity ±78 days, hypocotyl purple color, green epicotyl color, green leaf color, purple flower color, brown fur color, yellowish brown pod skin color, yellow seed coat color, green cotyledon color, brown hilum color, oval leaf shape, medium leaf size, branching 3 branches per plant, number of pods planted ±29, plant height ± 59.0 cm, slightly resistant to falling apart, pods breaking easily, large seed size, weight of 100 seeds ±14.3 grams, oval seed shape, potential yield of 2.9 t ha^{-1}, average yield ±1.7 t ha^{-1}, protein content ±36.7% DM, fat content ±18.8% DM, resistance to pests, resistance to leaf rust disease, susceptible to pod sucker *R. linearis* F. and armyworm pest *S. litura* F., and tolerant up to 50% shade. According to Poniman et al. [20], the Dena-1 variety weighed 100 seeds 13.95 g, the number of pods per plant was 44.25, and was resistant to pod borer attack.

2.9 Dega- 1

Has a deterministic growth type, ± 29 days of flowering, ± 71 days of maturity (69–73 days), purple hypocotyl, purple epicotyl color, green leaf color, purple flower color, brown coat color, light brown pod skin color, yellow seed coat, purple cotyledons, brown hilum color, oval leaves, medium-sized leaves, branching from 1 to 3 branches/plant), number of pods per plant ±29 pods, plant height ± 53 cm, resistant to falling, resistant to breaking pods, have a large seed size, weigh 100 seeds 22.98 g, have a potential yield of 3.98 t ha^{-1}, have a protein content of 37.78% DM, a fat content of 17.29%, are resistant to leaf rust disease [19]. According to Poniman et al. [20], the Dega-1 variety had 27.75 pods per plant, 100 seeds 21.38 g weight, and was somewhat resistant to pod borer attack.

2.10 Varieties of Detam- 1

The Detam-1 variety has a deterministic growth type, hypocotyl purple color, green epicotyl color, purple flower color, light brown hair color, dark brown pod skin color, black seed coat color, and yellow cotyledon color, slightly round leaf shape, and brightness of shiny seed coat. This variety also has a plant height of

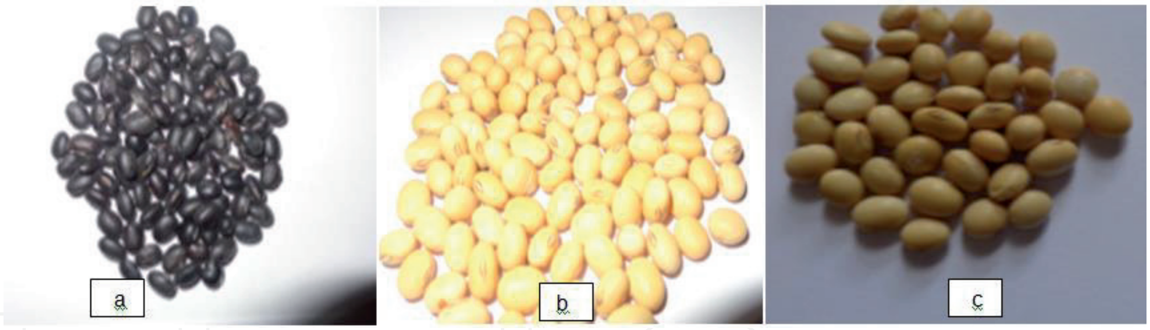

Figure 4.
Seed color of the Detam-2 (a), Anjasmoro (b), and Argomulyo (c) varieties. Source: Fattah et al. [22].

58 cm, a flowering age of 35 days, a pod ripe age of 84 days, has a large seed size (100 seeds weight 14.84 g), has a potential yield of 3.45 t ha^{-1} and an average yield of 2 seeds. 2. 51 t ha^{-1}, the seeds have a protein content of 45.36% and a fat content of 33.06%. The nature of resistance to pests, sensitive to armyworms and somewhat resistant to pod suckers and other properties are somewhat sensitive to drought (**Figure 4**) [19].

3. Armyworm life cycle, level of damage, percentage of yield loss, and economic threshold (ET) in armyworm pests

3.1 Life cycle of *S. litura* F

3.1.1 Egg phase

Adult insects (imago) lay eggs in clusters containing about 350 eggs and covered in fine hairs. The total eggs laid by one female insect in one life cycle are around 2000–3000 eggs [23]. Meanwhile, according to Schreiner [24], *S. litura* F. imago lay eggs in groups of about 200–300 under the leaves covered with brown hairs from the female body. Furthermore, it is said that the total eggs laid by one female insect in one life cycle are about 2,000 eggs.

