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STUDIES ON THE COMPATABILITY OF SIX HYBRID TEA ROSES

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It was found that all the cultivars must have produced fertile pollen for all the 6 x 6 crosses produced at leat some viable seeds. Some cultivars were poorer than others when used as females but no cultivar was always poor. The significant growth correlation between the number of viable seeds per hip helps to confirm the view that hip growth is controlled by the fruits develeping in the hip. The viability of seed (tested with 1% tetrazolium chloride solution) generally ranged between 40% and 60%.

INTRODUCTION

In the breeding of new cultivars of roses there are many factors which influence seed production. These include pollen behaviour prior to pollination, pollen germination and pollen tube growth, stylar and stigmatic compatibility, aneuploidy, polyploidy, apomixis, gametic and zygotic lethals, abortion and dehiscence of immature hips. In addition, the temperature and relative humidity prevailing during pollen maturation, pollen storage and crossing can affect the success rate. Lata (1971) found that tetraploid cultivars are mainly self-incompatible and reported good seed set in six intervarietal crosses although he indentified one variety, Gruss an Coburg, which was highly female sterile The relative ease of hybridization of cultivars has been reported by Atkins (1975) who listed some cultivars as good males, some as good female and some as both good males and females. A comprehensive review of rose breeding with a discussion of its genetical basis has been given by Pal (1963).

The practice of breeders is not constant. The method of Kordes *et al.* (1977) was to identify a plant which was particularly useful as either a male or a female parent and to avoid making reciprocal crosses while Kordes (1977) when seeking for a special colour used a number of mother plants and made a few crossess over a wide range to see what would happen. Breeding of roses appears to be more of an art than science, Nevertheless, some cultivars are much more useful as female than as male parents and vice-versa. In addition

fresh and stored pollen were compared as were different months. A comparison of fresh and stored pollen in relation to crossing and fruit set in different cultivars was reported by Wholers and Morey (1963). Visser *et al.* (1977) reported that some of the cold-stored pollen induced a reasonable seed set after one year but a low seed set was obtained using pollen stored for two years at 1°C and low humidity. Pembert *et al.* (1963) suggested that environmentol factors during pollen ontogeny were important in determining pollen viability and reported that stored pollen was less effective than fresh.

The present investigations were conducted to study the extent of intervarietal compatibility using some hybrid tae cultivars which have been reported to be 'difficult' and actual germination of hybrid seed (F_1) was not carried out. Instead, the viability of the embryos was tested using 2, 3, 5, triphenyl-tetrazolium chloride.

MATERIALS AND METHODS

Six cultivars, Apricot Silk, King's Ransom, Peace, Wendy Cussons, Josephine Bruce and Alec's Red were used. Twelve plants of each cultivar were planted in an unheated glass-house at Pen-y-ffridd Field Station Bangor. A preliminary survey of the fertility of pollen was made. One set of six labelled vials containing pollen from the test plats was placed in a desiccator containing calcium chloride and stored in a controlled temperature at 4°C for the use cross pollination. Another set was also placed in the desiccator stored in the same room and this pollen was used for pollination monthly from June to September.

In the Experiment, flower buds were emasculated on the evening before anthesis and bagged. Pollen was applied over the stigmatic heads the following day when the flowers were again bagged and labelled. The bags were removed after the stigmatic heads and turned brown or black when they had lost their receptivity. Crosses were made as female parents became available using stored as well as fresh pollen on different flowers. The several treatments were distributed at random in time over the four months period. Fruit set was recorded and fully-ripe rose hips were collected approximately six months after pollination.

The following characters were studied :

1. Hip size which was measured as hip diameter every two weeks from fruit set upto maturity.

2. Number of seeds per hip.
3. Viability of seed determined by the tetrazolium test. A 1% solution of TTC (2, 3, 5, triphenyl-tetrazolium chloride was used for the viability of seed.

The analysis of the data was not always straightforward for there were unequal number of crosses made. However, values and standard errors were calculated.

RESULTS

Male and female component crossing.

The chance of successfull fruit set did not depend significantly on the male component of the cross. The chance of successful fruit set depended significantly on the female component of the cross, Apricot Silk was the most successful female parent and Peace and Wendy Cussons were the least successful although when selfed both gave average fruit set. King's Ransom pollen on Wendy Cussons and Josephine Bruce pollen on Peace led to very poor fruit set. The most successful fruit set occurred with Alec's Red pollen on Apricot Silk as given in Table 1.

