



Colleges of
Agriculture at

CALIFORNIA
STATE
UNIVERSITY,
FRESNO

CALIFORNIA
POLYTECHNIC
STATE
UNIVERSITY,
SAN LUIS OBISPO

CALIFORNIA
STATE
POLYTECHNIC
UNIVERSITY,
POMONA

CALIFORNIA
STATE
UNIVERSITY,
CHICO

RESEARCH REPORT

Researchers study growth, development and biology of forktailed katydid

*David Headrick, Professor, Horticulture and Crop Science Department
California Polytechnic State University, San Luis Obispo*

Executive Summary

Secondary pests such as the forktailed katydid have typically been considered only minor or non-economic pests of citrus in California. Recently, both the cottony cushion scale and the forktailed katydid have become major citrus pests. In the case of the cottony cushion scale, the use of the insect growth regulator “Knack” against California red scale led to the decimation of the vedalia beetle, which was the introduced natural enemy of the cottony cushion scale. To control the scale, an extremely toxic, broad-spectrum pesticide was used; and this, in turn, has led to secondary outbreaks of citrus red mite and further use of pesticides. In the case of the outbreak of katydid, little is known about the cause, but a solid biological knowledge should lead to better management decisions and less expense for both the growers and the public. This project will provide details on the individual and population biology of the forktailed katydid.



Typical feeding damage to fruit done by the forktailed katydid.

Overview

Growth and Development

Longevity - At 26.7°C (80°F), ~75 percent R.H. and 14:10 L:D photoperiod, katydids developed from eclosion to adult in 40.60 ± 1.77 days (n = 35). Females lived longer than males 108.06 ± 14.75 days (n = 18) and 99.56 ± 13.19 days (n=17), respectively.

Longevity was recorded at low temperatures to determine cold tolerance and growth rates. At 1.11°C (34°F), ~75 percent R.H. and 14:10 L:D photoperiod, all katydid instars and the adult perished within 24 hours (n = 2 at each lifecycle stage). At 3.0°C (37.4°F), ~75 percent R.H. and 14:10 L:D photoperiod, first through fifth instars perished within 36 hours (n = 2 at each lifecycle stage). At 5.0°C (41°F) ~75 percent R.H. and 14:10 L:D photoperiod, first through third instars perished within four days (n = 2 at each lifecycle stage); fourth instars through the adult perished within seven days (n = 2 at each lifecycle stage). Longevity of first through fourth instars reared at 4.5°C (40.1°F), 7.5°C (45.5°F), and 9.0°C (48.2°F) ~75 percent R.H. and 14:10 L:D photoperiod (n = 5 at each lifecycle stage at each temperature).

Field Population Dynamics

See above for population growth and number of generations per year. Figure 1 details the staggered stage-class distribution for katydids in the San Joaquin Valley. The line indicating

(blue dots) the number of instars present on each sampling date corresponds to the lines below the chart, thus showing which instars were observed. Fruit is susceptible to katydid feeding damage until it reaches about 30 mm in diam. Thus, fruit are susceptible until early August. In some years three generations of katydids have developed by early August. However, it is the first generation (April through July) that causes the most damage to developing fruit.

