ROOTSTOCK COMPATIBILITY OF MAGUILAS F1 TO SELECTED HIGH YIELDING VARIETIES OF TOMATO SCION

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ABSTRACT

Tomato (Lycopersicon esculentum) is a globally significant crop, but its cultivation is severely hindered by waterlogging during the rainy season, leading to significant yield losses for farmers, particularly in areas like San Jose, Occidental Mindoro. Grafting offers a promising solution by combining high-yielding scions with waterlogging-tolerant rootstocks. This study investigated the grafting compatibility of three high-yielding tomato scion varieties (Diamante Max F1, Jewel F1, and Garnet F1) with the waterlogging-tolerant Maguilas F1 as a rootstock. Using a Completely Randomized Design (CRD) in a controlled healing chamber, we evaluated grafting success rate, height increment, and days to callus formation. Results showed that the Maguilas F1 and Diamante Max F1 combination exhibited significantly higher grafting success rates (mean = 82.22%) and greater height increments (mean = 3.47 cm) compared to Jewel F1 and Garnet F1. Diamante Max F1 also consistently formed callus earlier, indicating faster wound healing. While there was no statistically significant difference in days to callus formation across treatments, Diamante Max F1's quicker healing contributed to its superior performance. These findings highlight Diamante Max F1 as the most compatible scion for Maguilas F1 rootstock, offering a viable strategy for improving tomato cultivation during adverse rainy season conditions and potentially increasing farmer profitability and consumer access to affordable tomatoes.

Keywords*: callus, compatibility, grafting, rootstock, Solanum lycopersicum*

SDG: *SGD 2: Zero Hunger*

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INTRODUCTION

Tomato (Lycopersicon esculentum) is one of the most economically significant crops in the world (Akotowanou et al., 2022). In the Philippines, tomato is the top 25 profitable crop. The average yield per hectare is around 13,744 kg, the production cost per kilogram is PhP19.48 and the farmgate price per kilogram is PhP28.19. The gross return of tomato is PhP387,433, total cost averaging PhP267,785 and the net return is PhP119,648. Lastly, the return on investment for tomato production is 45% (Gomez, C.J.J., 2024).

However, local farmers in San Jose, Occidental Mindoro are discouraged to plant tomato during rainy season (June to August). Tomatoes cannot survive continues rain, which resulted to low yield and death of seedlings planted. Tomatoes are very sensitive to waterlogging (Pandey et al., 2021). Plant growth and development are impacted by waterlogging because it reduces the amount of oxygen that reaches the submerged tissues of plant roots (Tareq et al., 2020). Waterlogging will result in hypoxia in roots, or the insufficiency of oxygen. Oxygen is needed by root cells to perform respiration (Ide et al., 2021). Hypoxia inhibits root development, yield reduction and early senescence of leaf (Goto et al., 2022). According to Latifah et al., (2018), thirty percent less was produced by tomato plants that were water-logged for two days during their vegetative period.

One technique to lessen the detrimental effect of water logging on tomato output is by grafting the scions of tomatoes to a rootstock that are resistant to waterlogging. Grafting tomato plants on abiotic stress-tolerant rootstocks has been shown to improve yield (Turhan et al., 2015). However, in grafting, rootstock and scion compatibility test must be done. The changing availability of rootstock varieties, the relative lack of information on most of them, and the different sets of traits they contain makes selecting rootstock varieties difficult. Grafting tests are an important means for evaluating the compatibility between rootstocks and scions (Mao et al., 2022). Rootstocks are selected for rooting and grafting capacity, abiotic and biotic stress tolerance and their ability to beneficially alter scion phenotypes. Using the right rootstocks will aid tomatoes that are under water stress (Schwarz et al., 2010).

On the other hand, high yielding varieties such as Dimante Max F1, Jewel F1 and Garnet F1 will serve as scion. If positive results are obtained, this study greatly helped tomato farmers and the consumers. The cultivation of tomatoes during rainy season when supply is low and prices are high can give farmers better profit and while consumers will have access to tomato at fair price. Whereas several tomato rootstock accessions are used commercially to provide tolerances to salinity and temperature, no tomato rootstock has demonstrated a notable level of resilience to flood conditions to yet. Therefore, finding a rootstock that can withstand flooding would allow tomatoes to be grown in flooded environments. A strong candidate is eggplant, a close relative of tomatoes with numerous cultivars whose roots can withstand longer in moist soils (Petran & Hoover, 2013).

