Business Strategy for a Newly Designed Husk Fly Trap

By

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2013
ACKNOWLEDGEMENTS

First, I would like to thank my advisor, Dr. Holtz, for all his guidance and support throughout my senior project.

Second, I would like to thank Ag Chem Wholesalers for their encouragement and advice on this project. In addition, thank you Ag Chem Wholesalers for supplying the prototype for analysis.

Lastly, I would like to thank my parents for their countless support through school and this project, as well as, financially supporting my education.
ABSTRACT

This senior project discusses the analysis, evaluation and business strategy for a newly designed Husk Fly Trap from Ag Chem Wholesalers located in Yuba City, California. This prototype is designed to hold 2 to 3 weeks’ worth of Ammonium Carbonate and alleviate the hassle of monitoring the Walnut Husk Fly. This system is cost effective, able to hold the same amount, or 2 – 3 weeks, of Ammonium Carbonate as a “supercharged” trap. The Prototype Trap is easier to handle by not having to replace blown away traps or ruined sticky cards saving Pest Control Advisors time and allowing them to make more money by covering more acres with that saved time. Recommendations are to paint it yellow and to design a permanent mounting system, rather than a hook that may allow the monitoring sticky card to blow off the hook in high winds. Additionally, studying the effectiveness of the trap against a commercial trap and possibly replacing zip ties that hold on the cheesecloth on the ends of the trap with open PVC pipe covers or open PVC pipe covers with a screen in the opening.
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TABLE OF CONTENTS

ACKNOWLEDGEMENTS ........................................................................................................ iii
ABSTRACT .......................................................................................................................... iv
DISCLAIMER STATEMENT ............................................................................................... v
TABLE OF CONTENTS ...................................................................................................... vi
LIST OF FIGURES ............................................................................................................. vii
LIST OF TABLES ................................................................................................................ viii
INTRODUCTION ................................................................................................................ 1
LITERATURE REVIEW ....................................................................................................... 3
PROCEDURES AND METHODS ......................................................................................... 7
RESULTS ............................................................................................................................. 13
DISCUSSION ....................................................................................................................... 14
RECOMMENDATIONS ...................................................................................................... 16
REFERENCES ..................................................................................................................... 17
APPENDIX A ...................................................................................................................... 18
APPENDIX B ...................................................................................................................... 21
APPENDIX C ...................................................................................................................... 23
APPENDIX D ...................................................................................................................... 25
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Walnut Husk Fly Adult</td>
<td>1</td>
</tr>
<tr>
<td>2.</td>
<td>Walnut Husk Fly Damage on Walnut Shell</td>
<td>1</td>
</tr>
<tr>
<td>3.</td>
<td>Yellow Sticky Card</td>
<td>2</td>
</tr>
<tr>
<td>4.</td>
<td>Walnut Orchard</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>Walnut Tree Flowers</td>
<td>4</td>
</tr>
<tr>
<td>6.</td>
<td>Walnut Husk Fly</td>
<td>5</td>
</tr>
<tr>
<td>7.</td>
<td>“Supercharged” Yellow Sticky Card Husk Fly Trap</td>
<td>5</td>
</tr>
<tr>
<td>8.</td>
<td>Pouring Salt into Prototype</td>
<td>9</td>
</tr>
<tr>
<td>9.</td>
<td>Prototype Vs. Commercial Trap Layout</td>
<td>10</td>
</tr>
<tr>
<td>10.</td>
<td>Prototype Trap Hook System</td>
<td>11</td>
</tr>
<tr>
<td>11.</td>
<td>Raising the Prototype into the Cal Poly Walnut Orchard</td>
<td>12</td>
</tr>
<tr>
<td>12.</td>
<td>Prototype in a Walnut Tree</td>
<td>12</td>
</tr>
</tbody>
</table>
LIST OF TABLES

1. Cost of Prototype Walnut Husk Fly Trap ........................................ 7
2. Cost of Ammonium Carbonate per gram ........................................ 7
3. Cost of Commercial Husk Fly Trap ............................................. 8
4. Price Comparison of "In-Shell" to "Crack out" Walnuts ...................... 13
INTRODUCTION

The walnut husk fly is a major economic problem in the California Walnut industry as they feed on Black Walnuts and all varieties of English Walnuts (UC IPM 2003). The Walnut Husk Fly originated east of the Rocky Mountains and was first discovered in California in 1926. By the 1950s, the Walnut husk Fly had spread throughout the Pacific Northwest. The Walnut husk Fly’s scientific name is Rhagoletis complete Cresson from the Scientific Order Diptera (Riedl 1993).

