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# Treatment of Sorghum Hybrid 85 P15 (Pioneer®) Seeds and their Influence on *Melanaphis sacchari/sorghi* Infestation

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**Abstract**

**Context:** Sorghum is a hosting plant of *Melanaphis sacchari/sorghi*. The control measures against the insect include the treatment of seeds. However, evaluation of the effect of insecticides on insect populations and the agronomic variables of the crop, are needed.
**Aim:** To evaluate the influence of insecticides clothianidin, thiamethoxan, and imidacloprid during the treatment of hybrid 85 P15 (Pioneer®) seeds on the agronomic variables of the crop and infestation with *M. sacchari/sorghi*.
**Methods:** The experiment was conducted in the School of Higher Studies in Xalostoc, Mexico, in 2018. Four doses of Poncho®, Cruiser® 5 FS, and Tools® TS in the treatment of hybrid 85 P15 (Pioneer®) seeds. A randomized block experimental design was applied, and the percentage of germination, *M. sacchari/sorghi* infestation, and agronomic parameters of the crop, were determined.
**Results:** All the parameters achieved more than 90% of germination, which demonstrated that the products and doses did not affect this parameter. Likewise, no differences were observed in the treatments. The use of these insecticides in hybrid seeds had a little influence on aphid infestation. These treatments do not affect the content of chlorophyll, but other parameters, like Brix degree, and the fresh leaf weight were affected.
**Conclusions:** The seed treatment does not reduce the percentage of germination of 85 P15 (Pioneer®) hybrids, a strong control was not achieved over infestation of aphids, but it did affect some agronomic variables; hence, evaluation of other hybrids is recommended.

**Key words:** germination, pre-sowing, yellow aphid, bicolor Sorghum, agronomic variables.

## Introduction

Sorghum (*Sorghum bicolor* (L.) has acquired relevance since it can substitute other grains like corn and wheat in human and nutrition, and the industry Moench) (Pérez et al., 2010). This crop is one of the most important in Morelos, Mexico, with 42 541 ha by 2015 in that state alone (Agrofood and Fishing Information Service, 2015). However, like other species of grains, it is an important host of yellow aphid (*Melanaphis sacchari/sorghi*), a significant pest that causes economic losses (Singh, Padmaja & Seetharama, 2004), affecting the crop throughout all its development.

This aphid was detected in Morelos, in 2015 (Perales Rosas et al., 2017), it causes stress to plants by feeding from the sap, indirectly reducing the photosynthetic area by secreting honeydew, that creates a substrate on which fumagina (*Capnodium* spp.) (Singh et al., 2004). Although Bowling et al. (2016) described some symptoms of this affectation to the crop, including changes in the color of leaves, necrosis of mature leaves, and plant growth delay.

The insect also poses an imminent danger because it is a vector of important viral diseases.

Ramírez, Trujillo & Arenas (2017) suggested that efficient control of *M. sacchari/sorghi* populations is highly important. Therefore, many farmers are using several insecticides, such as Imidacoprid, Flupyradifurone, Spirotetramat, and others (Rodríguez del Bosque & Terán, 2015; Bowling et al., 2016; Tejeda et al., 2017; Perales, Hernández, Valle & Peralta, 2019).

This control system includes treatments to seeds using insecticides, as a first line of defense (Quijano, Pecina, Bujanos, Marín & Yáñez, 2017). The plants from treated seeds are protected against insect attacks during the first stage of the crop (Jones, Brown, Williams, Emfinger & Kerns 2015), though the cultivated hybrid must be considered as well. Therefore, Bayer AG (2019), BASF SE (2019) and Syngenta (2019) stated that sorghum may be treated before sowing, with Imidacloprid, Poncho®, and Cruiser® 5 FS, respectively. Nonetheless the consequences of these products on the populations of *M. sacchari/sorghi* and the agronomic variables of sorghum hybrid 85 P15 (Pioneer®), are still unknown.

Accordingly, the aim of this paper was to evaluate the influence of insecticides clothianidin, thiamethoxan, and imidacloprid during the treatment of hybrid 85 P15 (Pioneer®) seeds, on the agronomic variables of the crop, and infestation with *M. sacchari/sorghi* in Xalostoc, Morelos.

