BIOASSAY SUSCEPTIBILITY OF TWOSPOTTED SPIDER MITE, TETRANYCHUS URTICAE, TO ACARICIDES IN THE SAN JOAQUIN VALLEY

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Abstract

Spider mites (*Tetranychus* spp.) are key pests of cotton in the San Joaquin Valley. This arthropod historically has shown the ability to develop resistance to acaricides and resistance management has been important for successful management of this pest. The registration and availability of four new acaricides, with differing modes of action, for use in cotton have greatly facilitated resistance management for this pest group. The objective of this research was to 1.) investigate bioassay techniques for evaluation of spider mite susceptibility, 2.) develop baseline susceptibility values, and 3.) examine mite susceptibility from several SJV locations. Studies concentrated on these newly-registered materials and utilized the registered standards for comparison.

Introduction

Spider mites are key arthropod pests accounting for average estimated losses as high as 4% (not including the cost of control) in San Joaquin Valley cotton. Spider mites damage cotton by feeding on the leaves, thereby reducing plant photosynthetic activity and eventually yield. There are three species of spider mites in California cotton; strawberry spider mite (*Tetranychus turkestani*), twospotted spider mite (*T. urticae*), and Pacific spider mite (*T. pacificus*). The species present in a cotton field is influenced by the neighboring crops with *T. urticae* generally being the most important species.

A binomial sampling plan is used for spider mite monitoring which involves inspecting leaves for the presence of immature and adult spider mites. The treatment threshold is 30% of the 5th main stem node leaves infested with mites. Spider mite populations begin in cotton from overwintering adult mites emerging from the soil or from mites dispersing from neighboring crops or weeds. These early-season populations are generally held in check by predators including thrips. In fields with low natural enemy populations, spider mite populations can increase quickly. Later season problems are often associated with the use of disruptive, broad-spectrum insecticides, which release spider mites from their natural enemies, thus allowing damaging populations to build up. Spider mite infestations can also result from mites blowing from neighboring, maturing crops such as corn, seed alfalfa, sugarbeets, or beans.

Selective miticides sulfur, Kelthane®, Comite®, Zephyr®, and Onager® have been utilized on SJV cotton for the last 20-30 years. In laboratory bioassays conducted during the 1980s to the present, strawberry mite has not shown resistance to any of these registered miticides. Laboratory bioassays have demonstrated that Kelthane and Comite resistance can be detected in twospotted spider mite and Pacific mite populations (Bruce-Oliver and Grafton-Cardwell 1997, Grafton-Cardwell, Goodell, & Montez 2000) but the resistance is not dominant in inheritance and mites can revert to susceptible at the beginning of the season. However, careful rotation of miticides has been a critical factor in maintaining control options in SJV cotton.

The addition of several new acaricides in recent years (as shown below) as management options for spider mites in SJV cotton has greatly aided the resistance management scenario. The objectives of this study, concentrating on these newer products, were to 1.) investigate bioassay techniques for evaluation of spider mite susceptibility, 2.) develop baseline susceptibility values, and 3.) examine mite susceptibility from several SJV locations.

Materials and Methods

Selected registered acaricide formulated products were evaluated in this study, including Zephyr 0.15EC, Kelthane MF, Comite, Oberon 2SC, Zeal 72WDG, Acramite 4SC, and Fujimite 5EC. These latter four products were registered for use in California cotton in the last 3-5 years. These key characteristics of these products are summarized below.

