Effect of Systemic Use for Commercial Nursery Propagation of *Asclepias currasavica* on Monarch Larvae

Final Report to the Florida Wildflower Foundation

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Background: Florida is a particularly strategic state to the migratory lifecycle of the Monarch butterfly (*Danaus plexippus*). Each spring, as adult monarchs leave their overwintering grounds and move northward in search of milkweeds on which to lay their eggs, the available host resources they encounter are critical to help jump start the annual repopulation of the eastern U.S. and southern Canada. Beyond simply supporting monarch breeding, the quality and quantity of such accessible host resources facilitate population recovery from depressed numbers in any previous year. In many ways, the success of monarchs in the Deep South is a proxy for the overall health and size of the eastern population. On May 19th, 2015, the White House Pollinator Health Task Force published the National Strategy to Promote the Health of Honey Bees and Other Pollinators. The monarch is an integral component of this strategy, specifically efforts to help increase monarch butterfly numbers to protect the annual migration and to restore or enhance millions of acres of land for pollinators (including the monarch) through combined public and private action. In Florida and the Deep South, such habitat creation, augmentation, or restoration as well as public involvement through commercial or home landscaping is hindered by the lack of available native ecotype milkweed seed and the best practices for larger scale propagation and landscape use. In addition, the almost universal availability and use of tropical milkweed (*Asclepias curassavica*), presents some significant threats to monarch populations and causes confusion with the general public and other stakeholders about proper conservation actions.

Situation: People who buy milkweed plants (most commonly tropical milkweed, *Asclepias curassavica*) from big box stores such as Lowes and Home Depot to feed monarch larvae frequently report that their larvae often die soon after feeding on the purchased plants. This is likely due to the plants being treated with topical or systemic insecticides. However, detailed information concerning the exact chemicals used and their potential impact on monarch larval mortality is poorly understood.

Big Box Store and Grower Surveys: Following up on these anecdotal reports, we called all 119 Lowe's stores in the state of Florida to find out which growers supply their milkweeds. All Lowe's in Florida are either supplied by Costa Farms or Windmill Farms. The same was done for all 152 Florida Home Depot stores; they are either supplied by Costa Farms or Riverview Farms. We then called the growers to find out what they used to treat their plants. Aware that growers might be reluctant to disclose the use of neonicotinoids or other chemicals that might be harmful to larvae, we asked broad questions about "pest control for soft bodied insects on herbaceous perennials," without mentioning monarchs or neonicotinoids. We also called two growers who sell native Florida plants exclusively: Silent Natives Nursery and Trillium Gardens. The growers indicated a wide range of chemicals used, including: Endeavor insecticide (active ingredient, Pymetrozine), Aria insecticide (active ingredient, flonicamid), Sevin insecticide (active ingredient, carbaryl), Kontos insecticide (active ingredient, spirotetramat), M-pede insecticidal soap, Orthene insecticide (active ingredient, acephate), Pentathlon (active ingredient, Mancozeb) Florimite (active ingredient, Bifenazate), Captiva (Capsicum oleoresin and garlic oil), Dominion (active ingredient, Imidacloprid), clove oil and "contact fungicides." Along with asking about pesticide use, we also asked broad questions about how the chemicals

were applied and how long the plants were held before sale. One grower said they hold plants for a “waiting period” but did not disclose how long this was. Another, although not asked specifically about milkweeds, was careful to note that their milkweeds were treated, “early, not close to sale.”

Insecticide Trials: Based on the comprehensive surveys conducted, we chose three chemicals that were disclosed to us: Aria, Captiva and Sevin and decided to use them to see if we could replicate the larval mortality that was reported to us in the lab. Aria, a neonictinoid, Captiva, a chili and garlic extract that is mixed with soybean oil and Sevin, a very common insecticide that is sold to the public, were chosen as the chemicals that would most widely represent the options available. We also did one replication with Endeavor (Imidacloprid) and a control. Finally, we did one last replication using plants purchased from Lowe’s. We labeled each chemical as Group A (Aria), Group B (Captiva), Group C (Sevin) and Group D (Control) for replications 1-6. In replication 7 Group E (Endeavor) and Group D (Control) were used. There were 12 larvae in each group, each was kept in their own cup, labeled A-1 to A-6 and AA-1 to AA-6. Each cup/larvae corresponded with a plant of the same letter/number combination (Fig. 1).

Figure 1. Assay setup showing labeled cut containing one monarch larva and host leaves from pesticide-treaded *Asclepias curassavica* plant.

