SIXTEEN YEARS OF BIOLOGICAL CONTROL OF *Diatraea saccharalis* (FABR.) (LEPIDOPTERA: PYRALIDAE) BY *Cotesia flavipes* (CAM.) (HYMENOPTERA: BRACONIDAE), IN THE STATE OF SÃO PAULO, BRAZIL

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ABSTRACT

Sixteen years after starting a biological control program of the borer *Diatraea saccharalis* (Fabr.) based on massive production and systematic releases of the introduced parasite *Cotesia flavipes* (Cam.), embracing about 2 millions ha (São Paulo state, Brazil) the parameters infestation intensity (I.I.) and parasitism were evaluated. Parasitism was continuous and crescent and in overall, average infestation intensity decreased from 6.64% to 3.70%, in the period from 1975 to 1990, indicating the success of the program.

KEY WORDS: Insecta, biological control, sugarcane borer, parasitoid.

RESUMO

Dezesseis Anos de Controle Biológico de *Diatraea saccharalis* (Fabr.) (Lepidoptera: Pyralidae) por *Cotesia flavipes* (Cam.) (Hymenoptera: Braconidae) no Estado de São Paulo, Brasil

Dezesseis anos depois de iniciado um programa de controle biológico da broca *Diatraea saccharalis* (Fabr.), baseado na produção massal e liberação sistemática do parasitóide alienígeno *Cotesia flavipes* (Cam.), envolvendo uma área aproximada de dois milhões de hectares de cana-de-açúcar (Estado de São Paulo, Brasil), os parâmetros intensidade de infestação (I.I.) e parasitismo foram avaliados. No período analisado, de 1975 a 1990, o parasitismo foi crescendo e a intensidade de infestação média da praga decresceu de 6,64% para 3,70%, indicando o sucesso do programa.

PALAVRAS-CHAVE: Insecta, controle biológico, broca da cana-de-açúcar, parasitóide.

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INTRODUCTION

Brazil is one of the most important producers of sugarcane and alcohol in the world. The state of São Paulo, with a sugarcane area of about 2.2 millions and production of 125 million tons. of cane in 1991, 4.5 million tons. of sugar and 8.4 millions m^3 of alcohol, is the most important region where sugarcane is grown.

Diatraea saccharalis (Fabr.), the common borer, with average infestation intensity (I.I.) in 1983, of 7.5% considering direct losses (dead of stalks and weight reduction) and indirect ones (raw-material deterioration) which were estimated in US$ 100 millions annualy, was considered the most important pest in that region (Macedo & Botelho 1986). A program of biological control based on massive production and systematic releases of the parasitoid *Cotesia flavipes* (Cam.) (formely *Apanteles flavipes* (Cam.), started in 1975, and results obtained ten years later, showed that biological control through *C. flavipes* according to Planalsucar methodology was successful. Despite favorable factors for pest attack, such as expansion of the cultivated area and increasing planting of susceptible varieties, in that period, according to those same authors, the program was a real contribution to pest reduction.

Paratheresia claripalpis (Wulp). with a specific parasitism rate of 5.0% followed by *Lixophaga diatraeae* (Tns.) (0.6%) and *Metagonistylum minense* (Towns.) (0.2%) the braconid *C. flavipes* is exerting control of, *Diatraea* spp. in Trinidad (5.0 - 10.0%) (Mahadeo 1991). From parasites reared and releases, the overall parasitism rate has been within a range of 16.3 - 23.5%. This has resulted in a gradual reduction of the pest damage from 16.9% recorded in 1984 to 5.7% in 1987. Computer predicton analysis indicated a reduction in *Diatraea* spp. damage below the accepted economic threshold of 5.0% from 1987 to 1989. This paper deals with an evaluation of sixteen years analysis of biological control of *D. saccharalis* by *C. flavipes* in the state of São Paulo, Brazil.

MATERIAL AND METHODS

Percentage of infestation intensity (I.I.) of the pest was calculated from fields survey carried in different ecological regions of the state of São Paulo. In each of these fields, five sugarcane shoots, from 5 to 6 months of age, were monthly collected and the I.I. calculated using the formula: I.I. = 100 number of bored internodes/total number of internodes. In addition, the number of dead stalks (D.S.%) due to pest attack was recorded. The fields were distributed in the unit taking into consideration time of harvest, variety and type of soil; each plot represented a maximum of 500 ha. For the calculation of the average I.I. the data were pooled according to the proportion of each field in the total production of the state of São Paulo.

