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Selection of sweetpotato clones for starch or animal feed

(Pemilihan klon ubi keledek untuk kanji atau makanan ternakan)

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Key words: sweetpotato, multi-locational trials, mineral soils, *bris*, sand-tailings, drained peat, wide adaptability, root yield, root dry matter content

Abstrak

Sembilan hingga sepuluh klon ubi keledek (yang dipilih daripada ujikaji pengeluaran hasil yang lepas) dinilai bersama-sama lima atau enam varieti bandingan di lima tapak penanaman selama dua musim. Tapak-tapak tersebut sama ada, di stesen MARDI atau Jabatan Pertanian di Semenanjung Malaysia, terdiri daripada kawasan agro-ekologi yang berpotensi untuk penanaman ubi keledek, iaitu tanah mineral, bris, tanah bekas lombong dan tanah gambut bersaliran.

Dua klon, CN 1826-76 dan 192028-13, menunjukkan penyesuaian yang luas, dengan hasil ubi segar dan ubi kering yang pertama atau kedua paling tinggi di semua tapak penanaman. Hasil ubi kering tertinggi sebanyak 8.28 t/ha bagi CN 1826-76 di Rhu Tapai (salah satu daripada dua tapak penanaman di tanah *bris*) dan sebanyak 8.62 t/ha bagi 192028-13 di Kampong Kepayang (tapak tanah bekas lombong) melebihi hasil jagung bijian yang paling tinggi (5.4–6.6 t/ha). Ini mustahak sekiranya ingin menggunakan ubi keledek sebagai makanan ternakan. Klon CN 1826-76 dan 192028-6 mempunyai kandungan bahan kering yang paling tinggi (30–31%) dalam semua ujikaji. Kandungan bahan kering yang tinggi menunjukkan kandungan kanji yang tinggi juga. Sungguhpun varieti bandingan seperti Jepun, Gurun Putih Lama dan Bukit Naga, juga berhasil tinggi dan sesuai ditanam di merata tempat, namun varieti tersebut kurang sesuai sebagai varieti kanji atau makanan ternakan kerana mempunyai kandungan bahan kering yang lebih rendah.

Abstract

Nine to ten sweetpotato clones, which had been shortlisted from previous yield trials, were tested against five or six check varieties at five sites over two seasons. The sites, in either MARDI stations or Department of Agriculture stations in Peninsular Malaysia, were representative of potential sweetpotato-growing agro-ecologies, namely, mineral soils, *bris*, sand-tailings and drained peat.

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Two clones, CN 1826-76 and 192028-13, showed wide adaptability, ranking first or second in fresh and dry root yields at all sites. The highest dry yields of 8.28 t/ha for CN 1826-76 at Rhu Tapai (one of the two *bris* sites) and 8.62 t/ha for 192028-13 at Kampong Kepayang (sand-tailings site) compare very favourably with the highest reported yields of grain maize (at 5.4–6.6 t/ha). This is an important consideration if sweetpotato is to be used as animal feed. The clones CN 1826-76 and 192028-6 were among those with the highest root dry matter content (30–31%) in all the trials. High dry matter content reflects high starch content. Although the check varieties, Jepun, Gurun Putih Lama and Bukit Naga, were high-yielding and widely adaptable, they are unsuitable as starch or feed varieties because of their much lower dry matter contents.

Introduction

A large number of sweetpotato cultivars are currently grown by small farmers throughout Peninsular Malaysia, Sabah and Sarawak (Tan 1996). The commercial cultivars include Kuala Bikam 1, Kuala Bikam 2 (both especially popular on sand-tailings in Perak; Kuala Bikam 1 also in Terengganu), Jepun (in Kelantan), Gurun Putih Lama (in Kedah) and Ubi Biru (in Johor). In addition to these are the cultivars Bukit Naga endorsed by MARDI (Anon. 1990) and Gendut released by MARDI in 1994 (Tan 1994).

