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Performance evaluation of sweetpotato clones through multi-locational trials

(Penilaian prestasi beberapa klon ubi keledek di kajian multilokasi)

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Key words: sweetpotato clones, multi-locational trials, soil types, root yield, dry matter content

Abstract

Sweetpotato clones from AVRDC, NARC and Sabah were evaluated over six locations viz. at Seberang Perai (upland mineral soil), Bidor (sand tailing), Telong and Rhu Tapai (bris soil), Kuala Linggi (acid sulphate soil) and Pontian (peat soil). The clones used were CN 2067-15, CN 2054-13, CN 941-32, CN 2057-6, CN 2067-7, CN 2067-16, Kankei 30, SB 052 and AIS 1022-2. These were evaluated together with eight local clones as check varieties. The check varieties were six popular varieties from each location and two national check varieties. The popular varieties were Susu Lembu, Gurun Putih Lama and Bukit Naga (Kedah), Kuala Bikam and Miang (Perak) and Jepun (Kelantan and Terengganu). Gendut and UPMSS5 were recognized as national check varieties.

Generally, fresh root yield for most of the varieties tested were low. Susu Lembu produced the highest average total fresh root yield (18.2 t/ha) over six locations compared to an expected yield of 30 t/ha. These were followed by Bukit Naga, CN 2067-15 and CN 2054-13 varieties with yield ranging from 14.5–15.7 t/ha. However, the yield difference between these varieties were not significant at $p = 0.05$. Both clones, CN 2067-15 and CN 2054-13 also produced higher root dry matter content than the check varieties such as Susu Lembu, Bukit Naga, Miang, Jepun and UPMSS5. CN 2054-13 was also recorded second highest in percentage of dry matter content (32.7%) after Kankei 30 (which was a low yielding variety). However, clone CN 2054-13 was only able to produce dry root yield of 4.65 t/ha which was not significantly different from that of Susu Lembu (4.61 t/ha).

In a separate trial, CN 2054-13 had higher dry matter (or starch) content compared to Telong. CN 2067-15 together with the checks, Bukit Naga and UPMSS5, recorded the highest harvesting index, implying that they produced more tubers compared to vegetative growth (vines and leaf).

Of the six locations, Bidor (sand tailings) gave the mean highest fresh and dry root yields. The highest root dry matter content was obtained at Telong (33.9%). The acid sulphate soil at Kuala Linggi recorded highest harvesting index (0.55).

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Introduction

Sweetpotato is one of the most important tuber crops for fresh consumption in Malaysia. It is traditionally grown for the fresh root market with a very small percentage being processed into traditional snacks such as *kerepek* (sweetpotato crackers) or *cakar ayam* (fried sweetpotato) (Siti Hasidah and Khatijah 1994). The storage roots can also be commercially processed and used in the manufacturing of various food and non-food products. These include flour, starch, health food, baby food and animal feed (Khatijah 1997). The potential of using sweetpotato as an ingredient in animal feed is good since studies showed that it can partially substitute up to 30% of grain maize that is currently imported (Tan et al. 2000). The feed grain market is currently estimated to be more than 2 million tonnes a year (Anon. 2000).

The farmers' selections are based mainly on the fresh yield and marketability of the roots produced. For example, Jepun variety is popular in Kelantan and Terengganu whereas Susu Lembu, Miang and Kuala Bikam are popular in Perak. Gurun Putih Lama is, however, popular in Kedah. The two national varieties, i.e. Gendut and UPMSS5 were developed and released by MARDI and UPM (Universiti Putra Malaysia), respectively.

Sweetpotato germplasm in the form of true seeds (polycross seeds), meristem tissues (clonal introductions) or seed tubers was acquired from Asian Vegetable Research and Development Centre, Taiwan (AVRDC), International Potato Centre, Peru (CIP) or National Agricultural Research Centre, Tsukuba, Japan (NARC). Others include farmers' varieties that were collected from Sabah and Sarawak between 1989 and 1990 (Tarumoto et al. 1990). A series of the single row and yield trials on these collected germplasm were conducted at the experimental farm at MARDI Headquarters in Serdang. The initial results obtained showed that nine had potential that merited further evaluation (Tan, S.L., MARDI, pers. comm. 2004).

This paper presents the results obtained from the multi-locational trials of these selected clones/varieties under different soil types and agro-ecologies.

Materials and methods

Multi-locational trials (MLTs) are the last stage of evaluation and selection in the sweetpotato breeding programme at MARDI.

