duced flowering on the stock seedlings, the second treatment is best suited for hybridization. Under this treatment, the stock seedling is least damaged and, therefore, it can be further grown to study its bearing behaviour after recording the fruit characters of F_1 progeny. The main precaution in this technique is the choice of the scion. It should be a definitely regular bearing variety of mango and the shoots selected for inarching should be well matured and healthy so that they may flower in the next blossoming season. Three varieties, viz., Totapari Red Small, Totapari Hyderabad and Romani are best suited for this purpose under North Indian conditions. The present technique is very simple, easy as well as economical and will be of immense help in assuring extensive mango breeding work.

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POLLINATION AND FRUIT SET OF YELLOW PASSIONFRUIT IN SOUTHERN FLORIDA

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Since 1936, at least 62 introductions of several *Passiflora* species have been grown and evaluated at the U. S. Plant Introduction Station, at Miami. At the present time individuals from 2 introductions—1 of the yellow-fruited form *P. edulis* Sims, introduced from Trinidad, the other a clone of *P. laurifolia* L. collected in Java—are thriving on their own roots in the field there. Only 13 introductions of the 62 are represented by at least 1 living individual. Eight of these are recent introductions, and have not yet been tested extensively in field plantings. Nothing remains of a test planting of 18 introductions planted in 1936 and 1937.

In late August 1958, it became evident that some *Passiflora* vines were dying suddenly without apparent cause. The dead and dying vines were found to be heavily infected with a species of *Fusarium* fungus. At about that time grafting onto stocks of *P. laurifolia* L. (P. I. 159620) known to have survived well at the Miami station was initiated. Deaths of individual own-rooted clones of *P. edulis* have continued to complicate this study, but 9 of the 10 vines originally grafted on *P. laurifolia* have persisted. More recently, weak clones have been grafted on rooted cuttings of the most vigorous clones of *P. edulis* (P. I. 243804) but insufficient time has elapsed to evaluate completely this cion-stock combination.

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SELF-INCOMPATIBILITY

The yellow-fruited form of the purple passionfruit (*Passiflora edulis* Sims f. *flavicarpa* Deg.) is grown commercially in Hawaii (1). Some 5 years ago it was reported that contrary to earlier belief, the yellow passionfruit is self-sterile under Hawaiian conditions (2). Carpenter bees were later found of critical importance to obtain a good fruit set in Hawaii (3). The yellow passionfruit grows well in Queensland, but is said to show a tendency to self-incompatibility (4).

Self-pollinations of *Passiflora edulis* (P. I. 243804, P. I. 243805) and *P. foetida* L. (P. I. 201504) made by P. K. Soderholm, set no fruit at the Miami station in 1959, while a clone of *P. suberosa* L. wild or feral in the area (P. I. 277483) proved self-compatible and set seed without hand-pollination. Natural crossing between adjacent plants of *P. foetida* resulted in fruit set at that time. The majority of the *P. edulis* clones had already been found to be productive only when artificially pollinated. One clone which set fair crops from open-pollination was selected in 1959. This is referred to in the rest of this paper as clone 3-43(—45). In 1959 unsuccessful attempts were made to germinate pollen of *P. edulis* in 0.5 per cent agar solutions to which 5, 10 and 20 per cent sugar was added. The pollination investigations were carried forward by J. G. Gosselink in autumn 1960 and spring 1961. These results are included in table 1 with results from the current year's work.

