The Best Wildflowers for Enrichment Patches in the Coastal Plain of Central Georgia to Boost the Abundance of Target Native Bees and Pollinating Wasps.

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Abstract

Bees pollinate almost every fruit, vegetable, and nut. This equates to roughly one-third of the human food supply being dependent on bees, particularly honeybees. However, honeybees are in decline due to colony collapse disorder. The honeybee's decline has boosted farmers' costs, since renting honeybee hives dramatically increases costs and potentially puts the human food supply in jeopardy. The best alternative to honeybees is native bees already present in the environment. How can we get native bees in sufficient numbers at an orchard or farm to be beneficial to commercial agriculture? It is hypothesized that by using wildflower plots, we can boost the number of native bees in targeted agricultural areas. Boosting native bee abundance in early spring (late March-April) is very important, since this corresponds to when many commercially important crops (e.g. blueberries, apples) flower and when pollination is critical.

In the current study, we studied wildflower effectiveness in recruiting bees and surveyed native bee diversity and abundance in the poorly studied Coastal Plain of Central Georgia. Twenty-two different wildflower species were seeded in wildflower enrichment patches next to experimental plots of blueberry bushes. Wildflowers were observed for bee visitation. The wildflowers that recruited the most bees were Indian Blanket (*Gaillardia aristata*), Lanceleaf Tickseed (*Coreopsis lanceolata*), Red Clover (*Trifolium pratense*), and Cosmos Sensation *(Cosmos bipinnatus)*. Bees were surveyed in 2022 and 2023 to determine the impact of the wildflower plots. In 2023, the assembly of bees on the farm significantly changed. Large-size bees (e.g. Bumblebees, Carpenter Bees) and medium-size bees (e.g. Blueberry Bees, Mining Bees) were significantly more abundant before wildflower patches were installed.

Introduction

Background:

- Honeybees are nature's greatest pollinators for most crops [1]. Each year, honeybees contribute $15 - $20 billion in pollination services to US agriculture [2].
- One out of three bites of food is pollinated by a bee. Nearly every fruit, nut, and vegetable must be pollinated by a bee [3].

The Problem:

- Honeybee populations are in sharp decline due to Colony Collapse Disorder [4]. The U.S. Congress has documented a significant decrease in honeybee colonies since the 1970's [5-7].
- A lack of honeybee hives has resulted in increased food production costs for farmers (e.g. honeybee hive rentals), which results in higher food costs for the general public [1].
- Alternative pollinators that can either replace or supplement the honeybee need to be explored. Honeybee losses could put the global food supply at risk and significantly impact the global economy.

Possible Solutions:

- The best alternative to honeybees is the native bees already present in the local environment. Each year, it is estimated that native bees already provide $3 billion worth of pollination services to US agriculture [8-9].
- Many native bees are excellent pollinators; a few species have been documented to be more than 20 times as efficient as the honeybee in pollinating flowers [8]. However, the greatest challenge for farmers is to recruit large numbers of the "excellent pollinating" native bees to their farms and orchards [1-2].

Possible Challenges:

- Farms and orchards typically consist of a large monoculture of a single crop. This can cause a real challenge for native pollinators. Since many crops (e.g. flowers or blooms) last for only a short amount of time (3-5 weeks) during the year, there is a great abundance of pollen and nectar for only a short period of time. No other food resources are available for most of the year. This results in most pollinators leaving farms and orchards to secure food and nesting elsewhere.
- There are two main methods that can be used to boost native bee abundance in agriculture areas. These methods include: (a) providing nesting habitat and (b) providing food resources [10,11].

Objectives and Hypothesis

There are 3 objectives in this project:

(1) to recruit more native bees to the farm to pollinate the target crop (e.g. blueberries).
(2) to determine which wildflowers are the best at recruiting native bees to the farm.
(3) to encourage bees to stay and nest in the farm, so that their offspring will be available in future seasons.

Hypothesis

It is hypothesized that by providing additional flora resources (e.g. wildflowers), the abundance of native bee populations will increase during the current growing season.

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Table 1: This table shows the 590 native bees and honeybees collected in 2022 at the Pinefield Ecofarm in Hephzibah, Georgia.

Genera	Number	Percentage
Agapostemon	1	0.2%
Andrena	14	2.4%
Apis	2	0.3%
Augochlora	2	0.3%
Augochlorella	0	0.0%
Bombus	4	0.6%
Colletes	0	0.0%
Epeolus	1	0.2%
Habropoda	10	1.7%
Halictus	17	2.9%
Lasioglossum	528	89.5%
Megachile	8	1.4%
Melissodes	0	0.0%
Nomada	1	0.2%
Osmia	1	0.2%
Sphecodes	1	0.2%
Triepeolus	0	0.0%
Xylocopa	0	0.0%
Total	**590**	**100.0%**

Table 2: This table shows the 510 native bees and honeybees collected in 2023 at the Pinefield Ecofarm in Hephzibah, Georgia.

