# Monitoring and Controlling Katydids in Pear Orchards

*Lucia G. Varela*
*University of California Cooperative Extension & Statewide IPM Program*

## *Abstract*

In a survey conducted in 5 orchards in North Coast pear district the katydid found was the Mediterranean katydid. Mediterranean katydids overwinter as eggs laid in the bark of grapevines. In laboratory choice tests, the Mediterranean katydids laid their eggs in the sepals of the calyx of rose flowers, in roses and in pear leaves and between grapevine bark layers. First instar nymphs emerge for a period of six weeks beginning in early to mid-May. Third instar nymphs begin to migrate to pear orchards in mid-June. Feeding damage in pears is first observed at the edge of the orchard beginning in mid July. Damage increases as the fruit softens and as fifth nymphal stages and adults begin to appear. A residue bioassay was developed in which a treated shoot was placed in a cup with one katydid nymph and mortality assessed from day 4 to 14 or 21. I evaluated Success, Intrepid, Assail, Danitol and Dimilin using the residual bioassay with foliage collected from grower-sprayed orchards. All products tested gave moderate control of katydids. Insecticide applied to a vineyard reduced katydid population significantly, however some migration to the pear orchard had occurred before the spray application. Though katydid-feeding damage was significantly reduced at the orchards edge next to the treated vineyard, it was not eliminated.

## *Objectives*

**1)** Survey pear orchards to determine if populations of katydids are resident in the pear orchard or migrating from adjacent vegetation and which species of katydid inhabit the different environments.
**2)** Determine katydid susceptibility to registered insecticides with residue bioassays.
**3)** Develop methods to control migration of katydids into orchard from vineyards.

## *Introduction*

The reduction in use of broad-spectrum insecticides such as organophosphates has led to an increase of some secondary pests. Katydids are one of these secondary pests that cause feeding damage just as the fruit softens. This damage does not occur every year and is also sporadic in its distribution within the orchard. The damage appears as irregular chewing marks the diameter of a pencil eraser. Sometimes this damage is observed in trees at the margin of the orchard next to a vineyard or riparian vegetation but sometimes it is in low levels throughout. Therefore the question arises if there is a resident population of katydids in the pear orchard and/or do the katydids migrate from adjacent vegetation.

Two species of katydid were collected from pear orchards: Fork-tailed bush katydid, *Scudderia furcata*, and Mediterranean katydid, *Phaneroptera nana*. Katydids overwinter as eggs. According to the literature, fork-tailed bush katydids lay their eggs at the edge of leaves in evergreen plants. The Mediterranean katydid is readily collected from vineyards. It overwinters as an egg in the bark of grapevines. The third instar nymph begins to migrate to pear orchards in mid-June and fruit damage is observed at the edge of the orchard beginning in mid-July. Damage is also seen at the edge of the orchard next to

riparian vegetation. We do not know where in the riparian vegetation the overwintering eggs are laid.

During 2006 I developed a residual bioassay and tested the efficacy of five commonly used insecticides targeted for codling moth and leafrollers on katydid mortality. It is probably not economical to place an insecticide solely to control katydids; therefore it is important to know how effective these insecticides are for the control of katydid. I continued testing the efficacy of the most commonly used insecticides, evaluating them with different stages of nymphs and evaluating the longevity of the residue.

In pear orchards adjacent to vineyards, the katydids are resident in the vineyards. No matter how much control is achieved in the pear orchard, migration continues to occur, especially as the pear fruit ripens and the larger instar nymphs and adults readily jump or fly. This necessitates controlling the katydids in the vineyard. The question is how many rows need to be treated in the vineyard and at what timing to avoid migration into the pear orchard.

## *Material and Methods*

**1) Survey pear orchards to determine if populations of katydids are resident to the pear orchard or migrating from adjacent vegetation and which species of katydid inhabit the different environments.**

I monitored 5 orchards with a history of katydid presence and damage from mid-May until harvest. Three orchards were adjacent to the riparian corridor and two orchards were adjacent to vineyards. Nymphs were sampled on the weeds and on pear trees and the species present determined.

