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Insecticidal Application Methods against *Melanaphis sacchari* (Hemiptera: Aphididae) on Sorghum in Northeastern Mexico[1]

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Invasion of the sugarcane aphid, *Melanaphis sacchari* (Zehntner), into all sorghum (*Sorghum bicolor* (L.) Moench)–producing areas in Mexico in 2013 prompted a series of studies on assessing and developing integrated pest management strategies for the pest. To avoid economic yield losses, studies were first focused on identifying effective insecticides against this new insect pest. Several trials identified the best insecticides, and their use was soon popular among sorghum growers (Rodríguez-del-Bosque and Terán 2015, Southwest. Entomol. 40: 433–434). However, there was a need to explore economic and effective application methods against this invasive aphid; thus, the objective of this investigation was to determine the effectiveness of four application methods and timing of those applications for controlling *M. sacchari* in northeastern Mexico.

This study was conducted at the Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias Experiment Station near Río Bravo, in northern Tamaulipas, Mexico (N25°57′, W98°01′), during the fall growing season of 2014, spring and fall of 2015 and 2016, and spring of 2017. The sorghum hybrid DK-54 was planted in February and in July during the spring and fall seasons, respectively, using a randomized complete block design with four replications. Plots were 4 rows (0.8 m) wide × 10 m long. Imidacloprid (Velfidor 350 SC®, Velsimex, Cd. México, México) was applied with a 20-l manually operated backpack sprayer in the following treatments: (1) in-furrow application at planting at 210 g active ingredient (a.i.)/ha; (2) banded application of 210 g a.i./ha 7 cm to the side of the row and 7 cm deep when plants were in the boot stage; (3) application of 105 g a.i./ha at the base of the plants during the boot stage; (4) application of 105 g a.i./ha over the plants during the boot stage; and (5) no

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Table 1. Effectiveness of different application and timing methods against *M. sacchari* on sorghum. Río Bravo, Tamaulipas, México, 2014–2017.

	% Control*						
Method/ Timing	Fall 2014	Spring 2015	Fall 2015	Spring 2016	Fall 2016	Spring 2017	Overall Mean (SE)
In-furrow/planting	93 ab	87 b	41 b	96 a	94 a	82 b	82.2 (8.5) b
Banded/boot	85 b	99 a	25 c	95 a	75 b	80 b	76.5 (10.9) b
Base/boot	99 a	98 a	98 a	99 a	94 a	91 a	96.5 (1.3) a
Top/boot	99 a	96 a	99 a	99 a	90 a	75 b	93.0 (3.9) a
Aphids/leaf (control)	2,170	844	870	452	488	180	834 (288)

* Mean (7–14 d) % control = [(No. aphids in control − No. aphids in treatment$_n$)/(No. aphids in control)] × 100. Means within columns followed by the same letter do not differ significantly ($P < 0.05$) as determined by LSD test.

treatment (control). Insecticide was applied in Treatments 2–4 when *M. sacchari* density averaged 100 aphids/leaf at the boot stage of plant growth. For these treatments, aphid (adults + nymphs) density was determined on two leaves (bottom and middle) of 10 randomly selected plants in the two central rows of the plots 7 and 14 d after application. Percentage control obtained in each treatment was calculated as % control = ([No. aphids in control − No. aphids in treatment$_n$)/(No. aphids in control)] × 100. Percentage data were transformed by square root to normalize distribution. These transformed data were subjected to analysis of variance with treatment means compared using the LSD test ($P < 0.05$) (SAS Institute 2012, SAS release 9.3 ed., Cary, NC).

At 7–14 d after application, mean aphid density in the control treatment varied from 2,170 aphids/leaf during fall 2014 to 180 aphids/leaf during spring 2017 (Table 1), showing a progressive decline of *M. sacchari* population after first detected in 2013. Based on these results, the two most efficacious treatments were application of 105 g a.i./ha at the base of the plants during the boot stage (Treatment 3) and application of 105 g a.i./ha over the plants during the boot stage (Treatment 4) with a mean % control > 93%. These two methods were intended to simulate ground and aerial applications. Both were consistently effective in reducing aphid density, with the exception of the spring 2017 application over the plants that yielded only 75% control. Any differences in effectiveness of application over the plants versus application to the base of the plants might be explained by a longer time for translocation of the imidacloprid to reach the basal leaves where aphids are highly concentrated on the sorghum plant (Simon-Delso et al. 2015, Environ. Sci. Pollut. Res. 22: 5–34).

On the other hand, the prophylactic in-furrow application of imidacloprid at planting (Treatment 1) resulted in an observed 82% (range 41–96%) control, and the banded application at the boot stage (Treatment 2) resulted in 76% control (range 25–99%). Treatments 1 and 2 were inconsistent and costly (double insecticide dose) as compared with Treatments 2 and 3. In summary, the best application and timing methods for controlling *M. sacchari* in northeastern Mexico were either the application at the base or over the top during the boot stage.