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Robert G. Hartzler
Iowa State University, hartzler@iastate.edu

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The role of common milkweed in the lifecycle of the monarch butterfly has increased interest in the presence of this weed in the north central United States. An initial survey conducted in 1999 found that low densities of common milkweed occurred in approximately 50% of Iowa corn and soybean fields. In 2009, common milkweed was present in only 8% of surveyed fields, and the area within infested fields occupied by common milkweed was reduced by approximately 90% compared to 1999. The widespread adoption of glyphosate resistant corn and soybean cultivars and the reliance on post-emergence applications of glyphosate for weed control in crop fields likely has contributed to the decline in common milkweed in agricultural fields.

Keywords
Asclepias syriaca, weed distribution, glyphosate resistant crops, corn, soybean

Disciplines
Agricultural Science | Agronomy and Crop Sciences | Entomology | Weed Science

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Department of Agronomy, 2104 Agronomy Hall, Iowa State University, Ames, IA, 50010, USA

Abstract

The role of common milkweed in the lifecycle of the monarch butterfly has increased interest in the presence of this weed in the north central United States. An initial survey conducted in 1999 found that low densities of common milkweed occurred in approximately 50% of Iowa orn and soybean fields. In 2009, common milkweed was present in only 8% of surveyed fields, and the area within infested fields occupied by common milkweed was reduced by approximately 90% compared to 1999. The widespread adoption of glyphosate resistant corn and soybean cultivars and the reliance on postl emergence applications of glyphosate for weed control in crop fields likely has contributed to the decline in common milkweed in agricultural fields.

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Introduction

Common milkweed is a perennial native to northeastern and north central United States (US) and adjacent areas of Canada (Bhowmik and Bandeen, 1976). The plant is adapted to a variety of habitats, and is found in cropland, pastures, prairies and roadsides. Members of the Asclepiadaceae family are the sole food source of the monarch butterfly (*Danaus plexippus*) larvae, whereas adult monarchs feed on a variety of flowers (Brower, 1969). While numerous

Asclepias species are found in Iowa and surrounding area, common milkweed is the most prevalent and considered the preferred source of monarch larvae in the region.

Common milkweed is frequently found in agricultural fields (Cramer and Burnside, 1982; Hartzler and Buhler, 2000). Although common, it rarely reaches population densities that impact crop yield and typically does not drive weed management decisions. However, since approximately 75% of Iowa land is involved in agricultural production, the majority of common milkweed in Iowa is found in crop fields. Interest in the distribution of common milkweed has increased in recent years due to its relationship with monarch butterflies, the finding that 50% of wintering monarchs originated from the north central United States (Wassenaar and Hobson, 1998), and concerns regarding potential impacts of transgenic crops on the fate of the butterfly.

Shortly after the introduction of transgenic BT (*Bacillus thuringenienis*) corn, it was reported that pollen from some of these transgenic hybrids contained sufficient BT toxin to pose a threat to monarch larvae (Hansen and Obrycki, 2000). Monarchs were found to utilize common milkweed in corn fields, and larvae densities on common milkweed were as high or higher in agricultural fields as in nonl agricultural habitats (Oberhauser et al., 2001). Later research found that most BT hybrids expressed the toxin in pollen at concentrations unlikely to have severe fitness penalties to larvae feeding on milkweed within corn fields (Hellmich et al., 2001).

Since the majority of common milkweed in Iowa, and likely the north central US, is found in crop fields, and these plants are an important resource for monarchs, changes in weed management systems that increase common milkweed control could have an indirect effect on the monarch (Oberhauser et al., 2001). Soybean cultivars genetically modified for resistance to glyphosate (GR) were introduced in 1996 and the majority of US soybean acres were GR by

1999 (Dill et al., 2008). By 2006, 96% of US soybean possessed the GR trait. Although adoption of GR corn was much slower than that of soybean, approximately 35% of the US corn acres were planted with GR corn hybrids in 2006. Seventyl five percent of farmers reported planting continuous GR crops in a 2006 survey (Shaw et al., 2009). Due to the systemic characteristics of glyphosate, repeated use of glyphosate in GR crops could reduce infestations of perennial weeds such as common milkweed (Duke and Powles, 2008). To access the impact of changing weed management practices on common milkweed prevalence, crop fields and adjacent areas in Iowa were surveyed for the presence and abundance of common milkweed in the summer of 2009.

Materials and methods

The presence of common milkweed in corn and soybean fields, and the adjacent roadside, was determined by a plant census conducted during June and July of 2009. The timing of the survey was designed to assess common milkweed infestations after the crop and weed had emerged but prior to postl emergence herbicide applications. Since common milkweed emerging from vegetative rootstocks is not significantly affected by prel emergence herbicides used in corn and soybean, this allowed an accurate measurement of infestations within crop fields.

