The Export of Bacillus Thuringiensis to Nepal

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A little about Nepal

Nepal is a small country between China and India. It has a land mass of one-hundred-forty-thousand square kilometers and a population of approximately thirty thousand. That's only four million less than the population of Ontario and yet Ontario is seven times larger than Nepal. (Economy, 2015) There are three distinct geographical regions of Nepal. The first region in the South is the Teria which takes up twenty-three percent of Nepal's land mass. The people settled here are influenced by the Hindu culture. This area has a sub-tropical climate and consists of flat lands. The Teria is optimum for growing tropical fruits and fresh vegetables. The second region is located in central Nepal and is called the hill region and takes up forty-two percent of the total land mass. It consists of hills between six hundred and three thousand meters above sea level and has a climate between sub-tropical and warm temperatures. The settlements here are also mostly Hindu. The Hill region is ideal for Terrence farming with a maize and/or millet cropping system. It is however suitable for fruits and cash crops, as well as cattle. The third and final region found in the north is the Mountain or Himalaya area which takes up twenty-four percent of Nepal's total land area. It contains two-hundred-two mountains that are six-thousand to eight-thousand-fifty meters above sea level. This region has a climate between warm temperatures and alpine. The settlers here practice Tibetan cultures and mostly farm Barley, Buckwheat and Potato's. Yak and Chauries are native to Nepal but sheep, goat and hill cattle need to move to lower areas

during the winter months. Agriculture is a huge part of the Nepalese life. It employ's seventy percent of the population and accounts for thirty-nine percent of the GDP. The total land cultivated is approximately two-million-three-hundred-twenty-six-thousand hectors, this is point nine six hectors per person. Potatoes are widely grown across Nepal and one of the biggest problems with this crop is the Potato Beetle. (agriculture, 2011/2012)

