Developing an Action Threshold for Citrus Thrips on Lemons in the Low Desert Areas of Arizona[1]

David L. Kerns, Michael Maurer, Dave Langston and Tony Tellez

Abstract

Commercial and University citrus groves were sampled over a two year period in an attempt to develop mathematical models capable of predicting fruit scarring based on the population of immature citrus thrips on susceptible fruit. Five predictive models were derived. One model correlated used citrus thrips populations from fetal fall to 2.0 in. diameter fruit. While in the other models, thrips populations were divided into four distinct fruit size cohorts. Four of the five models were statistically valid. Based on these models, lemons ½ in. in diameter, should be treated with insecticides when the number of immature CT reaches 1.5 per 10 pieces of fruit. While fruit > ½ should be treated if immature CT reach or exceed 2.0 per 10 fruit.

Introduction

Much of the lemons in Yuma, AZ are grown for the fresh and export markets. These markets demand fruit free of cosmetic defects. Citrus thrips, CT, *Scirtothrips citri* (Moulton), is the most severe insect pest attacking citrus in the low desert areas of Arizona, annually resulting in millions of dollars in lost revenue due to scarred fruit and insecticide costs. In order for citrus producers to grow marketable fruit, it is imperative that fruit scarring caused by citrus thrips be prevented. Pest control advisors (PCA's) and growers in the Yuma area rely heavily on insecticides for CT control. Applications of insecticides for thrips control will vary from 3 to 5 per season depending on temperatures and thrips pressure. However, insecticidal control can be extremely costly, and during most years constitutes the greatest production expense. If growers could eliminate as little as one insecticide application for thrips control, the profitability of citrus production in Yuma could be greatly enhanced.

Although, much research has been conducted on sampling CT, little is known concerning what levels of thrips populations justifies an insecticide application. Research is needed to develop and evaluate a quick and easy sampling scheme that accurately estimates citrus thrips population densities and how those populations densities relate to fruit scarring in relation to fruit size. The purpose of this research is to develop an accurate and easy sampling plan, and action threshold for CT in lemons. The following report represent data collected during 1995 and 1996, on CT sampling and damage thresholds.

---

[1]The authors wish to thank the Arizona Citrus Research Council for supporting this project. This is the final report for project 95-09 -- Population dynamics, sampling and control of citrus thrips and control of citrus mealybug in Arizona lemons.

Materials and Methods

CT population dynamics were monitored in 1995 and 1996 in lemon groves in Yuma and Maricopa Counties. In 1995, 4 groves were sampled in Yuma County, 3 of which were treated for CT as needed and 1 which remained untreated. One grove from Maricopa County was sampled in 1995, and did not receive any insecticide applications. During 1996, an additional untreated grove was sampled in Yuma County, in addition the same groves sampled in 1995. Two basic sampling techniques were utilized. Flush growth was sampled using a beat-pan, where the flush is gently tapped against hardware cloth covering a black cake pan. One beat-pan sample was taken from four sides of 50 trees sampled within each grove. The thrips dislodged for the foliage into the pan were separated into adults and immatures and counted. Fruit infestation counts were also made, by inspecting two pieces of fruit from each side of 50 trees sampled. The numbers of adult and immature thrips were counted from each piece of fruit inspected. Each grove was sampled weekly from petal fall until the fruit exceed an average of 2.0 in. in diameter. A 1.5 - 2.0 in. diameter fruit is no longer considered susceptible to scarring by CT. Therefore sampling ceased once 80% of the fruit in the grove was 2.0 in. or greater in diameter.

In August, each grove was evaluated for CT related damage. Five fruit from four sides of 50 trees were rated for CT damage using a 1 - 5 rating scale, where 1 = no damage, 2 = minor damage, not completely encircling the calyx, 3 = calyx completely surrounded by scarring, 4 = calyx completely surrounded and some scarring on the neck or shoulder, and 5 = severely scarred fruit. Intense sampling of commercial groves over the past 3 years, has indicated that an average fruit scarring damage rating of 1.5 consistently yields commercially acceptable levels of CT scar free fruit suitable for fresh market export.