Nine accessions had been short-listed from a series of single-row and yield trials at the experimental farm of MARDI Headquarters in Serdang. The origin of these nine accessions is shown in *Table 1*.

The clonal introductions from AVRDC were in the form of meristem tissue cultures while the polycross seed from the same source were true seed. Kankei 30 was introduced from Japan in the form of seed tubers.

The nine clones were evaluated against check varieties such as Susu Lembu, Miang, Kuala Bikam 1 (popular varieties in Perak), Bukit Naga (a high-yielding variety from Selangor), Jepun (popular variety in Kelantan and Terengganu), Gurun Putih Lama (popular variety in Kedah), UPMSS5 (a variety developed by Universiti Putra Malaysia) and Gendut (a variety released by MARDI in 1994). In every location, Gendut and UPMSS5 were mandatory checks, while all or some of the other checks were included in the trials.

The six locations used in the evaluations were chosen based on their contrasting agro-ecologies *(Table 2).* In addition to the six trials, a local verification trial (LVT) was carried out with selected clones in a farmer's field in Sg. Blankan, Sepang, Selangor, which is located on drained peat. The five selected clones (CN 981-32, CN 2054-13, CN 2057-6, CN 2067-7 and CN2067-15) were evaluated against Gendut and two other checks – Telong (a processing variety released by

Table 1. The origin of the 9 accessions of sweetpotato

Accession	Origin (Year of acquisition)
AIS 1022-2	Clonal introduction from AVRDC (1991)
CN 941-32	Clonal introduction from AVRDC (1991)
CN 2054-13	Polycross seed from AVRDC (1991)
CN 2057-6	Polycross seed from AVRDC (1991)
CN 2067-7	Polycross seed from AVRDC (1991)
CN 2067-15	Polycross seed from AVRDC (1991)
CN 2067-16	Polycross seed from AVRDC (1991)
Kankei 30	Varietal introduction from NARC (1992)
SB 052	Farmer's variety collected from Sabah (1989)

Table 2. The agro-ecological characteristic of the experimental site

Location, State	Check varieties	Soil types	Trial dates	Rainfall during the growth period	
				Average monthly (mm)	Total (mm)
Bertam, Seberang Perai	Jepun, Gurun Putih Lama, Miang, Susu	Upland mineral soils	Feb.–May 1999	130	521
Bidor, Perak	Lembu, Gendut, UPMSS5	Sand-tailings	June–Sept. 2000	150	599
Telong, Kelantan		Bris (Rudua)	July–Oct. 1999	189	754
Rhu Tapai, Terengganu		Bris (Rhu Tapai)	July–Oct. 1999	131	523
Kuala Linggi, Melaka	Bukit Naga, Kuala Bikam 1, Gendut, UPMSS5	Acid sulphate soils	Oct.1998–Jan.1999	160	638
Pontian, Johor		Drained peat	May–Aug. 1999	147	589

MARDI in 2000) and Melaka (a favourite among local farmers in that area).

All the trials adopted a randomised complete block design with four replications. Standard agronomic practices suited to each agro-ecology were used. Data were collected on marketable fresh root yield (comprising undamaged roots, which were not less than 150 g each), total fresh root yield, harvest index (the ratio of total root weight: total plant weight, which includes the roots), root dry matter content (from chopped root samples dried at 70 ºC till constant weight) and dry root yield (total fresh root yield x dry matter content). A combined analysis of variance of the six MLTs was carried out for all the nine test clones and the two common checks, i.e. Gendut and UPMSS5.

Results and discussion

Results of the multi-locational trials are presented using data from one season's trial per location.

Clonal performance

Generally, fresh root yields were depressed as varieties of Susu Lembu and Jepun are capable of yields in excess of 30 t/ha (Yahaya et al. 1995; Chung 1998). This may be due to the phenomenon of sweetpotato yield decline, which has been commonly observed where sweetpotato is continuously planted on the same land (Tan 2000).

