Special Research Report #217: Optimizing Banker Plant Systems for Aphid Biological Control in Floriculture Greenhouses

Sara G. Prado[1], Adam G. Dale[2], Travis McClure[2], Steven D. Frank[2]

[1]NC Cooperative Unit, North Carolina State University, Raleigh, NC
[2]Department of Entomology, North Carolina State University, Raleigh, NC

BACKGROUND

The increased appreciation for environmental stewardship among regulators, producers, and the public (consumers) has increased the interest in biological control. Reducing reliance on insecticides and increasing the use of biological control has many benefits for growers and the floriculture industry. Unfortunately, concerns about efficacy and economics have prevented many growers from adopting biological control. The goal of this research is to improve the efficacy and economics of biological control in floriculture crops by optimizing banker plant systems.

Aphids feed on hundreds of floriculture crop species and, thus, reduce their aesthetic and monetary value. Aphids can be managed by releasing the parasitoid wasp, *Aphidius colemani* (Fig. 1). Parasitoids insert eggs into aphid hosts then the larval parasitoid develops within the host and emerges as an adult. Banker plants are a biological control technique that sustains parasitoids with alternative hosts negating the need for repeatedly purchasing new parasitoids. Banker plants consist of cereal plants infested with bird-cherry oat aphids, which only feed on grasses and are not floriculture pests. Bird-cherry oat aphids are hosts for the same parasitoid, *A. colemani* that attacks pests such as green peach aphid (*Myzus pericae*) and cotton aphid (*Aphis gossypii*). Thus, parasitoids reproduce on bird-cherry oat aphids and patrol greenhouses even when no pests are present. When pest aphids enter the greenhouse they can be located and killed rapidly.

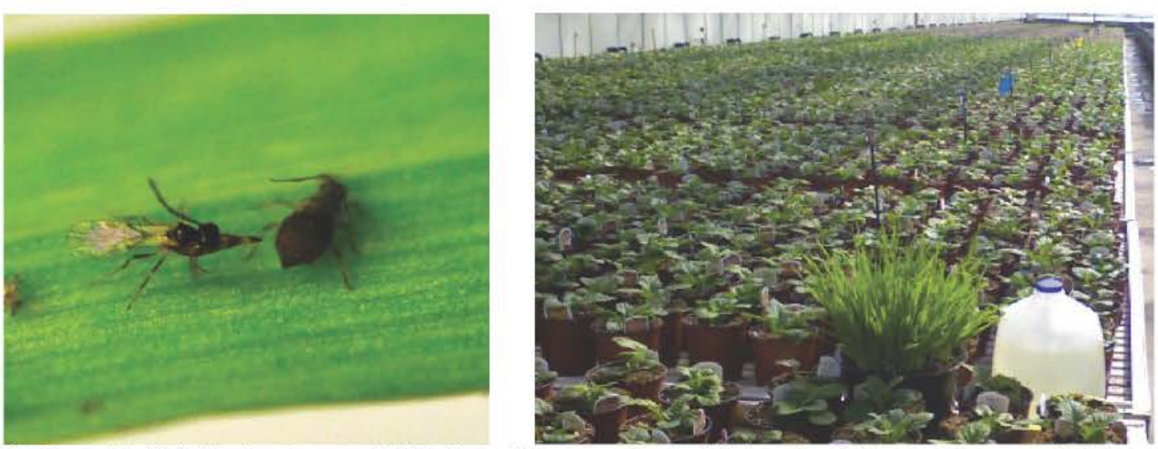

Fig. 1. Parasitoid 'stinging' an aphid to insert an egg that will develop into a new parasitoid feeding within the host (left) and a typical banker plant system at a commercial greenhouse in NC.

Some growers purchase banker plants while others create their own with only a few grain seeds. However, efficacy of banker plants is limited by a lack of research on optimal implementation practices. For example, at least 8 different grass species have been used and sold as banker plants but none have been compared to determine which plant species or cultivar best supports *A. colemani* development. Parasitoid preference for pest aphids compared to aphids on banker plants and parasitoid dispersal from banker plants to pests in the crop could also affect banker plant efficacy. Our goal was to better understand parasitoid behaviors that will affect the implementation and efficacy of banker plants so we can make specific recommendations to growers.

MATERIALS AND METHODS

Objective 1. Determine how banker plant species affects parasitoid development and efficacy.

Plant species and cultivars can affect the development and survival of insects that develop on them. To optimize banker plants, we need to find banker plant species to recommend that produce the largest, most fecund parasitoids in the shortest time. Three cultivars each of barley, rye, wheat, and oats were evaluated for their affect on *A. colemani* development time, survival, fecundity, and sex ratio. Each plant was grown to 6 inches in 2-gallon pots and infested with 100 bird-cherry oat aphids. Plants were covered with a cylindrical cage and 2 female parasitoids were be added. Emerging parasitoids were counted, sexed, measured, and dissected to determine egg load. We measured development time by growing each cereal cultivar in laboratory growth chambers, infested with aphids, and covered with a cylindrical cage. After one female parasitoid was added the aphids were inspected every 4 hours to determine when adults emerged.

