Using Genetically Modified Bacteria to Increase Crop Production and Eradicate the Number of Khapra Beetles Found on the Crops.

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Introduction

In our growing society, having a substantial amount of food to feed our booming population always seems to fall short. Khapra beetles are one of the main causes of crop destruction and have accounted for 70% of crop destruction. (*USDA APHIS | Khapra Beetle*, 2021) In order to maximize our food production, while maintaining our environment, I propose an experiment that should allow us to do both using genetically modified bacteria. Using a genetically modified bacterial species I will insert it into my chosen crops: corn, wheat, and rice. The genetically modified bacteria should not have negative effects on the crops; however, it should harm pests which tend to eat and destroy crops, mainly the Khapra beetles.

Hypothesis

If we introduce a new strain of genetically modified bacteria to corn, wheat, and rice then there will be no Khapra beetles found on those crops.

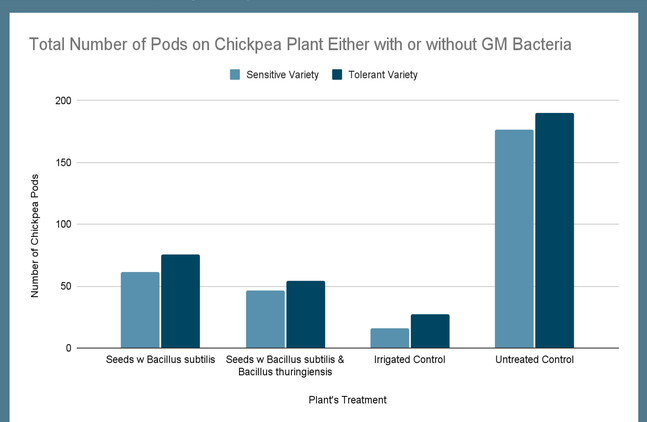
- Independent variable is the Bt bacterium that I will genetically modify and inject into my plants.
- Dependent variable is how many Khapra beetles will be found on the crops at the end of the experiment.
- My experimental group will be my corn, wheat, and rice crops that will have the genetically modified bacteria on them.
- My control group of my crops will not receive any of the genetically modified bacteria.
- Constants are the greenhouses where they will have the same amount of water and sunlight applied to them. Both groups will also be tested during one growing season and will be measured the same way after the experiment is over.

Literature Review

Since genetically modifying DNA was first experimented, people have been trying to genetically modify a countless number of things from plants to animals, and even a fetus in the womb. Genetically modifying bacteria has also grown some fame too. Scientists have changed bacteria's DNA for a host of reasons including antibiotic production and crop production (Azevedo & Araújo, 2003). However, bacteria can do more than just increase crops and antibiotic production. They can also be used to reduce harmful pests found on crops.

- Genetically modifying bacteria that are lethal to pests would cause a decrease in these pests, and therefore, there will be less pests destroying crops, and overall increase crop production.
- One important biopesticide is *Bacillus thuringiensis* (Bt). Bt produces proteins, called Cty toxins, that are toxic to insects when ingested (Amarger, 2002). When genetically modified, Bt can either increase the number of Cty toxins produced or increase the intensity of the toxins found within the proteins (Amarger, 2002).
- *Bacillus thuringiensis* has many advantages. For example, they are nontoxic to mammals, birds, and fish (Amarger, 2002). Since Bt is a biological pesticide and not a chemically, man-made one, insects are less likely to develop resistance to these bacterium (Amarger, 2002).
- However, Bt is unable to target specific insects and, therefore, its scope is relatively limited (Amarger, 2002).
- Khapra beetles are one of many pests that are detrimental to crop production, mainly grains (*USDA APHIS | Khapra Beetle*, 2021). They are pests that feed on grain plants, stored grain, and seeds.

The graph shows the number of pods found on Chickpea plants after one growing season. The untreated Chickpea plants did produce the most pods, however, the Chickpea plants with bacteria produced more pods than the normal, irrigated plants.



(Data for graph from: Khan et al., 2020)

Proposed Research Methods

My overall experiment:

- I will be genetically modifying *Bacillus thuringiensis* (Bt) to increase the toxication of the proteins be lethal to pests, specifically the Khapra beetles, applying the bacteria into the plant itself, and measuring the number of beetles on the plants at the end of the experiment.
- First start by using genetic engineering to genetically enhance the toxication of the proteins found in Bt. I will use genetic modification to interfere with the regulator promoter that stimulates the production of the Cty toxin.
- I will then inject the Bt bacteria directly into my chosen crops' stems.
- I will have two greenhouses, one that has my control plants and one with my experimental plants and will release 500 Khapra beetles in both greenhouses. Having two greenhouses will decrease the risk of the Bt contaminating the control plants, however, I will also provide a small section of different, packaged grains in my experimental greenhouse, so the Khapra beetles have something to eat.
- During the duration of the experiment, which will be one growing season or 90 days, I will water each corn, wheat, and rice crop with the same liter amount of water, three times a week and make sure they all receive the same amount of sunlight, 12 hours a day.
- My plants will all be the same age, which will be three weeks ago.
- There will be 50 crops each. 50 wheat, corn, and rice plants in both my experimental and control groups.
- Each week I will count the number of Khapra beetles on each of my plants, the number of dead Khapra beetles found in my greenhouse, and any bite marks or pieces missing of my plants. At the end of my experiment, I will count these numbers again.
- I will compare my results by comparing each crop individually with its control and experimental group.
- I predict that my experimental plants will have at least 50% less Khapra beetles found on them compared to my control plants.

Sources of error:

- One error in my experiment could be the Cty toxins not producing the desired amount of toxicity intended.
- Another error could be the plants not being able to grow properly with the Bt injected inside of them causing the plants to die.

I will take certain measures and precautions, however, to ensure that these errors do not happen.

- For example, I will thoroughly examine my Bt before, during, and after the genetic process to make sure that every step is going the way it should be.
- I will also monitor my plants very closely to make sure they are growing and behaving the way they should be.

Conclusion

Overall, this experiment could greatly change the way we use agriculture. Being able to use genetically modified bacteria to kill pests that cause damage and death to the main crops that are produced will cause an increase in crop production. Which in turn, could help the famine population of the world. However, this experiment can do more than just examine how Khapra beetles are affected by genetically modified Bt, it could also be an opportunity to see how Bt affects other pests and even other bacteria that could be used to decrease pests found on crops. This experiment will give us insight into what could get rid of agricultural pests altogether. Finally being able to rid the agricultural world would be a massive benefit to billions of people and could help in many ways.

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