Genera	Number	Percentage
Agapostemon	13	2.5%
Andrena	37	7.3%
Apis	27	5.3%
Augochlora	1	0.2%
Augochlorella	7	1.4%
Bombus	35	6.9%
Colletes	1	0.2%
Epeolus	1	0.2%
Habropoda	39	7.6%
Halictus	13	2.5%
Lasioglossum	297	58.2%
Megachile	7	1.4%
Melissodes	4	0.8%
Nomada	2	0.4%
Osmia	8	1.6%
Sphecodes	7	1.4%
Triepeolus	4	0.8%
Xylocopa	7	1.4%
Total	**510**	**100.0%**

Table 3: This table shows the difference in bees collected in the control plots (no wildflowers) and experimental plots (with wildflowers) in year 2 (2023).

Genera	Plots w/o Wildflowers	Plots with Wildflowers
Agapostemon	3	10
Andrena	12	25
Apis	2	25
Augochlora	1	0
Augochlorella	7	0
Bombus	3	32
Colletes	0	1
Epeolus	0	1
Habropoda	9	30
Halictus	0	13
Lasioglossum	101	196
Megachile	2	5
Melissodes	1	3
Nomada	2	0
Osmia	0	8
Sphecodes	5	2
Triepeolus	1	3
Xylocopa	2	5
Total	**151**	**359**

Table 4: This table shows the difference in bees collected in the experimental plots from year 1(2022) to year 2 (2023).

Genera	2022	2023	% change
Andrena	10	25	**150%**
Bombus	3	35	**1067%**
Habropoda	8	30	**275%**
Halictus	14	13	**-7%**
Lasioglossum	370	196	**-47%**
Other genera	10	60	**500%**
Total	**415**	**359**	**-13%**

Table 5: This table lists the most effective wildflower species that recruited native bee species.

Wildflower Species	Observations
Indian Blanket Flower *(Gaillardia aristata)*	> 50 bee observations
Lanceleaf Tickseed (*Coreopsis lanceolata*)	> 50 bee observations
Crimson Clover *(Trifolium incarnatum)*	> 50 bee observations
Cosmos Sensation *(Cosmos bipinnatus)*	> 50 bee observations

Methods

- Pinefield Ecofarm in Hephzibah, Georgia was the site of the on-farm research experiments. On the farm, there were six plots of blueberry bushes surveyed (3 control blueberry plots and 3 experimental blueberry plots). Wildflower patches of perennial and annual wildflowers were introduced to the experimental blueberry plots in the summer of 2022 (after the blueberry bloom). Wildflower patches were also reseeded with wildflower seed mix in January 2023.
- Wildflower species seeded were: Cosmos Sensation *(Cosmos bipinnatus)*, Lance Leaf Tickseed *(Coreopsis lanceolata)*, Plains Coreopsis (*Coreopsis tinctoria*), Purple Coneflower *(Echinacea purpurea)*, Siberian Wallflower *(Erysimum x allionii)*, Buckwheat *(Fagopyrum esculentum)*, California Poppy Orange *(Eschscholzia californica)*, Indian Blanket Flower *(Gaillardia pulchella)*, Sunflower Lemon Queen *(Helianthus annuus)*, Gayfeather *(Liatris spicata)*, Sweet Alyssum Tall White *(Lobularia maritima)*, Wild Perennial Lupine *(Lupinus perennis)*, Bee Balm *(Monarda didyma)*, Baby Blue Eyes *(Nemophila menziesii)*, Evening Primrose *(Oenothera biennis)*, Red Corn Poppy *(Papaver rhoeas)*, Lacy Phacelia *(Phacelia tanacetifolia)*, Mountain Mint *(Pycnanthemum muticum)*, Yellow Prairie Coneflower *(Ratibida columnifera)*, New England Aster *(Symphyotrichum novae-angliae)*, and Crimson Clover *(Trifolium incarnatum)*.
- Each experimental day at the farm (10 per year; March – September), bee observers watched wildflower patches for up to two hours per day. Wildflower effectiveness was defined as a floral visit by a native bee. Video cameras were also used to measure bee visitations. However, in-person bee/flower counts yielded much higher counts of bee- flower interactions.
- Bees were sampled each experimental day at the farm (10 per year; March – September), using blue, yellow, and white bowl traps, malaise traps, and sweep netting.