![Walnut Husk Fly Adult](image)

Figure 1. Walnut Husk Fly Adult (Riedl, 1993).

The walnut husk fly has one generation per year and over winters as pupae in the orchard floor. The adult husk fly emerges between mid-July and mid-August where the Female husk fly lays her eggs just below the husk of the walnut. As the eggs hatch, the husk fly maggots eat away at the walnut husk turning the husk black and staining the shell of the walnut. The Black Stain from the Walnut Husk Fly cannot be removed during the washing process, which brings down the economic value of the in-shell Walnut dramatically.

![Walnut Husk Fly Damage](image)

Figure 2. Walnut Husk Fly Damage on Walnut Shell (Growing Produce, 2010).

In order to monitor and control the husk fly a pheromone trap using Ammonium Carbonate as the lure is placed in the orchard to monitor the husk fly population with the use of a yellow sticky card. The monitoring itself is quite simple, but changing the lure and replacing the sticky cards that the husk fly sticks to can be troublesome. In addition, removing and replacing the trap from the tree is time consuming and can cost money in loss of time for the Pest Control Advisor.
In order to solve the time consuming, money loss due to time and hassle of the Walnut Husk Fly Trap, Ag Chem Wholesalers from Yuba City California has come up with a new innovative way to store the Ammonium Carbonate and to hang the Yellow Sticky Card. From this prototype an economic plan will be put together along with testing the prototype in a real world scenario for user feasibility. The Trap Prototype will not be able to be tested in full due to the time constraint of the project. After analyzing the newly designed Walnut Husk Fly Trap, a business decision can be made to invest in production of the prototype or to abandon the idea.
LITERATURE REVIEW

Walnut Tree Growth Cycles.

Walnut trees are in a state of dormancy throughout the winter months. During the time of dormancy, the tree does not have positive growth but does maintain a constant level of water movement and starch consumption in order to stay alive. The tree’s breakdown of starch in dormancy increases the levels of sugar in the cell sap, preventing freezing in the winter months. In order to do this, a sufficient amount of water must be taken up by the tree in the fall (UC IPM 2003).

![Walnut Orchard](image)

Figure 4. Walnut Orchard (Daniels Farms, 2013).

As spring comes and the temperature increases and the nutrients that are stored in the winter months are mobilized to the buds to provide energy for the development of leaves and flowers in order to form fruit. Dependent on the cultivar and climate, leaves are developed in the months of March or April. Photosynthesis occurs once the leaves appear and provide the energy for continued growth of the trees (UC IPM 2003).

Walnut trees are “monoecious” which means that they contain both a male and female flower. Both develop in buds formed during the previous growth seasons. The female flowers are hidden in the end of the growth tip from previous years or in lateral shoots called spurs depending on the cultivar. Male flowers are visible protruding above leaf scars from the previous growth season’s shoots. In the majority of cultivars the male flowers form first in the spring, followed by the female flowers. This flower progression allows for affective pollination of the female flowers by the male flowers assisted by the wind (UC IPM 2003).
After the female flower is fertilized, it begins to develop into what will be the nut. Good nut growth is dependent on total tree health and soil nutrient availability. Seven weeks following fertilization the nut shell begins to harden and the kernel starts to form, replacing the liquid tissue inside the nut containing the stored food. 15 weeks after fertilization, the nut meat is fully developed and any type of stress caused by pests, environmental factors or lack of water at any time of the nut meat development can affect its quality. At this full nut maturity, walnut husks have split open revealing the fully browned nut shell allowing for effective husk and shell separation in processing after harvest (UC IPM 2003).

**Walnut Orchard Monitoring.**

Orchard Monitoring provides vital information on daily and seasonal orchard conditions such as pest levels, weather conditions or soil moisture pertinent to a positive economic outcome. Since conditions are different from orchard to orchard, every orchard must be monitored as well. Keeping records of monitoring in every orchard is important for successful management (UC IPM 2003).

**The Walnut Husk Fly.**

The Walnut Husk Fly is a mid to late season pest that affects Black Walnuts and all English Walnut Cultivars in California except the central and southern growing areas in the state. Cultivars that mature in midseason and later such as Eureka, Hartley, Franquette, Mayette and Tulare are generally more susceptible to husk fly damage over other cultivars (UC IPM 2003). The adult walnut husk fly is the size of a common house fly with a yellow spot on the midsection of the body and a triangular band at the tip of each wing. Husk flies produce one generation a year and overwinter as pupae in the orchard soil before they emerge as adult husk flies from June to early September. The majority of husk flies emerge in the middle of July to the end of August. The husk fly will mate 8 days after emerging from the orchard soil. The female fly will lay eggs in groups of 15 below the walnut husk surface several days after mating (UC IPM 2003).
**Walnut Husk Fly Damage.**

The first signs of a Walnut Husk Fly infestation are small sting holes made from where the female fly lays her eggs in the husk. Once the eggs hatch, the worms will consume the husk turning it black and staining the walnut shell underneath the husk. The walnut shell cannot be bleached from this stain, affecting its marketability of “In-Shell” sale. Therefore, the walnut husk fly is a pest that does not affect the ability for the walnut tree to produce nuts, but the economic value of your crop which can be equally as bad (UC IPM 2003).

