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INTERCROPPING WITH SUNFLOWERS TO ATTRACT BENEFICIAL INSECTS IN ORGANIC AGRICULTURE

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Abstract

Sunflowers (*Helianthus* spp.) are listed in many extension factsheets and other such publications as excellent plants to attract beneficial insects in addition to those known to be important pollinators. We performed a 2-year study at a number of organic farms in Alachua County, Florida to determine if the presence of sunflower rows included in a polyculture system increased the occurrence and abundance of beneficial insects in cropped fields. The occurrence of beneficial insects was significantly greater on sunflower than on crop vegetation in control blocks and crop vegetation greater than 10 m distant from sunflowers. While crop vegetation 10 m distant from sunflowers harbored significantly fewer beneficial insects, this difference in occurrence was not seen in crop vegetation 1 m distant from sunflowers. Our results indicate that sunflowers indeed attract and play host to numerous beneficial insects suggesting that sunflower plantings within rows of vegetable crops may indeed be an effective way to attract beneficial insects into cropped fields. However, further study is required to fully describe the distances key beneficial insects move from sunflowers and the impact these beneficial insects have on crop pests.

Key Words: beneficial insects, sunflowers, insect diversity, intercropping, organic agriculture

Resumen

El girasol esta descrito en muchos folletos de extensión agrícola y otras publicaciones agrícolas como una planta excelente para atraer insectos benéficos, además de incluir insectos de importancia como los polinizadores. Nosotros realizamos un estudio por un periodo de dos años en varias granjas orgánicas en el condado de Alachua en Florida para determinar sí la presencia del girasol sembrado en hileras en un sistema policultural aumentaría la presencia y la abundancia de insectos benéficos en campos sembrados. La ocurencia de insectos benéficos fue mucho mayor en el girasol que en el cultivo en los bloques de control y en las plantas del cultivo sembradas a más de 10 m de distancia de las hileras de girasol. Aunque las plantas del cultivo sembradas 10 m del girasol fueron un refugio menos significativo para los insectos benéficos, esta diferencia no fue observada en plantas del cultivo sembradas a 1 m de distancia del girasol. Nuestros resultados indican que los girasoles en verdad atraen y juegan un papel como hospederos a un gran número de insectos benéficos y se sugiere que la siembra del girasol en hileras de cultivos vegetales en verdad pueden tener un efecto para atraer insectos benéficos dentro de los campos agrícolas. Sin embargo, se requiere estudios adicionales para determinar las distancias de las especies claves de insectos benéficos que se mueven del girasol al cultivo y el impacto que tienen estos insectos benéficos sobre las plagas en los cultivos.

Translation provided by the authors.

Insect predators and parasitoids of crop pests can be influenced to take up residence within cropping systems by providing habitat for them (Helenius 1998). Farm management to enhance the presence of beneficial insects refers to the establishment of food resources and habitat required by these species that increase and sustain their populations (Pickett & Bugg 1998). Pollinators and parasitoids can be attracted to cropped fields by including nectar producing flowering plants. For example the planting of sweet alyssum (*Lobularia maritime* Linnaeus) around cabbage fields is thought to increase longevity of parasitic wasps that are beneficial in reducing pest populations in the field (Johanowicz & Mitchell 2000). These natural enemies can be attracted to cropped areas and their numbers increased by including within-field habitat strips, select cover crops, and proper management of field margins, hedgerows, fencerows, windbreaks, irrigation and drainage ditches, and roadside margins. For example, several studies have found that sown weed strips within cropped areas increased natural enemy abundance and activity in crops by providing habitat for these enemies into and throughout the interior of the cropped fields. Additionally, rates of feeding of these natural enemies on pest insects were higher near the sown weed strips (Nentwig 1998; Schoenig et al. 1998; Wratten et al. 1998).

