Levels of self-pollination & cross-pollination among fruit on a Queensland strawberry farm

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- DNA fingerprinting reveals that almost all achenes (seeds) arose from self-pollination rather than cross-pollination
- Fruit size increased with an increasing number of filled achenes on each fruit

Dr Christopher Menzel provided an excellent review in Edition 8 (Spring 2021) of the Australian Berry Journal on the importance of pollination for strawberry production. His review highlighted that most strawberry cultivars are self-compatible, meaning that they only require pollen from the same cultivar rather than from a different cultivar to fertilise the achenes (seeds). He also pointed out that pollinating insects are important for increasing the amount of pollen deposited on the flowers, increasing the number of achenes that fully develop on the fruit and, as a consequence, increasing the yield of large marketable fruit.

Self-compatible strawberry cultivars are good for growers because they mean that fruit production is not dependent on pollen being transported across the farm from one cultivar to another. However, just because strawberry cultivars are self-compatible does not mean that their achenes can only be self-fertilised. Some flowers might receive pollen from a different cultivar and so some achenes might be cross-fertilised. A strawberry fruit might contain a mixture of self-fertilised and cross-fertilised achenes. Cross-pollination may be more frequent where one cultivar is planted very close to another cultivar, because the insects on flowers there are more likely to have arrived from the flowers of a different cultivar.

We used DNA fingerprinting techniques to determine what percentages of strawberry achenes arose from self-pollination versus cross-pollination on a strawberry farm (Strawberry Fields) at Palmview in southeast Queensland (Figure 1). The farm contained three cultivars, 'Red Rhapsody', 'Sundrench' and 'Scarlet Rose–ASBP'.

We studied a block on the farm where 44 rows of Red Rhapsody were planted next to 49 rows of Sundrench. We assessed DNA from the fruit of 24 plants for each cultivar. The plants were located along six transects per cultivar, with each transect consisting of a plant in the first row (1m), third row (3m), tenth row (10m) and twentieth row (20m) from the other cultivar. Three mature fruit per plant were harvested on 25 July 2019 and three mature fruit per plant were harvested on 28 August 2019. Ten achenes were analysed from each fruit. This meant that we analysed DNA from nearly 3000 achenes.

Almost all achenes on the fruit of both cultivars arose from self-pollination (Figure 2). Only 21 out of 1440 Red Rhapsody achenes (1.5%) were cross-pollinated, with cross-pollinated achenes being detected in only 14 out of 144 Red Rhapsody fruit. Similarly, only 32 out of 1440 Sundrench achenes (2.2%) were cross-pollinated, with cross-pollinated achenes being detected in only 28 out of 144 Sundrench fruit. The percentages of fruit that were partly cross-pollinated did not differ significantly with distance from the other cultivar. The percentages of cross-pollinated achenes per fruit were also not affected significantly by distance from the other cultivar.

On average, 96% of Red Rhapsody achenes were filled (Table 1) but only 78% of Sundrench achenes were filled (Table 2). The sizes of both Red Rhapsody and Sundrench fruit were strongly related to the number of filled achenes on each fruit (Figure 3). Colour, firmness and Brix:acid were not affected significantly by the number or percentage of filled achenes in either Red Rhapsody (Table 1) or Sundrench (Table 2).

Figure 1. Red Rhapsody and Sundrench plants at Strawberry Fields, Palmview, Queensland. Photo credit: Wiebke Kämper

Figure 2. Percentage of partly cross-pollinated fruit and fully self-pollinated fruit of (A) Red Rhapsody and (B) Sundrench at different distances from the other cultivar. Means (+SE) for cross-pollination levels within each cultivar do not differ significantly across rows (GLM, $p > 0.05$, $n = 6$).

