

Intercropping to create local refugia for natural enemies: Flowers and birds in organic agroecosystems

In this study, we tested the hypothesis that sunflower rows in vegetable cropping systems may serve as predator refugia. We predicted that fields including rows of flowers would have greater densities of insect-eating birds, and that greater foraging by birds would be observed in fields with flower intercrops than fields without.

Although the value of native insectivorous animals in agroecosystems was once widely recognized and promoted by scientists and farmers, research on potentially beneficial species inhabiting agroecosystems was largely abandoned in 20th Century North America due to the pervasive utilization of pesticide technologies. As the agricultural industry swings back toward lower input, more environmentally sustainable systems, research focused on designing farming systems that emulate more complex ecosystems is urgently needed.

Clearly, the farm landscape and within-field structure of cropped areas affects the maintenance and activity of predators at the scale of individual fields, and the conservation of predator diversity requires consideration of both favorable and unfavorable habitat aspects when designing predator-friendly farmscapes. Studies of abundances and foraging activities of insectivorous birds in cropped systems suggest that bird use of crops for foraging depends not only on food abundance, but also upon vegetation cover and microclimate in the field and



Multi-branched sunflower varieties were planted at 1 or 2 rows per acre between vegetable rows to attract birds and beneficial insects into cropped fields. Here, a row of sunflowers is planted between rows of tomatoes.

upon habitat composition in the surrounding landscape.

This study investigates effects of within-field habitat structure, microclimate, and food abundance upon the presence and foraging activity of insectivorous birds in cropping systems. These are all features under the direct control of farmers.

Objectives

1. To test whether sunflower rows in cropped fields increases the occurrence, density, and foraging activities of insectivorous birds, and to determine the density of sunflower rows per acre needed to maximize bird presence and foraging activities while having the least impact upon yield per acre of other marketable crop production.
2. To document foraging and behavioral patterns and activity budgets of insectivorous bird species utilizing cropped treatment and control plot, and to document which insects were preyed upon by birds within the experimental plots via visual observation.
3. To perform a limited survey of the insect fauna found in our test plots to establish a partial listing and the relative occurrences of beneficial arthropods in the test systems.

Methods

Cropped-field bird refugia - Five of the ten certified organic growers participating in our study incorporated rows of multi-branched open-pollinating varieties of sunflowers into their cropped acreage during their spring and summer planting seasons of 2002 and 2003.

Project Notes

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Birds began to utilize sunflower vegetation as soon as the plants were able to support them as a perch and begin to provide some cover. Once sunflowers reached a height of at least 24", birds were observed to fly into the fields and first land on the sunflowers before venturing into nearby crop vegetation. A Palm Warbler is shown perched on a sunflower while foraging for insects in nearby rows of kale.



As the sunflower plants grew taller, birds increasingly utilized them as cover to travel to and within cropped fields similar to utilizing a hedgerow. A female Northern Cardinal is shown perched on a sunflower after foraging for insects in nearby crop vegetation.

A total of 18 ten-acre blocks were chosen for the study, eight of which received a sunflower row treatment while the other 10 served as controls within the participating farms. Sunflower rows were 1m-wide at a density of 1 plant per square foot and were interspersed between, and parallel with, production rows. Vegetable crops grown in the experimental blocks included mixed plantings of kale, collard greens, yellow and zucchini squash, tomatoes, green beans, cucumbers, and sweet corn. Only two of the blocks were fields dedicated to a single crop type (sweet corn).

Bird community structure - Birds were censused and their foraging activities noted throughout the growing period between 1 April – 15 June in 2002 and 2003. Species occurrence, abundance, and foraging activity were noted during the study periods and compared to data collected during the past two years (2000 and 2001) at these same farm sites.

Foraging surveys - Observations of foraging behavior were made during six one-

hour scan sampling sessions at each treatment plot spread over the study period. An attempt was made to visually identify those insects being consumed by birds during foraging observation and census sessions.

Gut content surveys - Birds were captured utilizing mist-netting techniques within treatment plots 1 hour after foraging activities were observed to commence. A partial sample of each bird's stomach contents were collected via a non-lethal forced regurgitation method (an orally administered emetic consisting of 0.1cm³ of 1% solution of antimony potassium tartrate per 10 g of body mass). Within 2 – 3 minutes, most birds regurgitated pellets of partially digested insects.

Insect surveys - Insects were sampled a minimum of three times in ten randomly chosen 1m³ quadrates within the sunflower rows, and in ten randomly chosen locations a minimum of 10m distant from the sunflower rows within the crop vegetation at each ten-acre treatment site during

the 2002 growing season. During 2003, insects were sampled within sunflower rows and in crop vegetation 1m and 10m distant from the sunflower rows. A simple assessment was made as to the occurrence and abundance of those insects considered beneficial in the systems.

Results

Species occurrence and densities

An impressive list of bird species was observed on participating organic farms over four survey years. A total of 68 species were observed utilizing cropped fields or bordering habitats (within 50 m) of these fields. Of these, 62 species (91%) were observed in the matrix surrounding cropped fields while 49 species (72%) were observed in the cropped fields themselves, five of which were only observed within these fields.

