

Evaluation of Promising Sweet potato Clones for Higher Root Yield and Dry Matter Content

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Wiwit Rahajeng*, Joko Restuono, Febria Cahya Indriani, Purwono

Indonesian Legumes and Tuber Crops Research Institute

Jl. Raya Kendalpayak KM 8. Po Box 66 Malang, East Java, 65101, Indonesia

*Corresponding author, email: wiwit.rahajeng@gmail.com

ABSTRACT

Dry matter content is one of the important characteristics of sweet potatoes in addition to high yield. The aim of this study was to evaluate the performance of promising sweet potato clones for higher root yield and dry matter content. A hundred promising sweet potato clones were evaluated and arranged in randomized block design with two replication. The variables observed included: weight of vine, harvest index, number of root per plot, the weight of root per plot, dry matter content, root yield, root skin color, and flesh color. The analysis of variance showed a significant difference among the tested genotypes in all traits observed. A hundred promising sweet potato clones showed that root yield has varied ranged from 4.88–41.38 t ha⁻¹ with an average 20.28 t ha⁻¹ and dry matter content ranged from 19.19 – 40.65% with an average 30.47%. Fifteen promising clones of a hundred clones tested had high root yield and dry matter content with varying color flesh.

Keywords: *Ipomoea batatas*, Root yield, Promising clones, Root crop

ABSTRAK

Kadar bahan kering umbi merupakan karakteristik penting pada ubi jalar selain hasil umbi. Tujuan dari penelitian ini adalah untuk mengevaluasi keragaan klon-klon harapan ubi jalar untuk hasil dan kadar bahan kering tinggi. Seratus klon harapan ubi jalar dievaluasi dan disusun dalam rancangan acak kelompok dengan dua ulangan. Variabel yang diamati meliputi: bobot sulur, indeks panen, jumlah umbi perplot, bobot umbi perplot, kadar bahan kering, hasil umbi, warna kulit dan warna daging umbi. Analisis ragam menunjukkan perbedaan yang nyata antara genotipe yang diuji pada semua karakter yang diamati. Klon-klon harapan ubi jalar menunjukkan hasil umbi bervariasi antara 4,88 - 41,38 t/ha dengan rata-rata 20,28 t/ha dan kadar bahan kering berkisar antara 19,19 - 40,65% dengan rata-rata 30,47%. Lima belas klon harapan dari seratus klon yang diuji memiliki hasil umbi dan kadar bahan kering yang tinggi dengan warna daging umbi yang bervariasi.

Kata Kunci: *Ipomoea batatas*, Hasil umbi, Klon harapan, Tanaman akar

INTRODUCTION

Sweet potato (*Ipomoea batatas*) is a root crop which become one of the important food sources in Indonesia. In Indonesia, sweet potato as a food source ranks fourth after rice, corn and cassava commodities (Ambarsari et al. 2009). Flour has a considerable potential to be developed to support the diversification of non-rice food programs. Beside functions as a food source, it can be used as industrial raw materials, feed and renewable energy resources (Vimala et al. 2012; Waluyo et al. 2015; Pedrosa et al. 2015). Sweet potato is also rich of carbohydrate and nutrition content such as protein, dietary fiber, minerals (iron, calcium, potassium, phosphorus, and sodium), vitamins (vitamin C, vitamin B1, and vitamin B2) as well as bioactive compounds such as carotenoids, anthocyanins, and phenylpropanoids (Mohanraj and Sivasankar 2014; Shekhar et al., 2015; Pradhan et al., 2015).

The varied use of sweet potato for food sources and industrial materials causes the increase of sweet potato needs. Increased demand for sweet potatoes needs to be supported by increased productivity of sweet potatoes. Currently, the national average productivity of sweet potatoes is 18.02 t.ha⁻¹ (Statistics Indonesia, 2017). This value is below the potential yield of some of the superior varieties that have been released. Based on the description of sweet potato varieties (Balitkabi 2016), the productivity of superior sweet potato varieties can reach 25-30 t ha⁻¹. Therefore the productivity of sweet potato still has to be improved. One of the efforts to fulfill the increasing needs of sweet potato is by genetic improvement through the breeding program, especially with high yield potency.

