

## Resistance to papaya fruit freckles among three breeding lines and their hybrids

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Key words: papaya, *Carica papaya*, hybridization, disease resistance, fruit freckle

### Abstrak

Tiga warisan kacukan ke asal iaitu Line 7, Line 19 dan Line 20 dalam generasi B<sub>2</sub>F<sub>4</sub> dan tiga kacukan di antaranya telah dikaji kerintangannya terhadap penyakit bintik buah di MARDI, Serdang. Data bilangan bintik/cm<sup>2</sup>, lebar bintik dan kejadian penyakit dinilai sepanjang dua musim: Februari 1985 (musim lembap) dan Mei 1985 (musim kemarau).

Buah yang dihasilkan pada musim lembap lebih teruk dijangkiti; bukan daripada segi bilangan bintik tetapi saiz bintik yang lebih besar. Gejala penyakit yang ditunjukkan oleh enam genotip tersebut berbeza tetapi tindakbalas genotip x musim telah mengelirukan pemilihan genotip yang rintang. Pemerhatian prestasi genotip pada setiap musim menunjukkan Line 20 lebih rentan daripada Line 7 atau Line 19. Line 19 paling rintang. Kacukan Line 19 dengan Line 20 mengurangkan kejadian penyakit bintik di antara 27% hingga 68% jika dibandingkan dengan Line 20 yang rentan.

### Abstract

Three backcross lines viz., Line 7, Line 19 and Line 20 in the B<sub>2</sub>F<sub>4</sub> generation and their three possible hybrids were evaluated for fruit freckle resistance at MARDI, Serdang. Data on the number of freckles/cm<sup>2</sup>, diameter of freckle and disease severity were measured over two seasons: February 1985 (wet period) and May 1985 (dry period).

Fruits harvested during the wet season showed higher severity, not in terms of number of freckles but in freckle size. The six genotypes were found to be significantly different in expression of symptoms but significant genotype x season interaction complicated the selection of resistant lines or crosses. Examining the performance of the lines by each season, it was found that Line 20 was consistently more susceptible than Line 7 or Line 19. Line 19 was the most resistant. Line 19 x Line 20 crosses showed marked improvement ranging from 27% to 68% reduction of symptoms compared with the susceptible Line 20.

### Introduction

Fruit freckle is widespread in the Solo papayas and is considered a disease of unknown cause in Hawaii (Hine et al. 1965). Repeated isolation by these

workers have failed to consistently yield an organism of a possible parasitic nature. At MARDI, however, there is increasing evidence that the disease is pathogen related (Lim, W.H., MARDI,

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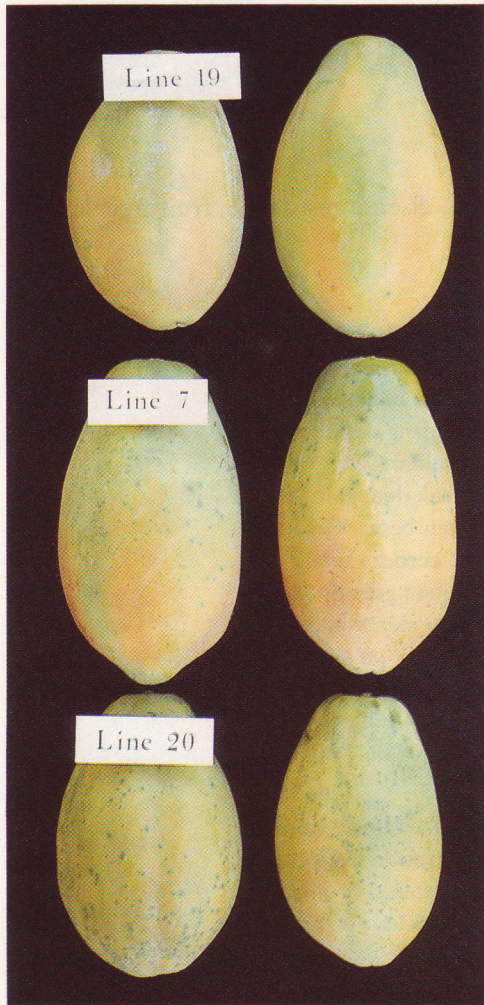


Plate 1. Expression of fruit freckles in three backcross lines

Klang, pers. comm., 1986).

The symptoms appear as superficial water-soaked spots of variable sizes (Plate 1), more apparent on the exposed surface of the maturing fruit on the tree. The spots are apparently associated with the lenticels of the fruit skin (Hine et al. 1965). Although the freckles do not affect the eating quality of the fruit, the cosmetic appeal of affected fruits may be considerably reduced.

The backcross breeding programme at MARDI used Sunrise Solo as the recurrent parent and the local Subang 6, which is resistant to freckling, as the non-recurrent parent. Freckling was prevalent in the early generation progenies, evidently as a result of repeated crosses with the susceptible Sunrise Solo. However, three selected lines in the  $B_2F_4$  generation showed variation in expression of the symptoms. Freckle-free fruit is an important consideration because the Backcross Solo variety is developed as a high quality dessert fruit with good potential for export. The present study evaluates the severity of freckling among the three backcross lines and their hybrids and discusses the possible ways to reduce the incidence in future generations.

#### Materials and methods

Three backcross lines viz., Line 7, Line 19 and Line 20 in the  $B_2F_4$  generation and their three possible hybrids viz., 7 x 19, 7 x 20 and 19 x 20 were used in the study. The  $B_2F_4$  lines were derived from three crosses to the recurrent Sunrise Solo (including the  $F_1$  cross with the non-recurrent Subang 6) and subsequently selfing to the  $F_4$  generation. Details of the backcross programme have been discussed by Chan (1987).

