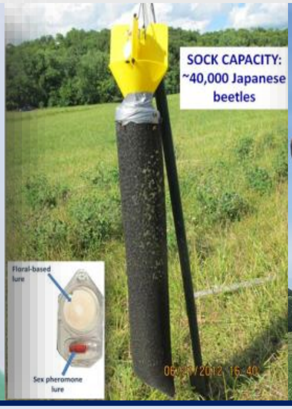


Organic Management Options for the Japanese Beetle

LINCOLN UNIVERSITY MISSOURI

Integrated Pest Management
Lincoln University Cooperative Extension

Austen Dudenhoeffer

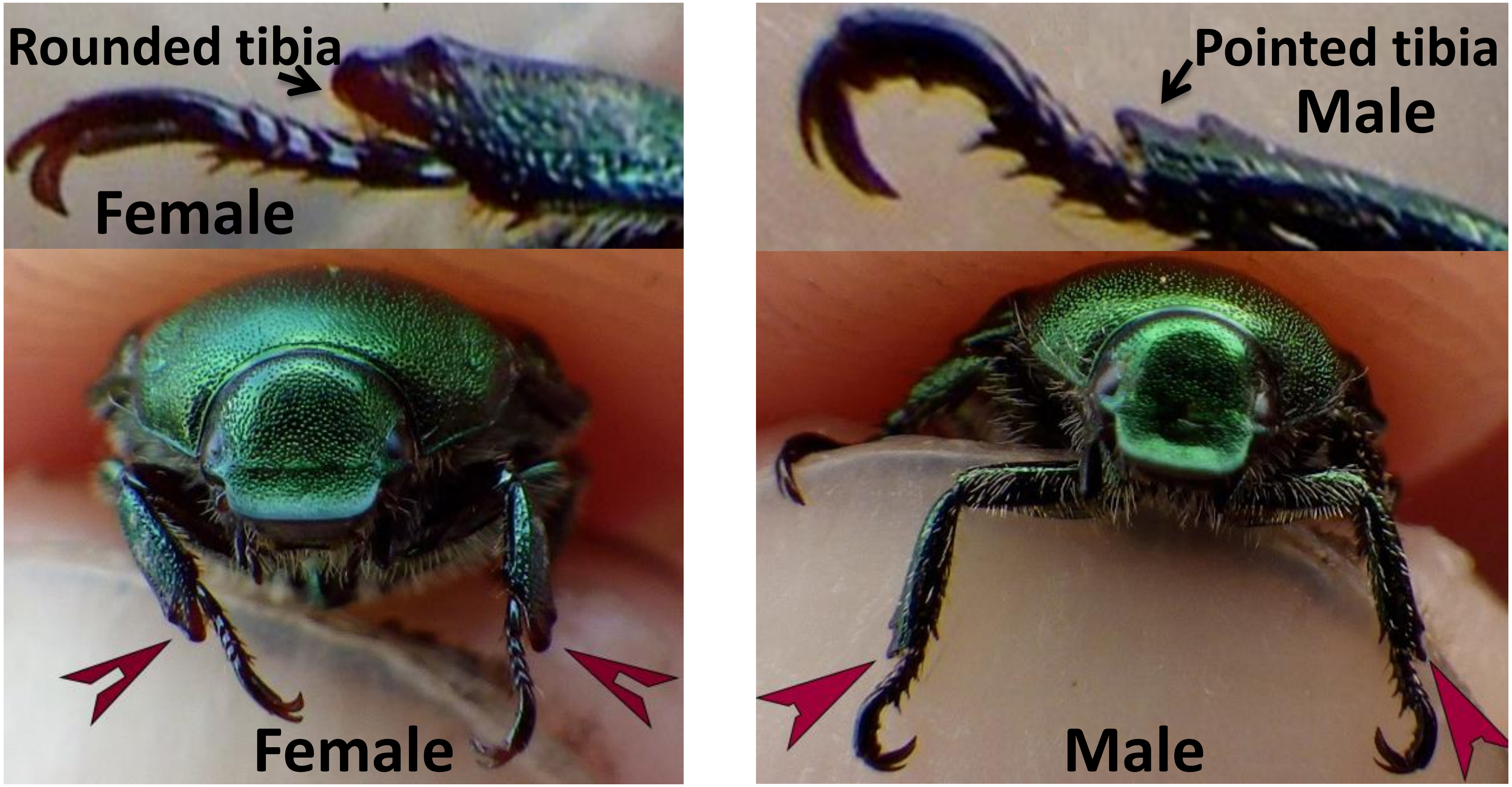
Area Educator: IPM
Lincoln University
IPM program
Jefferson City, MO 65102

General Introduction

A

B

1) A good insect is called a ____ and bad insect is a ____?
2) T/F: Most insects are beneficial
3) Which one is the “true” Japanese beetle?



1) *Popillia japonica:* Native to Japan/China

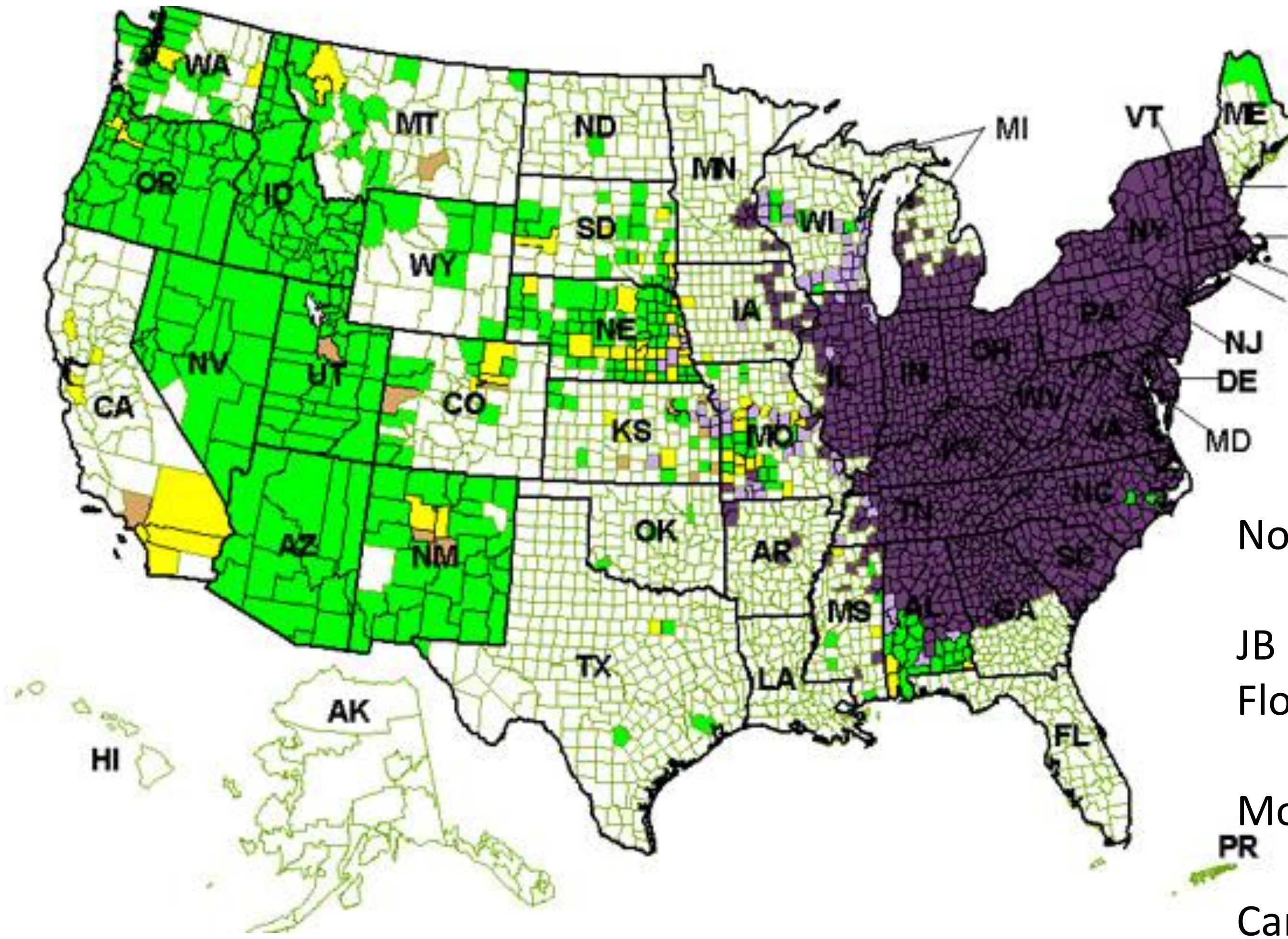
2) Imported accidently to Riverton, New Jersey, 1916

