Evaluation of Purple Sweetpotato Promising Clones Resistance to Scab (*Sphaceloma batatas*) Disease

F C Indriani[1], *Sumartini*[1], *W* Rahajeng[2], and *J* Restuono[2]

[1] Research Center for Food Crops, Research Organization for Agriculture and Food, National Research and Innovation Agency (NRIA)
[2] BSIP Aneka Kacang

Abstract. Scab disease is the main disease on sweetpotato, planting the resistance varieties to scab disease is an effective, easy, and inexpensive way. The research was carried out in Jambegede Experimental Station in January – April 2021. The material tested were 13 purple promising clones from the breeding section, four check varieties that are Antin 2, Antin 3, Papua Solossa and Ir, Melati. Inoculation of *Sphaceloma batatas* fungus (spore density 10^4 spores/ml solution) were done when the plantation 14 days old, in the afternoon, by evenly applying spore suspension to the entire plant. The severity of scab disease is observed when the plants at 60 days old. The sample used were 10 tendrils per clone, the scab intensity was percentage of tendril area infected by scab. Besides, tuber characters such sweetpotatoes as marketable tuber weight, tuber shape, dry matter content, also morphological characters such as plant type, leaf shape, anatomy of leaves such as number of bone leaves, number of stomata and stomata density and the The degree of infection of scab disease were observed. The experiment's result showed that eight sweetpotato promising clones was resistant, one clones were moderately resistant, four clones were moderately susceptible. Four clone recommended as new variety based on high productivity, good quality of tuber performance namely MSU 10001-15, MSU 10003-07, MSU 10010-43 and MSU 10018-40.
Keywords: sweetpotato, scab disease, production, resistance

1 Introduction

Sweetpotato is an important tuber crop in Indonesia after cassava. Sweetpotato is a staple food in some area, as Papua. Various snacks can be made from sweetpotato, there were onde-onde, cake, bread, etc. Anthocyanin-rich purple sweet potatoes function as foods that have a function for the health. The sweet potato is a great source of fiber, micro nutrients, and energy for users [1]. Some studies report that sweetpotato many various bioactive substances, including polyphenols, phenolic acids, carotenoids, and anthocyanins, can be found in the composition of cultivars [2] [3]. Purple sweet potato, rich in anthocyanins that function as antioxidants May play a role in preventing aging, cancer, and degenerative diseases such as atherosclerosis, in addition to having antimutagenic and anticarcinogenic abilities and can reduce blood sugar levels (antihiperglisemik) [4]. [5] report that purple sweetpotato Antin 3 variety contain many cyanidin as major anthocyanin which has been more potential as antidepressant activity through D2-dopamine receptor interaction. Purple sweetpotato especially Antin 3 variety, Purple sweetpotato has the potential as an athlete's antioxidant intake to reduce excessive free radical levels due to physical exercise too hard [6]. The purple flesh Variety Antin-3 is an antioxidant-rich food that prevents the build-up of oxidative stress after physical strenuous activity. Consuming a sufficient amount of purple sweet[potato after strenuous exercise can prevent the accumulation of oxidative stress.For increasing the sweetpotato production, there were some constraints, one of them is scab disease. Scab was a major disease of sweetpotato, the disease was caused by *Sphaceloma batatas*. In Indonesia, scab disease is spread in sweetpotato central area in Java, Bali, Sumatera, Kalimantan and Papua [7]. Yield losses can be reached 30% [8]. varying depending on the variety grown, the age of the plant when infected, and environmental conditions that affect the development of the disease in the field. Some methods of controlling scab disease were available. There were resistant varieties, cultural practices, natural fungicides, and chemical fungicides. [9] report that spraying extracts *Allium cepa* (4 g/100 ml of water) every week since plant two week old until 12 weeks old decreases the intensity of scab disease attacked.

Genetic factors and environmental factors greatly affect disease resistance, genetic factors for example the morphology of plant and anatomical character as parts of the plant. [10] stated that anatomical characters for resistance indicator. That is, epidermis thickness, cuticle thickness, mesophyll thickness, stomata size, and

[1*]Coresponding author: febr016@brin.go.id

stomata and trichome density. Scab diseases attacked increase in sweet potato plants, especially in the rainy season when air humidity is high. Rain splashes and wind cause the spread of fungal spores from diseased leaves/plants to other leaves/plants in the surrounding area [11]. The aim of the research was known information resistance promising purple sweetpotato clones to *Sphaceloma batatas* L.