Beside high yield potency, the good quality of tubers was also one important thing in the breeding

program (Khayatnezhad et al., 2011; Rahman et al., 2013). Dry matter content is one of the important characteristics of sweet potatoes in addition to high yield. Mbah and Eke-Okoro (2015) mentioned that for farmers and industry, the dry matter content is an essential economic value for sweet potato products, which is the chemical potential of crops and reflects its true biological yields. Mohammed et al. (2009) stated that the dry matter content is also one of the essential criteria in breeding programs, dry matter production is an important indicator for root yield. High dry matter content is vital for the processing industry and associated with consumer preferences (Placide et al. 2013; Shumbusha et al. 2014; Ngailo et al. 2015). Several studies stated that consumers and industry prefer sweet potato varieties with high dry matter content (Cervantes-Flores

et al., 2011; Mbah and Eke-Okoro, 2015).

Many breeding programs had been conducted to develop varieties of high yield potency and dry matter content (Vimala and Hariprakash 2011; Cervantes-Flores et al. 2011; Shumbusha et al. 2014; Waluyo et al. 2015; Mbah and Eke-Okoro 2015). Baafi et al. (2017) conducted a diallel cross to get tuber varieties with those criteria. Kathabwalika et al. (2016) got eight promising sweet potato clones with high yield potency and dry matter content. This study aimed to evaluate the performance of promising sweet potato clones for higher root yield and dry matter content. So that from this research it is hoped that some promising clones can be released into sweet potato varieties with higher root yields and dry matter content.

Table 1. List of promising sweet potato clones used in this study

No.	Genotype	No.	Genotype	No.	Genotype	No.	Genotype
1.	MSU 15001-05	26.	MSU 15008-69	51.	MSU 15013-39	76.	MSU 15016-92
2.	MSU 15001-01	27.	MSU 15008-07	52.	MSU 15013-44	77.	MSU 15016-97
3.	MSU 15004-04	28.	MSU 15009-01	53.	MSU15013-49	78.	MSU 15016-98
4.	MSU 15005-03	29.	MSU 15009-04	54.	MSU 15013-05	79.	MSU 15016-108
5.	MSU 15006-01	30.	MSU 15009-05	55.	MSU 15013-56	80.	MSU 15016-113
6.	MSU 15007-08	31.	MSU 15009-07	56.	MSU 15013-62	81.	MSU 15016-126
7.	MSU 15007-15	32.	MSU 15009-12	57.	MSU 15013-69	82.	MSU 15016-134
8.	MSU 15007-28	33.	MSU 15009-13	58.	MSU 15014-01	83.	MSU 15017-06
9.	MSU 15007-29	34.	MSU 15009-22	59.	MSU 15014-02	84.	MSU 15017-28
10.	MSU 15007-35	35.	MSU 15009-23	60.	MSU 15014-01	85.	MSU 15018-03
11.	MSU 15007-36	36.	MSU 15009-25	61.	MSU 15014-11	86.	MSU 15018-01
12.	MSU 15007-39	37.	MSU 15009-27	62.	MSU 15016-01	87.	MSU 15018-14
13.	MSU 15007-41	38.	MSU 15009-28	63.	MSU 15016-03	88.	MSU 15018-19
14.	MSU 15007-42	39.	MSU 15011-03	64.	MSU 15016-17	89.	MSU 15018-22
15.	MSU15008-06	40.	MSU 15011-08	65.	MSU 15016-23	90.	MSU 15018-39
16.	MSU15008-11	41.	MSU 15011-09	66.	MSU 15016-24	91.	MSU 15018-53
17.	MSU15008-16	42.	MSU 15012-08	67.	MSU 15016-36	92.	MSU 15018-55
18.	MSU15008-02	43.	MSU 15013-06	68.	MSU 15016-38	93.	MSU 15019-07
19.	MSU15008-22	44.	MSU 15013-01	69.	MSU 15016-49	94.	MSU 15019-24
20.	MSU15008-23	45.	MSU 15013-21	70.	MSU 15016-54	95.	MSU 15019-26
21.	MSU15008-29	46.	MSU 15013-22	71.	MSU 15016-61	96.	MSU 15019-31
22.	MSU 15008-33	47.	MSU 15013-23	72.	MSU 15016-67	97.	MSU 15019-40
23.	MSU 15008-36	48.	MSU 15013-24	73.	MSU 15016-69	98.	MSU 15019-44
24.	MSU 15008-48	49.	MSU 15013-28	74.	MSU 15016-78	99.	Sari
25.	MSU 15008-52	50.	MSU 15013-35	75.	MSU 15016-09	100.	Cilembu