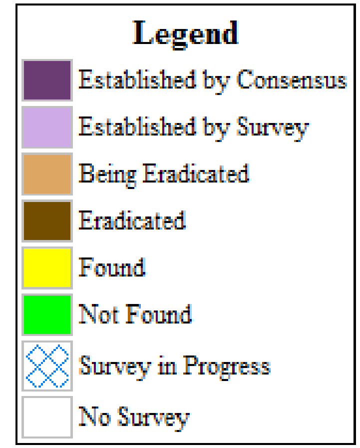
3) Univoltine in Missouri (1 generation per year)

4) Holometabolous (complete metamorphosis)

5) Females: Rounded tibia   Males: Pointed tibia

Survey Status of Japanese Beetle - *Popillia japonica*
All years





Not a concern 10-15 years ago

JB in 30 eastern states (except Florida)

Moving west: Oklahoma

Canada, Russia, and Portugal

Purdue Survey Map: PestTracker CERIS 2015
http://pest.ceris.purdue.edu/services/map/mapNew.php?code=INBPAZA#

Life cycle:

1) After mating, female JB deposit 40-60 eggs 5-7 cm deep (July)
2) After 2 weeks, eggs hatch. By September, 3rd instar (2.5 cm)
3) 9 months underground feeding. Pupate 2-3 weeks.
4) Adults emerge June & July, live 30-45 days, die in August

Ecological Significance

1) Generalist feeder >300 species (few predators)
2) Cause damage as larvae and adults
3) Economic Impacts: >$450 million annual prevention (USDA, APHIS)
4) Physical damage: turf, ornamentals, and crops

JB will eat leaf tissue, flower petals, corn silk, and even fruit

Common host plants of Japanese beetle

Adults

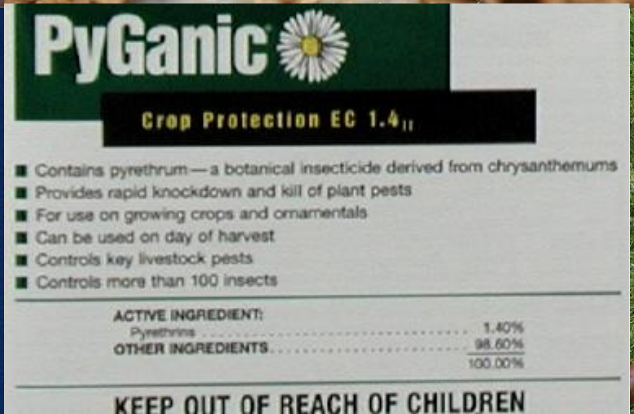
- oak (*Quercus*)
- elm (*Ulmus*)
- maple (*Acer*)
- grape (*Vitis*)
- peach, cherry, apricot, plum (*Prunus* spp.)
- apple (*Malus*)
- linden (*Tilia*)
- rose (*Rosa*)
- *Zinnia* spp.
- *Dahlia* spp.
- corn (*Zea mays*)
- *Asparagus officinalis*
- soybean (*Glycine max*)
- tomato (*Solanum lycopersicum*)
- hops (*Humulus lupulus*)
- blueberries, blackberries, raspberries (*Rubus* spp.)

Grubs

- roots of turf grass
- roots of ornamental plants

Organic Control Options

1) Hand removal (scouts, time consuming, impractical?)
2) Biological control agents (parasitoids, nematodes, & pathogens)
3) Organic Insecticides (OMRI approved materials)
4) Mass Trapping (traps as means of control?)



Parasitoids and Pathogens:

1) Spring Tiphia (*Tiphia vernalis)* & Winsome Fly *(Istocheta aldrichi)*
2) Released & established in USA—not commercially available

3) Winsome fly: lays eggs on JB adults, kills in 5-6 days, no JB reproduce
4) Connecticut, Rhode Island, and New England: >20% JB decrease

5) Spring Tiphia: lays eggs on JB larvae (61% reduction in Connecticut)
6) 120,000 shipped to US by 1933. Ohio, N. Carolina, New Jersey

Milky spore:

1) Most popular biological control — no harm to bees, pets, or children
2) Cost: expensive, difficult to produce, early instars mid-July 65°F
3) 2-3 years to establish population — lasts up to 10 years in soil
4) Turf protection: mortality after ingestion= 7 to 21 days
5) Kills 1st & 2nd instar grubs (July)-- 3rd instars more difficult to kill (September)
6) Requires host to reproduce — do not use with lawn pesticides
7) Treats ground where applied — not incoming pressure (5 mi flight!)
8) Can be used in combination with nematodes

Issues with milky spore:

"P. popilliae-based products have been expensive, with only small quantities available. This, along with a history of inconsistent performance against P. japonica, has limited the use of this pathogen....." **Koppenhofer and Fuzy (2002)**

"Application of a full dose of spore powder . . . failed to induce milky disease in grub populations in soil directly beneath the treated turf . . . We challenge the evidence that commercially available spore powder, applied according to conventional methods, is effective for suppressing localized grub populations" **Potter and Redmond (1995)**

2 billion spores per kg= 39-40% mortality

4 billion spores per kg= 74-78% mortality

St. Gabriel Organics= 100 million spores per gram

Each infected grub produces billions of spores

Entomopathogenic nematodes

ARBICO organics

Natural Solutions — Since 1979

Beneficial Nematodes are live microscopic organisms (non-segmented round worms) that occur naturally in soil.

Top Picks | Fly Control | Beneficial Insects | Pest Control | Indoor Growing | Organic Growing | Animal Care | Tools | Resources

Home / Organic Growing / Lawn & Turf Care / ...

+ Enlarge Image

NemaSeek™ - Hb Beneficial Nematodes

Heterorhabditis bacteriophora

Seeks Out Stationary Pests including Grubs, root zone weevils, citrus weevils, Japanese beetles, black vine weevils, ticks, queen ants/termites and more. Great for gardens, lawns, fields, pastures and orchards.

FREE SHIPPING IN THE CONTIGUOUS UNITED STATES!