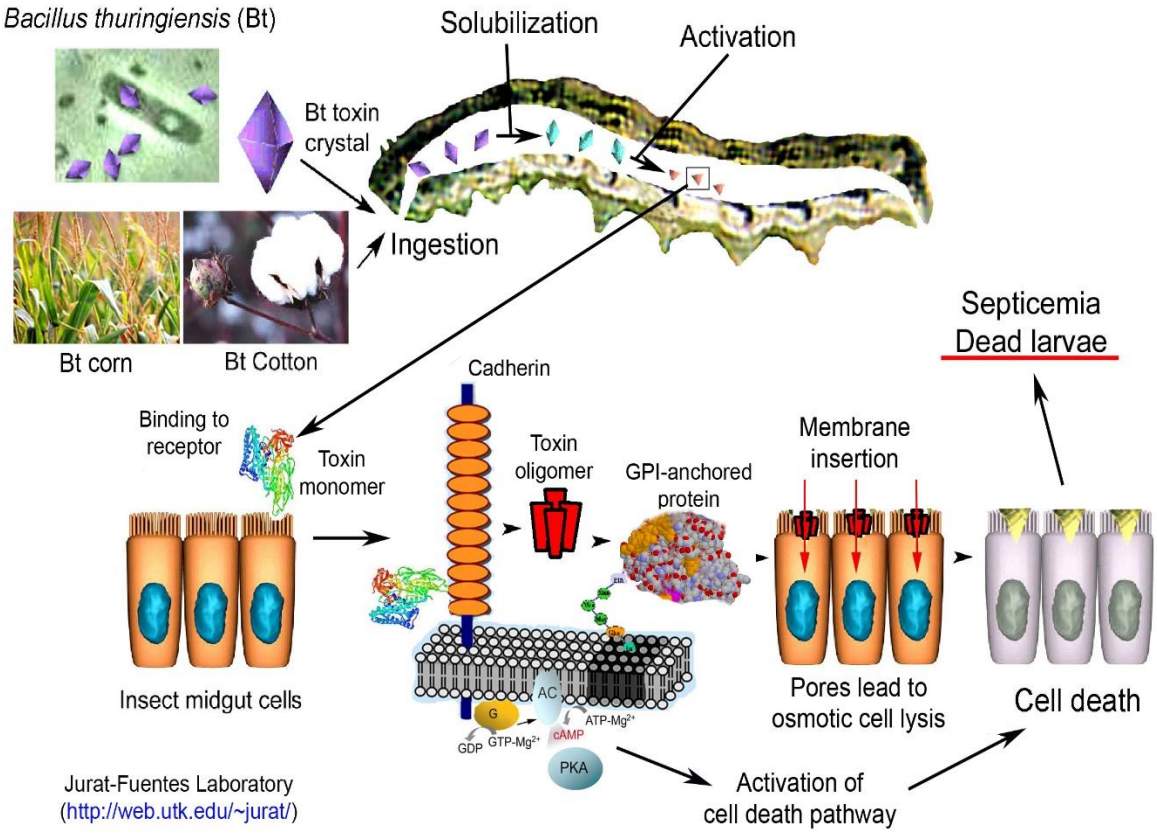
The Potato Beetle

The potato beetle is a small bug that lives off of the leaves of potato, tomato, eggplants and peppers. The adults will emerge in the spring after spending the winter in soil of fields and start eating as well as laying eggs. The females will start to lay eggs after a few days in the field. She will lay egg clusters between fifteen and twenty-five eggs, with approximately two-hundred-fifty eggs per female. Larva start out small but grow quickly molding during four different stages. The last of these stages is the largest and this is when the potato beetle eats the most foliage, though it spends its entire life eating leafs. After this fourth stage they will crawl back into the soil and emerge as adults. This process may happen anywhere from one to three times a season. (Grubinger, 2004) One of the best defensives against the potato beetle is Bacillus Thuringiensis var. San Diego. This bio pesticide will kill both the adult and larva of potato beetles after they ingest it.

Bacillus Thuringiensis var. San Diego

Bacillus Thuringiensis is a bacteria that when ingested will kill potato beetles and other insects that feed of the leaves of plants. When the bacteria reaches the stomach of the insects it will start to cause holes in the lining of their intestines which causes the Potato Beetles to stop feeding after a few hours and die after two or three days. The holes in the insects stomach is caused by a protein produced when resources are limited called Cry endotoxins. When the Cry endotoxins enter the insects intestines they bind to protein receptors called cadherin on the membrane of the gut. This causes a chain reaction as shown in the figure 1 bellow that results in the buildup of toxins and the ultimate demise of the Potato beetle. (Juan, 2015)

Figure 1: effects of *Bacillus Thuringiensis* on an insect



Bacillus Thuringiensis is applied using a spray over the leaves of plants. The best time for application would be in mid spring when the potato beetle is first emerging form the soil since it needs to be ingested to kill insects. There are certain alkaline metals that could harm *Bacillus Thuringiensis* and decrease effectiveness that can be found in some waters. To ensure the bacteria works the best it can water should be tested. If high levels of alkaline metals are found citric acid should be added to the water in order to neutralize the effects of the alkaline metals.

Koppert Biological Systems

Koppert Biological Systems is located in Scarborough Ontario. They were founded in nineteen sixty-seven and are one of the main producers of *Bacillus Thuringiensis*. They employ between 800-1000 people in Canada and export to sixty-one different countries. Their goal is to make agriculture more productive, healthier and safer for people and the plant. Rob Koppert the CEO of Koppert Biological Systems is focusing a lot of the companies resources in developing bio pesticides since it is a clean and effective way to reduce pests in crops. They have four main goals which are; pest control, natural pollination, seed treatment and resilient growth. They believe the best way to ensure success in agriculture is to educate everyone on all the major issues as best as possible. (Koppert, 2015)

