SHORT COMMUNICATION

NATURAL CONTROL OF WOOLLY APHID BY *ENCARSIA FLAVOSCUTELLUM* PREVENTS YIELD AND QUALITY LOSS IN SUGARCANE

J. Srikanth*, B. Singaravelu and N.K. Kurup

Abstract

Encarsia flavoscutellum Zehntner (Hymenoptera: Aphelenidae), the parasitoid introduced into tropical India for the control of sugarcane woolly aphid Ceratovacuna lanigera Zehntner (Homoptera: Aphididae), reduced the host populations by restricting their spatial and temporal spread. To assess the impact of such transient aphid populations on the crop, yield and juice quality parameters, marked canes from crop patches attacked during the grand growth period were examined at harvest with unattacked canes as control. In one study each in a grower's and an experimental farm, cane parameters such as height, diameter and weight did not differ significantly between attacked and unattacked canes. In the second study, the two juice quality parameters Brix and sucrose% were significantly higher in the attacked canes. Comparative analysis of the results from the study with yield loss assessments made in the pre-parasitoid introduction period indicated that the parasitoid, which controls the abundance and spread of aphid populations in a short span of time, eventually prevents economic loss to the crop.

***Key words**: Sugarcane, woolly aphid, Ceratovacuna lanigera, Encarsia flavoscutellum, cane yield, juice quality, loss prevention.*

Woolly aphid *Ceratovacuna lanigera* Zehntner (Homoptera: Aphididae), which ravaged sugarcane crop in tropical India for about half a decade with detectable impact on yield and quality of the crop (Mukunthan et al., 2008), was initially attempted to be restrained by predators that either accompanied it from its home land or adapted to it in the invaded tracts. *Dipha aphidivora* (Meyrick) (Lepidoptera: Pyralidae), the compatriot predator from north east (Tripathi, 1995), was mass multiplied by laboratory (Mukunthan et al., 2006) and shade-net (Patil et al., 2007) methods and released in the field augmentatively (Patil et al., 2007; Srikanth et al., 2009). Similarly, *Micromus igorotus* Banks (Neuroptera: Hemerobiidae), the predator that apparently forged a new association with the aphid in Karnataka State (Lingappa et al., 2004), was also bred in the laboratory (Vidya et al., 2007) and evaluated in the field (Vidya et al., 2010). In our augmentative studies with *D. aphidivora*, we noticed that the populations of the predator grew progressively and decimated the aphid population rather late in the season and the delayed suppression was found to be associated with extensive spatial spread of the aphid in the plot (Srikanth et al., 2009) and considerable impact on yield. Subsequent introduction of the parasitoid *Encarsia flavoscutellum* Zehntner (Hymenoptera: Aphelenidae) from Assam (Anonymous, 2005) and its establishment in tropical India gradually led to natural regulation of the aphid and a balance between them in the sites of release (reviewed in Srikanth et al., 2007). Subsequently too, the parasitoid was observed to closely follow the intermittent appearance of the aphid restricting its spatial spread to small patches of 50-100 m^2 and temporal spread to not more than two months from the time of occurrence (our unpublished data). Minimal visual damage due to the short-term attack, which generally occurs during the grand growth phase (120-270 days) of the crop, and the apparent recovery do not justify

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the presupposition of lack of impact on crop yield and quality. In the present study, we examined at harvest (12 months age) the cane yield and quality parameters of sugarcane attacked by the aphid during the grand growth period but completely controlled by the parasitoid in about two months time.

Due to the intermittent appearance of the aphid, studies were conducted in two different years in two discrete farms. In the first study, observations were recorded in a grower's farm at Coimbatore, Tamil Nadu State, south India, during the 2007-08 crop season. The aphid was noticed in two small adjacent patches of H" 30 m^2 area each (designated as patches I and II) in the middle of a 1 ha plot (cv. Co 86032) during 160-170 days age of the crop. Besides marking these attacked patches, an adjacent unattacked patch (patch III) of the same size was located and denoted as control. In each of these patches, 10-20 canes, the lower sample size decided by the limited availability of infested canes in the attacked patches, were labeled. The second study was conducted in the experimental farm of the Sugarcane Breeding Institute, Coimbatore, during the 2011-12 crop season, when the aphid colonized a small patch (50 m^2) of sugarcane (cv. Co 86032) in the middle of a 0.4 ha plot at about 210 days after planting (DAP). In the infested patch comprising seven 6m rows, four canes from each of the five middle rows totaling 20 canes were randomly selected and tagged. Similarly, 20 unattacked plants in an adjacent healthy patch were tagged for comparison. In both the studies, the aphid gradually disappeared under *E. flavoscutellusm* activity which was detected using a protocol standardized by us (our unpublished data). At harvest, cane yield and juice quality parameters of labeled canes from both attacked and unattacked patches were recorded. In the grower's plot, single cane height, diameter and weight were recorded in all the three patches. Single cane height was measured with a meter scale, diameter with a digital vernier calipers and weight with a 10 kg capacity top pan balance. In the experimental plot, height and diameter of single labeled canes in both attacked and unattacked rows were recorded. The number of millable canes (NMC) and weight of canes per each of the five rows were recorded in small lots and the mean weight of single cane per row was computed to adjust for the minor variation in plant stand among the selected rows. Besides, juice quality parameters such as Brix, sucrose and purity of four labeled canes from each of the five rows serving as replications were estimated using standard procedures. Yield and juice quality parameters of canes from attacked and unattacked patches or rows were compared using student's *t*-test, analysis of variance and Duncan's multiple range test (Gomez and Gomez, 1984).

