



Methods of corm disinfection in plantain cultivars (*Musa* AAB) on their morphological and productive characteristics

Métodos de desinfección de cormos en cultivares de plátano (*Musa* AAB) sobre sus características morfológicas y productivas

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Abstract

The present research was carried out at the Experimental Farm Río Suma of the “Eloy Alfaro” Laica University of Manabí, Extension in El Carmen, with the aim of evaluating the level of damage caused by *Cosmopolites sordidus* Germar on two cultivars of *Musa* ssp. with different disinfection methods. For this purpose, six treatments were established resulting from the factorial combination of two banana varieties: V1 (Curare enano), V2 (Dominico Hartón) for factor A, and for factor B, the disinfection methods (MD): MD1 (chemical Cadusafos g·cormo⁻¹), MD2 (physical immersion in hot water at 50 °C for 15 min), and MD3 (physical immersion in ambient water for 24 hours), arranged in a randomized complete block design with factorial arrangement of A (plantain varieties) by B (disinfection methods of corms). Mean comparisons were performed using Tukey’s test at a 5% probability level. The evaluated variables were: corm damage (scale), plant height (m), pseudostem perimeter (cm), number of leaves, and bunch biomass (kg). The results showed statistically significant differences only at the variety level ($P < 0.05$), with the Dominico Hartón cultivar being superior for the variables: corm damage, with 1.04 and 1.05 in phases IV and V, respectively, according to the Viladerbo scale; in the variable plant height (m) in all evaluated phases with: 2.98m (phase III); 3.48m (phase IV); and 3.96 m (phase V) and in the pseudostem perimeter only in phase V with 63.67 cm. Since there are no statistical differences between treatments (physical and chemical methods), it is suggested to use the former because it is more environmentally friendly, and it is also recommended to carry out future research with these treatments in several production cycles to minimize the use of agrochemicals.

Keywords: disinfection methods, corm, ‘Dominico Hartón’, ‘Barraganete’.

Resumen

La investigación se realizó en la Granja Experimental Río Suma, Universidad Laica “Eloy Alfaro” de Manabí, Extensión en El Carmen, con el objetivo de evaluar el nivel de daño ocasionado por *Cosmopolites sordidus* Germar en dos cultivares de *Musa* spp. con diferentes métodos de desinfección; para ello se establecieron seis tratamientos que resultaron de la combinación factorial de dos variedades de plátano: V1 (Curare enano), V2 (Dominico Hartón) para el factor A y en el factor B los métodos de desinfección (MD): MD1 (químico, Cadusafos 5 g·cormo⁻¹), MD2 (físico, inmersión en agua caliente a 50 °C por 15 min) y MD3 (físico, inmersión en agua a temperatura ambiente por 24 horas), dispuesto en un diseño de bloques completos al azar con arreglo factorial de A (variedades de plátanos) por B (métodos de desinfección de cormos), la comparación de las medias se realizó con la prueba de Tukey al 5% de probabilidad. Las variables evaluadas fueron: daño del cormo (escala), altura de planta (m), perímetro del pseudotallo (cm), número de hojas y biomasa del racimo (kg). Los resultados evidenciaron diferencias estadísticas significativas solo a nivel de variedades ($P < 0,05$), siendo superior en el cultivar Dominico Hartón para las variables: daño del cormo con 1,04 y 1,05 en la fase IV y V, respectivamente según la escala de Viladerbo; en la variable altura de la planta (m) en todas las fases evaluadas con 2,98 m (fase III) y 3,48 m (fase IV) y 3,96 m (fase V) y en el perímetro del pseudotallo únicamente en la fase V con 63,67 cm. Al no haber diferencias estadísticas entre tratamientos (métodos físicos y químicos), se sugiere utilizar el primero por ser más amigable con el ambiente, además se recomienda realizar futuras investigaciones con estos tratamientos en varios ciclos de producción para minimizar el uso de agroquímicos.

Palabras clave: métodos de desinfección, cormo, Dominico Hartón, Barraganete.



Introduction

Plantain is one of the most dynamic products in the global economy. In 2017, global production decreased by 2% compared to 2015, and as a result, exports also dropped by 29%. However, prices increased significantly by 15% compared to 2016. According to the Situational Bulletin of the Ministry of Agriculture and Livestock of Ecuador (MAG, 2017), national production in 2017 rose by 25% compared to 2016. By 2023, according to the Ecuadorian Institute of Statistics and Census (INEC), plantain cultivation reached 152,654 hectares (monoculture and associated), representing 1.25% of the country's total cultivated area.