The eggs that almost hatch, turn brown in color and enlarge like fish eggs (**Figure 5b**). According to Kalshoven [23], the almost hatched eggs turn brown and get bigger. Then hatch into larvae 3–5 days. Meanwhile, Ahmad et al. [26], the eggs hatched 3 days after being laid by the female *S. litura* imago. Furthermore, Kranz et al. [27], suggested that the eggs are laid in groups of 50–300 eggs

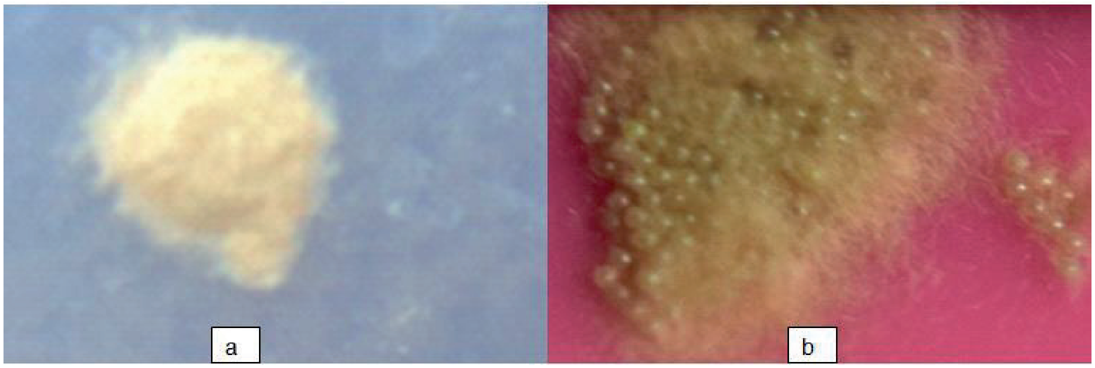

Figure 5.
Eggs in groups covered with hairs from female imgo (a) and eggs that are ready to hatch (b). Source: Fattah, Ilyas [25].

Figure 6.
Instar-1 larvae (newly hatched) (a), and instar-4 larvae (b). Source: Fattah [27].

under the leaf surface and hatch for 3–4 days, and one adult insect can produce 1,500–2,500 eggs.

3.1.2 Larva phase of S. Litura F

The newly hatched larvae feed from the leaves occupied by the eggs in groups (**Figure 6a**), then spread by using threads that come out of their mouths and are used to move from plant to plant. Armyworm larvae have different colors. The newly hatched larvae are light green, the sides are dark brown or brownish black and the last instar larvae have dark black necklaces (crescent moons) on the fourth and tenth abdominal segments. On the dorsal lateral side there is a yellow stripe, the larval stage consisting of 5 instars which lasts 20–46 days [23].

3.1.3 Pupa phase

The last instar larvae enter the soil, then become inactive larvae (Pra pupa) (**Figure 7a**). Then it turns into a pupa (without a cocoon (**Figure 7b**). The pupa is in the ground with a depth of 0–3 cm [28]. The pupa is reddish-brown, weighing about 0.341 g per pupa [29]. The pupal stage ranges from 8 to 11 days [17].

3.1.4 Imago phase

Pupa in the soil will change to the next phase to become butterfly insects (Imago) (**Figure 8**). The life cycle of *S. Litura* F. from egg to imago is about 30–60 days [17]. Meanwhile, Javar et al. [29], the life cycle of *S. litura* is approximately 29–35 days.

Figure 7.
Prepupa phase (a) and pupa phase (b) of S. Litura F. source: Fattah, Ilyas [25].

Figure 8.
Imago (female) S. litura F. (a) and imago (male) of S. litura F. (b). Source: Fattah, Ilyas [25].