Sunflowers (*Helianthus* spp.) are listed in many extension factsheets (Univ. of Florida Extension Circular 563, Univ. of Rhode Island Landscape Horticulture Factsheet, Univ. of Maine Coop Extension Bulletin # 7150) and other such publications (Long 1993; Starcher 1995; Turton 1998) as excellent plants to attract beneficial insects such as those known to be important pollinators (e.g., honey bees and other bee species) or known to prey upon or parasitize agricultural insect pests (e.g., lacewings, big eyed bugs, ladybird beetles, and numerous parasitoids). While informative, these particular extension publications are directed to the home gardener describing how to attract beneficial insects to their gardens. Therefore, we wanted to test the effectiveness of attracting beneficials with sunflower plantings in a commercial cropping system context.

We performed a 2-year study at a number of organic farms in Alachua County, Florida to determine if the presence of sunflower rows included in a polyculture system increased the occurrence and abundance of beneficial insects in cropped fields. In year one we compared the occurrence of both beneficial and pest insects on intercropped sunflowers to those occurring on paired crop vegetation in control plots. In year two we attempted to determine whether predatory insects attracted to the sunflower rows moved into adjacent crop vegetation by compared the occurrence of beneficial insects on sunflowers and crop vegetation adjacent to sunflower plantings (within 1 m) to those occurring on the same crop vegetation 10 m distant from sunflower rows.

Materials and Methods

Research Site Selection

With the help of the director of the Florida Organic Growers Association, Marty Mesh, growers were identified in North-central Florida during the fall of 2001 and permission was obtained to conduct research activities on their properties during the course of our 2-year study. All participating farms were under certified organic management as designated by the Florida Organic Growers Association (Florida Certified Organic Growers and Consumers, Inc., PO Box 12311, Gainesville, FL 32604) and most are now USDA Organic certified.

Sunflower Intercrop Strips

Four growers were asked to incorporate rows of multi-branched open-pollinating varieties of sunflowers into their cropped acreage at the earliest planting dates during their planting season spring-summer 2002 and 2003. A total of 16 ten-acre blocks were chosen for the study, 8 of which received sunflower row treatment while the other 8 served as controls within the 4 participating farms. On each farm one ten-acre block received a treatment of 1 row per acre, another ten-acre block received a treatment of 2 rows per acre and each was paired with a control block. Sunflower rows consisted of 1-m-wide rows of plants at a density of approximately 9 plants per square meter and were interspersed between, and parallel with, production rows (Fig. 1). Sunflower rows were maintained throughout the growing season as other crops were planted, harvested, and rotated through the acreage of each farm's production area. Treatment and control blocks were also paired by crop type, which included sweet corn, collards, tomatoes, okra, and watermelon. Treatment blocks were assigned different treatments during the second field season.

Insect Surveys

During growing season 2002, insects were sampled a minimum of 3 times in 10 randomly chosen 1-m^2 quadrats within sunflower rows consisting of the sunflowers and crop vegetation (directly adjacent to sunflowers). Insects were also sampled in 10 randomly chosen locations in control blocks of the paired crop vegetation. During 2003, insects were again sampled a minimum of 3 times in 10 randomly chosen 1-m^2 quadrats within sunflower rows, 10 quadrats in crop vegetation at 1 m, and 10 quadrats at 10 m distant from the sunflower rows. Insects were sampled by standard scouting techniques involving a sweep net and a beat cloth, as well as examination of each leaf and flower head occurring within each quadrant and counting the numbers of individuals found per m^2 of crop vegetation (after Morris 1960; Southwood 1978). Insects observed were identified to family level and relative abundances noted. For most of the insects sampled, identification to family was followed by a quick ID to genus or species level to determine if an insect was an actual crop pest, benign, or beneficial according to Henn et al. (1997) and the UF Coop. Ext. Service Insect Identification Sheets SPSET 5 (1997). Most of these IDs to genus were made in the field to reduce the cost associated with further taxonomy. In our record keeping, it was noted where a genus and or species occurred more frequently then a counterpart organism from the same family. Those records that are more accurate than family taxonomy are shown in the tables and their numbers are not combined with other members within the same family. The occurrence and number of individuals per m^2 beneficial and pest insects found upon sunflower plants and crop vegetation during the two growing periods was compared with a univariate analysis of variance (Zar 1999).