It is important to note that in Ecuador, plantain cultivation is a key agricultural activity that supports the livelihoods of many families. On a global scale, plantain exports reached a record 44,150,813.38 metric tons in 2022, with Ecuador accounting for 1.94% (857,561.89 tons), ranking 12th worldwide and third in Latin America, behind Colombia and the Dominican Republic (Food and Agriculture Organization of the United Nations (FAO), 2022).

Gold and Tinzaara (2008) described the damage caused by banana weevil larvae, which bore into the corm, destroying the roots and vascular system, limiting the absorption of nutrients and water in established plantations. These authors suggested that the damage can cause plant death, reduced bunch biomass, inhibition of sucker emergence, shortened cultivar lifespan, and yield losses exceeding 50%. Furthermore, the galleries formed by the larvae serve as entry points for pathogens such as *Fusarium* and *Ralstonia* (National Administrative Department of Statistics of Colombia (DANE), 2016).

Bonilla et al. (2020) reported that with adequate phytosanitary management of the Hartón plantain variety in Integrated Farms in Pastaza Province (Ecuador), the damage caused by pests was significantly reduced, enabling the recovery of the crop.

Tenkouano et al. (2006) reported that seedlings produced through field propagation techniques may be infected with soil-borne pests, such as nematodes and weevils. To reduce the risk of soil-borne contamination, the sanitation of suckers obtained through decapitation methods in the field was recommended. Therefore, the authors suggested incorporating this practice into integrated pest management (IPM) strategies, particularly for controlling black weevil and plant-parasitic nematodes. The latter are of special concern due to the positive (directly proportional) relationship between the rhizosphere and nematode populations in roots and soil (Riascos-Ortiz, 2021), especially in commercial plantations or monoculture fields (Prado et al., 2018).

It has been proven that peeling and hot water treatment are effective and simple procedures for eliminating weevils from plants. However, this technique has been difficult to implement for small-scale farmers (Tresson et al., 2021). Based on the above, it became necessary to conduct the present study with the objective of evaluating the level of damage caused by *Cosmopolites sordidus* Germar in two *Musa* spp. cultivars using different disinfection methods, since according to Carballo (2001), this insect pest is the main limiting factor in the global production of this musaceous crop.

Materials and methods

The study was conducted at the Río Suma Experimental Farm of the Universidad Laica “Eloy Alfaro” de Manabí, El Carmen Extension, located in the province of Manabí, at kilometer 25 on the Santo Domingo–Chone highway, with the following geographic coordinates: -0.25928 S, -79.42602 W.

The evaluated treatments consisted of six combinations resulting from the factorial combination of two plantain varieties: Factor A – Variety: V1 (Curare enano) and V2 (Dominico Hartón); and Factor B – Disinfection methods: MD1 (chemical, Cadusafos 5 g·corm⁻¹), MD2 (physical, immersion in hot water at 50 °C for 15 minutes), and MD3 (physical, immersion in room temperature water for 24 hours), as shown in table 1. These treatments were designed with the aim of reducing environmental damage caused by the use of agrochemicals.

Table 1. Description of applied methods.

Treatment	Variety	Disinfection methods
T1	Curare Enano	Chemical, Cadusafos 5 g·corm ⁻¹
T2	Curare Enano	Physical, immersion in hot water at 50 °C for 15 min
T3	Curare Enano	Physical, immersion in room temperature water for 24 hours
T4	Dominico Hartón	Chemical, Cadusafos 5 g·corm ⁻¹
T5	Dominico Hartón	Physical, immersion in hot water at 50 °C for 15 min
T6	Dominico Hartón	Physical, immersion in room temperature water for 24 hours

For the establishment of the cultivars, a total area of 1,278 m² was used, with a plant spacing of 1.50 m and row spacing of 3.0 m. A total of 1,080 plants were used, distributed among six treatments with three replications each, resulting in a total of 18 experimental units, each containing 60 plants.

A randomized complete block design (RCBD) was used, with a factorial arrangement: Factor A (plantain varieties) and Factor B

(corm disinfection methods). Mean comparisons were performed using Tukey’s test at a 5% probability level.

Table 2. Analysis of variance (ANOVA) framework used.

Source of variation	Degree of freedom
Total	17
Varieties	1
Method of disinfection	2
Repetitions	2
Varieties*Method of disinfection	2
Error experimental	10

a) Corm damage level: To assess the severity of the damage, the Vilardebo scale was used (Ruiz, 2007), which involved making a transverse cut of the corm and counting the number of galleries caused by larvae in defined segments or quadrants, assigning values ranging from 0 to 100. This scale allowed for the estimation of damage during each of the evaluated growth stages (leaf 10, 20, 30, belloteo, and harvest), thereby determining susceptibility. For the assignment of values, visual assessment grouped the damage into seven levels: 0 (healthy corm or no galleries), 5 (traces of galleries present), 10 (intermediate infestation between 5 and 20 galleries), 20 (galleries present in approximately one-fourth of the corm), 40 (galleries present in half of the corm), 60 (galleries present in about three-fourths of the corm), 100 (galleries present throughout the entire corm). The recorded data were divided by 100 and transformed by $\sqrt{x+1}$.

