Project Annual Report 2025-2026

California Grape Rootstock Improvement Commission

1. Summary

Project Title: Evaluation of Five Rootstocks under Saline Irrigation for Two Wine Grape Varieties in the Southern San Joaquin Valley

Principle Investigator (PI): George Zhuang

Summary:

A rootstock field trial was established in 2021 at the University of California West Side Research and Extension Center. The first replicated field experiment evaluated two wine grape varieties, Colombard and Barbera. A two-way (2 × 5) factorial split-block design was implemented, consisting of two water-deficit irrigation treatments and five rootstocks, with four replications. Each experimental unit contained seven vines. Water deficit treatments were assigned at the row level, with one vine row receiving a single irrigation treatment, and the five rootstocks randomized within each row.

A second, non-replicated field trial was established for demonstration purposes and included nine grape varieties grafted onto the same set of rootstocks. Vines for both trials were planted in July 2021, and deficit irrigation treatments were imposed during the 2024 and 2025 growing seasons. Data for GRN-3 and Ramsey rootstocks were not collected during the review period due to delayed planting.

Through both years, water deficit treatments had a stronger effect than rootstock on vine water status, leaf gas exchange, berry weight, and final yield. In contrast, rootstock selection had a major influence on boron uptake, with consistent effects observed across 2023 and 2024.

2. Annual or Final Report

This is an annual report (year 5)

3. Project Title and UGMVE proposal number

"Evaluation of Seven Rootstocks under Saline Irrigation for Eleven Grape Varieties in the Southern San Joaquin Valley." (Proposal # 2022-2724)

4. Principle Investigator/Cooperator(s)

Principle Investigator:

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5. Objective and Experiments Conducted to Meet Stated Objective

Project Objective

Rootstocks are widely used in grape-growing regions and have been extensively studied, primarily for protection against soilborne pests such as nematodes and phylloxera. However, implementation of the Sustainable Groundwater Management Act (SGMA), combined with prolonged drought in the southern San Joaquin Valley (SJV), is creating increasing challenges for growers by limiting access to high-quality irrigation water and necessitating greater reliance on saline well water.

The objectives of this project are to evaluate the performance of *Vitis vinifera cv.* Colombard and Barbera grafted onto seven rootstocks under two water deficit regimes using saline irrigation water in the southern SJV. In addition, a variety demonstration plot will be established to support extension activities and grower observation. This non-replicated demonstration trial will provide practical field information on yield and fruit quality characteristics for nine additional grape varieties grafted onto the same seven rootstocks.

The overarching objective of both the replicated research trial and the non-replicated demonstration trial is to identify rootstocks that confer improved tolerance to salinity and drought while maintaining high yield and desirable fruit and wine quality under saline growing conditions.

Experiments

Vineyard Site: The experiment is conducted at University of California, Westside Research and Extension Center (WSREC) in Fresno County, CA (36°20'36.6"N 120°06'32.9"W). The soil type of the planting site is Cerini clay loam with 85% Cerini clay, described as well drained (www.nrcs.usda.gov). Planting density is 6’ × 10’ (vine × row) with North to South row orientation. The vineyard is drip-irrigated with two pressure-compensating emitters per vine at the distance of 36” and each delivers 0.5 GA/hr. The replicated field trial, Barbera (red/black cultivar) and Colombard (white cultivar), were trained in the bilateral cordons and the other nine varieties were trained the same to establish the non-replicated demonstration trial. The grapevine cordon is trained to 1.7 m (68”) height above the vineyard floor, and vines will be mechanically pruned after the year 3 according to Zhuang et al. 2019.

Plant Materials: The replicated trial focuses on *Vitis vinifera cv.* Barbera and *Vitis vinifera cv.* Colombard and the non-replicated demonstration trial includes the other nine varieties, such as

Rubired, Syrah, Caberent Sauvignon, Chardonnay, Pinot Gris, Chenin Blanc, Muscat of Alexandria, Primitivo, and Sunpreme. Seven rootstocks are assigned to the vine row.

