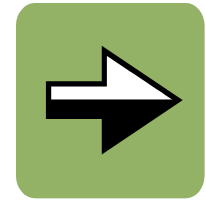


IRM GUIDE



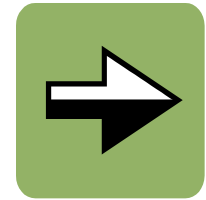
Helping Preserve Technology by
Protecting Against Insect
Resistance.

4 Score and 15 Years Ago....



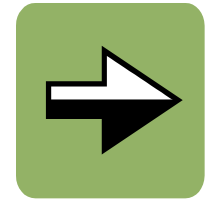
- What is B.t. (Bacillus thuringiensis) Technology?
 - It was discovered in 1911 by Ernst Berliner in Germany.
 - Bt is a naturally-occurring soil borne bacterium that is found worldwide.
 - A unique feature of this bacterium is its production of crystal-like proteins that selectively kill specific groups of insects.
 - These crystal proteins are insect stomach poisons that must be eaten to kill the insect.
 - Once eaten, an insect's own digestive enzymes activate the toxic from of the protein. The Crystal proteins bind to specific "receptors" on the intestinal lining and rupture the cells.
 - Insects stop feeding within two hours of a first bite and, if enough toxin is eaten, die within two or three days

Resistance



- ❑ Insects are known for their ability to rapidly develop resistance to certain insecticides.
- ❑ Resistant strains of insects require 30-60 times more toxins to kill 50% of a test population when compared with nonresistant strains.
- ❑ When a large portion of the European corn borer/corn rootworm population is exposed to the Bt insecticidal protein, more larvae carrying resistance genes could survive to adulthood.
- ❑ The overall population of Bt-resistant individuals increases with each generation.
- ❑ At some point, the resistant larvae will reach infestation levels in Bt corn fields similar to levels found in non-Bt corn fields.

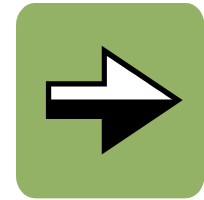
How to Stop Resistance



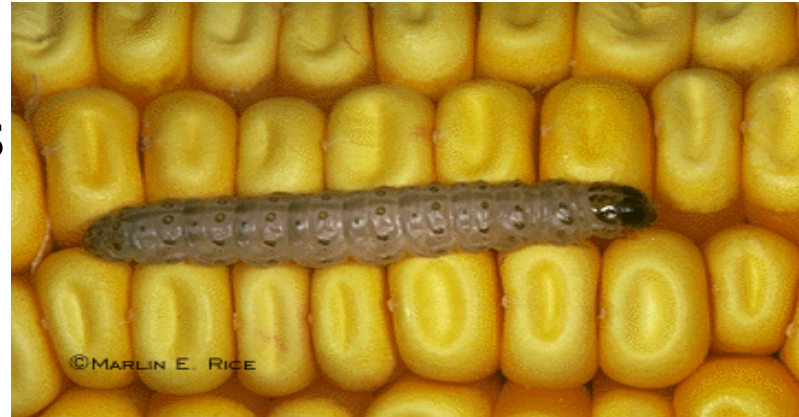
- Refuge!!!



What is a Refuge?

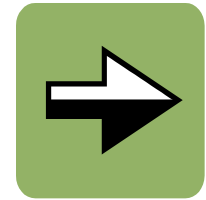


- ❑ A refuge is a block or strip of corn that does not contain a *Bacillus thuringiensis* or *B.t.* technology for controlling targeted insect pests.
- ❑ Use a refuge for:
 - European or Southwestern Corn Borer.
 - Western, northern, and Mexican corn rootworm.



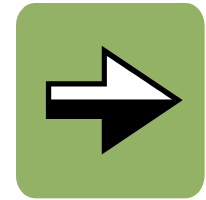
Top: European Corn Borer
Bottom: Rootworm Damage

Why Do I Need a Refuge?



- The primary reason is to maintain a population of corn insect pests that are not exposed to the B.t. Proteins.
 - Think about it. If your whole field is planted with a B.t trait, then future pest offspring will grow resistant to the trait. Making it ineffective.
 - In layman's terms...
 - Your insects will laugh at you while feasting on your crops because the technology will have no effect on them.

Why Do I Need a Refuge?