Table 3. Performance of sweetpotato clones and check varieties in multi-locational trials over six locations

Clone/Check	Marketable* fresh root yield (t/ha)	Total fresh root yield (t/ha)	Harvest index	Dry matter content (%)	Dry root yield (t/ha)	Dry matter in relation to Gendut (%)
CN 2067-15	10.5ab	15.7a	0.42ab	27.4d	4.07b	103.8
CN 2054-13	10.5ab	14.8ab	0.31efg	32.7a	4.65a	123.9
CN 941-32	8.9bc	12.7bc	0.32def	22.1g	2.81de	83.7
CN 2067-7	7.8cd	12.1cd	0.35de	29.8bc	3.53c	112.9
CN 2067-16	7.1de	10.4de	0.38bcd	31.0b	3.13cd	117.4
Gendut	6.4def	8.5efg	0.31efg	26.4de	2.40efg	100.0
UPMSS5	5.9efg	8.8efg	0.41abc	24.1f	2.09fg	91.3
SB 052	5.6efg	8.0fg	0.33de	23.2fg	1.82g	87.9
Kankei 30	5.5efg	7.6fg	0.24hij	33.5a	2.52ef	126.9
CN 2057-6	4.3gh	7.4fg	0.20j	30.9b	2.22fg	117.0
AIS 1022-2	3.0h	6.7g	0.21ij	28.9c	1.87g	109.5
Kuala Bikam 1**	2.8	4.2	0.27	26.1	1.06	98.9
Susu Lembu**	13.5	18.2	0.36	25.6	4.61	97.0
Gurun Putih Lama**	4.8	8.5	0.25	28.7	2.34	108.7
Miang**	10.1	12.8	0.26	23.1	2.92	87.5
Bukit Naga**	10.7	14.5	0.45	23.3	3.37	88.3
Jepun**	6.5	8.5	0.33	23.5	2.00	89.0
Mean	7.2	10.7	0.31	27.5	2.85	
CV (%)	30.4	26.2	22.1	6.5	25.8	

*Marketable fresh root yield refers to the yield of undamaged roots weighing more than 150 g
**Significance level not shown because these checks were not in all MLT's
Values within a column with the same letter are not significantly different from one another according to DMRT (p = 0.05)

Table 4. Performance of five selected clones in a local verification trial at Sg. Blankan

Clone/Check	Marketable fresh root yield (t/ha)	Total fresh root yield (t/ha)	Harvest index	Dry matter content (%)	Dry root yield (t/ha)	Dry matter in relation to Gendut (%)
Melaka	9.8a	14.2a	0.39def	22.0d	3.13b	90.2
CN 2054-13	8.1abc	14.1a	0.41cde	36.5a	5.15a	149.6
CN 941-32	7.1bcd	9.8bc	0.39def	21.5d	2.13cd	88.1
CN 2067-15	6.0cd	15.5a	0.60a	29.3b	4.54a	120.1
Telong	5.8cd	12.4ab	0.47bcd	34.1a	4.22a	139.8
CN 2067-7	2.3e	4.1e	0.36ef	27.0bc	1.09e	110.7
Gendut	1.7e	3.4e	0.32fg	24.4cd	0.87e	100.0
UPMSS5	0.9e	5.1de	0.49bc	24.4cd	1.25de	100.0
CN 2057-6	0.6e	2.7e	0.21h	33.0a	0.89e	135.2
Mean	4.8	9.0	0.40	28.7	2.59	

Values within a column with the same letter are not significantly different from one another according to DMRT (p = 0.05)

Susu Lembu (a check variety) had the highest total fresh root yield over the four locations (where it was included) at 18.2 t/ha *(Table 3)*. The yields of Bukit Naga (another check in two locations), CN 2067-15 and CN 2054-13, ranged from 14.5–15.7 t/ha; the latter two were not significantly different (p = 0.05). CN 2067-15 and CN 2054-13

Table 5. Location means of five important agronomic traits from the multi-locational trials

Location	Soil types	Marketable fresh root yield (t/ha)	Total fresh root yield (t/ha)	Harvest index	Dry matter content (%)	Dry root yield (t/ha)	Top yielding clone (Total fresh root yield t/ha)
Bidor	Sand-tailings	9.9a	15.9a	0.33b	24.8d	3.98a	CN 2054-13 (35.5*)
Kuala Linggi	Acid sulphate soils	8.4b	10.7b	0.55a	24.2d	2.55bc	CN 941-32 (16.4*) Bukit Naga (15.4*)
Rhu Tapai	Bris	7.0c	10.4b	0.23d	23.5e	2.41c	Susu Lembu (39.3*) CN 2067-15 (31.3*)
Bertam	Upland mineral soils	6.5cd	9.1c	0.32b	29.6b	2.65bc	Susu Lembu (28.8*) CN 2067-15 (28.8*)
Telong	Bris	5.8d	8.3c	0.28c	33.9a	2.79b	CN 2067-16 (20.4*)
Pontian	Drained peat	5.7d	9.0c	0.21d	27.8c	2.51bc	CN 2067-7 (13.9*)

Values within a column with the same letter are not significantly different from one another according to DMRT (p= 0.05)
*Significantly higher (p = 0.05) than other test clones and checks in that location

clones also showed significantly higher root dry matter content than the check, UPMSS5, and were also apparently higher than those of the checks, i.e. Susu Lembu, Bukit Naga, Miang and Jepun. CN 2054-13 with a particularly high dry matter content of 32.7% gave a dry root yield of 4.65 t/ha.