![Walnut Husk Fly Damage](image)

**Figure 6. Walnut Husk Fly Damage (UC IPM, 2003).**

**Monitoring and Treatment.**

In Walnut Production monitoring and spraying for Husk Fly is essential, says Tim Denney, Owner of Ag Chem Wholesalers. It is not a question of if a grower should monitor and spray for Walnut Husk Fly, but an absolute must (Denney, 2013).

Every year from late June till Harvest in late summer to early fall, “supercharged” Yellow Sticky cards should be placed to monitor Husk Fly Populations. In order to make a “supercharged” Husk Fly trap, inserting a tube containing 1 ounce (28 g) of Ammonium Carbonate and covering the ends with cheesecloth. The Ammonium Carbonate makes the trap 4 to 10 times more attractive than the standard yellow sticky card. For orchards 30 to 100 acres in size, a trap should be hung up for every 10 acres, while orchards over 100 acres should have a trap for every 20 acres (UC IPM 2003).
Traps should be placed in large shaded trees, trees in damp areas or near black walnuts, and trees that were damaged the previous season. All these areas are known as Husk Fly hotspots. The traps should be hung as high as possible in the upper third of the canopy in an area of dense foliage on the north side of the tree. Traps should be checked twice or more preferably three times per week with counting and cleaning of flies from the sticky card, shake and or stir the tube of Ammonium Carbonate and either replace or reapply sticky material to the trap surface as needed. Ammonium Carbonate should be replaced every 2 to 3 weeks or more often if needed depending on weather. In order to check the effectiveness of the Ammonium Carbonate, one should smell for the ammonia. If it cannot be smelled anymore, replace the Ammonium Carbonate (UC IPM 2003).

The supercharged traps will tell you when the flies are emerging in an orchard, but trap catches are not useful alone for timing of spray applications. For maximum effectiveness, sprays must be applied just before the female husk fly lays here eggs. The rate of walnut husk fly development is not dependent on the temperature, but the availability of food, so Degree-Day models cannot be used to evaluate development and times to treat. For the most accurate times to spray, female flies should be removed from the card and by using an object like a pencil point should be used to press on the female fly’s abdomen looking for eggs to be released through the ovipositor. Husk fly eggs are pearly white and resemble tiny grains of rice. In order to have an effective spray and treatment, one must spray for Walnut Husk Fly within one week after eggs are first found. Sprays are effective for 2 to 3 weeks, so constant monitoring throughout the season should be conducted until harvest to protect the Walnut crop (UC IPM 2003).

Ammonium Carbonate.

Ammonium Carbonate has a chemical formula of (NH4)2CO3. Ammonium Carbonate has potential acute health effects of irritation of eyes and skin if contact is made, and lung irritant if inhaled. It is non-flammable and possibly explosive when a presence of static discharge or presence of heat. Ammonium Carbonate is not toxic to either humans or animals and the LD50 and LC50 are not available for it (Ammonium Carbonate MSDS 2013).

Ammonium Carbonate degradates on average 14 to 16 days dependent on temperature. At lower temperatures, for example 18.3 °C (64.9 °F), Ammonium Carbonate degradates in 14 to 16 days. At higher temperatures, for example 29.4 °C (84.9 °F), Ammonium Carbonate degradates in 9 to 11 days. The higher the temperature, the faster Ammonium Carbonate degradates (Van Steenwyk, 2013).
PROCEDURES AND METHODS

Cost Study of Walnut Husk Fly Management.

According to the University of California Cooperative Extension’s Report in 2012 titled, “Sample Costs to Establish a Walnut Orchard and Produce”, it cost the grower $112 per acre per year to monitor and control Walnut Husk Fly in the Sacramento Valley. In addition, a pest control advisor will charge $30 per acre to monitor and check a walnut orchard. In return a typical walnut orchard in its 6th year produces 1500 pounds of dry, in-shell walnuts per acre and for the 7th year 2800 pounds of dry, in-shell walnuts per acre and levels off there. For a 100 acre walnut orchard, it will cost the grower $14,200 per year to monitor and control husk fly.