2 Materials and Methods

The study was conducted at the Jambegede experimental site from January to April 2021. The material used were 17 promising clones of purple flesh sweetpotato, with 4 sweetpotato varieties as comparison, namely: Antin 2(purple flesh variety), Antin 3 (purple flesh variety), Papua Solosa (resistant to Scab disease), and IR Melati (susceptible to Scab disease). Sweetpotatoes were planted on the field with a randomize complete block design with three replications. The plots were measured of 5m in length and a 2m in width, then ridge is made with a distance between the tops of the ridge of 100cm. The distance between plants inside the ridge is 20 cm. Inoculation of *Sphaceloma batatas* fungus (spore density 10^4 spores /ml solution) was done when the plantation 14 days old, in the afternoon, by spraying spore suspension to all parts of the sweetpotato plantation. Intensity of scab disease is observed when the plants are 60 days old. The sample used was 10 tendrils per clone, the scab intensity was percentage of tendril area infected by scab. The resistance of clone was categories as 0-10% is resistant, 11-20% is moderately resistant, 21-30% is moderately susceptible, > 30% is susceptible [12]. Observation tuber characters consist of marketable tuber weight, tuber shape, dry matter content, also morphological characters such as plant type, leaf shape, anatomy of leaves such as number of bone leaves, number of stomata and stomata density and the intensity of scab disease were observed.

3 Result and Discussion

Before releasing a new variety of sweetpotato, they are several things to consider, there are high productivity, resistance to pests and disease also according to market demand (marketable). The criteria for sweet potato characters usually the tubers are medium and large in size with a tuber weight of more than 100 g and have good tuber quality. The results showed that it had the highest number of marketable tubers was MSU 10018-40 clones and was not significantly with MSU 10001-15, MSU 10003-07 and MSU 10010- 43 clones. In addition the characteristics of the clones also has a tuber weight higher than other clones and also to compared with check variety Antin 2, Antin 3, Papua Solossa and local variety IR Melati. Average of dry matter content of the purple flesh sweetpotato was 24.88 – 35.94 %, the highest is clone MSU 10021-26 and was not significantly with MSU 10002-05. For tuber shape majority the promising clones were round elliptic as show in (Table 1).

Table 1. Agronomic traits of promising purple sweetpotato clones . Jambegede Experimental Station, Malang, January – April 2021.

No	Variety/Clones	Average of number of marketable tuber(kg)		Average of weight of Marketable Tuber		Average of Dry matter content (cm)		Tuber shape
1.	RIS 10043-02	5.67	d	1.20	f	27.86	i	Long elliptic
2.	RIS 10053-01	9.67	cd	1.07	f	32.53	de	Long Oblong
3.	RIS 10051-01	29.67	cd	5.60	cde	28.77	hi	Elliptic
4.	MSU 10001-32	25.33	cd	5.77	cde	26.52	j	Round elliptic
5.	MSU 10001-15	65.67	a	16.43	a	24.88	k	Long Elliptic
6.	MSU 10002-05	22.67	cd	2.70	def	35.59	a	Elliptic
7.	MSU 10003-06	58.67	ab	8.47	bc	29.90	gh	Oblong
8.	MSU 10003-07	64.67	a	3.87	def	27.57	ij	Elliptic
9.	MSU 10008-35	23.33	cd	2.83	def	31.14	fg	Round elliptic
10.	MSU 10010-43	64.33	a	8.40	bc	31.94	ef	Long Elliptic
11.	MSU 10010-50	6.67	cd	2.00	ef	33.51	cd	Round
12.	MSU 10018-40	83.67	a	10.90	b	27.70	ij	Round elliptic
13.	MSU 10021-26	4.00	d	0.57	f	35.94	a	Round elliptic
14.	Antin 2	22.33	cd	3.47	def	34.92	ab	Round elliptic
15.	Antin 3	21.33	cd	3.63	def	34.12	bc	Elliptic
16.	IR Melati	16.67	cd	3.40	def	32.73	de	Round
17.	Papua solosa	34.00	bc	6.40	cd	31.06	fg	Long oblong
	LSD 5%	28.17		3.88		1.31		

(kg)

Table 2. Plant characteristic and category resistance clones to scab disease. Jambegede Experimental Station Malang, January – April 2021.

