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Population Dynamics of Corn Flea Beetles and their Importance for Stewart's Disease of Corn

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Abstract
Stewart's disease of corn, caused by the bacterium *Pantoea (Erwinia) stewartii*, is extremely important for seed and sweet corn producers. Substantial economic losses are possible in both types of production. For the seed corn industry, zero tolerance phytosanitary regulations greatly inhibit the ability of seed corn to be exported from Stewart's diseaseinfected fields. Management often focuses on the role of the corn flea beetle (*Chaetocnema pulicaria*) vector that is necessary for both pathogen survival during the winter months and pathogen transmission during the field season. Research on the corn flea beetle is limited, especially in regard to its population dynamics during the growing season in Iowa and the proportion of the population that is harboring the bacterium. The corn flea beetle is the sole overwintering habitat for the bacterium; therefore, predicting the risk of Stewart's disease in each growing season is based primarily on the probability of corn flea beetle populations surviving northeast Iowa winters.

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Introduction

Stewart's disease of corn, caused by the bacterium *Pantoea (Erwinia) stewartii*, is extremely important for seed and sweet corn producers. Substantial economic losses are possible in both types of production. For the seed corn industry, zero tolerance phytosanitary regulations greatly inhibit the ability of seed corn to be exported from Stewart's disease-infected fields. Management often focuses on the role of the corn flea beetle (*Chaetocnema pulicaria*) vector that is necessary for both pathogen survival during the winter months and pathogen transmission during the field season. Research on the corn flea beetle is limited, especially in regard to its population dynamics during the growing season in Iowa and the proportion of the population that is harboring the bacterium. The corn flea beetle is the sole overwintering habitat for the bacterium; therefore, predicting the risk of Stewart's disease in each growing season is based primarily on the probability of corn flea beetle populations surviving northeast Iowa winters.

Materials and Methods

In 1999, 2000, and 2002, we monitored corn flea beetle populations on a near-weekly basis using sweep nets. This was accomplished by taking 10 replications of 10 sweeps per replication obtained from a linear, 6-m (20 ft) strip of grass border adjacent to corn and/or corn fields. Corn flea beetle samples were separated from other insects and plant debris and counted. The average number of corn flea beetles per 10 sweeps was calculated and plotted against time to determine the seasonality of corn flea beetle populations in northeast Iowa.

For corn flea beetles sampled in 1999 and 2000, we tested individual corn flea beetles for the presence of *P. stewartii* using enzyme-linked immunosorbent assay (ELISA). Approximately 90 corn flea beetles were tested per location per sampling date; however, when the number of corn flea beetles was less than 90, all corn flea beetles that were sampled were assayed.

To compare the observed populations of corn flea beetles with the predicted risk of Stewart's disease, we used the Iowa State Method that we developed to make pre-plant forecast concerning the seasonal risk for Stewart's disease in Northeast Iowa. This method examines the mean monthly air temperatures for the months of December, January, and February, and then a risk assessment is made based on the number of winter months that the mean monthly air temperature was ≥ 24ºF (Table 1).

Results and Discussion

The predicted risk for Stewart's disease was *moderate-to-high in 1999*, *high in 2000*, *negligible in 2001*, and *high in 2002*.

Corn flea beetle populations were very low during the overwintering and first generation of corn flea beetles in 1999. Figure 1 shows the population dynamics and the proportion of infested corn flea beetles in 1999 and 2000. The population of corn flea beetles was low throughout much of 1999; however, the proportion of corn flea beetles with *P. stewartii* was extremely high (maximum of 80% infested).

As predicted for 2000, the population of corn flea beetles was very high throughout the entire growing season (maximum 16 corn flea beetles

per 10 sweeps). The proportion of infested corn flea beetles in 2000 ranged between 0.20 and 0.40 (20 and 40%).

After a cold winter in 2000–2001, the corn flea beetle population was still very low and very slow to recover in 2002, even though the predicted risk for Stewart's disease was high. As a result, we did not find corn flea beetles until early September in 2002, when only 0.2 corn flea beetles per 10 sweeps was observed.

The coupling of predicting Stewart's disease risk with corn flea beetle population data provided useful new information for developing better management options for controlling Stewart's disease of corn, including choice of planting sites (low Stewart's disease risk), and predicting prior to planting whether or not seed and/or foliar insecticides would be needed for a specific year and location.

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Table 1. The Iowa State Method for predicting the risk of Stewart's disease of corn in a growing season.

Number of months ≥ 24ºF	Predicted risk for Stewart's disease
0	Negligible
1	Low
2	Moderate-to-high
3	High

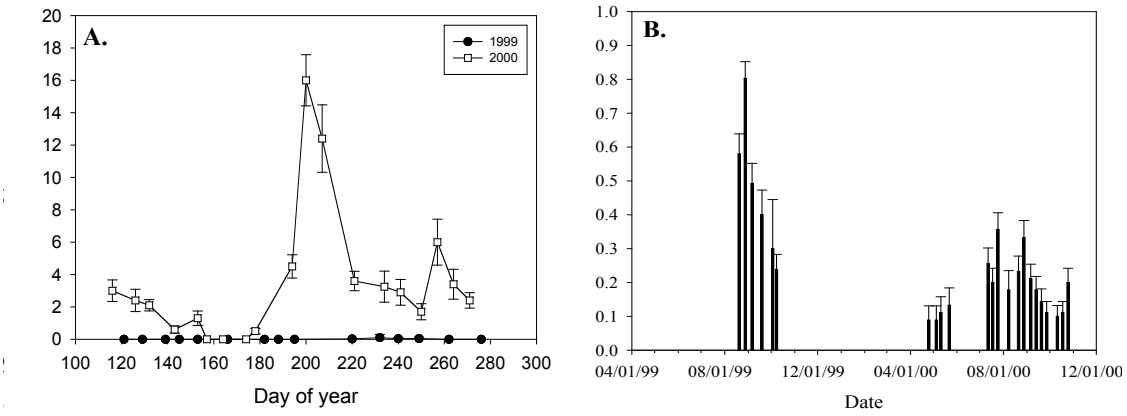

Figure 1. Corn flea beetle population dynamics (A) at the Iowa State University Northeast Research Farm in Nashua, IA, in 1999 and 2000, and (B) the proportion of infested corn flea beetles in 1999 and 2000 (Reference points for (A): DOY 120 = April 30, DOY 180 = June 29, and DOY 240 = August 28).