3.2 The level of leaf damage due to attack by armyworm pests on soybeans

The young larvae (instar-1 and instar-2) damage the leaves by leaving remnants on the upper (transparent) epidermis and leaf bones. The rates of armyworm infestation differ between plant types and between varieties. In susceptible plants provide better growth for pests. Conversely, resistant varieties will give poor growth and development of armyworm pests. The results of research by Shahout et al. [30], of several types of plants tested on *S. litura*, the development of the larvae was shorter in the feeding of mustard greens (15.55 d), cotton (15.73 d), and potato (15.82 d) than the diet from cowpeas (19.55 d). Likewise, the response of soybean varieties to the level of *S. litura* F. attacks will vary in each region. This is indicated by the results of research conducted by Fattah and Hamka [31] in Panincong, Soppeng Regency, showing that the intensity of armyworm attack on the Mahameru variety was 17.26%, Kaba 13.5%, Anjasmoro 10.94%, Sinabung 12.16%., Detam-1 12.53%, Wilis 14.41%, Detam-2 15.34%, Burangrang 12.11%, Argomulyo 10.16, and Grobogan 8.61%. Meanwhile, the results of research conducted by Rahman and Fattah [32] in Simbang, Maros Regency showed that the intensity of attacks on Grobogan was 11.60%, Anjasmoro 11.20%, Argomulyo 12.71%, Detam-1 15.21%, Wilis 15, 51%, Gema 13.30%. The results of research by Hendrival et al. [6], the intensity of *S. litura* attacks at plant age 1–2 WAP on the Kipas Merah variety was lower (2.36% -5.02%) than the Anjasmoro variety (3.81% -9.39%). Fattah et al. [33], the highest level of soybean leaf damage due to *S. litura* F. attack was in Anjasmoro variety 31.65% and the lowest was Grobogan 23.96%.

Damage and yield loss due to armyworm attack is determined by the level of the pest population, the stage of insect development, the phase of plant growth, and the type of soybean varieties. Pest attacks on susceptible varieties will cause very significant losses. Leaf defoliation due to armyworm attack when it occurs during the full flowering phase and pod formation phase will result in greater yield losses than attacks in the full pod filling phase (**Figure 9**) [17].

Symptoms of damage to leaves due to *S. litura* F. pests in each soybean variety have different levels. According to Fattah et al. [34], the symptoms of leaf damage due to *S. litura* pests on Anjasmoro varieties ranged from 20.19 to 28.61%, Argomulyo 14.68–26.17%, and Grobogan around 13.28–18.00%. Fattah et al. [36], the highest *S. litura* F., attack rate was in Anjasmoro (26.68–32.69%) and the lowest was in Grobogan (17.07–24.81%). One of the factors that influence the differences in the level of leaf damage is the number and length of trichomes possessed by each variety. The greater the number of trichomes in soybean leaves, the lower the symptom level of the attack. Likewise, the length of the trichomes, the longer the trichomes on soybean leaves, the lower the level of leaf damage. This is evident from the results of research by Fattah [35], Grobogan variety has the lowest symptoms of leaf damage because it has the highest

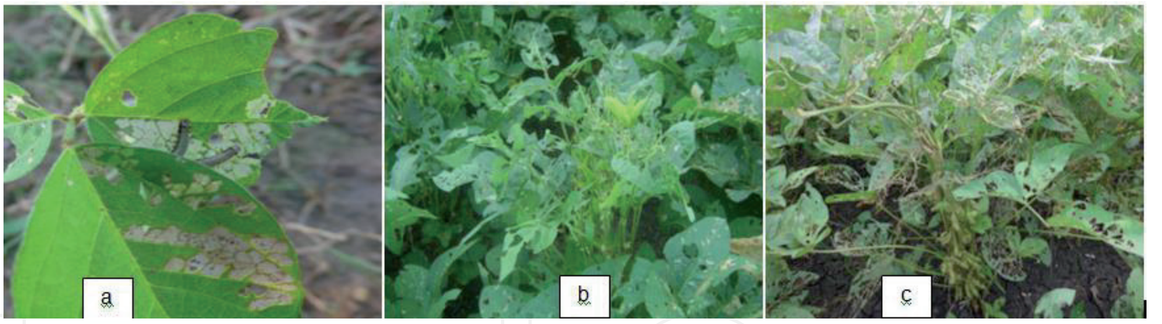

Figure 9.
Symptoms of leaf damage due to S. litura F. pests in the vegetative phase (30 days) (a), the vegetative phase before flowering (b), and the generative phase (c). Source: Fattah [27].

number of trichomes and lengths of trichomes (58.80 per cm2 and 1.90 mm) compared to Anjasmoro variety, only 28.95 per cm2 and 1.66 mm.