Cropped areas with sunflower treatments exhibited significantly greater mean densities of birds than did control plots (Figure 2). This difference between sunflower and control plots was significantly greater in 2003. Those plots having just 1

A note on figures: The complete project report includes 5 data figures. Figures 2-4 are included here.

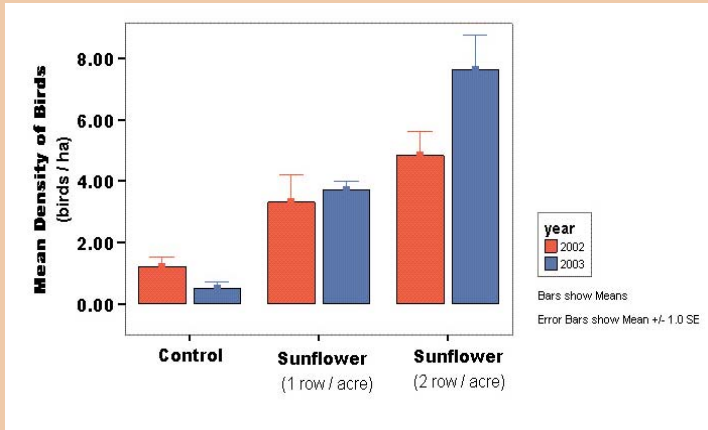


Fig 2. Sunflower treatment plots exhibited significantly greater mean densities of birds in the cropped fields than control plots during the 2002 and 2003 spring growing seasons. Plots having just 1 sunflower row / acre exhibited significantly greater densities of birds than control plots in both years. While cropped fields with 2 sunflower rows per acre exhibited greater mean density of birds than those with 1 row per acre in both years, this increase was significantly greater only in 2003.

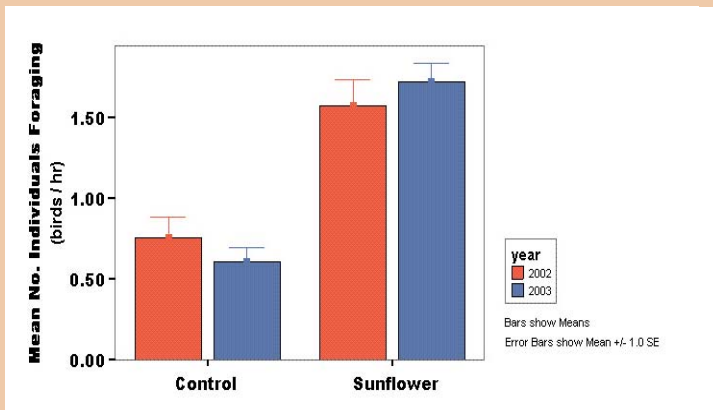


Fig 3. Mean number of individual birds foraging in cropped areas was significantly greater in those plots with sunflower treatments in both growing seasons 2002 and 2003.

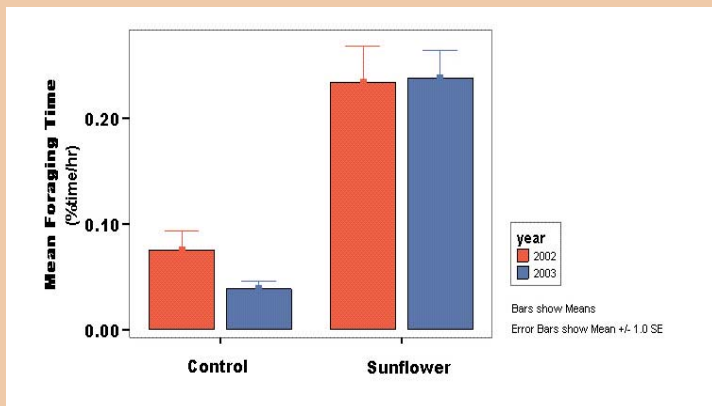


Fig 4. Mean foraging activity per hour in cropped areas was significantly greater in those plots with sunflower treatments in both growing seasons 2002 and 2003.

sunflower row per acre exhibited significantly greater mean densities of birds than control plots in both years. While cropped fields with 2 sunflower rows per acre exhibited greater mean density of birds than those with 1 row per acre in both years, this increase was significantly greater only in 2003.

Foraging Behavior

Over three years, numerous species were observed to actually forage for insects upon crop vegetation. Those species most often observed to forage in crops for insects include Northern Cardinals, Blue Grosbeaks, Northern Mockingbirds, Eastern Bluebirds, and Indigo Buntings. Foraging observations during two growing seasons indicated that the presence of sunflower rows significantly increased the presence and activity of insectivorous birds in vegetable or row-crops compared to control plots. Mean num-

ber of individual birds foraging in cropped areas (Figure 3) as well as mean foraging activity per hour (Figure 4) was significantly greater in those plots with sunflower treatments. The difference in foraging activity was consistent each year as treatment plots were rotated among the 18 experimental plots.

Birds were found to utilize sunflower plants as perches by the time they were 24” tall. As sunflowers increased in stature, birds were observed to increasingly utilize sunflower plants as cover and perch sites from which they would forage into crop vegetation.

