

Using statistical models to analyze trap color and location for effective capture of Velvet Longhorn

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- Data was collected on a farm in Utah by the Utah Department of Food and Agriculture
- I worked with Dr. Roy Bower at Furman University and biologist Dr. Annie Ray at Xavier University under a USDA Cooperative Agreement

Velvet Longhorn Beetle



Destruction of Trees



Orchard

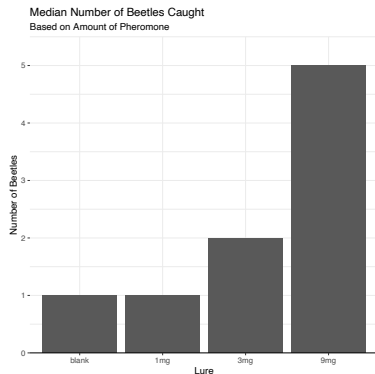
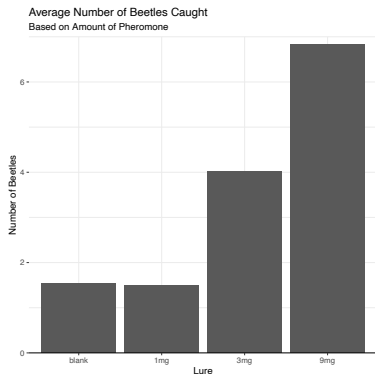


Traps



- Is there a significant difference in the overall number of beetles caught between different amounts of pheromone?

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Negative Binomial Mixed Effects Model

- $\log(y_{ij}) = \alpha_i + 0.0276 - 0.0310 I(\text{Lure} = 1 \text{ mg}) + 0.8948 I(\text{Lure} = 3 \text{ mg}) + 1.5641 I(\text{Lure} = 9 \text{ mg}) + \epsilon_{ij}$

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	Estimate	Std. Error	z-value	p-value
Intercept	0.0276	0.3135	0.088	0.930
1 mg	-0.0310	0.1300	-0.238	0.812
3 mg	0.8948	0.1165	7.682	< 0.0001
9 mg	1.5641	0.1132	13.823	< 0.0001

Incidence Rate Ratio Contrasts

contrast	ratio	SE	z ratio	p-value
1 mg / 0 mg	0.969	0.126	-0.238	0.9952
3 mg / 0 mg	2.447	0.285	7.682	< 0.0001
3 mg / 1 mg	2.524	0.297	7.870	< 0.0001
9 mg / 0 mg	4.778	0.541	13.823	< 0.0001
9 mg / 1 mg	4.929	0.565	13.907	< 0.0001
9 mg / 3 mg	1.953	0.192	6.798	< 0.0001

Incidence Rate Ratio Contrasts

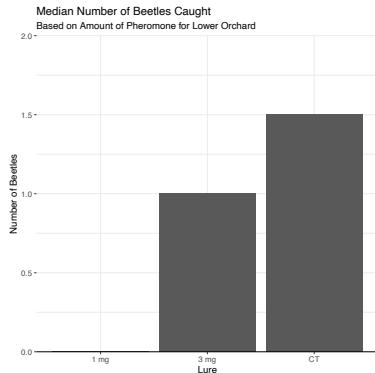
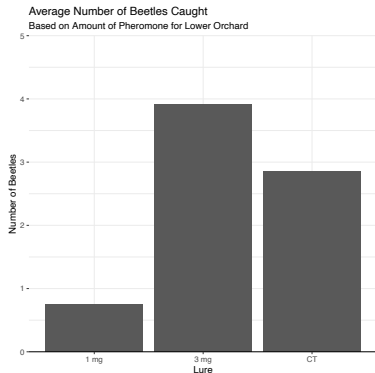
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- Conclusion from Upper Orchard: Pheromone amount is significantly associated with the overall number of beetles caught. Using 9 mg of pheromone results in significantly higher rates of beetles caught as compared to 0 mg, 1 mg, and 3 mg, respectively. There is not a significant difference between using 0 mg and 1 mg in regards to the rate of beetles caught.

- Is there a significant difference in the overall number of beetles caught between different manufacturers (Alpha Scents and Chem Tica)?

Lower Orchard

- Is there a significant difference in the overall number of beetles caught between different manufacturers (Alpha Scents and Chem Tica)?



Negative Binomial Mixed Effects Model

- $\log(y_{ij}) = \alpha_i + -1.2606 - 1.4319 \text{I(Lure = 3 mg)} + 1.5906 \text{I(Lure = CT)} + \epsilon_{ij}$

Negative Binomial Mixed Effects Model

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	Estimate	Std. Error	z-value	p-value
Intercept	-1.2606	0.6225	-2.025	0.0429
3 mg	1.4319	0.2689	5.326	< 0.0001
CT	1.5906	0.2828	5.624	< 0.0001

Incidence Rate Ratio Contrasts

contrast	ratio	SE	z ratio	p-value
3 mg / 1 mg	4.19	1.126	5.326	< 0.0001
CT / 1 mg	4.91	1.388	5.624	< 0.0001
CT / 3 mg	1.17	0.276	0.674	0.7784

