Intensity of pest attack and yield of potato plant during off-season in Sajang Village, Sembalun District, West Lombok

M Sarjan¹, A Jihadi², Kisman ² and A Nikmatullah²

¹Postgraduate, University of Mataram, Jalan Pendidikan no. 37, Mataram, 83127, Indonesia
²Faculty of Agriculture, University of Mataram, Jalan Majapahit 62 Mataram, 83127, Indonesia

Aluh_nikmatullah@unram.ac.id

Abstract. Pests and diseases attacks are major limitation for white potato (Solanum tuberosum L.) production, and therefore intensive treatments are employed during the cultivation. There is an increasing constraint of the intensive pest control to sustainable potato production and environmental impacts; therefore it is crucial to select suitable cultivar, particularly for the rainy, off-season cultivation, at which production is scared. This research evaluated the intensity of pest attack and yield of two variety of white potato, designated as cv. Chitra and Atlantic, during rainy season. Experiment was conducted in Sajang Village, of Sembalun District, West Nusa Tenggara from March to June 2021. In the field, the plants were maintained according to common maintenance employed farmer in Sembalun, and data collected at two weekly basis. The results showed that symptom of pest attached was visible since the plants was 4 weeks old with no real different intensity between the two variety. A higher rate of pest intensity was recorded in Chitra variety compared to the Atlantic. However, the yield of the two varietie was not differing significantly. The results indicated that the two varieties could be cultivated during off-season and insects are not a major problem during off-season that limits potato plant growth and production in Sajang Village. Further study is needed to evaluate the potential cultivation of the two varieties whole year.

1. Introduction
Potato is important crop in the world. It ranks as the forth most important staple foods after rice, corn and wheat. In Indonesia, potato is increasingly important due to the increased demand and popularity. The consumption of potato has increased by 13.9% from 2014 to 2018 [1], however the national production of potato in Indonesia has not changed for the last 10 years, at about 1.2 to 1.3 millions ton per year [2]. The increase of potato consumption indicates an increase demand, and this is due to many factors including a change in consumption preference patterns of younger generation, from rice only to include potato as a staple foods.

To meet the increased demand of potato required by food and food services industry (designated as industry-type potato), the Indonesian government allowed importation of industry-type potato (in fresh and processed forms). In 2019 and 2020, the amount of imported potato was ca. 8,000 ton per month valued US$ 10,000,000 [3]. This data indicates that the production of industry-type potatoes in Indonesia is much lower than the demand, which keep increasing yearly.

The plantation of industry-type potato in Sembalun District has been taken places for more than 15 years, utilising the Atlantic variety. However, the cultivation is limited by availability of seed tuber of Atlantic, which was imported from the producing country such as Australia, Canada and Scotland.
More recently, the imported seed tubers become more difficult to obtain since the variety has no longer been produced overseas. Recently, there is a new variety of industry-type potato, designated as Chitra variety released by Indonesian Government. The Chitra potato variety is bred from the cross of Atlantic and Lindsay, and was originally introduced from Australia [4] The variety has very similar characters as Atlantic with the flowering starts at 40-45 days after planting and the harvest age of 100-110 days after planting. It is described that the Chitra, as for Atlantic too, is suitable for planting in the dry season [4].

Potato plants are generally cultivated at the end of the rainy season, because potato plant is sensitive to both excess and lack of water [5]. On the other hand, the industry needs continuous supply of the commodity, both in adequate quantity and quality. Therefore, it is necessary to develop cultivation of potato throughout the year, including during the rainy season. Season will affect both growth and quality of potato produced [6],[7], [8], and therefore it is necessary to select suitable cultivar for out-season production of potato.

The response of potato plant to season and quality of tuber produced by the potato plants is influenced by the genetic characters of the variety [6]. Although the two varieties is claims to be most suitable during dry season, it is necessary to seek possibility for plantation during off-season, to meet the demand. Plantation of potato during rainy-season may be beneficial in order to reduce the intensity of pest and disease control, and thus producing potato tubers with less chemical insecticidal treatments. Many reports published relationship between season and the abundance of pests, and shown changes in pest population dynamic during rainy season [9]. These relationship is important to examine in order to develop suitable cultivation practices for whole year cultivation of industry-type potato plants in NTB.

2. Materials and Method

2.1. Experimental Design, Place and Site
The experiment was designed according to a Randomized Block Design (RBD) with a single factor of two potato varieties: Chitra and Atlantik, with 6 replications. The study was conducted in Sajang Village of Sembalun District, East Lombok (at ca. 900 m asl), Sembalun Bumbung Village (at ca. 1000 m asl) from March to June 2021.

