Ecological Pest Management in Urban Agriculture

2021

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Learning Objectives

- Define urban agriculture
- Discuss landscape, local and abiotic factors that affect pest and natural enemy populations in urban farms and gardens
- Overview of common pests and natural enemies
- Understand the useful features of both Ecological Pest Management and Integrated Pest Management
- Learn effective strategies to reduce pest populations and increase natural enemies in urban farms and gardens using EPM

Urban Agriculture

- Definition: Agriculture that occurs within or near urban areas (often defined by population density or landscape composition)

- *Agroecological* definition: Agriculture that is affected by unique abiotic and biotic factors that exist within the built environment

(Lin et al., 2015; McClintock, 2010; Mougeot, 2000)

Key Urban Agroecological Features

- Low usage of pesticides or limited use of OMRI certified pesticides
- Biodiverse (High crop and non-crop diversity)
- Varying sizes and areas of production
- Diversified production, products, and goals
- Landscape scale complexity – impervious surface and fragmentation

(Altieri et al., 2016; Davies et al., 2009; Goddard et al., 2013; Lin et al., 2015; Loram et al., 2008; Siegner et al., 2019)

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Abiotic Factors Affecting Urban Agriculture

- Increased heat (Heat Island Effect)
- Air pollution
- Disrupted water and nutrient cycling
- Habitat fragmentation/reduced green spaces
- Impacts to urban flora and fauna (reduced diversity, increased abundance, and negative effects on plants)

(Bowler et al., 2010; Hough, 1995; Kaye et al., 2006; Lehmann & Stahr, 2007; Liang & Gong, 2020; Nowak et al., 2014; Paul & Meyer, 2001; Pickett et al., 2001; Rosenfeld et al., 1998; Taha, 1997; Tratalos et al., 2007; White & McDonnell, 1988; Wortman & Lovell, 2013)

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Urban Agriculture: Pests and Natural Enemies

Two categories of animals important to urban farmers and are often impacted by urban abiotic factors are natural enemies and pests

- Pests: Herbivorous arthropods that attack crops above and belowground
- Natural enemies: Predator and parasitoid arthropods that prey on or use pest insects to complete their life cycle – negatively impacting pest populations

Pest Examples

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Natural Enemy Examples

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Urban Abiotic Effects on Herbivorous Pests and Plants:

- Herbivorous pests: can have additional seasonal generations, faster growth rates, increased size, and fecundity
- Plants: Reduced growth rates, Increased rates of pest infestations (perennials)
- Increased occurrence of invasive species
- Widespread herbicide use

(Dale & Frank, 2018, 2018; Meineke et al., 2013; Parsons & Frank, 2019; Raupp et al., 2010) (Gaertner et al., 2017; Hanke et al., 2010; Kiely 2004; Kolpin et al., 2006; Turrini et al., 2016; Zanette et al., 2005)

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Urban Abiotic Effects on Natural Enemies

- Fragmented landscapes affect taxa differently: Natural enemy movement can be hindered by fragmentation and suitable habitats can be disturbed or destroyed
- Pesticide use at different scales (landscaping and home use) can disproportionally impact natural enemies. Selective pesticides are very uncommon

(Amweg et al., 2006; Bolger et al., 2000; Lagucki et al., 2017; Langellotto & Denno, 2004; Otoshi et al., 2015; Tooker & Hanks, 2000; Turrini et al., 2016; Weston et al., 2005)

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Urban Abiotic Effects on Agroecosystem Function

Increased heat, the composition of surrounding landscapes, air pollution, increased occurrence of invasive species, soil compaction, reduced water, and nutrient cycling are all factors that can reduce the vigor of crop and non-crop plants as well as create an environment favorable to pest infestations and unfavorable to natural enemies

If landscape scale abiotic conditions in UA exacerbate pest issues – what can urban farmers do?

Integrated Pest Management (IPM)

Integrated Pest Management uses biological, cultural, physical, and chemical tools to reduce risk from pests. Under IPM, actions are taken to control pests only when their numbers are likely to exceed acceptable levels.

- Pest identification (*Who/where*)
- Monitoring and assessing pest numbers and damage (*What*)
- Guidelines for when management action is needed (*When*)
- Using a combination of biological, cultural, physical/mechanical, and chemical management tools
- After action is taken, assessing the effect of pest management

What is Ecological Pest Management?

Preventative rather than reactive strategies to increase natural regulation of pest populations:

1. Crop management: above ground habitat conservation and enhancement of biodiversity. Use a variety of practices or strategies to enhance beneficial organisms.
2. Soil management: Build healthy soil and maintain below-ground biodiversity. Provide the best possible chemical, physical, and biological soil habitat for crops.
3. Reactive inputs for pest management: If, after following preventive and planned management practices, pests are above threshold levels and beneficials populations are low, release beneficials or apply selected biopesticides with low environmental impact.

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Urban EPM – Testing Effectiveness

In a review of fifteen peer-reviewed publications related to ecological pest management in urban agriculture:

- Local factors (on-farm management practices) associated with improving the structure and composition of the garden increased natural enemy abundance and diversity
- Nine studies recorded higher rates of predation associated with a local factor/practice
- **Landscape factors had some effect, but on-farm practices had the most impact to ecosystem function regarding EPM**

Agroecological Practices in UA to Increase Pest Control

Agroecological practices – typically derived from traditional agricultural practices – can help reduce pest populations and crop damage and increase natural enemy abundance, diversity, and effectiveness.

