Use of Subsurface Drip Irrigation to Control Giant Borer (*T. Licus*) in Sugarcane is a Game Changer in the Viability of Growing Sugarcane in Northeast Brazil

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1. Introduction

What is Giant Borer?

Sugarcane is affected by several pests that can cause significant crop damage and economic damage, depending on the level of the pest infestation. Among these pests, Giant Borer (GB), *Telchin licus*, is one of the most important due to its damage to the sugarcane crop.
In Brazil, the incidence of GB has increased significantly, and the lack of control options is a cause for concern for sugarcane growers in the North-East region. Its presence was observed in the states of Acre, Alagoas, Amazonas, Bahia, Goiás, Maranhão, Mato Grosso do Sul, Minas Gerias, Para, Paraíba, Pernambuco, Rio de Janeiro, Rio Grande do Norte and Sergipe.

How GB Causes Crop Damage

In the first stage, the caterpillars drill into the cane stalk, causing considerable weight loss and eventually plant death. This drilling also facilitates penetration of fungi such as "podridão vermelha" which convert the sucrose into reduced sugars and damage cane quality. Plant damage caused by this pest can result in alarming rates of productivity decreases; reductions up to 65% have been observed (Mendonça 1973). In the second stage, the caterpillars seek to protect themselves by burying deep in the tunnels previously opened in the rhizome or between the roots.
Soon after the harvest, the caterpillars seal the tunnel entrance with food scraps (fibers). They then live hidden in the deepest and coolest part of the stalk, feeding on the rhizome. The stubble and the roots weaken and reduce germination vigor. In the ratoon cane, the caterpillars in search of food, work their way up the stalk and attack the shoots, penetrating several centimeters into the buds, destroying their vegetative pore, causing wilting and sometimes rotting of the apical bud.
Due to the poor nutritive quality of the infested tissues, the caterpillars pass successively and quickly to other shoots causing their death and the appearance of the “dead heart”, that is, death of the apical bud. The “dead heart” has at its base a gallery of about 10 mm in diameter which, when cut, appears generally clean and empty.

	
Healthy field treated by Altacor via sub surface drip	Nontreated field, severe damage by Giant Borer

2. **Infestation and Common Control Methods**

Transport of harvested, infested sugarcane can spread the pest to new fields. Phytosanitary inspection of transported cane, chemical, and, especially thermal treatments, are measures that can prevent the introduction of the pest into new regions.

During renovation of infested cane fields, the use of so-called “abolishing” equipment, combined with good soil preparation, are important practices for eliminating eggs, caterpillars and pupae and especially exposing the caterpillars to biological control, for example, carcarás (a bird of prey) help to eliminate them.

The most widely used method in infested areas in the Northeastern States of Brazil is physical destruction of caterpillars and pupae after manual harvesting, aiming at reducing their population. This process consists of introducing an iron rod into the hole left by the caterpillar and with circular movements the pest is crushed inside the gallery. Sixty to ninety days after this process, the field is again visited, now targeting the "dead heart" that is removed and examined. When the caterpillar or chrysalis is found, it is removed with the aid of adapted tools called “lurdinha” or “hoof” and stored in containers for later counting and disposal, usually by burning.

Apparently only the manual collection of caterpillars, pupae and the capture of adults with insect nets gives reasonable control results, but with low profitability. Although this practice is used throughout the year, due to labor shortages during the most critical times, significant increases in infestation may eventually occur.

Chemical control of this pest has not been effective so far due to the limited penetration of insecticide inside the cane clumps where the caterpillars are located.

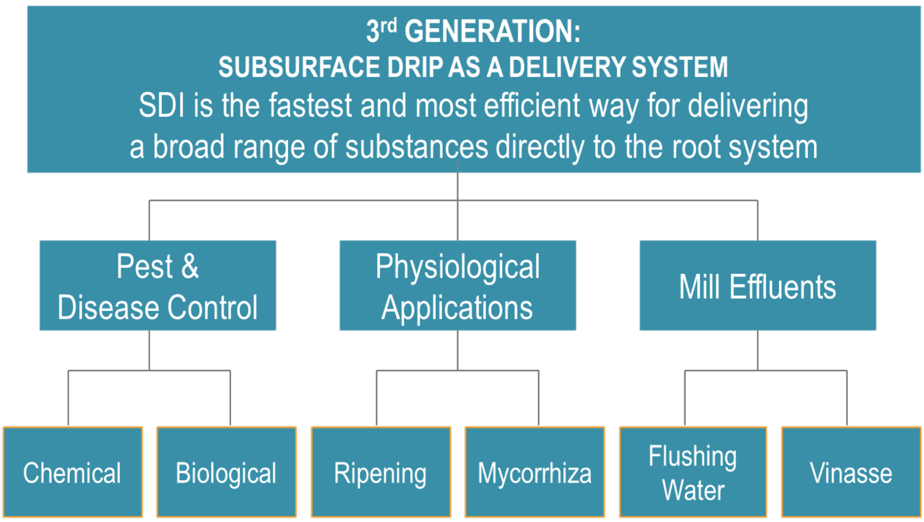
3. **Drip irrigation penetration in the Northeast Brazil sugar industry**