Acaricides Recently Registered for Use in California Cotton *

Trade Name	Active Ingredient	Producer	Targeted Life Stage(s) & Mode of Action	IRAC[1]
Acramite	bifenazate	Chemtura Corp.	contact toxin on all stages by unknown mechanism in nervous system	25
Fujimite	fenpyroximate	Nichino America, Inc.	contact toxin to eggs, juveniles and adults; inhibits electron transport in the mitochondria	21
Oberon	spiromesifen	Bayer CropScience	contact on all mite stages by inhibiting lipid biosynthesis; most effective on juveniles	23
Zeal	etoxazole	Valent U.S.A. Corp. Agri. Products	contact toxin on eggs; inhibits molting of juveniles; adult females produce sterile eggs	10B

[1] Insecticide Resistance Action Committee (IRAC) numbers used to denote mode of action - same number indicates same mode of action.
* Modified from "Table of Some of the Most Common Miticides for Use Against Spider Mites in California"; David Haviland (http://cottoninfo.ucdavis.edu/IMAGES/Miticide%20MoA%20Jan%202006.pdf)

Spider mites from 5 different locations in the SJV - Tulare Co. near Visalia, Kings Co. near Hanford, Westside Research and Extension Center (Fresno Co. near Five Points), Shafter Research and Extension Center (Kern Co. near Shafter), and a laboratory colony from UC-Davis were used to initiate mite colonies at the Shafter REC. The Davis colony had been in culture on cotton for the last 10 years and was assumed to be susceptible. Mites were reared in cages using 'Sierra RR' cotton plants in the cotyledon stage and mites from the different locations were kept isolated from one another.

Bioassays were conducted by dipping cotton leaf discs (3.5 cm diameter) into water solutions of acaricides; leaf discs were obtained from greenhouse-grown cotton plants in the two to four true leaf stage. Treated leaf discs were dried at room temperature and placed on a bed of 1% agar within a 100 mm diameter Petri dish as shown below. Two treated discs were stacked within each dish so as to provide an underleaf habitat for the mites without encountering the moist agar surface. Adult female spider mites (unless otherwise stated) were randomly selected from the colony and transferred on to the top leaf disc. Mites were transferred with a small paint brush with the aid of a dissecting microscope. Petri dishes were held at room temperature. Five concentrations were evaluated for each acaricide except Comite and Kelthane where only four levels were tested; six replications per dosage. Untreated discs, dipped only into water, were used to assess natural mortality. Mite mortality was counted with aid of microscope and recorded at 24, 48, 72, and 96 hours post treatment.

Analyses were done with SAS software Proc Probit using a $\log_{10}$ transformation of dosage and mortality data corrected for the control mortality. The Chi^2 criterion was used to assess significance of fit and the slope and 95% fiducial limits were used to explain the response.

Results

Bioassay results from 24 post-treatment are shown in Fig. 1-4 for Comite, Kelthane, Acramite, and Fujimite. Significant dose-response relationships were present for each comparison. Spider mite susceptibility was similar within each active ingredient among sites except for Comite where reduced susceptibility was seen in Kern Co.

For Zephyr, mite mortality averaged 67, 72, and 96% for dosages of 0.01, 0.1, and 1.0 ppm, respectively; the response was similar among locations. Mite mortality with Oberon, under the conditions of this bioassay method, was poor (14% at the highest dosage tested - 100 ppm). Mortality increased only slightly at 48, 72, and 96 hours and the dose response was poor. Control of adult mites in the field with Oberon is reported to be only moderate and these results support that. Mortality of adult mites in this bioassay with Zeal was poor at dosages up to 5000 ppm. This was not surprising given the mode of action of this active ingredient. On immature mites, even at lowest dosage tested (10 ppm), mortality was 58% at 24 hrs. post-treatment. The dose response relationship, however, was poor with the 5000 ppm dose resulting in 80% mortality.

