MANUAL FOR IMPLEMENTING BIOLOGICAL CONTROL OF AIR POTATO IN LOUISIANA

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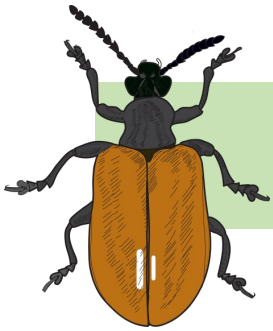

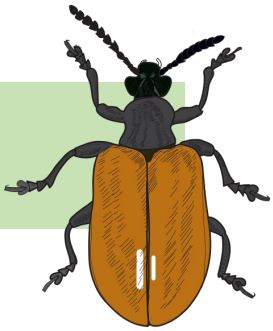

TABLE OF CONTENTS

I. BACKGROUND ON AIR POTATO.....2

1.1 How to recognize the vine.....2

1.2 Negative impacts.....3

1.3 Distribution in the US.....4

II. BIOLOGICAL CONTROL.....5

2.1 What is Biological Control?.....5

2.2 Air potato beetle 6

III. RELEASING THE BEETLE.....9

3.1 How to get beetles.....9

3.2 How to release beetles.....9

3.3 What to expect.....10

IV. MONITORING RELEASE SITES.....11

4.1 What to look for.....11

4.2 Before and after.....11

V. OTHER MANAGEMENT TACTICS.....12

5.1 Mechanical control 12

5.2 Chemical control 12

5.3 Integrating with Biological Control.....12

VI. REFERENCES.....13

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I. BACKGROUND ON AIR POTATO

1.1 How to recognize the vine

The air potato, *Dioscorea bulbifera* L. (Dioscoreales: Dioscoreaceae), is an invasive perennial vine native to Africa and Asia[1]. Member of the yam family, this vine is characterized by having large, green, heart-shaped leaves (**Fig. 1**). Air potato reproduces vegetatively through aerial bulbils which are produced in leaf axils during the summer and early fall[1]. The bulbils drop to the ground in the late fall as the vine begins to senesce[2]. New shoots emerge from bulbils or underground tubers the following growing season starting in early spring[2].

Figure 1. Air potato in Louisiana: a) Large infestation of vines taking over native communities, b) Heart-shaped leaves, and c) Bulbils (vegetative reproductive structure).

1.2 Negative impacts

Air potato invades disturbed areas such as urban landscapes and along roadsides, and natural settings such as forest edges, hammocks, and pinelands[2]. It grows fast reaching length of 51 m during a growing season, climbing over native trees and plants, and smothering vegetation[2]. This results in ecosystem modifications by displacing native species, changing the structure of communities, and interrupting ecological services[2,3]. In Louisiana, air potato has invaded many recreational parks, natural areas and forests, as well as private properties (**Fig. 2**).

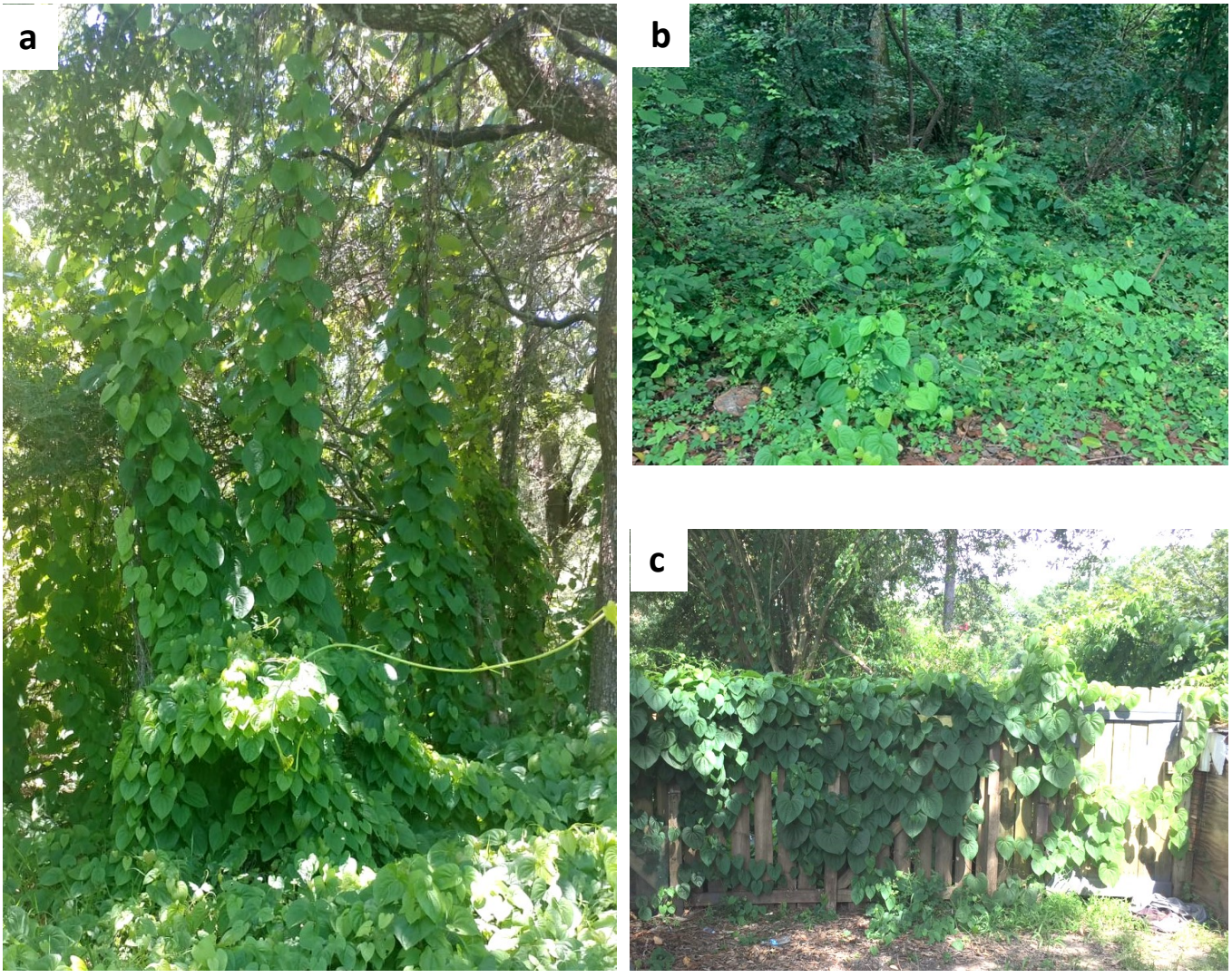
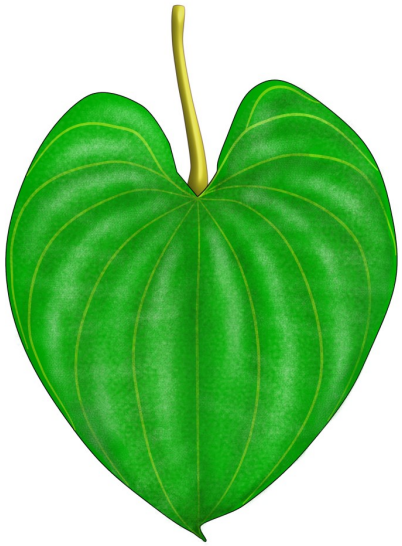


