Degree Day Prediction Models for Sunflower Stem Weevil (Curculionidae: Coleoptera) Development and Adult Emergence

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Summary: Simple prediction models such as degree day models are integral tools for development of sunflower stem weevil management strategies. Using data collected from Colorado, Kansas and Nebraska, we sought predictable variation between sunflower stem weevil pupation, adult formation and emergence and accumulated degree days (DD) using a temperature threshold of 41°F.

Accurate prediction models can be used to time scouting and insecticide application. The pupation model predicts 90% pupation at 585 DD. Model results predict 50% of adults will be ready to leave sunflower stalks after 745 DD**.**

A model averaged result from two sets of data predicts 5, 75 and 90% adult weevil emergence from stalks at 504, 1215, and 1431 DD respectively.

Scouting for sunflower stem weevil should be initiated after 504 DD have accumulated because current chemical controls target adults in the narrow window between emergence from stalks and before eggs are laid.

Introduction: In eastern Colorado, sunflower stem weevil is a consistent and serious pest, causing significant crop loss. There is need for information on field biology, ecology and management.

Management tactics for sunflower stem weevil include delayed planting (Rogers and Jones 1979), stalk burial (Charlet, 1994) and the use of insecticides (Rogers and Jones 1979, Charlet and Oseto, 1983).

Monitoring for this insect is difficult because of its small size, cryptic coloration and behavior (Knodel and Charlet 2002). Current monitoring recommendations call for scouting from late June through mid-July, which is logistically difficult and costly. Prediction models for emergence of sunflower adult weevils could improve timing of scouting efforts and of insecticide treatments.

Existing models for predicting emergence of adults from the stalk were developed from data obtained over a limited period of time or from a limited geographical range. Charlet (1987) examined sunflower stem weevil in North Dakota and found that initial emergence of adults occur from stalks occurred at 788 Degree Days (DD) Fahrenheit (based on a temperature threshold of 41ºF), with 90% emergence occurring by 1589 DD. In Colorado, Armstrong (1996) observed first emergence at 715 DD, with 90% emergence after 1204 DD.

However, no degree day models exist for determining timing of pupation and adult weevil formation within stalks. Our goal was the development of a DD prediction model for sunflower stem weevil pupation, adult formation within stalks and adult emergence from the stalk.

Materials and Methods

Pupation and appearance of adults within Stalks: Data were collected in 2003 and 2004 in Washington, Phillips, Yuma Counties in Colorado and Sherman County (northwestern Kansas) in Kansas. Sunflower stalks were collected weekly starting 30 March of each year. Thirty stalks with crowns and roots intact were removed weekly from each of four field sites. In total, 1,560 and 1440 stalks were collected over 13 weeks in 2003 2004, respectively. Stalks were dissected and developmental stages of sunflower stem weevil determined. Each developmental (larva, pupa, adult) stage was recorded during dissection of stalks. Sampling continued until no sunflower stem weevil was observed within stalks.

Daily maximum and minimum temperatures were obtained for the collection sites from the nearest Colorado State University weather stations. DD were tallied from January 1 of each year by using a temperature threshold of 41°F. DD was calculated as follows:

DD = (max temperature + minimum)/2-41°F.

For each sampling date, accumulated DD were calculated by summing DD from 1 January through current sampling date. If weather stations failed to collect temperature data, the next closest Colorado State University weather station was used.

Adult Emergence from the Stalks: To obtain sunflower stem weevil adult emergence numbers, we calculated the weekly decline in the number of adult weevils within the stalk. This weekly decline was used as an indicator of sunflower stem weevil emergence from stalks. Thus, the percentage decline in the number of adults within stalks was considered as percentage emergence. Cumulative percentage of adult emergence from stalks was determined for each sampling date.

Additional emergence data were collected in 1996 and 1997 at Thomas County, KS (northwestern KS); Cheyenne, KS (northwestern KS); Scottsbluff County NE (western NE); Ellis County, KS (central KS); Washington County, (eastern CO).

Results and Discussion

The non-linear logistic model fit the current data better than the linear model for all life stages. Prediction model results (pupation, adult formation and adult weevil emergence) are presented in Tables 1-3.

Table 1. The Relationship between Pupation of Sunflower Stem Weevil within Stalks and Accumulated Degree Days.

Predicted Rate of Pupation (%)	Predicted Accumulated Degree Days (DD)
5	119
50	387
75	486
90	585

Table 2. The Relationship between Sunflower Stem Adult Weevil Formation within Stalks and Accumulated Degree Days.

Predicted Rate of Adult formation (%)	Predicted Accumulated Degree Days (DD)
5	425
50	745
75	866
90	986

Table 3. The Relationship between Sunflower Stem Adult Weevil Emergence from Stalks in the field and Accumulated Degree Days.

Predicted Rate of Adult Emergence (%)	Predicted Accumulated Degree Days (DD)
5	504
50	1004
75	1215
90	1431

The model predicts initial pupation (5%) of sunflower stem weevil at 119 DD and 90% pupation at 585 DD (Table 1). The earliest observations of sunflower stem weevil pupae were on the 19 March 2004 sampling date at Sherman County, KS; and Phillips County, CO sites.

Adult weevils were predicted to appear within stalks at 425 DD and 90% adult formation was predicted at 986 DD (Table 2). The model predicts 5% adult weevil emergence from stalks at 504 DD and 90% emergence at 1431 DD (Table 3).

The first adult weevil occurrence within stalks was on the 16 April 2004 sampling date in Washington County, CO and the first adult weevil emerged on 2 May 1997 at Washington County, CO site.

Understanding sunflower stem weevil field biology in relation to weather will enhance Integrated Pest Management (IPM) practices by enabling more efficient scouting and better timing of insecticide applications.

In addition, adult emergence prediction models will help us understand the consequences of altering sunflower planting dates. Prediction of other life stages of the pest may allow us to target potentially vulnerable life stages with additional control tactics.

Therefore, scouting for sunflower stem weevil should be initiated after 504 DD have accumulated so that current chemical controls can target the pest in the narrow window between emergence of adults from stalks and egg laying.

Reference cited

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