Table 1. Materials Cost of Prototype Walnut Husk Fly Trap.

<table>
<thead>
<tr>
<th>Cost of One Prototype Husk Fly Trap</th>
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</tr>
</thead>
<tbody>
<tr>
<td>1&quot; PVC Tee</td>
<td>$ 0.66</td>
</tr>
<tr>
<td>7/8&quot; Brass Cup Hook</td>
<td>$ 1.18</td>
</tr>
<tr>
<td>3-1/8 x 3/4 Swivel Eye Quick Snap</td>
<td>$ 3.26</td>
</tr>
<tr>
<td>1&quot; Male Adapter SXMPT</td>
<td>$ 0.74</td>
</tr>
<tr>
<td>1&quot; PVC Cap FPT</td>
<td>$ 0.73</td>
</tr>
<tr>
<td>Cheesecloth</td>
<td>$ 0.05</td>
</tr>
<tr>
<td>5/16&quot; x 4&quot; Eye Bolt</td>
<td>$ 0.70</td>
</tr>
<tr>
<td>1&quot; x 10' PVC Class 200 PE Pipe</td>
<td>$ 1.49</td>
</tr>
<tr>
<td>26 inches of PVC Pipe</td>
<td>$ 0.30</td>
</tr>
<tr>
<td>2 Cut Washers 5/16&quot;</td>
<td>$ 0.24</td>
</tr>
<tr>
<td>Hex Nuts - USS 5/16</td>
<td>$ 0.11</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$ 9.46</strong></td>
</tr>
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Table 2. Volume Cost of Ammonium Carbonate per gram (Sigma-Aldrich Co. 2013).

<table>
<thead>
<tr>
<th>Cost of Ammonium Carbonate</th>
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<tr>
<td>Grams</td>
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<tr>
<td>25</td>
<td>$17.80</td>
</tr>
<tr>
<td>100</td>
<td>$35.70</td>
</tr>
<tr>
<td>500</td>
<td>$54.60</td>
</tr>
<tr>
<td>1000</td>
<td>$104.00</td>
</tr>
<tr>
<td>2500</td>
<td>$218.50</td>
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Table 3. Cost of Commercial Husk Fly Trap (Peaceful Valley Farm and Garden Supply).

<table>
<thead>
<tr>
<th>Amount</th>
<th>Cost</th>
<th>Cost/Trap</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>$10.79</td>
<td>$1.08</td>
</tr>
<tr>
<td>50</td>
<td>$9.59</td>
<td>$0.19</td>
</tr>
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</table>

As the Tables show, it costs $9.46 to build one prototype trap. Using a 100 acre orchard, their will need to be $94.60 worth of prototype traps. Over a monitoring season, 57 grams of Ammonium Carbonate will fill the traps worth $5.13. In addition, there will be a need of 100 Traps to replace dirty Cards worth 19.18 dollars. For the 100 acres it would cost $118.91 to monitor Husk Fly with the prototype trap, coming to $1.19 per acre. For the first season it is a quite a bit more expensive than just using the normal “supercharged” AM Traps that cost the same as the prototype materials, but for the following years the prototype traps will be able to be re-used, equaling the cost of a “supercharged” AM Trap at $0.24 per acre. In addition, a flat standard rate of $30 per acre is charged by the PCA (UC Extension 1994, 2012).

Walnuts come in multiple grades, but “In-Shell” and “Crack out” are the two ends of the spectrum. An orchard that has had considerable husk fly damage resulting in black stains, with a sticky goo like substance possibly resulting in mold can result in a less desirable grade of shelled Walnuts. The highest and most desirable grade to a farmer is “In-Shell”. “In-Shell” drying and cleaning cost is considerably less than the cost of processing of damaged, needed to be shelled and sorted by hand.

When it comes to walnut processing, the “In-Shell” processing cost is $378 per acre, while “Crack out” processing cost $1,110.00 per acre (UC Extension 1994, 2012). That is a $722 difference per acre of processing cost.

In 2012 the cost per pound for In-Shell Walnuts was $1.70 per pound and the cost of “Crack out” Walnuts was $0.85 per pound.