We used a professional pesticide applicator from a local nursery- Grandiflora nursery. We used four groups of 16 plants each (12 to be used in the experiment and 4 as back-ups) and had each of three groups treated with an insecticide and the fourth left untreated as our control. The plants were treated according to label directions and picked up the following day. Once at UF, all plants were kept outdoors in a screen house or a greenhouse if frost was expected, and then moved to a screen house as soon as the danger of frost was over. We ran seven replications of the experiment between August 2016 and August 2017.

Danaus plexippus eggs were obtained from a local purveyor, Shady Oak, for replications 1-4. The eggs were obtained from wild caught females in replications 5-7. (In the Lowe's plant experiment, larvae were gathered from milkweeds in the vicinity.) After the eggs emerged, larvae were randomly allocated to a designated cup (Fig.2).

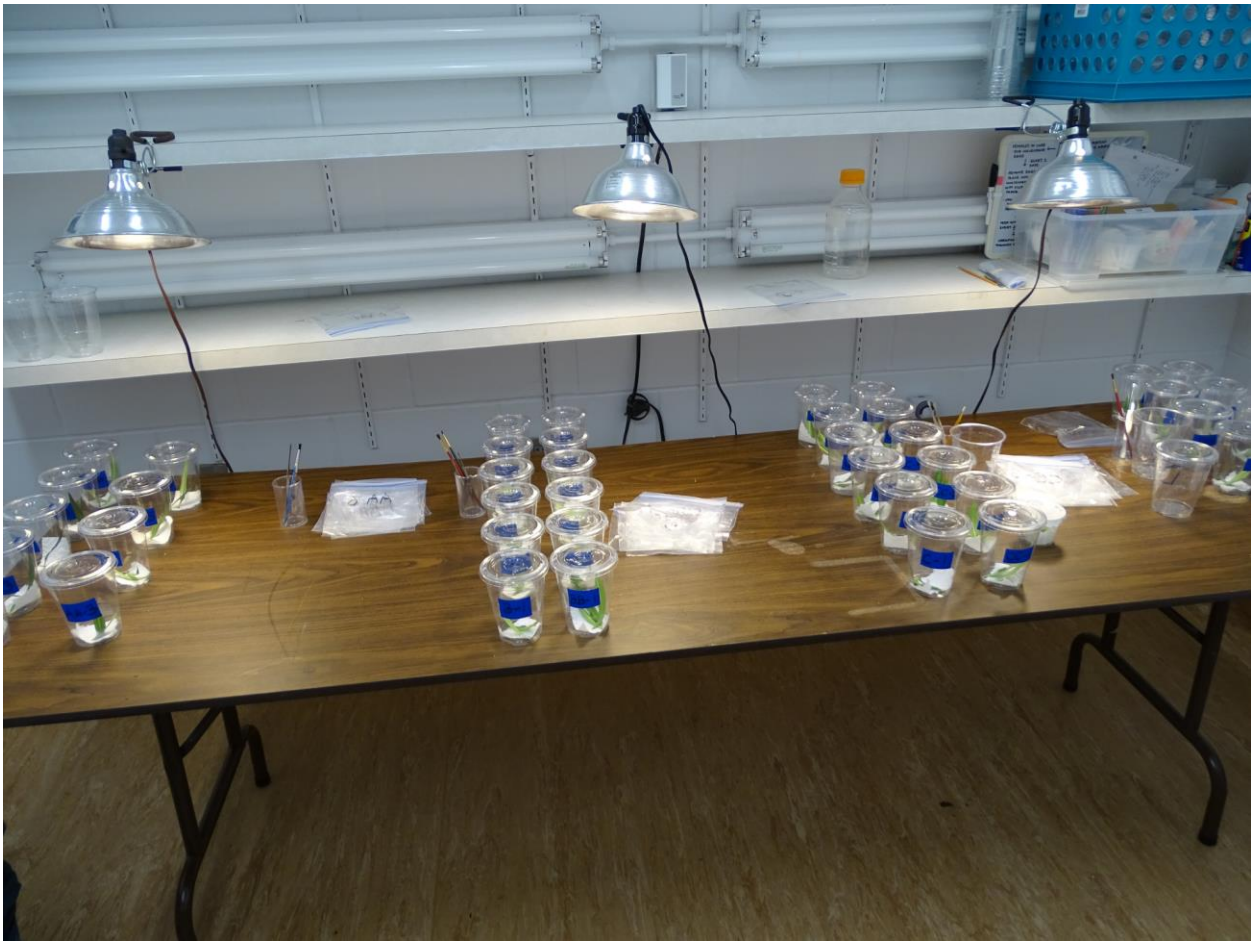

Figure 2. Laboratory setup for pesticide treatment assays.