MATERIALS AND METHODS

The research was conducted in Maret – August 2016 at Tumpang, Malang, East Java, Indonesia. A hundred sweet potato promising clones were evaluated and arranged in a randomized block design with two replication. The list of sweet potato promising clones used in this study was presented in Table 1. Each genotype was planted on a 1 m wide x 5 m long plot with the spacing between rows and plants was 100 cm x 25 cm. 2/3 dose of fertilizer (300 kg/ha NPK Phonska) was applied at planting, and the remaining was applied 5 weeks after planting. Weeding was done at 4, 7, and 10 weeks after planting. Earthing down was done at 4 weeks after planting, earthing up was done at 7 or 8 weeks after planting. Irrigation, pest, and disease control were applied as needed.

Sweet potato clones harvested and evaluated at five months after planting. The variables observed included: weight of vine, harvest index, number and weight of root per plot, dry matter content, root yield, root skin and flesh color. Analysis of variance using PKBT-STAT 2.1 was conducted to determine the variability of each character. Least significant differences (LSD) at 5% level of probability were used to detect differences between means.

RESULTS AND DISCUSSION

The result of the variance analysis for all the traits tested is shown in Table 2. The performance of all tested accessions statistically was highly significant ($P < 0.01$) in weight of vine, number and weight of root per plot, harvest index, root yield, and dry matter content. Indicated that each accession used has a different genetic nature, and gives a significant influence on growth and yield, especially for the six traits. Gebremeskel et al. (2018) added there is also a high variability in the accessions used.

Descriptive statistics of the weight of vine, number and weight of root per plot, harvest index,

Table 2. Analysis of variance sweet potato promising clones

Characters	Mean			CV(%)
	Block	Genotype	Error	
Weight of vine	4.74*	9.64**	0.88	20.31
Number of root perplot	103.68ns	504.04**	37.36	13.90
Weight of root perplot	27.18**	28.43**	2.21	17.12
Harvest index	0.07**	0.03**	0.01	12.34
Root yield	125.88**	122.34**	10.13	15.70
Dry matter content	0.01ns	34.52**	0.09	0.96

Note: ** significant at $p < 0.01$, ns= non significant

Table 3. Descriptive statistics of sweet potato promising clones quantitative traits

Characters	Mean	StDev	Min	Max
Weight of vine	4.62	2.20	1.80	12.35
Number of root perplot	43.96	15.88	9.00	96.00
Weight of root perplot	8.69	3.77	0.98	18.16
Harvest index	0.66	0.13	0.32	0.88
Root yield	20.28	7.82	4.88	41.38
Dry matter content	30.47	4.15	19.19	40.65

root yield, and dry matter content of the sweet potato promising clones are presented in Table 3. The result of the vine weight which is varied can be caused by environment factor or the effect of genetic factor of each observed clone. Then, the vine weight/plot and the root weight/plot will be used for calculating the harvest index. The total and the weight of roots have important role in deciding the tuber yield. The more roots and the heavier the root weight, the higher the root yield. The harvest index of the observed clones shows quite vary numbers, the harvest index can be seen from the vine weight and the tuber weight (Suminarti and Susanto, 2015; Nwankwo et al., 2018). The harvest index is the ratio between the tuber weight and the assimilate total. Clones with high tuber yield generally have high harvest index. It shows that those clones have high efficiency in using assimilate in the root formation process. Prabawardani (2008) also stated the same thing that the higher the harvest index, the more assimilate is used in the root formation.