The northeast costal region is characterized by an average precipitation of 800 to 1,500 mm per year, concentrated between May and July; evapotranspiration is around 1,200 mm and soils are characterised by low water retention capacity. In this region irrigation of sugarcane plantations harvested "early" (harvests between August and October), deficit irrigation for sugarcane harvested "mid-season" (harvests between November and December) and full irrigation for "late" harvest cane. According to results obtained in recent years, drip irrigation (full irrigation) has become one of the main sources of revenue in the sector, showing an excellent cost-benefit ratio compared to other irrigation methods. Based on this fact, drip irrigation is growing rapidly in northeastern Brazil. According to the UNICA census, there are approximately 1.0 million hectares planted with sugarcane. Approximately 79% are irrigated, with an estimated 60% by big guns, 15% pivots for preservation or deficit irrigation and 15% drip for full crop demand irrigation.

4. Development of Drip as a Delivery System

Subsurface drip irrigation has been in use in sugarcane for almost thirty years. First it was developed for irrigation only. Later on, fertigation (application of fertilisers through the drip system) proved to be a highly effective solution. In recent years, a new and innovative use of subsurface drip for delivering a wide range of materials directly to the root zone is being developed.

The use of drip as a delivery system can be divided into 3 types or families of substance applications as shown in the diagram below:



Each type of application requires technical know-how to ensure success. While in fertilizer applications the quantities applied are relatively large (hundreds of kg per year) and in several applications, precision is a less significant factor. In pesticides. However, the dose is very small (can be less than 1 L/ha) and is often applied only once throughout the season. Therefore, any miscalculation can be critical.

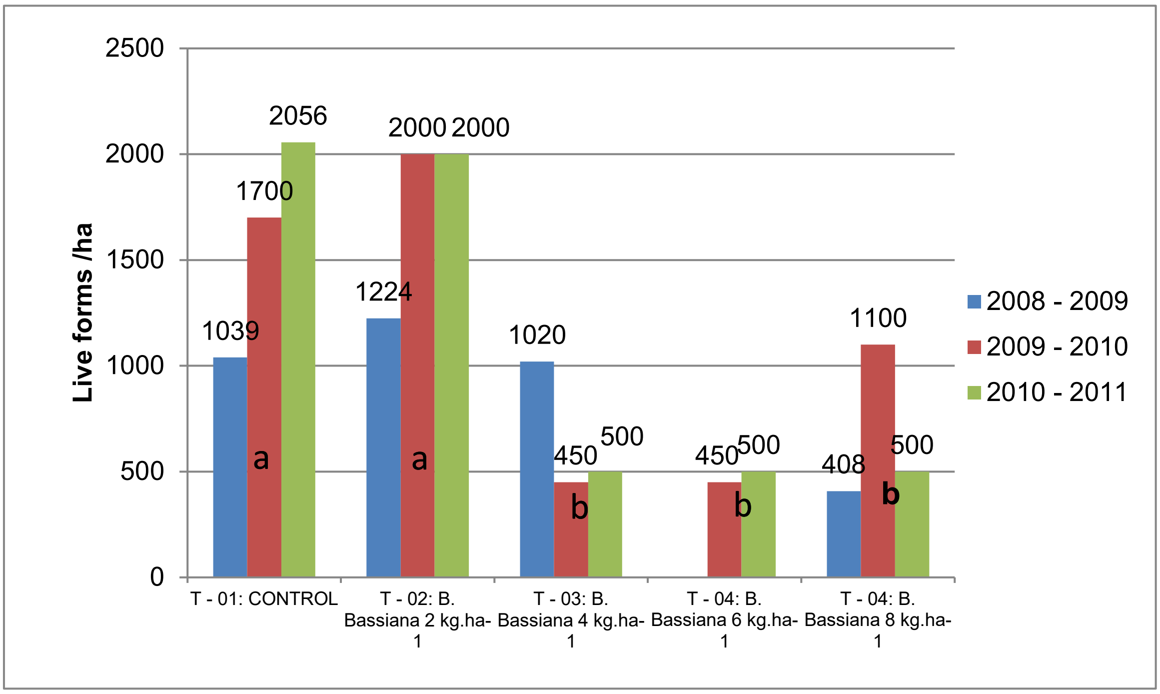
The use of subsurface drip for a broader range of applications also requires knowledge about how to calculate the dose and schedule it within the irrigation regime; how to distribute the substance uniformly through the drip system so that each emitter will discharge the same dose; and understanding the pattern of substance movement in the soil and its availability to the plant, mainly its leaching/adsorption properties. (Krontal, 2014)