Results & Discussion

- The wildflowers that recruited the most bees were Indian Blanket (*Gaillardia aristata*), Lanceleaf Tickseed (*Coreopsis lanceolata*), Red Clover (*Trifolium pratense*), and Cosmos Sensation (*Cosmos bipinnatus*). Each of these flowers had 50 or more visits (bee- flower interactions) (Table 5). The Indian Blanket (*Gaillardia aristate) was visited by the widest range of bees and had the greatest bee visitation rate.*
- In 2022 (Control Year), 590 native bees and honeybees were sampled. Small sweat bees (*Lasioglossum* species) (89.5%) dominated the sample (Table 1). In 2023 (Experimental Year – Wildflowers were present all season), 510 native bees and honeybees were sampled. Small sweat bees dropped in abundance; while large-size bees (e.g. *Bombus* and *Xylocopa*) and medium-size bees (e.g. *Andrena* and *Habropoda*) significantly increased in abundance (Tables 2 and 4).
- In 2023 (Experimental Year – wildflowers were present all season), the 3 blueberry plots with added wildflowers patches had more than twice the number of bees than the 3 control plots that did not have wildflower patches. There were 359 bees collected in the experimental plots and 151 bees collected in the control plots (Table 3).
- The results suggest that certain species of wildflowers such as Indian Blanket, Lanceleaf Tickseed, Red Clover, and Cosmos Sensation can significantly alter and boost the native bee abundance and diversity in agricultural areas. It should be noted that the large-size bees (e.g. *Bombus* and *Xylocopa*) and medium-size bees (e.g. *Andrena* and *Habropoda*) have been linked to boosting agricultural yield across a wild range of commercially important crops [8,9]. The pollination value of the small sweat bee has been questioned due to their small size. Thus, if wildflower patches can boost large and medium size bee abundance, then improved agricultural yield should follow.

SCOLIID WASPS

- The sandy soils of the Coastal Plain of Central Georgia has large numbers of the Scoliid wasps. There were 44 Scoliid wasps collected in the sample in 2022 and 108 Scoliid wasps in 2023. The wildflower may be responsible for doubling the abundance of these large wasps at the farm. These wasps were observed interacting with both the wildflowers and blueberry flowers. Other studies have documented Scoliid wasp usefulness as both pollinators and predators of pest insects. High abundance, large size, and beneficial behaviors of Scoliids could have significant impacts on target crops. The most common species (over 95% of the Scoliid sample) was *Campsomeris plumipes fossulana.*

SIGNIFICANCE: Why should the public care about boosting native bee populations in agriculture?

- Increasing the number of native bee pollinators in commercial agriculture will result in: (1) lower production costs (e.g. fewer honeybee hives rented), (2) increased food production, and (3) lower food costs for the general public.
- Food security will also be improved by recruiting native bees. One-third of the human food supply will no longer be completely dependent on the honeybee. We will have alternatives.

Literature Cited

1. Losey, J.E., and M. Vaughan. 2006. The economic value of ecological services provided by insects. BioScience 56:311–323.
2. Morse, R.A., and N.W. Calderone. 2000. The value of Honey Bees as pollinators of US crops in 2000. Bee Culture 128:1–15
3. Klein, A. M., B. E. Vaissiere, J. H. Cane, I. Steffan-Dewenter, S. A. Cunningham, and C. Kreman. 2007. Importance of pollinators in changing landscapes for world crops. Proceedings of the Royal Society B: Biological Sciences 274:303-313.
4. Parker, F.D., S.W.T. Batra, and V.J. Tependino. 1987. New pollinators for our crops. Agricultural Zoology Review 2:279–304.
5. Johnson, R. 2007. Recent Honey Bee colony declines. Congressional Research Service Report to Congress 7-5700:1–17.
6. Leibenluft, J. 2008. Rent-a-Hive How much does it cost to borrow a colony of honeybees.
7. Vaughan, M., Hopwood, J., Lee-Mader, E., Shepherd, M., Kremen, C., Stine, A., and Black, S. H. 2015. ARMING FOR BEES Guidelines for Providing Native Bee Habitat on Farms. *The Xerces Society for Invertebrate Conservation*. 1-59.
8. Winfree, R., N.M. Williams, H. Gaines, J.S. Ascher, and C. Kremen. 2008. Wild bee pollinators provide the majority of crop visitation across land-use gradients in New Jersey and Pennsylvania, USA. Journal of Applied Ecology 45:793–802.
9. Kremen, C. and Greenleaf, S. S. 2006. Wild bees enhance honey bees' pollination of hybrid sunflower. Proc Natl Acad Sci USA.103(37):13890-13895.
10. Shepherd, M., Buchmann, S. L., Vaughan, M., and Black, S. H. 2003. Pollinator Conservation Handbook. The Xerces Society In Association with The Bee Works. 3-113.
11. Schlueter, M. A. and Stewart, N. G.. 2010. Native Bee (Hymenoptera: Apoidea) Abundance and Diversity in North Georgia Apple Orchards throughout the 2010 Growing Season (March to October). *Southeastern Naturalist*. 14(4):724-739.

Butterfly Milkweed | **Crimson Clover** | **Bee Balm** | **Blanket Flower** | **Cosmos Sensation** | **Dwarf Sunspot Sunflower** | **Lance Leaved Coreopsis** | **Mexican Hat** | **Partridge Pea** | **Plains Coreopsis** | **Purple Coneflower** | **Arroyo lupine** | **Buckwheat** | **Dwarf Lupine Pixie** | **Lacy Phacelia** | **Swamp Sunflower** | **Perennial Lupine**