Figure 2. Air potato invading natural and urban areas in Louisiana: a) Climbing trees at Nature Conservancy property in Grand isle, b) Growing at ground level at Bluebonnet Swamp Nature Center, and, c) Covering fence of residential property in Lafayette.

1.3 Distribution in the US



Air potato was introduced into Florida as an ornamental plant in 1905 and was identified as a weed of concern by 1944 in the U.S.[4] It is now considered one of the fastest growing and aggressive vine in Southeastern U.S.[5] Air potato has naturalized in several states including Alabama, Georgia, Hawaii, Mississippi, Puerto Rico, Texas, Louisiana (**Fig. 3**)[6].

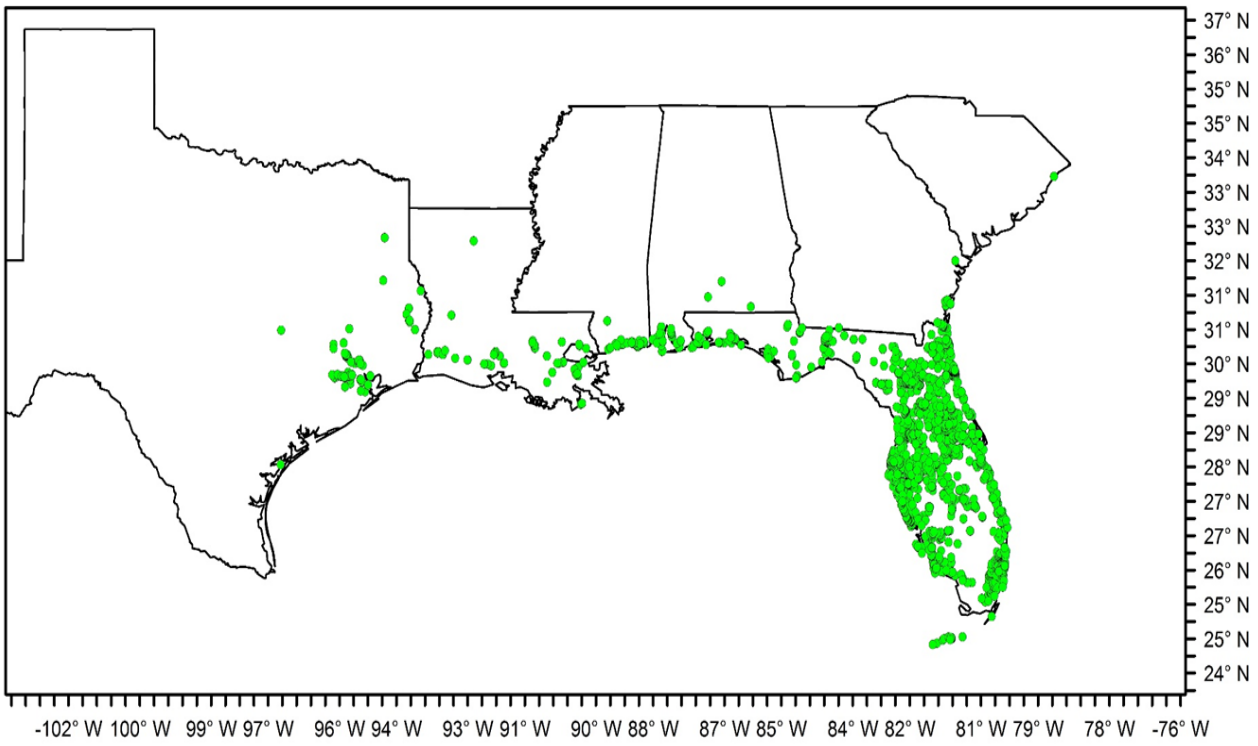


Figure 3. Air potato distribution in continental U.S. (Reports from EDDMaps and iNaturalists). In Louisiana, it is present in 15 parishes including West Carroll and Ouachita (north), Calcasieu to St. Tammany (central) and Lafourche and Terrebonne (south).