Sweetpotato in Malaysia is grown largely for the fresh root market, with a smaller fraction processed into local snacks (such as *kerepek* and *cakar ayam*) or used as a thickener in bottled tomato and chili sauces (Siti Hasidah and Khatijah 1994). Large potential markets exist for the use of sweetpotato as a source of starch and as a feed ingredient. The local starch market is currently estimated at around 90 000 t/yr, increasing at a rate of more than 25% per annum (Tan 1998). At the moment, cassava is the main local source of starch, followed by sago. As a feed ingredient, sweetpotato can be used as a partial substitute (up to 30%) of grain maize which is totally imported. The feed grain market is currently estimated at more than 2 million t/yr (Anon. 2000).

For both purposes, it is imperative that the sweetpotato root should contain high dry matter content, indicative of high starch content and therefore promises a higher extraction or conversion rate if processed into starch, or if chipped and dried as feedstuff. Existing commercial varieties which are for table consumption generally do not fit this bill.

Sweetpotato germplasm in the form of true seed and meristem tissue cultures (from the International Potato Center [CIP] in Peru) as well as the Asian Vegetable Research & Development Center [AVRDC] in Taiwan) were introduced from 1990 to 1993. In addition, there were farmer varieties collected in Sabah and Sarawak in 1989 and 1990 (Tarumoto et al. 1990). These accessions were bulked, and underwent preliminary evaluations at MARDI Headquarters Station at Serdang. The yield trials were repeated at MARDI Seberang Perai and Pontian Stations. The selection criteria included high fresh root yield, high harvest index and high dry matter content.

Shortlisted clones were subsequently tested in a series of multi-locational trials (MLTs) at MARDI research stations and Department of Agriculture crop production stations over two seasons. The final selections were to be used for subsequent evaluation in farmers' fields in major sweetpotato production areas.

Materials and methods

Trial sites

Sites for the MLTs were selected on the basis of their differing agro-ecologies and their potential for the commercial growing of sweetpotato. The sites are listed in the following table:

Station/Site	State	Type of agro-ecology
1. MARDI Seberang Perai	P. Pinang	upland mineral
2. DOA* Kampong Kepayang	Perak	sand-tailings
3. MARDI Pontian	Johor	drained peat
4. MARDI Telong	Kelantan	*bris***
5. DOA Rhu Tapai	Terengganu	*bris*

*Department of Agriculture
**Beach ridges interspersed with swale (sandy beach deposits commonly found on the east coast of Peninsular Malaysia)

Clones

Nine to ten shortlisted clones were tested against five or six check varieties at every site for each of two seasons. The test clones together with their outstanding characteristics, as revealed by the preliminary yield trials, are listed in *Table 1*. Except in the case of the trials at Pontian, clone 192031-19 was only included for testing in the second season trials at the other four sites. The check varieties include the national checks Gendut and Bukit Naga, and the local farmer varieties Gurun Putih Lama (Kedah), Kuala Bikam 1 (Perak, Terengganu [Rasnani 1994]), Kuala Bikam 2 (Perak), Jepun (Kelantan) and Ubi Biru (Johor).

Experimental details

The experimental design for each MLT was a randomized complete block design with four replications. Each plot measured 10 m^2, comprising two ridges of 5 m length, and spaced 1 m apart. Cuttings of 30 cm length specially raised in a nursery and cut at 2–2$^1/_2$ months after planting were planted at 25 cm apart on the ridges.

Agronomic practices adopted at each site are summarized in the *Appendix 1*. The trials were carried out over two seasons at each site.

Data collection

Data were collected at harvest (4 months after planting) on total fresh root yield, harvest index, root dry matter content and dry root yield. Harvest index is expressed as

Table 1. Sweetpotato clones tested in multi-locational trials

Clone	Origin	Promising characteristics	Form of introduction
CN 1345-8	AVRDC	Moderately high root DMC*; high fresh root yield	Tissue culture
CN 1826-76	AVRDC	High root DMC	True seed
192001-1	CIP	Moderately high fresh root yield and moderately high root DMC	True seed
192028-6	CIP	High root DMC	True seed
192028-13	CIP	Moderately high root DMC; high fresh root yield	True seed
192031-19	CIP	Moderately high root DMC	True seed
192047-12	CIP	High root DMC; moderately high fresh root yield	True seed
Papota	CIP	Moderately high root DMC; high fresh root yield	Tissue culture
SB050	Sabah	High root DMC	Farmer cultivar
SR011	Sarawak	Moderately high fresh root yield and moderately high root DMC	Farmer cultivar

*Dry matter content
AVRDC = Asian Vegetable Research and Development Center, Taiwan
CIP = International Potato Center, Peru

the ratio of storage root weight over total plant weight (including the storage roots). It gives an indication of how efficient a clone is in partitioning dry matter produced into the economic plant organs. Dry root yield was computed from the product of fresh root yield and dry matter content.

