Attack intensity of pest in the vegetative phase of Atlantic potato variety in three different altitudes

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Abstract. Potato plants are grown well in the highlands and have the potential to grow at different altitudes. One of the challenges in growing potatoes is pest attack during plantations, especially during the vegetative phase. The study aims to determine the attack intensity of potato pests on Atlantic variety at three different altitudes. This study was conducted in the Sembalun District, East Lombok, in three different locations, namely Sajang Village (at ca. 900 m asl), SembalunBumbung Village (at ca.1000 m asl), and SembalunLawang Village (at ca.1200 m asl) from March to June 2021. The plantations were maintained according to the standard maintenance of potato plantation farmers in Sembalun, and data was collected on a two-week basis. The research method used was an experimental method based on a Randomized Block Design (RBD). The sampling of potato plants was done using systematic random sampling. The results showed that the highest attack intensity of pests in the vegetative phase was observed nine weeks after planting, where the plants were suitable for the foliar pest. Altogether, potato plantation in SembalunBumbung had the highest attack intensity than in SembalunLawang and Sajang village. Further research is needed to examine the resistance of several varieties of potato in different altitudes and different seasons to attack the intensity of pests.

1. Introduction
Potatoes have a crucial role in feeding society worldwide and have become the alternative source of carbohydrates in developing countries. Their popularity in Africa and Asia grew in the last 30 years, which previously relied on other staple crops. Potato is also a tuber vegetable that has great potential to support food diversification programs and is widely consumed as a food source by the world community. In Indonesia, the potato has become an alternative food substitute for rice [1,2].

Potatoes one of the largest productions alongside the other five seasonal vegetable commodities in Indonesia. The population of society in Indonesia continues to grow, so that the demand for vegetables, including potatoes, is also increasing. The annual potato production in Indonesia has fluctuated over the past 10 years and declined from 2015 to 2017. However, potato production had risen by 10.31% in 2018 compared to 2017 [3]. In West Nusa Tenggara, potato production was still lower than in other major Indonesian provinces [3, 4], so development methods are required to increase potato production. An alternative approach that can be used is to plant at different altitudes.
Potato plants are grown well in the highlands but have the potential to grow at different altitudes. Differences in altitude have different environmental and climatic conditions that influence the condition of the potato plants and pest, especially during the vegetative phase. The pest that attacks during the vegetative phase is divided into some criteria, i.e. leaf-miner insect, leaf-sucking insect, and leaf-feeding insect. One of the potato plant pests spreading in several countries is the leaf miner fly (*Liriomyza huidobrensis*). This fly was recorded worldwide, which is associated with the global trade of ornamental plants [5].

Moreover, some of the important barriers potatoes face can be changes in the growing environment in the form of biotic and abiotic restrictions during the vegetative phase. Biotic restrictions in the form of pests that limit potato production in Indonesia include leaf rot (*P. infestans*), bacterial wilt disease *Ralstonia solanacearum*, yellow cyst nematode, leaf sucking pests, and soil pests. Abiotic restrictions: high temperature and scarcity of water sources [6]. These restrictions can cause significant yield losses. It is therefore important to examine the pest infestation at different altitudes to estimate their infestation intensity.

2. Materials and methods

2.1 Location and time

This study was conducted in the Sembalun District, East Lombok, in three different locations, namely Sajang Village (at ca. 900 m asl), Sembalun Bumbung Village (at ca. 1000 m asl), and Sembalun Lawang Village (at ca. 1200 m asl) from March to June 2021.

2.2 Methodology and observation

The plantations of potatoes were maintained according to standard maintenance of potato plantation farmers in Sembalun, and data was collected on a two-week basis. The variety of potato used in this study was Atlantic variety. The research method used was an experimental method based on a Randomized Block Design (RBD). There are four blocks of plantation in every altitude which have 72 potato plants. The sampling of potato plants was done using systematic random sampling, and twelve of potato plants were observed in each altitude to measure the attack intensity of pests.

2.3 Data analysis

Attack intensity was calculated by using a formula:

\[ I = \frac{\sum (n,v)}{Z.V} \times 100\% \]

| Scale | Value          |
|-------|----------------|
| 0     | If there is no leaf attack | 0 %   |
| 1     | If there is leaf attack    | 1% - 25% |
| 2     | If there is leaf attack    | 26% - 50% |
| 3     | If there is leaf attack    | 51% - 75% |
| 4     | If there is leaf attack more than | 75%   |

Table 1. The scale of pest attack intensity value [7]
To examine the variation of attack intensity in every observation time; we used the ANOVA test (Analysis of variance). If the analysis was significantly different, we continue with the Tukey test (with 95% confidence level) among altitudes and among observation time.