We surveyed overwintering eggs in the riparian corridor, inside pear orchards and on adjacent vegetation at a location in the Ukiah Valley and in Hopland. In the riparian corridor, timed searches for eggs were conducted on blackberry, boxelder tree, cottonwood and willow. To monitor for eggs on pear trees we conducted 10-minute bark searches per tree. Fifty trees were monitored per orchard. Loose bark was removed to search for eggs.

Because eggs were not found in the riparian vegetation nor on pear trees sampled (eggs have only been found inserted between bark layers in grapevines) I conducted choice studies in lab cages. Five pairs of katydids were introduced into a cage containing fresh roses, pear shoots and two 3-inch long sections of grapevine cordons with bark. Each cage was replicated 8 times. Cages were checked once a week, all the eggs were removed and counted and the roses and pear shoots were replaced with fresh ones.

**2) Determine katydid susceptibility to registered insecticides with residue bioassays.**

Katydids were collected starting in May from vineyards in the Ukiah Valley. All the katydids collected for the bioassays were Mediterranean katydids, *Phaneroptera nana.* Every week we collected approximately 200 katydids. Each katydid was collected individually in a plastic vial, placed in a cooler and taken to the lab. In the lab the nymphal stage of each specimen was determined by the amount of development of the wing pads. Specimens were grouped by their stage.

Field treated shoots were collected from orchards shortly after the grower sprayed them. Leaves were collected 0 to 3 days after the spray was placed. Under the heading "Residue days pre-bioassay" in Table 1, I record the number of days elapsed between the application of the spray and the collection of the leaves for the bioassay. Shoots were cut to

a length of 8 inches and the bottom leaves removed, leaving 5 to 7 leaves from the tip per shoot. The shoots were kept turgid by placing the base of the shoot in a small closed container with water. One shoot and water container were placed inside a 20 oz cup. One katydid nymph of known stage was introduced per cup and the cup was closed with organdy cloth secured with a rubber band. Each treatment was replicated 30 times. As a control, I collected shoots from a backyard pear tree that was never sprayed. Control shoots were placed in the cup in the same manner as the treated shoots. Controls were also replicated 30 times. Both treatment and control had the same stage katydid. As the season progressed, older stages were tested. Mortality was assessed after 4, 7, 14 and 21 days from the start of the bioassay. Treatment mortality was corrected by the control mortality. Results were discarded if control mortality exceeded 10%. The following insecticides applied in the field were tested: Success, Intrepid 2F, Assail 70WP, Danitol 2.4 Ec and Dimilin 2L.

**3) Methods to control migration of katydids into an orchard from vineyards.**

To determine if we could suppress damage in pear orchards adjacent to vineyards we treated a 15 acres portion of the vineyard with Danitol 2.4 EC at the rate of 21 fl oz/acre and another 15 acres portion with Success a the rate of 8 fl oz/A. In early spring we conducted a survey of eggs to determine the resident population in the vineyard. Five minute pre-treatment katydid counts were conducted in each of 5 rows per treatment to determine populations' levels. Grape leaf damage was also evaluated prior to treatment by recording presence of absence of feeding on 100 leaves. The leaf selected for evaluation was the second leaf from the tip of the shoot. Katydid feed on the newly developed leaves, thus monitoring the second leaf gives a measure of recent feeding. Treatments targeted to control the second and third instar stages were applied on June 12. Insecticide selection was done in consultation with the vineyard manager. Populations of katydid were monitored a month after treatment by collecting and counting the number of katydids found in the treated area on a 5-minute count in each of 5 rows and in adjacent untreated areas as the control. Feeding damage on 100 grapevine leaves was also assessed after the spray as a measure of katydid population levels on treated areas and an untreated portion of the vineyard. Feeding damage on 5 fruit in 50-pear trees/treatment on the orchard adjacent to the treated vineyard was assessed at harvest.

