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Interest in the population dynamics and geographic distribution of common milkweed (*Asclepias syriaca* L.) has recently increased due to the importance of common milkweed in the life cycle of the monarch butterfly (*Danaus plexippus*). A survey of common milkweed occurrence in various habitats was conducted in Iowa in June and July of 1999. Common milkweed was found in 71% of the roadsides and approximately 50% of the corn (*Zea mays* L.) and soybean (*Glycine max* L. Merr.) fields. Corn and soybean fields had 85% fewer patches than roadsides. Conservation reserve program fields had the greatest average area infested. While common milkweed was frequently found in corn and soybean fields, average frequency and patch sizes were much greater in noncrop areas.

Keywords
Bt pollen, Monarch butterfly, weed distribution, maize, soyabean

Comments
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Occurrence of common milkweed (*Asclepias syriaca*) in cropland and adjacent areas

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Abstract

Interest in the population dynamics and geographic distribution of common milkweed (*Asclepias syriaca* L.) has recently increased due to the importance of common milkweed in the life cycle of the monarch butterfly (*Danaus plexippus*). A survey of common milkweed occurrence in various habitats was conducted in Iowa in June and July of 1999. Common milkweed was found in 71% of the roadsides and approximately 50% of the corn (*Zea mays* L.) and soybean (*Glycine max* L. Merr.) fields. Corn and soybean fields had 85% fewer patches than roadsides. Conservation reserve program fields had the greatest average area infested. While common milkweed was frequently found in corn and soybean fields, average frequency and patch sizes were much greater in noncrop areas.

Keywords: Bt pollen; Monarch butterfly; Weed distribution; Maize; Soyabean

1. Introduction

Common milkweed is native to northeastern and north central United States and adjacent areas of Canada (Bhowmik and Bandeen, 1976). This perennial dicotyledonous species is present in crop and pasture lands of many areas, including Iowa. Common milkweed and other members of the Asclepiadaceae family are the sole food source of monarch butterfly larvae (Brower, 1969), whereas the adults feed on a wide range of flowers. Common milkweed is the most prevalent *Asclepias* species and is considered the preferred food source for monarch larvae in Iowa. The importance of common milkweed populations in the central United States to the monarch (Wassenaar and Hobson, 1998) and toxicity of the pollen of Bt (*Bacillus thuringiensis*) transformed-corn deposited on common milkweed leaves (Hansen and Obrycki, 1999; Losey et al., 1999) to monarch larvae has generated interest in the distribution of common milkweed in crop lands and adjacent areas.

Common milkweed is adapted to a wide range of climatic and edaphic conditions (Bhowmik and Bandeen, 1976). Infestations may be found under a wide range of soil conditions in any textural group, but are most prevalent on well-drained soils of loamy texture. In a roadside survey, Cramer and Burnside (1982) found that infestation frequencies in Nebraska varied greatly by crop and land use. Over 70% of the soybean, oat, (*Avena sativa* L.) and sorghum [*Sorghum bicolor* (L.) Moench.] fields were infested with common milkweed, while infestation frequencies for corn, wheat (*Triticum aestivum* L.), and alfalfa (*Medicago sativa* L.) were 36, 28, and 6% respectively. Railroad, roadside, and pasture areas had infestation percentages of 70, 51, and 14%.

Corn pollen may be dispersed 60 m or more by wind (Raynor et al., 1972) and deposited on other plants in and around corn fields and can be ingested by non-target organisms that feed on these plants. Recent research (Hansen and Obrycki, 1999; Losey et al., 1999) has shown that the expression and dispersal of the Bt toxin in the pollen of transgenic corn may be toxic to non-target Lepidoptera species. In a laboratory assay, larvae of the monarch butterfly reared on common milkweed leaves dusted with pollen from Bt corn, ate less, grew more slowly, and had higher mortality than larvae reared on leaves dusted with untransformed pollen or on leaves

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without pollen (Losey et al., 1999). Hansen and Obrycki (1999) found that common milkweed leaf samples taken from within and at the edge of corn fields caused 19% mortality of monarch larvae with Bt pollen compared with 0% with non-Bt pollen and 3% in no pollen controls.