According to Vimala dan Hariprakash (2011), the varied yield of the root yield and the dry matter content is affected by many factors, such as: varieties, location, climate, pests, diseases, and the breeding system. In the sweet potato selection, beside the root yield, the dry matter content is also one important criteria. The dry matter content can be used as the root quality indicator. Kathabwalika et al. (2013), mentioned that in sweet potato production, dry matter content is a property most preferred by consumers and an important quality parameter as it indicates mealiness in the roasted or boiled sweet potato. The farmer preference of the root dry matter content is > 25% (Mbah and Eke-Okoro, 2015). Meanwhile, for industry, the root dry matter content is > 30% (Rukundo et al. 2013). The information of the root dry matter content is important because it can be used as the indicator of the starch content, 70% of the main composer of the root dry matter content is starch (Ginting et al. 2012).

Based on the criteria of root yield and dry matter content, there are 15 clones with high yield potency and high dry matter content (>25 t/ha dan >30%). Those clones have varied morpho-agronomy (Table 4). Beside of having high root yield and dry matter content, the 15 clones also have high harvest index (0.51 - 0.88). The color of root skin is mostly red with varied intensity, the rests are beige and orange, while the flesh colors are white, yellow, orange, and purple. Clone MSU 15011.09 has the highest root yield which is 41.38 t ha⁻¹, the dry matter content is 30.24%, and the harvest index is 0.61. The highest dry matter content is shown by clone MSU 15016.126, with the root yield of 28.62 t ha⁻¹ and the harvest index of 0.82. This result shows that the 15 clones are selected from 100 observed clones to be continued to the next step of varieties assemble (the yield potency test to the multi-location test). Those clones have possibility to be proposed in the varieties release with the purpose of high yield and dry matter content.

Table 4. The appearance of selected clones based on root yield and dry matter content criteria

No.	Genotype	Weight of vine (kg)	Number of root per plot	Weight of root per plot (kg)	Harvest index	Root yield (t ha ⁻¹)	Dry matter content (%)	Root color	
								Skin	Flesh
1.	MSU 15011-09	6.55	43.00	13.01	0.61	41.38	30.24	M5	K1
2.	MSU 15009-05	3.45	69.50	14.33	0.83	37.14	31.59	O4	O4
3.	MSU 15007-41	11.35	54.00	14.83	0.51	37.08	30.44	M4	K1
4.	MSU 15016-92	3.05	32.00	12.88	0.82	34.67	32.17	M5	P
5.	MSU 15008-07	5.10	39.50	13.01	0.68	32.52	32.88	M5	K1
6.	MSU 15016-69	3.05	55.50	13.89	0.83	32.41	30.74	Krem	K3
7.	MSU 15001-05	8.95	59.00	13.44	0.63	31.35	31.22	M5	K30
8.	MSU 15016-126	2.00	29.00	12.27	0.82	28.62	34.48	M1	K02
9.	MSU 15013-22	3.25	96.00	16.69	0.84	27.94	33.68	M6	K2
10.	MSU 15018-14	3.95	59.00	13.54	0.78	27.87	33.30	M5	U3
11.	MSU 15016-17	3.50	50.50	9.53	0.75	27.80	34.31	M6	K302
12.	MSU 15009-25	6.05	62.50	13.92	0.67	25.70	33.13	Krem	O5
13.	MSU 15016-108	2.80	57.50	10.99	0.81	25.64	31.48	M5	P
14.	MSU15008-11	1.80	34.50	8.64	0.80	25.20	32.20	Krem	K3
15.	MSU 15018-03	2.10	51.50	13.58	0.88	25.01	31.41	M5	P

Note: M= red, Krem= cream, O= orange, K= yellow, P= white, U= purple
1 = very pale, 2 = slightly pale, 3 = pale, 4 = bright, 5 = slightly dark, 6 = dark, 7 = very dark.

CONCLUSION

Based on the above discussion, it can be concluded that the analysis of variance showed the significant difference among the tested genotypes in all traits observed. The descriptive analysis showed that root yield have varied ranged from 4.88 – 41.38 t h⁻¹ with an average 20.28 t h⁻¹ and dry matter content ranged from 19.19 – 40.65% with an average 30.47%. Fifteen promising clones of a hundred clones tested had high root yield and dry matter content with varying color flesh (white, yellow, orange and purple). It is expected that high yields and high dry matter content characters of the fifteen clones can be stable at the next selection stage. So the clones can be proposed as high yields and high dry matter content varieties.

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