## *Results*

**1) Survey pear orchards to determine if populations of katydids are resident to the pear orchard or migrating from adjacent vegetation and which species of katydid inhabits the different environments.**

Only Mediterranean katydid, *Phaneroptera nana* was collected in the 5 orchards surveyed (three orchards adjacent to riparian vegetation and 2 orchards adjacent to vineyards). Numbers collected were very low in the three orchards adjacent to the riparian corridor with an average of 5 katydids collected per site through the monitoring period from May 17 to August 13. In the two orchards adjacent to vineyards we collected an average of 3 katydids per sampling date (with a range of 1 to 9/sampling date) beginning in mid June through harvest. The Mediterranean katydid was collected in large numbers from a vineyard adjacent to a pear orchard in the Ukiah Valley (figure 1). When we started sampling on May 17 we found first and second instars, thus egg hatching occurred at least

one week earlier than in 2006. We continued finding first instar nymphs through the end of June, indicating that emergence from the egg might take up to 6 weeks. Figure one displays the stages collected throughout the 2006 and 2007 season. Throughout 2007 development was one week ahead of 2006. The first adults collected in 2007 were on July 12. Males emerge first and 10 days later the females begin to emerge. The first females were collected on July 23rd. Only one generation was observed.

In the sampling done on the trees and shrubs of the riparian vegetation and on the pear trees, we did not find eggs. Eggs were readily found between bark layers in grapevines. To know more precisely where to look in the field we conducted cage studies. We gave three vegetation choices: roses, pear shoots and grapevine cordons with bark. On average 75% of the eggs were laid on rose sepals, 15% were laid on leaves and 10% on the bark of the grapevine cordons.

**2) Determine katydid susceptibility to registered insecticides with residue bioassays.**

Results for the bioassays conducted with field-sprayed foliage are presented in table 1.

***Success Bioassays***

Foliage treated in the field with Success was collected two days after application. The rate used was 8oz/A (table 1). We tested first and second nymphal stages. There was no difference in mortality between the first and second stage. Mortality ranged from 47% at 4 days to 80% at 7 days and did not increase after that. These results are similar to last year's bioassay results (see 2006 report, table 1).

***Intrepid Bioassay***

Foliage treated with Intrepid was collected from a site treated at 16 fl oz/acre. The results are similar to the ones obtained in 2006. Intrepid is an insect growth regulator insecticide, killing the insect when it molts. Thus, only 2% mortality was detected at 4 days but it increased rapidly as the insects began to change from one nymphal stage to the next. Mortality was 82% at 14 days and 95% at 21 days. Katydid feeding damage does not occur until the last nymphal stages or when adults are present and the fruit begins to soften, starting in mid-July. Thus, even though Intrepid may take two weeks to show its effect, when it is applied to target early nymphal stages, control is achieved before any damage occurs.

***Assail Bioassay***

The bioassay with Assail was conducted with foliage collected from a site treated at 3.4 oz per acre. Mortality ranged from 75 to 80% at 14 and 21 days respectively. The results are similar to those obtained last year. As with last year, we noticed that the insects that survived after 14 days moved very slowly. Thus, even though the treatment did not kill them, there was a sub-lethal effect. In the field this slow movement may increase predation, thus increasing mortality.

***Danitol Bioassay***

Foliage treated with Danitol was collected from two sites. One site was treated at a rate of 16 fl oz/acre, we collected leaves with three days old residue and 1st and 2nd nymphal stages were tested. The second site was treated at a rate of 20 fl oz/acre, the leaves were collected the day they were sprayed and 2nd and 3rd nymphal stages were tested. Higher mortality was observed with the higher rate and tested the day of the application with mortality reaching 100% at 14 days. These results are better than those obtained in 2006 in a lab treated bioassay (see 2006 report, table 6).

***Dimilin Bioassay***

The bioassay with Dimilin was conducted with field-treated foliage at the rate of 8 fl oz/A. Dimilin is an insect growth regulator: mortality occurs at the time of molting from one instar stage to the next. Highest mortality reached was 98% at 14 days. The experiment was not continued to 21 days due to high control mortality.