Damage rating were correlated to the number of immature CT on the fruit using simple linear regressions. Correlation analyses were conducted comparing end of season fruit damage to CT populations averaged from petal fall to 2.0 in. diameter fruit, and also based on CT populations a various fruit sizes. Fruit size groupings used in our study included: petal fall - ¼ in., >¼ in. - ½ in., >½ in. - 1.0 in., and >1.0 - 2.0 in. Where significant correlations were detected, the models could be used to predict the amount of fruit damage a grower might expect to have at the end of the season based on the number of thrips in the grove at a particular fruit size cohort. Additionally, by using these correlation models, and using an acceptable damage threshold of 1.25 (a conservative value based on our damage assessment index), we can determine at what level of CT infestation a grove can tolerate before suffering economic loss.

Results and Discussion

In this report we will focus entirely on the data collected from visual fruit counts. Also, we will limit the discussion to that data dealing only with immature CT. At this point in the study it is not realistic to consider the beat-pan samples. Most growers and PCA's will not take the time necessary to count all the thrips dislodged from a piece of flush growth. However, counting immature thrips on the fruit is not difficult and can be accomplished quickly. When sufficient data is collected, it is our intention to develop this sampling plan into a binomial system, where the grower or PCA would not have to count the CT, but simply note their presence or absence. Beat-pan sampling may be of use in a binomial system where every single thrips is not counted. Data concerning the relationship of adult CT to fruit scarring was not included in this report. Immature CT are considered the damaging stage, while little if any damage is caused by adults. Using adult CT to predict fruit scarring in a predictive model could result in erroneous conclusions.

A highly significant correlation (P>F=0.0003) was detected when comparing the average number of immature CT from petal fall until the fruit is no longer susceptible to damage (1.5-2.0 in. diameter), to fruit scarring in August (Figure 1). The R^2 value is a measure of the degree of linear association between CT density on the fruit and the fruit scarring at the end of the season. An R^2 value of 1.0 would indicate a 100%, or perfect linear relationship, while a R^2 value of 0.1 would indicate only a 10 % relationship. Generally speaking, a R^2 value of 0.5 or greater demonstrates a reliable linear relationship. The R^2 value in Figure 1., suggests a good linear relationship between seasonal immature CT populations on the fruit and fruit scarring. Using a scarring index of 1.25, a conservative value that would yield high quality fruit, the model can be used to predict the maximum level CT populations on the fruit can reach before an insecticide treatment is warranted. Based on the model in Figure 1., on average, ca. 0.15 immature CT per fruit, or 1.5 per 10 fruit, can be tolerated before unacceptable damage occurs. Based on this model, if a grower were to use insecticides only when the CT populations reached or exceeded 1.5 immature CT per 10 fruit, then when harvested, that crop would produce fruit with commercially acceptable levels of scarring (average of 1.25). At this point, the only weak portion of our model is the lack of sufficient data points toward the center of the graph. Currently, there is only one data point in the center portion of the graph. Hopefully, the 1997 data set will fill this void.

Based on efficacy trials conducted over the past two year it has become apparent that, although lemons may be susceptible to CT scarring from petal fall to 2.0 in. diameter size fruit, larger fruit within this range may be less susceptible to CT scarring than smaller fruit. Based on these casual observations, we broke out the CT counts based on specific fruit size grouping, and correlated it to fruit scarring. When fruit was <¼ in. in diameter, the number of immature CT on the fruit was significantly correlated (P>F=0.019) to scarring at the end of the season (Figure 2). Although the R^2 value, 0.48, wasn't extremely high, it was reasonably high enough to make reliable predictions. Using a scarring index of 1.25 as an tolerable level of scarring, it appears that fruit >¼ in. in diameter can tolerate slightly more than 1.5 thrips per 10 fruit. Similar to the full season correlation (Figure 1).

The correlation analysis based on >¼ to ½ in. diameter fruit was not statistically significant (P>F=0.06) (Figure 3).. Thus no inferences can be derived from the model. However, with fruit >½ in. to 1.0 in. in diameter, a highly significant (P>F=0.0001) model was derived (Figure 4). The R^2 value of 0.86 indicated an excellent linear relationship. Using a scarring index of 1.25 as an tolerable level of scarring, it appears that fruit >½ to 1.0 in. in diameter can tolerate almost 2.0 thrips per 10 fruit. Larger fruit, 1.0 to 2.0 in. in diameter appear to be able to tolerate greater thrips populations (Figure 5). Based on the significant model (P>F=0.0029) and a good linear relationship (R^2=0.65), we can predict that slightly over 2.0 immature CT could be tolerated on fruit before economic injury occurred.

Based on the correlations models presented in this study, we can make some preliminary recommendations for CT action threshold. On fruit ½ in. in diameter, growers and PCA's should avoid applying insecticides unless the number of immature CT reaches 1.5 per 10 pieces of fruit. While fruit > ½ should be treated if immature CT reach or exceed 2.0 per 10 fruit.

