

Evaluation of three ‘piping-leaf’ pineapple hybrids

(Penilaian prestasi tiga hibrid nanas daun ‘piping’)

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Key words: *Ananas comosus* L. (Merr.), pineapple, breeding, hybrid, piping-leaf

Abstract

Three introduced ‘piping-leaf’ pineapple hybrids viz. 53-116, 73-50 and 59-656 were evaluated with Josapine and AF3-8 as controls. The ‘piping-leaf’ hybrids were completely spineless along the leaf margins compared with the control genotypes which have spines at the tip of the leaves. The hybrids were not productive in ground and aerial suckers, thus crop ratooning with these hybrids may be difficult. The hybrids excelled in resistance to flesh blemishes and have high soluble solids content ranging from 13.9–16.3%. The most promising was 73-50 which was 76% higher yielding than Josapine, primarily due to good response to flower induction, resistance to heart rot and good fruit size. This genotype has the potential to replace Gandul in the canning industry and may also have a place in the fresh fruit market because of its high sugar and low acid contents.

Introduction

Pineapple is the most important fruit for canning in Malaysia with annual export revenue ranging from RM70–RM100 million in the last 5 years. Fresh pineapple export is also on the rise, grossing about RM10 million in 2001, up more than three-fold compared with the revenue a decade ago (Chan 2002). Against this backdrop of a fairly successful industry, lies a surprising fact that several of the varieties are at the threshold of antiquity. In the canning industry, for example, the estates are still planting, to a large extent, Gandul (Singapore Spanish) that has been around for three or more decades.

According to many growers, Gandul has deteriorated in yield, particularly in peat areas continuously cropped with pineapple. Development of varieties with improved

yield, vigour and fruit qualities to replace Gandul would be a much-needed infusion to increase the efficiency and competitiveness of the pineapple canning industry.

Hybridization and selection of progenies in the segregating F_1 has been the method of choice for pineapple breeding at MARDI. Josapine, a table-fruit variety released in 1996, is a product from such a hybridization programme (Chan and Lee 1996). Apart from this method, there is also scope for selection of spontaneous field mutations e.g. Masmerah (Wee 1974) and adoption of introduced clones that have good adaptability to local environments.

This paper evaluates the performance of three introduced hybrids reported to be promising in Hawaii (Williams and Fleisch 1993) and Australia (Sanewski 1998). These three hybrids have ‘piping’ leaves, an

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unusual characteristic where leaf-margins are rolled-over, leading to complete absence of spines. This study compared the economic characters of these hybrids with two local control varieties and made recommendations on the commercial potential of these introductions based on systematic scoring using performance ranking of genotypes and priority rating of characters.

Materials and methods

Three 'piping-leaf' pineapple hybrids i.e. 53-116, 59-656 and 73-50 were evaluated with Josapine and AF3-8 as controls. The 'piping-leaf' genotypes were Smooth Cayenne hybrids developed by the now defunct Pineapple Research Institute in Hawaii (Williams and Fleisch 1993). They were introduced into MARDI in 1993 in a germplasm exchange with the Maroochy Horticultural Station in Nambour, Queensland through Dr. Garth Sanewski.

Josapine is a commercial hybrid released by MARDI in 1996 while AF3-8 is an advanced early-fruited selection obtained from a population of Spanish x Smooth Cayenne cross. To reduce experimental error due to propagule age and size, the quartering technique of Lee and Tee (1978) was used to propagate the plants. The plants were raised to a height of 30 cm before they were planted in the field.

The experiment was conducted on peat at the MARDI research station in Pontian, Johor. The five genotypes were planted on 20 October 1999 in a randomized complete block design with four replicates. In each plot, there were 60 plants grown in three double-row beds of 10 plants in each row. The spacing was 30 cm x 60 cm between plants and 90 cm between beds.