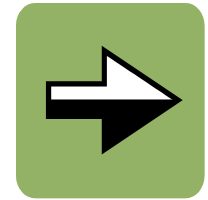
- With a Refuge. Nearby Insects that are susceptible to the B.t. technology will mate with resistant insects and pass the B.t. susceptibility on to their offspring.
- History shows that insects can build up resistance to B.t. insecticides.
- This will lessen the chance of future generations to become resistant to the B.t. Technology.
- **The MAIN reason to use a refuge is to stop insects from becoming resistant to Bt. Traits.**



Penalties for Not Planting a Refuge

- **The Penalty for not using a Refuge is a stiff one.**
- **If you do not use a refuge your field will be defenseless against Corn Borer and Root worm in the Future.**
- **Cotton growers must plant 50% of their fields as a refuge because resistance is too high!!!**
 - **They did not use a refuge in the past!**

Why Should I Plant a Refuge?

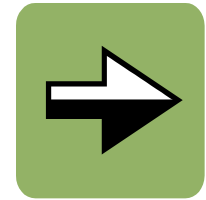


- Can my Neighbor be my Refuge?

NO!!!

But more importantly is the reason why!!!

What Happens If I Don't Plant A Refuge?



□ Minor Issues

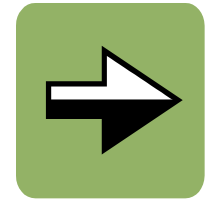
- Lose Opportunity To Buy Traited Corn From Seed Company that supplied you with seed
- Get Letter From Trait Provider saying you did not comply with refuge requirements.

□ Major Issue

- **You will Have Resistant bugs on your farm or the farm you rent!!!!**

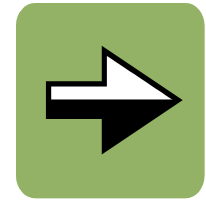
Note: The resistant bugs will most likely not be on your neighbors farm

So!



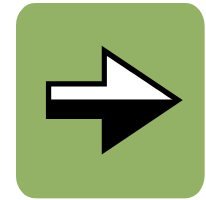
-
- The biggest Penalty I have for not planting a refuge is the build up of resistant bugs on my farm????

Herculex 1 or Yieldgard Corn Borer Refuge



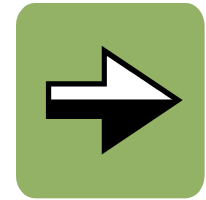
- ❑ 20% of your corn acres (this includes the total of the B.t. trait acres and the Refuge Acres) need to be planted with non B.t. for Corn Borer Traited corn.
- ❑ The Refuge must be at least ½ mile (1/4 mile preferred) within, adjacent to, or near B.t for Corn Borer Corn Fields.

Herculex Rootworm or Yieldgard Rootworm Refuge

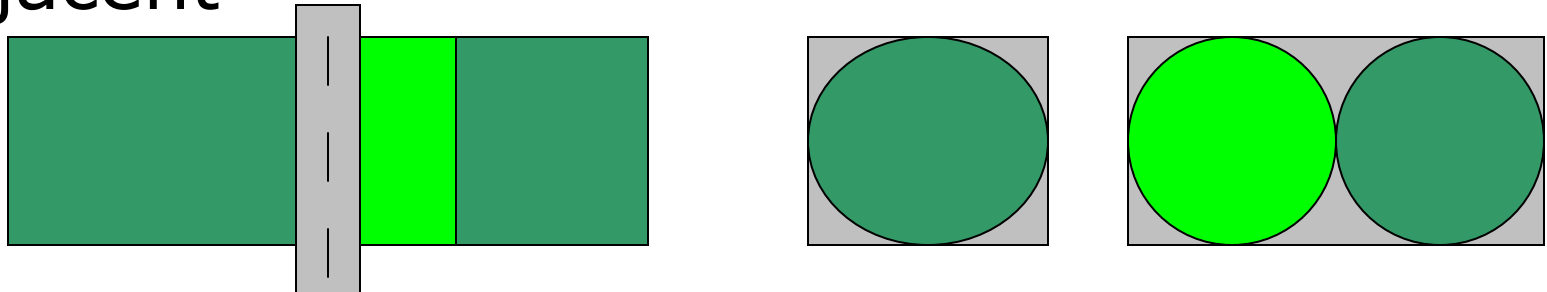




- ❑ 20% of your corn acres need to be planted with non B.t. for Corn Rootworm Traited corn.
- ❑ Plant the refuge within or adjacent to Herculex Rootworm or YieldGard Rootworm corn fields.
- ❑ The corn refuge can be separated by a ditch or a road but not by another field.
 - Now let's look at some examples of ways you can plant your refuge.