The plants used in the pollination investigation reported here were all *Passiflora* introductions growing in the field at the U. S. Plant Introduction Station at Miami. The bulk of the 1962 work centered on *P. edulis* f. *flavicarpa* after attempts to obtain fruit set in *P. quadrangularis* L., *P. foetida,* and *P. laurifolia* through hand-pollination failed. Results with the last 3 species were not conclusive, but failures with *P. laurifolia* may be the result of having only 1 clone of this species available at present. Both *P. laurifolia* and *P. foetida* have produced an abundance of pollen which appears "good", but have set no fruit in 1962. Failures with *P. quadrangularis* may be due to defective pollen as the pollen produced by the several clones here has always appeared relatively scanty. All plants of *P. quadrangularis* in the field are on their own roots and none show vigor, nor do plants of *P. edulis* grafted on *P. quadrangularis.*

Materials and Methods

Self- and cross-pollinations in *Passiflora edulis* f. *flavicarpa* were begun in April 1962. A more extensive program of controlled selfing and crossing continued from July into the autumn of 1962. Successes and failures were recorded within a week after pollination, by which time the fertilized ovary had swollen considerably or the flowers had already abscised in failures.

Three introductions were used. Seedling clones 1-1 through 1-13 derive from P. I. 243804; 1-14 through 1-33 and clone 3-43 (—45) from P. I. 243805. Clone 3-32 (P. I. S. 17236) was propagated from a reputedly self-fruitful seedling growing in a Miami garden.

In a series of pollinations carried out from August 21 through 30, 1962, the stigmas were removed from the ovary 24 hours after pollination and macerated in a saturated chloral hydrate solution. Aceto-carmine squashes of the pollinated stigmas were then prepared following the method of Esser (5), with the modification of soaking the stigmas in 80% acetic acid at 60° C. for an hour after removal from the chloral hydrate and then in a 10 percent hydrochloric acid solution immediately before squashing. It was hoped to determine the extent of pollen inhibition by this means. After the 24-hour pollinations were made, additional self- and cross-pollinations of clones 1-1, 1-7 and 1-13 were made. Stigmas from this work were collected at various intervals, all less than 24 hours after pollination, and squashed just as those from the first lot.

Results

The fruit set resulting from pollination work during the past 3 seasons is summarized in table 1. From this it can be seen that a total of 136 fruits have resulted from open pollinations, while hand pollinations have produced 424 fruits—55 from selfing and 369 from cross-pollination.

Reactions to cross- and self-pollinations in 8 different clones are summarized in table 2. Four of the 8 clones—1-1, 1-10, 3-43(—45) and 5-18, hereinafter designated group I—are completely self-incompatible, while the second 4—1-7, 1-13, 1-26 and 1-32, hereinafter termed group II—are only partially so. Though more data are desirable, the information presently available allows the 8 clones to be segregated into the 2 groups. In table 2, all pollination combinations in which 60 percent or more of the flowers set fruit are classified "compatible", those in which from 5 to 59 percent set fruit as "partially incompatible", and those setting less than 5 percent as "incompatible". This arbitrary classification procedure is considered a satisfactory short-hand method of classifying the pollination reactions of the different clones. Most members of group II are only partially incompatible with other members of the same group. Group II plants are wholly cross-compatible with group I plants except in the cross 1-7 x 3-43(—45).

When used as a seed parent, clone 1-7 has not shown complete cross-incompatibility with any other member of group II. Furthermore, 1-7 has shown only partial compatibility with 3-43(—45) from group I, a compatible pollen parent with the other clones in group II. The reciprocal cross, 3-43(—45) x 1-7 is completely compatible. Used as a pollen parent, 1-7 has been completely incompatible only with 1-32, and has even shown partial self-compatibility, which peculiarity it has shared with the other 3 clones in group II as well as with clone 3-32 which died in the field before it was tested in many combinations.

When used as a seed parent, 1-32 has to date been wholly incompatible only with 1-7 but a very few pollinations of this cross have yet been made. Relatively few pollinations of 1-32 by 1-26 (4.3 per cent) have set fruit. Used as a pollen parent 1-32 has been at least partially successful in all combinations excepting with 1-13.

The results of pollinations termed "incompletely incompatible" are listed in table 3. They produce "illegitimate fertilizations" which would

[2]In calculating this figure the results from selfing 3-32 (50 per cent of 6 pollinations) were excluded because of the small sample size resulting from 3-32's early death.