Each fall (autumn), millions of monarch butterflies from eastern North America migrate to 10–13 discrete colonies in the Oyamel forests of central Mexico (Wassenaar and Hobson, 1998). Although monarch migration has been extensively studied, the migration patterns to these locations from specific areas in North America has not been characterized. Using an isotopic labeling technique, Wassenaar and Hobson (1998) determined that all monarch wintering colonies were composed of individuals originating mainly from the Midwest United States. The importance of the Midwest in the monarch butterfly life cycle raises concerns over common milkweed populations in corn and soybean fields as the use of glyphosate-resistant crops increase. Glyphosate provides an additional herbicide for the control of common milkweed in the growing crop (Owen and Hartzler, 1999) and may reduce common milkweed occurrence in crop fields.

In areas of the North America where the landscape is dominated by row-crop production, a large proportion of the common milkweed may be either in corn/soybean fields or in adjacent areas within several meters of the field edge. The objective of this research was to determine the relative distribution of common milkweed in different habitats in Iowa. The results will help assess the potential impact of Bt pollen on monarch populations and proportion of milkweed that occurs in crop fields that may be affected by changing herbicide use patterns.

2. Materials and methods

Distribution and patch characteristics of common milkweed in Iowa were determined by a plant census conducted during June and July of 1999. To generate a random, representative sample of the state, a 10 km grid was superimposed on a map of the state of Iowa. The grid was generated using a Universal Transverse Mercator coordinate reference system for use with other digital map data in Arc/Info.[1] The grid was bisected horizontally and vertically to create four quarter grids. Within each quarter grid, ten 10 km grid cells were selected at random. The random selection was performed for each quarter using the Arc/Info RESELECT command with the RANDOM option. The selected grid cells were mapped with the 1 : 100,000-scale US Geologic Survey Digital Raster Graphic map series for navigation and field map selection. If a 10 km grid cell was split between two 1 : 100,000-scale map sheets, the sample was shifted one cell south and two cells east.

Within each 10 km grid cell ten 0.5 ha (50 m × 100 m) sampling areas were surveyed for the presence of common milkweed. County plat maps were used to locate the sampling areas within grid cells. Sampling areas were identified prior to going to the field by arbitrarily specifying a distance from a landmark, usually a road intersection or railroad crossing. This method eliminated sampling bias since the sampling areas were selected without prior knowledge of terrain or vegetation. Each sampling area was immediately adjacent to the road, extending 100 m into the field. The majority of sampling areas consisted of publicly owned roadside adjacent to the road and a second area of private property. The width of roadside in most situations was approximately 10 m and the dominant vegetation was smooth brome (*Bromus inermis* Leyss.).

Each sampling area was divided into sub-samples (sites) based upon the land use (i.e., roadside and corn). Data collected included size of site, vegetation type, crop growth stage, number of distinct common milkweed patches, and size of individual common milkweed patches. Common milkweed stems within 1 m of each other were considered be part of a single patch, and patch size was estimated as the area encompassed by the contiguous stems. Solitary stems were assigned a patch size of 1 m^2.

Data were analyzed using analysis of variance to allow comparison of common milkweed distribution among the different land uses. Data presented include the percentage of sites infested with common milkweed, mean number of patches per site, and cumulative area infested with common milkweed. Sites not infested with common milkweed were not included in the data set when calculating the mean number of patches and cumulative infestation. Paired *t*-tests were used to compare common milkweed patch frequency and area of infestation among land uses.

