The intensity of attacks and the use of insecticides by farmers in controlling soybeans pests for various agroecosystems in South Sulawesi

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Abstract. The types of pests that attack many soybean plants in South Sulawesi are armyworms, aphids, pod suckers and pod borer. This study aims to determine the level of pest attack and the use of insecticides at the farm level of soybeans. Inventory research on the intensity of major soybean attacks was carried out in 2016/2017 in many agroecosystems/vegetation spread across 3 districts, Wajo, Jeneponto, and Bulukumba Districts. The three districts are centers of soybean cultivation with diverse agroecosystems/vegetation. The results achieved showed that the intensity of the main soybean attack was highest in the monoculture vegetation (Wajo District), respectively Spodoptera litura armyworm (45.65%), pod borer (Etienlla zinkenella) (31.26%), aphids (20.15%), and pod suckers (26.13%). Whereas in the polyculture area of coconut + soybean plants (Bulukumba Regency), the rate of pest attacks were respectively: armyworm S. litura (22.13%), pod borer, E. zinkenella (18.12%), aphids (10.12%), and pod suckers (16.19%). In the polyculture area of palm + chili + soybean (Jeneponto Regency), the rate of pest attacks were: S. litura armyworm pest (19.11%), pod borer (15.17%), aphids (14.28%), and pod suckers (11.13%). The highest use of insecticides in monoculture agroecosystems (8.1 l ha\(^{-1}\) per season) and the lowest in soybean + chili + palm tree agroecosystems (1.5 l \(\text{ha}^{-1}\) per season). Polyculture farming on soybeans will reduce the use of insecticides at the farm level, so as to create an environmentally friendly agricultural model compared to monoculture agroecosystem.

1. Introduction
Soybean is one of the commodities that are widely planted by farmers both in wetland and dry land. Soybean productivity achieved in Indonesia is still very low at around 1.30 t ha\(^{-1}\), while in South Sulawesi around 1.8 t ha\(^{-1}\) and productivity is still very low compared to the national potential of around 2.2 t ha\(^{-1}\) [2]. One cause is the high attack of pests on soybeans. In the tropics, there are 60 types of insects that cause damage to soybeans [13]. While in India there are around 150 species of insects that can cause severe damage to soybeans from the time of planting to harvest [3]. Whereas in Indonesia, there are 17 types of pests that can cause damage and losses to soybean plants. Among others: Ophiomyia Phaseoli, Spodoptera litura, Phaedonia inclusa, Etiella zinckenella, Riptortus linearis, and Nezara viridula [11]. So Marwoto et al. [8] pests that attack many plants in soybeans include S. litura, Riptortus linearis F., Nezara viridula, Etiella zinckenella T., Lamprosema indicata, Aphis glycines, and Bemisia tabaci. Whereas Sari and Suharsono [14], pod sucking pests that attack soybeans include Piezodorus hybneri, Riptortus sp. and Nezara viridula.
The level of damage caused by attacks is very varied in each region depending on the form of friction and the climatic conditions of the area. According to Oerke [10] soybean yield loss due to pest attacks can reach 26-29%. Rahman and Fattah [12], the intensity of pod borer *E. zinkenella* (15.71%), pod suckers (13.21%), and armyworm *S. litura* 16.21%. The level of damage to soybean leaves due to the attack of *S. litura* in Indonesia is around 23-45% Adie et al. [1]. According to Susanto and Adie [15], armyworms of *S. litura* can cause a decrease in the yield of around 90%, so the soybean yields in South Sulawesi due to attacks by armyworms around 10.45-18.01% [5].

To overcome the damage caused by these pest attacks in South Sulawesi, farmers still rely heavily on insecticides that are applied regularly starting from the vegetative until generative phase with a frequency of 2-3 times per ha so that insecticide use by farmers can reach 8-12 l ha$^{-1}$ per season [6]. This is if allowed to happen continuously, it can cause negative impacts, including disruption of environmental sustainability, the killing of useful animals, the emergence of secondary pests, the occurrence of pest resurgence, environmental pollution such as water, soil, and air.