Table 1. Fruit Set from open and controlled Pollinations of *Passiflora edulis* f. *flavicarpa* at Miami during 3 Seasons

	1960-61	1961-2	1962-3 1/
Number of plants setting fruit, open pollinations	2	30	17
Total no. fruit from open pollinations	2	105	29
Average no. fruit per bearing plant (o.p.)	1	3.5	1.7
No. of clones which set fruit (o.p.)	2	26	16
Average no. fruits set per bearing clone (o.p.)	1	4.03	1.81
Total no. self-pollinations made	43	33	467
(per cent setting fruit)	(6.3)	(3.) 2/	(10.9)
Total no. cross pollinations made	33	73 2/	643
(per cent setting fruit)	(63.6)	(19.2)	(51.9)
Average no. seeds per fruit self-pollinations	--	--	48.5
Average no. seeds per fruit cross pollinations (inter- and intra-group)	--	--	174.7

1/ Data incomplete; 1962-63 fall season still in progress at presstime.

2/ This work confined to spring 1961, not continued through summer.

not be expected after the failure resulting from intra-group selfing and crossing in group I. In table 3 it can be seen that the lowest percentage of set from self-pollination, 10.3, appeared in clone 1-13, the highest in 1-32 selfed (20.4 per cent set). The average fruit set for the clones in group II which set fruit as a result of self-pollination was 15.5 per cent.[2] The positive results from cross-pollinations within group II varied from 5 per cent or less (1-7 x 1-26, 1-3 x 1-26, 1-24 x 1-13 and 1-32 x 1-26) to nearly 60 per cent (1-7 x 1-13).

Degree of incompatibility as indicated by inhibition of the pollen tube's growth 24 hours after pollination is listed for 17 clones in table 4. This was determined by examining squashes prepared from stigmas collected one day after pollination. Although pistils were collected 24 hours after pollination, some fruit was set in 13 of the 34 pollination combinations made. In such cases the

Table 2. Summary of Results of Pollinating 8 Passiflora Clones during the 1962 Season 1/

Clones used as seed parent	Clones used as pollen parent							
	1-1	1-10	3-43 (-45)	5-18	1-7	1-13	1-26	1-32
1-1	I	I	I	I	C	C	C	C
1-10	I	I	I	I	C	C	C	C
3-43 (-45)	I	I	I	P 2/	C	C	C	C
5-18	I	I	P 2/	I	C	C	C	C
1-7	C	C	P	C	P	P	I 3/	P
1-13	C	C	C	C	P	P	I 3/	I
1-26	C	C	C	C	P	P	P	P
1-32	C	C	C	C	I	P	I 3/	P

1/ Reactions of seed parent to pollen parent are designated as follows:
I = wholly incompatible reaction, no fruit set (or less than 5 per cent)
P = partially incompatible reaction, 5 to 59 per cent fruit set;
C = compatible reaction, fruit set in 60 per cent or more of total.

2/ Backcross to pollen parent. Clone 5-18 = 1-33 x 3-43(-45).

3/ Some fruit set but less than 5 per cent of all pollinations.

percentage of fruit set is recorded. (Since these pollinations were made, fruit set has resulted from compatible pollinations in which the pistils were removed as early as 8 hours after pollination. No fruit occured when the removal of pistils was done 4 hours after pollination.)

No inhibition of pollen tube growth could be observed on slides of 7 of the 34 different pollinations. At least 60 per cent fruit set resulted in these 7 compatible combinations, and from 80 to 100 per cent set in 5 of the 7. The observed results from the squashes do not altogether coincide with the results recorded as fruit set in 4 of the 34 pollinations. Even though growth of all pollen grains appeared to be inhibited in the squashed material of 1-24 self-pollinated, 1-24 x 1-13, 1-15 x 1-13, and 1-3 x 1-15, still a fruit was set in 20 per cent—or 1 of the 5 pollinations made—of each of these 4 combinations. It is possible that the tubes from the compatible pollen grains had lost their stainability after fertilization occurred and long before the pistils were collected.