Acknowledgements

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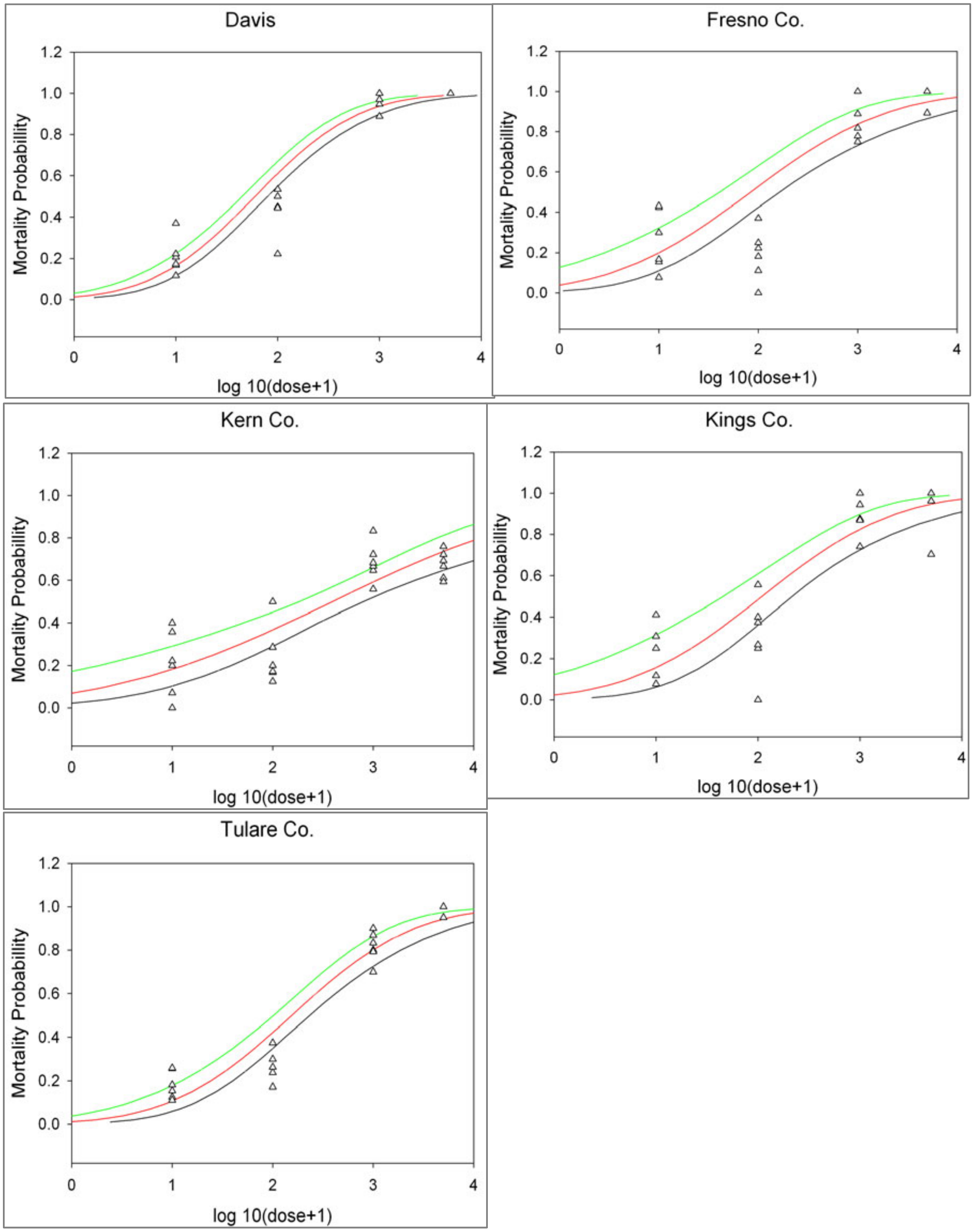

Fig. 1. Dose response curves for two-spotted spider mites from five locations in the SJV against Comite®; log dose – red line; 95% fiducial limits (upper) – green line; 95% fiducial limits (lower) – blue line.