Objective 2. Determine parasitoid preference for aphids on banker plants compared to pest aphids.

Parasitoid preference for aphids on banker plants versus pest aphids is important to determine the aphid pests for which this banker plant system will be effective. Parasitoids were released in greenhouse cages containing 100 bird-cherry oat aphids on banker plants and 100 pest aphids on ornamental peppers. We recorded the number and order of each species parasitized for 1 hour. Parasitoids were reared from aphids to measure development, size, survival, and fecundity.

Objective 3. Determine optimal implementation practices for aphid banker plant systems by examining parasitoid dispersal and efficacy at different spatial scales.

The optimal number and spatial arrangement of banker plants per acre is essential knowledge for successful implementation. To determine this, we needed to evaluate the ability of *A. colemani* to locate and travel to pest aphids at different distances from banker plants. In greenhouses, plants infested with pest aphids were placed 10, 20, and 30 feet from banker plants. After 5 days, the plants and sticky cards were collected. Plants were moved to laboratory growth chambers for several days to determine how many aphids were parasitized at each distance.

Objective 4. Evaluate efficacy of banker plant system for aphid control in commercial greenhouses

Using knowledge gained from previous objectives, we placed banker plants in large NCSU greenhouses to test their efficacy controlling aphids on ornamental peppers. In a second experiment, we placed banker plants at different densities in commercial hoop houses in Pittsboro, NC. Efficacy was determined by monitoring natural pest aphid abundance and parasitism. We also used sticky cards and sentinel aphid populations as in the previous objective to measure parasitoid abundance and parasitism.

RESULTS

Objective 1. Determine how banker plant species affects parasitoid development and efficacy.

We found that banker plant species has strong effects on many aspects of parasitoid development and parasitism rate. For example, parasitoids developing on barley had the shortest development time. Rye appeared to be the worst host because parasitoids took longer to develop and only 30% were female (Fig. 1). Since only female wasps parasitize pests, this is a major disadvantage. Based on these results and effects on parasitoids size and fecundity, **we recommend barley as a reliable species for banker plants**. This study was conducted largely by an undergraduate student, Mr. Adam Dale, and a graduate student, Ms. Sara Prado.

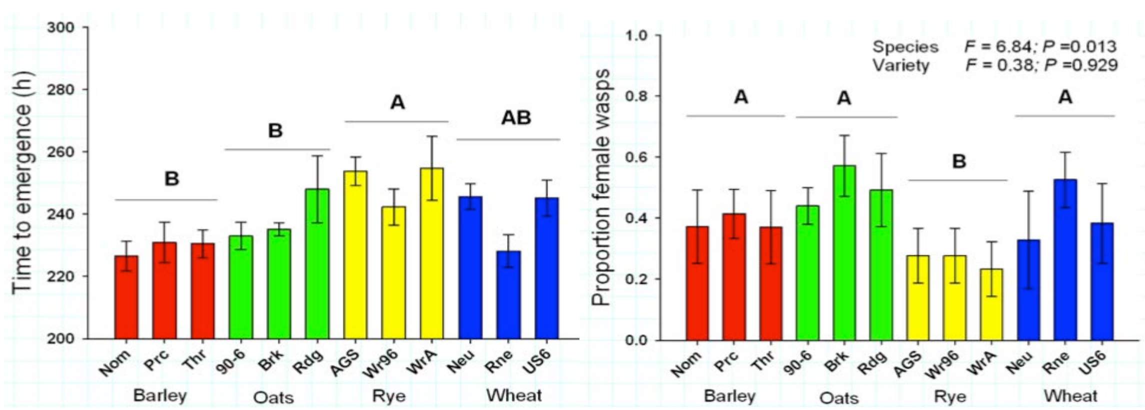

Figure 2. Testing different species of barley, oats, rye, and wheat for their effects on the parasitoid *A. colemani* development time and proportion of female wasps.

Objective 2. Determine parasitoid preference for aphids on banker plants compared to pest aphids.

We found that parasitoids prefer to parasitize pest aphids as compared to banker plant aphids. This is good because it means that over 50% of parasitoids leave banker plants to parasitize pests. Moreover, 90% of parasitoids that develop within pests attack other pests instead of returning to banker plants. This means parasitoids switch to pests and stay on pests when they are present and return to banker plants when pest density is low. This study was conducted by graduate student, Ms. Sara Prado.