In both studies conducted in two different years, the aphid exhibited moderate intensity of colonization on the attacked leaves and minimal sooty mould growth on lower leaves in the attacked patches or rows. The aphid disappeared from the patches within about two and half months of first appearance apparently under the influence of the parasitoid. No subsequent re-colonization of canes in the same patches or any other part of the farm was observed. In the grower's farm (Table 1), single cane height did not differ significantly among the two attacked patches and the unattacked patch whereas cane diameter was significantly higher in attacked patch-I than in unattacked patch (III) with overlapping differences among the patches. Single cane weight was not

Table 1. Yield parameters of woolly aphid attacked and unattacked canes under natural activity of *Encarsia flavoscutellum* in a grower's farm (2008-09)

Status of crop patch	Single cane parameter at harvest[#]		
	Height(cm)	Diameter (cm)	Weight (kg)
Attacked canes (Patch I)	253.08 a[1]	2.61 b	1.196 a
Attacked canes (Patch II)	277.20 a	2.77 ab	1.560 a
Unattacked canes(Patch III)	258.50 a	2.87 a	1.428 a
SEm	10.13	0.07	0.124

[#] Mean of 10-20 canes tagged at six months age

[1]Means followed by the same letter in a column are not significantly (P>0.05) different by DMRT

significantly different among the three patches. The experimental farm (Table 2) generally recorded lower values of cane yield parameters than the grower's farm. Single cane height and diameter, and NMCs, cane yield and single cane weight per row did not differ significantly between attacked and unattacked patches. Juice quality parameters showed some interesting trends (Table 2). Both Brix and sucrose % were significantly higher in attacked canes than unattacked canes whereas purity %, a computational derivative of Brix and sucrose %, did not differ significantly between attacked and unattacked patches.

Table 2. Yield and quality parameters of woolly aphid attacked and unattacked canes under natural activity of *Encarsia flavoscutellum* in an experimental farm (2011-12)

Parameter at harvest	Attacked canes	Unattacked canes	*t*-statistic	*P* value
		Cane yield parameters		
Height (cm)[#]	132.45	139.90	1.309	0.199
Diameter (cm)[#]	2.57	2.60	0.367	0.715
NMC / 6m row	45.2	48.4	0.618	0.554
Cane yield / 6m row (kg)	28.400	33.500	1.020	0.338
Cane weight (kg)[!]	0.626	0.691	1.031	0.333
		Juice quality parameters[@]		
Brix	21.38	20.14	2.644	0.030
Sucrose (%)	19.12	17.94	2.441	0.041
Purity (%)	89.42	89.09	0.556	0.594

[#] Mean of 20 canes tagged at six months age
[!] Mean from five rows of 31-57 canes each
[@] Mean of five replications of four canes each from different clumps

The lack of significant differences in cane yield parameters at harvest among attacked and unattacked patches in the grower's farm clearly indicated that the cane that harbored the aphid for a brief period of about 60-75 days either did not suffer damage due to desapping or recovered from the brief loss of vigor. In the experimental farm too, cane growth was not generally affected by the transient aphid attack as was evident from the similar cane growth parameters. The lack of difference in NMCs between attacked and unattacked patches indicated that aphid attack late in the season did not lead to their outright mortality. Despite the relatively poor growth of the crop in the experimental farm, as evidenced by the lower values of all growth parameters, the normal cane yield per row and computed single cane weight in the attacked patch endorsed the trend observed in the grower's farm. The present observations contrast with the negative impact of aphid attack on cane growth and yield parameters observed in earlier studies. In Assam, a part of the home land for the aphid and *E. flavoscutellum*, 100% infestation caused greater reduction in yield and quality parameters than lower levels of damage (Gupta and Goswami, 1995), apparently due to low activity of the parasitoid whose observations were not recorded in the study. In the pre-parasitoid introduction period in tropical India, cane height and cane weight were significantly lower in infested canes than in healthy canes from an 8-month old crop whereas cane girth did not differ significantly (Patil *et al.*, 2003). In our earlier studies, conducted in the same study site as the present studies in the pre-parasitoid introduction period (Mukunthan et al., 2008), intense aphid attack that persisted for about 105-120 days, as was the case with any attacked crop in the absence of the parasitoid, significantly affected cane growth but the rates of reduction, however, varied between study years and with crop age at first aphid attack. In the present studies, differences in the year of attack (2007-08 and 2011-12) and the crop age at which aphid attack occurred (160-170 and 210 DAP) in the grower's farm and experimental farm,

respectively, neither differentially favored the aphid nor rendered the crop vulnerable. We also observed in our earlier studies that aphid attack had no effect on brix and sucrose at harvest when the attack occurred in fifth month whereas these parameters were enhanced when the attack began at 6 months age and persisted for another four months; occurrence of this trend in only one of the two study years indicated the role of aphid intensity and variety (Mukunthan et al. 2008). These observations recorded at harvest give room for the possibility that the trend of significantly lower values of brix and pol% in infested canes than in healthy canes from an 8-month old crop observed by Patil *et al*. (2003) would have been different if the quality parameters were recorded at harvest, possibly due to some recovery. The enhanced brix and sucrose% (Mukunthan et al. 2008) indicated that prolonged desapping by aphids, and possibly other sap sucking pests, apparently concentrates the plant sap enhancing the content of total solids and sucrose. However, the marginal, yet significant, increase in brix and sucrose in the experimental farm of our studies was an interesting observation in view of the short-term feeding of the aphid. Even if this observation needs confirmation, overall, it is unlikely that the short-lived aphid populations naturally regulated by *E. flavoscutellum*, leading to temporal restriction to less than 60-75 days of feeding and spatial restriction to one or two patches of less than 50 m^2 in any cropped area, would cause economic loss. In the light of such recurrent natural regulation, adoption of a strategy of parasitoid conservation after confirming its field activity was recommended (Srikanth et al., 2008) to avoid indiscriminate and uneconomical use of insecticides.

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