Although Telong was not included in the multi-locational trials, it would appear from the LVT *(Table 4)* that CN 2054-13 had a dry matter (or starch) content, which was marginally higher than Telong (which has a dry matter content of around 30%) (Tan et al. 2000).

CN 2067-15 together with the checks, Bukit Naga and UPMSS5, recorded the highest harvest index, implying that they produced less top growth (vines and leaves) in relation to roots, the economic yield.

The good performance of CN 2067-15 and CN 2054-13 clones were confirmed in the LVT at Sg. Blankan *(Table 4)*. Although their total fresh root yields were not significantly different from those of the checks, Melaka and Telong, their root dry matter contents were higher than that of Melaka. The dry matter content of CN 2054-13, CN 2067-15 and Melaka were found to be 36.5, 29.3 and 22.0 %, respectively. No differences in total fresh root yield were observed between these clones.

Location performance

Of the six locations, Bidor gave the highest fresh and dry root yield, whereas Telong recorded the highest root dry matter content at 33.9% *(Table 5)*. The highest mean harvest index (0.55) was achieved at Kuala Linggi on acid sulphate soil.

The marketable fresh root yield obtained from Telong was generally low compared to the other locations. The lower yield obtained was expected as planting was done during the off-season (July–October 1999). The main planting season in the east

coast is from February to June (Zaharah et al. 1994; Zaharah et al. 2004). The rainfall data showed that the average monthly and total rainfall were highest in Telong during the growing period.

It is clear that sweetpotato can grow reasonably well on marginal soils such as sand-tailing, acid sulphate soil and on bris, when appropriate agronomic practices are adopted. Rainfall did not seem to be associated with the location mean yields *(Tables 2* and *5)*. The highest total fresh root yield exceeds 30 t/ha on sand-tailings and on bris *(Table 5)*. This is of significance because it means that sweetpotato need not compete with other crops for fertile arable land, which is becoming scarce especially in Peninsular Malaysia.

Conclusion

CN 2054-13 and CN 2067-15 clones were consistently able to produce high fresh root yield comparable to the check varieties, Susu Lembu and Bukit Naga. These two clones also produced higher root dry matter content especially CN 2054-13 (36.5%), which was higher than Telong, the variety released for flour production. This indicates that the two clones have the potential for starch production.

References

Anon. (2000). *Statistics of imports and exports, Peninsular Malaysia.* Kuala Lumpur: Ministry of Agriculture

Chung, C.W. (1998). Penanaman keledek di tanah bekas lombong, Kampong Baru Kuala Bikam, Daerah Batang Padang, Perak Darul Ridzuan Tech. Bull., 17 p. Taiping: Unit Pembangunan Teknologi Wilayah Utara, Pejabat Pertanian

Khatijah, I. (1997). Sweetpotato starch and its food products. Paper presented at the Networking Meeting Among MARDI Researchers Working on sweetpotato, Serdang, 15–16 July 1997. Organiser: MARDI

Siti Hasidah, N. and Khatijah, I. (1994). Food uses of tuber crops. *Proc. National seminar on tuber crop production and utilization,* 5–7 Sept. 1994, Kuantan (Tan, S.L. et al., ed.), p. 184–96. Serdang: MARDI, UPM and Malays Soc. Hort. Sci.

Tan, S.L. (2000). Problems related to yield performance decline in sweetpotato in Malaysia *Proc. International Workshop on Sweetpotato Cultivar Decline Study,* 8–9 Sept. 2000, Miyakonojo, Kyushu, Japan (Y. Nakazawa and K. Ishiguro, ed.), p. 27–32 Miyakonojo, Japan: Kyushu National Agriculture Experiment Station (KNAES)

Tan, S.L., Mooi, K.C., Zaharah, A., Cheah, L.S. and Tan, H.H. (2000). Selection of sweetpotato clones for starch or animal feed *J. Trop. Agric. and Fd. Sc.* ***28(1):*** 1–12