Fig. 1. Multi-branching sunflower varieties were planted at 1 or 2 rows per acre between vegetable rows to attract birds and beneficial insects into cropped fields. A row of sunflowers is shown here planted between rows of tomatoes.

RESULTS

Beneficial Insects

Beneficial insects were attracted to sunflower plants by the time the plants reached 0.15 m in height. Beneficial insects observed on sunflowers and nearby crop vegetation (within 1 m of sunflowers) included arthropod predators, parasitic wasps, and important pollinators representing 30 different families (Table 1). The most commonly occurring beneficial insects observed on sunflowers were big-eyed bugs (*Geocoris* spp.), honeybees (*Apis mellifera*), green lynx spiders (*Peucetia viridans*), ants (Formicidae), and sphecid wasps (Sphecidae). The most commonly occurring beneficial insects observed on nearby crop vegetation were green lynx spiders (*Peucetia viridans*), lady beetles (Coccinellidae), big-eyed bugs (*Geocoris* spp.), predatory stink bugs (Pentatomidae), and assassin bugs (Reduviidae). The occurrence of beneficial insects was greater on sunflower than on crop vegetation in control blocks in 2002 ($F_{1,16}$ = 11.78, P = 0.003; Fig. 2) and crop vegetation greater than 10 m distant from sunflowers in 2003 ($F_{1,16}$ = 12.94, P = 0.002; Fig. 3). While crop vegetation 10 m distant from sunflowers harbored significantly fewer beneficial insects, this difference in occurrence in sunflower and crop vegetation was not seen in crop vegetation 1 m distant from sunflowers when this was assessed during the 2003 growing period ($F_{1,22}$ = 2.29, P = 0.144; Fig. 3).

Pest Insects

Pest insects representing 12 different arthropod families were found on sunflowers and nearby crop vegetation (Table 2). The most commonly occurring pest insects were green stink bugs (*Acrosternum hilare*), corn flea beetles (*Chaetocnema pulicaria*, Chrysomelidae) and imported cabbageworm larvae (*Pieris rapae*), respectively. The occurrence of pest insects on sunflower and crop vegetation in control plots did not differ in 2002 ($F_{1,16}$ = 0.12, P = 0.74; Fig. 4) but did differ in 2003 ($F_{1,16}$ = 14.7, P = 0.001; Fig. 5). Greater mean numbers of pest insects per meter

TABLE 1. BENEFICIAL INSECTS THAT WERE OBSERVED TO OCCUR IN RANDOMLY PLACED 1-M SCOUTING PLOTS ON SUNFLOWER AND NEARBY CROP VEGETATION (WITHIN 1 M OF SUNFLOWERS) DURING SPRING GROWING SEASONS 2002 AND 2003. BENEFICIAL INSECTS INCLUDED ARTHROPOD PREDATORS, PARASITIC WASPS, AND IMPORTANT POLLINATORS REPRESENTING 30 DIFFERENT FAMILIES.

Family	Common name	Benefit
Anthocoridae	Pirate Bugs	Predator
Apidae	Honey Bees	Pollinator
Asilidae	Robber Flies	Predator
Cantharidae	Soldier Beetles	Predator
Chrysididae	Cuckoo Wasps	Predator
Coccinellidae	Lady Beetles	Predator
Danaidae	Milkweed Butterflies	Pollinator
Dermaptera	Earwigs	Predator
Eulophidae	Eulophid Wasps	Parasite
Formicidae	Ants	Predator
Gelastocoridae	Big-eyed Bugs	Predator
Halictidae	Green Metallic Bees	Pollinator
Hesperiidae	Skippers	Pollinator
Ichneumonidae	Parasitic Wasps	Parasite
Lycaenidae	Gossamer-winged Butterflies	Pollinator
Mordellidae	Tumbling Flower Beetles	Predator
Mutillidae	Velvet-ants	Predator
Mymaridae	Mymarid Wasps	Parasite
Oxyopidae	Lynx Spiders	Predator
Papilionoidae	Swallowtail Butterflies	Pollinator
Pentatomidae	Predatory Stink Bugs	Predator
Plutellidae	Diamond-backed Moths	Pollinator
Reduviidae	Assassin Bugs	Predator
Scarabaeidae	Scarab Beetles	Predator
Sphecidae	Sphecid Wasps	Parasite
Tenebrionidae	Darkling Beetles	Predator
Thomisidae	Crab Spiders	Predator
Tiphiidae	Tiphiid Wasps	Parasite
Trichogrammatidae	Trichogrammatid Wasps	Parasite
Vespidae	Vespid Wasps	Parasite