**Volume Measurements and Calculations of Ammonium Carbonate.**

In order to identify at what point the cheesecloth would fall off the tube due to the amount of Ammonium Carbonate in the container, a similar substance was used. At the end of the tubes cheesecloth is held on by zip-ties, raising the likelihood that for the cheesecloth will fall off. If the cheesecloth were to fall off, Ammonium Carbonate would spill all over the ground, not allowing you to monitor the Husk Fly. Regular table salt was poured down the top of the container until it was completely full. The cheesecloth did not loosen due to outward pressure of salt.
Volume Calculations were then performed in order to determine how much Ammonium Carbonate the prototype could hold. Measuring the prototype to be 17 inches long by 12 inches tall and 1 inch diameter PVC Pipe, it was determined that the prototype could hold 22.7 cubic inches of Ammonium Carbonate. Using bulk density, cubic inches were then converted into ounces resulting in 8 ounces of Ammonium Carbonate. One “supercharged” trap holds 1 ounce, lasting 2 to 3 weeks.

**Commercial “supercharged” Yellow Sticky Card Trap vs. Prototype Trap.**

For proper comparison, a test involving a commercial “supercharged” yellow sticky card trap and the Prototype Trap should be conducted. Due to time constraints of the project and the time of management and monitoring of Walnut Husk Fly, a test can only be laid out for future comparison. The comparison should be performed in the late part of July in order to have fair results for efficacy.

When comparing the two traps, the experimental environment should be a 100 acre Walnut Orchard in the Northern Sacramento Valley in late July. For a 100 acre orchard, ten traps are needed to monitor Walnut Husk Fly effectively. For comparison, 50 acres and 5 traps should be designated for the commercial trap and the other 50 acres and 5 traps should be allocated for the Prototype Trap. Three of the Prototype Traps shall have the cheesecloth end covers on the trap. The two other Prototype Traps will have two different cap types, a PVC cap with a ¼ hole and an open ended cap with a screen mesh covering the end. One must lay out the traps following the map shown below, having the blue circles give the locations of each trap and place them two thirds the way up the tree canopy. The two types of traps are to remain separate from one another, but are still located in the same 100 acre orchard. Dr. Michael Costello from the Cal Poly Horticulture and Crop Science Department added that the experiment should take place in three different 100 acre orchards. They do not have to be on the same ranch as long as the climate is similar. Having three different experiments allows for statistical data analysis of both traps.
All traps will have one ounce of Ammonium Carbonate and will be placed two thirds up the canopy of the tree and will use the same yellow sticky cards. Ensuring the same amount of Ammonium Carbonate, same height in the tree and the same yellow sticky cards eliminates any other variables, simply studying the efficacy of the Prototype Trap versus the commercial trap. The items that will be studied to evaluate efficacy will be human smell associated with degradation, Husk Fly numbers on the yellow sticky card and user feasibility.

To test for smell, the traps will be visited once a day at the same time every day. On a scale of 1 to 10, 1 being nonexistent and 10 being fresh, the trap will be rated by human smell on how potent the Ammonium Carbonate is. The Traps will be shaken when they are checked to continue to keep the Ammonium Carbonate active. The different cap types for the Prototype Trap, cheesecloth, cap with a ¼ inch hole and an open ended cap with screen mesh, will be recorded separately to determine degradation rates and to record any differences in degradation rates. The traps will be recorded and removed after 4 weeks.

The collection test will be based on the number of flies the trap collects on a day to day basis. The more number of flies there are on the trap, the more efficient the trap. Data will also be recorded on the number of flies on the individual sticky cards daily. The traps will no longer be used after 4 weeks.
Lastly, every time the trap is checked comments will be made on the state of the trap. If the trap has to be placed back in the tree or if the Ammonium Carbonate had been poured onto the card and needed to be replaced or if the trap is wrapped up or tangled. At the end of the experiment comments will be marked as negative or positive.

After the 4 week experiment numbers will be pooled together and studied. The Trap with the higher average smell numbers, fly counts and positive over negative marks over the 4 week period will be selected as the best trap.

**User Feasibility and Prototype Trap Use Function.**

The prototype trap was taken to the Cal Poly Deciduous Orchard located at the Crops Unit to be tested in the Walnuts for the user feasibility. The trap was placed on the North Side of the tree and placed two thirds of the way up the tree, following the UC IPM Guidelines to monitoring Walnut Husk Fly. The trap was easy to raise, lower and remove from the rope. The clip at the top of the trap where the Ammonium Carbonate is poured into was attached to the rope which assisted in its removal from the rope. The trap was large and was able to be seen from the edge of the row. The trap was heavy enough to ensure that the trap would not fall out of the tree like the commercial traps available and Ammonium Carbonate could not fall out directly onto the sticky card ruining the card.