Table 1 : *Percentage of the crosses giving successfull fruit set. Different cultivars used as male and female parent. (In brackets the number of attempts made).*

Male / Female	Apricot Silk	King's Ransom	Peace	Wendy Cussons	Josephine Bruce	Alec's Red	Means
Apricot Silk	55.6 (27)	52.5 (40)	40.7 (27)	48.5 (33)	46.7 (15)	63.3 (30)	52
King's Ransom	52.3 (44)	48.3 (29)	41.7 (24)	42.5 (40)	34.4 (32)	34.3 (35)	43
Peace	22.2 (18)	30.8 (26)	45.0 (20)	20.0 (25)	10.7 (28)	28.0 (25)	25
Wendy Cussons	24.3 (37)	7.7 (13)	28.6 (21)	40.9 (22)	33.3 (27)	19.4 (31)	26
Josephine Bruce	50.0 (26)	39.3 (28)	17.4 (23)	34.8 (23)	36.7 (30)	25.0 (24)	34
Alec's Red	40.0 (25)	30.8 (26)	34.8 (23)	35.7 (28)	35.7 (28)	36.8 (19)	36
Means	42	39	35	38	32	35	

X^2 = 4.5 for male component; N. S. ; X^2 = 34.9 for female component; ***;

The effect of time of seasn on fruit setting

The chance of fruit set was greater following pollination in July and August than in June or September (Table 2).

The effect of fresh or stored pollen on fruit set

The data in Table 3 show that fruit set was more successful with stored than with fresh pollen.

Table 2 : *Percentage of crosses leading to successful fruit set following pollination during various months.*

	June	July	August	September	Mean
Total No. of crosses made	221	329	242	180	—
Successful fruit set (%)	29	45	40	27	37

$X^2 = 23.3$ * * *

Table 3 : *Comparison of fresh and slored pollen in relation to fruit se .*

	Fresh	Stored	Mean
Total No. of crossess made	364	387	—
Successful fruit set (%)	34	44	39

$X^2 = 8.9$ * *

Hip size from different crosses

The data in Table 4 show that as females Peace, Apricot Silk, King's Ransom and Wendy Cussons bore larger hips than did Alec's Red and Josephine Bruce. The differences in hip size due to the pollen parents were much less. There were some some interactions. For example, pollen of Peace on stigmas of Apricot Silk led to an apparent increase in hip size and King's Ransom pollen on Peace stigmas led to an apparent decrease in hip size.

Number of seeds per hip

On average, hips of Apricot Silk and Wendy Cussons contained more seeds than hips of the other cultivars (Table 5). Similarly, pollen of Apricot Silk appeared to increase, ($P<0.05$) on average, the number of seeds per hip. However, if the intrahybrid results are used for comparison other results merit attention. When Apricot Silk was used as the female parent pollen from other cultivars increased the number of seeds above that of self pollen ; for Kihg's Ransom, pollen of Wendy Cussons and of Josephine Bruce depressed seed set,

but with the Apricot Silk pollen there was an increase. For Wendy Cussons, pollen of Josephine Bruce greatly increased seed number per hip and for Alec's Red, which showed poor intrahybrid results, pollen of Apricot Silk, Kings Ransom and Peace all led to increases ($P<0.05$). The use of pollen from Apricot Silk or King's Ransom led to higher seed ($P<0.05$) numbers in Apricot Silk, King's Radsom and Alec's Red than in Josephine Bruce. Pollen from Peace gave low seed numbers in King's Ransom and Alec's Red. The latter cultivar was notable because in general its own pollen was apparently inferior to those of all other cultivars in respect of the number of seed per hip.

Table 4 : *The effect of pollen from different p rents on hip size.*

Male / Female	Apricot Silk	King's Ransom	Peace	Wendy Cussons	Josephine Bruce	Alec's Red	Means
Apricot Silk	2.9	2.7	3.2	3.0	2.7	2,6	2.9
King's Ransom	2.8	2.9	2.8	2.8	2.7	2.9	2.8
Peace	3.1	2.7	3.1	3.2	3.0	2.8	2.9
Wendy Cussons	2.7	2.8	2.7	2.7	2.9	2.4	2.7
Josephine Bruce	2.3	2.2	2.3	2.3	2.1	2.2	2.2
Alec's Red	2.6	2.5	2.4	2.5	2.2	2.2	2.3
Means	2.8	2.7	2.8	2.8	2.6	2.5	
S. E.	0.05	0.05	0.06	0.06	0.06	0.07	

Viability of seed tested with tetrazolium chloride (TTC)

Most of the results lie between 40% and 60% viability (Table 6). Values for Alec's Red were rather consistently low. For Apricot Silk as a female, pollen of Peace and of Wendy Cussons appeared to increase the viability and for King's Ransom, Wendy Cussons pollen led to a similar result. Peace as a female yielded the highest ($P<0.05$) percentage of viable seeds with Apricot Silk pollen and for Josephine Bruce all foreign pollens apparently gave higher values for percentage viability of the seed than did its own pollen.