II. BIOLOGICAL CONTROL

2.1 What is Biological Control?

Weed biological control involves the release of specialist insects that will feed on the target plant reducing its growth and densities over time. Rigorous procedures are followed before insects are introduced into new areas such as host-range testing to make sure these agents are safe to release. The USDA-APHIS-PPQ regulates and provide release permits in the U.S. Biological control is considered a cost-effective, environmentally-friendly and sustainable management practice used successfully against many invasive species worldwide. In Louisiana, LSU Agcenter has been managing the invasive aquatic giant salvinia (*Salvinia molesta*) using the salvinia weevil (*Cyrtobagous salviniae*) for many years (**Fig. 4**). This program has saved the state millions of dollars in control costs and has recovered many aquatic ecosystems for wildlife and recreation[7].

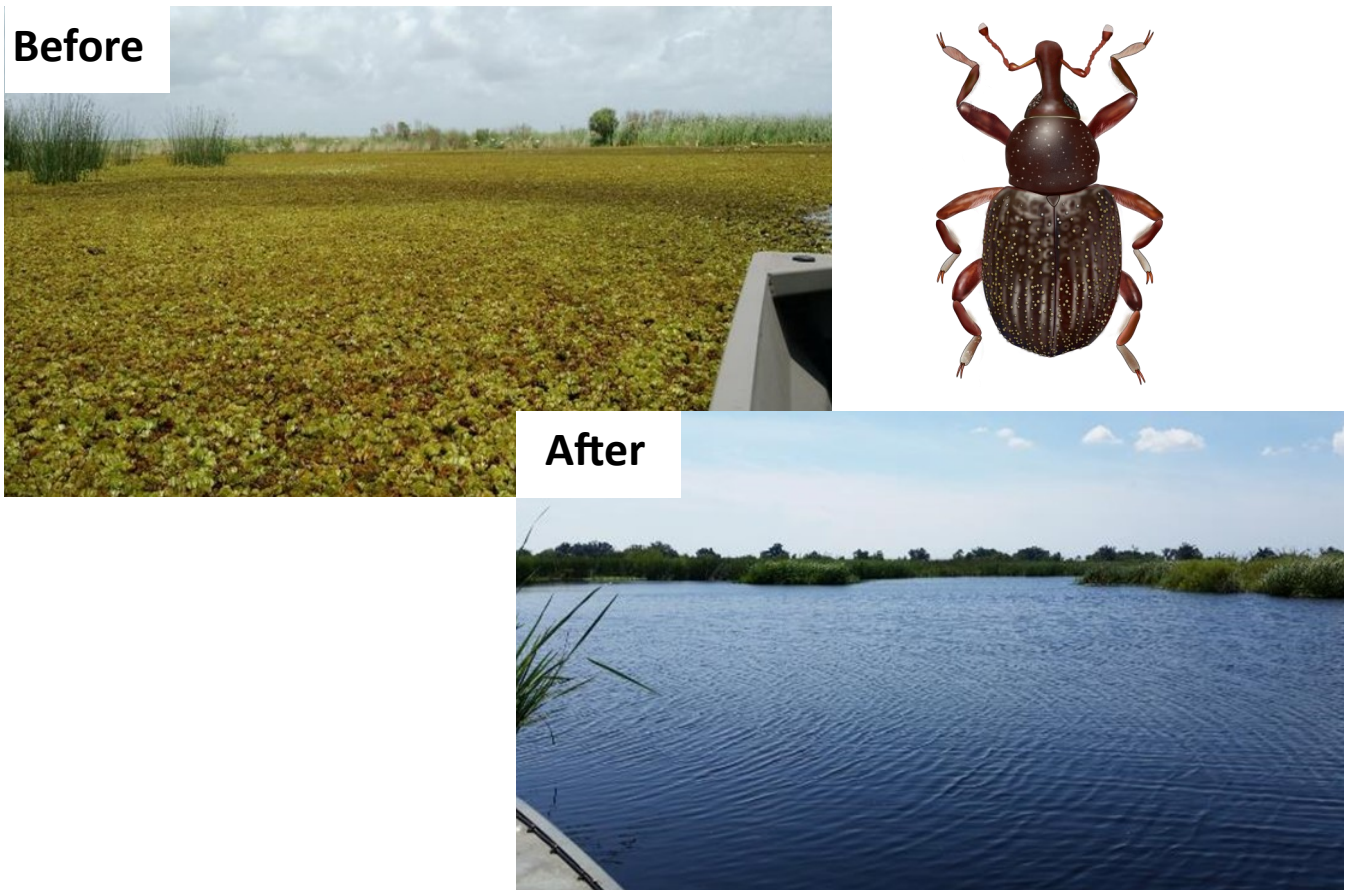


Figure 4: Biological control of Giant salvinia in Louisiana: Before and after damaged by the salvinia weevil (*Cyrtobagous salviniae*).