## Materials and Methods

The experiment was conducted in land from the School of Higher Studies, Autonomous University of Morelos State (UAEM), Mexico, between June and September 2018.

Hybrid seeds of sorghum 85 P15 (Pioneer®) from seed sales companies in Mexico, were used. Besides, active ingredients 48% clothianidin, equivalent to 600 g of ai/liter; 47.9% thiamethoxam equivalent to 600 g of ai/per liter; and 70% imidacloprid, equivalent to 700 g of ai/kilogram, were used.

The experimental area where the trial was held, was located on 18º 44´39´´ N y 98º 54´34´´ W, on clay vertisol, 1294 meters above sea level. A randomized experimental block design was established in thirteen lots, with four repetitions. Each block was composed of 13 treatments (Table 1), sown in experimental units of four row each. The length of the experimental units was 4 m, width was 0.7 m, for a total area per lot of 11.2 m$^2$. Before sowing, the land was tilled deep to prevent the emergence of weeds.

**Table 1. Pre-sowing treatments hybrid 85 P15 (Pioneer®) seeds**

| Treat. | Description |
|---|---|
| T-1 | Seeds treated with 4 mL of Poncho® per seed kilogram |
| T-2 | Seeds treated with 5 mL of Poncho® per seed kilogram |
| T-3 | Seeds treated with 6 mL of Poncho® per seed kilogram |
| T-4 | Seeds treated with 8 mL of Poncho® per seed kilogram |
| T-5 | Seeds treated with 2.5 mL of Cruiser® 5 FS per seed kilogram |
| T-6 | Seeds treated with 3.5 mL of Cruiser® 5 FS per seed kilogram |
| T-7 | Seeds treated with 5 mL of Cruiser® 5 FS per seed kilogram |
| T-8 | Seeds treated with 7 mL of Cruiser® 5 FS per seed kilogram |
| T-9 | Seeds treated with 5 mL of Tools® TS per seed kilogram |
| T-10 | Seeds treated with 6 mL of Tools® TS per seed kilogram |
| T-11 | Seeds treated with 7 mL of Tools® TS per seed kilogram |
| T-12 | Seeds treated with 9 mL of Tools® TS per seed kilogram |
| T-13 | Seeds not treated with chemicals (absolute control) |

The trial began with the treatment of seeds on June 19, and 48 hours later the seeds were sown. Each treatment was sown in separate lots. The seeds were planted at a density of 20 plants per square meter, and they were covered evenly (3 cm cover), to ensure fast and even germination. Before sowing, proper moistening was ensured with irrigation. Later, two rounds of sample collections were performed, the first was done after seven days of sowing (AS), and the second took place 14 days later, to collect germination data. *M. sacchari/sorghi* infestation was determined alongside the evaluations. Spot-free seedlings, or seedlings with very poor signs of necrosis, were considered, following the criterion of ISTA (1999).

Moreover, yellow aphid infestation was also evaluated since the beginning of emergence to 56 days later. Accordingly, 10 plants were taken from the mid rows of the lots of each treatment, ruling out 0.5 m from each end of the rows to prevent the effect of edges. A category was assigned according to the modified scale of Bowling et al. (2015), and the infestation degree was determined using the formula by Towsend & Heuberger (1943):

- 0 -no presence of aphids
- 1 -from 1-25 aphids per leaf
- 2 -from 26-50 aphids per leaf
- 3 -from 51-100 aphids per leaf

- 4 -from 101-500 aphids per leaf
- 5 -from 501-1000 aphids per leaf
- 6 -equal or more than 1001 aphids per leaf

$$P = \left( \frac{\sum_{i=1}^{n=5} (n \times t)}{N \times C} \right) \times 100 \qquad (1)$$

Where:

- P -infestation degree in the leaf
- N -number of leaves in each category
- T -numeric value of each category
- N -total number of plants in the sample
- C -highest category in the scale

Then, at 63 days AS, 10 plants were selected per treatment to evaluate the following agronomic parameters: Fresh leaf weight, fresh stem weight, plant height, fresh ear weight, fresh kernel weight, chlorophyll, and Brix degree.

