# Symptom Variation and Disease Severity of *Sweet potato leaf curl virus* on Sweetpotato in Gianyar, Bali

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***ABSTRACT***

*Sweet potato production fluctuates every year, one of the factors causing the decline in production is the presence of pests and diseases. Sweet potato leaf curl virus (SPLCV) has been reported to infect sweet potatoes in Indonesia in 2022. Until now, there is no information regarding the variation in symptoms and severity of SPLCV disease in sweet potatoes. Therefore, this study aims to analyze the variation in symptoms and severity of SPLCV disease in Gianyar, Bali. The research was carried out directly in the field with observational parameters such as symptoms variation, incidence and disease severity. Observations were made every week when the plants were 63 to 91 days after planting (DAP). The results showed that SPLCV causes a variety of symptoms in the form of mild vein clearing, severe vein clearing, upward vein clearing, and downward vein clearing. The incidence and severity of the disease has increased every week. The incidence and severity of the disease were highest when the plants were 91 DAP, namely 73.33% and 40%, respectively. The high incidence and severity of the disease in the field is due to the use of stem cuttings from previous plants which may have been infected with SPLCV and whitefly vectors are always found in the field.*

***Keywords****: Begomovirus, disease incidence, SPLCV, whitefly*

## INTRODUCTION

Sweet potato (*Ipomea batatas* L.) is one of the source of carbohydrates main commodities after rice, corn, and cassava (Setyaningsih & Nurul 2017). Sweet potato is crucial in providing food, industrial raw ingredients, and feed. Sweet potato also contains nutrition that are beneficial for health, such as beta carotene and anthocyanin which prevent cancer, and also rich in vitamins A and C (Ministry of Food Crops Agriculture, 2016). Regarding nutrition, sweet potato is generally dominated by carbohydrates which may reach 27.9% in 68.5% water content (Alam 2021).

The sweet potato harvest area in Indonesia expands 229 hectares every year, spread in all provinces on both rice fields and moorlands with an average national production of 10 tons/ha. Sweet potato is one of the highly potential plants in Indonesia. The main sweet potato producers in Indonesia are Java and Irian Jaya which hold around 59 percent of the portions (Ministry of Food Crops Agriculture, 2016).

Sweet potato production in year 2015, 2016, 2017, and 2018 are 2.298, 2.169, 2.023, and 1.914 tons respectively (Central Bureau of Statistics, 2019). According to the Agriculture and Food Security Agency of Bali Province (2021), the sweet potato production in Bali on 2016, 2017, 2018, 2019, and 2020 are 42.952, 35.225, 21.880, 22.130, and 26.821 tons respectively. Based on that data, sweet potato production fluctuates every year. Factors that can cause sweet potato production to drop are decreasing planting area, cultivation method, and the presence of pests and diseases attacking the sweet potato plants. Moreover, the sweet potato plants on the field show many unhealthy symptoms akin to plant virus infections. Efforts are required to overcome the hindering factors, such as virus spread which is the main factor for production loss.

Crucial viruses infecting sweet potatoes in various countries are *Sweet potato feathery mottle virus* (SPFMV), sweet potato feathery mottle virus strain internal cork (SPFMV-IC), *Sweet potato feathery mottle virus* strain russet crack (SPFMV-RC), *Sweet potato mild mottle virus* (SPMMV), *Sweet potato chlorotic stunt virus* (SPCSV), *Sweet potato virus C* (SPVC), and *Sweet potato virus G* (SPVG) (Anjarsari *et al.*, 2014; Cuellar *et al.*, 2015; Maina *et al.*, 2018; Listihani & Selangga 2021). Begomovirus species infecting sweet potato has been reported in several countries such as Kenya, the United States, Brazil, and Indonesia which are *Sweet potato leaf-curl virus* (SPLCV), SPLCV-US (US isolate), SPLCV-SP (Sao Paolo isolate) and SPLCV-IDN (Indonesia isolate) (Cho *et al.*, 2020; Listihani *et al.*, 2022).

The first SPLCV report has been made in Indonesia, especially in Bali by Listihani *et al.* (2022). The SPLCV infection on sweet potato shows vein clearing symptoms on young leaves. The SPLCV detection in sweet potato plants in Indonesia makes plant quarantine even more important in preventing the spread of this virus into other regions in Indonesia. Currently, SPLCV status in Indonesia is still unregistered as Quarantine Plant Pest Organism (OPTK). According to the Ministry of Agriculture Law Number 25 Year 2020 on quarantine plant pest organisms, pest organisms are categorized as quarantine plant pest

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organisms (OPTK) when they have not been found in Indonesia or they have been found but in limited areas and are under government control with important economic impact. One of the criteria determining the OPTK status is fulfilled through study on disease severity or damage caused by the pest.