1/2 Garden Size, 5 Mil SKU: 1220300	$36.00	1	Treats 1,600 sq. ft
Garden Size, 10 Mil SKU: 1220301	$42.95	1	Treats 3,200 sq. ft
Farm Size, 50 Mil SKU: 1220302	$72.00	1	Treats 1 acre
Small Ranch Size, 250 Mil SKU: 1221703	$198.00	1	Treats 5 acres
Large Ranch Size, 500 Mil SKU: 1221706	$270.00	1	Treats 10 acres

https://www.arbico-organics.com/product/nemaseek-beneficial-nematodes-hb-heterorhabditis-bacteriophora

JB Larvae Parasitized by Nematodes

Heterorhabditis bacteriophora

1 billion juveniles/acre

1st JB instar= 75-97% mortality

2nd JB instar= 53-88% mortality

3rd JB instar= 0-33% mortality

(Power K.T. et al. 2009)

1) Will not harm mammals, birds, or aquatic life
2) Can be stored 2 weeks in refrigerator (no water)
3) Mix with water to apply (backpack sprayer)—spread evenly
4) 2 applications—7 days apart (soil temperature >44^{o}F)
5) Ground needs to stay moist (water every 3-4 days)
6) “entomopathogenic” penetrate body wall/openings
7) Kill JB larvae in 24-48 hrs, 2-4 week max effect (late July)
8) Nematodes mostly die in winter—reapply annually

OMRI-listed insecticides

Azera Insecticide

$337.65
Free Shipping!

Size/Description
gallon (128 oz) Buy 1: $337.65 each Buy 2 or more: $334.79 each

PyGanic Crop Protection EC 1.4 II

$49.95 - $184.69
Free Shipping!

Size/Description
quart (32 oz) Buy 1: $49.95 each Buy 2 or more: $49.49 each
gallon (128 oz) Buy 1: $184.69 each Buy 2 or more: $181.80 each

Azera= Azadirachtin 1.20% (neem oil)
+ 1.40% Pyrethrin
High rate= $126 per Acre (48 oz)
1 oz Azera= $2.64
12 hr Re-entry Interval (REI)
Zero Pre-Harvest Interval (PHI)
Direct contact & 4-5 day deterrent
Dissipates after 1-2 days (rainy weather?)

PyGanic= 1.40% Pyrethrin
(chrysanthemum extract)
High rate= $85 per Acre (59 oz)
1 oz PyGanic= $1.44
12 hr Re-entry Interval (REI)
Zero Pre-Harvest Interval (PHI)
“Can be used on day of harvest”
Direct contact & 2 week deterrent

RATE CHART Azera

		Most commonly used rate	*Rates for treating high populations of adults and/or hard to kill insects*	
AZERA	**1 Pint per acre** 16 fl. oz. (473 ml)	**2 Pints per acre** 32 fl. oz. (946 ml)	**3 Pints per acre** 48 fl. oz. (1.42 L)	**3.5 Pints per acre** 56 fl. oz. (1.66 L)
Acres per Quart	2	1	0.67	0.57
Acres per Gallon	8	4	2.7	2.3

For growing field crop and orchard applications, do not exceed the maximum application rate of 0.050 lb. Pyrethrins / Acre (equivalent to 59 fl. oz. of AZERA Insecticide / Acre) or .0012 lb. Pyrethrins / 1,000 sq. ft. (equivalent to 1.42 fl. oz. AZERA Insecticide / 1,000 sq. ft.). For surface applications to green house grown crops do not exceed the maximum application rate of 0.050 lb. Pyrethrins / Acre (equivalent to 59 fl. oz. of AZERA Insecticide / Acre) or .0012 lb. Pyrethrins / 1,000 sq. ft. (equivalent to 1.42 fl. oz. of AZERA Insecticide / 1,000 sq. ft.). For space spray applications to greenhouse grown crops do not exceed the maximum application rate of .00014 lb. Pyrethrins / 1,000 cu. ft. (equivalent to 0.17 fl. oz. or 5.0 mls of AZERA Insecticide / 1,000 cu. ft.).

Dilution Rates	
Conventional Equipment	In sufficient water for thorough coverage. Dilution in a minimum of 30 gallons (114 L) of water per acre is recommended
Hand Sprayers	1-2 fluid ounces (30-60 ml) of AZERA per gallon (3.8 L) of water
Arial Application	This product may be applied by air at the rate of 16-56 fluid ounces (473 mL-1.9 L) per acre in a minimum of 25 gallons (95 L) of water
Greenhouse	Dilute 53-107 fl. oz. (1567-3164 ml) with 100 gallons (378.54 L) of water for applications with conventional hydraulic sprayers, or 1 to 2 fl. oz. (30-60 ml) per one gallon (3.8 L) of water, or applications with compressed sprayers. Use 2.3 gallons (8.71 L) of spray solution per 1,000 square feet (93 m²).

PyGanic

- Do not reapply within 3 days except under extreme pest pressure.
- In case of extreme pest pressure, do not reapply within 24 hours.
- Do not harvest until spray has dried.
- Do not wet plants to point of runoff or drip.

For growing field crop and orchard applications, do not exceed the maximum application rate of 0.050 lb. active ingredient/acre (equivalent to 59 fl. oz. of PyGanic® Crop Protection EC 1.4II/acre) or 0.0012 lb. active ingredient/1,000 sq. ft. (equivalent to 1.42 fl. oz. of PyGanic® Crop Protection EC 1.4II/1,000 sq. ft.).

For surface applications to greenhouse grown crops, do not exceed the maximum application rate of 0.050 lb. active ingredient/acre (equivalent to 59 fl. oz. of PyGanic® Crop Protection EC 1.4II/acre) or 0.0012 lb. active ingredient/1,000 sq. ft. (equivalent to 1.42 fl. oz. of PyGanic® Crop Protection EC 1.4II/1,000 sq. ft.).

For space spray applications to greenhouse grown crops, do not exceed the maximum application rate of 0.00014 lb. ai/1,000 cu. ft. (equivalent to 0.166 fl. oz. or 4.92 mls of PyGanic® Crop Protection EC 1.4II/1,000 cu. ft.).

https://www.domyown.com/msds/Azera%20Spec%20Label.pdf
https://www.domyown.com/msds/Pyganic_Crop_1.4_SKU_2711_Label_.pdf

OMRI-listed insecticides [*cont'd*]

Entrust SC Naturalyte Insecticide - 1 Quart (OMRI Certified Organic - Spinosad)

from Keystone Pest Solutions

Registered for use on organically produced crops - Convenient new liquid formulation makes measuring and mixing easier - Demonstrates good activity against pests like armyworms ... more »

$419.95

+$17.20 shipping. No tax

Keystone Pest Solutions

Shop

- **Microbial-based insecticide**
- **Spinosad** is a fast-acting, somewhat broad-spectrum material that acts on the insect primarily through **ingestion**, or by **direct contact** with a spray droplet or a newly treated surface

Spinosad residues on the leaf surface are broken down by **sunlight**. Half-lives for spinosyn A (active ingredient) are 2 to 16 days depending on the amount of sunlight received

But, how effective are organic insecticides?

Gupta G. and V. A. Krischik. 2007 “Professional and Consumer Insecticides for Management of Adult Japanese Beetle on Hybrid Tea Rose” J. Econ. Entomol. 100(3): 830-837

“Monterey 70% Neem Oil and Garlic Barrier, did not show statistically significant mortality of Japanese beetle or reduce leaf damage.”

“Japanese beetle mortality was low (15%) on Pygenic (1.4% Pyrethrin)-treated leaves, but leaf damage (51%) was reduced.”

“ . . .Conserve SC (11.6% spinosad) did not show significant mortality. In contrast, professional products containing pyrethroids resulted in significant mortality to Japanese beetles.”