Results and discussion

By site

Seberang Perai (mineral soils) Over the two seasons of testing, none of the clones significantly outyielded Gurun Putih Lama, the local farmer variety (*Table 2)*. Nevertheless, CN 1826-76 gave a mean fresh root yield (21.2 t/ha) which was more than 10% and 100% higher than the national checks, Bukit Naga and Gendut, respectively. Following second was 192028-13 with 20.1 t/ha.

Harvest index of 192028-13 was significantly higher at 0.52 than all the rest, except 192001-1 (0.45).

Four of the test clones (CN 1826-76, 192028-6, 192028-13 and 192047-12) had significantly higher root dry matter contents, ranging from 23.5–25.3%, than all the check varieties. This resulted in CN 1826-76 and 192028-13 having the highest dry root yields.

Kg. Kepayang (sand-tailings) 192028-13 (at 28.9 t/ha) significantly outyielded the local farmer varieties (*Table 3)*, Kuala Bikam 1 and Kuala Bikam 2, as well as all the other checks except Gurun Putih Lama. Following close behind is CN 1826-76 at 24.5 t/ha.

The highest harvest index was recorded by 192028-13 (0.54), followed by 192001-1 (0.48). Root dry matter content was highest in 192028-6 (33.0%) and CN 1826-76 (31.2%), values which were significantly different from those of all the checks. 192028-13 had a moderately high dry matter content of 29.8%.

Thus, 192028-13 gave the highest dry root yield (at 8.62 t/ha), followed by CN 1826-76 at 7.66 t/ha.

Telong (*bris)* Due to unintentional omission, data on dry matter content of the roots were not collected in the first season at this site, so the figures for dry matter

Table 2. Performance of sweetpotato clones at Seberang Perai (mineral soils) over two seasons

Clone	Fresh root yield (t/ha)	Harvest index	Dry matter content (%)	Dry root yield (t/ha)
CN 1826-76	21.2a	0.38b	25.3a	5.38a
192028-13	20.1ab	0.52a	24.7a	4.74ab
192001-1	17.0abc	0.45ab	20.4de	3.35bcd
Papota	15.4abc	0.38b	21.1cd	3.21bcd
192047-12	14.6abcd	0.26de	23.5ab	3.38bcd
SB050	13.2abcd	0.27cd	22.4bc	2.94bcde
192028-6	11.9abcd	0.25de	25.1a	2.97bcde
CN 1345-8	8.8bcd	0.16e	19.8de	1.64def
SR011	3.8d	0.07f	20.4de	0.79f
Checks:				
Jepun	21.2a	0.40b	14.9h	3.14bcde
Gurun Putih Lama	20.4ab	0.35bc	19.9de	4.04abc
Bukit Naga	19.0ab	0.41b	16.4gh	3.10bcde
Kuala Bikam 1	17.7abc	0.21de	17.8fg	2.75cde
Gendut	10.2abcd	0.19de	15.9h	1.59def
Kuala Bikam 2	7.0cd	0.18de	19.0ef	1.38ef

Values within the same column bearing the same letter are not significantly different from one another according to Duncan's new multiple range test at $p = 0.05$

Table 3. Performance of sweetpotato clones at Kg. Kepayang (sand-tailings) over two seasons