Data measurements at harvest included the number of ground suckers, aerial suckers, and slips, and fresh weights of crown, fruit and plant. Fruit analyses were carried out for total soluble solids (TSS%) and acid content, core diameter and disease blemishes in the flesh. TSS% was recorded

using a hand refractometer (0–25% Brix) while acid content was determined by titration following the method described by Tay (1972). Flesh blemishes were visually scored from 1–10 with higher scores indicating more severe blemishing. For heart rot disease, the number of plants of each genotype infected in the plots was noted at the flower induction stage.

Scores for selection based on 10 characters were computed from the sum of the rank-priority product. Priority refers to the arrangement of the characters from 1 to 10 according to its economic importance, with the most important i.e. 'flesh blemish' placed at priority rating 10. Rank refers to the placement of the genotype in accordance to its superiority in the character with the best ranking given a value of 1. The rank-priority product is obtained by multiplying the priority rating of the character with its genotypic rank. The genotype with the lowest cumulative scores for rank-priority product will be the best overall selection.

Results and discussion

The Analyses of Variance in *Table 1* show that varieties differed significantly in all characters with the exception of number of slips.

Comparison of means

Planting materials The usual propagules for pineapple planting are slips, ground and aerial suckers and crowns. All genotypes in this trial rarely produced slips (*Table 2*). The three 'piping-leaf' hybrids viz. 53-116, 59-656 and 73-50 were also not productive in aerial and ground suckers. This means that propagation of these three hybrids has to be done with crowns only. This may present a problem if the hybrids are recommended for fresh fruit where the crown has to be retained for reasons of longer fruit storage and cosmetics. In this case, morphactin growth regulators such as Multiprop (Maintain CF-125) may have to be used for proliferating propagules for these three

Table 1. ANOVA: Mean square values of 12 characters

df	Plant wt.	Crown	Ground sucker	Aerial sucker	Slip	Fruit wt.	Acid	TSS	Blemish	Core	Fruit:plant ratio	Fruit shape	
Variety	4	3.1571**	134633**	2.1170**	0.3550**	0.1280 ns	0.5121**	0.2545**	11.0899**	44.5170**	193.27**	0.1330**	0.4499**
Rep	3	0.4262 ns	6861 ns	0.2613 ns	0.0160 ns	0.0587 ns	0.0003 ns	0.8563 ns	0.2613 ns	6.13 ns	0.0012 ns	0.0024 ns	
Error	12	0.1539	3106	0.0996	0.0630	0.0518	0.0024	0.4589	0.2930	1.88	0.0033	0.0035	
Total	19												

** significant at $p = 0.01$

ns = not significant

Table 2. Mean values of 12 characters in 5 pineapple genotypes

Genotype	Plant wt. (kg)	Crown (g)	Ground sucker (no.)	Aerial sucker (no.)	Slip (no.)	Fruit wt. (kg)	Acid (%)	TSS (%)	Blemish rating	Core (mm)	Fruit:plant ratio	Fruit shape
73-50	3.64ab	195.0c	0.25c	0.05ab	0.00a	1.76a	0.58c	16.29a	0.40b	28.45b	0.38cd	1.30b
59-656	3.33b	532.7a	0.00c	0.55ab	0.40a	1.58ab	1.23a	13.89bc	0.50b	36.05a	0.49bc	0.96c
53-116	2.05c	366.5b	0.20c	0.00b	0.00a	1.16b	0.78b	14.23b	0.05b	16.55c	0.57b	0.99c
AF3-8	2.77bc	94.7c	1.00b	0.05ab	0.00a	2.00a	0.66c	12.52c	7.90a	27.70b	0.74a	1.79a
Josapine	4.41a	128.0c	1.75a	0.60a	0.20a	1.12b	0.82b	16.42a	0.95b	25.20b	0.26d	1.28b

Column means with the same letter(s) are not significantly different at $p = 0.01$ according to DMRT

hybrids. The production of ground suckers in AF3-8 and Josapine appeared sufficient for replenishing planting materials in field plantings. If fruit of the three 'piping-leaf' hybrids are used for canning, their vigorous crowns are suitable as planting materials. Crowns of AF3-8, on the other hand, may be too small to be considered for planting materials. The excessively large crowns of the 'piping-leaf' hybrids like 59-656 and 53-116 may require gouging or 'Fruitone' treatment to reduce the size of the fruit that are marketed fresh.