Objective 3. Determine optimal implementation practices for aphid banker plant systems by examining parasitoid dispersal and efficacy at different spatial scales.
Parasitoids dispersed over 30 feet to find pests with no reduction in parasitism. Thus, banker plants could be spaced over 60 feet apart in greenhouses to maintain efficacy. We are continuing research on this question at commercial greenhouses. This study was conducted by graduate students, Ms. Sara Prado and Mr. Travis McClure.

Objective 4. Evaluate efficacy of banker plant system for aphid control in commercial greenhouses.
Our research in either large research greenhouses or commercial greenhouses has found that banker plant systems provide a higher level of biological control when compared to releasing parasitoids without banker plant systems. When banker plants are present, pest aphid abundance remained low but increased exponentially when banker plants were absent (Fig. 3). This is supported by greater parasitism rates and parasitoid abundance in greenhouses with banker plants.

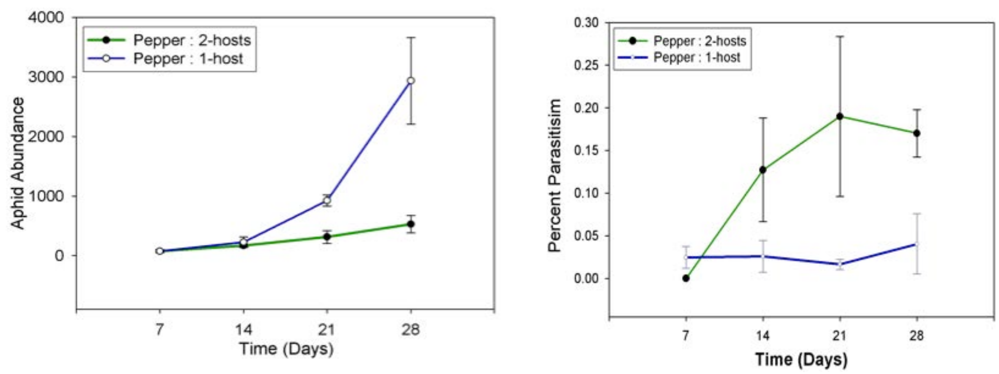

Figure 3. Aphid abundance (left) and percent parasitism of pests (right) in greenhouses where parasitoids were released with (green line) and without (blue line) banker plants.

In commercial greenhouses, we are finding that as few as 2 banker plants in 30 x 60 ft hoop houses provides biological control that is comparable to greenhouses where more banker plants are present. This means growers do not have to dedicate much space to banker plants to achieve biological control benefits. In addition, we found that 60% of parasitoids reared from banker plants were female in our commercial houses; whereas, 20-40% of parasitoids purchased from commercial sources were female. Since only females parasitize aphids, this difference is a big advantage for growers. This work was conducted by graduate students, Ms. Sara Prado and Mr. Travis McClure.

CONCLUSIONS

For three years, we have studied banker plant systems and other aspects of aphid biological control in floriculture greenhouses. We found that barley is a consistent and widely available banker plant species for growers to use. Seeds are inexpensive and grow quickly. Other research we have done shows that barley banker plants can last for over 10 weeks and require very little maintenance. Most importantly, banker plants increase parasitoid abundance and reduce pest aphid abundance better than just releasing parasitoids alone. Our research has shown that many parasitoids do not live more than 2 days after they are released and if they do not find hosts quickly they will die without reproducing. In addition, commercially available parasitoids have a high percentage of males that are ineffective for biological control. Our banker plant system produced parasitoid populations with more females for more biological control. From our research, banker plants appear to be a relatively easy way to increase the efficacy of aphid biological control by parasitoids wasps.

INDUSTRY IMPACT

Employees do not enjoy donning a spray suit, mixing chemicals, and working after hours to make insecticide applications. Not having to apply insecticides is the primary benefit identified by growers who have implemented biological control. In addition, biological control agents do not have Restricted Entry Intervals (REI) that restrict worker access and productivity. Furthermore, biological control has no crop residue or phytotoxicity and can be applied during the flowering period of sensitive plants. Our research will assist growers to implement biological control in a more effective and economical fashion. Thus, they can benefit from reduced-risk pest control and premium floriculture markets. We have disseminated our findings through multiple venues. In addition to dozens of extension and industry presentations, we have published three peer-reviewed papers on aphid biological control, two articles in industry magazines, and Webcasts for the Greenhouse Grower Floricast series.

Most importantly, this research has contributed to the Masters Theses of Ms. Sara Prado and Mr. Travis McClure and undergraduate research by Mr. Adam Dale. With funding from AFE, we were able to leverage more funding from the NCSU Department of Entomology and industry groups to expand the scope and impact of our work and AFE resources.

For additional information contact steven_frank@ncsu.edu.

American Floral Endowment
703.838.5211
afe@endowment.org
www.endowment.org