Clone	Fresh root yield (t/ha)	Harvest index	Dry matter content (%)	Dry root yield (t/ha)
192028-13	28.9a	0.54a	29.8bc	8.62a
CN 1826-76	24.5abc	0.40cd	31.2ab	7.66ab
Papota	23.4bcd	0.45bc	27.8cd	6.48bc
192001-1	23.0bcd	0.48ab	25.4de	5.84cd
192028-6	19.3de	0.34de	33.0a	6.44bc
SB050	17.3ef	0.33ef	29.0c	4.99de
192047-12	16.8efg	0.28fg	29.4bc	5.14cde
SR011	13.1fgh	0.22gh	27.5cd	4.16e
CN 1345-8	8.1i	0.18h	27.6cd	2.32g
Checks:				
Gurun Putih Lama	25.3ab	0.40cd	23.3ef	6.00c
Bukit Naga	23.4bcd	0.43bc	20.9g	4.91de
Jepun	19.7cde	0.40cd	22.4fg	4.33e
Gendut	16.7efg	0.34de	23.4ef	3.98ef
Kuala Bikam 1	12.3ghi	0.24gh	22.1fg	2.77fg
Kuala Bikam 2	9.4hi	0.20h	22.8fg	2.21g

Values within the same column bearing the same letter are not significantly different from one another according to Duncan's new multiple range test at $p = 0.05$

Table 4. Performance of sweetpotato clones at Telong (*bris*) over two seasons

Clone	Fresh root yield (t/ha)	Harvest index	Dry matter content (%)*	Dry root yield (t/ha)**
CN 1826-76	22.7a	0.50a	33.5ab	7.60
Papota	14.5bc	0.47abc	26.8ef	3.89
SB050	14.0bc	0.32e	32.0abcd	4.48
192028-13	13.4c	0.43abcd	27.2def	3.64
192028-6	13.0c	0.36de	35.2a	4.58
192001-1	10.1cd	0.47abc	29.2bcdef	2.95
SR011	7.5de	0.18fg	32.0abcd	2.40
192047-12	7.0de	0.23f	32.8abc	2.30
CN 1345-8	6.9de	0.16fg	31.8abcd	2.19
Checks:				
Jepun	23.4a	0.49ab	24.2f	5.66
Gurun Putih Lama	18.8ab	0.40bcd	30.0bcde	5.64
Bukit Naga	14.3bc	0.38cde	24.5f	3.50
Gendut	11.1cd	0.39cde	24.2f	2.69
Kuala Bikam 2	9.1cd	0.22f	27.2def	2.48
Kuala Bikam 1	3.1e	0.11g	25.5ef	0.79

Values within the same column bearing the same letter are not significantly different from one another according to Duncan's new multiple range test at $p = 0.05$

*Data from first season trial only
**Product of dry matter content (1st season data) and fresh root yield (mean of 2 seasons)

content in *Table 4* are based on data collected in the second season. Dry root yields were then computed by multiplying the second season data on dry matter content with the means over two seasons for fresh root yield (thus, these values were not analyzed for statistical significance).

Only CN 1826-76 had a mean fresh root yield (22.7 t/ha) equivalent to that of Jepun, the local farmer variety. However, dry matter content was highest in 192028-6 (35.2%), followed by CN 1826-76 (33.5%) and 192047-12 (32.8%), all significantly higher than the values of every check except for Gurun Putih Lama. As a result, CN 1826-76 produced the highest dry root yield as well.

Rhu Tapai (*bris*) CN 1826-76 ranked first *(Table 5)* in fresh root yield (26.8 t/ha), although the value was not significantly different from those of 192028-13, 192001-1 and Papota (ranging from 20.9–23.3 t/ha), nor from the checks Gendut, Jepun and Gurun Putih Lama (ranging from 22.9–26.4 t/ha). Harvest indices were also high in these clones.

For root dry matter content, the best clones were 192028-6, CN 1826-76, SB050 and 192028-13, with values ranging from 29.5–31.7%. These four clones had significantly higher dry matter content than all the checks.

Consequently, CN 1826-76 produced the highest dry root yield (8.28 t/ha), followed by 192028-13 at 6.93 t/ha (although this value was not significantly different from the values of the checks Gendut and Gurun Putih Lama).

Pontian (drained peat) None of the test clones outyielded the national check Gendut *(Table 6)*, although CN 1826-76, 192001-1, 192028-13, Papota and 192031-19 had fresh root yields which were not significantly different, but higher than the local farmer variety Ubi Biru.