The level of damage to soybean leaves due to *S. litura* F. pests is not only determined by the type of variety that the farmer uses, but also by the population density of *S. litura* F. in the field. This is in accordance with Fattah et al. [36], the level of damage to soybean leaves at 35 days after planting due to *S. litura* F., pests was the highest at a population density of 6 larvae per plant (38.64–43.52%), 4 larvae 33.43–36.33%), and 2 larvae per cropping (25.82–27.88%). The same thing in the results of Fattah's study [35], the level of damage to soybean leaves at the age of 25 days after planting due to *S. litura* F. pests was the highest at a population density of 6 larvae per crop (32.01–34.50%), 4 larvae per cropping (22.00–28.70%), and 2 larvae per crop (19.17–26.74%).

3.3 Yield loss due to attack by armyworm pests on soybeans

The rate of loss of soybean seeds due to *S. litura* F. pests was different for each variety depending on the level of damage. This is consistent with Fattah [35], the highest rate of seed loss due to *S. litura* F. armyworm attack was in Anjasmoro (8.97%) and the lowest was in Argomulyo (6.77%). Meanwhile, Fattah et al. [36], the rate of loss of soybean seeds due to *S. litura* F. pests was the highest in Argomulyo variety (13.57%) in the vegetative phase and 14.93% in the generative phase.

The difference in the level of loss of soybean seeds due to *S. litura* F. pests, apart from being influenced by the variety, is also influenced by the level of larval population density. The higher the population density of *S. litura* F larvae per plant, the higher the yield loss. According to Fattah et al. [36], the level of soybean yield loss due to *S. litura* F. armyworm attack was the highest at a population density of 6 larvae per plant (38.64–43.63%) in the vegetative phase and 38.35–41.98%) in the generative phase. While the lowest was in the population density of 2 larvae per plant (25.82–30.96%) in the vegetative phase and 24.39–30.96%) in the generative phase. Meanwhile, Fattah [35] stated that the highest rate of soybean seed loss due to *S. litura* F. attack was at a population density of 6 larvae per plant (23.47%) and the lowest was at a population density of 2 larvae per plant (13.94%).

3.4 Economic threshold (ET) on *S. litura* F

The national economic threshold set by the Government in the use of insecticides for the control of *S. litura* F. armyworms on soybeans is if 1 instar-3 larvae per clump is found at the age of the plant 20 days after planting or if an attack intensity is found around 12.5% at age the same [17]. This is different from the results of Fattah's research [35], by using three varieties namely Anjasmoro, Argomulyo and

Grobogan with the calculation of the costs incurred by farmers (cost) during one growing season with 2 insecticide applications per week, so the total cost of farmers' expenses is around IDR 2,340,000 per ha and loss of seed yield per larva per plant is 96 kg. Based on this data, it was obtained the economic threshold (ET) of *S. litura* F. armyworms of 3.0 3 instar larvae per plant [35]. The difference in the economic threshold is influenced by several factors, including the types of soybean varieties planted by farmers (recommended) which are different from those that were in the past. Some of the factors that differ between recent varieties and ancient varieties are morphological factors including physical resistance, seed yield, plant height, number of pods, number of branches, and chemical resistance characteristics.

Based on the results of Fattah's research [35] from the results of data analysis, it was found that the average yield loss in Anjasmoro variety was around 130 kg, the total cost (Cost) was IDR 2,340,000 per ha, then the economic threshold (AE) for Anjasmoro was 2.25 tails. Larvae per plant or 2.0 larvae per plant. Furthermore, the economic threshold (ET) was found in the Argomulyo variety, if the average yield loss per hectare was 105 kg, then the economic threshold (ET) for Argomulyo variety was 2.78 larvae per plant or 3.0 larvae per plant. The economic threshold (ET) for Grobogan variety if the average yield loss is 91 kg per ha, then the economic threshold value is 3.21 larvae per plant or 3.0 larvae per plant [35].

According to Fattah [35] the economic threshold (ET) value of Anjasmoro variety (2 larvae plant^{-1}) is lower than Argomulyo (3.0 larva plant^{-1}) and Grobogan (3.0 larva plant^{-1}), this is due to the variety Anjasmoro is more sensitive to armyworm attacks than Argomulyo and Grobogan. This is consistent with Fattah and Hamka [31], the attack rate of *S. litura* F. armyworms in Anjasmoro variety (10.16%) was higher than Grobogan (8.60%).