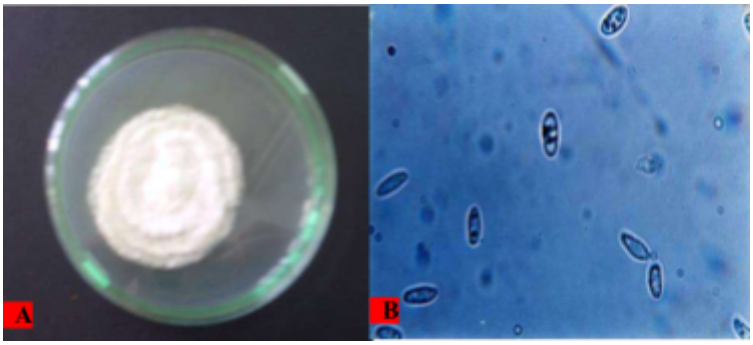
No.	Promising Clones	Plant Type	Mature Leaf shape	Average of			Scab disease at 60 days(%)	Category Resistance
				Number of bone leaves	Number of stomata	Stomata density		
1.	RIS 10043-02	Spreading	Lobed	16.66	40.66	255.9	1.67	Resistant
2.	RIS 10053-01	Spreading	Lobed	16.44	36.67	230.8	8.33	Resistant
3.	RIS 10051-01	Spreading	Lobed	16.67	30.67	193.0	0.00	Resistant
4.	MSU 10001-32	Spreading	Lobed	17.78	45.44	286.0	0.00	Resistant
5.	MSU 10001-15	Semi compact	Lobed	16.22	32.78	206.3	9.83	Resistant
6.	MSU 10002-05	Spreading	Lobed	17.33	30.67	193.0	0.00	Resistant
7.	MSU 10003-06	Semi compact	Lobed	20.56	36.00	226.6	22.00	MS
8.	MSU 10003-07	Semi compact	Cordate	16.11	28.89	181.8	33.67	MS
9.	MSU 10008-35	Semi compact	Cordate	16.67	26.89	169.2	6.17	Resistant
10.	MSU 10010-43	Semi compact	Lobed	16.89	30.11	189.5	27.33	MS
11.	MSU 10010-50	Semi compact	Triangular	16.00	49.33	310.5	13.83	MR
12.	MSU 10018-40	Semi compact	Cordate	16.56	31.22	196.5	31.83	MS
13.	MSU 10021-26	Extremely spreading	Triangular	16.00	25.67	161.5	3.50	Resistant
14.	Antin 2	Spreading	Cordate	18.33	54.67	344.0	9.33	Resistant
15.	Antin 3	Spreading	Lobed	16.45	34.33	216.1	1.00	Resistant
16.	IR Melati	Semi compact	Lobed	17.00	37.67	237.0	19.33	MS
17.	Papua Solossa	Spreading	Lobed	17.56	44.11	278.3	0.00	Resistant

Note: 0-10%: Resistant (R), 11-20%: Moderately Resistant (MR), 21 – 30%:Moderately Susceptible (MS) and >30%: Susceptible(S) (Source: Martanto EA, H Semangun, Christanti, S. 1997)

The type of sweetpotato plant affects crop production, generally farmers like a compact and semi- compact character because it is easier to maintain than the spreading type. Seven clones of the 13 purple sweet potato clones have a semi compact type as check variety IR Melati, but check variety Antin 2, Antin 3 and Papua Solossa have characters spreading. For the mature leaf shape, generally the promising clones have a leaf shape lobed. Whether plant type and leaf shape correlate with Intensity of scab disease. Based on the observations of most promising clones that have spreading plant types and lobed leaf shapes resistant to scab disease as shown in Table 2. In addition, the anatomy structure of the leaves can be used as an indication of resistance to scab disease. [13] reported that infection with the fungus Sphaceloma butatas can lead to changes in the anatomy, especially the length and width of the stomata. The results showed that there was no indication that the number and density of stomata correlated with the intensity of scab disease (Table 2).