The sampling protocol was similar to a 1999 survey (Hartzler and Buhler, 2000), although a different method was used to generate a random sample. Iowa is divided into nine Crop Reporting Districts via two vertical and two horizontal transects along county lines. Counties within Iowa are divided into townships of approximately 94 km^2. Four townships were randomly selected within each Crop Reporting District, and then plat maps were used to locate

six sampling areas within each selected township. A total of 216 sites were sampled in 2009. Sampling areas were identified prior to going to the field by arbitrarily specifying a distance from a landmark, usually a road intersection. In situations where the designated area was not planted to corn or soybean, the first field encountered beyond the designated area was surveyed. This method eliminated sampling bias since the sampling areas were selected without prior knowledge of the terrain or vegetation.

A 50 m section of the roadside was surveyed for common milkweed, the width of the roadside at most sites was approximately 10 m and the dominant roadside vegetation was smooth brome (*Bromus inermis* Leyss.). A 50 m by 100 m area of the adjoining crop field was then surveyed for the presence of common milkweed. Data collected included 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 to b e part of a patch, and patch size was estimated as the area encompassed by contiguous stems. Solitary stems were assigned a patch size of 1 m^2.

Analysis of variance was used to compare common milkweed infestations among different habitats. Data presented are percentage of sites infested with common milkweed and cumulative area infested with common milkweed. Sites not infested with common milkweed were not included in the data set when calculating cumulative area infested.

Results and discussion

Common milkweed occurrence did not vary across the state of Iowa, thus data from the nine Crop Reporting Districts were combined. In addition, data from corn and soybean field were pooled due to lack of a significant difference in infestations between the two crops.

Eighty two percent of roadsides surveyed had common milkweed present in 2009, compared to 71% of roadsides in 1999 (Table 2). Although the Iowa land area maintained in roadsides is relatively small (approximately 330,000 ha), it is uniformly distributed across the landscape and may be important as an oviposition site for monarchs. A survey in Nebraska in the early 1980's reported 51% of roadsides infested with common milkweed (Cramer and Burnside, 1982). Herbicide use on Iowa roadsides and mowing has declined since the establishment of an integrated roadside vegetation management program in 1988 (Flynn 1994), which likely contributes to the high frequency of occurrence of common milkweed in this habitat. Roadsides are typically only sprayed with herbicides when weeds designated as noxious by the state are present.

The percentage of crop fields infested with, and the amount of common milkweed present in infested fields declined in the time between the two surveys (Table 1). In 1999 common milkweed was found in 51% of the crop fields, whereas in 2009 only 8% of the fields were infested with the weed. In several of the infested fields, common milkweed was only found within a few m of large common milkweed patches present in the adjacent roadside (data not presented). The area occupied by common milkweed patches in infested fields declined by approximately 90% from 1999 to 2009.

A large reduction in common milkweed in Iowa corn and soybean fields occurred between 1999 and 2009. Although several factors could have contributed to this decline, the widespread adoption of GR crops and concomitant applications of glyphosate are likely primary contributing factors. A survey of cropping systems employed by Iowa farmers found 75% of crop rotations used in the state consisted of continuous GR crops (Shaw et al., 2009).

Iowa's landscape is dominated by cropland, with approximately 75% of the land mass dedicated to agricultural production. It was estimated that Iowa corn and soybean fields produced 78 times more monarchs than nonl agricultural habitats (Oberhauser et al., 2001). Thus, the decline in common milkweed found in corn and soybean fields could affect monarch reproduction within Iowa and surrounding states with similar land use patterns. The land areas most frequently infested with common milkweed were roadsides and areas enrolled in the Conservation Reserve Program (Hartzler and Buhler, 2000), but approximately 1 million hectares are dedicated to these land uses compared to 9.1 million hectare planted to corn and soybean. Estimates of monarch wintering populations in Mexico over the time frame of the common milkweed surveys do not indicate a decline in butterflies that parallels that of common milkweed (www. monarchwatch.org). Rather, fluctuations in monarchs were reported to correlate with climatic events that influenced survival and reproduction of the monarch. Thus, the longl term impact of declining common milkweed populations in Iowa on monarchs is difficult to access.

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Table 1. Occurrence of common milkweed in Iowa roadsides and crop fields (corn and soybean).

Land use	Number of sites surveyed		Sites infested (%)		Area infested ± SD (m^2 ha^{-1})	
	1999[a]	2009	1999[a]	2009	1999[a]	2009
Roadside	407	216	71	82	102 ± 238	96 ± 242
Crop field	332	216	51	8	52 ± 51	5 ± 5

[a]1999 data adapted from Hartzler, R.G., Buhler, D.D., 2000.