4. Pod sucking pests *N. viridula* L

The pod sucker *N. Viridula* L. is the main pest on soybeans in Indonesia, including in South Sulawesi. According to Marwoto et al. [37] Mature green ladybugs begin arriving at the plant near the flowering phase. Furthermore, it was said that the eggs were laid in groups, with an average of 80 eggs, on the lower leaf surface, the upper leaf surface, pods and plant stems. The egg's cup-like shape is yellow and turns brick red when it hatches. The eggs hatch after 5–7 days. Young ladybugs (nymphs-1) live in groups on the egg shell. To become an adult insect, the nymphs of 5 instar-5 will experience a change in color and size. The body length of nymph-1 to nymph-5 is 1.2 mm, respectively; 2.0 mm; 3.6 mm; 6.9 mm, and 10.2 mm. Young instar-4 ladybugs begin to spread to surrounding plants. In the morning, ladybugs usually stay on the upper leaf surface, but during the day will descend to the pods to feed and take shelter. Young and adult ladybugs damage the pods and seeds by poking their stylet on the pod shells and into the seeds and then sucking the seed juices. The damage caused by these green ladybugs causes a decrease in yield and seed quality. Host plants other than soybeans are rice, beans, Crotalaria, potatoes, sesame, maize, tobacco, chilies, and Tephrosia. According to Kalshoven [23], *N. Viridula* L. has a green color which is commonly called the green ladybug, lays the eggs in groups of 10–90 eggs on the leaves. Its life cycle from egg to adult is around 4–8 weeks, the total life cycle is around 60–80 days. This pest has a host of legumes, maize, cotton, and rice.

According to Manurung et al. [38], the level of pod sucking pest *N. viridula* L. attack on soybeans was 51.66%. Bayu and Tengkano [39], the rate of yield loss due to pod sucking pest *N. Viridula* L. can reach 10.0–41.0%. Sari and Suharsono [40], the level of damage to soybean pods due to pod sucking pests of *N. viridula* L on Burangrang varieties was 32.50%, Kaba 31.50%, and Wilis 36.83%. According to

Rahman and Fattah [32], the level of pod damage caused by pod sucker *N. viridula* L was the highest in Burangrang variety (13.20%), followed by Gema (12.50%), Dering (10.50%), Argomulyo varieties. (9.40%), Detam-1 (9.0%), Grobogan 8.50% and Anjasmoro (7.70%).

5. The pod borer *E. zinckenella* T

The pod borer *E. zinckenella* is an important pest on soybeans. This is in accordance with Sidabutar et al. [41], the pod borer *E. zinckenella* T. is one of the important pests of soybean in Indonesia. The same thing was expressed by Apriyanto et al. [42], the pod borer is an important pest of soybeans. Furthermore, it was said that in addition to attacking soybean plants, *E. zinckenella* T. also attacked other legumes and could cause pod damage levels of up to 100% without the use of insecticides. According to Marwoto et al. [7], adult insects *E. zinckenella* T. lay eggs in groups of 4–15 eggs under leaves, flower petals or on pods. Eggs hatch 3–4 days after being laid, instar 1 and 2 bore the pod shells, bore the seeds and live in the seeds. Furthermore, it is said that the last instar larva has a size of 13–15 mm with a width of 2–3 mm. This last instar turns into a pupa 8–10 mm long and 2 mm wide which forms in the soil. The pupae will turn into moths after 9–15 days.

The level of damage to pods due to *E. zinckenella* T. pests was different for each soybean variety. This is evident from the results of research by Rahman and Fattah [32], the level of damage to soybean pods due to pod borer *E. zinckenella* T. attacks was the highest in Detam-1 (15.71%), then followed by Dering (14.5%), Kaba (11.30%, Burangrang (10.60%), Gema 10.0, Detam-2 (9.20%), Tidar (9.10%) Argomulyo 8.20%, Grobogan 7.10%, and Anjasmoro 6, 70%. According to Baliadi et al. [43] argued that female imago disinterest in laying eggs on host plants plays an important role in the resistance of soybean varieties to pod borer. Furthermore, it is said that trichomes have a negative effect on the number of eggs laid, but have a role important in the mechanism of resistance to pod borer. The average density of trichomes in pods of Wilis variety was 10 mm^{-1}, lower than those in the IAC-100 and IAC-80-596-2 lines, respectively 25 and 22 mm^{-1} so that the genotype it is more resistant than Wilis. Bayu et al. [44] suggest that wa genotypes IAC 100 and G100H had the lowest pod and sed attack rates and were categorized as resistant to *E. zinckenella* T. attack. Furthermore, it was said that this happened because the *E. zinckenella* T. imago did not like laying eggs in both genotypes because they had hard pod skin and dense trichomes. Furthermore, it is said that in addition to the two genotypes having non-preferential characteristics, it is also suspected that the two genotypes have secondary compounds which are not preferred by *E. zinckenella* T. imago as a place to lay eggs. According to Poniman et al. [20], the Argomulyo variety had the highest trichomes (24.75) compared to Demas (8.0), Dega-1 (15.50), Dena-1 (15.00), Dering 16.0) and Gema (21.50) so that Argomulyo has the lowest population of *E. zinckenella* T. pod borer larvae (8.0 larvae).

