seeds may contribute to the soft-nose condition.

SUMMARY

Heavy nitrogen fertilization substantially increased yields of Kent mangos growing on deep, acid, sandy soil. A smaller increase resulted from heavy potash fetrilization. Incidence of soft-nose, a physiological disorder in the fruit, increased with increased nitrogen, but tended to decrease with increased potash fertilization. Increasing the calcium level in the tree by heavy applications of limestone or gypsum reduced incidence of soft-nose. Trees receiving the combination of heavy nitrogen, potash *and calcium* fertilization yielded a yearly average of about 8 bushels of sound, marketable fruit, which was about 2 3/4 bushels greater than the yield from the control trees, for the four years of the test. Seasonal effects, which may be beyond control by fertilizer manipulation, appear to be involved in frequency of soft-nose.

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HETEROSTYLY AND POLLINATION IN CARAMBOLA

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ABSTRACT

Heterostyly (distyly) which exists in *Averrhoa carambola* L. has been associated with self-incompatibility in other members of the Oxalidacae. We pollinated 2,058 flowers in the possible combinations; we bagged and observed 371 as unpollinated controls. The largest set of ripe fruit (2.98 percent) resulted from 336 short-style X long-style pollinations. From 573 long-style X short style pollinations, 2.79 percent produced ripe fruit. Long-style selfed and long-style X long-style produced 0.62 and 0.47 ripe fruit respectively, while 247 short-style flowers used as bagged unpollinated controls produced 0.40 percent ripe fruit. No fruit resulted from short-style selfed or short-style X short-style pollinations, or from long-style controls which because of their structure probably underwent a minimum of spontaneous self-pollinations. Results suggest a self- and cross-incompatibility in carambola associated with distyly. That the incompatibility sometimes breaks down is indicated by these data and also by the dependable fruiting of the 'Golden Star' variety when planted in isolation.

INTRODUCTION

Many home gardeners of southern Florida are aware of the possibilities of *Averrhoa carambola* as a fruit tree for dooryard planting. One commercial planting is in production in Sarasota County, and a chain of supermarkets is handling the fruit on a small scale (Figure 1). The U.S. Plant Introduction Station, Miami, is the site of a program of evaluation of carambola seedlings and introduced clones at the present time. We have observed consistant variation among individual seedling trees for fruit production during this work.

The 'Mih Tao' cultivator, P. I. 272065 imported from Taiwan, was received at the Miami station on September 26, 1963. By November 1964, when grafted 'Mih Tao' plants held in quarantine began to bloom, we noted that this clone unlike the other Formosan carambolas under evaluation, bears "short-style" flowers. The filaments are much longer than the styles; thus the anthers are borne well above the stigmas and are quite prominent. Individual seedling plants in a population of P. I. 221126 blooming at the same time as 'Mih Tao' bore either "long-style" or "short-style" flowers. The heterostyly then apparent has been maintained by the individual plants through three subsequent flowering periods. Preliminary self- and cross-pollinations made in the autumn of 1964 indicated the desirability of determining the degree to which incompatibility and heterostyly are related in this fruit crop.

MATERIALS AND METHODS

Pollinations began with the summer bloom in June and continued through the first week of August 1965. P. I. 272067 ('Tean Ma' *variety)* was used as a source of "long-style" pollen. P. I.

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Michael A. Irwin, B. S., performed most of the field work reported here.

272065 ('Mih Tao' cultivar) and one seedling of P. I. 221126 provided "short-style" pollen for this work. Plants of P.I. 272067, 272064, and individual seedlings of P. I. 221126 were used as seed parents. The 6 types of pollination and 2 control treatments are listed in Table 1. Pollination was done in the field, and the inflorescences were bagged to prevent contamination of treatments by insects. Because of the abundance of the small-sized carambola flowers, we picked individual blooms for their pollen and held them in forceps while rubbing anthers directly on the stigmas of the prospective seed parent.

Structure of the short-styled flowers made it feasible to remove all anthers in one operation with forceps; thus minimal damage was done to the rest of the flower. All short-styled flowers which were cross-pollinated were so emascu-

Figure 1.—Packaged Carambolas appearing on sale in local supermarket. By Mrs. Julia F. Morton, Morton Collectanea, University of Miami, Fla.

lated; thus accidental self-pollination was avoided. Removal of individual anthers from long-styled flowers without serious damage to the remaining structures was difficult. Furthermore, it was not necessary, inasmuch as the position of the anthers (short-stamen) would preclude accidental self-pollination.

Within a week to 10 days after pollination, we made examinations and recorded observations as fruit set became evident through swelling of the ovary, or failure was shown by dropping of the flower. We used old nylon stockings to bag inflorescences in which fruit had set; thus fruit which dropped could be kept and observed. We recorded the number of fruit that remained on the plants until maturity in each treatment.

RESULTS

Data from all crosses and treatments are recorded in Table 1. The greatest number of mature fruit (2.98 percent of the pollinations) resulted from short-style by long-style pollinations, but nearly as many, 2.79 percent, developed from long-style by short-style pollinations. These results differed markedly from mature fruit records of treatments 3 through 8. Treatments 6 through 8 matured no fruit, while treatment 3 matured 0.62 percent of the initial pollinations, or slightly more than treatments 4 (0.47 percent) and 5 (0.40 percent).