Fruit characteristics Fruit shape as expressed by the ratio of fruit length to diameter, ranged from globose (59-656 and 53-116) to cylindrical (73-50 and Josapine) to decidedly elongate (AF3-8). The most suitable shape for canning is cylindrical with square shoulder that allows even removal of fruit skin from top to bottom by the coring knife. The elongate shape of AF3-8 will not be acceptable because the coring knife will either cut too much at the base or it may not remove the skin at the tapered end if the base is cut too shallow. Josapine and 73-50 (*Plate 1*) with square shoulders have the ideal shape for canning.

Fruit size as depicted by weight of the five genotypes ranged from small (Josapine and 53-116) to medium large (59-656, 73-50 and AF3-8). The smaller fruited varieties may be suited only for fresh fruit while the others can be accepted both for canning and fresh consumption. The core of 53-116 was the narrowest (16 mm) while that of 59-656 (36 mm) may be too wide for the coring knife to remove the core completely during processing. Cores of diameter less than 30 mm are usually acceptable to the canning factory.

With regard to TSS%, Josapine and 73-50 had the highest sugar content of more than 16%. The high sugar content of these genotypes may save the canning industry considerable costs in sugar input. There is also the possibility of canning these fruit in their natural juice without added sugar, a

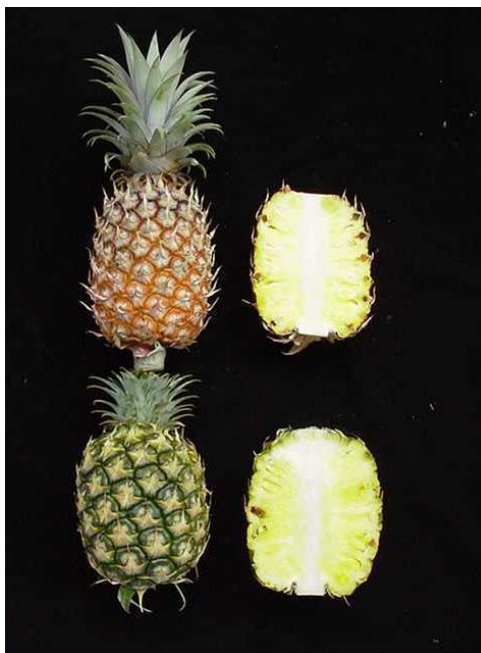


Plate 1. 73-50 fruit (bottom row) compared with Josapine (top row)

product that will appeal to the health-conscious. With regard to acid content, 73-50 had the lowest (0.58%) and with the high sugar, the fruit tastes plain sweet without the piquancy and aroma of Josapine. There are consumers, however who prefer sweet, low acid fresh pineapple and 73-50 would fit into this category. The acid content of 59-656 was unusually high (1.23%) and this imparted a very 'tart' taste.

The three 'piping-leaf' hybrids and Josapine had very clean flesh with blemish rating ranging from 0.05 to 0.95 only. AF3-8 with a score of 7.9 would definitely preclude it from being recommended commercially either as fresh or canning variety. It was very susceptible to black eye caused by *Penicillium funiculosum*.

Yield *Table 3* computes the plot yields of the five genotypes and expresses them as a percentage of the control Josapine. Two variables, flowering percentage and tolerance to heart rot were used to compute the number of fruit obtained from the

Table 3. Yield and yield components of pineapple hybrids compared with Josapine

Genotypes	Flowering (%)	Survival to heart rot disease (%)	No. fruit per plot	Fruit wt. (kg)	Plot yield* (kg)	Yield comparison (% of Josapine)
73-50	77.9	97.3	182	1.76	320.3	176.6
59-656	98.7	49.8	118	1.58	186.4	102.8
53-116	64.2	90.9	140	1.16	162.4	89.5
AF3-8	100.0	100.0	240	2.00	480.0	264.6
Josapine	99.6	67.8	162	1.12	181.4	100.0