The above scenario prompted the researcher to test the compatibility of Maguilas F1 as rootstock for high yielding varieties of tomato planted by farmers. Grafting onto resistant rootstocks like Maguilas F1 can control bacterial wilt caused by Ralstonia solanacearum, achieving up to 100% control (Albuquerque et al., 2021).

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The objective of this study is to determine the grafting compatibility of different scions (Diamante Max F1, Jewel F1 and Garnet F1) to Maguilas F1 rootstock.

METHODS

Study Design

This study used the experimental method of research following laid- out in Completely Randomized Design (CRD). This is the appropriate design because the study was conducted inside a healing chamber where a cover and air cooler were installed to partially control humidity and temperature.

The treatment levels used were as follow:
T_1 – Maguilas F1 (root stock) x Diamante Max F1 (scion)
T_2 – Maguilas F1 (root stock) x Jewel F1 (scion)
T_3 – Maguilas F1 (root stock) x Garnet F1 (scion)

Study Settings

This study was conducted at the Nursery and Developmental Project of Occidental Mindoro State College, Yaw-yawi I, Murtha, San Jose, Occidental Mindoro.

Materials

Table 1. Materials used in this study.

Quantity	Unit	Materials
450	Pcs	Maguilas F1 Seedlings
150	Pcs	Diamante max F1 Seedlings
150	Pcs	Jewel F1 Seedlings
150	Pcs	Garnet F1 Seedlings
3	Pcs	Spade
5	Pcs	Blade
3	Pcs	Air cooler
1	Sack	Garden Soil
1	Sack	Organic Fertilizer
1/2	Sack	Rice Hull
450	Pcs	Grafting silicone clips
9	Pcs	Seedling trays
5	Yards	UV sheet
1	Pc	Ruler

Experimental Layout

Table 2 shows the layout of the experiment. The three (3) treatments were replicated 3 times and were randomly assigned to each plot using draw lots.

Table 2. Experimental layout of the study.

T_2R_2	T_2R_1	T_1R_1
T_3R_1	T_1R_2	T_3R_2
T_3R_3	T_2R_3	T_1R_3

Preparation of Seedlings

The growing media used in this study were garden soil, organic fertilizer and rice hull/mixed in 1:1:1 ratio. Garden soil was used because it allows good air and water movement, and it holds water very well in their small pores spaces and can drown roots. Organic fertilizer provides the necessary nutrients for the tomato seedlings to grow. Rice hull, on the other hand, helped improve drainage water holding capacity, and aeration. The media were mixed thoroughly, then it was sterilized using hot-plate method. This is to ensure that the growing mixture is free from any disease-causing organism.

The media was then poured to the seedling trays and 1 seed per hole was sown. The seedling trays were placed in the greenhouse to prevent pest and diseases infestation.

Grafting

The seedlings were grafted 25 days after germination or when the seedlings' stem diameter were already 2.5cm. Monitoring of seedlings' diameter was done using vernier caliper. Prior to grafting seedlings were hardened by slowly exposing them to sunlight.

Cleft grafting was used in this study. Prior to grafting, seedlings were watered to avoid dehydration. Using a sterilized blade, rootstock was cut 3 cm from the base of the stem. Then a 1 cm vertical cut was made from the root stock. Scion seedling with the same diameter as the rootstock were prepared. The length of the scion was 6 cm from its apical buds. The scion stem was trimmed into a wedge shape with two diagonal cuts. Then it was inserted into the rootstock. The wound was sealed using a grafting clip. A total of 30 seedlings were grafted per treatment plot.

Healing of Grafted Seedlings

After grafting, seedlings were placed in a healing chamber covered with UV sheet plastic. The healing chamber was placed in a shaded area with a bit of sunlight which favors the healing of grafted seedlings. Three air coolers were installed inside the chamber to reduce the temperature and prevent the dehydration of seedlings. Maintaining the low relative humidity (RH) through air coolers were maintained for 1 week, then gradual lowering of RH was done. The seedlings stayed in the healing area for two weeks.

Healing Chamber

A three-layer desk made of bamboo splinters and *bubutahe* tree. The chamber was 153.5 cm tall, 68 cm wide and had a length of 158 cm. Three layers of beds were constructed. The chamber will be covered with UV sheets.

