ever, has been considered by many commercial lime growers for a number of years as a favored side dresser at any time of the year, except the wet summer and early fall months.

Varying the percentage of natural organic nitrogen in the complete mixture seemed to have very little effect upon the yield, fruit size or even tree growth. It should be borne in mind that the trees all received one to two leaf applications per year of zinc, boron, manganese and copper as well as adequate magnesium as a soil application. Were these not given the 30 and 40% natural organic nitrogen plots would probably have been outstanding. Also under sod culture a good organic mulch was developing under the trees by the 3rd year (1952). Were these trees under clean cultivation the higher percentages of organic nitrogen would have given more pronounced results. At the present age of the trees with the adequate natural organic mulch under them and covering most of the root area it is expected that 0% organic nitrogen should continue to be more economical in fruit production than the other treatments in this part of the experiment.

The results indicate that in choosing the most economically practical interval for fertilizer application one would find it to be about 60 days. This is primarily true for the shallow Miami oolite soils. Deeper soils with a deeper root system should not have to consider such a close interval. If one adds to this the information beginning to take form in the experiments reported last year, raising the nitrogen to 6% applied at 60 day intervals would be approaching a commercially practical fertilizer practice. A fertilizer mixture approximately 6% nitrogen, 4% phosphorus, and 6% potash containing 4 units of magnesium applied at roughly 120 day intervals with intermediate applications of nitrate of potash, in similar quantity units of nitrogen as the regular mixture, should give good average results on Persian Limes on the oolite limestones of Dade County until more data is available to adjust the formula. If the trees are three years or older under sod culture the organic nitrogen can be cut to 10% or less in the mixture.

SUMMARY

Among nitrogenous side-dressers applied to Persian Limes growing on oolitic limestone soils in Dade County intermediate between applications of regular 4-6-6 fertilizer mixtures showed that nitrate of potash and Uramon resulted in the greater increase in yield, whereas sulfate of ammonia as a side dresser actually resulted in a drop in yield over a 4 year period.

There appears to be very little correlation between 0, 20, 30 and 40% natural organic nitrogen in a 4-6-6 fertilizer mix applied every 60 days to Persian Limes on the oolitic limestone soils and the yield, fruit size or trunk area growth of the trees. 0% and 30% organic nitrogen were equally as beneficial.

Increasing the interval between applications of fertilizer to Persian Limes on the oolitic soils from 45 to 60 and again to 90 day intervals results in a decrease in fruit yield but no apparent effect on trunk area growth. From the rate of decrease 60 day intervals appears most economical.

LITERATURE CITED

1. Lynch, S. John, Seymour Goldweber and Clarence E. Rich. **Some effects of nitrogen, phosphorus and potassium fertilization on the constituents of Persian Lime fruits.** Proc. Fla. State Hort. Soc., 67:224-227. 1954.

2. Goldweber, Seymour, Manley Boss and S. John Lynch. **Some effects of nitrogen, phosphorus and potassium fertilization on the growth, yield and fruit quality of Persian Limes.** Proc. Fla. State Hort. Soc., 69:328-332. 1956.

POLLINATING INSECTS ON LYCHEE BLOSSOMS

F. GRAY BUTCHER

Division of Research and Industry

University of Miami

Coral Gables

It is generally recognized that lychees are pollinated by insects, and brief reports have indicated that adequate numbers of honey bees in lychee plantings will be helpful in assuring an adequate fruit set (1). Khan (2), studying lychee pollination and fruit formation, states that "pollination from another flower, either of the same plant or of a different plant, is inevitable in the litchi plant." He observed "large numbers of many

different insects" visiting the blossoms, but did not identify them or correlate their activity to total fruit production. Singh and Singh (3) list without discussion or additional notes eleven species of insects "found visiting the flowers" of lychee. However, detailed reports of the different insects actively involved in lychee pollination have not been found.