One leaf from the terminal growth from their corresponding plant was added, along with a small piece of damp paper towel to prevent the leaf from desiccating. Larvae were fed twice a day, in the morning and afternoon. Old food was removed each time new food was placed in the cup. Amount of plant matter eaten was recorded in percentage before each feeding. Larvae were bumped up to two or three leaves or more as needed as they grew. Care was taken to prevent

cross contamination of chemicals by changing gloves before dealing with the next group, both when picking leaves and changing out food in cups. Different tools (paint brushes, forceps) were used to handle larvae in different groups, also to prevent cross contamination. Tools were sanitized after each feeding with a bleach solution. Notes were made on larval behavior and mortality at each feeding. Larvae were photographed on the tenth day of the experiment along with a coin for scale. The largest and smallest larvae across all groups were also photographed (Fig 3).

Figure 3. Image of largest and smallest monarch larva across all groups.

Over the course of six replications of this experiment we were not able to consistently observe the type of mortality that has been anecdotally observed when feeding larvae treated milkweed from Lowe's or Home Depot (Table 1).

Table 1. Larval mortality across seven replications of pesticide-treaded *Asclepias curassavica* plants.

	1-mortality	**2-mortality**	**3-mortality**	**4-mortality**	**5-mortality**	**6-mortality**	**Average**
Aria	60%	100%	34%	73%	33%	0%	50%

Captiva	59%	100%	88%	82%	17%	17%	60.5%
Sevin	28%	77%	50%	90%	8%	0%	42%
Control	30%	50%	75%	100%	17%	8%	46%

For replication seven, we opted to use a third chemical, Dominion (Imidacloprid). Grandiflora applied it for us and furnished us with untreated plants for the control. Eggs were obtained from a wild caught female. We had only one larva die in both the treated and control group. All other larvae pupated successfully.

After the seventh replication, we also purchased ten *Asclepias curassavica* plants from Lowe's. The plants had been delivered an hour or so before purchase, based on communication with a sales associate. We placed each plant in a flight cage outdoors and randomly placed five larvae of various stages on the plant- 2nd instar and older. After 48 hours, 42% of the larvae were dead and there was very little feeding damage and frass observed. After 6 days, 72% of the larvae were dead, and there was still a very small amount of frass and feeding damage on the plants. After one week of having the plants outside and exposed to the elements, we added 17 more larvae, split across three plants. Sixteen days after the start of the experiment, only two of the 67 larvae were alive. Only at this time did we observe the last two larvae to eat a normal (larger) amount, evidenced by feeding damage and frass present. The mortality rate across the experiment was 84%. Nine of the larvae out of the 67 placed on these treated plants made it to pupation. These pupae were observed to be smaller than average and several of the adults who emerged had wings that failed to inflate or were otherwise malformed.

Conclusions: Based on the overall results of the project, the following conclusions can be reached:

1. Costa Farms or Windmill Farms are the two primary suppliers for all Lowes and Home Depot stores/nursery centers in Florida.
2. Florida growers of the non-native *Asclepias curassavica* and native milkweeds use a wide variety of topical or systemic insecticides as well as several fungicides for the control of soft-bodied insect pest and plant pathogens. Several chemicals may also be used in combination with one another. As a result, plants available for sale may be treated in a variety of ways and with a variety of chemicals. This may lead to significant differential monarch larval mortality and tremendous consumer confusion.
3. Plants directly obtained from big box stores resulted in significant larval mortality when used. These results indicate that many plants obtained by the general public from Lowes or Home Depot can act as ecological sinks for monarchs in Florida. In addition, this practice is particularly worrisome for consumers who are looking to purchase butterfly or wildlife-friendly plants, and for retailers specifically marketing plants as beneficial to the monarch.
4. Based on the laboratory assays completed using four different commonly used pesticides, we were not able to consistently observe monarch larval mortality. It is

possible that mortality would be higher if other chemicals were used, the fact that only one pesticide was used at a time (and not in combination with other chemicals such as fungicides), the frequency of application (some nursery plants may be repeatedly treated prior to being made available for sale), or the possibility that some growers do not apply at the recommended label rate.

5. More research is needed to test other pesticides and store-purchased plants.