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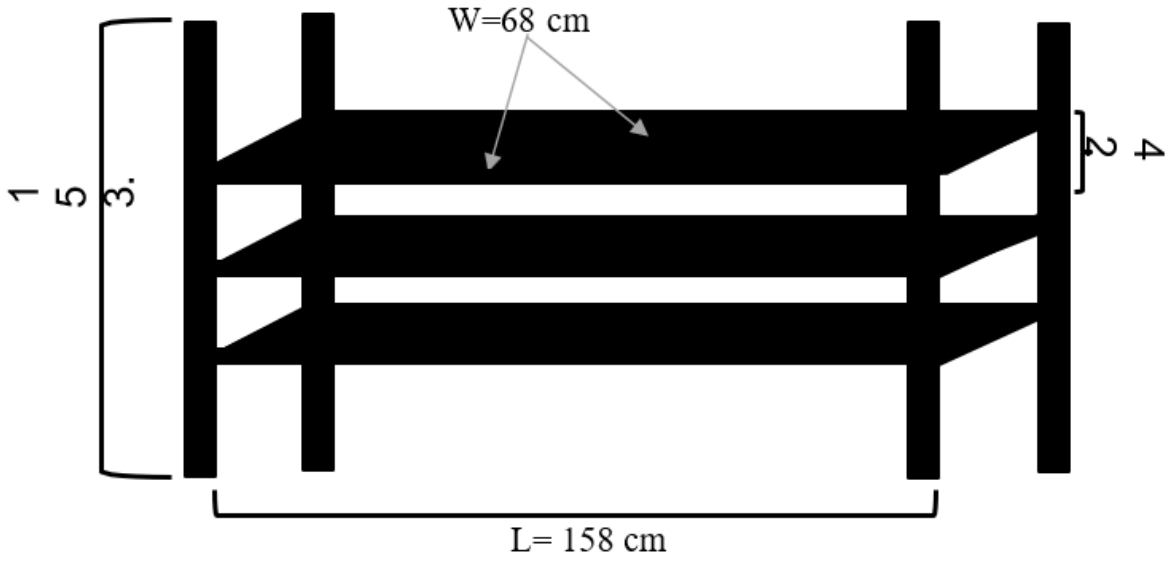

Fig. 1. Illustration of healing chamber

Water Management

Watering of grafted seedlings was done depending on the soil moisture. The grafted seedlings were watered cautiously below the grafted part using the improvised watering tool.

Unit of Analysis and Sampling

Data was measured from 20 grafted tomatoes per replication. Each plant was labelled as P1, P2, P3...P30. Twenty sample plants were randomly selected using draw lots.

Statistical Analysis

Various data were gathered from the experiment and were analyzed using the Analysis of Variance. Difference among treatments was determined using Least Significant Differences (LSD) at 5% level of significance.

Scope and Limitations

This study focused only on the rootstock compatibility of Maguilas F1 to Diamante F1, Jewel F1 and Garnet F1 scion. Therefore, the results of this study are limited only in the mentioned varieties. Growth and yield response of grafted tomatoes were within the scope of this study. The result of this study was limited only to cleft grafting. Grafting conducted when the seedlings' stem diameter was already 2.5cm. The study duration was for twenty-one days. After grafting, seedlings were placed in a healing chamber covered with UV sheet plastic. The healing chamber was placed in a shaded area with a bit of sunlight which favors the healing of grafted seedlings.

RESULTS

Grafting Success Rate

This data presents three treatments (T_1, T_2, T_3) with their respective success rates across three repetitions (R_1, R_2, R_3), along with total and mean success rates. T_1 (Diamante F1) has the highest mean (82.22%) success rate, followed by T_2 Jewel F1 (72.22%). On the other hand, grafted T_3 Garnet F1 had the lowest (68.89%) success rate.

Table 3. Rootstock compatibility of Maguilas F1 to selected high yielding varieties of tomato scion in terms of success rate (%).