In an attempt to survey pollinating insects on these fruit trees, collections of all insects found at the blossoms were made once a week for the 6-week period from Feb. 19 thru March 26 while blooms were open in our Experimental Farm planting during the spring of 1957. Collections were made during morning hours from 10:00 A.M. to noon, and of afternoons from 1:00 to 3:00 P.M.* Since honey bees were quite abundant in the bloom panicles during most of the survey period, no attempt was made to collect all specimens of these bees. Instead, counts of numbers of bees at a given panicle during a 5-minute period were recorded as an indicator of relative abundance of honey bees on each counting date.

Collections obtained during this survey period contained 27 different species of insects, representing six different insect Orders. The most abundant species encountered was the secondary screw-worm fly, *Callitroga macellaria* (F.), representing the dipterous family Calliphoridae. Adult flies of this species were collected both mornings and afternoons on each collection date for the entire 6-week period, and frequently were so abundant that no attempt was made to collect all of the specimens observed. This fly was quite active throughout the period, frequently moving from one blossom panicle to another, so it surely must have been an effective pollinator.

The only other insect species approaching the abundance of this calliphorid fly was the honey bee. Bees were moderately abundant at the lychee blossoms the morning of the first count when the first blooms were opening (Feb. 19), and were observed in similar numbers of mornings only on each succeeding counting date until March 12 inclusive. After that date, when blossoming was rapidly decreasing, relatively few bees were observed. It was interesting to note that honey bees were not found in the lychee blooms on any date during afternoons. Microscopic examinations of open lychee flowers revealed that nectar secretions were absent during afternoon hours, so the bees apparently went elsewhere in search of nectar. The complete absence of honey bees on the blossoms in afternoons rather clearly indicates that lychee blooms are an attractive source of nectar, but they did not compete successfully with other sources as a supply of pollen for bees.

The complete list of insects collected is shown in detail in Table I. As this tabulation indicates, the secondary screw-worm fly

TABLE I. Insects taken at lychee blossoms during six-week survey, spring 1957

Species and Insect Order	No. days observed during survey	Total No. of Specimens observed
Callitroga macellaria (F)		over 100
Order Diptera, Calliphoridae	6	abundant each day
Apis mellifera Linn.	5	over 100
Order Hymenoptera, Apidae		abundant each day
Chauliognathus marginatus Fab.		
Order Coleoptera, Cantharidae	3	9
Oncopeltis fasciatus (Dell)		
Order Heriptera, Lygaeidae	1	4
Leptoglossis phyllorus (Linn)		
Order Heriptera, Coreidae	2	3
Cothonaspis sp.		
Order Hymenoptera, Figitidae	2	2
Vespula sp.		
Order Hymenoptera, Vespidae	2	2
Eupeodes sp.		
Order Diptera, Syrphidae	1	2
Volucella sp.		
Order Diptera, Syrphidae	1	2
Sarcophaga sp.		
Order Diptera, Sarcophagidae	1	1
Unidentified species		
Order Diptera, Sarcophagidae	1	1
Archytes sp.		
Order Diptera, Tachinidae	1	1
Unidentified species		
Order Diptera, Tachinidae	1	1
Unidentified species		
Order Diptera, Calliphoridae	1	1
Unidentified species		
Order Diptera, Muscidae	1	1
Crytocheilus sp.		
Order Hymenoptera, Pompilidae	1	1
Psammochares sp.		
Order Hymenoptera, Pompilidae	1	1
Polistes sp.		
Order Hymenoptera, Vespidae	1	1
Tiphia sp.		
Order Hymenoptera, Tiphiidae	1	1
Ponerine ant		
Order Hymenoptera, Formicidae	1	1
Unidentified species		
Order Hymenoptera, Crabronidae	1	1
Unidentified, two species		
Order Hymenoptera, Ichneumonidae	1	1
Pachnus opalis Cliv.		
Order Coleoptera, Curculionidae	1	1
Phymata erosa (Linn)		
Order Hemiptera, Phymatidae	1	1
Oncometopia sp.		
Order Homoptera, Cicadellidae	1	1
Unidentified sp.		
Order Lepidoptera, Lycaenidae	1	1

* The field collections for this survey were made by Mr. Owen P. Macken as part of a student research project. This assistance from Mr. Macken is herewith gratefully acknowledged.

and the honey bee were the only forms encountered in any considerable numbers. The next most abundant species was the coleopteran, *Chauliognathus marginatus* Fab., of the family Cantharidae. This "soldier beetle" was present in lychee blooms from Feb. 19 through March 4. Beetles of this family are generally known as pollen and nectar feeders, and undoubtedly the few specimens of this species pollinated many flowers as they crawled over the bloom panicles.