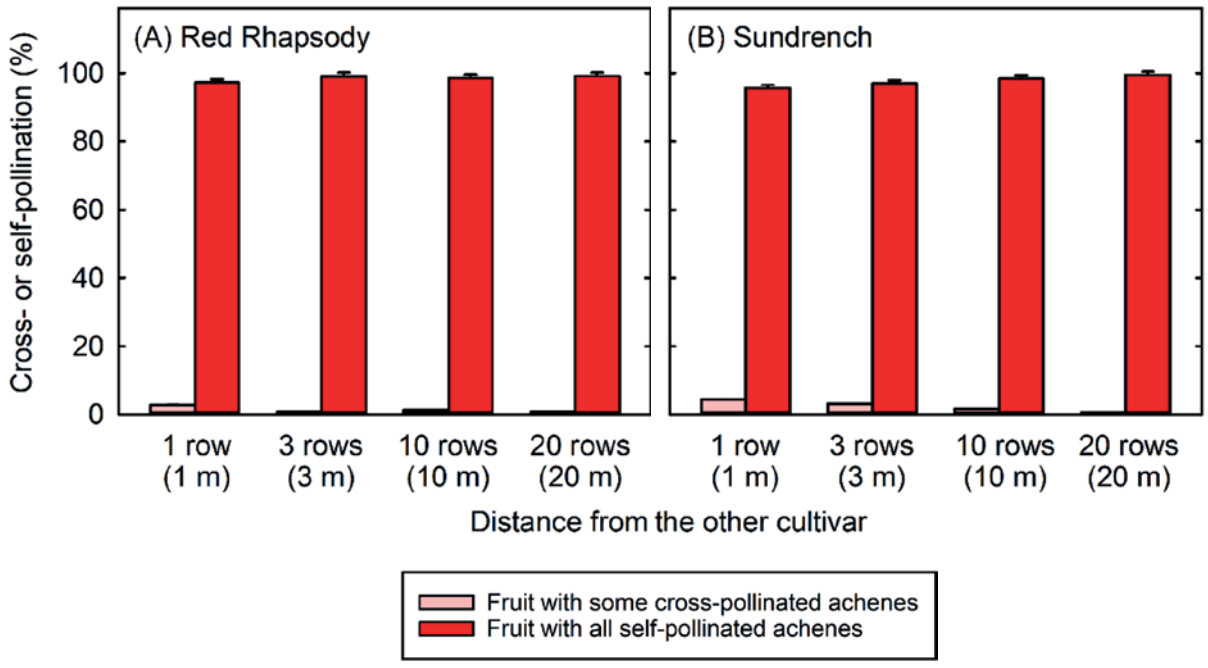


Table 1. Strength of relationships (r^2: 0–1 scale) between the number or percentage of filled achenes and the size or quality of Red Rhapsody fruit.

Red Rhapsody fruit had 270 filled achenes on average, which represented 96% of all achenes.

Fruit size & quality	Number of filled achenes		Percentage of filled achenes	
	r^2	P	r^2	P
Length	0.04	*	<0.001	
Diameter	0.33	***	0.02	
Mass	0.42	***	0.03	*
Brightness	0.01		0.02	
Redness	0.005		0.006	
Yellowness	0.001		0.015	
Firmness	0.007		0.001	
Brix: Acid	0.025		0.014	

Significant linear regressions are indicated by asterisks (* P < 0.05; *** P < 0.001; n = 14-129). All r values were positive.

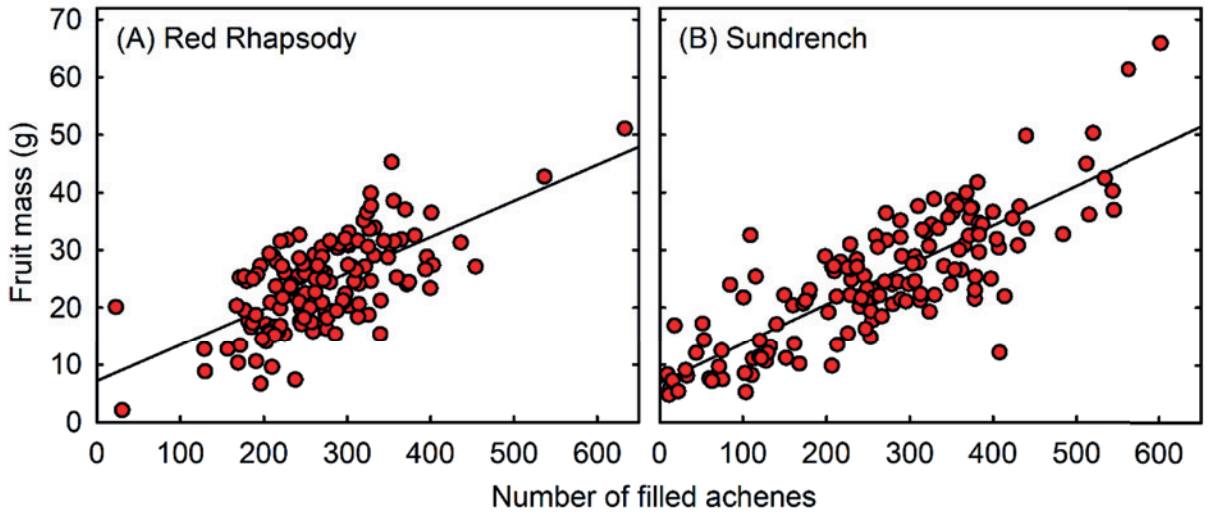
Table 2. Strength of relationships (r^2: 0–1 scale) between the number or percentage of filled achenes and the size or quality of Sundrench fruit.

Sundrench fruit had 263 filled achenes on average, which represented 78% of all achenes.

Fruit size & quality	Number of filled achenes		Percentage of filled achenes	
	r^2	P	r^2	P
Length	0.69	***	0.32	***
Diameter	0.65	***	0.31	***
Mass	0.68	***	0.26	***
Brightness	0.06		0.02	
Redness	0.001		0.003	
Yellowness	0.001		0.012	
Firmness	0.003		0.006	
Brix: Acid	0.004		0.007	

Significant linear regressions are indicated by asterisks (*** P < 0.001; n = 28-116). All r values were positive.

Figure 3. Relationships between fruit mass and the number of filled achenes on (A) Red Rhapsody fruit and (B) Sundrench fruit.



Relationships between fruit size and the number or percentage of filled achenes are a common feature among strawberry cultivars, as explained by Dr Christopher Menzel last year in the Australian Berry Journal.

Our results support his conclusion that exposing the flowers to more pollinators, for example by introducing bee hives, is likely to increase the yield of marketable fruit by improving pollen deposition, achene filling and fruit size.

Moreover, pollinators do not need to deposit cross-pollen (i.e. from a different cultivar), at least in the case of Red Rhapsody and Sundrench, because these cultivars can produce marketable fruit almost entirely as a result of self-pollination (i.e. with pollen from the same cultivar).

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