Table 5 : *The effect of pollen from different parents on the number of seeds produced.*

Male / Female	Apricot Silk	King's Ransom	Peace	Wendy Cussons	Josephine Bruce	Alec's Red	Means	S. E
Apricot Silk	21.4	14.8	16.9	14.9	19.2	14.3	17.8	0.89
King's Ransom	20.7	15.3	12.3	8.7	8.8	11.4	13.8	1.15
Peace	17.0	11.7	16.4	15.3	12.8	12.3	14.3	0.97
Wendy Cussons	15.2	19.0	15.5	17.2	25.3	16.5	18.3	1.92
Josephine Bruce	11.5	9.8	15.8	12.8	13.6	13.8	12.8	1.23
Alec's Red	21.0	15.6	12.7	8.5	7.0	8.1	11.3	1.04
Means	19.3	14.4	15.1	13.2	14.2	12.4		
S. E.	1.02	1.24	1.21	1.03	1.37	0.90		

Table 6 : *The effect of pollen from different parents on the viability of the seeds produced. Percentage of seed produced that was viable : rating 1 or 2 in tetrazolium test. (For percentage of seed of rating 1 in tetrazolium test see Table App. 2.2).*

Male / Female	Apricot Silk	King's Ransom	Peace	Wendy Cussons	Josephine Bruce	Alec's Red	Means	S.E .
Apricot Silk	46.0	47.7	61.6	62.4	50.8	41.3	51.6	2.2
King's Ransom	47.1	53.4	58.9	65.1	57.0	50.1	55.2	2.3
Peace	67.6	55.8	52.4	56.6	52.0	52.9	56.3	1.9
Wendy Cussons	61.3	56.5	52.4	55.3	51.6	64.8	57.0	2.9
Josephine Bruce	50.0	58.4	58 9	51.6	40.0	54.9	52.3	2.8
Alec's Red	43.6	45.5	30.0	42.3	46.5	32.1	40.0	3.1
Means	50.0	51.5	51 6	56.5	50.2	46.6		
S. E.	2 2	2.3	2.7	2.9	3.5	2.3		

Judging from the mean values, all the chosen cultivars appeared to be equally successful as male parents perhaps because of the high viability of their pollen; but there were some individual crosses which gave low values for fruit set. As female parents, significant differences were found between the average performances of cultivars. Peace and Wendy Cussons as female parents produced the lowest mean fruit set. This may have been due to certain physiological as well as genetical factors which occurred between pollination and fruit setting The pollen grains, after landing on the stigmatic surface of the ovary, absorb water and other substances, such as sugar, and germinate by producing a tube which grows down type style to the embryo sac. The pollen tube penetrates the embryo sac, where one male gamete unites with the egg to form the zygote which by mitotic division becomes the embryo. Embryo development appears to control the development of the hip (Janick, 1972).

In this whole process there are many physiological and environmental factors involved. If any one fails or is 'wrong' potential hips fail to develop. For example, pollen incompatibility is a physiological mechanism that prevents self-fertilization. Sometimes genetic factors serve to prevent pollen tubes produced by a plant from growing into the style and when these species or cultivars are used in cross-pollination a similar reaction may lead to limited fruit set. Some factors may vary from day to day, from plant to plant, and even from flower to flower and consequently affect fruit set (Flory, 1950). Some of the factors are effective before fertilization and others after fertilization.

In the present study, fruit set and viable seed production were not different in general between intra and intervarietal crosses. Some rose breeders (Lata, 1971; Pal, 1969) have reported that more seeds were produced in inter- than in intra-varietal crosses.

The reciprocal differences in seed production especially in crosses involving cultivars'Alec's Red'and'Josephine Bruce'may be due to a sporophytic incompatibility system. In this, the reaction of the pollen is determined by the genotype of the sporophytic tissues in which it was formed and it is controlled by two S alleles and all the pollen of a plant has the same incompatibility reaction. The two S alleles may react independently or may interact by one being dominant over the other. These relationships may exist in pollen or pistil, or in both or even may not exist at all (Frankel and Galun, 1977). The

dominance/independence relationships of S alleles may differ in pollen or pistil. Therefore, such a dominance relationship may lead to complex incompatibility reactions.

Generally between 40 and 60% of the seeds produced were viable (as determined by the tetrazolium test). The mean numbers of viable seeds per hip are given in Table 9. From these results it is reasonable to conclude that a rose breeder would obtain sufficient viable seeds of any of the crosses made, to allow him to select from the progeny. None of the attempted crosses failed totally.

The use of tetrazolium chloride as a test of viability does provide an estimate of the potential vigour of seeds for other workers have compared the tetrazolium test with germination (Metzer, 1961; Moore, 1964; Buszewicz and Holmes, 1957). They concluded that tetrazolium ratings were significantly correlated with the results from the chemical test were available within four to six hours while evaluation by germination required between four to six weeks. In the case of *Rosa*, Blundell (1973) reported that untreated seeds of roses take at least two to three months to germinate and that some hybrid seeds may take upto a year.

The greater success fruit set in July and August than in June and September (Table 2) must have been due to factors on the female side for the differences were found using both fresh and stored pollen. The existence of such factors has been emphasized by Peimbert *et al.* (1963) and Pal (1963).

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