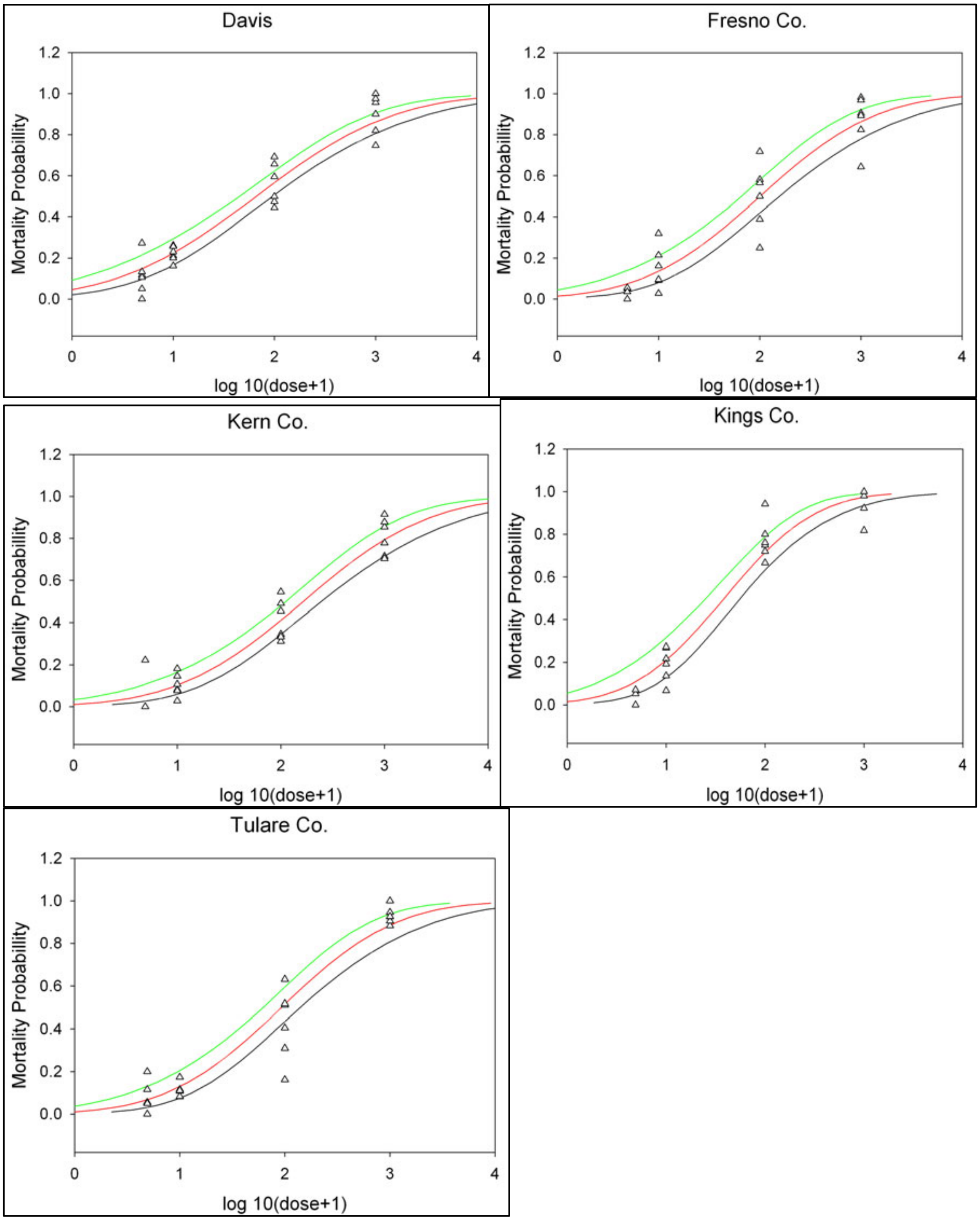

Fig. 2. Dose response curves for two-spotted spider mites from five locations in the SJV against Kelthane®; log dose – red line; 95% fiducial limits (upper) – green line; 95% fiducial limits (lower) – blue line.