2.2 Air potato beetle

Scientists from USDA in Ft. Lauderdale, Florida discovered the air potato beetle (*Lilioceris cheni* Gressit and kimoto) (Coleoptera: Chrysomelidae) in Nepal and later in China (**Fig. 5**)[8]. Host range testing probed that this beetle is a specialist and can only feed on air potato, so field releases were initiated in Florida in 2011 upon issue of release permits[9]. Adults and larva feeds on air potato leaves causing extensive defoliation (**Fig. 6**).

Air potato beetle has established throughout Florida and has successfully reduced growth and reproduction of air potato[10]. Following the success in Florida, field releases of *L. cheni* were initiated in Louisiana in 2016. Collaboration was established between Louisiana State University and Southern University to implement this biocontrol program throughout the state.

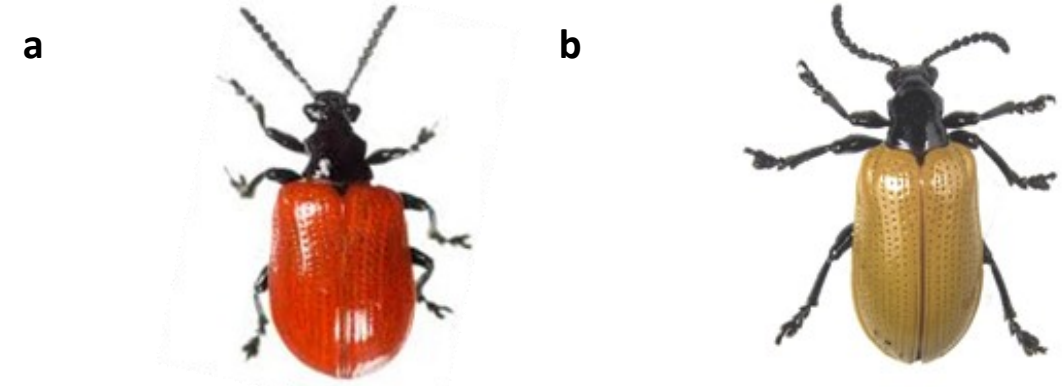


Figure 5. Air potato beetles originated from: a) China (red elytra), and b) Nepal (orange elytra).

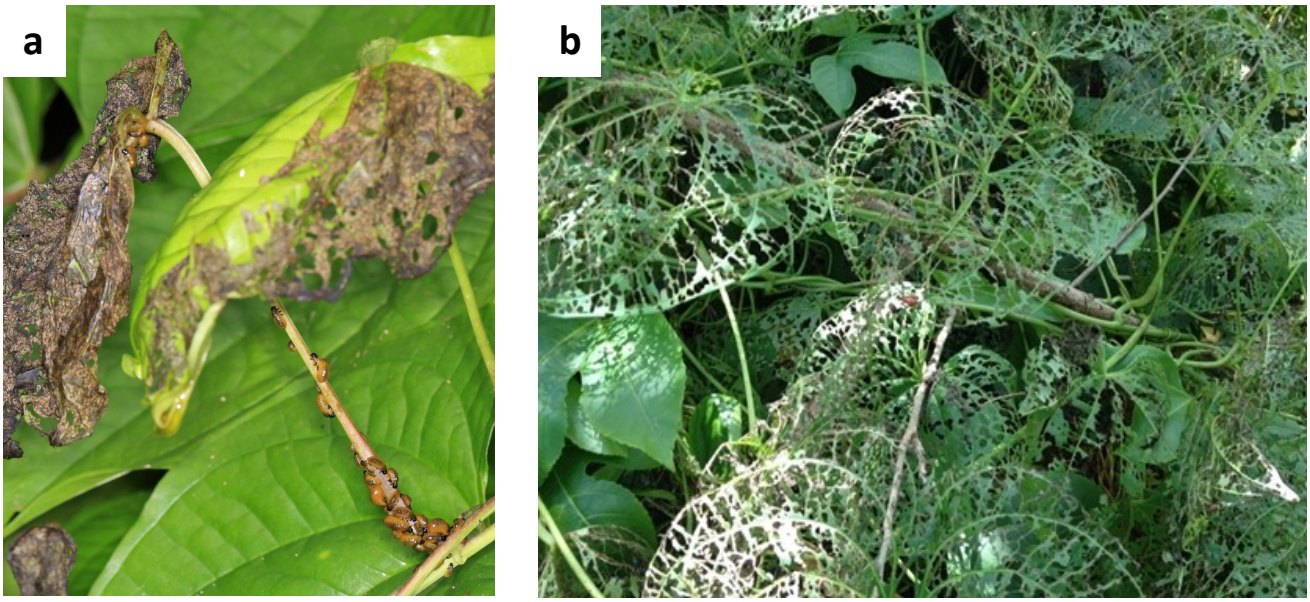


Figure 6. Feeding by air potato beetles: a) Larval damage, b) Adult damage.

The adults of air potato beetles measure 8–9 mm in length and can live for more than 5 months[8]. Females can lay 1200 eggs in clusters under air potato leaves, and hatch in about 4 days. Larvae complete four instars in 10 days before dropping to the ground to form a pupal case with soil particles and saliva[8]. Adults emerge 15 days later and start feeding on air potato. Mating begins 10-14 days later, followed by oviposition to continue with the life cycle (**Fig. 7**).