Date:

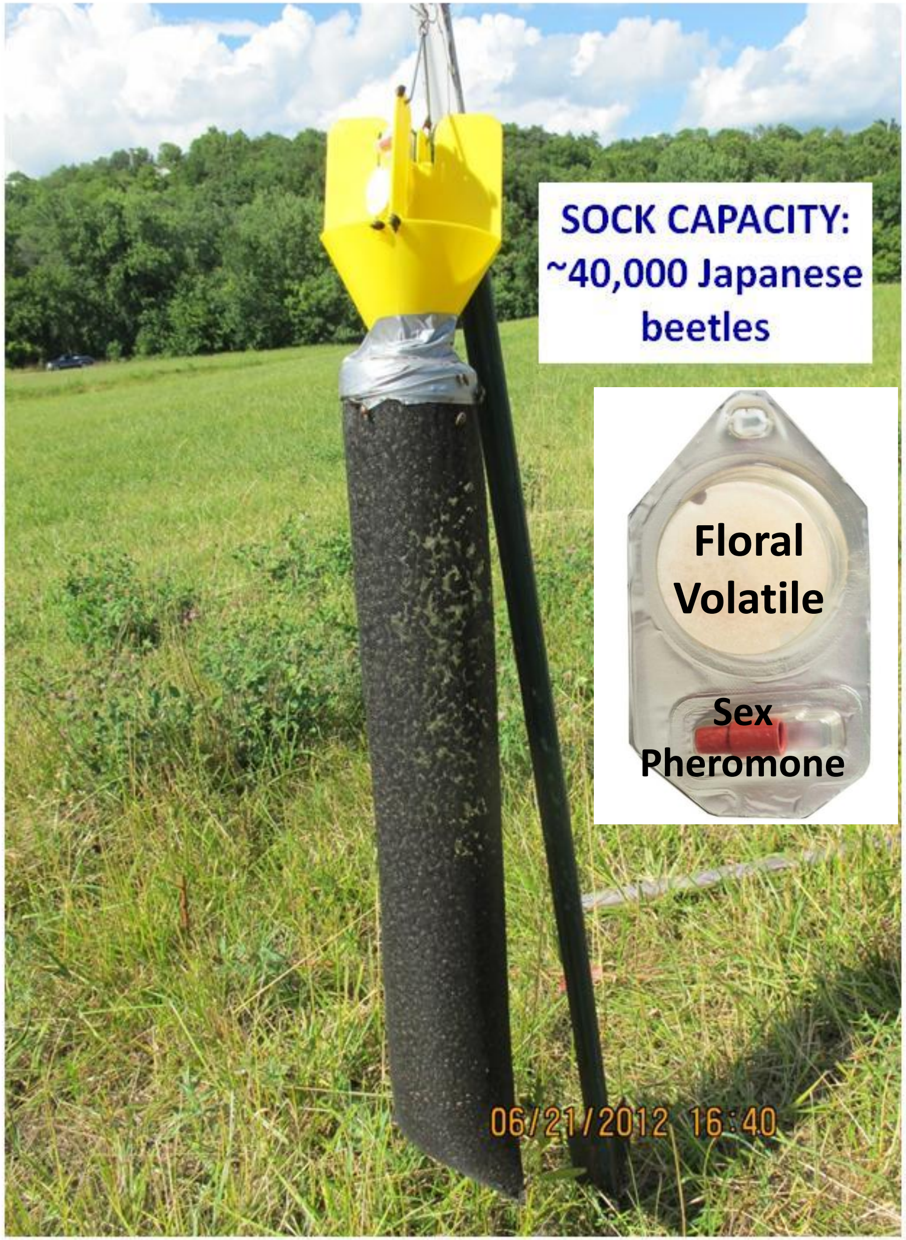
Hi Dr Pinero. Thank you for your insight and resources last week. I applied Azera to all four groups of peaches, and Azera and Surround to three of the four areas, containing the younger peaches/further from harvest. As I applied product I had many many beetles falling to the ground. The following morning at 10am I saw very few beetles on the trees, and moderate traffic in the air around the trees and in the traps. By noon however the entire four areas and all points in between were swarming with beetles. By 2pm there were as many beetles in clusters on the trees in all four groups, as if I had not applied anything. It is my impression that the

Can mass trapping be used to control Japanese beetles organically?

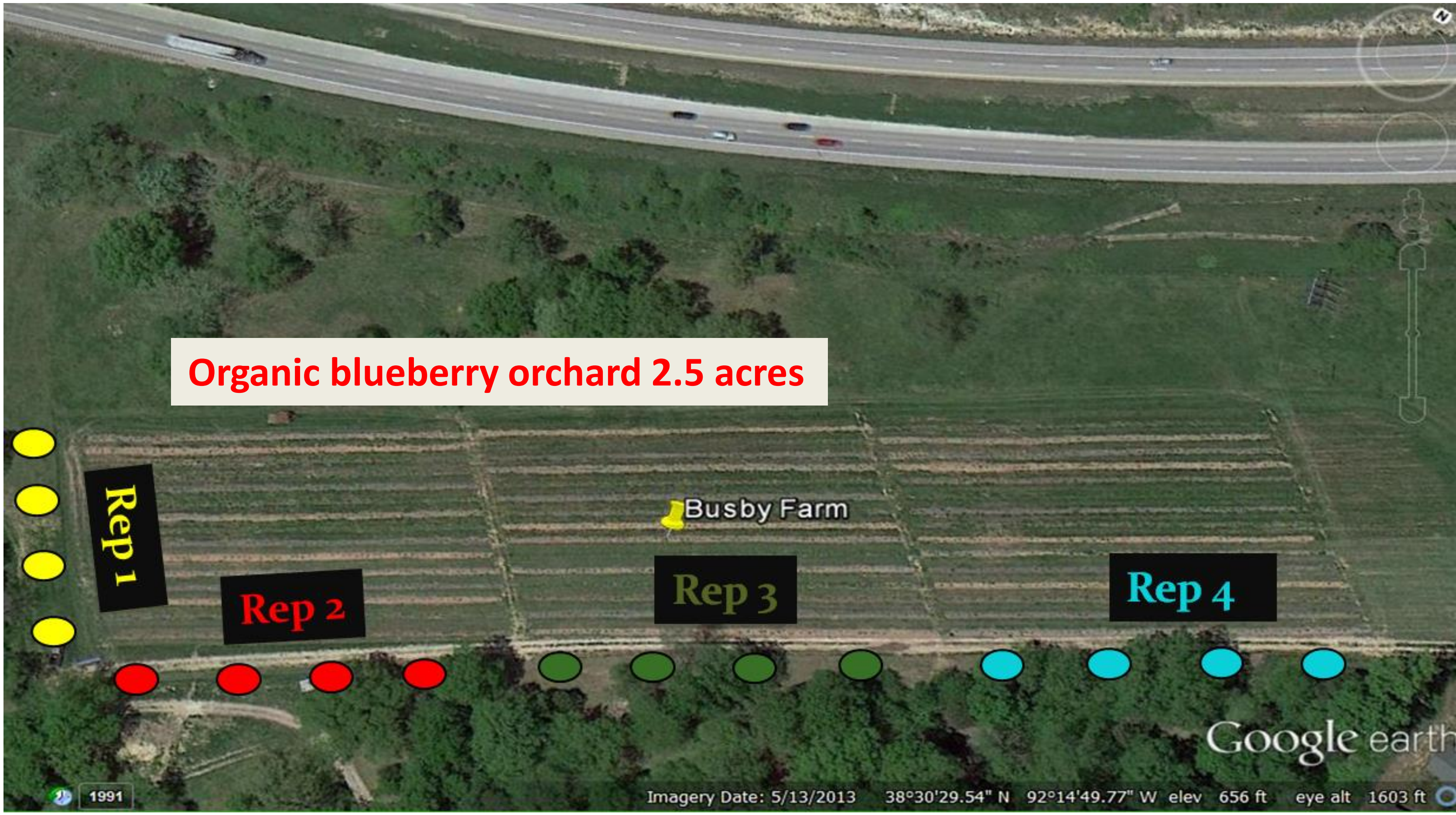
Early Designs Not Effective for Mass Trapping

1. Commercial traps for monitoring
2. Problems: lure, panels, color, capacity, & number of traps deployed
3. Result: spillover effect/frustration
4. More harm than good?