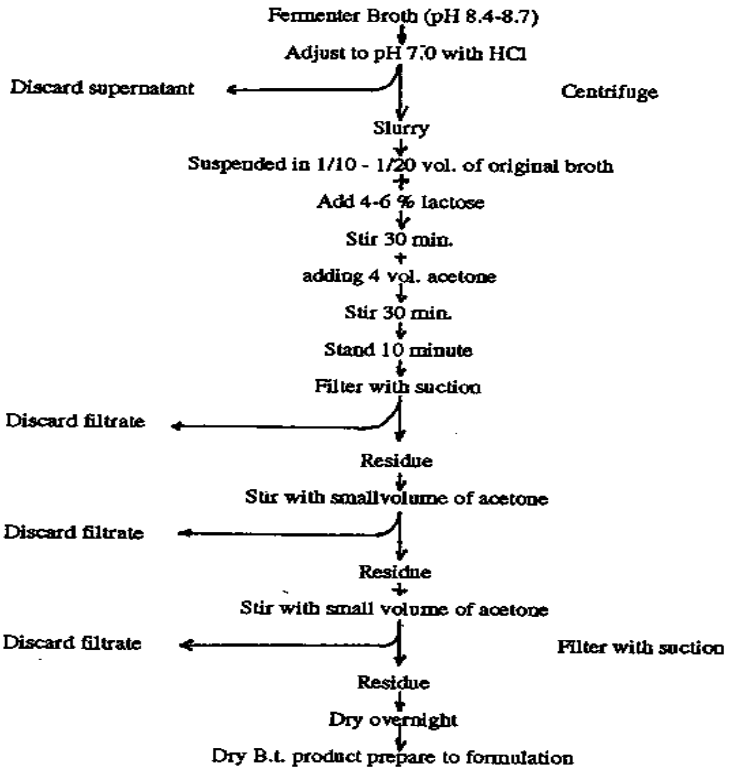
Other producers of *Bacillus Thuringiensis var. San Diego*

Green Methods is a company in the United States that produces the same product. Founded in nineteen-ninety-six by Mike Cherim, it is a major distributer of bio-insecticides. (Cherim, 2004) They produce a *Bacillus Thuringiensis* briquettes. However their product is used for mosquitoes not potato beetles. It costs eight dollars per puck. One puck per hundred square feet of water is used every four weeks. (Green Methods; your biocontrol and IPM resource , 2015)

Bacillus Thuringiensis var. San Diego Production Process

Bacillus Thuringiensis is produced using the technique found in Figure two below. The process starts with a Fermenter broth that contains the bacteria. The pH is changed to seven by the addition of hydrochloric acid. The liquid left after is placed in approximately one tenth the amount of broth used in the beginning. After four to six percent lactose is added and then filtered and the filtrate is discarded. The residue is stirred with a small volume of acetone then filtered again. The filtrate is discarded and the residue is left to dry overnight. Once this process is complete Dry *Bacillus Thuringiensis var. San Diego* is left and can be placed in solution for market. (John D. Nalewaja, 1970)

Figure 2; the production process of *Bacillus Thuringiensis*.



(John D. Nalewaja, 1970)

Bacillus Thuringiensis has a very low production costs. Approximately two point two pounds (one kilogram) cost seventy US cents which is equivalent to seventy-four point seven five Nepalese rupees. (Devi, 2005) After shipping *Bacillus Thuringiensis var. San Diego* would be sold for about three US dollars per two point two pounds (one kilogram) or three hundred and twenty Nepalese rupees. A farmer would need four point four pounds (two kilograms) per hector. (Ricardo Antonio Polanczyk, 2012) Since the average farmer in Nepal has point nine six hectors (Adhikary, 2004) it would cost them six hundred and twenty Nepalese rupees per year to use *Bacillus Thuringiensis var. San Diego*.