were observed on sunflower vegetation than on crop vegetation greater than 10 m distant from sunflowers (2.5 individuals/m^2 vs. 0.2 individuals/m^2, respectively). This same difference was found

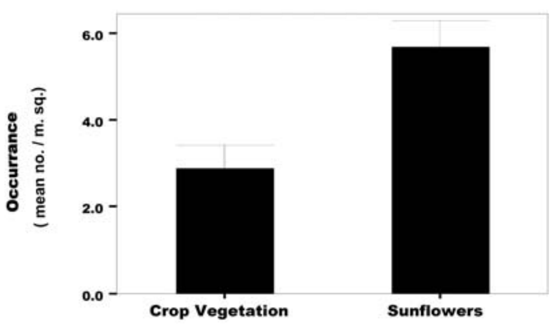

Fig. 2. Occurrence of beneficial insects was greater on sunflower vegetation than on crop vegetation during the 2002 growing season ($F_{1,16}$ = 11.78, P = 0.003). Error bars = 1 SE.

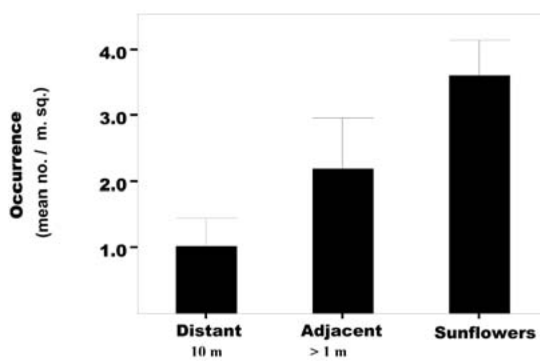

Fig. 3. The occurrence of beneficial insects was greater on sunflower vegetation than on crop vegetation more than 10 m distant from sunflowers in 2003 ($F_{1,16}$ = 12.94, p = 0.002). Occurrence of beneficial insects on crop vegetation 1 m distant from sunflowers did not significantly differ from that found on sunflower vegetation ($F_{1,22}$ = 2.29, P = 0.144). Error bars = 1 SE.

TABLE 2. PEST INSECTS THAT WERE OBSERVED TO OCCUR IN RANDOMLY PLACED 1-M SCOUTING PLOTS ON SUNFLOWER AND NEARBY CROP VEGETATION (WITHIN 1 M OF SUNFLOWERS) DURING SPRING GROWING SEASONS 2002 AND 2003. INSECTS OBSERVED ARE LISTED IN ORDER OF RELATIVE ABUNDANCE.

Family	Common name	Pest problem
Aphidae	Aphids	Disease transmission
Aleyrodidae	White flies	Disease transmission
Pentatomidae	Stinkbugs	Feeding damage
Chrysomelidae	Plant Beetles	Feeding damage
Lygidae	Plant bugs	Feeding damage
Coreidae	Plant bugs	Feeding damage
Cicadellidae	Leafhoppers	Disease transmission
Noctuidae	Armyworms	Feeding damage
Pieridae	Cabbageworms	Feeding damage
Plutellidae	Diamondback moths	Feeding damage
Sphingidae	Sphinx moths	Feeding damage

on crop vegetation within 1 m of sunflowers as well in 2003 (2.5 individuals/m^2 vs. 0.5 individuals/m^2, respectively, $F_{1,22}$ = 13.4, P = 0.001; Fig. 5).

