SAVANNA INSTITUTE

NORTH CENTRAL SARE
Sustainable Agriculture Research & Education
Partnership Grant

Crop Performance, Pests, & Pollinators in Diverse Agroforestry (DA) Systems - Research results

Introduction

Farmers adopt a wide range of management regimes, ranging from low to high labor (e.g. mulching, pruning) and low to high inputs (e.g. fertilizer, herbicide). The four collaborating farms studied in this project span this spectrum and can provide some general insights into optimal management of DA systems.

Representative yields from four farms with young, establishing diverse agroforestry systems, including (A) cut flowers, (B) blackberries, (C) raspberries, (D) culinary herbs, and (E) cut floral stems.

Objectives

RESEARCH

1) Evaluate the growth & yield of DA systems across different management strategies
2) Identify baseline pollinator communities present in DA systems compared to adjacent conventional crops
3) Identify & monitor pests affecting perennial crops in DA systems

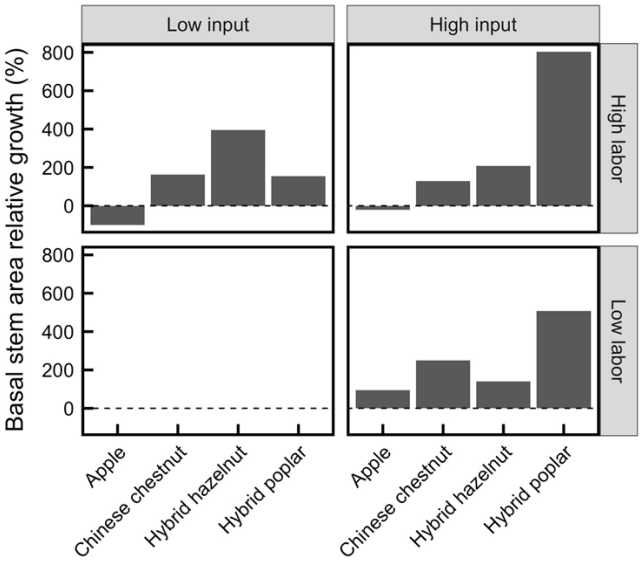
OUTREACH

1) Document the establishment & growth of DA systems via time-lapse photography
2) Distribute results via printed materials, online media, and field days

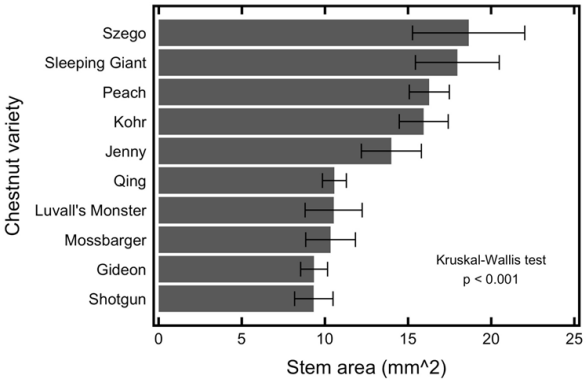
Crop Performance

MANAGEMENT APPROACH

Low-input, low-labor management approach proved highly unsuccsessful as weeds completely took over and plants either died or were impossible to find. This is the reason no data were collected from this farm at the end of the project (graph to the right). Similarly, overall results from the high-input, high-labor farm were not dramatically better than applying high-input or high-labor singularly. Hybrid poplar is the exception, as it is extremely fast-growing and is highly responsive to fertilizer inputs and reduced competition. Also, note hybrid hazelnut growth was higher in the low-input farm compared to the other two high-input farms. This may be the result of fertilizer stunting growth in the hazelnuts, which has been documented in previous studies. These results reiterate that management must be species-specific; not all tree/shrub species have the same requirements or responses.



Relative basal stem area growth for selected species across the four farms, classified by management regimes.



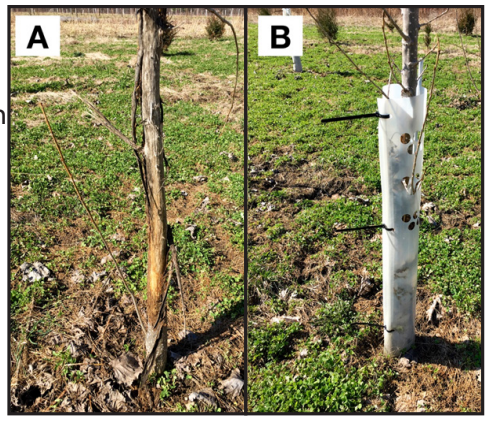
Basal stem area of ten Chinese chestnut varieties at the end of the project.

VARIETY SELECTION

While variety selection is wildly known to be critical for disease resistance, fruit quality, and yield, it is less often thought of as fundamental to plant establishment and growth. However, after two years of growth, results show basal stem area of Chinese chestnut ranged from 9-18mm depending on variety. This suggest the variety selection may be much more important to plant management in the successful establishment and early growth of tree species in DA systems.

TREE PROTECTION

One critical aspect of crop management in the early years of DA systems is tree trunk protection from herbivore damage. Much rubbing was observed on unprotected trees (A) above and below 4' height, yet severe rubbing was not observed on trees protected by 4' tree tubes (B). This suggests tree tubes also deter deer from rubbing, perhaps by the noise created by the plastic tubes when deer attempt to rub on the trees. When just looking at unprotected trees, those that had all branches pruned in the fall were much more likely to experience rubbing damage compared to trees that had no pruning. Not pruning the lateral branches may help deter deer as the branches tend to poke deer in sensitive places, like the eyes.