Bacillus Thuringiensis var. San Diego effects on health

Bacillus Thuringiensis does not have any ill effects for human beings. Since the Cry endotoxins need to bind to a specific enzyme humans do not have to start the reaction that causes holes in a stomach and eventually death. (Pesticide Information Project, 1994)

Bacillus Thuringiensis will not cause any damage to the environmental health either. It is a naturally occurring Bacteria that decomposes quickly after it dies leaving no trace in the soil. Also any animal besides the leaf eating insects will not be harmed by the pesticide. Other insects such as pollinators do not ingest the bacteria and mammals that may eat it do not have the enzyme needed to make Cry endotoxins deadly. (O'Callaghan, 2005)

Transportation of *Bacillus Thuringiensis* to Nepal

As shown in figure three bellow the product will be taken from Scarborough, Ontario to Ocean falls, British Colombia via the railroads. After it reaches Ocean Falls it will be shipped to Fuzhou, China. Then will travel be railroads to Nepal. Canadian National Railway Company or CN will be the company that takes the *Bacillus Thuringiensis* from

Scarborough, Ontario to Ocean falls, British Colombia. It will cost one-thousand-three-hundred-seventy-two dollars to transport one ton or one-thousand pounds of the product using CN Transportation services. (CN Intermodule prices, 2015)In order to move the Product from Ocean falls to Fuzhou Inscape shipping services will be used. They will charge three-hundred-two point eight four dollars per ton shipped and most also have the original invoice and an export code from the shipper. (ISS Cargo Servieces , 2015) Finally to get the *Bacillus Thuringiensis* from China to Nepal the product will trivial via railway. In total the overall price to ship from Scarborough Ontario to Nepal is one-thousand-six-hundred-seventy-two point eight four dollars per ton.