Fig.1. Sweet Potato Plants Infected by *S. batatas*

Fig.2. Spore Colonies of *S. batatas* (A), Spora *S. batatas* (B) (Source: [14])



The symptoms of Scab disease showed characteristics, the appearance of leaves, stems and shoots of plants become wrinkled (Figure 1) and Spore colonies of *S. batatas* (A), Spore *S. batatas* (B) (Figure 2). Based on observations 60 days after inoculation, it showed a difference in the percentage of attacks of each promising clone. The disease severity of percentage range 0 – 33.67 %, the level of resistance to Scab of the 13 clones tested consists of eight sweetpotato promising clones was resistant, one sweetpotato promising clones were moderately resistant, four sweetpotato clones were moderately susceptible (Tabel 2). The difference of resistance levels is due to the genetic traits of each sweetpotato promising clone. [15] **reported a sweetpotato genotypes** resistance response to **common** scab in two growing **regions of** East Nusa Tenggara, Indonesia. The research showed **Most of** the **sweetpotato** genotypes **investigated showed** consistent **tolerance** performance **across** the two **sites**. Testing genotypes of sweetpotato in various growing seasons and locations to determine the stability of resistance to Scab disease [16].

Table 3. Morphological characteristics of purple sweetpotato promising clones resistance to Scab (*Sphaceloma batatas*), JambegedeExperimental Station, Malang. January – April 2021.

No.	Clones/Variety	Tuber		Uniformity		Cracking	Tuber Color		Visual color of
		Quality	Shape	Shape	Size		Skin	Flesh	flesh tuber
1.	RIS 10043-02	4	4	4	4	4	P6	P6	dark
2.	RIS 10053-01	4	4	5	4	4	P7	P6	dark
3.	RIS 10051-01	5	4	5	5	4	P6	P5	slightly dark
4.	MSU 10001-32	4	4	4	4	4	P7	P4	bright
5.	MSU 10001-15	5	4	4	4	5	P4	P3	pale
6.	MSU 10002-05	4	4	4	3	4	P6	P7	very dark
7.	MSU 10003-06	3	3	4	4	5	P5	P3	pale
8.	MSU 10003-07	5	4	4	3	5	P7	P7	very dark
9.	MSU 10008-35	5	4	5	4	4	P6	P7	very dark
10.	MSU 10010-43	4	4	4	4	5	P6	P5	slightly dark
11.	MSU 10010-50	4	4	4	4	4	P6	P5	slightly dark
12.	MSU 10018-40	5	4	5	5	5	P6	P4	bright
13.	MSU 10021-26	5	5	5	5	5	P5	P5	slightly dark
14.	Antin 2	4	4	4	4	4	P6	P6	dark
15.	Antin 3	4	4	4	4	4	P7	P7	very dark

Note:
a.Tuber quality and Tuber shape: 5=very good, 4=good, 3=moderately good, 2=bad, 1 = very bad
b.Uniformity of shape and size: 5=very homogen, 4=homogen, 3= moderately homogen, 2= not homogen, 1= least homogen
c.Cracking: 1≥75% crack, 2=51-75%cracks, 3=26-50%cracks, 4=11-25% cracks and 5=no cracks.
d. Tuber skin colour and flesh colour: R=red, P=purple; 1=very pale, 2=slightly pale, 3=pale, 4=bright, 5=slightly dark, 6=dark, 7=very dark