Incidence Rate Ratio Contrasts

contrast	ratio	SE	z ratio	p-value
3 mg / 1 mg	4.19	1.126	5.326	< 0.0001
CT / 1 mg	4.91	1.388	5.624	< 0.0001
CT / 3 mg	1.17	0.276	0.674	0.7784

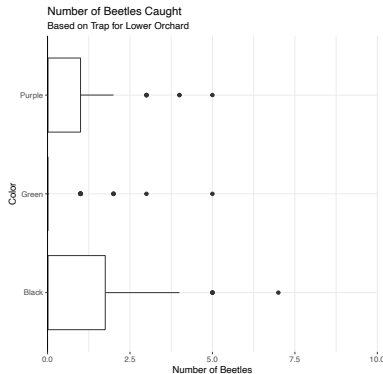
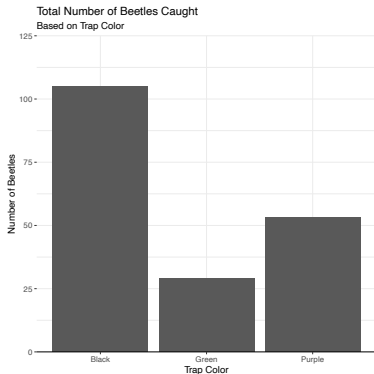
- Conclusion from lower orchard: 3 mg and CT both caught more beetles than 1 mg, but there was no difference in the number caught between 3 mg and CT. No significant difference in the two manufacturers.

Trap Colors

- Is there a significant difference in the overall number of beetles caught between different colored traps?

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Black and Purple Traps



Green Traps



Negative Binomial Mixed Effects Model

- $\log(y_{ij}) =$
 $\alpha_i + -1.6205 + 0.8571 I(\text{Color} = \text{Purple}) + 1.7118 I(\text{Color} = \text{Black}) + \epsilon_{ij}$

Negative Binomial Mixed Effects Model

- $\log(y_{ij}) = \alpha_i + -1.6205 + 0.8571 I(\text{Color} = \text{Purple}) + 1.7118 I(\text{Color} = \text{Black}) + \epsilon_{ij}$

	Estimate	Std. Error	z-value	p-value
Intercept	-1.6205	0.3732	-4.342	< 0.0001
Purple	0.8571	0.3230	2.654	0.0080
Black	1.7118	0.2991	5.724	< 0.0001

Incidence Rate Ratio Contrasts

contrast	ratio	SE	z ratio	p-value
Green / Purple	0.424	0.137	-2.654	0.0217
Green / Black	0.181	0.054	-5.724	< 0.0001
Purple / Black	0.425	0.100	-3.626	0.0008

Incidence Rate Ratio Contrasts

contrast	ratio	SE	z ratio	p-value
Green / Purple	0.424	0.137	-2.654	0.0217
Green / Black	0.181	0.054	-5.724	< 0.0001
Purple / Black	0.425	0.100	-3.626	0.0008

- Conclusion from color data: purple attracts more beetles than green but black attracts more beetles than both purple and green, so black is the best.

Height Data

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- Data from 2015-2018
- 2015: lure - EtOH
- 2016: lure - EtOH

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- Data from 2015-2018
- 2015: lure - EtOH
- 2016: lure - EtOH
- 2017: lure - EtOH, IPA (solvent), PHE (pheromone)

Height Data

- Is there a significant difference in the overall number of beetles caught between different trap heights?
- Data from 2015-2018
- 2015: lure - EtOH
- 2016: lure - EtOH
- 2017: lure - EtOH, IPA (solvent), PHE (pheromone)
- 2018: lure - IPA (solvent), 3 mg

Trap Heights



Mood's Median by Year

- Are there population median differences in number of beetles caught across the four years?

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- Are there population median differences in number of beetles caught across the four years?
- No significant differences $\chi^2_3 = 0.4829$, $p = 0.9226$

- $\log(y_{ij}) = \alpha_i + -0.2162 + 0.4561 \text{I}(\text{Height} = \text{High}) + \epsilon_{ij}$

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	Estimate	Std. Error	z-value	p-value
Intercept	-0.2162	0.2327	-0.929	0.3527
High	0.4561	0.1243	3.668	0.0002

Incidence Rate Ratio Contrasts

contrast	ratio	SE	z ratio	p-value
Low / High	0.634	0.0788	-3.668	0.0002

Incidence Rate Ratio Contrasts

contrast	ratio	SE	z ratio	p-value
Low / High	0.634	0.0788	-3.668	0.0002

- Conclusion: High traps attract more beetles than low traps

Future Directions

Interactions between variables

- Pheromone amount and color

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- Color and Height

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- Pheromone: 9 mg of pheromone attracts more beetles than the solvent and smaller amounts of pheromone (0mg, 1mg, 3mg), no difference in the two manufacturers (Chem Tica and Alpha Scents)

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Overall Project Conclusions

- Pheromone: 9 mg of pheromone attracts more beetles than the solvent and smaller amounts of pheromone (0mg, 1mg, 3mg), no difference in the two manufacturers (Chem Tica and Alpha Scents)
- Color: black attracts the most beetles
- Height: in most cases, high traps attract more beetles than low traps, but this result is only statistically significant when using solvent or EtOH, not pheromone

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- Any Questions?