TREATMENT	REPLICATION			TREATMENT TOTAL	TREATMENT MEAN
	R_1	R_2	R_3		
T_1 (Diamante Max F1)	76.67	83.33	86.67	246.67	82.22 a
T_2 (Jewel)	66.67	76.67	73.33	216.67	72.22 b
T_3 (Garnet)	66.67	73.33	66.67	206.67	68.89 b
Grand Total				670.00	
Grand Mean					74.44

Legend: Mean(s) with the same letter(s) do not differ significantly by the Least Significant Difference (LSD) at 5% level.

Furthermore, Table 4 presents the Analysis of Variance in CRD for Rootstock Compatibility of Maguilas F1 to selected high yielding varieties of tomato scion in terms of grafting success rate (%). The result shows that the computed P-value (0.03), which is higher than critical value of 5.14 suggest that there is a significant difference among the treatments, meaning that the treatments have a statistically significant effect on the outcome. On the other hand, the compatibility with T_1, T_2 and T_3 with mean of 82.22%, 72.22% and 68.89% are significantly different among treatments as determined by LSD at 5% level of significance. Thus, the experiment rejected the null hypothesis.

Table 4. Analysis of Variance in CRD for Rootstock compatibility of Maguilas F1 to selected high yielding varieties of tomato scion in terms of success rate (%).

Source of Variation	df	SS	MS	F	P-value	F crit
Treatment	2	288.89	144.44	6.50*	0.03	5.14
Error	6	133.33	22.22			
-Total	8	422.22				

**Significant, CV=6.33%*

Height Increment

Table 5 shows the height increment of grafted tomatoes. The increased in height of grafted varies significantly depending on the varieties used as a scion. The combination of Maguilas F1 and Diamante Max F1 variety significantly produced taller (mean=3.47 cm) plants compared to Jewel F1 (mean=2.20 cm) and Garnet F1 (mean=2.30 cm). This result further verifies the compatibility of Maguilas F1 (rootstock) and Diamante Max F1 (scion). The result in increased height could attributed to early callusing of Diamante Max F1

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Table 5. Rootstock compatibility of Maguilas F1 to select high yielding varieties of tomato scion in terms of height increment (cm).

TREATMENT	REPLICATION			TREATMENT TOTAL	TREATMENT MEAN
	R_1	R_2	R_3		
T_1 (Diamante Max F1)	4.00	3.10	3.30	10.40	3.47 a
T_2 (Jewel)	2.00	2.20	2.40	6.60	2.20 b
T_3 (Garnet)	2.10	2.70	2.10	6.90	2.30 b
			Grand Total	23.90	
			Grand Mean		7.97

Legend: Mean(s) with the same letter(s) do not differ significantly by the Least Significant Difference (LSD) at 5% level.

Table 6 presents the Analysis of Variance in CRD for rootstock compatibility of Maguilas F1 to select high yielding varieties of tomato scion in terms of height increment (cm). The ANOVA result shows highly significant difference among treatments, it posted a computed P-value of 0.01, which is much lower than allowable limit of 0.05. Test revealed that there is highly significant difference among T1, T2, and among T3. Thus, the experiment rejected the null hypothesis.

Table 6. Analysis of Variance in CRD for Rootstock Compatibility of Maguilas F1 to select high yielding varieties of tomato scion in terms of height increment (cm).

Source of Variation	df	SS	MS	F	P-value	F crit
Treatment	2	2.98	1.49	11.64**	0.01	5.14
Error	6	0.77	0.13			
Total	8	3.74				

***Highly Significant, CV=4.52%*

Days to Callus Formation

Table 7 shows that the days to callus formation in the point of junction between rootstocks and scion between varieties of tomatoes. Consistently, Diamante Max F1 developed callus on the point of junction earlier than Jewel F1 and Garnet F1 varieties. This implies that Diamante Max F1 healed its wound faster than the two said varieties. This also explains why Diamante F1 has higher success rates and higher height increment.

Table 7. Rootstock compatibility of Maguilas F1 to selected high yielding varieties of tomato scion in terms of number of days to callus formation

TREATMENTS	REPLICATION			TREATMENT TOTAL	TREATMENT MEAN
	R_1	R_2	R_3		
T_1 (Diamante Max F1)	13.48	13.92	13.85	41.24	13.75
T_2 (Jewel)	14.15	14.17	14.13	42.45	14.15
T_3 (Garnet)	14.15	13.86	14.15	42.16	14.05
			Grand Total	125.86	
			Grand Mean		41.95

Table 8 presents the analysis of variance in CRD the number of days to callus formation after grafting. Result show by the computed P-value (0.050) that there is no significant difference among treatment groups at the 5% level. This is lower than the critical value of 5.143 at 5% level of significance. Thus, the experiment failed to reject the null hypothesis.