Until now, there has been no information in Indonesia on the symptom variations and disease severity of SPLCV infection. Thus, this research aimed to analyze the SPLCV disease symptom variety and severity in sweet potatoes in Gianyar, Bali.

## MATERIAL AND METHOD

### Plant survey and observation

Surveys and samplings were conducted in five locations in Gianyar Regency, Bali. At each location, 30 plants were observed which makes the total number of observed plants to be 150 plants. Observations were performed weekly when the sweet potato plants reached 63 to 91 days after planting (DAP). Observed parameters include symptom variations, incidence, and vein clearing disease severity on sweet potatoes.

### Disease Incidence

Disease incidence was calculated based on the proportion of infected plants without considering the severity of the infection. The used equation is as follows:

$$IP = \frac{n}{N} x\ 100\%$$

Note:
IP = Disease incidence (%)
n = Number of plants showing mosaic symptoms
N = Total number of plants observed

### Disease severity

Disease severity was calculated based on the proportion of infected plants within a population while considering the severity of the disease by using the equation:

$$KP = \frac{\sum_{i-1}^{n}(ni\ vi)}{N\ X\ Z}\ X\ 100\%$$

Note:
KP = Disease severity (%)
N = The number of plants observed shows a certain score
v= Score for sweetpotato crop
N= Highest score value
Z= Number of all sweetpotato plants

Disease symptom calculation assessed visual symptom variations occurring in the field and input symptoms scoring (0-5).

0 = Leaf symptomless
1 = Leaf vein clearing
2 = Leaf vein clearing and curling
3 = Leaf vein clearing, curling upward or downward
4 = Leaf vein clearing, curling upward and downward
5 = Leaf vein clearing, curling upward and downward, and plant become a dwarf.

## RESULT AND DISCUSSION

Sweet potato plantation in Gianyar Regency is planted on dry field, in temperatures ranging in 29-32 ºC. Sweet potato cultivation was performed in a monoculture system using local cultivars obtained from previous harvests. Before sowing, the field was treated to clean up previous plant soil and remaining weeds. The sweet potato cultivation field in Gianyar Regency is presented in Figure 1, showing dense planting with 15 cm spacing.

The first sweet potato treatment performed by the farmers includes weeding, fertilization, and irrigation. Weeding was performed once a week but often done late. This caused the plants to compete with weeds in obtaining soil nutrition. Fertilization was performed twice in one planting season. The pest organism treatments performed by farmers are sanitation or cleaning the remains of other plants. Irrigation was performed if the soil was too dry.

Sweet potatoes infected by SPLCV generally have vein clearing symptoms by the leaves. Healthy sweet potato has green color spread evenly on all areas of the leaves and wide leaf size (Figure 8A).

The SPLCV infection on sweet potato in Bali has been reported by Listihani *et al.* (2022) and caused vein clearing symptoms on young leaves. In this research, SPLCV infection caused symptom variation on Selo Sidan cultivar sweet potato, which were mild vein clearing, upward vein clearing, downward vein clearing, and severe vein clearing which gradually turned the leaves completely yellowing (Figure 2).