Parasitism index in the areas that did not receive releases of the parasitoid *C. flavipes* was calculated in at least six different places. These collections consisted of examining sugarcane plots to find the pest and its parasitoids. The material collected was identified and the percentage of

parasitism calculated. Parasitism index in the areas that received parasitoid releases of *C. flavipes* was also calculated, where at least, 20 larvae/labor-hour, were collected. In these fields an average of 5000 adults (males + females)/ha were released to assure a good distribution of the material in the plots. New collections of biological forms of the pest were made 20 to 25 days after the releases. These data where used to calculated the % parasitism in the area, as follows: Parasitism = 100 x parasitoids total/parasitoids total + pest.

The number of parasitoids was obtained after breeding out all the individual larvae collected in the field, to determine if they were parasitized. The live and empty pupae (either of wasps or flies) and the empty cases found in the field were also taken into account. For 1990, all evaluations were based on data from three units, São Luiz, São Martinho and Ester Sugar Mills.

The evaluation of the biological control program was made through parameters collected on all over the state for two situations: Areas where *C. flavipes* were not released; areas where massive quantities of *C. flavipes* were released during 1975 to 1984; and during 1985 to 1990.

RESULTS AND DISCUSSION

The first period (1975 to 1984) was analysed and showed that during this period, while sugarcane area increased by 246%, the I.I. and D.S.% were relatively stable, during the years 1975 to 1978, followed by a large increment in 1979 and 1980, continued with a significant decline from 1981 to 1984 (Table 1).

Since the I.I. represents the pest population level and is a result of the interaction of two considered factors (area expansion x parasitoids action), there is evidence that the increasing impact of parasitoids (13.77% in 1975 to 21.19% in 1984), is the main factor mitigating the pest population. The total parasitism was higher than that obtained in the areas without releases, due basically to, the action of *C. flavipes* (Table 2).

The increasing performance of *C. flavipes* from the first releases until 1984 can be seen from data of biological control situation in three production units (Fig. 2A, B, C). According to the Planalsucar methodology the biological control of *D. saccharalis* through systematic releases of *C. flavipes* was successful. In the second period (Tables 1,2, Fig. 1) the performance of *C. flavipes* was continuous and crescent: 3.84% in 1984 to 10.38% in 1989 and, 20.78% in 1984 to 44.83% in 1989, for areas without and with systematic releases, respectively. These data indicate the widespread of the parasitoid in the field, as a result of its adaptation with increase of total parasitism in both areas (21.19% to 1984 to 33.77% in 1989 and 36.91% in 1984 to 57.76% in 1989). The cultivated sugarcane area in the period was stable, but some susceptible varieties have been cultivated. Interactions of all factors, lead to a decrease of the I.I. from 6.49% in 1984 to 3.70% in 1989. Taking the same units as example (São Luiz, São Martinho and Ester sugar mills), the high performance and the success of the parasitoid in the control of *D. saccharalis* is evident (Fig. 2A, B, C). The analysis of this second period

Tabela 1. Parameters used to evaluate *Diatraea saccharalis* attack and the performance of the parasitoid *Cotesia flavipes*, in sugarcane areas that did not receive release of this parasitoid in São Paulo State.

Year	Sugarcane area (ha)	Sampling			Attack evaluation		Total of biological forms	Parasitism evaluation				
		Reg.	Unit	S.F.	I.I.	D.S.		*C. flavipes*	*M. minense*	*P. claripalpis*	Others	Total
1975	759,900	07	09	261	6.64	N.C.	N.C.	N.REC.	7.64	6.06	0.07	13.77
1976	890,500	08	11	321	6.78	N.C.	N.C.	*	13.33	4.24	0.15	17.72
1977	927,600	08	12	358	6.28	0.60	N.C.	**	12.64	1.86	0.19	14.69
1978	1,053,300	08	15	471	5.66	0.52	10.689	0.13	7.67	2.00	0.28	10.08
1979	1,145,700	08	16	463	8.79	0.86	12,303	0.85	11.79	2.53	0.42	15.59
1980	1,217,900	08	15	461	9.23	0.52	26,859	1.25	9.81	4.08	0.82	15.95
1981	1,346,500	08	17	569	7.80	0.66	58,567	2.40	9.18	4.54	0.93	17.05
1982	1,634,700	08	19	590	7.67	0.58	46,180	2.60	13.43	7.57	0.55	24.15
1983	1,836,800	08	19	550	7.49	0.27	47,321	1.87	11.21	6.20	0.69	19.97
1984	1,870,300	08	24	-	6.49	-	36,033	3.48	12.81	3.98	0.92	21.19
1985	2,000,950	08	21	-	5.61	-	46,175	5.09	8.57	6.07	0.85	20.57
1986	2,041,800	08	22	-	5.09	-	53,868	8.83	10.69	9.53	0.62	29.67
1987	1,941,900	08	24	-	6.14	-	27,097	18.30	10.14	10.43	1.10	39,97
1988	1,941,900	08	24	-	4.27	-	20,185	16.05	6.95	6.30	0.25	29.55
1989	1,900,000	08	24	-	3.70	-	16,785	10.38	12.73	9.86	0.40	33.37