A Novel Mass Trapping system



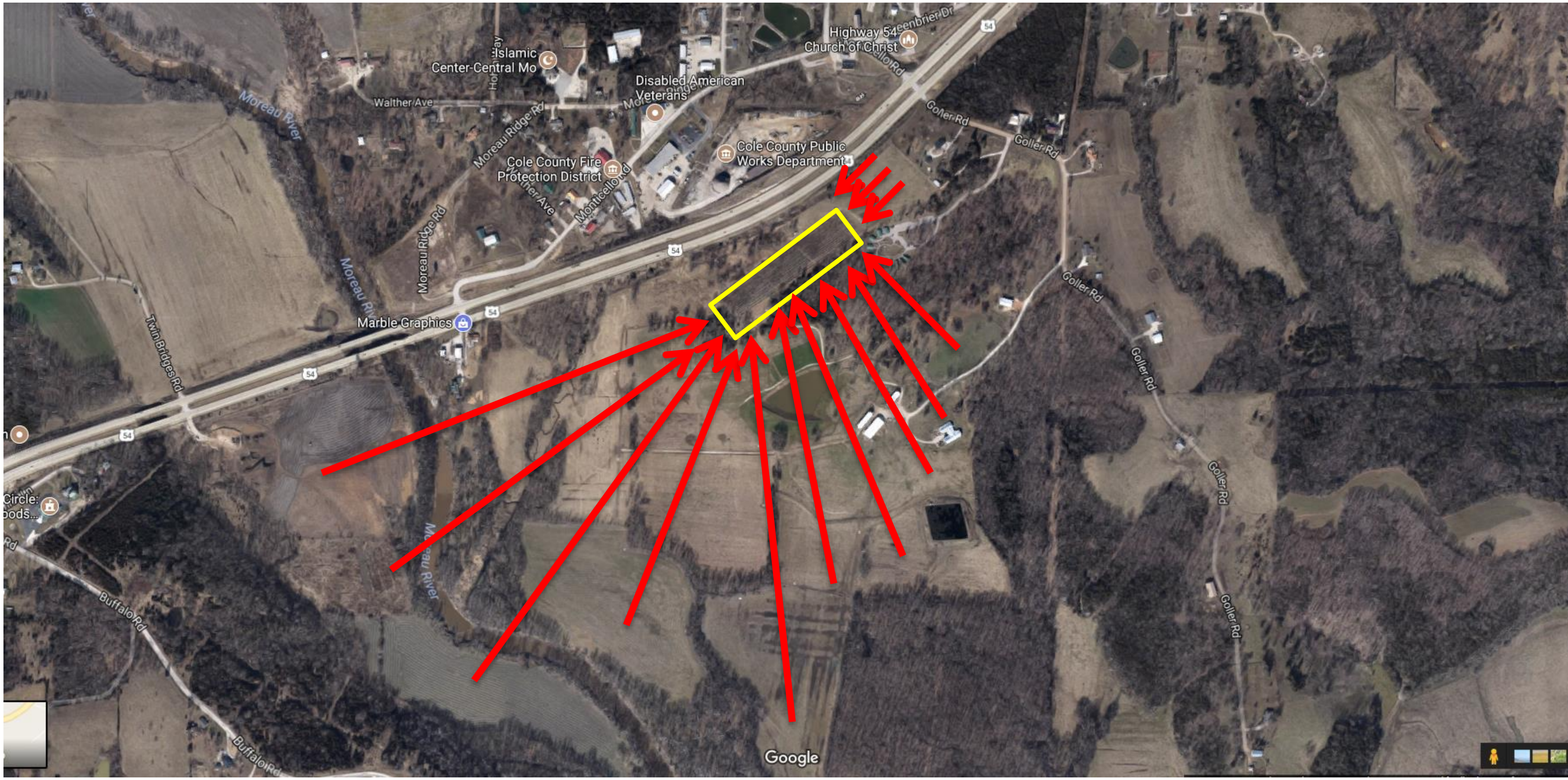
Lincoln University Alan T. Busby Farm -- 280 acres Certified Organic Jefferson City, MO



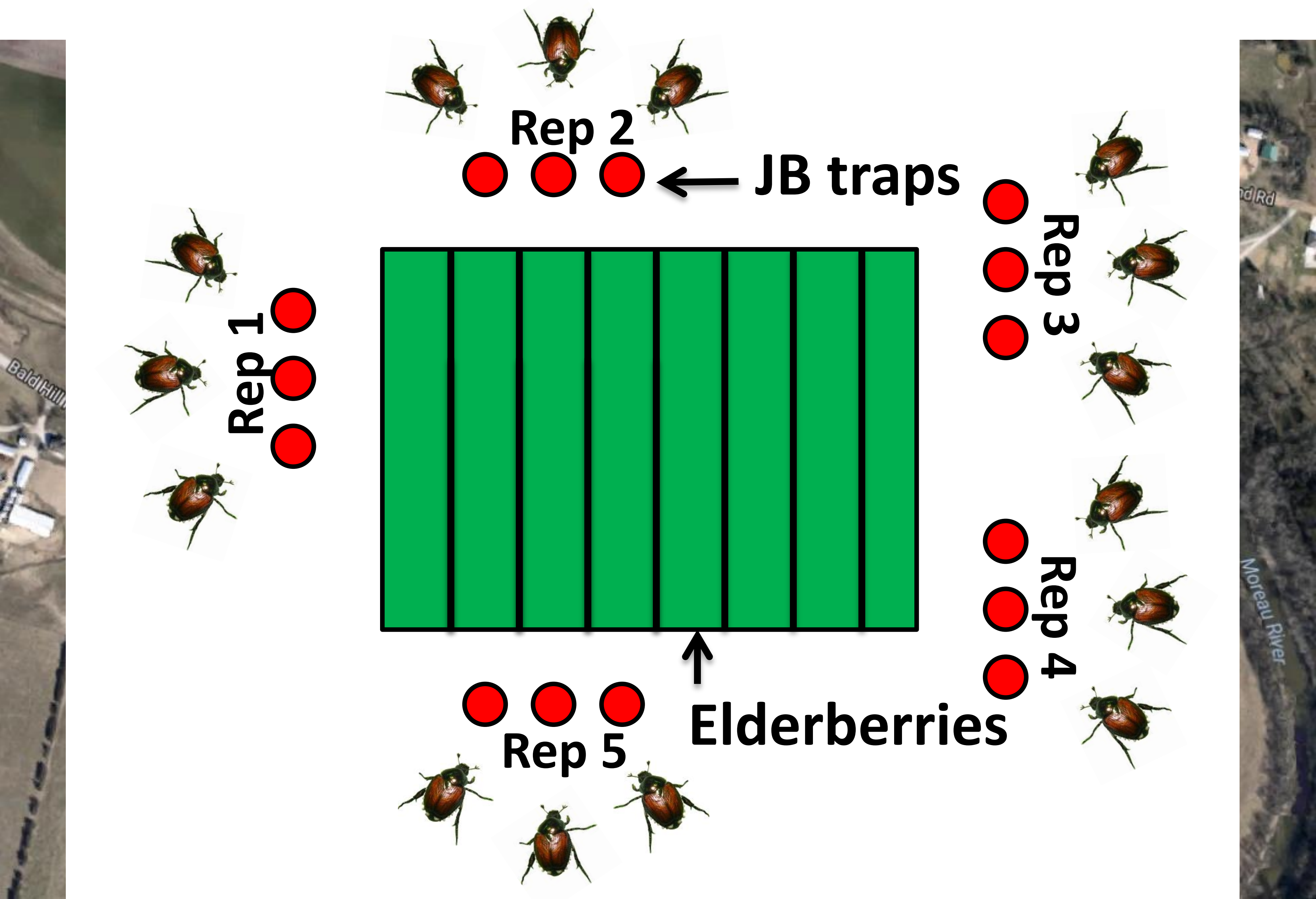
16 traps kept #JB below economic threshold

<5 JB per row most field counts!