To avoid environmental damage caused by the use of insecticides by soybean farmers, environmentally friendly control techniques are needed such as increasing plant diversity including the application of intercropping, crop rotation and planting of open land is needed to improve ecosystem stability and reduce the risk of pest attack [17].

2. Materials and Methods

Inventory research on the intensity of major soybean attacks was carried out in 2016/2017 in various agroecosystems/vegetation spread across 3 districts, namely Wajo, Jeneponto, and Bulukumba Districts. The three districts are centers of soybean cultivation with diverse agroecosystems/vegetation. In three districts there are 5 types vegetation: monocultur (soybean), coconut tree + soybean (polyculture), palm tree + soybean + chilli crop (polyculture), chilli crop + soybean (polyculture), soybean + corn (polyculture), palm tree + soybean (polyculture). The vegetation type is treatment (5 treatments) and farmers as replications (3 replications).

Parameters observed: the level of damage of soybean leaves in the vegetative and generative phase due to *S. litura*, the level of population density of pests and damage due to attack by Aphis, the density of *N. viridula* and the degree of pod damage due to attack by seed *E. zinkenella*, the amount of insecticide used by farmers in pest control per ha, average use of plant height, number of branches, and number of pods per plant and seed yield per ha.

Leaf damage intensity is calculated based on the following formula:

$$I = \frac{\sum_{i=1}^{x} n_{i} \times v_{i}}{Z \times N} \times 100\%$$

$I =$ Attack intensity

$n_{i} = Number \ of \ leaves \ observed \ at \ v_{i}$

$v_{i} =$ The value of leaf damage at the $i$ leaf

$N = Number \ of \ leaves \ observed$

$Z =$ The highest scale value to leaf damage

$1 =$Scale Value:

$0 =$ no damage to leaves

$1 =$ Leaf damage> 0 - 20%

$3 =$ Leaf damage> 20 - 40%

$5 =$ Leaf damage> 40 - 60%

$7 =$ Leaf damage> 60 - 80%

$9 =$ Leaf damage> 80 - 100%

All observed data were analyzed using variance analysis (ANOVA). The comparison of mean leaf damage intensity caused by pests and other parameters was made using the Duncan test at a 5% probability level.
3. Results and Discussion

3.1. The level of damage to leaves, pods and seed yields due to major soybean attacks

The intensity of leaf damage due to *S. litura* armyworm attack in the vegetative phase was highest in monoculture (soybean) vegetation (41.45%), followed by polyculture vegetation, soybean + corn (28.18%). Whereas the lowest is in the area of vegetation polyculture, palm tree + soybean + chilli crop, (13.19%). Accordance Fattah *et al.* (5), the intensity of *S. litura* armyworm attack on Kaba soybean varieties in four districts had different vegetation, namely in Wajo Regency, monoculture vegetation (17.16%), Pangkep Regency, polyculture vegetation (15.43%), Soppeng Regency, polyculture vegetation (14.59%) and Maros Regency has polyculture vegetation (11.01%).

**Table 1.** The average intensity of soybean leaf damage due to the attack of *S. litura* in the vegetative and generative phases

| Type of Vegetation                      | Damage intensity of *S. litura* (%) |
|-----------------------------------------|-------------------------------------|
|                                         | Vegetative phase | Generative phase |
| • Soybean (Monoculture)                | 41.45a           | 45.65a           |
| • Coconut tree + Soybean (Polyculture) | 19.45c           | 22.13c           |
| • Palm tree + Soybean + Chilli crop (Polyculture) | 13.19e | 19.11cd |
| • Chili crop + Soybean (Polyculture)   | 15.39de          | 17.21d           |
| • Soybean + corn crop (Polyculture)    | 28.18b           | 29.45b           |
| • Palm tree + soybean (Polyculture)    | 18.21cd          | 20.87c           |

The column number (followed by a similar letter) has no significant difference at 5% Duncan Test