3. Results and discussion

The results showed that the highest attack intensity of pests during the vegetative phase was observed 9 weeks after planting. This was due to the availability of sufficient food and an environment that supports leaf pests on potato plants. In the vegetative phase, the plant has leaves that still contain a lot of water, which is favored by pests. The microhabitat of plants with moisture also supports the development of pests on the potato plant. Direct observations indicated that some pests have found a dominant pest attack potato plantation in vegetative phase, i.e. leafminer fly (*Liriomyza huidobrensis*), *Thrips palmy*, *Myzus persicae*, and *Bemisia tabacci*. Some of these pests are pests that affect potato plants in different regions of Indonesia. Recent years research in Sembalun have found five types of sucking pests that infest several varieties of potatoes. These important pests include *Bemisia tabaci*, *Aphid spp.*, *Planococcus sp.*, and *Tetranychus spp.* [7]. In the other country, five major pests that attack potato plants in Nepal, namely *Myzus persicae* (Suzler), *Liriomyza huidobrensis* Blanchard, *Agrotis ipsilon*, *Helicoverpa armigera*, and *Epilaccus virgintioctopunctata* (Fab.) [8].

Altogether, pest attack intensity was significantly different in the three altitudes during observation (Table 2). In tropical countries, attack intensity of pest is high due to year-round favorable climatic conditions for pest population growth and the availability of host plants. Slight temperature changes will have substantial consequences on pest growth compared to temperate regions due to already higher current metabolism rates of organisms such as insects [9, 10]. In addition to the temperature, the vegetation around the study area also has an influence on the occurrence of pests on potato plants. Surrounding plants can serve as a habitat for pests. So, this state affects the diversity of pests that attack potato plants.

| Day Observation | Analysis of Variance (ANOVA) |
|-----------------|-------------------------------|
| Day 28          | $F_{2,6}=105.6, P=2.11e-05^{***}$ |
| Day 42          | $F_{2,18}=5.484, P=0.044^*$     |
| Day 56          | $F_{2,18}=5.577, P=0.042^*$     |

The intensity of pest attacks is generally influenced by altitude. The temperature difference at different altitudes is an important factor affecting the development of pests, so they can increase the spread and outbreak of pests [11]. The results in Table 3 and Figure 1 show that the intensity of the pest attack between Sembalun Lawang and Sembalun Bumbung showed a significant increase from the fourth week after planting. However, both sites showed different intensity of pest infestation in Sajang. This difference in attack intensity is assumed to be influenced by several environmental factors, namely rain intensity, temperature, and humidity. The precipitation from March to April is quite high at 150-910 mm and the temperature range in East Lombok is between 19 °C and 35 °C [12]. Potatoes grow productively in the highlands and in the mountains with ideal air temperatures of 15-18 °C at night and 24-30 °C during the day. The altitude suitable for growing potatoes is around 1200-1500 m above sea level for high yields [13]. According to the other study [11], several pests that attack potatoes plant during vegetative phase are...
the potato tuber moth (PTM) (*Phthorimaea operculella*), the pea leafminer (*Liriomyza huidobrensis*), the Andean potato weevil (genus *Premnotrypes*), the potato psyllid *Bactericera cockerelli*, bud midge *Prodiplosis longifila*, the Colorado potato beetle *Leptinotarsa decemlineata*, and the green peach aphid, *Myzus persicae*.

**Table 3.** The attack intensity of pest among three different observation times in three altitudes

| Location         | Average of AI (Day 28) + SD | Average of AI (Day 42) + SD | Average of AI (Day 56) + SD |
|------------------|-----------------------------|-----------------------------|-----------------------------|
| 1. Sembalun Lawang (SL) | 3.852 ± 0.411 a             | 4.147 ± 0.367 ab            | 6.636 ± 1.811 a             |
| 2. Sembalun Bumbung (SB) | 5.631 ± 0.436 b             | 6.643 ± 1.327 a             | 4.960 ± 0.566 ab            |
| 3. Sajang (S)     | 0.848 ± 0.372 c             | 3.681 ± 1.505 b             | 3.517 ± 0.574 b             |

* The numbers followed by the same letters show results that are not significantly different according to Tukey test 5% (between rows).

![Attack intensity during observations in three different altitudes](image.jpg)

**Figure 1.** Attack intensity during observations in three different altitudes (SL: Sembalun Lawang; SB: Sembalun Bumbung and S: Sajang).

4. **Conclusion**

In conclusion, altitude affects attack intensity of pests in the vegetative phase of potato. Potato plantations in Sembalun Bumbung had the highest attack intensity among the others (Sembalun Lawang and Sajang village). Lastly, further research is needed to examine the resistance of several varieties of potato in different altitudes and different seasons.

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