Japanese beetle pressure at the Busby Farm



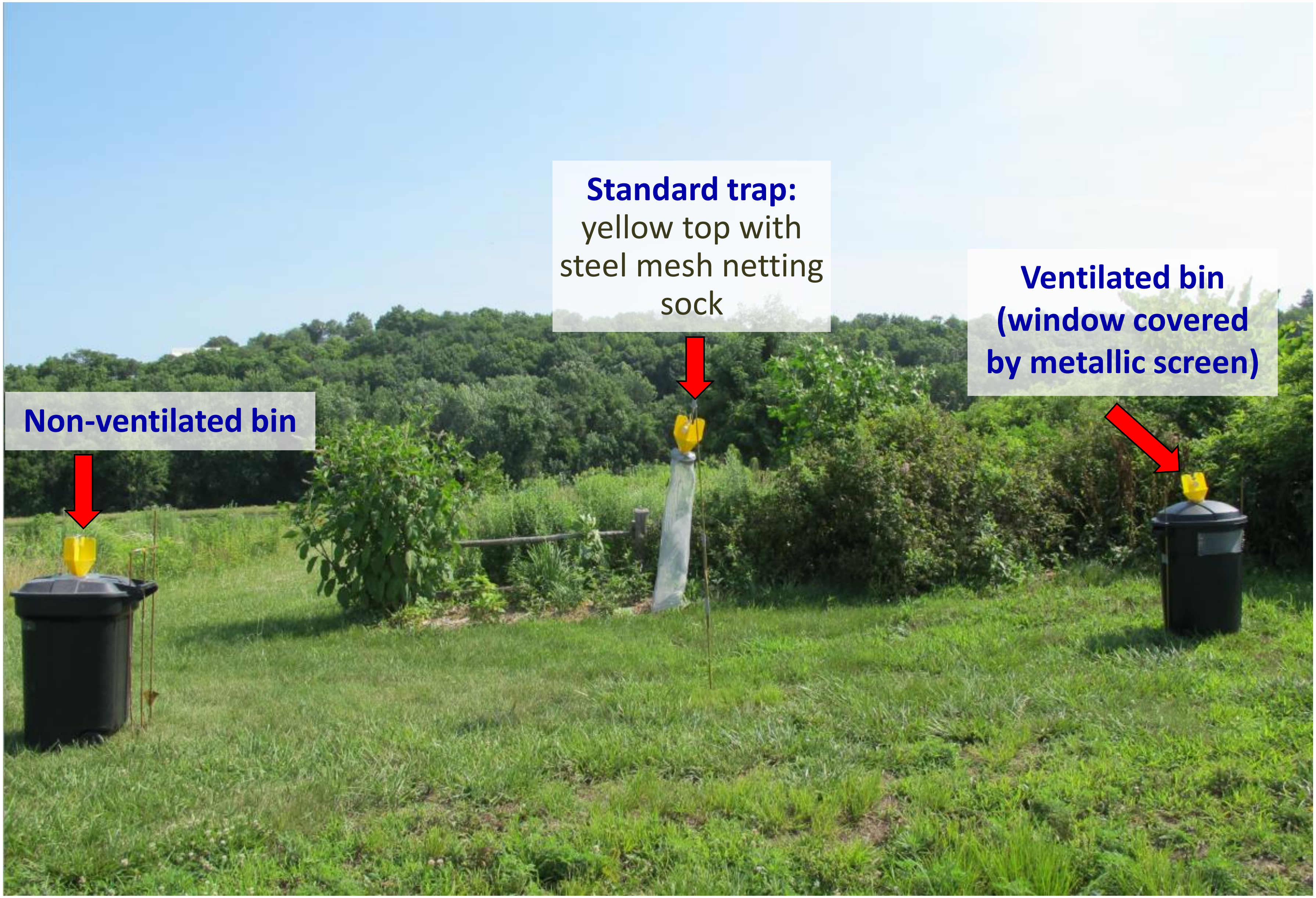
Lincoln University George Washington Carver Farm



The proto-type worked great, but required maintenance + it was frequently damaged by animals

“The Japanese beetle Terminator 3,000”

2015-2016 studies at Carver Farm



New low-maintenance design

Ventilation is important!

RESULTS In the 2015 study, the standard trap captured significantly more JB than the non-ventilated bin (ANOVA , $F_{2,56}$= 3.9, P= 0.027). The performance of the bin improved with the presence of 60 holes per side (240 in all) for ventilation (Fig. 2).

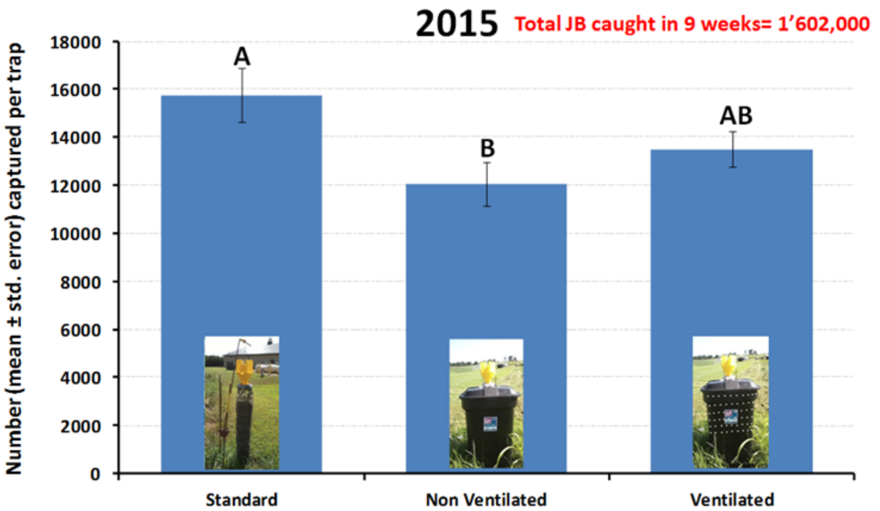
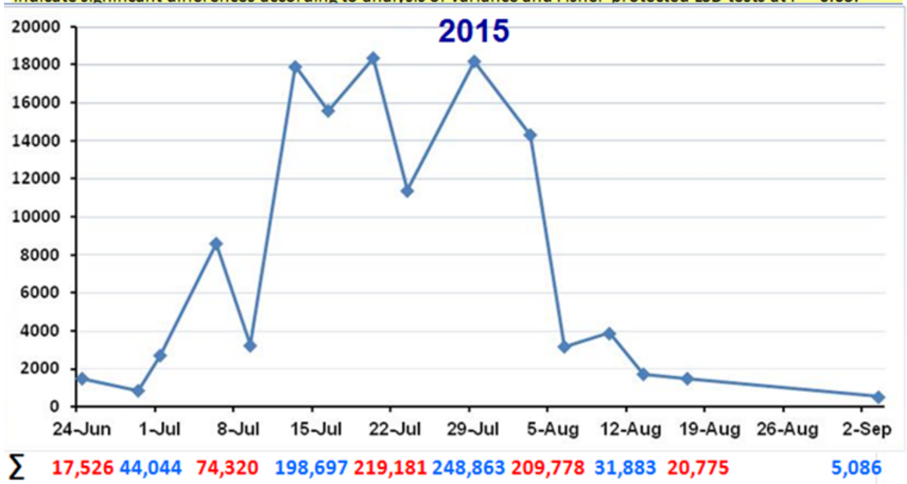


Fig 1: Captures of Japanese beetles according to trap type(2015). Different letters indicate significant differences according to analysis of variance and Fisher-protected LSD tests at P = 0.05.