Air potato beetles are found feeding on vines from May to November (**Fig. 8**). As temperature gets colder and days shortened, air potato starts senescing and die-back during the winter months. During that time, beetle adults can survive without food by entering diapause (dormancy state)[9]. Higher overwintering survival has been reported for the Nepalese biotype in Florida[11]. Therefore, this biotype was selected to release in Louisiana since 2016.

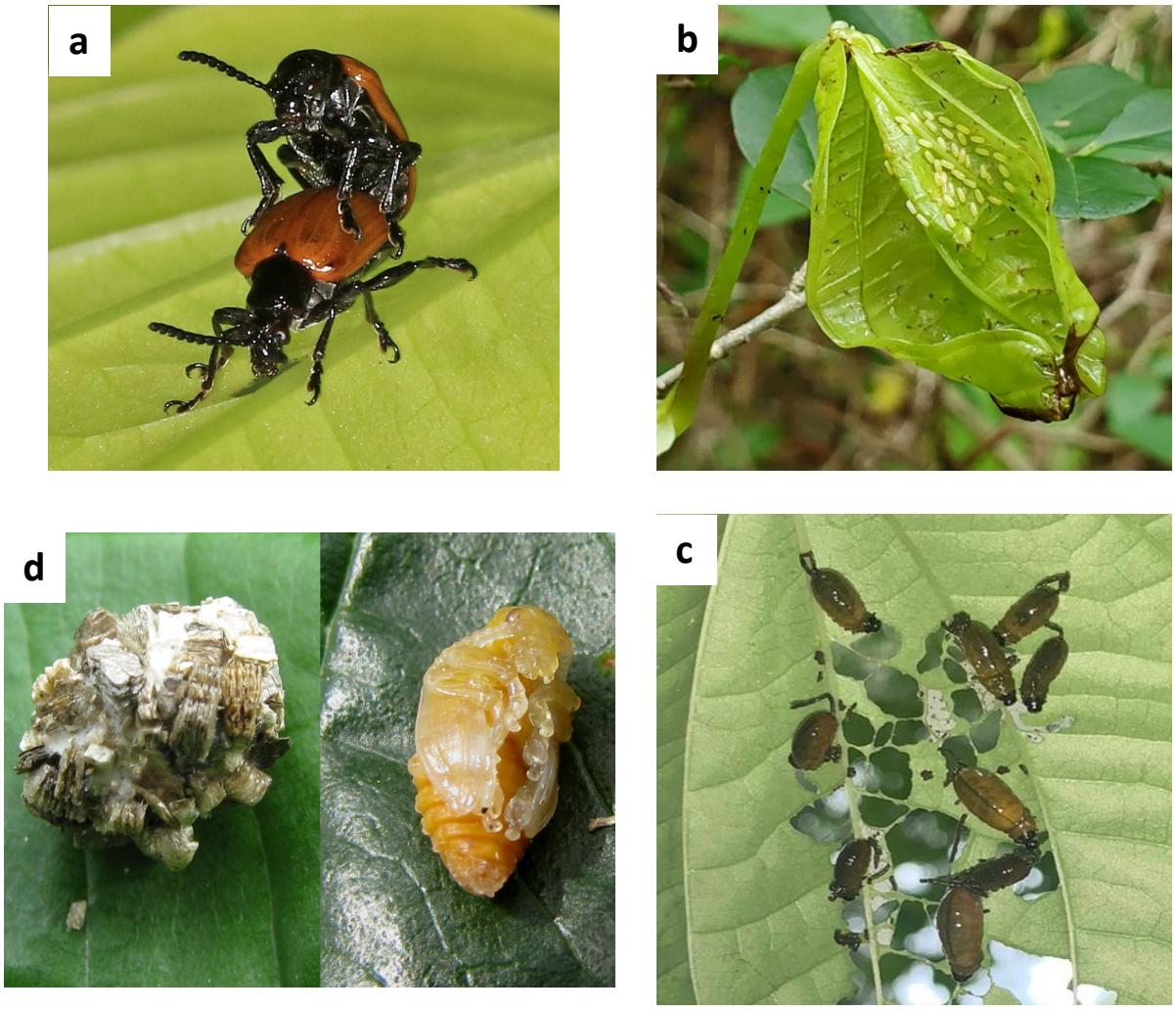


Figure 7. Life cycle of air potato beetles: a) Mating pair of adults, b) Eggs laid by forming cup-shaped leaf, c) Groups of larvae feeding on underside of leaf, and d) Pupa inside and outside cocoon found in the ground.