(*) Recuperation in 4 different locals.
(**) Recuperation in 8 different locals.
N.C. = Not Computed.
D.S. = Dead sugarcane.
S.F. = Survey fields.
N.REC. = Not recorded.

Table 2. Paramenters used to evaluate the performance of different native parasitoids and of *Cotesia flavipes* in areas that received systematic releases of this parasitoids, in São Paulo State.

Year	*C.flavipes* released	Protected area (ha)	Biological forms collected	Parasitism					
				M. minense	*P. claripalpis*	*C. flavipes*	Others	%Participation *C.flavipes*	Total
1975[1]	27,104	5.4	-	-	-	-	-	-	-
1976[2]	197,089	40.0	-	-	-	-	-	-	-
1977[3]	6,430,624	1,286.0	-	-	-	-	-	-	-
1978[4]	50,427,609	10,086.0	21,555	11.08	0,73	6.08	0.39	33.26	18.28
1979	97,969,820	19,594.0	15,721	17.80	0.41	8.33	0.22	31.13	26.76
1980	120,902,816	24,180.0	20,184	8.66	1.29	9.96	0.52	48.75	20.43
1981	171,097,958	34,220.0	52,936	6.06	2.17	19.63	0.53	69.14	28.39
1982	213,526,300	42,705.0	57,357	9.80	2.54	26.82	0.51	67.61	39.67
1983	332,058,400	66,412.0	113,491	12.93	1.42	20.22	0.48	57.69	35.05
1984	510,697,850	102,140.0	121,270	13.20	2.26	20.78	0.67	56.30	36.91
1985	855,035,550	171,007.0	226,293	8.45	6.68	19.98	1.85	54.06	36.96
1986	962,709,800	192,542.0	218,735	5.69	6.72	26.26	1.12	65.99	39.79
1987	926,406,750	185,282.0	127,956	4.73	7.08	37.89	0.53	75.43	50.23
1988	908,203,650	181,691.0	87,194	5.02	5.56	30.85	0.56	73.47	41.99
1989	755,331,150	151,066.0	45,291	5.61	6.93	44.83	0.39	77.61	57.76

[1]Beginning of the releasing with material from Alagoas State (Brazil).
[2]Beginning of the local production and of the recuperation (4 locals).
[3]Recuperation in 8 different locals.
[4]Import of new "strain" - India and Pakistan.

stresses the conclusions of the first period and allows to state that the sixteen years of biological control of *D. saccharalis* by *C. flavipes*, in the state of São Paulo is one of the largest and successful program in the world.

Results of comparative studies carried out in 24 sugar mills in São Paulo, which maintain sugar borer biological control through systematic releases *M. minense*, *P. claripalpis*, and *C. flavipes* have shown that in average infestation intensity decreased from 9.90 in 1980 to 3.30 in 1990 (Copersucar 1991). This allowed an estimated recuperation of US$ 37.5 millions, in cane, sugar and alcohol. Millions of dollars have been saved annually through reducing attack of the sugarcane borer, no chemical use to control the pest, the environment has been preserved, and new sugarcane varieties, which would not be cultivated due to its high susceptibility to the borer, are being growing, with greater profits for producers. The results proved that the biological control program of *D. saccharalis* applied in the most important sugarcane areas in Brazil, through systematic and massive releases of *C. flavipes* is successful.