Examples of Refuge Planting



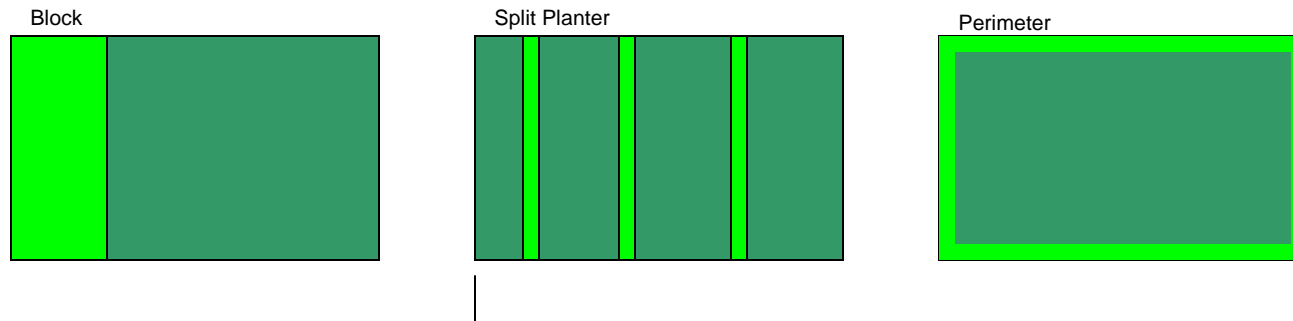
□ Adjacent -



 YieldGard Corn Borer
 Refuge

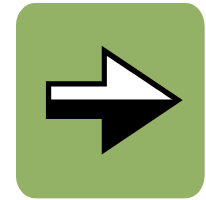
Separated by road, path, ditch, etc., but not by another field.

■ Within Field Configuration



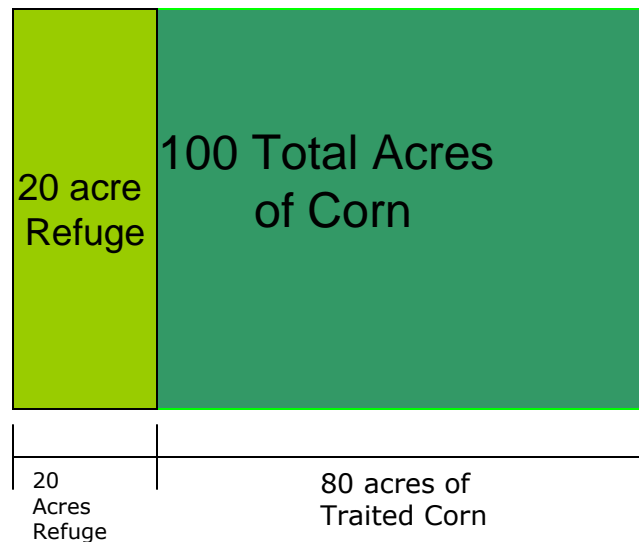
Minimum of 4 rows

Now for Some Math



- ❑ Let's say you have a 100 acre field to plant.
- ❑ You want to Maximize your potential for Corn Borer/Rootworm Protection.
- ❑ How much refuge will you need to plant?

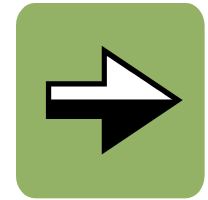
Answer: 20 Acres of Non B.t. Traited Corn



20 Acres is 20% of 100 Acres.



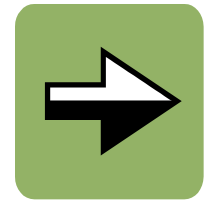
BE CAREFUL!!