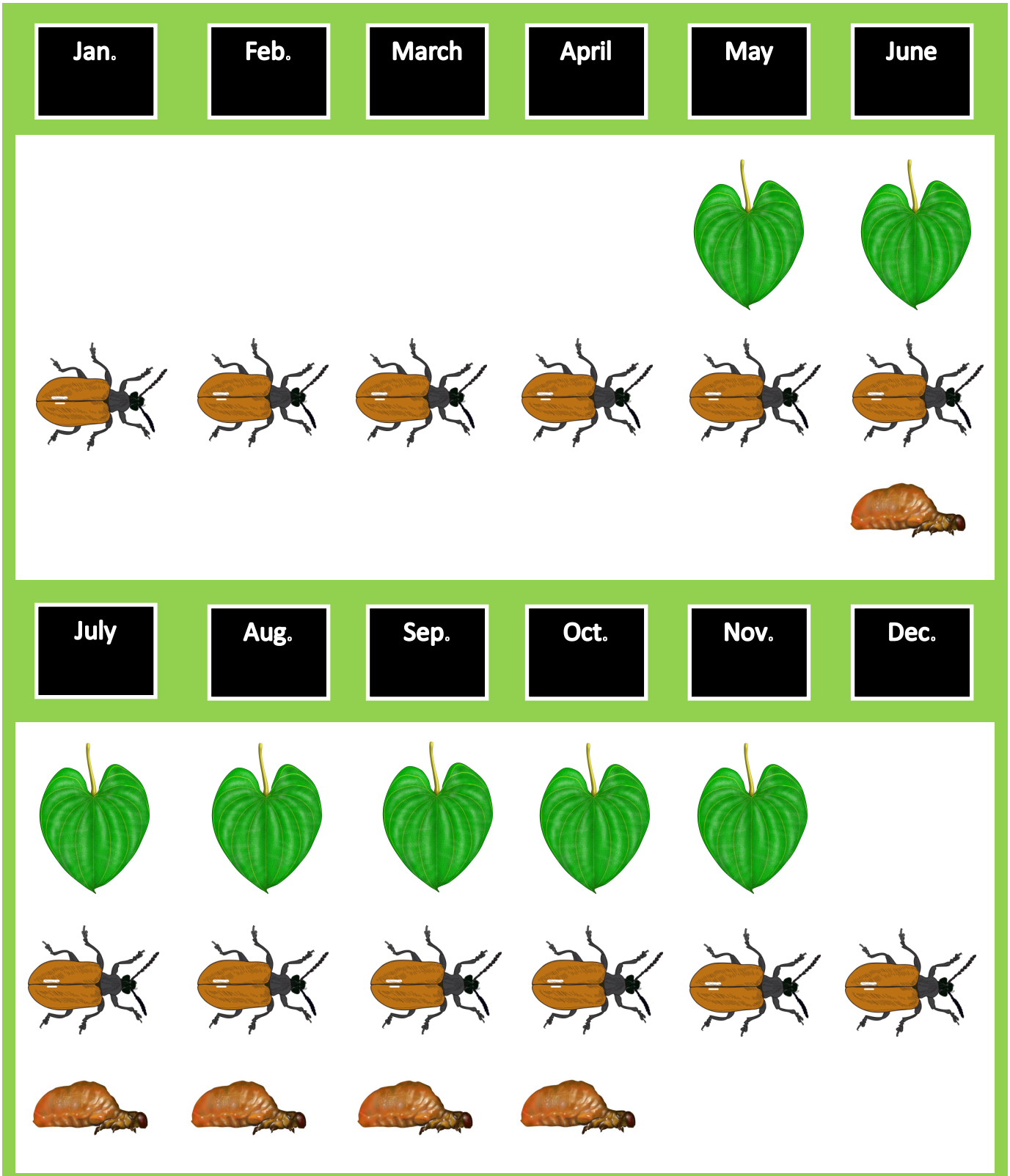


Figure 8. Phenology of air potato and beetles in Louisiana: Vine's active growth is from May to November and senesces during the winter months. Beetle adults and larvae are found feeding on vines from June to October or November. Adults enter diapause (dormancy state) and stop feeding during the winter when the vine is absent. Digital illustrations from R. Diaz.

III. RELEASING THE BEETLE

3.1 How to get beetles

If your property is infested with air potato vine and no beetles are found (or holes in leaves) by mid-June, contact us at:

- **veronica_manrique@subr.edu**
- **RDiaz@agcenter.lsu.edu**

We will hand-carry or mail the beetles directly to you. Beetles will be provided based on availability, between June and October, at no cost.

3.2 How to release beetles

A box containing the adult stage of the air potato beetle (>50) will be provided. Studies have shown that releasing 50 to 100 adults will provide high chances of establishment in new areas[12]. Upon receiving the box, beetles should be released soon after. If this is not possible, the box can be kept inside with Air Conditioner for 1-2 days. To release the beetles, open the box close to air potato leaves and allow adults to fly off or gently turn the box upside down (**Fig. 9**). Spread the beetles among locations with air potato vines to facilitate movement.