The highest harvest indices were recorded by 192028-13 (0.52) and 192001-1 (0.50). The local farmer variety Ubi Biru, 192028-6 and SB050 had the highest root dry matter contents, ranging from 30.7% to 33.1%. CN 1826-76 and 192028-13 had moderately high dry matter contents of 30.2% and 27.1%, respectively. The other

Table 5. Performance of sweetpotato clones at Rhu Tapai (*bris*) over two seasons

Clone	Fresh root yield (t/ha)	Harvest index	Dry matter content (%)	Dry root yield (t/ha)
CN 1826-76	26.8a	0.42ab	30.9ab	8.28a
192028-13	23.3abc	0.46a	29.5ab	6.93ab
192001-1	22.7abc	0.46a	26.3cd	5.98bc
Papota	20.9abcd	0.42ab	25.1de	5.21cd
SB050	19.6bcd	0.34bc	29.8ab	5.89bc
SR011	18.2bcd	0.32c	27.2cd	5.26bcd
192047-12	17.7cde	0.34bc	28.6bc	5.25bcd
192028-6	16.6de	0.34bc	31.7a	5.30bcd
CN 1345-8	12.3ef	0.23d	26.4cd	3.34fg
Checks:				
Gendut	26.4a	0.46a	21.9fg	5.82bc
Jepun	24.3ab	0.46a	21.4fg	5.12cde
Gurun Putih Lama	22.9abc	0.40abc	23.5ef	5.37bcd
Bukit Naga	19.3bcd	0.42ab	20.3g	4.00def
Kuala Bikam 2	15.9de	0.32c	22.6fg	3.60ef
Kuala Bikam 1	9.9f	0.22d	20.4g	2.01g

Values within the same column bearing the same letter are not significantly different from one another according to Duncan's new multiple range test at $p = 0.05$

Table 6. Performance of sweetpotato clones at Pontian (drained peat) over two seasons

Clone	Fresh root yield (t/ha)	Harvest index	Dry matter content (%)	Dry root yield (t/ha)
CN 1826-76	13.1a	0.43bc	30.2bc	3.94a
192001-1	12.3ab	0.50ab	24.9efg	3.10bc
192028-13	11.8abc	0.52a	27.1de	3.26ab
Papota	11.6abc	0.44bc	24.2fgh	2.85bc
192031-19	11.1abc	0.42c	24.8efg	2.73bcd
192028-6	9.5bcd	0.40c	32.0ab	3.05bc
SB050	7.8de	0.31d	30.7abc	2.43bcde
SR011	5.4ef	0.22e	28.9cd	1.57fgh
192047-12	5.1ef	0.21e	28.3cd	1.49gh
CN 1345-8	4.6f	0.19e	26.2def	1.74efgh
Checks				
Gendut	13.7a	0.42c	22.2ghi	3.09bc
Jepun	11.8abc	0.40c	19.5j	2.32cdef
Bukit Naga	9.4bcd	0.40c	20.7ij	1.98defg
Ubi Biru	9.0cd	0.31d	33.1a	2.96bc
Kuala Bikam 1	4.4f	0.22e	22.0hij	0.98h

Values within the same column bearing the same letter are not significantly different from one another according to Duncan's new multiple range test at $p = 0.05$

checks had the lowest dry matter contents (19.5–22.2%).

For dry root yields, CN 1826-76 surpassed all the clones (except 192028-13) and checks.

Combined analyses

A combined analysis of variance of the data on all the trials (at five sites over two seasons each) was run. As not all the checks were included in every trial, only data from four of them, *viz.* Jepun, Gendut, Bukit Naga and Kuala Bikam 1, were used, to eliminate the problem of missing data and unbalanced analysis.

CN 1826-76 and 192028-13 were outstanding over the five sites and over two seasons of testing in producing fresh root yields *(Table 7).* Nevertheless, the local farmer variety Jepun and the national check Bukit Naga were equally high yielders. The highest mean dry matter contents were recorded by 192028-6 (31.2%) and CN 1826-76 (30.1%). Although the dry matter content of 192029-13 was lower at 27.5%, this value was still significantly higher than the checks.

Highest root yields (both fresh and dry) were recorded at Rhu Tapai and Kampong Kepayang, although the highest dry matter contents were recorded at Telong. Incidentally, all these were sites with sandy soils. Yield performance was generally lower on drained peat at Pontian.