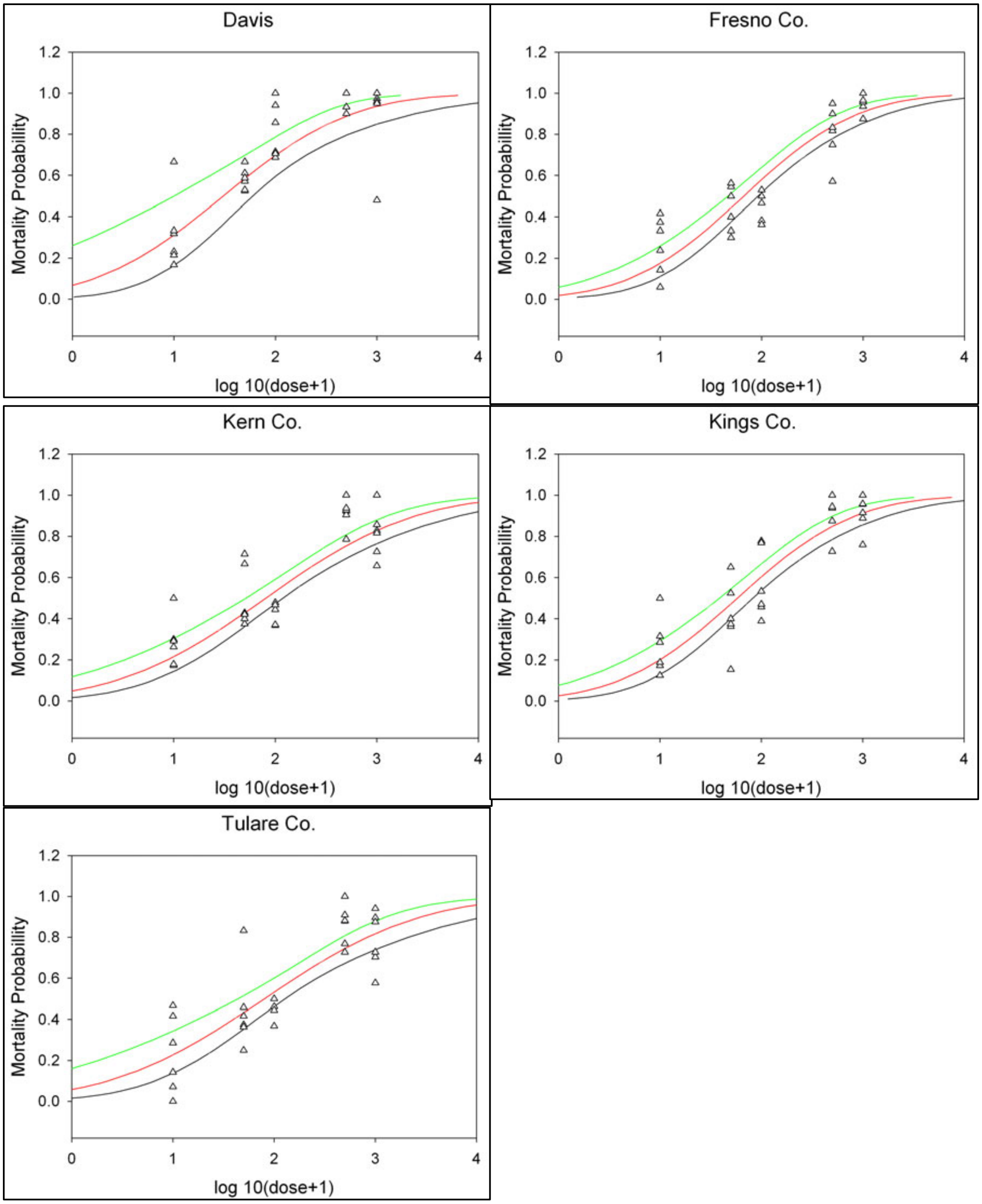

Fig. 3. Dose response curves for two-spotted spider mites from five locations in the SJV against Acramite®; log dose – red line; 95% fiducial limits (upper) – green line; 95% fiducial limits (lower) – blue line.