Biological control of Giant Borer by application of Beauveria bassiana

In the northeast Brazilian sugarcane industry, the first trials to protect the crop against Giant Borer were done using biological control by injecting Beauveria bassiana fungus.

Beauveria bassiana is a naturally occurring entomopathogenic fungus that acts as a parasite of various arthropod species, causing white muscardine disease; when the microscopic spores of the fungus come into contact with the body of an insect host, they germinate, penetrate the cuticle, and grow inside, killing the insect within a matter of days. Afterwards, a white mould emerges from the cadaver and produces new spores. A typical isolate of B. bassiana can attack a broad range of insects; various isolates differ in their host range (Groden, 1999).

Application of B. bassiana spores via the drip system proved successful in doses of 4, 6 and 8 kg/ha and kept the number of Giant Borer specimens at half the untreated level.



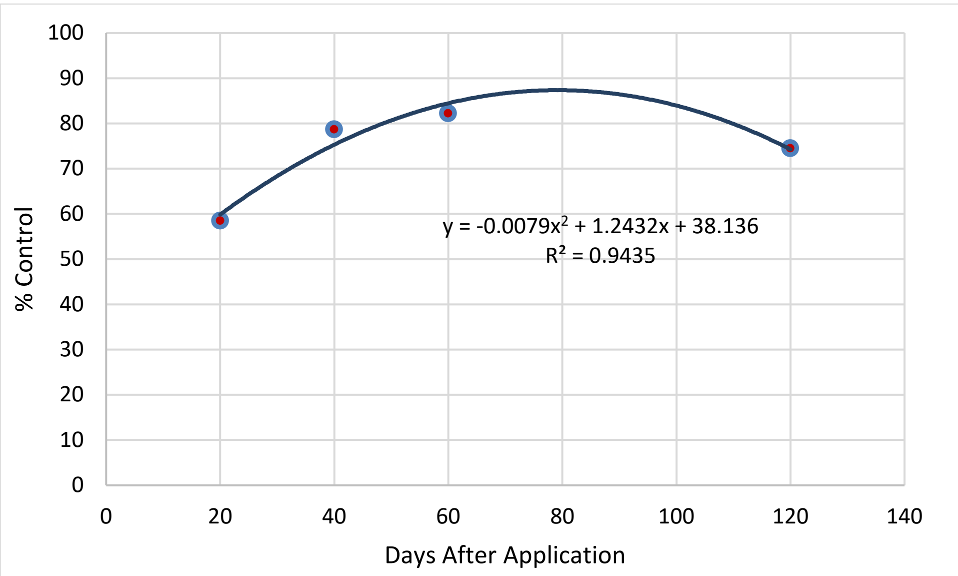
Level of live B. bassiana forms 90 days after application

This success is due to the fact that part of the pest's life cycle is in the soil. Since the adult borer lays its eggs in the soil, application of Beauveria bassiana spores through the drip system directly into the soil effectively brought the pest in contact with the disease inoculant. It may be even more effective to treatment 3 and 4 where B. bassiana were at lower infection rates (Garcia 2012).