Although both Telong and Rhu Tapai were *bris* soil sites, the soil series at Telong was the Rudua series, while the latter was the Ru Tapai series. Yields at Rhu Tapai were higher than at Telong, probably because the Ru Tapai series has a shallower spodic horizon (50 cm or less) whereas in the Rudua series the spodic layer is much deeper (50–100 cm). The presence of a shallow spodic horizon is more conducive to sweetpotato growth in terms of higher inherent organic matter content, and thus better water retention (Zahari and Wong 1986).

As the clone 192031-19 *(Table 8)* was included in the second season trials only (except at Pontian), a separate combined analysis of variance was conducted on all the data from these second-season trials to get an idea of how this clone performed vis-

Table 7. Performance of sweetpotato clones at five sites over two seasons

	Fresh root yield (t/ha)	Harvest index	Dry matter content (%)	Dry root yield (t/ha)
Clone				
CN 1826-76	21.6a	0.42b	30.1b	6.53a
192028-13	19.5ab	0.49a	27.5cd	5.30b
Papota	17.3bc	0.43b	24.9g	4.36c
192001-1	17.0bcd	0.47a	25.2fg	4.25c
SB050	14.4cde	0.31d	28.6c	4.14cd
192028-6	14.1de	0.34cd	31.2a	4.31c
192047-12	12.2ef	0.26e	28.5c	3.50de
SR011	10.0fg	0.21f	27.1de	2.88ef
CN 1345-8	8.2g	0.18f	26.3ef	2.37fg
Checks:				
Jepun	20.1ab	0.43b	20.2i	4.14cd
Bukit Naga	17.0bcd	0.41b	20.4hi	3.47de
Gendut	15.6cd	0.36c	21.3hi	3.41e
Kuala Bikam 1	9.5fg	0.20f	21.5h	1.87g
Site				
Rhu Tapai	19.9a	0.37a	26.1b	5.26a
Kg. Kepayang	19.0a	0.36ab	26.4b	5.51a
Seberang Perai	15.0b	0.31c	20.6c	3.02c
Telong	12.4c	0.34b	29.2a	3.62b
Pontian	9.3d	0.36ab	25.9b	2.48d
Season				
Season 1	15.2a	0.31b	25.3b	3.93a
Season 2	15.0a	0.38a	25.9a	3.88a

Values within the same column in the same grouping and bearing the same letter are not significantly different from one another according to Duncan's new multiple range test at $p = 0.05$

à-vis the others as well as the checks. This clone ranked fifth in fresh root yield, but ranked sixth in dry root yield, coming after 192028-6, because of its lower dry matter content.

It is clear that except for the local farmer variety for Johor, i.e. Ubi Biru, all the other checks had a much lower root dry matter content than some of the outstanding clones. Dry matter content is associated with starch content; hence, it will be reasonable to assume that clones having high dry matter contents will also have high starch contents.

Conclusion

The findings from the MLTs may be summarized as follows:

i. The clones CN 1826-76 and 192028-13 were widely adaptable to the range of agro-ecologies covered by these trials. They ranked first or second in high fresh and dry root yields among the test clones at all sites except at Telong where only CN 1826-76 was far superior.

ii. The dry root yields of CN 1826-76 and 192028-13 averaged 6.53 t/ha and 5.30 t/ha over the five sites and over two seasons of testing. The highest dry yields in fact were 8.28 t/ha for CN 1826-76 at Rhu Tapai *(Table 5)* and 8.62 t/ha for 192028-13 at Kampong Kepayang *(Table 3)*. These yields compare very favourably with the highest yields of grain maize reported from experimental plots which range from 5.4–6.6 t/ha

Table 8. Second season's performance of sweetpotato clones (including 192031-19) at five sites