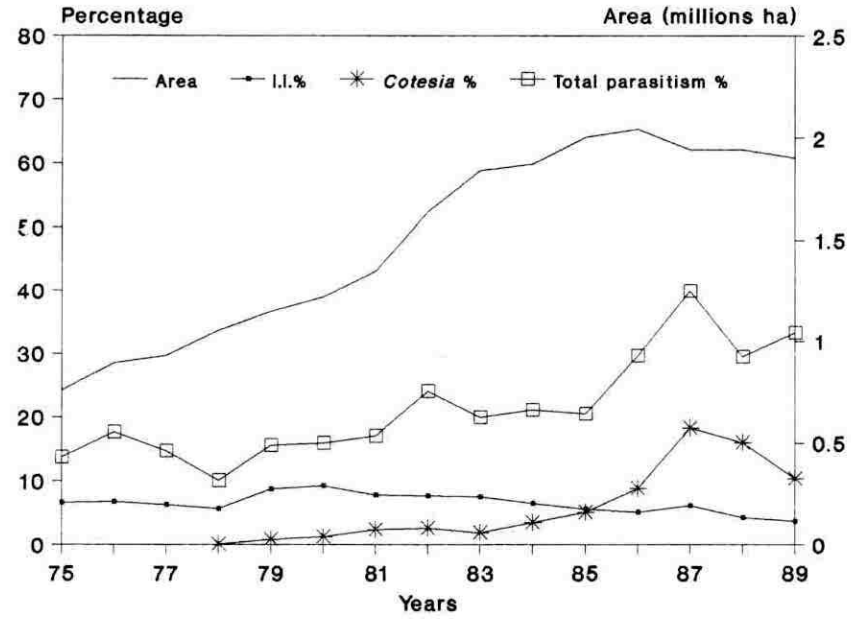

Figura 1. Comparative evolution of the area planted with sugarcane, infestation intensity of *Diatraea saccharalis*, total parasitism and parasitism of *Cotesia flavipes* in São Paulo state.

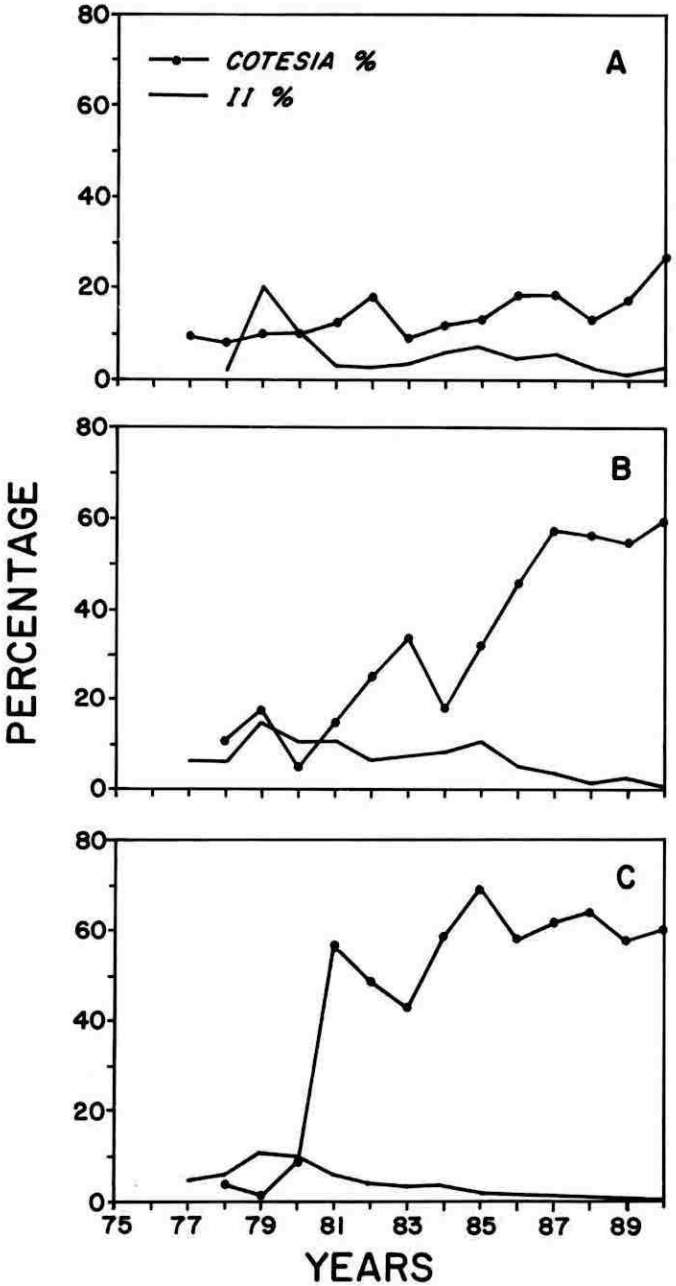

Fig. 2. Fluctuation of the *Cotesia flavipes* parasitism and of the infestation intensity of the sugarcane plant of São Luiz (A), São Martinho (B) and Ester (C) Sugar Mills.

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