Beneficial "Local" factors documented in pest management experiments in urban agriculture include:

- Mulching and ground cover
- Intercropping/increased crop biodiversity
- Manipulation of vegetative structure
- Floral provisioning

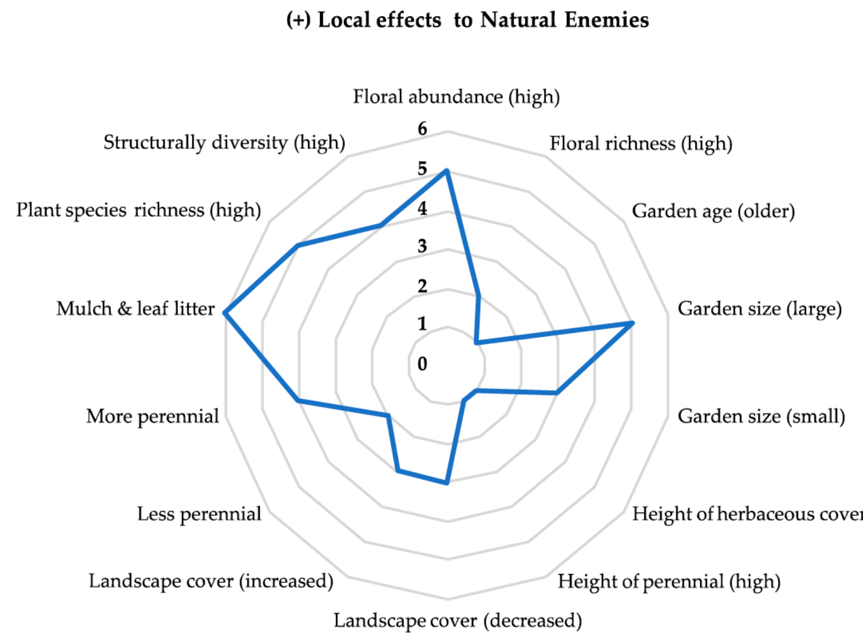

Figure 2. Numbers along the center y-axis represent the number of reportable results in the reviewed literature that indicate a positive effect to natural enemy richness, abundance, and rates of biological control. Reported results are correlated with explanatory variables (local factors) listed on the exterior of the radar chart.

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(Arnold and Egerer 2019)

Mulch and Complex Ground Covers

- Increases soil health – affecting plants and increasing soil fauna (Bottom-up food web effects)
- Increases abundance of parasitoid wasps
- Increased predator richness (lady beetles and spiders)
- Positive effects to predation (increased predation and prey removal)

(Burks & Philpott, 2017; Morales et al., 2018; Otoshi et al., 2015; Philpott & Bichier, 2017)

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Intercropping and Crop Biodiversity

Increased crop biodiversity and intercropping:

- Increase parasitoid and predator diversity

- Increase predator and parasitoid abundance

Burks & Philpott, 2017; Egerer et al., 2017; Mace-Hill, 2015; Morales et al., 2018; Sperling & Lortie, 2010)

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Increased Perennials and Complex Vegetative Structure

- Parasitoid richness and abundance increases with more perennials
- Predator abundance and richness increases with more vegetative complexity
- Increased predation on pests with more perennials
- Negative effect on aphid abundance

(Burks & Philpott, 2017, 2017; Egerer et al., 2017; Lagucki et al., 2017; Otoshi et al., 2015)

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Floral Provisioning

Floral richness and/or abundance:

- Increases parasitoid and predator abundance
- Negatively effects aphid abundance – reducing pest populations

(Arnold et al., 2019; Egerer et al., 2018; Lowenstein & Minor, 2018; Mace-Hill, 2015; Morales et al., 2018)

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Summary: Effective Urban EPM Strategies

While landscape and abiotic factors certainly play a role in pest issues, urban farmers can focus on local factors that directly impact pest control on the farm by implementing EPM practices such as the following:

- Mulch: ensure portions of your farm are covered with natural material like wood chips, leaves, forest duff.
- Floral provisioning throughout the year – both temporal and genetic diversity as well as abundance.
- Enhance structural diversity: Incorporate perennials and remember that complex agroecosystems can increase ecosystem function

Evaluation

- What are natural enemies?
- What are some of the abiotic factors that complicate pest management in urban agriculture? (Effects to pests, plants, and natural enemies)
- What are "local" and "landscape" factors? Which is more critical when managing pests in UA?
- What are some of the EPM practices that can be implemented?

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Thank you!

Questions?

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About us

Joshua Arnold is a PhD Candidate at UC Berkeley and Professor of Sustainable Agriculture at Warren Wilson College in Asheville, North Carolina.

The Growing Roots project supports the economic and ecological viability of California small-scale urban and peri-urban farmers from diverse communities. This publication is supported by the Foundation for Food And Agriculture Research.

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Slide 8:

- Pic 1 (Wasp and aphids): https://www.inaturalist.org/observations/44209135
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Slide 15:
Urban Tilth North Richmond Farm – Photo by Mizzica Films, https://civileats.com/2021/04/06/civil-eats-tv-planting-with-purpose-at-urban-tilth/

Slide 18:
Mulched garden bed and paths: https://www.creativevegetablegardener.com/vegetable-garden-mulch/

Slide 19:
California Hotel Garden (Formerly City Slickers now Sankofa Garden) – Photo by Author

Slide 20:
Alan Chadwick Garden UCSC, Picture: https://casfs.ucsc.edu/visit/farm-garden.html

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