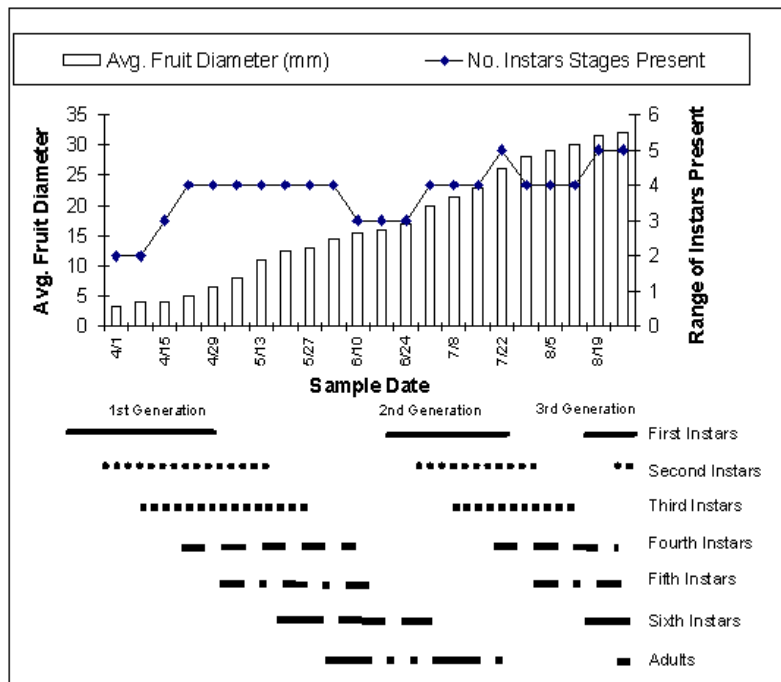


Figure 1. Growth and development of citrus fruit and range of instars present at field sites in the San Joaquin Valley.

We used the line intercept method to estimate degree days for development from eclosion to fourth instar nymph. The lower developmental threshold is 10°C.

Eclosion to 4th instar nymph = 425 DD.

Degree-day model

We developed a preliminary degree day model based on development rates at various temperatures. The biofix date is set at 50 percent egg hatch in the field. The first generation is considered to inflict the most economical damage, especially first through fourth instars. Fruit susceptibility decreases as the fruit hardens and reaches golf-ball size, thus later instars or subsequent generations feed mainly on foliage.

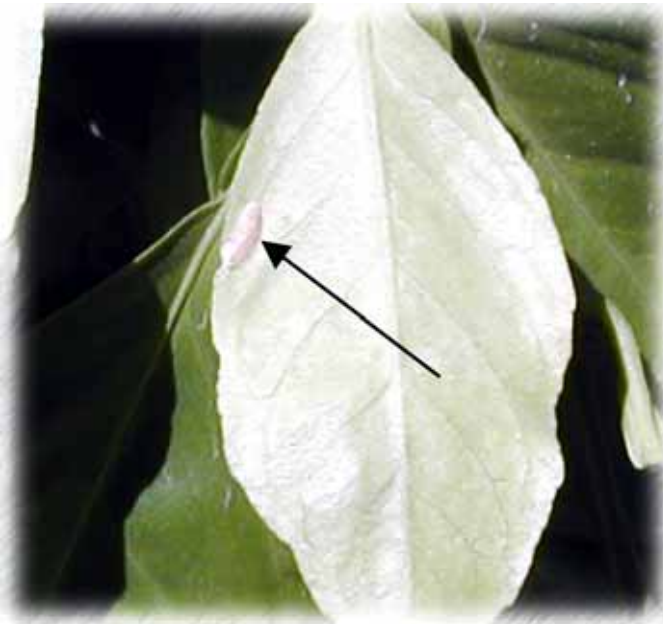
Behavior

Individual – All stages of *S. furcata* commonly exhibit a basking behavior. All stages can be found during daylight hours resting around the perimeter of trees and at all heights. Younger instars move slowly, but as instars mature, they exhibit coy behavior; hiding behind leaves or jumping into foliage when disturbed. Late instars and adults are easily disturbed and are quick to escape a disturbance, such as a shadow or movement.

Mating – In captivity paired males and females mated readily. Mating occurred late evenings and after sunset. Males and females were paired together as soon an adult of each sex was available. Cages containing pairs were removed from growth chambers and placed in a greenhouse. Males and females were separated following successful mating periods, no pairs were partnered more than 48 hours. All but one pair in captivity engaged in copulation during the late evening or night (n = 17 pairs). Copulation was prefaced by male stridulating, in each successful mating. Stridulating began at sunset and continued until males copulated with females. Males having engaged in copulation and successfully transferring the spermatophore to the female were never observed to mate again, although stridulating continued by a majority of the males. Males began stridulating in the evening hours of the day, within 24 hours following each male adult molt. Stridulating was in the form of rasping noises emitted in sequences. Copulation lasted 21.88 ± 9.74 minutes (n = 17).



Above and below: Placement of eggs into leaves. Eggs occur singly or in groups of up to 4-5.