b) Plant height (m): The height of the plant was measured onbetween he seventh month after the transplant and the harvest. The plants was measured with a tape measure, from the floor to the insertion point of the last leaf. For the statistical analysis of this variable, the measurement was done in three stages: leaf 30, inflorescence initiation, and harvest.

c) Pseudostem diameter (cm): Pseudostem diameter was recorded starting from the seventh month after transplanting until harvest, measured at a height of 60 cm from the ground using a measuring tape. For the statistical analysis of this variable, the values measured on the plants were taken at three growth stages: leaf 30, inflorescence initiation, and harvest.

d) Number of leaves on harvest: The number of leaves per plant was counted at the time of harvest. For the statistical analysis of this variable, the values were recorded at three growth stages: leaf 30, inflorescence initiation, and harvest.

e) Bunch biomass: The bunch biomass was determined at harvest using a scale (in pounds), and the rachis was included in the total weight.

Results and discussion

For the variable corm damage (scale), it was confirmed that there was a significant effect only at the variety level ($P<0.05$), with

Dominico Hartón showing the lowest damage, recording values of 1.04 and 1.05 in phase IV (inflorescence initiation) and phase V (harvest), respectively (table 3; figure 1).

Tabla 3. Responses from varieties from corm damage (scale).

Varieties	Average				
	Phase I	Phase II	Phase III	Phase IV	Phase V
Curare enano	1.04 a	1.14 a	1.14 a	1.15 b	1.14 b
Dominico Hartón	1.05 a	1.10 a	1.06 a	1.04 a	1.05 a

Averages with common letter are not significantly different ($P>0.05$).

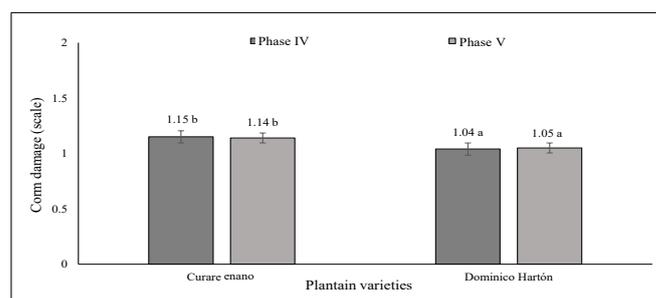


Figure 1. Corm damage scale as affected by the evaluated plantain varieties.

As shown in figure 1, there is less damage in the “Dominico Hartón” variety, it can be inferred that varietal resistance was responsible for the reduced weevil damage, rather than the control methods applied. This finding corroborates the results of Armendáriz et al. (2016), who, when estimating the presence and activity of larvae in the corm after harvest, found no statistical differences among treatments. They reported that 38.67% of the corms presented larval galleries, suggesting that this could be due to the initial inoculum present in the plantation, associated with inadequate disinfection of planting material—even when a chemical treatment was used—or to soil with low organic matter content (Álvarez, 2011).

With regard to varietal resistance, the results confirmed the findings of Armendáriz et al. (2014), who stated that not all musaceous species (plantain, banana, and *Ensete*) nor all varieties exhibit the same level of susceptibility to weevils. Finally, these results contrast with those of Vélez (2011), who reported that “Dominico,” “Dominico Hartón,” and “Barraganete” were more susceptible to the banana weevil (*Cosmopolites sordidus*). In the present study, however, “Dominico Hartón” was found to be less susceptible to weevil attack during the flowering stage (phase IV) and harvest stage (phase V).

Regarding the morphological variables, these were evaluated starting from phase III (emergence of the 30th leaf, inflorescence initiation, and harvest), as shown in table 4. For the variable plant height (m), statistical analysis revealed a significant effect only at the variety level ($P<0.05$) across all evaluated phases (figure



2). In this context, the “Dominico Hartón” cultivar exhibited the greatest height, with values of 2.98 m, 3.48 m, and 3.96 m in phases III, IV, and V, respectively.

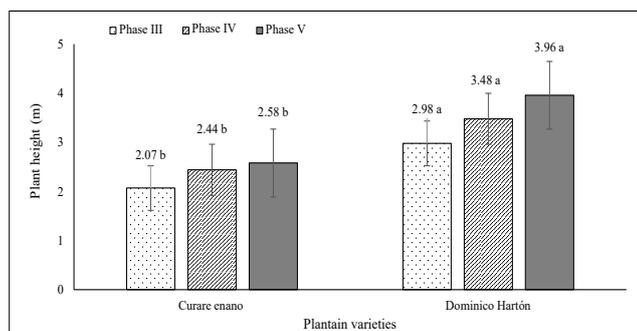


Figura 2. Plant height (m) by effect of plantain varieties evaluated.