Birds observed to forage in crop vegetation consumed numerous lepidopteran larvae as well as grasshoppers and beetles. These insects included Green Stink Bugs, Imported Cabbageworm, and numerous flies. Insects were taken directly from crop vegetation and either consumed on the spot or carried off into nearby field border habitat to presumably be consumed there or fed to young. A total of twenty birds representing the three species most commonly observed to forage for insects in crop vegetation (10 Northern Cardinals, 3 Blue Grosbeaks, 6 Indigo Buntings, and 1 Summer Tanager) were captured after foraging. Gut content samples obtained from twelve of these captured birds confirmed that economically important pest insects, such as leaf-chewing caterpillars and grasshoppers, were consumed.

Beneficial Insect Occurrence

Beneficial insects were attracted to sunflower plants by the time they reached 6” in height. Those beneficial insects observed on sunflowers and nearby crop vegetation (within 1m of sunflowers) included arthropod predators, parasitic wasps, and important pollinators representing 30 different families. The most commonly occurring beneficial insects observed on sunflowers were Big-eyed Bugs, Honey Bees, Green Lynx Spiders, Ants, and Sphecid Wasp. The most commonly occurring beneficial insects observed on nearby crop vegetation were Green Lynx Spiders, Lady Beetles, Big-

eyed Bugs, Predatory Stink Bugs, and Assassin Bugs. The relative occurrence of beneficial insects was significantly greater on sunflower vegetation than on crop vegetation in both 2002 and 2003. However, in 2003 when we censused and compared insects on crop vegetation directly adjacent to sunflowers (within 1m) and then 10 meters distant, we found the relative occurrence of beneficial insects did not significantly differ between sunflower and the adjacent crop vegetation.

Discussion

Our results support the hypothesis that cropped fields with sunflower rows incorporated into the cropping system exhibit greater bird densities. Those fields with even one row of sunflowers per acre exhibited significantly greater bird densities than those without, regardless of crop type or crop diversity. While an additional increase in density was seen with another row of sunflowers per acre, it appears that a single row may be enough to make cropped areas significantly more attractive for bird use.

Results of our foraging observations also support the hypothesis that foraging activity would be increased in crop vegetation with the presence of sunflower rows. Birds were found to begin to utilize sunflower vegetation as soon as the plants were able to support them as a perch and begin to provide some cover. Once sunflowers reached a height of at least 24", birds were observed to fly in to the fields and first land on the sunflowers before venturing into nearby crop vegetation. Birds flew first to sunflowers, perched and surveyed crop vegetation for prey, and then dropped down to capture prey from their sunflower perch. As the sunflower plants grew taller, birds increasingly utilized them as cover to travel to and within the rows, similar to utilizing a hedgerow.

Since birds responded to the presence of sunflower rows after they reached a certain height, timing of planting of these rows is critical to maximize the benefit of attracted insect predators. Sunflower plantings should precede that of other crop vegetation by several weeks to allow their

establishment and potential attraction of beneficial predators before crops, and any associated pests, reach critical growth stages.

Several bird species are known to cause considerable damage to certain crops, especially flocking species such as Red-winged Blackbirds and Cedar Waxwings. During our four years of observations of birds in cropping systems we observed

very little crop damage by birds. During this study participating farmers reported that they did not experience any increase in bird damage due to attracting more birds into their cropping systems with sunflower plantings.

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 predacious insects almost immediately after establishment. Parasitoids and pollinators were attracted as soon as these plants began to produce flowers.

In the 2003 growing season we modified our sampling methodology in an attempt to determine whether beneficials attracted to the sunflowers were indeed moving out from the sunflowers into adjacent crop vegetation. Results indicated that crop vegetation 10 m distant from sunflowers harbored significantly fewer beneficial insects than did that within 1 m. Moreover, crop vegetation exhibited nearly the same abundance and diversity of beneficial insects as did the sunflowers themselves. Therefore we believe that these insects attracted to the sunflowers were indeed moving from them into crop vegetation. Further study is required to determine the actual distances key beneficial



As sunflowers increased in stature, birds were observed to increasingly utilize sunflower plants as cover and perch sites from which they would forage into crop vegetation. An Eastern Kingbird surveys crop vegetation from a sunflower perch looking for a tasty insect.

insects actually move from sunflowers and the effective distance into crops these insects impact pests.

Growers unanimously indicated that adding sunflower rows into their cropping plans did not interfere with their normal management operations. All growers indicated that they noticed an increase in bird presence and activity in those areas with sunflowers compared to control plots.

Two of the five growers participating in the study reported they were able to sell blooms at local farm markets and generate some additional income having done so. Several growers commented that they thought it would be possible to generate income with sunflower plantings if they decided to market and establish a client base for the this produce. At the conclusion of the study 4 of 5 participants indicated they would continue to intercrop sunflower strips as part of their regular cropping scheme.

The next obvious step in this research is to attempt to quantify the actual impact bird predation has on pest insect populations and see if there is a measurable yield difference due to the predation.

Gregory Jones' complete project report (38 pages, including cited literature, additional data figures and project photos) is available at http://ofif.org/fundedl/reports/sieving-jones_03s33.pdf ■