Plant Pathogens

In total, 17 pathogen species were observed on 11 plant species across all farms. All observed pathogen issues were fungal diseases. Fungal diseases may be exacerbated in DA systems due to the relatively high density and multiple layering of crops, which can decrease airflow, which is a major contributor to fungal disease pressure. . In addition, the spring seasons of both 2015 and 2016 experienced abnormally high precipitation at all studied farms, which can also exacerbate fungal disease issues.

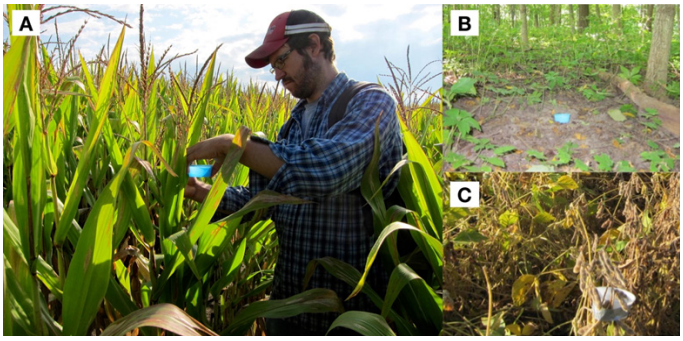
Arthropod Diversity & Abundance

Pan traps were used to target bees, which also captured a range of other flower-visiting insects. In total, over 13,500 arthropods were collected across all systems during two growing seasons. Ten different broad categories (orders) were collected and catalogued.

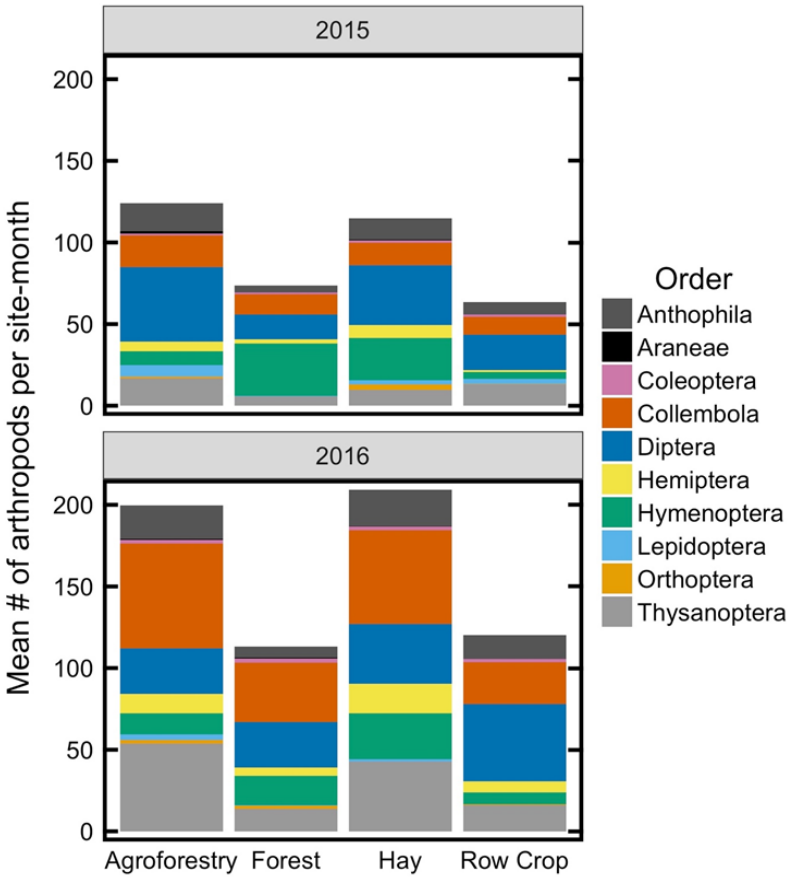
DA and hay systems had significantly higher diversity than row crop systems and were similar in both overall abundance and type. Similarly, forest and row crops were similar in both overall abundance and type.

On average, low-labor farms hosted over twice as many bees (Anthophila) compared to high-labor farms, which is probably related to more weed quantity and diversity. The only arthropods significantly affected by the level of farm inputs were thrips (Thysanoptera), which were almost three times more abundant in the low-input farms (i.e. little/no herbicide) compared to the high-input farms, probably because of higher quantity of weeds.

While higher insect diversity is well-documented in mature agroforestry systems, a positive shift in diversity within just the first 1-2 years after establishment is a very impressive sign of their capacity to foster biodiversity. In addition, it is interesting to see that the types of arthropods within the DA is most similar to that in the hay systems. This makes sense since the herbaceous ground cover is the dominant component during DA establishment, and is often of similar species composition to the adjacent hay communities.



To sample pollinators in the various land-use systems, (A) bowl traps were set out in the morning and recollected at the end of the day. Example bowl traps in (B) forest and (C) soybean are also shown.



Mean abundance of arthropods in each of the four land-use systems studied. All months at all four sites were average together for each year.

More information

See great timelapse videos of the sites at:
http://www.savannainstitute.org/timelapse-videos.html.

Field days held annually at each farm, with tours led by farmers and conversations lead by Savanna Institute staff.

Acknowledgements

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