Figure 1. The sweet potato planting field condition in Gianyar Regency

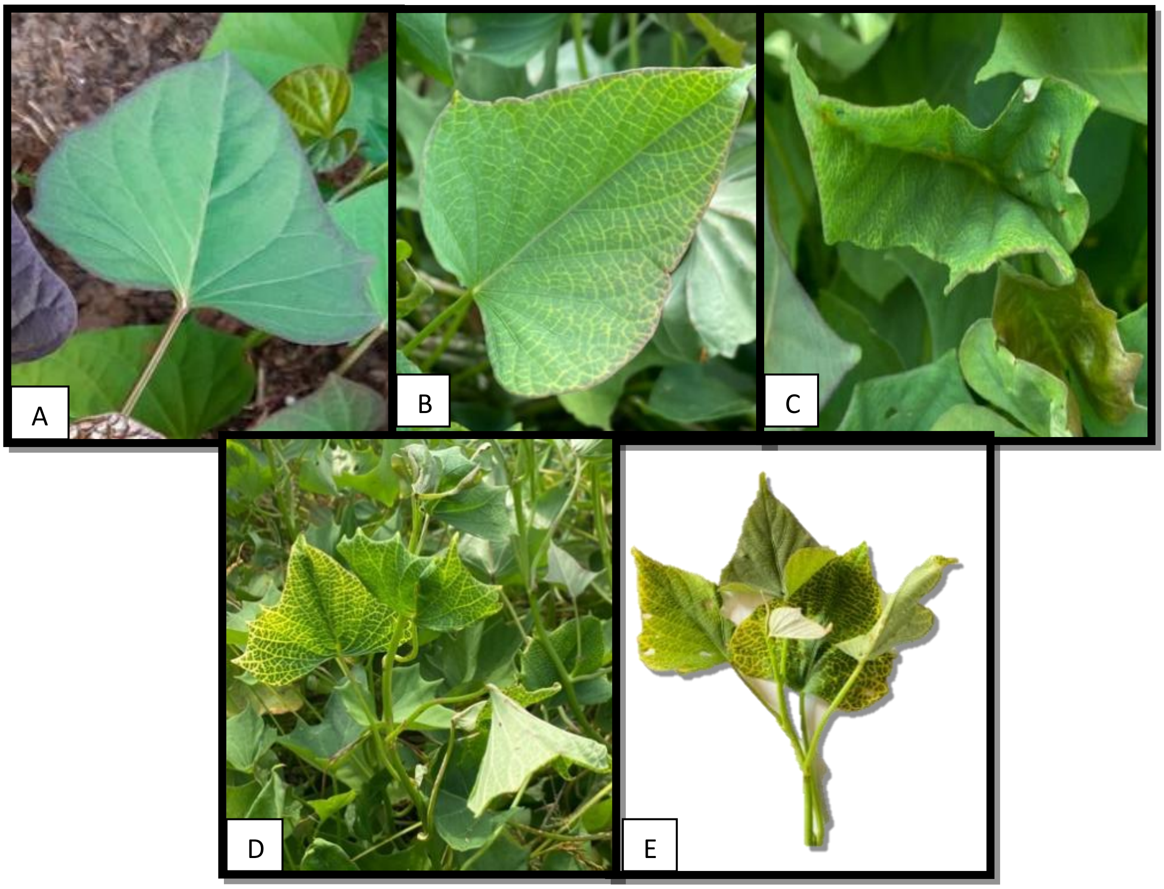


Figure 2. SPLCV symptom variations in sweet potato plantation in Gianyar Regency: (A) healthy plant, (B) mild vein clearing, (C) upward vein clearing, (D) downward vein clearing, (E) severe vein clearing.

Table 1. The SPLCV disease incidence progress in sweet potato

| Locations | Disease incidence (%) (DAP) | | | | | Total | Average |
|---|---|---|---|---|---|---|---|
| | 63 | 70 | 77 | 84 | 91 | | |
| 1 | 53,00 | 53,00 | 57,00 | 67,00 | 70,00 | 300,00 | 60,00 |
| 2 | 50,00 | 53,33 | 63,33 | 66,67 | 70,00 | 303,33 | 60,67 |
| 3 | 46,67 | 60,00 | 64,00 | 66,67 | 66,67 | 304,01 | 60,80 |
| 4 | 53,33 | 56,67 | 63,33 | 70,00 | 73,33 | 316,66 | 63,33 |
| 5 | 56,67 | 56,67 | 60,00 | 60,00 | 60,00 | 293,34 | 58,67 |
| Total | 259,67 | 279,67 | 307,66 | 330,34 | 340,00 | | |
| Average | 51,934 | 55,934 | 61,532 | 66,068 | 68,00 | | 60,69 |

The disease incidence observation was conducted by observing SPLCV symptoms on the leaves. The SPLCV incidence observation result on several fields for five weeks can be seen in Table 1. The disease incidence progress showed an increase from the initial point until the end of observation on every location. Disease incidence at the start of the observation on location one aged 63 DAP appeared to be 53.00 % which changed into 70.00 %, on location two the disease incidence was 50.00% which changed into 70.00%, on location three the disease incidence was 46.67 % which changed into 66.67 %, on location four the disease incidence was 53.33 % which changed into 73.33 %, and on location five the disease incidence was 56.67 which changed into 60.00 % (Table 1). The highest SPLCV disease incidence was found on location 4 with infection level when plants were 91 DAP in age being 73.33%.

Table 2. The SPLCV disease severity progress in sweet potato

| Locations | Disease severity (%) (DAP) | | | | | Total | Average |
|---|---|---|---|---|---|---|---|
| | 63 | 70 | 77 | 84 | 91 | | |
| 1 | 11,33 | 12,67 | 20,00 | 22,67 | 23,33 | 90,00 | 18,00 |
| 2 | 14,67 | 16,00 | 26,67 | 29,33 | 30,00 | 116,67 | 23,33 |
| 3 | 14,67 | 17,33 | 25,33 | 32,00 | 34,00 | 123,33 | 24,67 |
| 4 | 19,33 | 24,66 | 32,67 | 38,00 | 40,00 | 154,66 | 30,93 |
| 5 | 12,67 | 14,67 | 22,00 | 35,33 | 38,00 | 122,67 | 24,53 |
| Total | 72,67 | 85,33 | 126,67 | 157,33 | 165,33 | | |
| Average | 14,53 | 17,07 | 25,33 | 31,47 | 33,07 | | 24,29 |