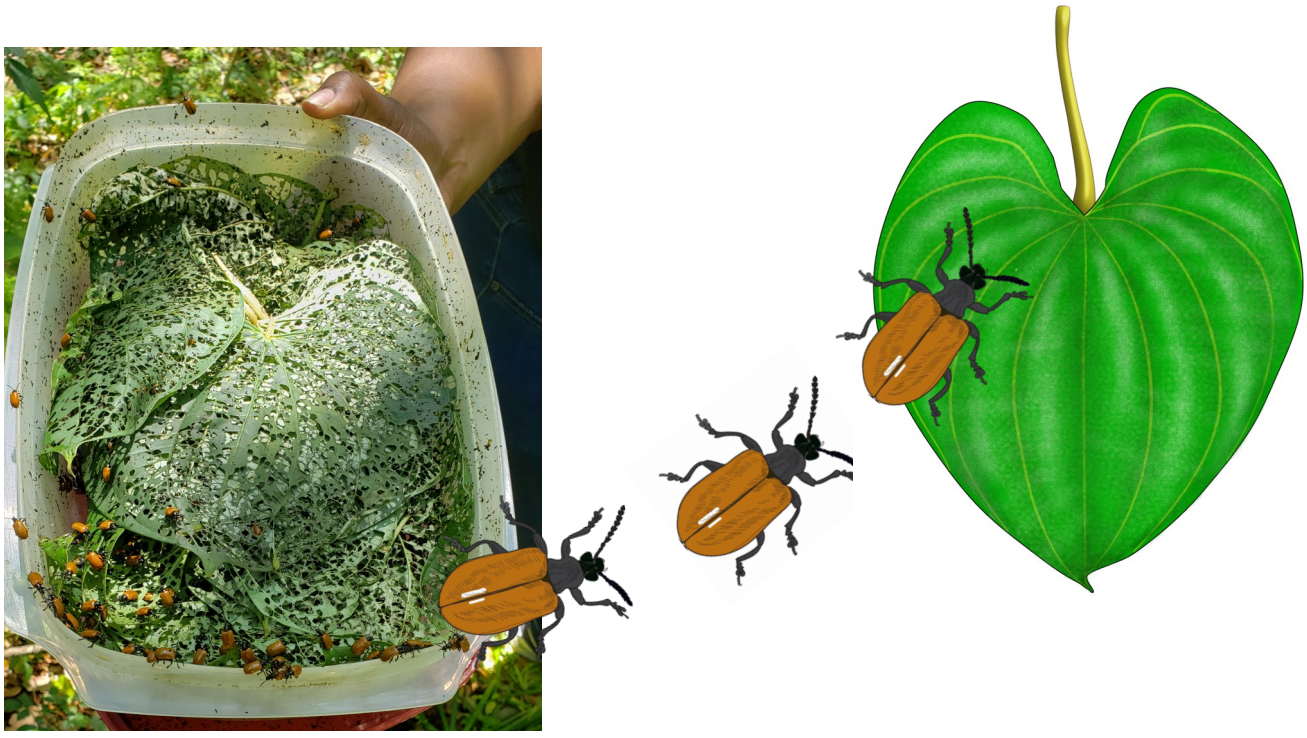


Figure 9. Releasing air potato beetles by opening containers near air potato leaves at infested areas.

3.3 What to expect

Adult beetles will start feeding on air potato leaves close to release sites, and holes will be noticed few days after. Adults will start laying eggs immediately, and small larvae feeding in groups will be observed on the underside of the leaves two weeks after release. As larvae start growing in size, feeding will be more noticeable and whole sections of the vine will be damaged (**Fig. 10**). It will take several months for beetle densities to increase and start making major impact on air potato. As air potato start deteriorating, beetles will move away and disperse to new sites. To facilitate spread, beetles found in high densities can be collected and moved to areas with low or no signs of beetles. Even though air potato will continue to be present at the site, vines will have reduced growth and produce less number of bulbils over the years[10].