**3) Methods to control migration of katydids into orchard from vineyards.**

Pre-treatment populations were similar in all three plots with an average of 15 katydids per 5-minute count and 70% of the second leaves from the tip of the shoot with feeding damage. In the evaluation conducted one month after treatment the number of katydids found on a 5-minute count was on average 0 in the Danitol plot, 1 in the Success plot and 13 in the control plots. The percent of leaves with feeding damage on the second leave was 7 for Danitol, 15 for Success and 67% for the control plot. Migration into the pear orchard from the vineyard was first noticed in early-June; the stage was the 3rd instar nymph. Damage in pear trees adjacent to the control plots was 5% and in the Danitol and Success plots was 1%.

## *Discussion*

A closer study of the katydids found in pear orchard revealed that the species migrating from adjacent vineyards is the Mediterranean katydid. This is an introduced species but has probably been in Mendocino County for several decades. Migration into pears from vineyard begins when nymphs are third instar. Though we only found eggs in the bark of grapevines, the cage studies gives us some knowledge of where to look in the riparian vegetation.

Several insecticides targeted for other pests in pear orchards gave control of katydid. In studies conducted in 2006 the most effective chemical with the longest residue was Imidan. In studies in both 2006 and 2007, Success, Intrepid, Assail, Danitol and Dimilin gave acceptable control. For the best control of a population of katydids resident in pear orchards, insecticides should be targeted when the majority of the eggs have hatched (any time after late May) and before the fourth instar nymphs begin to appear in late June. Thus there is a window of 2 to 3 weeks in late May and early June for optimal control. However, since pear damage does not occur until mid to late July and since not all katydids feed on fruit, control measures applied later may also be adequate. The problem arises when larger instars continue to migrate in large numbers from vineyards as the fruit softens. When attempting to control the populations in the vineyard we documented a substantial decrease in katydids, to the point they were very hard to find in either treated plot (Danitol and Success) yet the reduction in pear damage at the edge of the vineyard was only from 5% to 1%. An explanation for getting 1% damage in the pears even though the

populations in the vineyard was substantially reduced is that by the time the treatment was applied migration to the pear orchard had already occurred. On June 12 when the application was done, approximately 50% of the population was in the second nymphal stage and 50% was in the third nymphal stage. Third nymphal stages are large enough to migrate to pear orchards. Better results might have been obtained if the application was done one week earlier when the majority of the population was in the second stage.

**Table 1. Percent katydid mortality on leaf residue treated in the orchard with Success, Intrepid, Assail, Danitol or Dimilin.**

| Insecticide | Residue days pre-bioassay | % mortality at | | | | Instars Assessed | Rate |
|---|---|---|---|---|---|---|---|
| | | 4 days | 7 days | 14 days | 21 days | | |
| Success | 2 | 47 | 80 | 80 | 80 | 1st | 8 fl.oz/A |
| Success | 2 | 47 | 80 | 80 | 80 | 2nd | 8 fl.oz/A |
| Intrepid | 1 | 2 | 35 | 82 | 95 | 2nd & 3rd | 16fl.oz/A |
| Assail | 1 | 10 | 40 | 75 | 80 | 2nd & 3rd | 3.4 oz/A |
| Danitol | 3 | 60 | 87 | 93 | 93 | 1st | 16fl.oz/A |
| Danitol | 3 | 53 | 67 | 67 | 67 | 2nd | 16fl.oz/A |
| Danitol | 0 | 90 | 100 | | | 2nd & 3rd | 20fl.oz/A |
| Dimilin | 0 | 38 | 58 | 98 | | 2nd & 3rd | 8 fl.oz/A |

**Figure 1. Percent nymphal stages and adult Mediterranean katydid, *Phaneroptera nana*, per sampling date collected from a vineyard in the Ukiah Valley from May through August in 2006 and 2007.**