Tarumoto, I., Sakaguchi, S., Tan, S.L., Liaw, H.L., Chin, T.H., Puddhanon, P. and Limsila, A. (1990). Collection and inventory of indigenous sweetpotato germplasm in malysia and Thailand, 1990 [in Japanese]. *Annual report on exploration and introduction of plant genetic resources* ***6(3):*** 175–219

Yahaya, H., Zaharah, A. dan Kamaruddin, A.R. (1995). Potensi penanaman tanaman selain tembakau di tanah bris *Prosid. Seminar Penyelidikan Tembakau 1995,* 30–31 Dec. 1995, Putrajaya (Musa, Y. et al., ed.), p. 59–75. Serdang: MARDI

Zaharah, A., Vimala, P., Mohd Shukor, N. and Engku Ismail, E.A. (1994). Planting and management of potato on sandy soils in the lowlands. *Proc. National seminar on tuber crop production and utilization,* 5–7 Sept. 1994, Kuantan (Tan, S.L. et al., ed.), p. 41–52. Serdang: MARDI, UPM and Malays Soc. Hort. Sci.

Zaharah, A., Yahaya, H. and Engku Ismail, E.A. (2004). Production technology of sweetpotato (*Ipomea batatas*) on sandy *bris* soils in Malaysia. Paper presented at the First International Symposium on 'Root and Tuber Crops: Food Down Under', 9–12 Feb. 2004. Palmerton North: ISSH and Massey University

Abstrak

Klon ubi keledek dari AVRDC, NARC dan Sabah telah dinilai di enam lokasi iaitu di Seberang Perai (tanah mineral), Bidor (tanah bekas lombong), Telong dan Rhu Tapai (tanah bris), Kuala Linggi (tanah asid sulfat) dan Pontian (tanah gambut). Klon yang digunakan ialah CN 2067-15, CN 2054-13, CN 941-32, CN 2057-6, CN 2067-7, CN 2067-16, Kankei 30, SB 052 dan AIS 1022-2. Klon-klon ini dibandingkan dengan lapan klon tempatan yang digunakan sebagai varieti bandingan. Varieti bandingan ialah enam varieti popular dari setiap lokasi dan dua varieti bandingan nasional. Varieti popular ialah Susu Lembu, Gurun Putih Lama dan Bukit Naga (Kedah), Kuala Bikam dan Miang (Perak) dan Jepun (Kelantan dan Terengganu). Gendut dan UPMSS5 diiktiraf sebagai varieti bandingan nasional.

Secara keseluruhannya, hasil ubi segar daripada kebanyakan varieti yang diuji adalah rendah. Purata bagi enam lokasi menunjukkan Susu Lembu berupaya mengeluarkan jumlah hasil ubi segar tertinggi (18.2 t/ha) berbanding dengan jangkaan hasil 30 t/ha. Ini diikuti oleh varieti Bukit Naga, CN 2067-15 dan CN 2054-13 dengan julat hasilnya 14.5–15.7 t/ha. Walau bagaimanapun perbezaan hasil antara varieti-varieti ini tidak bererti pada tahap $p = 0.05$. Kedua-dua klon CN 2067-15 dan CN 2054-13 juga menunjukkan kandungan hasil kering ubi yang lebih tinggi daripada varieti bandingan seperti Susu Lembu, Bukit Naga, Miang, Jepun dan UPMSS5. CN 2054-13 juga mencatatkan peratus kandungan bahan kering kedua tertinggi (32.7 %), selepas Kankei 30 (varieti yang berhasil rendah). Walau bagaimanapun klon CN 2054-13 hanya mampu mengeluarkan hasil ubi kering sebanyak 4.65 t/ha yang nyata tidak berbeza daripada Susu Lembu (4.61 t/ha).

Dalam uji kaji yang berasingan, CN 2054-13 menunjukkan kandungan bahan kering yang lebih tinggi daripada varieti Telong. Dari segi indeks penuaian, varieti CN 2067-15 dan varieti bandingan Bukit Naga dan UPMSS5 memberikan indeks yang tertinggi, iaitu penghasilan ubi yang lebih tinggi berbanding dengan pertumbuhan vegetatif.

Daripada enam lokasi kajian, Bidor (tanah bekas lombong) memberikan hasil ubi segar dan hasil ubi kering tertinggi. Kandungan bahan kering tertinggi diperoleh di Telong (33.9 %). Tanah asid sulfat di Kuala Linggi mencatatkan indeks penuaian yang tertinggi (0.55).

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