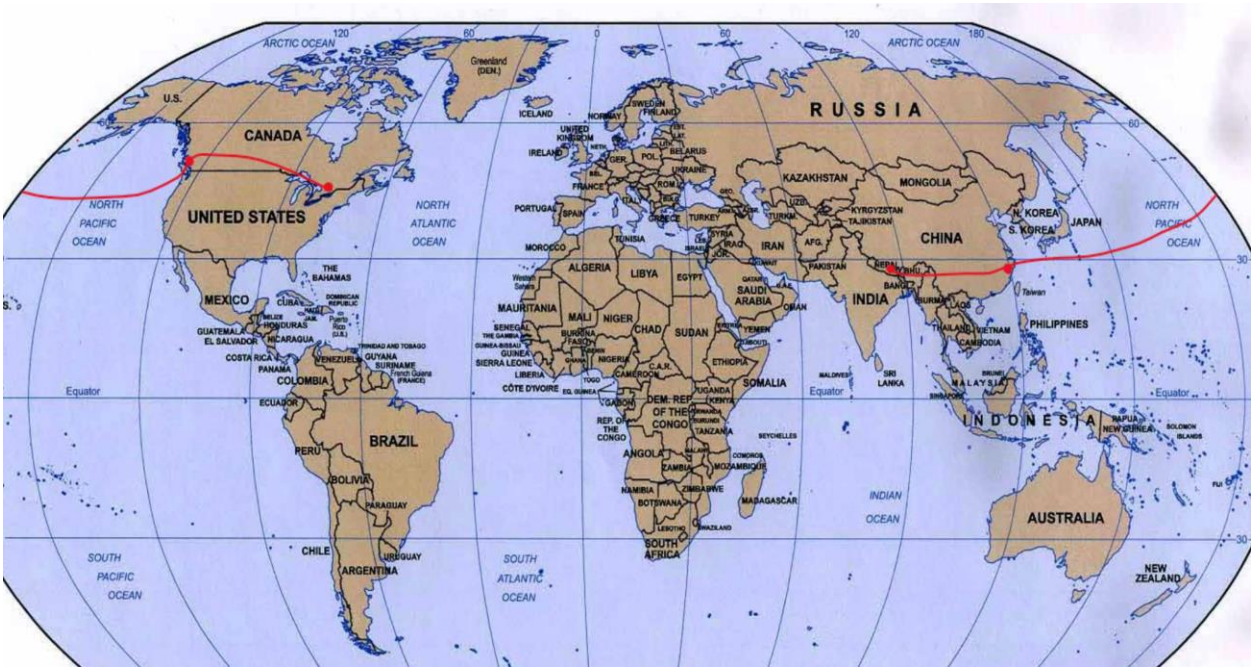


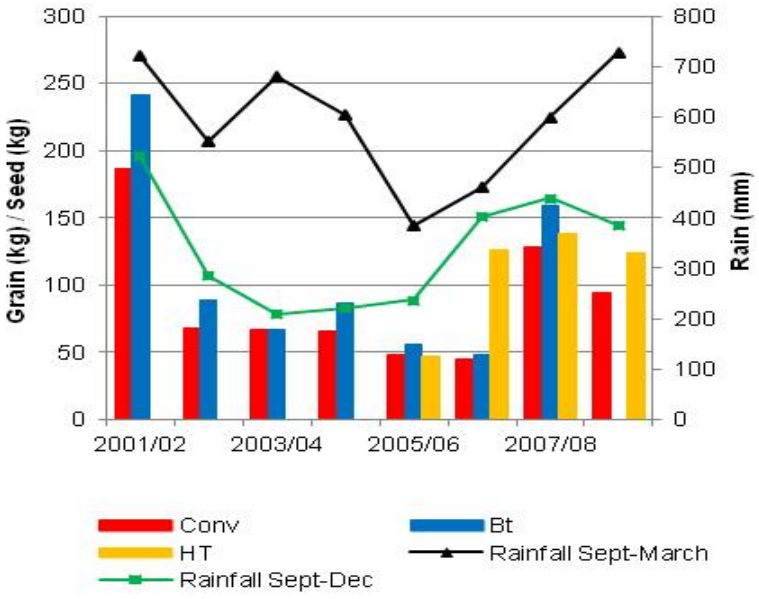
Figure 3; transportation route from Scarborough Ontario to Nepal (Brown, 2015)

Bacillus Thuringiensis var. San Diego Storage needs

Before shipping it should be kept in a cool dry place that is well ventilated and away from any sources of heat. (Bioscience, 2004) During shipping this product should be kept between two to eight degrees Celsius in a dark dry area. (ATCC, 2015) After purchased *Bacillus Thuringiensis* should be stored in a cool dry place and used within six months. (*Bacillus Thuringiensis*, 2004)

Benefits of *Bacillus Thuringiensis var. San Diego* to Nepal

Figure 4; effects *Bacillus Thuringiensis var. San Diego* has on the yield of crops



As Shown in figure four above *Bacillus Thuringiensis* causes a huge increase in the yield of crops it is applied to. (Gouse, 2012) It has an approximate thirty to forty percent increase on average for the potato plant. This would give a Nepalese farmer about nine hundred and seventy Nepalese rupees per acre. Another benefit of using *Bacillus Thuringiensis* is that unlike chemical pesticides the bio-insecticide will not harm any pollinators or helpful insects well killing the harmful beetles. Plus bio-insecticides do not harm the ecosystems unlike chemical pesticides the Nepalese farmers may use now.

Benefits of the export of *Bacillus Thuringiensis var. San Diego* to Canada

The export of *Bacillus Thuringiensis var. San Diego* out of Canada to Nepal will create jobs and increase the Canadian economy. There will be an increase of between 100-150 employees at Koppert Biological systems for research and production of *Bacillus Thuringiensis*. (Koppert, 2015) Also there will be more jobs in the railway and shipping yards. The Canadian economy will be helped by the extra income coming from Nepal as well as the new jobs allowing people to buy objects for luxury not just necessity.

In Conclusion

Bacillus Thuringiensis var. San Diego would be a very beneficial product to Nepal. Since the average Nepalese farmer makes eighteen thousand rupees a year it would only be three point four percent of their yearly income spent on this product. (Rural poverty in Nepal, 2013) However it would be difficult to get the product set up in Nepal as well as teaching the Nepalese when and how to use *Bacillus Thuringiensis var. San Diego* on their crops. Also this product is produced in China (King Quenson, 2015) making it less expensive for the Nepalese if they were to import from there instead of from Canada. Overall it would be a great product to sell in Nepal but may be better if it were to be imported from a closer country.

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