**Table 2.** Average level of damage and aphids population density in soybean

| Type of Vegetation                      | Damage intensity (%) | The population of *Aphis sp* (ekor plant \(^{-1}\)) | Vegetative phase | Generative phase |
|-----------------------------------------|----------------------|---------------------------------------------------|-----------------|------------------|
|                                         |                      |                                                   | Vegetative phase | Generative phase |
| • Soybean (Monoculture)                | 20.15a               | 7.38a                                             | 8.13a           |
| • Coconut tree + Soybean (Polyculture) | 10.12d               | 5.36c                                             | 5.19b           |
| • Palm tree + Soybean + Chilli crop (Polyculture) | 14.28b | 3.18e | 4.26c |
| • Chili crop + Soybean (Polyculture)   | 11.23c               | 3.62e                                             | 3.19d           |
| • Soybean + corn crop (Polyculture)    | 15.25b               | 6.37b                                             | 5.31b           |
| • Palm tree + Soybean (Polyculture)    | 12.71c               | 4.42d                                             | 5.04b           |

The column number (followed by a similar letter) has no significant difference at 5% Duncan Test

The rate of attack and aphids population density was highest in monoculture vegetation areas (20.15%), 7.38 tails plant \(^{-1}\) (vegetative) and 8.13 tails plant \(^{-1}\) (generative), while the lowest aphids attack rate was in coconut tree + soybean crop vegetation areas (10.12%) (Table 2). The lowest population density of *Aphis sp* is on palm tree + soybean + chilli crop (3.18 tails plant \(^{-1}\)) and chilli crop + soybean (3.62 tails plant \(^{-1}\)) for vegetative vase. The different for the generative phase, the lowest population density of aphis is in the vegetation area of chilli crop + soybean (3.19 tails plant \(^{-1}\)).
The highest population of *N. viridula* was found in monoculture vegetation areas (5.19 tails plant$^{-1}$) and the lowest was in palm tree vegetation + chile crop + soybean (2.27 tails plant$^{-1}$). The highest rate of pod sucker attack on monoculture vegetation areas (26.13%) and the lowest in vegetated areas of palm tree + soybean + chilli crop and chilli crop + soybean respectively 11.13% and 11.24% (Table 3). The rate of attack of pod suckers is still lower than the rate of attack of pod suckers in Muneng, Probolinggo (16.33-36.83%) (14).

**Table 3.** Average population and intensity of damage due to attack by pod suckers and pod borer

| Type of Vegetation                        | The population of *N. viridula* (tail per m$^2$) | Damage intensity of pod suckers (%) | Damage intensity of *E. zinckenella* (%) |
|------------------------------------------|-----------------------------------------------|-----------------------------------|----------------------------------------|
| Soybean (Monoculture)                    | 5.19a                                         | 26.13a                            | 31.26a                                  |
| Coconut tree + Soybean (Polyculture)     | 3.69c                                         | 16.19c                            | 18.12c                                  |
| Palm Tree + Soybean + Chilli crop (Polyculture) | 2.27e                                      | 11.13e                            | 15.17d                                  |
| Chili crop + Soybean (Polyculture)       | 2.92d                                         | 11.24e                            | 13.01e                                  |
| Soybean + corn crop (Polyculture)        | 4.15b                                         | 20.53b                            | 21.28b                                  |
| Palm tree + Soybean (Polyculture)        | 3.12d                                         | 15.61d                            | 18.57c                                  |

The column number (followed by a similar letter) has no significant difference at 5% Duncan Test

The density of *N. viridula* population is positively correlated with the level of damage to pods, the higher the population density, the higher the level of damage caused by these pests. At a population density of 5 tails plant$^{-1}$, the level of damage to pods is around 26.13%, as well as population densities of 4 tails plant$^{-1}$, the level of damage caused by 20.53%. According to Sari and Suharsono (14), population density 4 pod suckers can cause damage to pods at the age of R5-R6 around 20.69%.