JB presence on plants and level of defoliation

Lincoln University Missouri
Integrated Pest Management
Lincoln University Cooperative Extension

Evaluation	Carver farm (in 60 plants) June 30th	Busby farm (in 100 plants) July 6th	Carver farm (in 60 plants) July 14th	Busby farm (in 100 plants) July 14th
Total no. of Japanese beetles	50	0	20	1
% defoliation (average)	1.8%	0%	12%	0%

Elderberry plants showing little or no defoliation by Japanese beetles

SUMMARY OF CAPTURES (2012-2017)

FARM	2012	2013	2014	2015	2016	2017	TOTAL
LU Carver farm	801,000	92,300	873,400	1’602,000	2’649,300	2’895,000	8’913,000
LU Busby farm	710,800	100,400	817,050	1’531,000	2’800,600	672,000	6’631,850
TOTAL	**1’511,800**	**192,700**	**1’690,450**	**3’133,000**	**5’449,900**	**3’567,000**	**15’544,850**

What about costs?

- Cost of yellow top: $ 10.50
- Cost of bin with lid: $ 15.00
- Cost of mesh + glue: $ 5.00

TOTAL: $ 30.50 per trap (durability: several years)

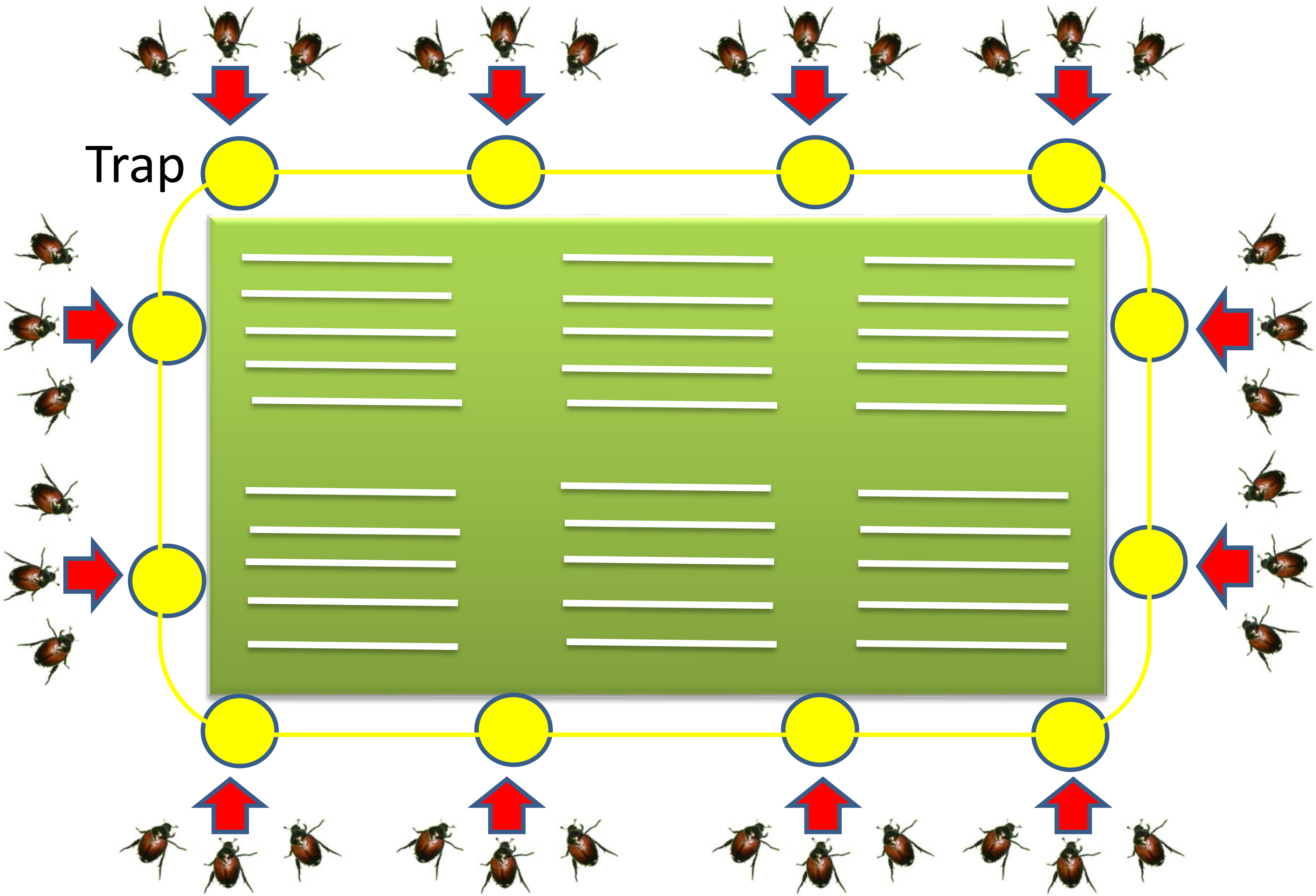
- Trap density at Busby farm (blueberry): 7 per acre
- If a 1-acre blueberry orchard has a mass trapping system in place with 7 traps, then the total cost of traps will be: $ 213.50 (one-time investment)
- Annual cost of 14 lures ($ 4.25 each), including one replacement: $ 59.50.

- Cost of spraying PyGanic 5.0 EC against Japanese beetle in one-acre plot: **$ 77 PER APPLICATION** (high rate). Cost is for insecticide only.
- Cost of applying PyGanic twice a week for 6 weeks: $ 924

Use of traps also means that negative impacts of insecticide application on non-targets will be avoided.

Perimeter Strategy: "Complete Block" used (Ideal)