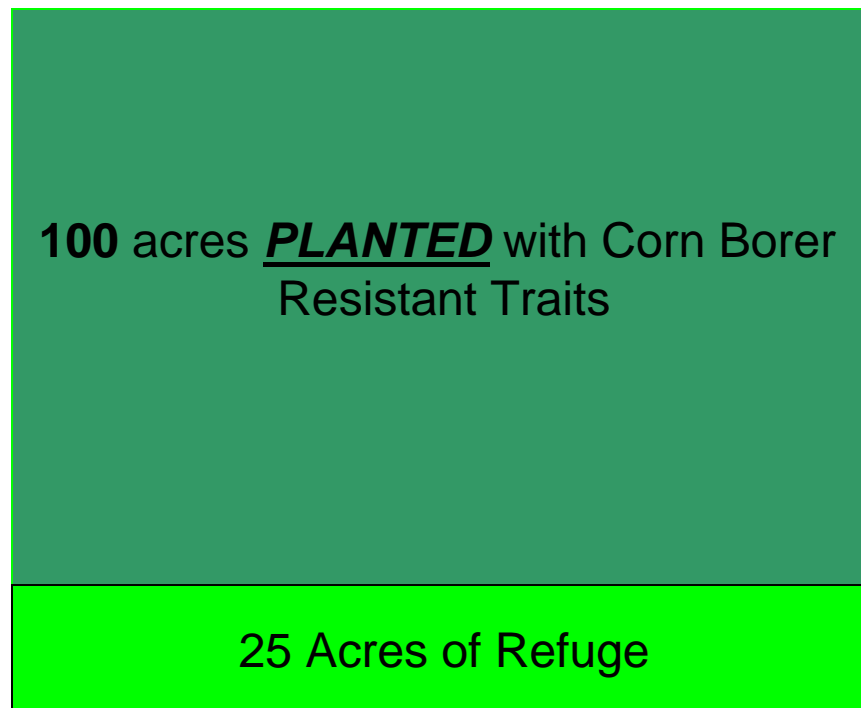
Here's where it get's tricky

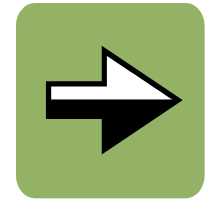


What if you have already planted all of your Corn Borer Traited Corn?



How much refuge is needed?





Why not 20 acres???

(isn't 20% of 100...20?)



Here's Why



100 acres **PLANTED** with Corn Borer Resistant Traits

25 Acres of Refuge

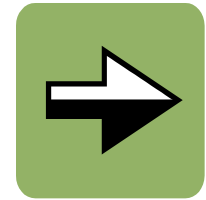
Remainder 75 Acres
Planted to Soybeans for
example.

If you are planting in addition to your Corn Borer Resistant Traited Corn, then you have to think of the TOTAL number of corn Acres you will be planting.

In this Scenario, you will be planting a total of 125 acres of corn.

20% of 125 Acres = 25 Acres

Here's How



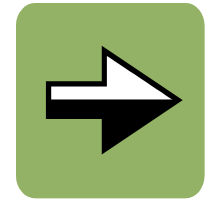
- Remember. You must have 20% of your **TOTAL** acres within the refuge field planted with Non-B.t. traited corn.
 - Try out this formula:

$$\begin{array}{rclcl} \text{B.t Acres} & + & \text{Refuge Acres} & = & \text{Total Acres} \\ \text{Acres Planted} & + & .2(\text{Total Acres of} & = & \text{Total Acres of corn} \\ \text{with B.t trait} & + & \text{corn to plant)} & = & \text{to plant} \end{array}$$

From our Previous example:

$$\begin{array}{l} 100 \text{ acres planted} + .2(x) = x \\ 100 \text{ acres planted} = x - .2(x) \\ 100 \text{ acres planted} = .8(x) \\ 100 \text{ acres planted} / .8 = x \\ 25 = x \end{array}$$

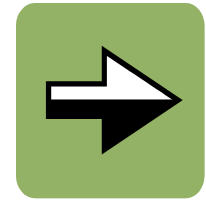
That's the long Boring Way



□ Try This

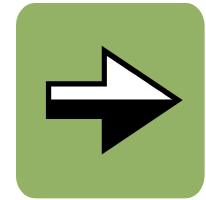
- Take the total number of Traited Corn Planted and divide that by .8.
 - $\text{Traited Corn Planted} / .8 = \text{Total Amount of Corn to Plant}$
 - This will give you the total amount of corn to plant.
- Then, Subtract the total number of traited corn planted from the total amount of corn to plant, and that is your refuge.
 - $100 \text{ Traited acres planted} / .8 = 125 \text{ total corn acres}$
 - $125 \text{ total corn acres} - 100 \text{ Traited Acres Planted} = 25 \text{ acres of Refuge.}$

How About 1 More Cheat



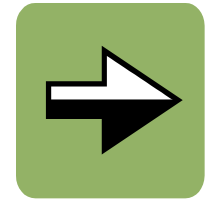
- This one is really easy.
 - Trait Acres Planted/4 = Refuge
 - From our Example:
 - 100 Trait Acres Planted/4 = 25 Acres of Refuge!!!

To Recap



- ❑ Plant a refuge on every farm where B.t. corn hybrids are planted.
- ❑ Plant the refuge at the same time as B.t. corn.
- ❑ Mixing non-B.t. seed with B.t. seed for use into the same row or planter box is not permitted.
- ❑ Adjacent refuge fields must be owned or managed by the grower.
- ❑ If the refuge is planted on rotated ground, then B.t. Rootworm corn must also be planted on rotated ground.

To Recap



- ❑ Any corn hybrid that does not contain a B.t. technology planted adjacent or within to the YieldGard Plus field can serve as a refuge for corn **rootworm**.
- ❑ Any corn corn hybrid that does not contain a B.t. technology planted within a ½ mile of the YieldGard Plus field can serve as a refuge for **corn borer**.