Table 8. Analysis of Variance in CRD for the Rootstock Compatibility of Maguilas F1 selected high yielding varieties of tomato scion in terms of number of days to callus formation.

Source of Variation	df	SS	MS	F	P-value	F crit
Treatment	2	0.266	0.133	4.76	0.050	55.143
Error	6	0.168	0.028			
Total	8	0.434				

Not Significant, CV= 1.19%

DISCUSSION

Diamante Max F1 had the highest success rate (mean=82.22%) and were found to be significantly higher compared to Jewel and Garnet F1. This implies that Diamante Max F1 has higher rate of survivability compared to Jewel F1 and Garnet F1 in terms of success rate. This positive outcome is attributed to the fast recovery and superior adaptability of Diamante max F1 than Jewel and Garnet F1. The adaptability of grafted seedlings depends on the ability to recover when under stress. Varieties with high adaptability tend to have higher rate of survivability (Duan et al., 2023). One factor that contributes to success rate of graft is the speed of callus formation in wounds. Varieties that heal earlier tend to have higher success rate and adjust faster. Additionally, varieties with such characteristics are compatible to use as scion.

Another factor is the adaptability of scion to low humidity. Low humidity can cause disease occurrence. Increasing relative humidity significantly increased the percentage of diseased plants during the healing and acclimatization period. High diseased plant was the cause in the reduction and final survival rate of grafted tomato under high humidity conditions. This further explains the superiority of Diamante max F1 in terms of resiliency and adaptability (Vu et al., 2013)

Scion significantly influences the growth characteristics of grafted tomatoes. It was also revealed that grafted seedlings that heals faster had higher biomass and height increments (Mahbou et al., 2022). The type of scion (variety) used in grafting can influence the growth of the grafted tomato plant. For example, certain scions may exhibit greater height gain than others. Faster healing of the graft union between the rootstock and scion is associated with higher biomass and height increments. This indicates that the plant's ability to quickly establish a connection between the two parts affects its growth potential (Cacayurin et al., 2024). Rootstocks and scions can have varying levels of compatibility and may impact the growth of the grafted tomato. The interaction between rootstock and scion can influence factors like fruit quality, yield, and disease resistance (Mauro et al., 2020). Environmental factors such as light, wind, and temperature can also affect graft-take and the growth of grafted tomato seedlings (Ding et al., 2023). Faster-healing grafted seedlings exhibit higher biomass and height increments compared to slower-healing seedlings. This suggests that the scion's

health and vigor play a crucial role in the overall growth and development of the grafted tomato plant (Khopade et al., 2025).

The accelerated wound healing process in Diamante max F1 tomatoes compared to Jewel F1 and Garnet F1 tomatoes can be attributed to several underlying mechanisms, primarily involving enhanced cellular responses and signaling pathways. Wounding in grafted planted induces the expression of wound induced dedifferentiation. This mechanism is mediated by auxin and cytokinin (Daniello et al., 2024). There is an increased amount of auxin and cytokinin in grafted tomato, especially on its wound. Increased auxin and cytokinin content promote callus formation at the wound union. Conversely, while Diamante max F1 exhibits superior healing capabilities, Jewel F1 and Garnet F1 may have less efficient wound induced dedifferentiation, potentially leading to slower wound healing responses (Duan et al., 2023).

CONCLUSION

Based on the finding's compatibility of Maguilas as rootstock varies depending on varieties of tomato. Maguilas F1 and Diamante Max F1 scion consistently performed the best across all parameters, with the highest success rate, the greatest height increment, and the shortest time to callus formation. This variety is recommended as the most effective, given its statistically superior performance across all measured outcomes. There is significant difference on the rootstock compatibility of Maguilas F1 and the different varieties of tomato scion.

Based on the relevant findings the researcher recommends utilizing metal equipment when constructing a healing chamber. Use Maguilas F1 as rootstock and Diamante max F1 as scion in tomato production. Conduct a follow-up study on the growth and yield performance of the grafted varieties of tomato. Comparative analysis of different varieties of tomatoes used in the study.

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