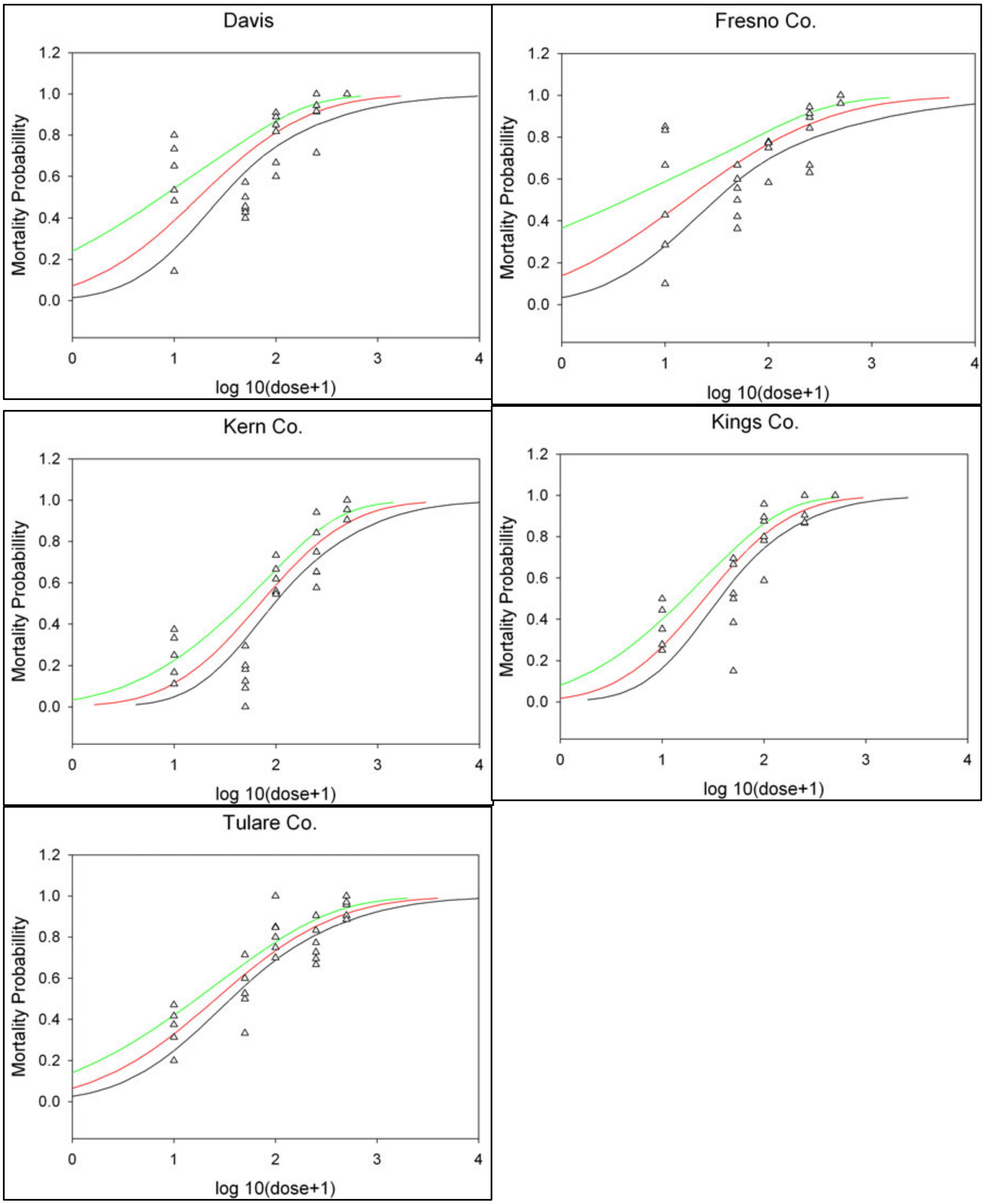

Fig. 4. Dose response curves for two-spotted spider mites from five locations in the SJV against Fujimite®; log dose – red line; 95% fiducial limits (upper) – green line; 95% fiducial limits (lower) – blue line.