As it applies to normal day to day Pest Control Advisor work of checking the traps and replacing the Ammonium Carbonate the old way with a “supercharged” AM Trap, it takes 5 minutes to do so by lowering the trap, refilling the Ammonium Carbonate, shaking the vile, counting the card, replacing the card and raising it back into the tree. With the prototype design, the hassle of handling the commercial “supercharged” trap is eliminated. Using the prototype design cuts 2 minutes from an individual checking a single trap. Cutting 2 minutes off of your trap checking time saves you 20 minutes for your 100 acre Orchard per day, one hour per week and 4 hours per month. This results in less time checking traps and more time advising. With saving an hour a week, that puts extra money in the PCA’s pocket. Within a 17 week monitoring season it could
save the PCA 17 hours alone on one 100 acre Orchard, resulting in being able to check another 100 acres if it takes a PCA to check 100 acres an hour.

Figure 11. Raising the Prototype into the Cal Poly Walnut Orchard.

Figure 12. Prototype in a Walnut Tree.
RESULTS

Table 4. Price Comparison of "In-Shell" to "Crack out" Walnuts.

<table>
<thead>
<tr>
<th>Profit and Losses for a 100 Acre Walnut Orchard</th>
<th>“In-Shell”</th>
<th>“Crack out”</th>
</tr>
</thead>
<tbody>
<tr>
<td>7th Leaf Walnut Orchard Production (pounds per acre)</td>
<td>2,800</td>
<td>2,800</td>
</tr>
<tr>
<td>Total Production 100 Acres</td>
<td>280,000.00</td>
<td>280,000.00</td>
</tr>
<tr>
<td>Monitoring (cost per acre)</td>
<td>$ 112.00</td>
<td>$ 112.00</td>
</tr>
<tr>
<td>Total Monitoring Cost</td>
<td>$ 11,200.00</td>
<td>$ 11,200.00</td>
</tr>
<tr>
<td>Walnut Price per pound</td>
<td>$ 1.70</td>
<td>$ 0.85</td>
</tr>
<tr>
<td>Total Gross Profit</td>
<td>$ 476,000.00</td>
<td>$ 238,000.00</td>
</tr>
<tr>
<td>Processing Cost (per acre)</td>
<td>$ 378.00</td>
<td>$1,110.00</td>
</tr>
<tr>
<td>Total Processing Cost</td>
<td>$ 37,800.00</td>
<td>$111,000.00</td>
</tr>
<tr>
<td>Total Net Profit</td>
<td>$ 427,000.00</td>
<td>$115,800.00</td>
</tr>
</tbody>
</table>

During the cost analysis for a 100 acre Walnut Orchard it was found that it cost $112 per acre or $11,200 to monitor and manage Walnut Husk Fly. During the 7th leaf of Walnut Trees, the Orchard can produce 2,800 pounds per acre on average. In 2012 “In-Shell” Walnuts paid $1.70 per pound and for “Crack out” Walnuts $0.85 per pound. Based on these prices, “In-Shell” Walnuts for 100 acres would result in $476,000 made and for “Crack out” Walnuts would result in $238,000 made. When processing the Walnuts, “In-Shell” cost $378 per acre or $37,800 for the 100 acres and $1,110 per acre to process “Crack out” Walnuts or $111,000 for the 100 acres. Adding all the profits and losses together results in a $427,000 profit for “In-Shell” Walnuts and $115,800 profit for Crack out. This large margin of profit shows that managing for Walnut Husk Fly alone is essential for a grower to make money.

When evaluating the Prototype Trap, the trap was found to hold 8 ounces of Ammonium Carbonate, plenty of space to hold 2 to 3 weeks’ worth, equaling about one ounce. Even though the Prototype Trap can hold a season’s worth of Ammonium Carbonate, it should still be changed on a regular bases to ensure an active and effective trap. In addition, using the Prototype Trap saved the PCA 2 minutes per trap of monitoring, resulting in 17 hours saved throughout the whole season.

When analyzing the Costs and Benefits of the Prototype Design by Ag Chem Wholesaler against the standard “supercharged” Husk Fly Trap, the Prototype Trap beats the commercial trap in all areas except the initial cost. On average, the PCA charges growers $30 per acre to walk and monitor a Walnut Orchard. In the first year the Prototype Design costs $118.91 compared to the standard trap costing $24, both for a 100 acre orchard. Both traps cost the same in the years to come once the Prototype Traps are bought or built. By not having to spend time refilling traps, the PCA can see a gross profit increase of $3,000. This is a result of being able to acquire 100 more acres than before using the commercial “supercharged” trap.
DISCUSSION

As seen in the results, the Prototype Trap meets all of the expectations. It is cost effective, saves time and makes the PCA’s job easier. All these findings are valid as long as the Prototype Trap works. The proposed future experiment to compare the commercial “supercharged” trap and the Prototype Trap should show that the Prototype Trap works better than the commercial trap. The trap is just another way of doing things based off of already found tactics. Husk Flies are attracted to the Ammonium Carbonate and get stuck on the Card. Monitoring the cards allows the PCA to know when to spray based on the number of flies in the trap and if eggs are present in the females. The Prototype Trap will assist the PCA in saving time and money. It will allow the PCA to check traps faster and be able to acquire more acres and make more money.