The statistical analyses were made using SAS® version 9.0. Analyses of variance and Tukey and Friedman mean comparison tests were performed (95% confidence), to determine significant differences among the treatments.

## Results and discussion

The analysis of the data collected first showed that at 7 days AS, the germination percentage was over 50% in all the treatments evaluated; however, there were differences among some of them (Figure 1). Having 99% of the seedlings emerged, T-8 underwent the greatest germination percent in that period, with significant differences in relation to T-7 (though the dose used was lower than in T-8), and T-12, which only reached 85 and 86% of germination, respectively. According to O. Valarezo, Loor & C. O. Valarezo (2013), the micronutrients present in the insecticides favor plant development; however, the treatments of seeds treated with clothianidin, thiamethoxam, and imidacloprid did not show significant differences in relation to the absolute control (T-13), regardless of the doses used in each product.

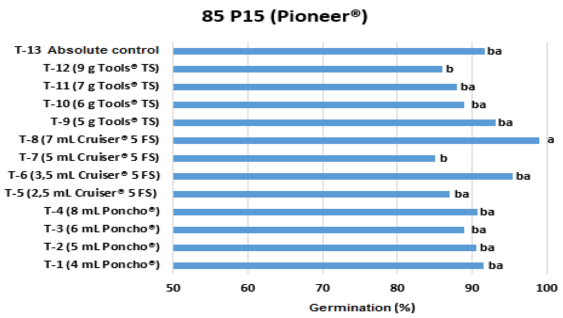


Fig. 1. Germination of hybrid 85 P15 (Pioneer®) at 7 days *Means with unequal letters on the bars show statistically significant differences, Tukey (α ≤0.05)

The analysis of the data from the second collection, at 14 AS, showed that the insecticide doses evaluated did not have a negative effect on the germination percentage of hybrid 85 P15 (Pioneer®) (Figure 2). All the treatments showed germination over 90% in the field conditions, producing vigorous plants, according to ISTA (1999). Furthermore, no statistical differences were observed among the treatments of seeds using clothianidin, thiamethoxam, and imidacloprid, in relation to T-13 (absolute control).

These results corroborate the arguments of Bayer AG (2019), BASF SE (2019) and Syngenta (2012), claiming that the insecticides recommended for the treatment of seeds cause not toxicity to sorghum.

The germination percentage of the seed was lower than 100% in all the treatments evaluated, including the absolute control, with 92.7% germination. Only T-4 was below T-13, with 91.7% germination, but without significant differences. The necessary optimum circumstances for germination, never or almost never, are supplied in the field. Even when aeration, humidity, and temperature are right, there will be obstacles from the soil, microflora, and the fauna, which affect this process. As a result, the seeds emerged from the ground do not equal the full germination capacity (Perry, 1978 cited by Machado, 2015).

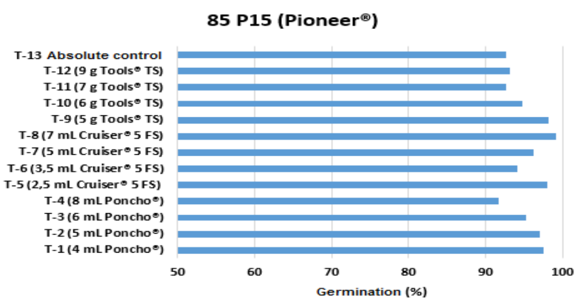


Fig. 2. Germination of hybrid 85 P15 (Pioneer®) at 14 AS in Xalostoc, Morelos

The use of clothianidin, thiamethoxam, and imidacloprid in hybrid 85 P15 (Pioneer®) seeds, is part of the strategy established to control *M. sacchari/sorghi*, and according to Quijano et al. et al. (2017), the treatment delays or prevents the application of foliar insecticides for up to 30 days. It was corroborated in the work, but during the first 14-21 AS (Table 2). Quantification of the winged specimens, the first ones to colonize the hybrid plants, was done during the third screening. Infestation was higher than 30% in all the treatments, except the control (50%), with significant differences from T-8 and T-12.