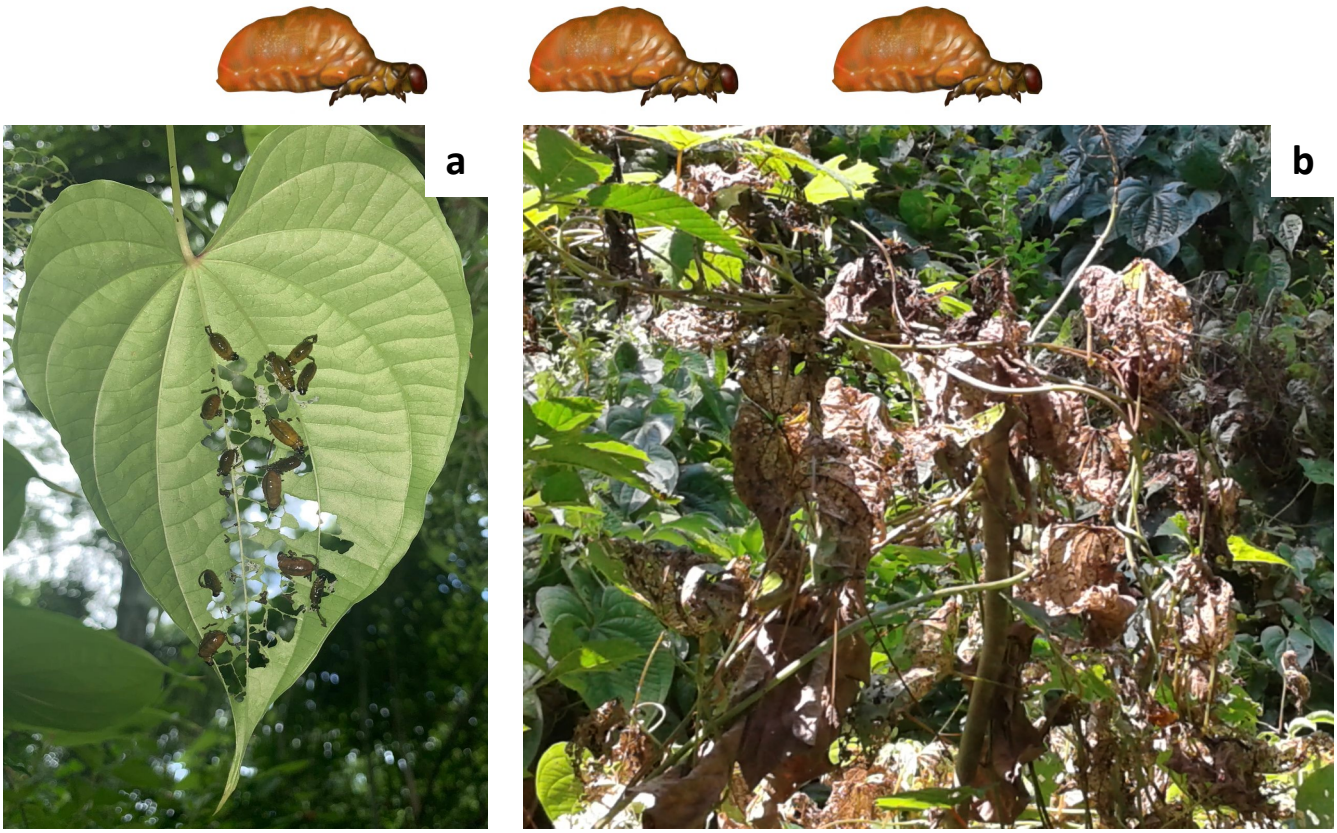


Figure 10. Larvae feeding on air potato leaves: a) Early damage, b) Extensive damage resulting in dead leaves and reduced growth of the vine.

IV. MONITORING RELEASE SITES

4.1 What to look for

The efficacy of beetles on managing air potato will vary among sites and years. Prolonged flooding may cause pupal mortality and extreme cold winters may reduce adult survival. The timing that beetles become active after the winter is important for reducing air potato growth. Ideally, you should start seeing beetles or damaged leaves in May or early June. Keeping records by taking pictures of infested sites over time will help assess changes in air potato growth and cover.

4.2 Before and after

More than 4,600 beetles were released in Louisiana from 2016 to 2020. Field surveys showed that air potato beetles have established in south and central parts of the state. In addition, beetles are dispersing naturally to new sites which contributes to management of air potato. Several release sites were monitored, and reduction of air potato cover and reproduction has been recorded in some areas (**Fig. 11**).

Figure 11. Air potato infestation at Lumen Christi Retreat Center, Schriever, LA: See pictures before and a year after beetles were released. Reduction of air potato allowed the recovery of native vegetation.

V. OTHER MANAGEMENT TACTICS

5.1 Mechanical control

Manual removal of air potato vines early in the growing season may provide control in small areas[3]. Collecting bulbils during the winter have helped reduce infestations in some sites (**Fig. 12**). For example, public events such as 'Air Potato Round Up' has removed 13 tons of bulbils in Gainesville in 2003. Vine removal along waterways will help reduce spread as bulbils may float to new areas. Also, digging up and removing underground tubers can also help reduce infestations. Overall, mechanical control is labor intensive, time consuming, and costly; and is not effective for large air potato infestations[3, 13].

5.2 Chemical control

Air potato bulbils sprayed with chemicals delayed sprouting as much as five months. The most effective herbicides are those with ingredients triclopyr or glyphosate[13].

Foliar application of Garlon 3A (1.25%-2.0%) or Garlon 4 (0.5%-2.0%) can control air potato. These treatments should be repeated over a two- or three-year period. However, herbicide use should be the last option as the application can harm other vegetations including native plants.

5.3 Integrating with Biological Control

Several management tactics can be incorporated with biological control to manage air potato. For instance, hand picking of air potato bulbils during the winter or early removal of small air potato vines in spring before beetles become active. Maintaining a healthy ecosystem with high species diversity will help to deter infestations as air potato mostly invade disturbed areas. If beetles are not present at the site by mid-summer, herbicides may be used as a last resource.

Figure 12. Manual removal of bulbils during the fall or winter will reduce air potato spread and help reduce vine densities.

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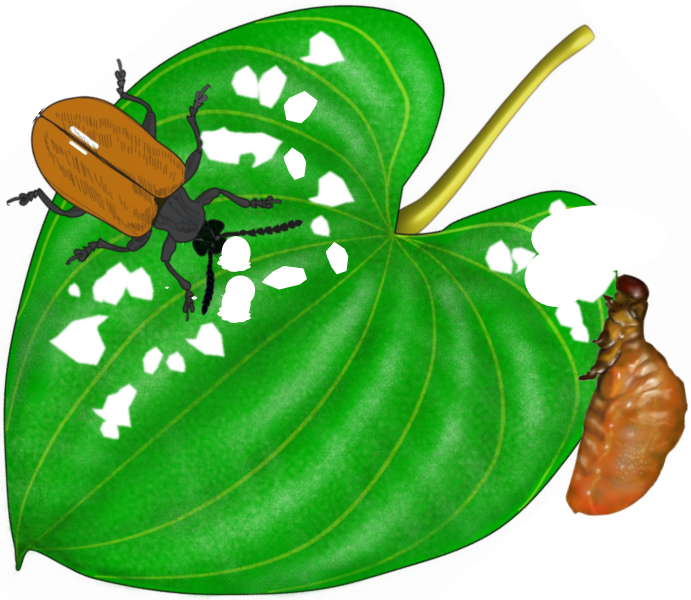
Rearing of air potato beetles at the entomology laboratory and outdoor cages at Southern University. Graduate students: Charity Schaffer (left) and Shivonne Marshall (right).

Field releases of air potato beetles and monitoring impact of biological control program in Louisiana. Graduate student, Charity Schaffer (left), and Dr. Veronica Manrique (right).



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For more information:

https://www.suagcenter.com/page/Entomology

www.lsuagcenter.com/airpotato

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