Table 1. Mature Fruit resulting from Carambola Pollination Treatments.

Treatment	Total flowers treated No.	Fruit matured %
1. Short-style x long-style	336	2.98
2. Long-style x short-style	573	2.79
3. Long-style x self	161	0.62
4. Long-style x long-style	427	0.47
5. Short-style, unpollinated control (bagged)	247	0.40
6. Short-style x self	191	0.0
7. Short-style x short-style	370	0.0
8. Long-style, unpollinated control (bagged)	124	0.0

DISCUSSION AND CONCLUSION

Self-incompatibility has been demonstrated in other heterostylous members of the Oxalidacae (2). A breakdown or loss of incompatibility has been reported in the tristylous species *Oxalis suksdorfii* (3). The data from the present work seem best interpreted to indicate self- and cross-incompatibility associated with the distyly long known in *Averrhoa carambola* (4). An examination of pollen tube growth in the types of carambola pollination possible has not yet been made. Until it has been demonstrated that there is definite pollen inhibition or failure of zygotes in presumably " illegitimate" combinations, there is a possibility that the differences in fruit set observed might result from heterosis or lack of heterosis. This seems a less reasonable interpretation of the data than the simple assumption of incompatibility associated with distyly, accompanied by occasional breakdown or loss of incompatibility — a condition similar to the present situation in *O. suksdorfii.*

As discussed above, the fact that fruit result from selfing and from crossing similar floral types suggests an incompatibility system which occasionally breaks down. This phenomenon must explain the performance of such clones as the newly named cultivar 'Golden Star' which is reported to fruit well, even when planted in such isolation that the opportunities for cross-pollination must be exceedingly rare. We should point out that a mature crop of one-half of one percent of the total bloom (which the data for treatments 3 through 5 roughly approximate) may represent a good yield of fruit, especially if one considers that a reasonably prolific carambola tree produces several thousand flowers during one flowering period.

Conceivably, additional loss of incompatibility resulting in enhanced self-fertility can occur in seedlings raised from self-pollination or crossing between similar stylar types. Seedlings will have to reach fruiting age before we can be sure. A minimum of 3 years is required in southeastern Florida, from seed planting to the time when an appreciable sample can be evaluated for fruiting character.

Our study demonstrates that a program of breeding for improved varieties of carambola through controlled pollination (as in work with citrus and passionfruit) would be practical. It would not be necessary (as in work with the avocado, mango, and lychee) to rely mainly on chance pollinations.

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SOURCES OF ERROR IN FOLIAR ANALYSES OF PEACHES

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The reintroduction of the peach as a potential commercial crop in Florida has increased the need of accurate foliar analyses in nutritional experiments as well as in diagnosing nutritional problems in commercial orchards.

In recent Florida experiments (1, 8) analyses were reported on leaves harvested from the midpoint of the shoot. Most samples were taken in May or June at or shortly after fruit harvest, as it was assumed that this period most nearly corresponded in leaf maturity with sampling dates reported from other areas.

The purpose of this investigation was to study some factors that influence the accuracy of data obtained from peach leaf samples. An understanding of these factors should be helpful in designing future experiments and in sampling leaves from current experiments and commercial plantings.

PROCEDURE

Each leaf sample consisted of 40 leaves (including the petiole) taken as specified from random locations on the tree. Each sample taken by one sampler was duplicated by a second sampler and each sample was analyzed in duplicate by the laboratory. Standard laboratory procedures were used in sample preparation and chemical analyses for K, Ca, Mg, and P as previously described (6). However, Ca was also determined by an ethylenediaminetetraacetic acid (EDTA) titration procedure (4) and N was determined by a semimicro adaptation of the Kjeldahl method. The data were examined statistically using analysis of variance and an estimate of variance components (2, 7).

The first experiment consisted of samples from six uniformly fertilized 'Okinawa' seedling trees at fruit harvest. Median leaves from fruiting and non-fruiting branches were sampled separately.

The second experiment consisted of samples from six 'Flordawon' trees fertilized at different N and K rates using two N sources, NH_2NO_3 and $Ca(NO_3)_2$. These trees had no fruit because of a freeze during bloom. Samples were taken from the oldest, median and youngest full-sized leaves on the twig and from the median leaves on waterspouts.

The third experiment utilized six 'Early Amber' trees that had been previously treated with different rates of lime or dolomite, but otherwise fertilized uniformly. A good crop was harvested three weeks before the leaf samples were taken, and no attempt was made to distinguish between fruiting and non-fruiting branches. Samples were taken in the same manner as in the second experiment.

RESULTS AND DISCUSSION

Okinawa. The data from the first experiment with the 'Okinawa' seedlings are summarized in Table 1. Significant differences occurred in the mineral contents between leaves from fruiting and non-fruiting branches except for Mg. The change in mineral contents between non-fruiting and fruiting branches was similar to that of leaf ageing, as shown by data obtained from the two other experiments. Significant differences were also found between the uniformly treated trees in a relatively compact block, where the maximum distance from the first to last tree was 150 feet and individual trees were selected for uniform appearance and fruit set. The differences observed could be the result of seedling or soil variation.

There were also significant differences between

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