**Table 2. Infestation de *M. sacchari/sorghi* in sorghum hybrid 85-P-15 during the first AS**

| Treat. | | Evaluation | | |
|---|---|---|---|---|
| | | 7 AS | 14 AS | 21 AS |
| Poncho® | T-1 | 0 | 0 | 39.58 ab |
| | T-2 | 0 | 0 | 38.74 ab |
| | T-3 | 0 | 0 | 40.83 ab |
| | T-4 | 0 | 0 | 33.33 ab |
| Cruiser® | T-5 | 0 | 0 | 41.25 ab |
| | T-6 | 0 | 0 | 38.75 ab |
| | T-7 | 0 | 0 | 37.08 ab |
| | T-8 | 0 | 0 | 30.00 b |
| Tools® TS | T-9 | 0 | 0 | 48.75 ab |
| | T-10 | 0 | 0 | 36.66 ab |
| | T-11 | 0 | 0 | 32.49 ab |
| | T-12 | 0 | 0 | 30.83 b |
| T-13 | | 0 | 0 | 56.66 a |

Treat. - Treatment; *Means with unequal letters on the columns show statistically significant differences, Tukey (α ≤0.05)

Despite the previous, at 28 AS, significant differences were observed among treatments, with T-4 and T-11 the least infested (Table 3). Treatment T-12 also showed differences from the control. The analysis of data collected at 35-56 AS, showed not statistically significant differences among the treatments, which demonstrates the little influence of the seed treatment on the infestation of yellow aphid in sorghum hybrid 85-P-15. Overall, the infestation percentage was below 70% all the time, in all the treatments, throughout the evaluation period. At 42 AS, the infestation percentage decreased due to the mechanical effect of precipitation, though the populations were restored a week later, and then decreased again, at 56 AS, because the insects moved to the ears of the plants, and due to the plant disability caused by the large amounts of individuals feeding from it (Peña et al., 2018).

The growth in the population of insects may be originated by the habits these winged species have to move in swarms, or perform directed flights to yellow or green plants (Peña et al., 2018), and the high reproductive rate of this species (Rodríguez del Bosque & Terán, 2018).

The analysis of the data collected in relation to the agronomic variables, the hybrid 85-P-15 seed treatment with clothianidin, thiamethoxam, and imidacloprid, did not influence on the content of chlorophyll in the leaves (Table 4). However, this is not the effect observed on all the other parameters, where the seeds treated with insecticides, T-2, were known to have the lowest values achieved, except the Brix degree, whose value was inferior in T-4, and whose height was also inferior to the ones reached by the absolute control.

These results show the way these insecticides influence on hybrid 85 P15 (Pioneer®), when they are used in seed treatments. Concerning infestation, no differences were observed in relation to the control, which demonstrate the need for foliar applications to diminish the colonies of the insect.

**Table 3. Infestation of *M. sacchari/sorghi* in sorghum hybrid 85-P-15 following 21 AS**

| Treat. | | Evaluation | | | | |
|---|---|---|---|---|---|---|
| | | 28 AS | 35 AS | 42 AS | 49 AS | 56 AS |
| Poncho® | T-1 | 49.16 abc | 60.00 | 27.50 | 60.00 | 27.50 |
| | T-2 | 48.75 abc | 59.59 | 26.25 | 55.83 | 28.75 |
| | T-3 | 47.50 abc | 59.17 | 28.75 | 59.17 | 25.00 |
| | T-4 | 39.58 c | 55.83 | 24.17 | 55.83 | 24.17 |
| Cruiser® | T-5 | 55.83 a | 64.59 | 36.25 | 64.59 | 38.75 |
| | T-6 | 54.16 ab | 61.25 | 38.75 | 61.25 | 36.25 |
| | T-7 | 50.00 abc | 57.50 | 19.17 | 57.50 | 19.17 |
| | T-8 | 48.33 abc | 57.92 | 17.50 | 57.92 | 17.50 |
| Tools® TS | T-9 | 50.83 abc | 60.00 | 32.92 | 60.00 | 29.58 |
| | T-10 | 50.00 abc | 60.00 | 29.58 | 60.00 | 23.33 |
| | T-11 | 41.25 c | 59.58 | 25.84 | 59.58 | 25.84 |
| | T-12 | 43.75 bc | 55.42 | 22.92 | 55.42 | 22.92 |
| T-13 | | 59.16 a | 60.42 | 23.33 | 60.42 | 32,92 |