The level of soybean damage caused by *E. zinckenella*, the highest in soybean (monoculture) (31.26%) and lowest in Chilli + soybean (polyculture) (13.01%). This is in accordance with Aprianto et al. (4), the level of damage to pods on monoculture (soybeans) is higher (28.93%) compared to polyculture (soybeans + peanuts) (18.40%).

### 3.2. Vegetative and generative growth of soybeans

In Table 4, it can be seen that the soybean monokullture farming system shows higher plant height and is significantly different from other vegetation models. Likewise, the Chilli crop + Soybean (polyculture) vegetation model shows a higher plant height and is significantly different from the palm tree + soybean + chilli crop, soybean + corn crop, and palm tree + soybean vegetation models. The highest number of branches per plant, in the monoculture soybean vegetation, followed by the chilli crop + soybean vegetation.

The highest number of pods per plant in soybean monoculture. Whereas the chilli crop + soybean, soybean + corn crop, and palm tree + soybean vegetation were not significantly different. The lowest number of pods was found in palm tree + soybean + chile (50.97).
### Table 4. Average use of plant height, number of branches, and number of pods per plant

| Type of Vegetation                        | Plant height (cm) | Number of branches | Number of pods |
|------------------------------------------|-------------------|--------------------|----------------|
| • Soybean (Monoculture)                  | 77.47d            | 3.28c              | 63.35d         |
| • Coconut tree + Soybean (Polyculture)   | 64.86b            | 2.31a              | 53.21b         |
| • Palm tree + Soybean + Chili crop (Polyculture) | 62.48a           | 2.26a              | 50.97a         |
| • Chili crop + Soybean                   | 67.14c            | 2.61b              | 57.35c         |
| • Soybean + corn crop                    | 64.62b            | 2.34a              | 56.17c         |
| • Palm tree + Soybean (Polyculture)      | 62.46a            | 2.25a              | 54.45c         |

The column number (followed by the similar letter) has no significant difference at 5% Duncan Test.

#### 3.3. The use of insecticides at the farm level and soybean seed yields

The use of insecticides for soybean pest control is highest in vegetated areas of monoculture (8.10 l ha$^{-1}$) and the lowest in vegetated areas of palm tree + soybean + chili crop (1.50 l ha$^{-1}$). The use of insecticides in monoculture areas is quite high, but the level of damage to soybeans is still high. The use of insecticides in monoculture areas is quite high, but the level of damage to soybeans is still high. This is in accordance with Fattah et al. (7), the use of insecticides in soybeans around monoculture-vegetated Lake Tempe is quite high at around 24.0 l ha$^{-1}$ every season. The same is expressed by Tengkano and Suharsono (16), the use of insecticides by East Java farmers to control armyworm pests is quite high, but armyworm attacks still remain high above 12.5%. This is thought to be caused by unwise use of insecticides at the farmer level, resulting in the killing of natural enemies, the occurrence of resistant pests and pest resistance. The same thing was expressed by Maesyaroh (9), in order to preserve natural enemies, the use of insecticides at the farm level needs to be more prudent.

### Table 5. Average use of insecticides by farmers and soybean seed yields

| Type of Vegetation                        | Using of insecticide of farmers (l ha$^{-1}$) | Seed yield (t ha$^{-1}$) |
|------------------------------------------|----------------------------------------------|--------------------------|
| • Soybean (Monoculture)                  | 8.10a                                        | 2.36a                    |
| • Coconut tree + Soybean (Polyculture)   | 4.12c                                        | 2.00b                    |
| • Palm tree + Soybean + Chili crop (Polyculture) | 1.50c                                        | 1.43c                    |
| • Chili crop + Soybean (Polyculture)     | 2.99d                                        | 1.88b                    |
| • Soybean + corn crop (Polyculture)      | 6.15b                                        | 2.35a                    |
| • Palm tree + Soybean (Polyculture)      | 4.10c                                        | 1.98b                    |

The column number (followed by a similar letter) has no significant difference at 5% Duncan Test.