DISCUSSION

In this study we found that diversity and abundance of beneficial insects increased in crop vegetation directly adjacent to sunflower rows. Our scouting efforts revealed that sunflowers did indeed attract and play host to numerous beneficial insects as has been described in numerous publications. Sunflower plants were found to attract predaceous insects almost immediately after establishment when sunflower plants reached a minimum height of 6 inches. Parasitoids and pollinators were attracted as soon as these plants began to produce flowers. Some of the same beneficial insects were found also to occur on crop vegetation but in significantly lower numbers. It has been found in several studies that providing predator refugia within cropping systems via strip crops or uncultivated corridors can result in the migration of predatory insects into adjacent crops (see Johanowicz & Mitchell 2000; Mensah 1999; Nentwig 1998; Schoenig et al. 1998; Wratten et al. 1998; Rodenhouse et al. 1992). In the 2003 growing season, we modified the sampling methodology in an attempt to determine whether beneficial insects attracted to the sunflowers may have been moving out from the sunflowers into adjacent crop vegetation. Results indicated that crop vegetation within 1 m of sunflowers exhibited nearly the same abundance and diversity of beneficial insects as did the sunflowers them-

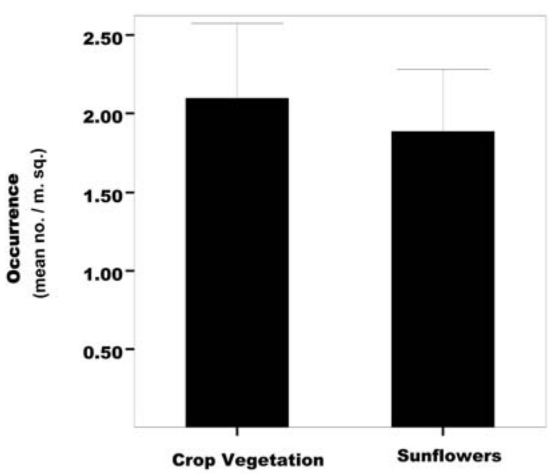

Fig. 4. Occurrence of pest insects on sunflower and crop vegetation in control plots did not differ in 2002 ($F_{1,16}$ = 0.12, P = 0.74). Error bars = 1 SE.

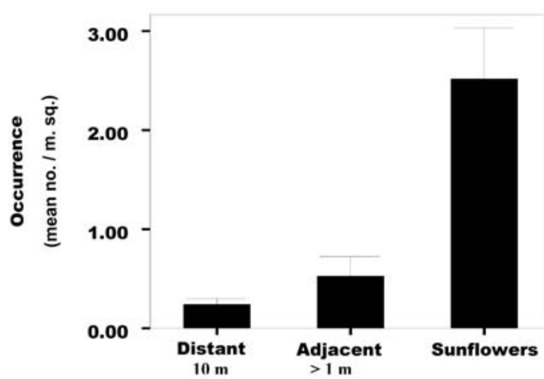

Fig. 5. Occurrence of pest insects on sunflower and crop vegetation greater than 10 m distant from sunflowers differed in 2003 ($F_{1,16}$ = 14.7, P = 0.001). Greater mean numbers of pest insects per meter were observed on sunflower vegetation than on crop vegetation greater than 10 m distant from sunflowers (2.5 individuals/m^2 vs. 0.2 individuals/m^2, respectively). This same difference was found on crop vegetation within 1 m of sunflowers as well (2.5 individuals/m^2 vs. 0.5 individuals/m^2,respectively, $F_{1,22}$ = 13.4, P = 0.001).

selves. However, crop vegetation 10 m distant from sunflowers harbored significantly fewer beneficial insects than did that within 1 m. Further study is required to fully describe the distances key beneficial insects move from sunflowers and the impact these beneficial insects have on crop pests. However, results of this study suggest that sunflower plantings within rows of vegetable crops may indeed be an effective way to attract beneficial insects into cropped fields.

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