The Benefits of Insecticide Use: Sugarcane

Sugarcane Borer Adult Moth

Sugarcane Borer Larvae Damage

Treated

Untreated

Sugarcane Borer Damage

Insecticide Spray Sugarcane

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Key Points

- The borer tunnels in the sugarcane stalks feeding on plant tissue and disrupting the flow of nutrients in the plant.
- Each sugarcane borer female lays about 200 eggs; there are four generations each summer, resulting in 202 million potential offspring from each female emerging in spring.
- In Louisiana in the 1920s the borer destroyed 20% of the sugarcane crop.
- Chemical insecticides provide about 90% control of the borer and deliver about $60/A in net return.

Technical Summary

Sugarcane is a giant perennial tropical grass that originated in Southeast Asia. Sugarcane is grown from cuttings which are laid in a row. It grows from late spring through the summer and must be cut before it is damaged by cold weather. The stalks are ground in a mill, this being the first step in the manufacturing of sugar. Domestic sugarcane production supplies about 37% of U.S. sugar consumption.

Louisiana is the top producing sugarcane state accounting for 42% of the nation’s sugarcane production. Sugarcane in Louisiana is grown on 455,000 acres resulting in an annual production of 21 billion pounds of sugarcane with a value of $260 million. The estimated cost of insecticides in Louisiana sugarcane is $24/A which represents about 4% of the cost of growing sugarcane [15]. Approximately 75% of Louisiana’s sugarcane acres are treated with insecticides. Approximately 2.8 billion pounds of raw sugar are produced annually by Louisiana sugar mills.

Growing sugarcane, a tropical crop, in Louisiana’s subtropical climate presents a number of problems. Sugarcane in a tropical setting requires at least 14 months to mature while in Louisiana it has only an eight month growing season.

In the 1720’s the French brought sugarcane plants to Louisiana to determine if a profitable crop could be grown there. After many failed attempts to grow the crop and produce sugar, the first commercial scale production of sugarcane in Louisiana began in 1796 with 100,000 pounds of sugar production. In 1891 the Louisiana sugar crop was 550 million pounds.

The sugarcane borer is the most damaging insect pest of sugarcane in Louisiana. The larvae hibernate in scraps of cane, stalks of large grass, cane stubble and planted cane. Only a small proportion (10%) which go into hibernation survive the winter [10]. Winter and spring rains and freezing conditions are primary mortality factors for the borers in hibernation. The adult moths emerge in the spring when the cane plants are small and deposit clusters of eggs on the leaves of the young plants. The eggs hatch and the small larvae feed on the leaves. The larvae are active from the time of emergence and almost immediately begin their search for food. Many of the larvae perish during this period partly because of their cannibalistic habits [10]. If 200 or 300 newly hatched larvae are
left together they will be reduced to 40 or 50 within two or three days. The smaller ones are eaten by the larger ones. It seems that the larvae usually are attacked when they are weak or inactive [10].

It is on account of its rapid rate of reproduction that the borer is able to inflict enormous damage. As many of the larvae are killed in the fall by the grinding of the cane and there is a high mortality in the winter, it is evident that comparatively few emerge in the spring [10]. Allowing 200 eggs for each female and four generations a year, each pair surviving the winter is capable of producing 202 million descendants [10]. If the offspring of just one female were confined to an acre, there would be 10,000 borers per stalk of cane [10].

The larvae bore into the stalks, develop, and emerge as adult moths; the cycle being repeated in four generations. The young larvae feed on the leaves for a few days and then bore into the plant where they feed on the central tissues. Thus, the growing shoot is gradually cut off and dies. In older plants, borers attacking the stalk near the top cut off the flow of food substances to that portion of the plant and it dies. The consumption of plant tissue by the borers and the cutting of vessels that carry plant food decrease the size and weight of the stalks as well as the amount of juice in the cane. Borers make tunnels up and down the stalk, sometimes gnawing their way out and reentering at another place. The feeding interferes with translocation of plant food substances. Thus, size and weight of the stalks are decreased as well as the amount of juice in the cane [1]. In an extreme infestation nearly every stalk will be bored several times and tunneled from end to end.