The SPLCV disease severity can be observed in Table 2. The SPLCV disease severity at each location, when the plants were 91 DAP in age, appeared to be below 50%. The SPLCV disease severity at each location showed an increase every week during the five times observation. Disease severity on the plants at 63 DAP in location one was 11.33 % which changed to 23.33 %, in location two the disease severity was 14.67 % which changed to 30%, in location three the disease severity was 14.67 % which changed to 34.00%, in location four the disease severity was 19.33 % which changed to 40.00 %, in location five the disease severity was 12.67 % which changed to 38.00% (Table 2). The highest SPLCV disease severity was found in location four when the plants were 91 DAP being 40%. Based on the observation, high disease incidence influences the disease severity occurring.

Most plant viruses are transmitted through mechanical contact or via vectors, such as fungus, insect, or nematodes (Kim *et al.,* 2015). Until now, SPLCV disease is a new virus transmitted by the whitefly insect vector (*Bemisi tabaci*) in Indonesia which attacks sweet potato (Choi *et al.,* 2012).

Several factors might contribute to disease occurrence. They are the sweet potato cultivar sowed, cultivation pattern, and plant management implemented. Farmers in Bali plant the local sweet potato cultivar “Selo Sidan” which has unknown resistance level against SPLCV infection. The cultivation pattern implemented by the farmers is monoculture, which causes the high disease incidence in the field. In a research by Listihani *et al.* (2021) disease incidence due to SPLCV infection in sweet potato reached 50% at Badung and Gianyar Regency whereas in this research the disease incidences on several fields reached up to 60.69%. This is also influenced by climate, as during the research various climate changes such as heavy wind, heat, and the whitefly vector were found in the field. The influence of environmental conditions on virus transmission depends on the environment, in addition to the planting location condition before inoculation, during inoculation, and during the disease progression for they also influence virus infection persistence (Listihani *et al.*, 2018; Listihani *et al.,* 2019; Listihani *et al.,* 2020; Listihani *et al.,* 2021; Selangga & Listihani 2021; Selangga *et al.,* 2021; Selangga & Listihani 2022; Selangga *et al.,* 2022; Selangga *et al.,* 2023)

Other pests and disease growth in the sweet potato field were cotton leaf worms, frog eyes, grasshoppers, and aphids. Leafworm and frog eyes attacked with severe intensity. SPLCV virus infection can be managed by using certified healthy seeds (not from previous seeds), ideal plant spacing, fertilization according to the recommended dosage, sowing timing according to soil condition, and intercropping cultivation pattern. Choi *et al.* (2012) showed that sweet potatoes infected by several viruses may act as the source of infection of several viruses through several vectors. In line with what occurred in the field, incidence progress and disease severity increase every week.

The cause of the low sweet potato productivity is because most farmers are still using the seed or stem cutting from the previous planting season without any guaranteed quality. Research performed by Kim *et al.* (2015) stated that more than 70% seeds harvested from SPLCV-infected sweet potatoes are positive for SPLCV, the SPLCV transmission rate from seed to seedling reached 15%, and the research result showed that SPLCV in the researched sweet potato cultivar can be transmitted from the seed.

Virus infection in plants is systemic because the virus grows and spreads to almost all parts of the plant. Once the plant is infected by the virus, it can be guaranteed that the sweet potato stem cutting taken from the stem or the tip of the plant is also infected. In the field, virus transmission is performed by insect vectors, so controlling virus vectors is an alternative to virus control. However, most viruses that infect sweet potatoes are transmitted by *B. tabaci* whitefly persistently. This group of viruses can be very easily taken out of infected plants and transmitted to healthy plants by its transmitting insect (vector) (Albuquerque *et al.,* 2012). Sweet potato farmers in Gianyar Regencys have applied insecticides but it was ineffective. According to research by Jackson *et al.* (2014) on 2010 and 2011 to test whether insecticides can protest sweet potatoes, showed that within two years most insecticides were ineffective in decreasing the whitefly population. Thus, virus control via vector control with insecticide still cannot the implemented to prevent SPLCV transmission.

## CONCLUSION

SPLCV causes various symptoms which are mild vein clearing, severe vein clearing, upward vein clearing, and downward vein clearing. Disease incidence and severity increased every week. The highest disease incidence and severity were found in plants aged 91 DAP, 73.33% and 40% respectively.

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