The Prototype Trap is easier to use than the commercially available traps. The Prototype is heavy enough to stay in the trees without being blown out by high winds or get tangled up in itself. Making it easy to hang and place in the tree allows the PCA to place the Prototype Trap wherever he/she wants it, allowing for more accurate data and placing the trap in the flight line of Walnut Husk Fly. With the placement of the sticky card on the spring loaded paper clip attached to a hook on the bottom of the Prototype Trap, the PCA will not get the sticky stuff from the card all over them, their clothes, their truck and anywhere else imaginable. Being able to open the spring loaded paper clip and drop the card in a bucket without even touching it is a great advantage.

As it relates to the Ammonium Carbonate in the Prototype Trap, one will not be able to go all season and not have to refill it. It will have to be refilled on a 2 to 3 week bases as normal or when it does not give off an ammonia smell anymore. Current long lasting lures in the market are not fully trusted by PCA’s due to that the liability of crop gain or lose is in the PCA’s hands. PCA’s will always weigh on the side of caution on lure longevity and change lures regularly. Still, the fact of making the container in which the Ammonium Carbonate is located in larger and easier to fill reduces the risk of leaking all over the card makes it easier for the PCA. The way that the existing commercial traps are hung, the Ammonium Carbonate is tied with a bread tie to the trap, allowing it to fall off in high winds and onto the sticky card, ruining the sticky card. When such an event occurs, this could result in loss of time that the card could be collecting flies. Since the Walnut Husk Fly does not follow the “degree day” growth concept, it is essential to monitor constantly to check for females with eggs. As soon as females are observed with eggs in their abdomen ready to be laid, your Economic Injury level has been reached and it is time to spray. The time that the Ammonium Carbonate might be on the card could cost the grower money in yield. Not allowing the Walnut Husk Flies to stick to the card could be the window of where the females where just about ready to lay their eggs, costing a large economic loss to a walnut crop due to a missed spray.

The Prototype Trap costs significantly more in the first year, but once the trap has been paid for it comes back down to the regular price of the existing commercial traps. This extra cost can be seen as a luxury as well, just like a closed cabbed tractor, with the benefits of being hassle free out weighing the cost. The time saved would increase the price per hour made due to that the PCA is spending less time in the field, but the cost of the trap would take the extra money in the first year. In addition, with the ability to acquire 100 extra acres at $ 30 per acre, this results in an
extra $3,000 made covering the initial Prototype Trap costs. The grower would not see an increase in cost per acre to monitor their walnut orchard and will see an added benefit, making the Prototype Trap cost effective.

With all of these aspects the Prototype is a very marketable product. Allowing the PCA to make more money by covering more acres of Walnuts and saving time will appeal to PCA’s.
RECOMMENDATIONS

Ag Chem Wholesalers has provided a Prototype Husk Fly Trap to be analyzed and tested for improvements.

Upon testing the first thing that was discussed was painting the prototype yellow. The sticky cards used to monitor the Husk Fly are yellow and Dr. Headrick from the Plant Protection Science Department at Cal Poly, San Luis Obispo stated that Husk Flies are attracted to the color yellow. Painting the trap yellow could increase the attractiveness to the trap along with the Ammonium Carbonate. In addition, it could be easier to see the trap with the bright yellow color in the dense orchard foliage.

Another idea that was discussed was constructing a different system to clip the card to the trap. Right now a simple hook is used to hold a spring loaded paper clip attached to a yellow sticky card. With this method it could be possible for the cards to fall off the trap. In order to solve this problem a closed I-Hook that the spring loaded paper clips could be attached to could prevent the card from falling off the trap.

In addition, currently the Ammonium Carbonate is being held in the trap by a piece of Cheese Cloth help onto the PVC Pipe by the means of a zip tie. Replacing the zip ties with an open PVC cap to be placed over the cheesecloth could reduce the risk of the cheesecloth slipping off. Additionally, an open PVC cap filled by a screen mesh could also reduce the risk of the ends opening and releasing the Ammonium Carbonate all over the ground.