Oviposition – Females readily oviposited in captivity during the day and night (n = 15). Potted Valencia seedlings served as a host plant and a single gravid female was enclosed in a cage with a single citrus seedling until egg laying was complete. Females oviposited eggs at all heights of the seedling and did not segregate between new and old growth leaves when selecting foliage for oviposition. Pre-oviposition periods, the time between copulation and first occurrence of egg laying, lasted 16.93 ± 4.81 days. Ovipositional periods, measured as the total time females spent between the first and last oviposition of eggs, lasted 23.64 ± 6.66 days. Females laid each egg singly and one to seven eggs was deposited during any single ovipositional event. Females laid 24.57 ± 8.84 eggs in a lifetime as a result of mating with a single male.

Egg distribution in the field was quantified in order to develop a sampling method for egg detection and delimiting katydid populations for subsequent spring management treatments.

Of 120 trees examined 33 percent of eggs were laid in the SE quadrant of trees, 23 percent in the SW quadrant, 21 percent in the NE quadrant, and 23 percent in the NW quadrant. Further, eggs placement in leaves was as follows: 27 percent of eggs were located in the anterior (tip) section of leaves, 47 percent in the middle section of leaves and 26 percent in the anterior (basal) section of leaves.



CALIFORNIA POLYTECHNIC STATE
UNIVERSITY, SAN LUIS OBISPO

Impact Statements

- 1) Quantified growth and development of katydid in commercial citrus
- 2) Feeding damage and fruit susceptibility periods determined
- 3) Monitoring techniques developed and validated

I gave a final presentation to the CRB in July of 2002. Upon completion of the presentation a board member requested that the following statement be officially added to the minutes:

“This research is exactly what we needed, it was executed with a high level of skill and completeness, and provides for our growers much needed and very valuable information. I wish we had more researchers committed to the industry as exemplified by this project.”

As the industry increases the use of natural enemies to control key pests such as California red scale, secondary pests will require thoughtful biologically/ecologically-based management compatible with biological control to avoid pest population upsets.

Successful completion of the katydid research program objectives provides the citrus industry with substantive information with which to develop the most appropriate management tactics in commercial citrus production.

The Citrus Research Board has funded the study of the fork-tailed katydid a secondary pest of citrus for three years, substantiating their commitment to such research. Refining and validating the research findings to ease the transition into mainstream use in the industry is a unique and valuable opportunity for us. Adding to the knowledge base through respected and widely used publications and information outlets such as the UCIPM webpage is an opportunity not to be missed.

Project Director

David Headrick, Professor
Horticulture and Crop Science Program
California Polytechnic State University,
San Luis Obispo
Phone: (805) 756-5382
Email: dheadric@calpoly.edu

Cooperators

Beth Grafton-Cardwell, UCCE
Kearney Ag Center
Parlier, California
Phone: (559) 646-6591

Judy Stewart-Leslie
Pest Management Associates, Inc.
Exeter, California
Phone: (559) 592-9641

Acknowledgments

Funding and administrative support for this project was provided by the California State University Agricultural Research Initiative (ARI), administered by the California Agricultural Technology Institute at California State University, Fresno. Additional support was provided by the Citrus Research Board.

For More Information

This Research Report contains summarized results of David Headrick's study entitled "Citrus IPM: Secondary Pest Biology and Demography, Phase II," ARI Project No. 02-3-023 (Research Focus Area: *Production and Cultural Practices*). To view and/or obtain a copy of the complete final report, or to obtain additional information about this or other research projects, visit the ARI website at ari.calstate.edu. For information on projects specific to Cal Poly San Luis Obispo, visit the Cal Poly ARI website at ari.calpoly.edu.

ARI Administration

California Agricultural Technology Institute
California State University, Fresno
2910 E. Barstow Ave. M/S OF115
Fresno, CA 93740-8009
Phone: (559) 278-2361
Fax: (559) 278-4849
Web: ari.calstate.edu

ARI Executive Director

Joe Bezerra, Director of Operations
California Agricultural Technology Institute
California State University, Fresno

The Agricultural Research Initiative (ARI) is a California State University (CSU) multiple campus collaborative partnership between the CSU colleges of agriculture and the state's agriculture and natural resources industries and allied business communities. ARI provides public funds that are matched with industry resources to fund high impact applied agricultural and natural resources research, development, and technology transfer, as well as related public and industry education and outreach. ARI projects and programs improve the economic efficiency, productivity, profitability, and sustainability of California agriculture while providing for consumer sensitive and environmentally sound food and agriculture systems and fostering public confidence in food safety and agricultural research and production systems.