Treat. - Treatment; *Means with unequal letters on the columns show significant differences, Tukey (α ≤0.05)

**Table 4. Agronomic variables of hybrid 85 P15 (Pioneer®) in Xalostoc, Morelos**

| Treat. | FLW | FSW | PH | FEW | FKW | CI | BG |
|---|---|---|---|---|---|---|---|
| T-1 | 8.90 c | 27.00 f | 121.40 c | 29.45 defg | 25.40 bcde | 33.82 | 9.0 c |
| T-2 | 4.54 d | 14.03 g | 94.20 g | 23.57 fg | 19.09 ed | 32.99 | 9.4 bc |
| T-3 | 12.69 b | 69.61 a | 123.67 bc | 47.04 a | 38.21 a | 32.64 | 9.3 bc |
| T-4 | 7.57 cd | 16.31 g | 97.80 fg | 37.61 bcd | 22.48 cde | 31.17 | 7.1 ef |
| T-5 | 13.85 ab | 55.72 bc | 124.20 bc | 40.89 abc | 33.43 ab | 33.06 | 10.1 a |
| T-6 | 9.26 c | 28.41 f | 105.53 ef | 27.04 efg | 22.33 cde | 29.70 | 8.1 ed |
| T-7 | 7.70 cd | 58.83 b | 121.60 c | 46.62 ab | 37.43 a | 30.92 | 7.5 ef |
| T-8 | 16.57 a | 42.56 de | 119.13 dc | 32.19 cdef | 25.70 bcd | 32.04 | 7.6 edf |
| T-9 | 7.24 cd | 46.18 d | 130.80 ab | 38.65 abcd | 31.36 ab | 32.03 | 10.3 a |
| T-10 | 9.11 c | 47.89 cd | 134.73 a | 35.09 cde | 28.05 bc | 31.72 | 9.9 ba |
| T-11 | 8.91 c | 51.91 bcd | 127.33 abc | 34.97 cde | 28.26 bc | 33.08 | 8.9 c |
| T-12 | 13.50 ab | 35.55 ef | 110.47 de | 35.19 cde | 30.25 abc | 32.65 | 8.2 d |
| T-13 | 7.50 cd | 16.02 g | 100.00 fg | 21.45 g | 17.22 e | 28.08 | 10.5 a |

Treat. - Treatment; *Means with unequal letters on the columns show significant differences, Tukey (α ≤0.05)

**Legend:** FLW - fresh leaf weight in g; FSW - fresh stem weight in g; PH - plant height in cm, FEW - fresh ear weight in g; FKW - fresh kernel weight in g; Cl - chlorophyll, BG - Brix grades.

## Conclusions

Seed treatments with imidacloprid, thiamethoxam, and clothianidin do not affect germination of hybrid 85 P15 (Pioneer®).

The utilization of imidacloprid, thiamethoxam, and clothianidin to treat seeds does not influence *M. sacchari/sorghi* infestation in fields sown with hybrid 85 P15 (Pioneer®) seeds.

The insecticide treatments evaluated did not influence the chlorophyll content, but it did affect agronomic variables plant height, fresh leaf weight, fresh stem weight, fresh ear weight, fresh kernel weight, and Brix degree. Therefore, it is recommended to perform further evaluations to other sorghum hybrids.

## Author contribution

Daniel Perales Rosas: Planning, practical application of research, design and review of the bibliography, tabulation, and analysis of results.

Dagoberto Guillén Sánchez: Planning, guidance, and advisory, control of research, and analysis of the results and discussion.

María Andrade Rodríguez: Guidance, analysis of results, final review of the manuscript.

Francisco Perdomo Roldán: Guidance during the experimental phase, tabulation, and analysis of results, final review of the manuscript.

Mairel Valle de la Paz: Guidance during the experimental phase, analysis of results, redaction of the manuscript, final review of the manuscript.

Maykel Hernández Aro: Statistical analysis, collaborator in the practical part of research, redaction of the manuscript.

## Conflicts of interest

There are no conflicts of interest.

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