The six genotypes were planted on 8 January 1985 at MARDI, Serdang, in a randomized complete block design with four replicates and with 20 trees per plot. The trees were spaced at 1.8 m within rows and 2.7 m between rows. The trial was irrigated with a trickle system. A bi-monthly fertilizer application of formulation 12:12:17:2 + TE was given at a rate of 2.7 kg/tree per year. Anthracnose was controlled with monthly rounds of *Dithane M45* while *Kelthane* and *Alboral* were used against spider mites and scale insects respectively. The experimental plots were kept free from weeds throughout

the study using *Paraquat* on monthly rounds.

Data on freckling was taken over two seasons. The first set was taken in February 1986 (rainy period) and the second in May 1986 (dry period). Eighty mature fruits per season of each genotype were scored for disease symptoms. The symptoms included number of freckles counted using 1-cm<sup>2</sup> windows on cards taken at three areas with colour breaks on the fruit and the measurement of the diameter of the freckles. The severity of the disease was expressed as the area of the infection (calculated as number of freckles  $\times \frac{\text{diameter}^2 \times \pi}{4}$ ).

The main effects of breeding lines and seasons and their interactions were analysed with the Generalized Linear Model in SAS.

**Results and discussion**

The six genotypes were significantly different for all the characters but seasonal differences were detected only for diameter of the freckle and severity (Table 1). Significant genotype x season interaction indicated that the lines and their crosses did not express symptom changes in the same relative proportion over the two seasons. In this case, it was necessary to study the performance of individual lines and crosses in each season before concluding on the superiority of the genotypes.

Comparing the means of the two seasons, it appears that conditions in season 1 which coincided with a wet period, were more conducive to freckling (Table 2). Although the number of freckles recorded in both seasons were similar, the diameter of the freckles was significantly larger in season 1, leading to higher disease severity in that season. This observation supports evidence that the disease may be pathogen related.

The small disproportionate changes in values showed by the genotypes from one season to another caused the genotype x season interaction to be significant. Although its presence complicated the identification of resistant genotypes, some firm conclusions about the relative resistance of the lines and their crosses can be elucidated when each season was examined separately. Line 20 was consistently more susceptible for the three measurements of symptoms than Line 7 or Line 19, the latter being the most resistant (Plate 1 and Table 2). It is encouraging to note that the susceptible Line 20 when crossed with the more tolerant Line 19 produced the progeny (19 x 20) which showed significantly lower disease symptoms than the susceptible parent. This cross behaved like the intermediate Line 7. Line 20 is generally regarded as more adaptable than the other lines but its major weakness is its susceptibility to fruit freckling. As the three lines (Line 7, Line

Table 1. Analysis of variance for number, diameter and severity of fruit freckle

Source	df	No. of freckles	Diameter	Severity
		MS	MS	MS
Replicate	3	5.60*	0.06ns	4.71ns
Genotype	5	69.36**	0.54**	209.50**
Season	1	3.22ns	4.67**	704.59**
Genotype x season	5	6.29**	0.13**	65.69**
Error	33	1.08	0.02	6.01
Total	47			

Table 2. Genotypic means for freckle symptoms over two seasons

Genotypes	No. of freckles		Freckle diameter		Severity				
	Season 1	Season 2	Mean	Mean	Season 1	Season 2			
	Mean	Mean	Season 1	Season 2	Mean	Mean			
Line 20	9.37a	13.15a	11.26a	1.51ab	0.81ab	1.16b	19.03a	7.27a	13.15a
Line 7 x Line 20	6.38b	5.50b	5.94b	1.87a	0.93a	1.40a	21.45a	4.88b	13.16a
Line 19 x Line 20	5.10b	4.68b	4.89bc	1.09cd	0.62bc	0.86cd	6.77b	1.65c	4.21bc
Line 7 x Line 19	4.66b	4.50b	4.58bc	1.19bc	0.66bc	0.92c	6.28b	1.79c	4.04bc
Line 7	4.62b	4.08b	4.35c	1.44bc	0.59bc	1.02bc	8.86b	1.31c	5.08b
Line 19	2.08c	3.41b	2.75d	0.77d	0.52c	0.65d	1.32c	0.83c	1.05c
Mean	5.37	5.89		1.31	0.69		10.62		2.96

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

19 and Line 20) are in fact closely related sib families, intercrossing between them will not be expected to bring about major changes in the other fruit qualities of the Backcross Solo. Hybridization between Line 19 and Line 20 presents a useful method in alleviating the incidence of freckling in Line 20. The cross of Line 20 with the intermediate Line 7, however, was not worth considering. Although the number of freckles was considerably reduced as compared with the susceptible Line 20, the size and severity of the freckles of the progeny (Line 7 x Line 20) remained the same (Table 2).

### Conclusion

The causal agent of fruit freckling has not been hitherto identified. However, the present studies support, to some extent, that it is pathogen related because fruits harvested during the wet season showed higher severity, not in terms of freckle number but in freckle size. The studies further indicated that genotypes did not express the symptoms in the same proportionate extent over the two seasons thus complicating efforts in identifying resistant lines or crosses. Although genotype x season interaction occurred, examination of the performance of the genotypes by each season gave clear evidence that Line 20 was consistently more susceptible than Line 7 or Line 19. The latter was the most resistant. The progeny from Line 19 and Line 20 cross showed considerable improvement in the range of 27% to 68% reduction in freckling symptoms compared with the susceptible parent.

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