Chemical control via Altacor (Rynaxapyr)

Altacor® insect control is an insecticide that when used early in the pest life cycle, prevents the build-up of pest populations. High larvicidal efficacy and long-lasting activity, rapid cessation of feeding, and excellent rainfast properties of Altacor insect control deliver nearly

immediate and long-lasting protection from damage under a wide range of growing conditions, even when circumstances prevent optimal application timing.
Altacor was first introduced in Brazil for Giant Borer control in 2010. One of its most important characteristics is that it can keep the sugarcane free of Borers for over 150 days.
Application of substances via subsurface drip irrigation requires certain chemical characteristics, such as the molecule will move in the soil and be taken up by the plant's roots. The main characteristics are:
KOC - defined as the ratio of pesticide concentration in a state of sorption, Altacor Koc is 241, which is in the optimal range.
DT50 - persistence describes the staying power of a chemical in maintaining its structure. Pesticides are degraded at different rates by soil microorganisms, chemical reactions, and sunlight. Altacor DT50 is 32.4 - also located in the optimal range.
These characteristics make Altacor a preferred product to be applied via drip with excellent results.
Studies of Altacor® application showed that dosages of 150 and 300 g/ha had similar results (70.7% control) and were better than the highest dosage, 450 g/ha (58.5% control). However, analyzing the remaining period until harvest, the dosage of 450 g/ha gave superior efficacy showing 78.7% (40 DAA), 82.2% (60 DAA) and 74.5% (120 DAA), and 92.1% at harvest. This is considered due to its long-term protection effect over time, which subsequently decreased new penetration of caterpillars (Garcia 2012).
The figure below shows the performance of Altacor® at 450 g/ha during 120 days after its application. This chart shows its maximum residue at 83 days after application (87.6%), decreasing until 120 days (74.5%). This reinforces its efficiency in reducing the pest population, even after 120 DAA.



5. Evidence from the field

In Japungu Mill located at the state of Paraiba, application of Altacor at a dose of 450 g/ha is a standard practice in all the drip fields (3000 ha) for the control of Giant Borer.

According to Alexandre Guerra, head of the irrigation department in the mill: "In the fields neighbouring the drip fields, that are only treated on planting with a dry formulation spread in the furrow, the Borer level varies from 10 to 15%. In comparison, the drip fields that can be treated by injecting through drip system have insect levels of only 3%".

Alexandre Guerra, Head of the Irrigation department

At the Japungu mill, the yields in the drip fields average 115 ton/ha while the rest of the mill averages 47 ton/ha (dry land and other irrigation systems). It is hard to isolate the effect of Borer control on the yield, but it can be estimated at 15 - 20 ton/ha. Alexandre also adds that: "Due to the success of the Borer control, application of Altacor is done today as a preventive measure in all drip fields every year immediately after harvest".

At the Porto Rico mill, located in Alagoas state the picture is similar. Antonio Carlos Fortes, Porto Rico mill irrigation manager, has managed to develop a method where he applies a dose of 450g/ha on planting, but in the ratoon crop he can reduce the dose to 300 g/ha.

"Before controlling the Borer via drip, the Borer level in the field was 33%. Today, with controlled application via drip the Borer level is only around 0.3%. This is also noted in the yields. In drip irrigation without Borer control the yields were around 91 ton/ha. After treating through the drip system, the yields rose to 138 ton/ha," said Antonio.

Antonio Carlos: Porto Rico Mill, Irrigation Manager

At the Seresta mill, also located in the state Alagoas, by using a dose of 450 g/ha the number of live forms found in the field after harvest was reduced from 7 to 0.

6. Summary

The average cost today of a liter of Altacor is around 1600 R$/l and the dose is 450g/ha, therefore, the cost of the product per ha is 720 R$/ha. Since it is applied through the drip system, there is basically no cost of application.
The current payment today for a ton of cane is 80 R$/ton. With an estimated additional 15 ton of yield, the income will increase by 1200R$/ha. Taking the cost (720R$) into consideration, the expected profit for the grower is estimated at 500R$/ha.
While in other irrigation methods the application is in the furrow with an additional application cost of 45 R$/ha and yield increase of 7-8 ton/ha, which is equal to 640 R$/ha income, viability of the whole operation is in doubt. Manual control which cannot increase yield but will keep the field from complete loss, is estimated in 1400R$/ha.

The economic viability as mentioned, can make a significant difference in the feasibility of growing sugarcane in the northeast region of Brazil.
Other applications, such as ripening regulators and disease controlling products, further broaden the use of drip systems to implement new growing techniques that are efficient and more environmentally friendly. Although each new application via the drip irrigation system necessitates pre-experimentation and method development, use of the drip system for application of most crop treatments could become a routine, convenient and sustainable application method.

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