Squashes made since those reported in table 4, relatively few in number, indicate that the

Table 3. Results of partially incompatible or incompletely incompatible Pollinations, 1962 Season

Clones involved in pollination	Number of pollinations	Number setting fruit	Percent setting fruit
1-3 x 1-13	10	3	30.0
1-7 x self	75	14	18.7
1-7 x 1-13	30	17	56.7
1-7 x 1-26	22	1	4.5
1-7 x 1-32	15	7	46.7
1-10 x 1-15	4	1	25.0
1-13 x self	68	7	10.3
1-13 x 1-7	17	2	11.8
1-13 x 1-26	21	1	4.8
1-15 x 1-13	10	5	50.0
1-24 x 1-13	20	1	5.0
1-26 x self	16	2	12.5
1-26 x 1-7	20	4	20.0
1-26 x 1-13	16	1	6.3
1-26 x 1-32	18	1	5.6
1-32 x self	49	10	20.4
1-32 x 1-13	25	4	16.0
1-32 x 1-26	23	1	4.3
1-32 x 3-32	11	6	54.5
5-18 x 3-43(-45) 1/	5	1	20.0
3-43(-45) x 5-18 1/	11	1	9.1

1/ Backcross (Clone 5-18 = 1-33 x 3-43 (-45)

majority of pollen grains of the yellow passionfruit germinate in ½ hour or less after being placed on a receptive stigma of the same species whether or not the stigma is from a compatible clone. The pollen tubes of incompatible genotypes appear to be restricted to a length approximately equal to or slightly greater than the diameter of the pollen grain. They have already reached this length, and appear to be surrounded by confining sigmatic tissue, within 30 minutes after pollination. Pollen grains from compatible clones, under no such restriction, may within an hour after pollination reach a length from 4 to 7 times the diameter of the pollen grain.

Discussion and Conclusions

The occurrence of self-incompatibility in the yellow passionfruit as reported here confirms

Table 4. Apparent Degree of Inhibition of Pollen Germination 24 hours post-pollination, and Per Cent of Fruit Set, in a Series of Pollinations involving the Yellow Passionfruit.

	Self-pollinations		Cross-pollinations		
Clone used as seed Parent	Apparent degree of inhibitions 1/	Per cent set	Apparent degree of inhibitions	Per cent set	Pollen parent in crosses
1-1	I 2/	0	C 3/	80	1-13
1-3	I	0	I	20	1-13
1-5	I	0	C	100	1-13
1-6	I	0	I	0	1-13
1-7	I	0	I	0	1-13
1-10	I	0	C	80	1-13
1-11	I	0	C	100	1-13
1-13	I	0	C	100	3-43(-45)
1-13	-	-	I	0	1-32
1-15	I	0	I	20	1-13
1-24	I	20	I	20	1-13
1-26	I	0	I	0	1-13
1-29	I	0	I	0	1-13
1-32	I	0	I	0	1-13
1-32	-	-	C, I:mixed	40	3-32
3-43(-45)	I	0	C	70	1-13
3-43(-45)	-	-	C	60	1-32

1/ Apparent degree of inhibition in prepared squashes was rated as follows: C= No apparent inhibition; germination, rapid elongation of pollen tube.

I= Inhibition; Pollen germination with length of tube approximately equal to or a little greater than diameter of pollen grain; inhibition took place in stigma.

2/ The same degree of inhibition was evident in selfed stigmas of clone 1-1 collected 1 hour after pollination, as 24 hours afterward.