2.2. Plantation Establishment
Each plot comprised of 4 planting beds (1 m x 1.5 m x 0.3 m), and there were 24 of planting beds for each treatments. Before the plantation, the land used for the experiment were ploughed (twice, in a week interval) and 150 kg of Dolomite and 300 kg of organic fertilizer (Pertoganic) was added and mixed with the soil (for 10 acre) to increase the soil pH from 5.0 to 6.0 and increase the organic matter in the soil. The distance between each bed in the block was 30 cm, and intra block was 40 cm. Before planting, insecticide Furadan 3G (20 kg/Ha or 4.5 g/bed) and NPK Ponska fertilizer (300 kg/ha or 67.5 g/bed) was applied, and the beds were covered with a plastic mulch and watered. The planting hole were made just before plantation (using a sharpened-wood) at ca. 15 cm depth, two row per bed (70 cm distance) and 30 cm intra-row space. The seed tubers were planted, with the stem faced upward (one seed per hole), and then covered with soils, and watered. At 5 weeks after planting, the plants were fertilized with NPK Ponska and ZA (350 kg/ha, each). The plants were routinely sprayed with insecticide and pesticide (once a week) and weeded 5 times (at 2 weeks interval). The plants were harvested at 9 days after planting.

2.3. Observation
The attack intensity data was collected at two-weekly basis. The sampling of potato plants was done using systematic random sampling. Twelve of potato plant was observed in each variety to measure the attack intensity of pest.
Attack intensity were calculated by using a formula:

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

**Table 1.** The scale of pest attack intensity value.

| 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% |

The yield and yield quality were examined after harvest at 90 days after planting. The parameters observed were number of tuber per plant, weight of each tuber, yield per plant (weight of tuber per plant). Yield per m² (calculated from yield per plant x number of plant per m²), estimated yield per ha (calculated from yield per m² x 10.000 m² x 0.7), length of each tuber and wide of each tuber.

2.4. **Data Analysis**

All data were analyzed for difference according to Student t-test to compare the difference in pest intensity and yield of the two varieties.

3. **Results and Discussion**

The number of rain (rainy day) in Sajang Village was recorded during the course of experiment while average day and night temperature for each month was obtained from AccuWeather [10], and presented in Table2.

**Table 2.** Number of Rainy Day, Average Day Temperature and Average Night Temperature in Sajang Village of Sembalun District from April to June 2021.

| Month | Number of rainy day | Average Temperature (°C)* |
|-------|---------------------|----------------------------|
|       |                     | Day | Night |
| March | 22                  | 32  | 23    |
| April | 23                  | 31  | 22    |
| May   | 10                  | 32  | 20    |

*Data obtained from AccuWeather

Sajang is a village in Sembalun District of East Lombok, West Nusa Tenggara. Sajang village has been classified to have rather dry climate (type E) according to climate classification by Smith & Ferguson [11] with 3 - 4 months of rainy season between December to April and 8 to 9 month of dry season (between May to Nopember). In Sajang village, there were 22 rainy days in Mach, 23 rainy day in April and 10 rainy day in May with average day temperature from March to May 2021 was 31 - 32°C and night temperature of 20 – 23 °C (Table 2). The number of rainy days suggest that plantation of potato in this experiment was undertaken during the rainy-season which is considered as off-season for potato plantation.

Intensity of pest attack in the two varieties, Chitra and Atlantic, was examined from the initial stage of plant growth to 8 weeks after planting. There are four kind pest found during the plantation, that were leafminer fly (Liriomyza huidobrensis), thrips (Thrips palmy), leaf mite (Myzus persicae) and whitefly (Bemisia tabacci). Thrips, leaf mite and whitefly are common leavesucking insect in potato...
plantation including in Sembalun [12], [13], [14]. The leafsucking insect attack may cause a significant lost if the population is not control appropriately, as it can damage the leaves, reduce area for photosynthesis and also potential as the vector for potato viral diseases [11], [12], [13]. In addition to the leaf sucking pests leafminer fly (Liriomyza huidobrensis) is also important pest during potato plantation which can cause major lost during plantation [14], [15], [16].

In this experiment, the population of each pest was not examine, and observation was undertaken to evaluate the intensity of attack in the leaves of the two varieties of potato plants (Figure 1). The emergence of shoots from the potato tuber was visible since the plant was 7-14 days old, and at that time, there was no symptom of pest attacked observed in the newly emerging leaves. The damage in leaves was visible since the age of 28 days, with initial intensity of 0.9% to 1.1%. In both varieties, intensity of pest attack increased at the age 42 days after planting, with the rate of 3.8% in Atlantik variety and 4.3% in the Chitra. However, the intensity of pest attack was not increase as the plant age increase to 56 day. The intensity of these four pests attack in the Chitra and Atlantik varieties was considered low (less than 5%), with no significant different between the intensity of attack in Chitra and Atlantik varieties.