*Based on experimental population of 240 plants (60 plants/plot x 4 replicates)

experimental area consisting of 240 plants of each genotype. The product of number of fruit and mean fruit weight would give the yield of each genotype. The lowest yielder, 53-116 was the only genotype having lower yield (89.5%) compared with Josapine. Its poor yield arose from poor flower response and small fruit. 59-656 had a similar yield as Josapine while 73-50 was 76% higher yielding. The most impressive yielder was AF3-8 which was more than 2.5 times higher yielding than Josapine. AF3-8 was perfect in flower response, totally resistant to heart rot and coupled with the heaviest fruit, easily out-yielding all the other genotypes. Josapine, reported earlier to be fairly susceptible to heart rot (Chan et al. 2002), again showed susceptibility in this trial. 59-656 was the most susceptible to heart rot with only half its population surviving to fruit harvest. To reduce bacterial heart rot incidence in Josapine, Chan et al. (2002) recommended that foliar urea spray be avoided or reduced to prevent leaf scorching which may allow the entry of the *Erwinia* pathogen.

Fruit and plant weight relationship Chan and Lee (2000) have established that early fruiting in pineapple is related to the fruit:plant weight ratio, the higher ratio having higher possibility for earlier fruiting. The fruit:plant ratio, presented in *Table 2* indicated that AF3-8 had the highest ratio of 0.74 and therefore has good potential for early fruiting. The most inefficient genotype that partitioned more photosynthate to plant

mass than fruit is Josapine. *Figure 1* shows the relationship of fruit and plant weights of the five genotypes. It is clear that Josapine with a fairly 'flat' regression was an inefficient genotype. It is extremely vigorous, but increase in plant mass is not concomitant with fruit weight increase. On the other hand, AF3-8 was very efficient; a unit increase of plant mass was followed by 0.74 increase in fruit weight. 53-116 was the least vigorous genotype, with a scatter of plant mass concentrating around 2 kg only (*Figure 1*).

Rank-priority scores for selection

Table 4 shows the rank-priority scores used for selection of genotypes based on the 10 characters. 73-50 (*Plate 2*) appears to be the most promising selection with the lowest rank-priority scores (91), outperforming even Josapine. It does not have glaring shortcomings, and it excelled in the 'piping' smooth leaf character, resistance to heart rot and the three most important characters, i.e. fruit shape, TSS % and resistance to flesh blemish. The 'piping-leaf' character with completely smooth leaf margin will be a definite advantage to growers' comfort while working in the pineapple field. 73-50 has also been reported to be very high yielding in Hawaii and the fruit contains high vitamin C, but its weaknesses are low juice content and lacking in flavour (Williams and Fleisch 1993). Trials with 73-50 in Australia also showed that it performed very well and it has been recommended as a parent for hybridization programmes because of its