3/ Compatible reaction with pollen tubes already 5 to 7 x pollen grain's diameter were observed in stigmas of 1-1 x 1-13 collected 1 hour after pollination. Stigmas collected 24 hours post pollination showed no trace of inhibited pollen tubes.

earlier observations in Hawaii (3) and Australia (4). Percentage of fruit setting from self-pollinations, however, appears to be higher than in Hawaii under southern Florida's conditions. The average fruit set obtained from all selfing to date in Florida, 10.9 per cent (table 1), is greater than that obtained in Hawaii, 5.97 per cent (3). The degree of successful fruit set from self-pollinating 2 clones growing in southern Florida (table 3) 1-32 (20.4 per cent) and 1-7 (18.7 per cent) exceeded that of the most successful Hawaiian material (12.0 per cent). It is unfortunate that clone 3-32 (P.I.S. 17236) died in Florida in the field before enough pollinations could be done to confirm or contradict the relatively high rate of success (3 of 6 pollinations) which attended the few selfings made.

The more than 3-fold increase in seed production from crossing over that from selfing (table 2) must represent genuine differences in the number of pollen grains effecting fertilization, as an effort was made to cover all stigmas thoroughly and uniformly in this work. A critical threshold number of fertilizations, approximating the number of seeds obtained from selfing, may be required for fruit to set. However if this threshold exists it apparently does not always operate since one fruit was found to contain only 13 seeds, and one seedless fruit, similar to the "hollow" fruit reported from Hawaii (3), was obtained this season. The partial breakdown of stigmatic inhibition of the pollen tube's growth within group II apparently does not result from segregation in heterozygous genotypes. If this were the case fertilization and contingent fruit set would result regularly, rather than only occasionally, from intra-group pollinations.

The present work was done on a few clones derived from 2 foreign introductions, each presumably a progeny of siblings, and 1 clone (3-32) obtained in Florida. Present data support the existence of 2 incompatibility groups (table 2). Until a larger sample is examined, it cannot be assumed that only 2 incompatibility groups exist in the species. Obviously additional information is desirable on the inheritance of incompatibility and any possible loss of incompatibility in seedlings from self-pollinated parent plants. Such work may be delayed by the expense inherent in raising plants which require as much space as does this passionvine.

The nearly-total absence of hymenopterous pollen vectors from the *Passiflora* plots at the Miami Station during the entire spring and summer of 1962 may be largely responsible for the low set of fruit from open pollinations (table 1). Research on means of attracting and encouraging the multiplication of carpenter bees as recommended for Hawaii (2) might be rewarding. Investigation of pollination of *Passiflora edulis* in its native area (Brazil, Paraguay and northern Argentina) should answer the question of the advisability of introducing pollen vectors other than Hymenopterids already present in Florida and Hawaii.

Since dependable production is directly contingent upon a high percentage of compatible pollinations, fully self-compatible clones of yellow passionfruit, if obtainable, would be of value provided this trait were combined with other essential characteristics.

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HERBICIDE TRIALS WITH YOUNG TROPICAL AND SUB-TROPICAL FRUIT AND NUT TREES

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Numerous reports have discussed the effects of various herbicides on several of the horticultural crops of the tropics and subtropics, but little information is available about the response of evergreen fruit trees other than citrus. During evaluation of several introduced fruit crops it became desirable to determine those species which might safely be maintained as young plants in areas where herbicides are used. The purpose of the studies reported here was to determine whether herbicides could be used during the first season of growth in the field, when extensive hand weeding would otherwise be required for satisfactory maintenance.

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MATERIALS AND METHODS

Experiments in two previous seasons demonstrated that diuron (3-(3,4-dichlorophenyl)-1, 1-dimethyl urea) and atrazine (2-chloro-4-ethylamino-6-isopropylamino-s-triazine) provided satisfactory control of native weeds in plantings of 3- and 4-year-old mangos. Both materials at a rate of about 5 pounds active ingredient per acre inhibited weed growth for 6 or more weeks under heavy rainfall or irrigation. Tests using various types of herbicides led to recognition of