![Graph showing the intensity of pest attack](image)

**Figure 1.** The intensity of pest attacked during off-season plantation of Chitra and Altantic potatoes in Sajang Village of Sembalun.

In the study by Mujica & Kroschel [17], the important stage of controlling potato pest causing foliar injury was in the flowering and tuber formation. The intensity of leaf injury by leafminer fly of 21 - 74% at these developmental stages will cause a significant economic lost, and the rate is depending on the variety. The economic injury level for variety Desire is 21 - 28% while for variety Tomasa is 55 - 74%. In this experiment, the incident of injury by each pest was not evaluated, and for future works, it will be necessary to examine the intensity of foliar injury and population of each pest to obtain more information of which pest is dominant and should be considered for management of pest during potato plantation in off-season.

The yield and yield quality of Chitra and Atlantic during the rainy season under these intensity of pest attacked were examine, and the data is presented in Tables 3 and Tables 4.

| Variety | Weight per tuber (g) | Yield per plant (g) | Yield per m² (kg) (estimated) | Yield per hectar (ton) (estimated) |
|---------|---------------------|---------------------|-----------------------------|----------------------------------|
| Chitra  | 110.45 ±10.33       | 790.72 ±31.21       | 3.77 ±1.49                  | 26.40 ±1.04                      |
| Atlantic| 121.98 ±13.24       | 850.50 ±36.76       | 4.05 ±1.76                  | 28.40 ±1.23                      |

**Table 3.** Yield of Chitra and Atlantic varieties during off-season in Sajang Village of Sembalun.
Both variety can adapt well and produce high yield in Sajang Village during the rainy season, with Atalantic variety produced a higher yield. The weight of each tuber produced by the Chitra was ca. 110 g and the Atlantic was ca. 120 g. Each of the Chitra plant was able to produce ca. 790 g of tuber (ca. 3.8 kg per m²) while the Atlantic produced ca. 850 g of tuber per plant (ca. 4.1 kg per m²). The potential yield of Chitra variety during rainy season in Sajang was 26.4 tons/ha, and the Atlantic was 28.4 tons/ha. The yield consider high at it was similar to the yield of the two varieties during optimal growth seasons. The potential yield for Chitra variety is 25.58 – 26.33 tonnes/ha [4] and Atlantic of 8 – 20 tonnes/ha [18].

Table 4. Quality of tuber produced by Chitra and Atlantic varieties during off-season in Sajang Village of Sembalun.

| Variety | Number of tuber per plant (tuber) | Length of tuber (cm) | Wide of tuber (cm) |
|---------|----------------------------------|----------------------|-------------------|
| Chitra  | 8.22± 0.64                       | 8.00± 0.22           | 5.97± 1.09        |
| Atlantic| 9.00±0.86                        | 7.79±0.69            | 6.19± 0.80        |

Both varieties showed no significant difference in the number of tubers, length of tuber and wide of tuber produced during the rainy season in Sajang Village. The Chitra variety produced 8.22 tubers whilst the Atlantic produced 9.00 tuber per plants, with standard error of 0.64 to 0.86. The tubers were oval in shape with length of 7.79 cm in the Atlantic and 8.00 in the Chitra (standard error of 0.22 and 0.69), and wide of 6.19 cm in the Atlantic and 5.97 in the Chitra plants (standard error of 0.80 and 1.09).

Taken together the data suggests that both Chitra and Atlantic variety adapts well in Sajang Village during the off-(rainy) season with high yield (similar to the potential yielded during optimal season). The calculated/predicted yield of potato plants in Sajang village during rainy season was 26.4 tons/ha for the Chitra, and 28.4 tons/ha for the Atlantic. In addition, the yield was not greatly affected by pest attacked, as the intensity of pest attacked was low.

4. Conclusion
The intensity of pest attack in both Atlantic and Chitra varieties cultivated during off(rainy)-season in Sajang Village was low, that was less than 5 % at the peak vegetative growth. There was no different pest attack intensity between the Atlantic and the Chitra varieties during off(rainy)-season in Sajang Village. Under such pest attack intensity, both varieties were able to grow and produce high tuber yield with good characteristics during off(rainy)-season in Sajang Village, with Atlantic had a slightly higher yield than the Chitra.

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