6. Pod-sucking pests *R. linearis* F

The *R. linearis* pest is an important pest in Indonesia. According to Marwoto [45], one of the important factors in soybean is *R. linearis* F. and can cause pod damage by about 15–20% when pods are formed and filled. Furthermore, Prayogo and Suharsono [18] suggested that the level of damage to the seeds was also influenced by the location and number of punctures in the seeds, while the attack of *R. linearis* F. in the pod formation phase caused the pods to dry and fall and in the pod growth phase and seed development it caused pods and seeds to collapse later pods dry up and eventually fall off. Furthermore, Asadi [46], the loss of soybean seed due to *R. linearis* F. attack can reach 79% depending on the type of genotype or variety. Furthermore, it was said that the genotypes GM425 Si and TGM131–1-1-1B had the lowest *R. linearis* F. attack rates, respectively 11% and 14%, pods were attacked by 19% and 20%, respectively, and seeds were attacked by 11% and 14%, respectively. The attack of pod pods on soybeans on farmers' land is largely determined by the type of variety the farmer is growing. According to Sarjan and Sa'i [47], the attack rate of *R. linearis* F. pod suckers varied greatly from the lowest, namely Burangrang 17.69–22.35%, then followed by Anjasmoro 26.31–29.07%, Grobogan 31.92–37.88%, Argomulyo 35.83–38.32%, Panderman 42.63–72.87%, Kaba 44.79–85.77%, and 54.89–86.87%. Furthermore, it was said that the low rate of pod sucker attack on Burangrang was one of the causes was the high length of pod trichomes in these varieties. The following is the length of the pod trichomes of each variety from highest to lowest Burangrang 1.54–1.59 mm^2, Anjasmoro 1.26–1.29 mm^2, Panderman 1.13–1.28 mm^2, Argomulyo 1.20–1.24 mm^2, Grobogan 1.20–1.26 mm^2, Kaba 1.22–1.26 mm^2, and Tanggamus 1.18–1.24 mm^2 [47]. According to Sunarno [48], the IAC-100 variety had a higher number and length of trichomes 1.90 mm and 13.1 per mm2, respectively, having a lower number of stylet punctures per seed 5.48 and 6, respectively. 33 imago phases, while the MGL 2979 variety had a low length and number of trichomes, respectively 1.0 mm and 4.90 per mm2, having a higher number of stylet punctures per seed 12.62 nymph phases and 9.31 phases, respectively. Imago.

7. Conclusion

South Sulawesi Province is one of the centers for soybean development in Indonesia. Farmers develop new high yielding varieties such as Anjasmoro, Argomulyo, Grobogan, Dering, Gema, Deja-2, Dena-1 Dega-1, Detap-1, and Detam-1. The level of leaf damage caused by *S. litura* F and pod damage caused by *N. viridula* L. and *E. zinckenella* T. varies greatly depending on the level of resistance of each variety. The level of leaf damage caused by *S. litura* F was the highest in Anjasmoro (10.94–32.69%) and the lowest was in the Grobogan variety (8.61–24.81%). The level of pod damage due to the attack of *N. viridula* L. was the highest in the Burangrang variety (13.20%) and the lowest in Anjasmoro (7.70%). The level of pod damage caused by *E. zinckenella* T. was the highest in Detam-1 (15.71%) and the lowest in Anjasmoro (6.70%). The rate of yield loss due to S. litura F. was the highest in the Anjasmoro variety (8.97%) and the lowest was in Argomulyo (6.77%). The results of this paper are expected to be a reference or guideline for farmers in South Sulawesi in choosing superior soybean varieties for growing crops.

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Conflict of interest

All authors claim to have no conflicts of interest.

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