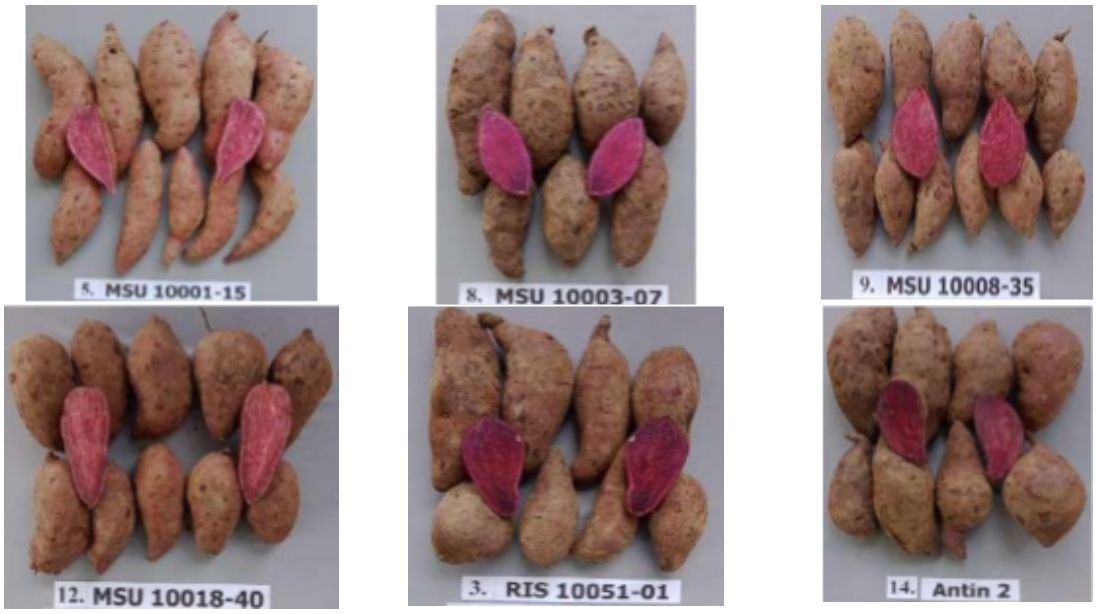


Fig.3. Variability morphology of purple sweetpotato promising clones. Jambegede Experimental Station, Malang. January - April 2021.

Evaluation of tuber morphological characteristics is carried out to assess tuber quality, uniformity of tuber shape and size, this information is needed to support the release of varieties. The results showed (Table 3) that the purple sweetpotatoes tested generally had good and very good quality and shape of tubers (Figure 3), uniformity in the size and shape of tubers also showed good and very good values.Tuber performance is also one of the selection criteria. Consumers choose tubers that look good and are consistent in tuber shape and size. [17]. The brightness / density of purple indicates a high and low anthocyanin content visually, purple flesh color correlated with anthocyanin content. There are three promising clones that have very dark purple flesh tuber like the ceck variety Antin 3 and two promising clones that have dark purple flesh like the check variety Antin2. These clones have a high content of anthocyanins. High anthocyanins are usually correlated by a bitter taste, but steamed tubers of two dark purple genotypes, namely MSU 10010-43 and antin 3, were sufficient liked for their color, texture and flavor characteristics. [18]. Cracking in sweetpotato tuber also indicated quality of the tuber. Cracking can be caused by nematodes or genetics, the research showed that the promising clones generally 4 and 5 categories that mean the promising clones have 11-25% cracks and without cracks. The cases showed that the clones have good performance and quality (Table 3).

4 Conclusion

The result of the experiment showed that eight sweetpotato promising clones was resistant, one sweetpotato promising clones were moderately resistant, four sweetpotato clones were moderately susceptible. Four clone recommended as new variety based on high productivity, good quality of tuber performance namely MSU 10001-15, MSU 10003-07, MSU 10010-43 and MSU 10018-40.

References

[1] C. E. C. Leite, O. M. Porcu, and A. Francisco, "Sweetpotato (Ipomoea batatas L. Lam) nutritional potential and social relevance: a Review," International Journal of Engineering Research and Applications, vol. 10, no. 6, pp. 23-40, 2020, doi: 10.9790/9622-1006082340.

[2] C. C. Teow, V. D. Truong, R. F. Mcfeeters, R. L. Thompson, K. V. Pecota, and G. C. Yencho, "Antioxidant activities, phenolic and Beta carotene contents of sweetpotato genotypes with varying flesh colours," Food Chemistry, vol. 103, pp. 829-838, 2007, doi: 10.1088/1755-1315/756/1/012077.

[3] S. C. Park et al., "Enhanced accumulation of carotenoids in sweetpotato plants overexpressing Ibor-Ins gene in purple fleshed sweetpotato cultivar," Plant Physiology, vol. 86, pp. 82-90, 2014, doi: 10.1016/j.plaphy.2014.11.017.

[4] S. Widowati, "Diversifikasi konsumsi pangan berbasis ubi jalar," PANGAN, vol. 20, no. 1, pp. 49-61, 2011.