The two hemipterans, *Oncopeltis fasciatus* (Dall.) (Lygaeidae) and *Leptoglossis phyllopus* (Linn.), (Coreidae), were not numerous enough or found regularly enough to be of significance as pollinators. As plant sucking species normally feeding on foliage, they would seldom be considered as important pollinators of any flowers. The various other forms encountered are not individually important pollinators. While their movements over the flower panicles could aid materially in pollen distribution to receptive stigmas, they would all appear to qualify only as incidental visitors to the flowers rather than as direct pollinators, and are so considered because of the known habits of the various species represented or their occurrence as single specimens in the collections. Some of the different wasp species might be considered as attracted to blossoms, but the lychee bloom did not compete successfuly with other flowers as an attractant for them.

The complete absence of any species of wild bees in the survey collection is somewhat surprising. Adjoining the lychee planting used in this survey were rather large expanses of virgin pine-lands in which the natural insect fauna has not been disturbed. A few weeks after the lychee blooming period, a similar survey on nearby barbados cherry blossoms revealed a wild bee quite abundant in the area, identified as *Centris versicolor* (Fab.) by Dr. C. D. Michener. Likewise, numerous specimens of megachilids and andrenids are very commonly observed in the area. However, most of these species appear to be attracted to flowers primarily in search of pollen, so there is again evidence that lychee pollen is not highly attractive to pollen-collecting insects.

A summary statement on this survey would thus reveal only three of the 27 species of insects collected were important as pollinators of lychee blooms in our area during the spring of 1957; these are the secondary screw-worm fly, the honey bee, and the soldier beetle. The brief study reported by the writer last year (1) indicated no set of lychee fruit on a screened tree where insects were absent. Thus, these insects serving as pollinators assume a position of major importance to the lychee grower.

The study on floral biology and sequence of blossom types of lychees by Mustard, Lui, and Nelson (4) and Lui (5) show rather clearly that some pistillate flowers are receptive to pollen during a period of several days. While the normal sequence of floral types provide first male flowers, then female flowers, and finally male-functioning hermaphrodites, the fact that "all panicles on a tree are not necessarily at the same stage in the floral cycle at the same time" (4) suggests the desirability of pollinators as continuously as possible. In this respect, the secondary screw-worm fly was the only insect species actively working the blooms both mornings and afternoons. However, since this insect can be considered as a pest form, and its abundance is not readily manipulated by man, the importance of honey bees for the lychee grower becomes even more obvious. Their daily visits in large numbers seeking nectar from lychee blossoms during morning hours provide excellent pollinating service. Accordingly, it would appear that supplying honey bees to lychee plantings is an important and a practical recommendation for assuring adequate pollination and fruit setting.

REFERENCES CITED:

1. Butcher, F. Gray. 1956. Bees pollinate lychee blooms. Proc. Florida State Hort. Soc. for 1956: 59-60.
2. Khan, S.A.R.K. 1929. Pollination and fruit formation in litchi. Agr. Jour. India **24**: 183-187.
3. Singh, Lal Behari, and Uday Pratop Singh. 1954. The Lychee. Superintendent, Printing and Stationery, U.P., Lucknow, India. p. 1-87.
4. Mustard, Margaret J., Su-Ying Lui, and Roy O. Nelson. 1953. Observation of floral biology and fruit setting in lychee varieties. Proc. Florida State Hort. Soc. for 1953: 212-220.
5. Lui, Su-Ying. 1954. Studies of **Litchi chinensis** Sonn. Unpublished thesis, University of Michigan. p. 1-261.