	Fresh root yield (t/ha)	Harvest index	Dry matter content (%)	Dry root yield (t/ha)
Clone				
CN 1826-76	22.5a	0.48a	30.4ab	6.81a
Papota	18.7abc	0.48a	24.8e	4.68b
192028-13	17.0bc	0.51a	27.8cd	4.82b
SB050	15.5bcd	0.36d	29.1bc	4.56b
192031-19	14.6cd	0.37cd	24.8e	3.58cd
192028-6	14.5cd	0.39cd	31.5a	4.60b
192001-1	13.4cd	0.50a	25.3e	3.34cd
SR011	11.6de	0.26e	27.5cd	3.22cd
192047-12	10.8de	0.26e	29.1bc	3.18cd
CN 1345-8	6.8e	0.18f	27.0d	1.92e
Checks:				
Jepun	20.2ab	0.45ab	20.4f	4.19bc
Gendut	15.3bcd	0.41bc	21.7f	3.39cd
Bukit Naga	15.2bcd	0.42bc	20.4f	3.08d
Kuala Bikam 1	13.4cd	0.27e	21.4f	2.57de
Site				
Kg. Kepayang	24.2a	0.46a	26.8b	6.51a
Rhu Tapai	17.1b	0.33b	25.1c	4.34b
Seberang Perai	13.6c	0.30b	21.9d	2.86cd
Telong	11.0cd	0.33b	29.1a	3.23c
Pontian	8.9d	0.49a	26.0b	2.32d

Values within the same column in the same grouping and bearing the same letter are not significantly different from one another according to Duncan's new multiple range test at $p = 0.05$

A B

Plate 1A. 192028-6: Vine characteristics; 1B. Root characteristics

Plate 2. *CN 1826-76: Root characteristics*

A

B

Plate 3A. 192028-13: Root characteristics;
3B. CN 1826-76: Vine characteristics

(Lim 1969; Wong 1969; Lee 1986, 1990) – an important consideration if sweetpotato is to be used as animal feed. (Nevertheless, it should be cautioned that currently there is as yet no cost-effective technology for the drying of sweetpotato chips. Without a cheap drying system, the cost of producing sweetpotato for animal feed will not be competitive compared to the price of imported grain maize).

iii. The dry root yields of the best cassava clones currently under testing for starch production range from 9.4–13.2 t/ha (Tan, S. L., unpublished data). However, these yields are achieved only after 12 months, whereas sweetpotato is harvested after 4 months. Allowing for two crops of sweetpotato per year (leaving 4 months fallow as a cultural practice against sweetpotato weevil), CN 1826-76 and 192028-13 would produce mean dry root yields of 13.1 and 10.6 t/ha, respectively – which compares favourably with cassava productivity.

iv. The clones CN 1826-76 and 192028-6 were among those with the highest root dry matter content in all the trials.

v. While the check varieties, Jepun, Gurun Putih Lama and Bukit Naga, were also high-yielding and widely adaptable, they will not be suitable as starch or feed varieties by reason of having much lower dry matter content than the outstanding clones identified in this series of trials.

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Appendix 1. Agronomic practices adopted for the multi-locational trials

Agronomic practice	Mineral soils: *Seberang Perai*	Sandy soils: *Telong, Rhu Tapai, Kg. Kepayang*	Drained peat: *Pontian*
Liming	Nil	Nil	5–10 t/ha to raise pH to around 5.0
Planting	On machine-built ridges, spaced 1 m apart; use of terminal vine cuttings of 30 cm length cut from 2–2½ month old plants; plant spacing 25 cm		
Organic manure (chicken dung)	5 t/ha, applied after land preparation	20 t/ha, incorporated during land preparation	Nil
Chemical fertilizer application	35 kg N, 35 kg P_2O_5, 70 kg K_2O per ha, band-applied at planting	100 kg N, 80 kg P_2O_5, 120 kg K_2O per ha, split for band-application at 1, 4 and 8 weeks after planting	46 kg N, 28 kg P_2O_5, 67 kg K_2O plus 17 kg $CuSO_4.5H_2O$ per ha, band-applied at planting
Weevil control	Cuttings dipped in 0.01% a.i. malathion solution before planting; endosulfan granules applied at 1 g/plant at 4 and 8 weeks after planting		
Weed control	4 L alachlor/ha, preemergence; supplemented by hand-weeding when necessary		
Irrigation	In first 2 weeks after planting		Nil
Harvest	At 4 months after planting		

Adapted from Tan and Saad (1994)