Due to the time constraints of the project, a plan to test the Prototype Trap for the upcoming summer months should be conducted. One should follow the outlined procedures for the test explained in the Procedures section of the report. This test will assess the effectiveness of the Prototype Trap in a Northern California walnut orchard in the dry, hot summer climate against a set of commercial traps. In addition, the degradation rates of the different types of ends on the Prototype Trap will evaluate the best end cap style for the longest lasting period of Ammonium Carbonate in the Trap.
REFERENCES


11. Van Steenwyk, Novotny, Thayer, Weiss, Coates, Verhaeghe, Grant and Hasey. 2013."Evaluation of Monitoring Techniques for Walnut Husk Fly"
APPENDIX A

HOW PROJECT MEETS REQUIREMENTS FOR THE ASM MAJOR
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ASM Project Requirements.

The ASM Major senior project must include a problem solving experience that incorporates the application of technology and the organizational skills of business and management, and quantitative, analytical problem solving. This project addresses these issues as follows.

Application of Agricultural Technology. This project involves the application of volume measurements and calculations.

Application of Business and/or Management Skills. This project involves business/management skills in the areas of orchard management, cost and productivity analysis and PCA labor considerations.

Quantitative, Analytical Problem Solving. Quantitative problem solving techniques include the cost analysis and volume calculation calculations.

Capstone Project Experience.

The ASM senior project must incorporate knowledge and skills acquired in earlier coursework (Major, Support and/or GE Courses). This project incorporates knowledge/skills from these key courses.

- AGB 202 Sales, Communication and Leadership
- AGB 212 Ag Econ
- AGB 310 Ag Credit and Finance
- BRAE 128 Careers in Bioresource/Ag Eng.
- BRAE 129 Lab Skills/ Safety
- BRAE 203 Agricultural Systems Analysis
- BRAE 321 Agricultural Safety
- BRAE 342 Ag Materials
- BRAE 418/419 Ag Systems Management
- PPSC 311 Ag Entomology
- PPSC 431 Insect Pest Management

ASM Approach.

Agricultural Systems Management involves the development of solutions to technology, business or management problems associated with agricultural or related industries. A systems approach, interdisciplinary experience, and agricultural training in specialized areas are common features of this type of problem solving. This project addresses these issues as follows.

Systems Approach. This project involves the integration of business and crop science to assist the Walnut Grower and the Pest Control Advisor in charge of assisting those growers

Interdisciplinary Features. This project touches on aspects of Agricultural Business, Crop Science, Pest Management and Sales.
**Specialized Agricultural Knowledge.** This project applies specialized knowledge in crop science and Ag Entomology.
APPENDIX B

HUSK FLY TRAP PROTOTYPE DRAWING
APPENDIX C

CALCULATIONS
Monitor/Control: $ \frac{112}{acre} \times 100 \text{ acres} + \frac{30}{acre} \times 100 \text{ acres} = $ 14,200

Prototype Monitor: $ 9.46 \times 10 \text{ traps} + \frac{5.13}{100 \text{ acres}} + \frac{19.18}{100 \text{ acres}} = $ 118.91 \text{ or } $ 1.19 \text{ per acre}

Monitor: $ \frac{19.18+5.13}{100 \text{ acres}} = $ 24.31 \text{ per 100 acres or } $ 0.24 \text{ per acre}

“In-Shell” Processing: $ 378 \text{ per acre}

“Crack Out” Processing: $ 1,110 \text{ per acre}

Difference in processing: $ 1,110 \text{ per acre} - $ 378 \text{ per acre} = $ 722 \text{ per acre}

“In-Shell” 2012 Price: $ 1.70 \text{ per pound}

“Crack Out” 2012 Price: $ 0.85 \text{ per pound}

“In-Shell”:

(2,800 pounds per acre x 100 acres) − ($ 378 per acre x 100 acres) = $ 427,000 Profit

“Crack Out”:

(2,800 pounds per acre x 100 acres) − ($ 1,110 per acre x 100 acres) = $ 115,800 Profit

1 ounce of Ammonium Carbonate = 28.349 grams

1 Teaspoon of Ammonium Carbonate = 3 grams

.3 in$^3$ of Ammonium Carbonate per teaspoon

Volume of Trap: $\frac{\pi x d^2}{4} = \frac{\pi x 1^2}{4} = 0.785 \text{ in}^2 + 12 \text{ in} + 17 \text{ in} = 22.765 \text{ in}^3$

Amount of Ammonium Carbonate Trap can hold:

$\frac{22.765 \text{ in}^3 \times \frac{1 \text{TSP}}{3 \text{ in}^3} \times \frac{3 \text{ grams}}{1 \text{TSP}} \times \frac{1 \text{ ounce}}{28.349 \text{ grams}} = 8 \text{ ounces}$
APPENDIX D

HUSK FLY TRAP PROTOTYPE PHOTOS