Using a predictive model to help PCA's and growers make insecticide application decisions is a sound IPM practice, and should help eliminate unneeded insecticide applications while maintaining high quality fruit and maximizing profitability.

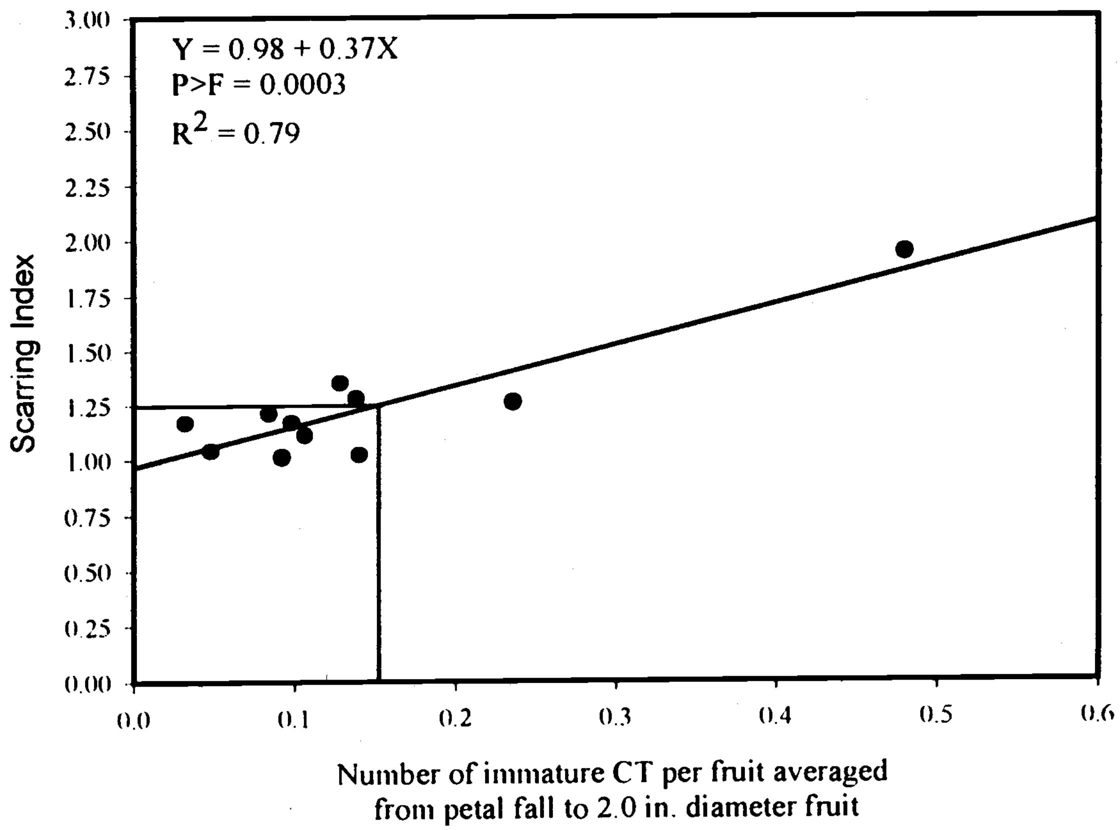

Figure 1. Simple linear regression correlation analysis of number of immature CT per fruit from petal fall to 2.0 in. diameter fruit to a 1-5 scale scarring index. A scarring index of 1 = no scarring, 2 = minor scarring, calyx not completely surrounded, 3 = calyx completely circle by CT scarring, 4 = calyx completely circled and some scarring on neck or shoulder, and 5 = severely scarred fruit. An average scarring index of 1.5 or less would produce commercially acceptable fruit for fresh market.