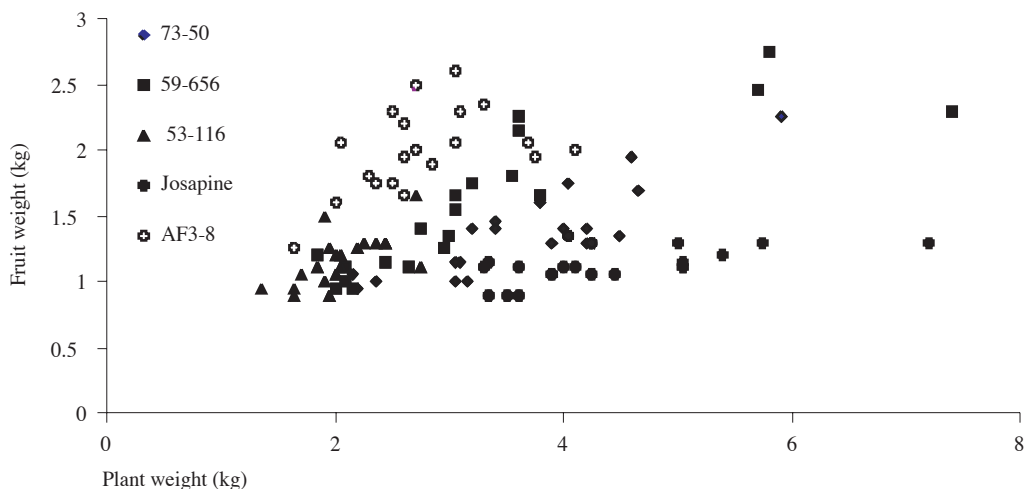


Figure 1. Fruit and plant weight relationship of five pineapple genotypes



Plate 2. 73-50: the most promising 'piping-leaf' hybrid

high breeding values (Sanewski 1998). This genotype has the potential to replace Gandul in the canning industry, and it may also have a place in the fresh fruit market because of its high sugar and low acid contents.

The other two 'piping-leaf' genotypes 53-116 and 59-656 did not fare well with high scores of 146 and 163 respectively. 53-116 had poor scores in flowering response and yield while 59-656 was rejected because of its poor scores in heart rot resistance and core size. However, 53-116 had a very narrow fruit core which might make it suitable for canning into 'mini' rings. This genotype was reported to have excellent product appearance and

excellent plant crop yield in Hawaii but failed to be adopted commercially because of a physiological glandular base defect (Williams and Fleisch 1993).

The worst genotype was AF3-8 with the highest rank-priority score of 179. Although it surpassed considerably the others in yield and the yield components (fruit:plant ratio, flowering response and resistance to heart rot), it had the most serious shortcomings in the three most important characters. Its tapering fruit shape, low TSS % and high susceptibility to flesh blemish will preclude any possibility of it being released as a commercial variety. AF3-8, however, may be recommended as a parent in hybridization programmes to improve yield, earliness in fruiting and resistance to heart rot disease.

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Table 4. Rank-priority scores for selection of genotypes based on 10 characters

Priority rating	Sucker	Leaf margin	Fruit: plant ratio	Flowering	Heart rot resistance	Yield	Core	Fruit shape	TSS	Blemish	Rank-priority score			
	Rank	RP	Rank	RP	Rank	RP	Rank	RP	Rank	RP	ΣRP			
1		2	3	4	5	6	7	8	9	10				
73-50	3	1	2	4	16	2	12	14	1	8	9	10	91	
59-656	3	1	2	1	4	3	18	35	4	24	36	1	10	163
53-116	5	1	2	5	20	5	30	7	3	24	27	1	10	146
AF3-8	2	5	10	1	4	1	6	14	5	40	45	5	50	179
Josapine	1	4	8	15	4	3	18	14	1	8	9	1	10	107

Rank = Genotype rank according to DMRT

RP = Rank x Priority rating of character

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Abstrak

Tiga nanas hibrid 'piping-leaf' yang diperkenalkan iaitu 53-116, 73-50 dan 59-656 diuji bersama Josapine dan AF3-8 sebagai kawalan. Hibrid 'piping-leaf' tidak mempunyai duri di tepi daun berbanding dengan genotip kawalan yang mempunyai duri di hujung daun. Hibrid ini tidak mengeluarkan banyak sulur tanah dan sulur angin, oleh itu tanaman ratun dengan hibrid ini mungkin sukar. Hibrid ini sangat rintang terhadap bintik di dalam isi dan mempunyai kandungan jumlah pepejal larut yang tinggi antara 13.9–16.3%. Hibrid yang terbaik ialah 73-50 yang hasilnya 76% lebih tinggi daripada Josapine oleh sebab gerak balas terhadap induksi pembungaan yang tinggi, kerintangan terhadap penyakit reput dalam dan saiz buah yang baik. Genotip ini berpotensi untuk menggantikan varieti Gandul dalam industri pengetinan dan mungkin juga ada tempat di pasaran buah segar kerana kandungan gula yang tinggi dan kandungan asid yang rendah.