As shown in figure 2, the “Dominico Hartón” cultivar significantly exceeded “Curare enano” in plant height, and this difference was not related to the corm disinfection methods used as weevil control measures. This finding contrasts with Armendáriz et al. (2016), who reported that plantain height was influenced by plot sanitation, used as a weevil control technique.

Significant differences ($P < 0.05$) were detected only at the level of the varieties evaluated for the variable pseudostem perimeter (cm), only in phase V (at harvest), being the banana cultivar “Dominico Hartón” the best with 63.67 cm (figure 3), despite the fact that diameter was closely related to bunch biomass (Angulo, et al., 2020), in this study no such relationship was found; since, there were no statistical differences in bunch biomass as mentioned below.

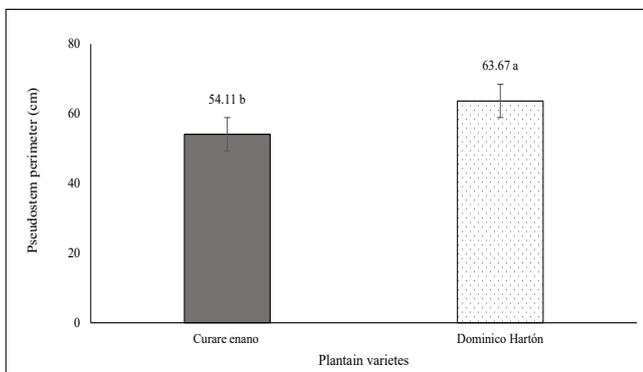


Figure 3. Pseudostem perimeter (cm) in evaluated plantains varieties.

Regarding the number of leaves at harvest, no statistical differences ($P > 0.05$) were detected for any of the sources of variation. The overall average was 7.78 leaves for “Curare enano” and 8.08 leaves for “Dominico Hartón” (table 4). This result contrasts with that of Guzmán et al. (2012a), who reported that corms subjected to sanitary peeling exhibited excellent sprouting, and that the seedlings developed a well-structured root and shoot system.

In the present study, no statistical differences ($P > 0.05$) were found in bunch biomass (kg), showing a behavior similar to the previously evaluated variable. The overall averages were 11.21 kg for “Curare enano” and 12.07 kg for “Dominico Hartón” (table 4). The latter value is noticeably lower than the values reported by Guzmán et al. (2012b), who, when evaluating the effectiveness of various sanitary practices applied to “Dominico Hartón” plantain corms against plant-parasitic nematodes and weevils, found that sanitary peeling combined with carbofuran, chicken manure, and *Paecilomyces lilacinus* resulted in a higher bunch biomass of 18.6 kg, which also reduced plant toppling (3%) and significantly increased crop yield.

Table 4. Responses from the varieties according to plant height (m), pseudostem perimeter (cm), number of leaves, bunch biomass (kg).

Varieties	Plant height (m)			Pseudostem perimeter (cm)			Number of leaves			Bunch biomass (kg)
	III	IV	V	III	IV	V	III	IV	V	
Curare enano	2.07 b	2.44 b	2.58 b	21.11 a	63.67 a	54.11 b	7.89 a	8.89 a	6.56 a	11.21 a
Dominico Hartón	2.98 a	3.48 a	3.96 a	20.56 a	63.00 a	63.67 a	7.79 a	9.33 a	7.11 a	12.07 a

Averages with common letter are not significantly different ($P > 0.05$).

Conclusion

The level of damage varied according to the plantain variety evaluated, with “Dominico Hartón” being the cultivar that showed the highest damage levels. Regarding the morphological variables, it was observed that only variety had a significant effect on plant height, with “Dominico Hartón” being superior in all evaluated phases. For pseudostem circumference, statistical significance was detected only in phase V (harvest) for the same cultivar.

Since no statistical differences were found between treatments (physical and chemical disinfection methods), the use of physical methods is suggested, as they are more environmentally friendly. Furthermore, it is recommended that future studies evaluate these

treatments over multiple production cycles in order to minimize the use of agrochemicals.

Conflict of interest

The authors declare that they have no conflicts of interest in this publication at any stage.

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Author's contribution statement according to the CRediT classification

Leonardo Avellán-Vásquez: conceptualization, methodology, research, formal analysis, original draft-writing, drafting-revising and editing. **Diana Alava-Cruz:** formal analysis, original draft-writing, drafting-revising and editing. **Gema Moreira-Basurto:** data curation. **Manuel Meza-Loor:** drafting-revising and editing.