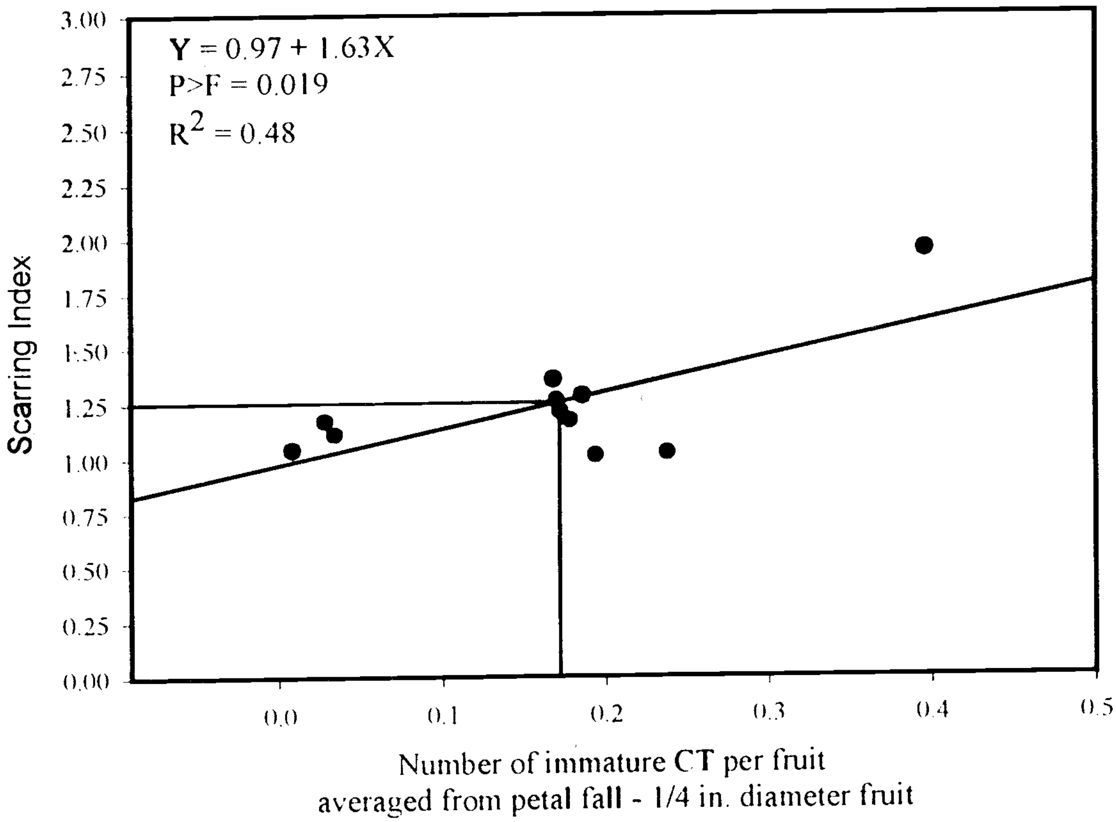

Figure 2. Simple linear regression correlation analysis of number of immature CT per fruit from petal fall to 1/4 in. diameter fruit to a 1-5 scale scarring index. A scarring index of 1 = no scarring, 2 = minor scarring, calyx not completely surrounded, 3 = calyx completely circle by CT scarring, 4 = calyx completely circled and some scarring on neck or shoulder, and 5 = severely scarred fruit. An average scarring index of 1.5 or less would produce commercially acceptable fruit for fresh market.