3. Results and discussion

A total of 859 sites were surveyed with roadside being the most common habitat sampled (Table 1). Corn and soybean were the next most common land uses followed by lower numbers of pastures, waterways and terrace areas, and conservation reserve program fields. Other land uses, including crops other than corn and soybean, railroad right-of-ways, wooded areas, grassed field corners, and fallow, comprised 7% of the observations and were treated as a single group in analysis of the data. Based on the design of the experiment and land use

[1] Source of materials: ESRI, Redlands, CA 92373. Reference to a trade or company name is for specific information only and does not imply approval or recommendation of the company by the USDA to the exclusion of others that may be suitable.

Table 1
Common milkweed occurrence, patch number, and estimated area infested by land use category in Iowa in 1999

Land use	Number of observations	Sites infested (%)	Number of patches[1] (no. 0.1 ha^{-1})	Area infested[1] (m^2 ha^{-1})
Roadside	407	71	4.8 a[2]	102 b
Corn	179	46	0.7 c	30 c
Soybean	153	57	0.7 c	16 d
Pasture	36	28	0.7 c	14 d
Waterways and terraces	13	46	1.7 b	169 ab
Conservation reserve program	15	67	0.9 c	212 a
Other[3]	56	41	2.0 b	61 bc

[1]Based on infested fields.
[2]Means followed by the same letter within a column do not differ using paired t-tests at $P \leqslant 0.05$.
[3]Other land uses included crops other than corn and soybean, railroad, wood lots, and grassed field corners.

patterns in Iowa, this was considered a representative sample of the landscape.

Common milkweed was found in 71% of the roadside sites, 46 and 57% of corn and soybean fields, 28% of pastures, 46% of the waterway and terraces sites, and 67% of conservation reserve program fields. Generally, noncropped lands had higher percent infestation than corn and soybean fields. Higher infestations of perennial plants are expected in undisturbed areas (Buhler, 1995). These infestation percentages are somewhat different from those observed in Nebraska (Cramer and Burnside, 1982) where 73% of the soybean fields and only 51% of the roadsides were infested.

Roadside areas had the highest frequency of common milkweed patches (4.8 0.1 ha^{-1}) within infested sites (Table 1). Waterways and terraces and other land uses had the next highest frequencies of common milkweed patches, but the frequency of patches was 42% or less of that in roadsides. Frequency of patches in pastures and corn and soybean fields was only 15% of that in roadside areas. The frequent soil disturbance and herbicide application in corn and soybean fields would be expected to prevent rapid spread of common milkweed in areas producing annual crops (Bhowmik and Bandeen, 1976).

Conservation reserve program fields, waterways and terraced areas that were infested with common milkweed had the greatest average area infested, even though the number of patches was relatively low (Table 1). Average area per ha infested in roadsides was about 50% of conservation reserve program fields, but was still 3.4–6.4 times greater than the average infested area in corn and soybean fields. Undisturbed areas provide individual common milkweed plants greater opportunity to develop an extensive root system and develop larger patches (Bhowmik and Bandeen, 1976).

Common milkweed was ubiquitous in the state of Iowa. Infestation levels were lowest in agricultural land (corn, soybean and pasture), however, this land use encompasses 78% of the total Iowa land area (Tiffany and Miller, 1999). The 9 million ha planted to corn and soybean annually may be an important refuge for monarchs. Therefore, changes in herbicide use patterns that result in more effective common milkweed control may impact monarch populations.

Roadsides had the highest infestation frequency of the vegetation types surveyed. There are approximately 330,000 ha of roadsides in Iowa. Although the total land area maintained in roadside vegetation is relatively small, the uniform distribution of roadsides across the landscape may increase their importance for the monarch butterfly. The narrow width of roadsides (10 m or less in most situations) places much of the common milkweed found in this habitat close to land planted to corn and soybeans. Monarchs that use these plants may be at risk if the adjacent corn fields are planted to Bt hybrids (Hansen and Obrycki, 1999; Losey et al., 1999).

This research provides information about the distribution of common milkweed in Iowa and areas with similar climate and land use patterns. However, additional information is required before an accurate assessment can be made of the potential impact of genetically modified crops on monarch butterflies.

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