Losses in sugar yields where borer infestations are not held below the economic threshold average 13-15% [3].

The sugarcane borer is a native of the West Indies and Central and South America. It is believed to have been introduced into the U.S. about 1854 in a cargo of seed cane from South America. The borer attracted little attention before 1890 and not until 1900 did it inflict enough damage to be considered an important pest [1]. Beginning in 1912, estimates were made of the annual losses in Louisiana sugarcane caused by the sugarcane borer [10](Figure 1). Annual losses totaled 8-30% 1912-1925.

The special study of methods for control of the sugarcane borer in Louisiana was begun in 1925 when a severe outbreak caused the destruction of nearly one-third of the total crop in the state [9]. The assessment was that a practical and economical control measure had to be found if the cane-growing industry was to be preserved in Louisiana [20].

Attempts to control moth borers with biological agents have mostly involved introduction of exotic parasite species or rearing and release of native egg parasites, especially *trichogramma* species. Twenty-one species of exotic parasites have been released in Louisiana for sugarcane borer control. These parasites had been known to be parasitizing borers in the Caribbean Islands and South America. Though they attacked the borer in Louisiana, they subsequently died out and only one species has become established. It parasitizes less than 4% of the sugarcane borer population annually [6]. Reasons set forth for the failure of these parasites are that winter temperatures in Louisiana may be below
their survival limits and that there is not sufficient host population available in the winter to maintain parasite populations from one crop season to the next [6].

*Trichogramma minutum* is a small parasite which attacks the eggs of more than fifty insect species including sugarcane borers. *Trichogramma minutum* wasps are microscopic—about one-fiftieth of an inch long. In the fields, the female wasps search for borer eggs very soon after emergence. Finding a cluster, the female inserts her own eggs into the borer eggs. In the course of eight days, a new generation emerges, the parasite having developed from egg to adult within the borer egg [10]. The parasitic wasp eats the content of the borer egg.

Tests indicated that *trichogramma* wasps parasitized 3% of the borer eggs in March-April, 24% in May–June, and 89% in August-October [7]. The scarcity of host eggs in the winter depletes the stock of *trichogramma* existing in every cane field in Louisiana. The winter survival of *trichogramma* is possible but occurs in very limited numbers and the distribution of the wasps in the spring is exceedingly irregular and does not include all fields until late in August [9].

Attempts have been made to increase the usefulness of *trichogramma minutum* by breeding and releasing it in large numbers early in the year. Large-scale experiments to determine the value of mass releases of *trichogramma* were conducted in Louisiana in 1933-1935. Areas where parasites were released showed no increase in parasitism and no increase in yield per acre over similar areas in which no parasites were released. No way of increasing the effectiveness of *trichogramma* against borer is known [11].

For many years, it was believed that releases of *trichogramma* at rates of 5,000-10,000 per acre in the spring would provide sufficient parasitism. However, studies showed that this practice failed to provide control even when releases were made at rates as high as 43,000 per acre [12].

Prior to 1965 imported fire ant populations in many Louisiana sugarcane fields were severely suppressed by the use of heptachlor in the fire ant eradication program and by the use of endrin for sugarcane borer control. Crop damage more than doubled due to increased sugarcane borer populations following programs for fire ant eradication [3]. However with the discontinuation of the use of heptachlor and replacement of endrin with azinphos-methyl in the borer control program in 1964, colonies of the fire ant became much more numerous in sugarcane fields. The fire ant is one of the most beneficial borer predators in Louisiana sugarcane fields [4].