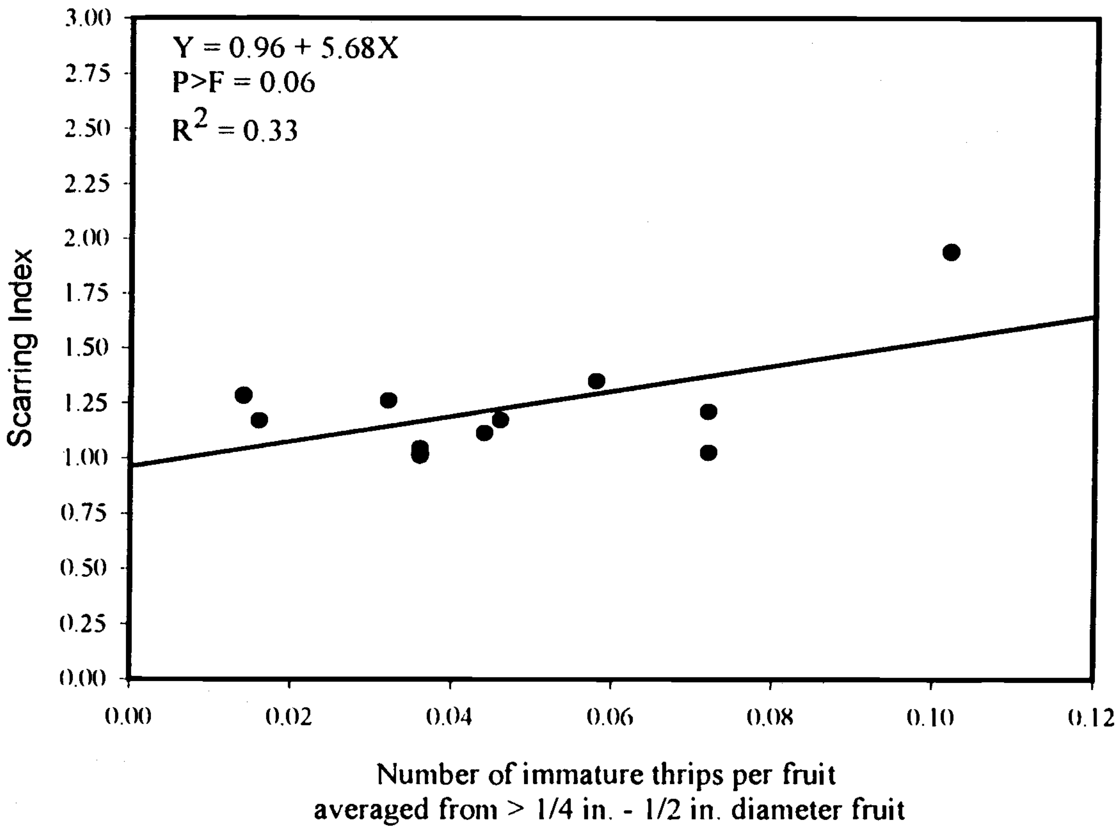

Figure 3. Simple linear regression correlation analysis of number of immature CT per fruit from >1/4 in. - 1/2 in. diameter fruit to a 1-5 scale scarring index. A scarring index of 1 = no scarring, 2 = minor scarring, calyx not completely surrounded, 3 = calyx completely circle by CT scarring, 4 = calyx completely circled and some scarring on neck or shoulder, and 5 = severely scarred fruit. An average scarring index of 1.5 or less would produce commercially acceptable fruit for fresh market.