[5] N. Kurnianingsih, R. Ratnawati, T. A. Nazwar, M. Ali, and F. Fatchiyah, "Purple Sweet potatoes from east java of Indonesia revealed the macronutrient, anthocyanin compound and antidepressant activity candidate," ORIGINAL PAPER, vol. 75, no. 2, pp. 94-100, 2021, doi: 10.5455/medarh.2021.75.94-100.

[6] M. W. Dewangga, D. P. Irianto, and Dimyati, "Potensi ubi jalar ungu (Ipomoea batatas Var. Antin 3) sebagai asupan antioksidan untuk atlet," Jurnal Tumbuhan Obat Indonesia, vol. 15, no. 2, pp. 136-145, 2022, doi: 10.22435/jtoi.v15i2.5655.

[7] H. Semangun, "Penyakit-penyakit Tanaman Pangan di Indonesia," Gajah Mada University Press, Yogyakarta, Indonesia, 2004, p. 449.

[8] M. Amir, "Studies on sweet potato scab (Elsinoe batatas) in Indonesia," in International Workshop on Integrated Management of Disease and Pest of Tuber Crops, Bhutaneshwar, October 21–27, 1990.

[9] S. Sumartini, "Efficacy of onion (Allium cepa L) extract as biofungicide to control scab disease (Spaceloma batatas) of sweetpotato (Ipomoea batatas)," Journal of Experimental Biology and Agricultural Sciences, vol. 2, no. 4, pp. 397-402.

[10] V. Kumar, J. Kodandaramaiah, and M. V. Rajan, "Leaf and anatomical traits in relation to physiological characteristics in mulberry (Morus sp.) cultivars," Turk. J. Bot., vol. 30, pp. 683-689, 2012.

[11] N. Saleh and S. A. Rahayuningsih, "Pengendalian terpadu penyakit kudis (Sphaceloma batatas Saw.) pada ubi jalar," Buletin Palawija, vol. 25, pp. 37-44, 2013.

[12] E. A. Martanto, H. Semangun, and S. Christanti, "Ketahanan ubijalar terhadap penyakit kudis," Jurnal Perlindungan Tanaman Indonesia, vol. 3, no. 2, pp. 72-76, 1997.

[13] S. Samiyarsih, J. Juwarno, and J. S. Mulyowati, "The Structural Resistance's Anatomy of sweetpotato leaves to fungal pathogen Sphaceloma batatas," Biosaintifika, vol. 10, no. 1, pp. 131-137, 2018, doi: 10.15294/biosaintifika.v10i1.12116.

[14] E. A. Martanto, "Potensi Euphorbia hererophylla sebagai inang alternatif penyakit kudis pada ubijalar," Jurnal HPT Tropika, vol. 10, no. 2, pp. 172-177, 2010, doi: 10.23960/j.hptt.210172-177.

[15] Y. S. Mau, "Resistance response of fifteen sweetpotato genotypes to Scab disease (Sphaceloma batatas) in two growing sites in East Nusa Tenggara, Indonesia," Tropical Drylands, vol. 2, no. 1, pp. 5-11, 2018, doi: https://doi.org/10.13057/tropdrylands/t020102.

[16] F. Widiantini, E. Yulia, A. A. Roosda, and A. Karuniawan, "Seleksi ketahanan ubi jalar madu genotipe F1 terhadap penyakit kudis (Sphaceloma batatas Saw.)," Jurnal Agrikultura, vol. 26, no. 1, pp. 23-29, 2015, doi: 10.24198/agrikultura.v26i1.8457.

[17] F. C. Indriani, J. Restuono, W. Rahajeng, and M. J. Mejaya, "Yield potential and morphological characters of promising sweetpotato clones rich in anthocyanin and high dry matter content," Proceedings of the 3rd KOBI Congress, International and National Conference Advances in Biological Sciences Research, vol. 14, pp. 26-30, 2020.

[18] E. Ginting, R. Yulifianti, and F. C. Indriani, "Selected purple-fleshed sweetpotato genotypes with high anthocyanin contents," IOP Conf. Series: Earth and Environmental Science, vol. 456, p. 012023, 2019, doi: 10.1088/1755-1315/456/1/012023.