#### 4. Conclusions

Polyculture farming systems are more environmentally friendly than monocultures. This is evidenced by the low use of pesticides and low levels of attack and pest populations in the polyculture system. But the seed yields achieved by farmers in monoculture and polyculture (soybean + corn) were not significantly different.
References

[1] Adie M A, Krisnawati A, Mufidah 2012 Degree of resistance of soybean genotype to armyworm pest. National Seminar on Various Peanut and Bulb Crops Research Results. Increasing Competitiveness and Implementation of Peanut and Bulb Commodity Development Supporting Achievement of the Four Successes of Agricultural Development, Research and Development Center for Agriculture, IAARD: 29-36.

[2] Agricultural Research and Development Agency 2015 Report on Agricultural Research and Development Agency. Ministry of Agriculture.

[3] Ahirwar KC, Marabi RS, Bhowmick AK, Das SB 2013. Evaluation of microbial pesticides against major foliage feeders on soybean [Glycine max (L.)]. J. biopest 6 (2):144-148.

[4] Apriyanto D, O H Yoga and A Mulyadi 2009 Appearance of Soybean Pod Borer, Etiellazinckenella Treitschke (Lepidoptera: Pyralidae), and Selection of Hosts on Soybeans and Peanuts. Agrosia Deed Journal 12 (1): 62 - 67.

[5] Fattah A, S Syam, ID Daud, VS Dewi and Rahman 2018 The Intensity of Leaf Damage Caused by Attack of Spodoptera litura F and Seed Yield on Some Soybean Varieties in South Sulawesi Indonesia. Scientific Research J. 5: 1-6

[6] Fattah A, S Syam, ID Daud and VS Dewi 2018 The Type Caterpillar of Lepidoptera Ordo and Control Techniques by Farmers for Soybean in South Sulawesi. Scientific Research J. 5:55-60

[7] Fattah A 2018 Determination of the economic threshold of the Army gray caterpillar pest on several soybean varieties in South Sulawesi. Dissertation. Postgraduate School, Hasanuddin University, Makassar: 110 p.

[8] Marwoto, S Hardaningsih and A Taufik 2014 Pests, diseases, and nutrient problems in the soybean plants. Book. Agriculture Research and Development Agency. Ministry of Agriculture, Indonesia: p 77

[9] Maesyaroh S S 2012 The role of predators and other natural enemies in the carrot agroecosystem in the Ckajang region, Garut Regency. Essay. Department of Plant Protection, Faculty of Agriculture, Bogor Agricultural Institute: p 41

[10] Oerke EC 2006 Crop losses to pests. Journal of Agricultural Science 144: 31–43.

[11] Radiyanto I, M Sodiq, Noeng and Nurcahyani 2010 Diversity of Natural Pest and Enemy Insects on Soybean Planting in Balong-Ponorogo District. Entomol Journal. Indon. 7 (2): 116-121.

[12] Rahman and Fattah 2014 The potential for some best practices is second only to the second in South Sulawesi. Proceedings . National Seminar on Results of Peanut and Goat Crops Research. Agricultural Research and Development Agency: 43-48.

[13] Panizzi AR and Ferreira BSC 1997 Dynamics in the insect fauna adaptation to soybeans in tropics. Trends in Entomology 1: 71-88.

[14] Sari KP and Suharsono 2011 Status of pod sucking pests in soybeans, areas of spread and methods of control. Palawija Bulletin, 22: 79-85.

[15] Susanto GWA and M Adie 2015 Identification of phenotypic small lines on resistance to attack by armyworm pests (S. litura F.). J. HPT Tropika 15 (2): 180 – 187

[16] Tengkano and Suharsono 2005 Armyworm S. litura on soybean plants and its control. Palawija Bulletin 10: 3-52

[17] Tobing MC 2009 Biodiversity and management of pest insects in the ecosystem. Speech of Inaugural Position of Permanent Professor in Entomology, Faculty of Agriculture, University of North Sumatra: p 35