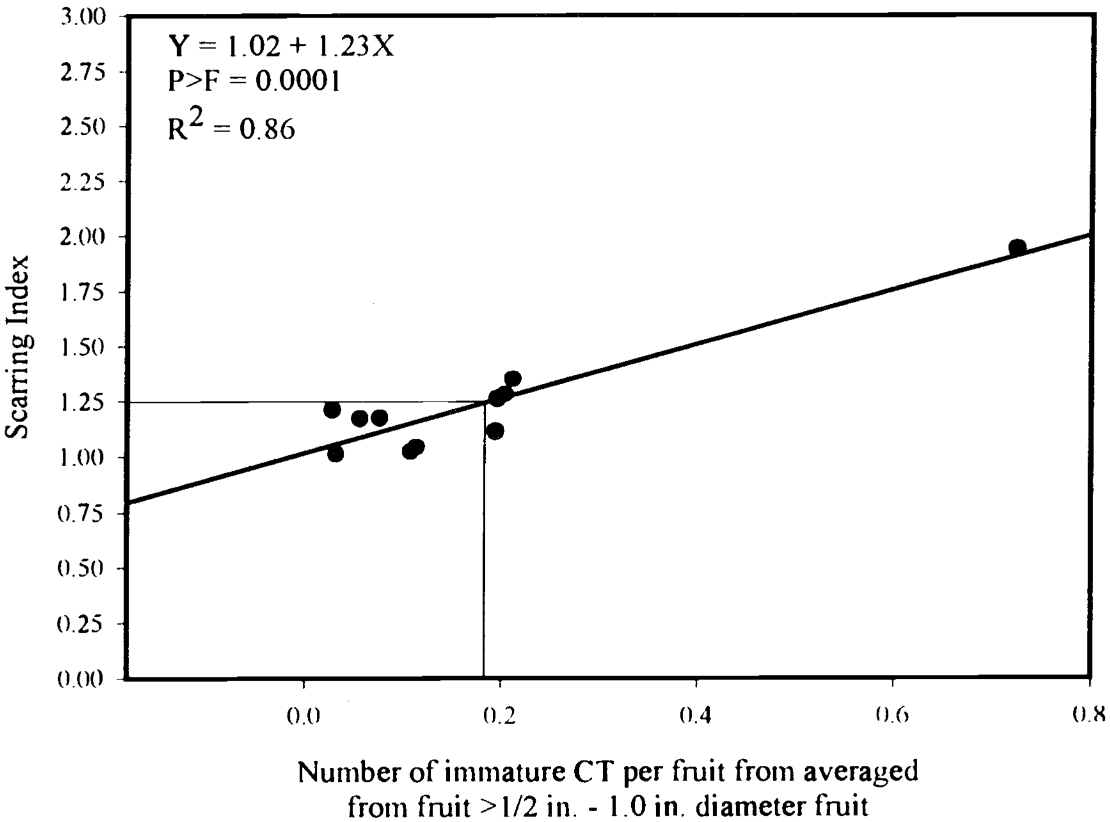

Figure 4. Simple linear regression correlation analysis of number of immature CT per fruit from 1/2 in. - 1.0 in. diameter fruit to a 1-5 scale scarring index. A scarring index of 1 = no scarring, 2 = minor scarring, calyx not completely surrounded, 3 = calyx completely circle by CT scarring, 4 = calyx completely circled and some scarring on neck or shoulder, and 5 = severely scarred fruit. An average scarring index of 1.5 or less would produce commercially acceptable fruit for fresh market.

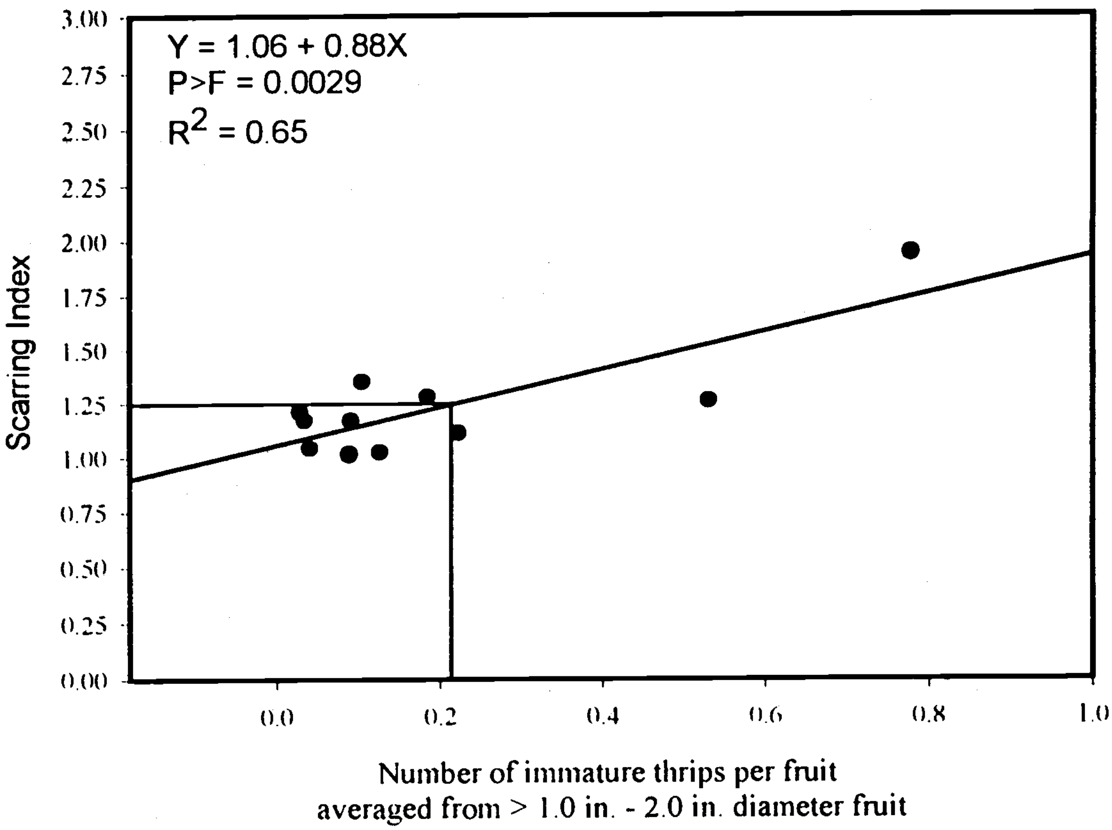

Figure 5. Simple linear regression correlation analysis of number of immature CT per fruit from 1.0 to 2.0 in. diameter fruit to a 1-5 scale scarring index. A scarring index of 1 = no scarring, 2 = minor scarring, calyx not completely surrounded, 3 = calyx completely circle by CT scarring, 4 = calyx completely circled and some scarring on neck or shoulder, and 5 = severely scarred fruit. An average scarring index of 1.5 or less would produce commercially acceptable fruit for fresh market.