Plant breeders have produced some new cultivars that partially resist attacks from the borer. Plant resistance to the sugarcane borer is obtained through two physical characteristics that cause direct mortality and other sublethal effects to the young larvae: (1) Tight appression of the leaf sheath around the stalk to prevent larval movement (susceptible cultivars have leaf sheaths that loosen rapidly as the plant grows) and (2) premature hardness of the internode to reduce penetration and feeding [14]. A
susceptible variety received an average of 3.3 insecticidal applications for borers while a resistant variety averaged only 1.1 applications [13].

Sugarcane breeding programs often emphasized selection for disease resistance and made much progress, yet selection for sugarcane borer was minimized by the plant breeders on the premise that the pest was being effectively controlled with insecticides [16]. Research demonstrated that certain cultivars had a third less joints bored than more susceptible varieties [16].

Before 1993, sugarcane acreage in Louisiana was predominately planted to two cultivars of sugarcane, rated resistant and moderately resistant to the sugarcane borer (CP70-321 and CP65-357). In 1993, the high yielding cultivar LCP85-384, rated susceptible to the sugarcane borer was released and replaced the earlier varieties [17].

Cutting out and destroying first-generation borers in dead hearts of cane shoots was a fairly common practice before the cost of labor became so high. Laborers would go through fields and cut out plants showing a yellow dying condition of the inner leaves, since most of this damage is caused by borers. About 90% of the borers in a field could be destroyed by this method [18].

Insecticides historically have assumed a major role in control of sugarcane borer in Louisiana. The arsenicals were not used since they were ineffective against the borer. The larvae would push the arsenic particles aside before beginning to feed and less than 20% were killed [20]. The botanical compound ryania and the inorganic compound cryolite were recommended for sugarcane borer control since the early 1920s.

In large scale experiments with cryolite and ryania sprays, the average reduction in borers was 51% and the average increase in yield of sugar was 268 pounds per acre [11]. Ryania and cryolite were used on fixed weekly application schedules. This procedure often resulted in growers making 8 to 12 applications of ryania or cryolite at a cost of $24-30/acre [12]. Losses to sugarcane borers averaged about 15% during the period 1935-1958 [21].

Replacement of ryania and cryolite with synthetic organic chemicals greatly improved sugarcane control programs in Louisiana. The average number of insecticide applications per field of sugarcane was reduced from 12 to 2 [14].

Endrin was first recommended for control of the sugarcane borer in 1958. Endrin treatments provided 90% control of borers with a two week residual increasing sugar yields by 1000 pounds per acre [5]. Endrin provided effective control of borers for approximately five years before problems with resistant populations became acute [2]. Organophosphate insecticides replaced endrin to control the sugarcane borer. Research indicated that azinphos methyl provided 90% control with sufficient residual to permit 2 to 3 weeks interval between applications with an increase of 1000 pounds of sugar yield per acre [2][8]. Tebufenozide is currently the most widely-used insecticide in sugarcane in Louisiana.
Yield increases of 5 to 9 tons of cane per acre were obtained following 3-4 applications of endrin or azinphos methyl [6]. Based on a value of a ton of cane in Louisiana ($11), growers realized savings of $50-100 per acre in yield increase by applying insecticides which required maximum expenditures of less than $10/A for endrin or $15/A for azinphos-methyl [6]. In a recent experiment, it was estimated that in the untreated sugarcane there were 65,000 sugarcane borer exit holes per acre while in the insecticide-treated area the number of exit holes was 556/A [19].

A 5% stalk infestation criterion is used in Louisiana as the treatment threshold for sugarcane borer. 75% of Louisiana sugarcane is scouted by professional pest management consultants who monitor the pests and determine if the 5% infestation level has been reached. It is believed that the other 25% of the acreage is scouted by the farmers themselves.

Population regulation of sugarcane borers during the growing season relies on three principal components: varietal resistance, insecticidal control, and natural enemies.

A three year experiment determined that control of sugarcane borer populations during the growing season was accounted for by predation (16%), varietal resistance (24%) and insecticides (60%) [13].

References


Figure 1. Losses in Louisiana Sugarcane Caused by Sugarcane Borers

Source: [10]