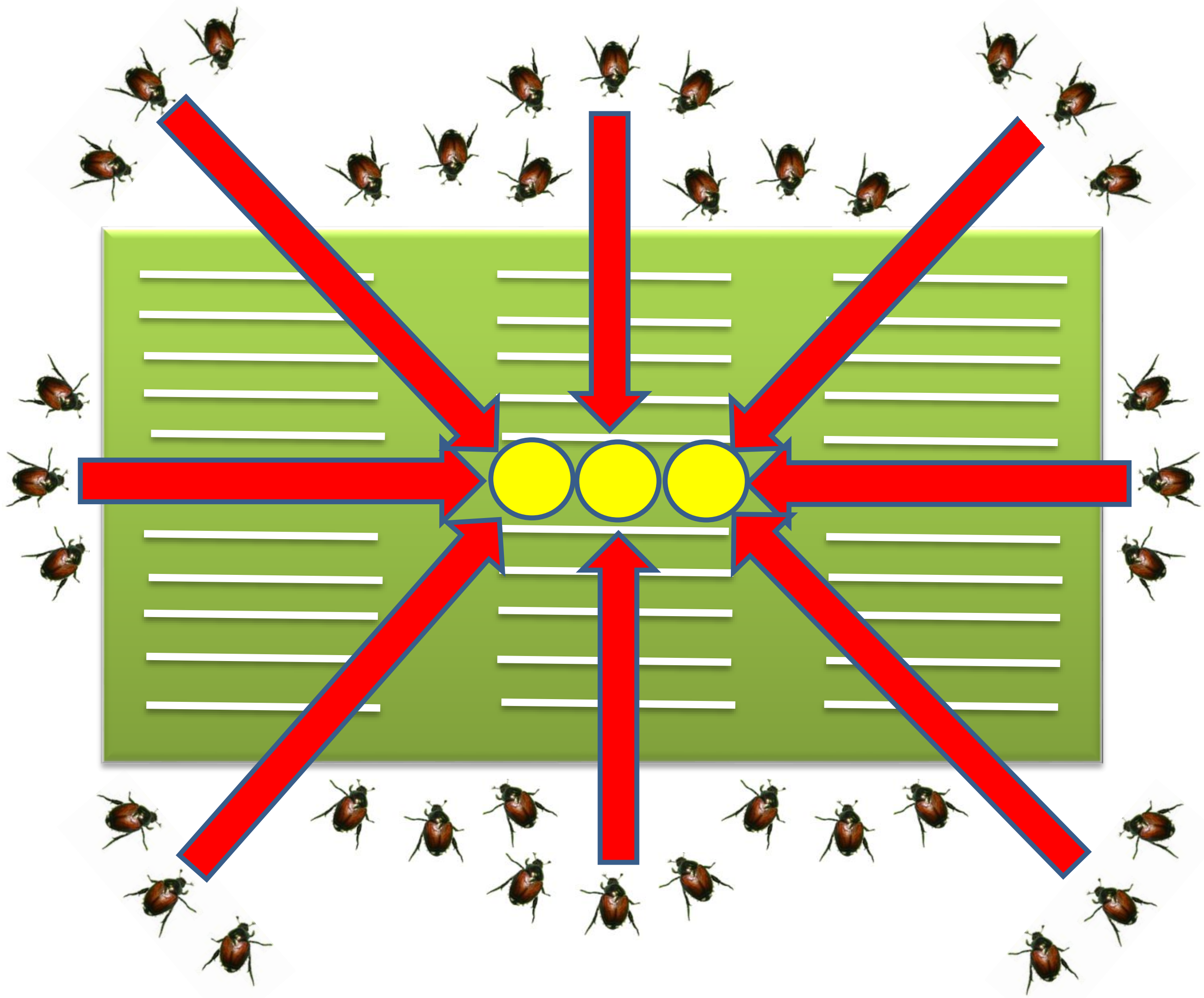
Diagram 1: "force-field"



How not to trap Japanese Beetles!

Goal: Draw JB away from cash crop—not toward it!

Diagram 2: Poor trap placement



How to Build a Mass Trapping System for Japanese Beetles

Drill small holes in bottom of the 32 gallon bin with 3/8ths inch bit to allow rain water to drain.

Cut a 5 by 15 inch rectangle out of cardboard. Use as a template to draw 2 windows (one on each side of bin)

Use an aviation "tin-snip" tool to cut out the window you traced with permanent marker.

The front and back of bin should look like this.

Stand the bin on it's base

Use sandpaper to sand the inside edges of the windows. This will allow the glue to adhere to the plastic. WARNING: Do not use hot glue because it will melt outside in the summer heat!

Cut a 7 by 20 inch rectangle out of cardboard. Use this template to cut out 2 window screens (with scissors).

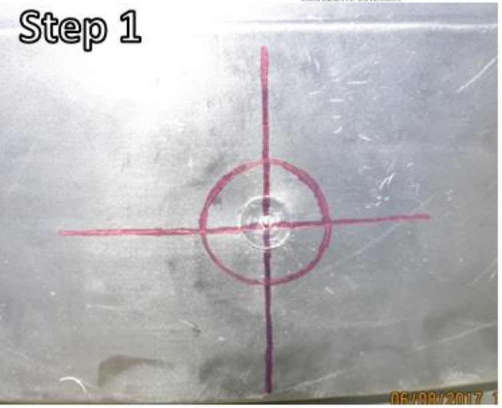
Lay the bin on one side and secure the aluminum screen inside with Duck tape.
Glue the screen to the bin and allow glue to dry overnight.
Gorilla glue is best—you can also use epoxy or E6000.

Both steel mesh windows in place

How to Build a Mass Trapping System for Japanese Beetles

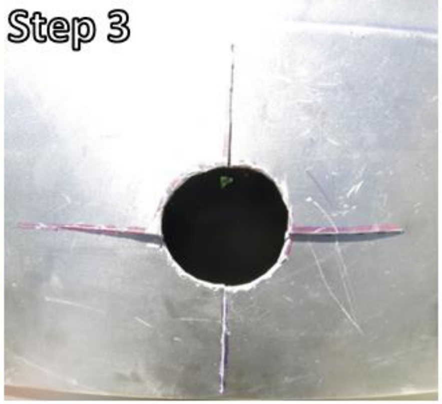
LINCOLN UNIVERSITY MISSOURI COOPERATIVE EXTENSION

Integrated Pest Management
Lincoln University Cooperative Extension



At the center of the lid, draw an "X" that is 4 inches by 4 inches. Draw a 2 inch circle around the center.

Drill a large hole in the center and use that as a starting point to cut out the "X" & circle shape you drew.

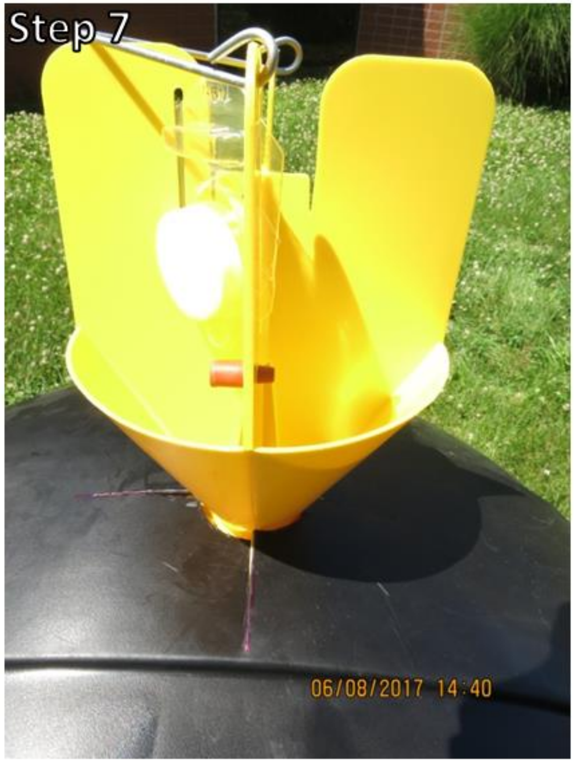


It should look like this.

Push the base of yellow commercial top through the slots you made.

Use Gorilla tape or Duck tape to seal the cracks so beetles can't escape.

Snap lid onto bin



Peel the silver tab off of lure, remove rubber pheromone stopper, and place in cutout hole. Make a perimeter of traps approximately 15 meters away from the crop you want to protect. Intercept incoming beetles from the side of highest pressure or place traps upwind. Remember, Japanese beetles emerge from fescue pasture—traps positioned between the pasture and cash crop will intercept incoming beetles. This is a preventative control option, so deploy traps before beetles land on your crop because they are reluctant to leave once they find a food source. Trap tops & lures can be purchased from: www.greatlakesipm.com

To keep the bin upright, we used two 4 ft. metal "electric fence posts" slid through the handles (They only cost $1.50 each). You can also use Rebar or simply hammer a tomato stake in the ground. Then, wrap a piece of string or wire around the bin to secure it.

Conclusions

1) Mass trapping may offer a cost effective organic control option
2) Environmentally friendly approach that is pesticide-free
3) Potential benefits of composting beetle biomass
4) Works autonomously and suppresses adult beetles from cropped areas

Thank you!

Project led by Dr. Jaime C. Pinero, Lincoln University State IPM Specialist.

We thank Junille Baker, Tina Coombs, Jason Miller, Traron Shivers, Binita Shrestha, and Jacob Wilson for technical assistance.

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