Experimental Design: The field trial for Vitis vinifera cvs. Colombard and Barbera was established using a two-way factorial (two water-deficit treatments × seven rootstocks) split-block design with four replications. Water deficit treatments served as the main plots and included: (a) severe water deficit at 40% ETc and (b) moderate water deficit at 80% ETc. From budbreak to bloom, both treatments received 80% ETc. Differential irrigation treatments were imposed from fruit set through harvest by adjusting the number of emitters per vine, with one emitter per vine for the severe water deficit treatment and two emitters per vine for the moderate water deficit treatment.

Seven rootstocks were assigned as subplots within each vine row, and each experimental unit consisted of seven vines. In addition, a non-replicated demonstration trial was established that included nine grape varieties. Each variety was planted in a single vine row, with the same seven rootstocks assigned within each row.

Soil and Irrigation Water Test: Well water sampled in 2016 indicated high pH (pH at 9.3) and high boron (B at 1.3 ppm). Irrigation water and soil were sampled in 2021, 2023, and 2025 to monitor the salinity level on site, and data were presented in Table 1.

6. Summary of Major Research Accomplishment and Results by Objective

The experimental vines (green potted vines) were planted in July 2021, and stakes, wires, and drip hoses were installed immediately thereafter. Due to limited plant availability, GRN3 and Ramsey rootstocks were planted one year later in July 2022; therefore, data from these two rootstocks were not collected during the current reviewing cycle. As the experiment progressed, differential foliar symptoms of boron toxicity were observed among treatments (Figure 1).

Petiole samples were collected at bloom and veraison in both years, and rootstock had a major effect on boron uptake (Figure 2A and 2B). Own-rooted vines and 1103 Paulsen consistently exhibited lower petiole boron concentrations. In contrast, measurements of midday leaf water potential and leaf gas exchange indicated that water-deficit treatments had a more pronounced effect on vine water status and photosynthetic rate than rootstock (Table 4; Figure 3A and 3B).

Harvest yield components for Barbera and Colombard are presented in Tables 2 and 3. Water deficit had a stronger effect on yield than rootstock, primarily through reductions in berry weight. Notably, scion cultivars responded differently to boron toxicity: Barbera showed more severe toxicity symptoms than Colombard despite being grown under the same rootstock and irrigation treatments (Figure 1). These field observations are consistent with previous findings by Christensen (2003), which reported greater boron tolerance in Colombard and higher susceptibility in Barbera.

These results highlight the importance of evaluating the same rootstocks across multiple scion cultivars, as scion-specific differences in boron susceptibility may contribute to variation in yield and vine performance. Interactions between scion and rootstock may therefore explain some of the observed differences among scion and rootstock combinations.

7. Outside Presentations of Research

2023 UC ANR Kearney Grape Day

2023 Sustainable Ag Expo at San Luis Obispo

2025 San Joaquin Valley Grape Rootstock Field Day at UC West Side REC

8. Research Success Statements

9. Funds Status

Fund from 2025-26 will be fully spent to cover the cost of pruning and plant tissue test in the winter of 2025.

Literature Cited

Zhuang, S., Fidelibus, M., Kurtural, K., Lund, K., Torres, G., Stewart, D., and Summer, D. (2019) Sample Cost to Establish A Vineyard and Produce Winegrapes. University of California Agricultural and Natural Resources. 2019 Sample Costs to Establish a Vineyard and Produce Winegrapes – Fresno, Madera, Merced, and Stanislaus Counties – Cabernet Sauvignon Variety (ucdavis.edu).

Christensen, L. P. (2003) Wine Grape Varieties of California. University of California Agricultural and Natural Resources. First Edition. ISBN-13: 978-1879906631.

Figure 1. Barbera (left) leaf showed typical boron toxicity and Colombard (right) canopy showed no symptom under the same rootstock and irrigation management

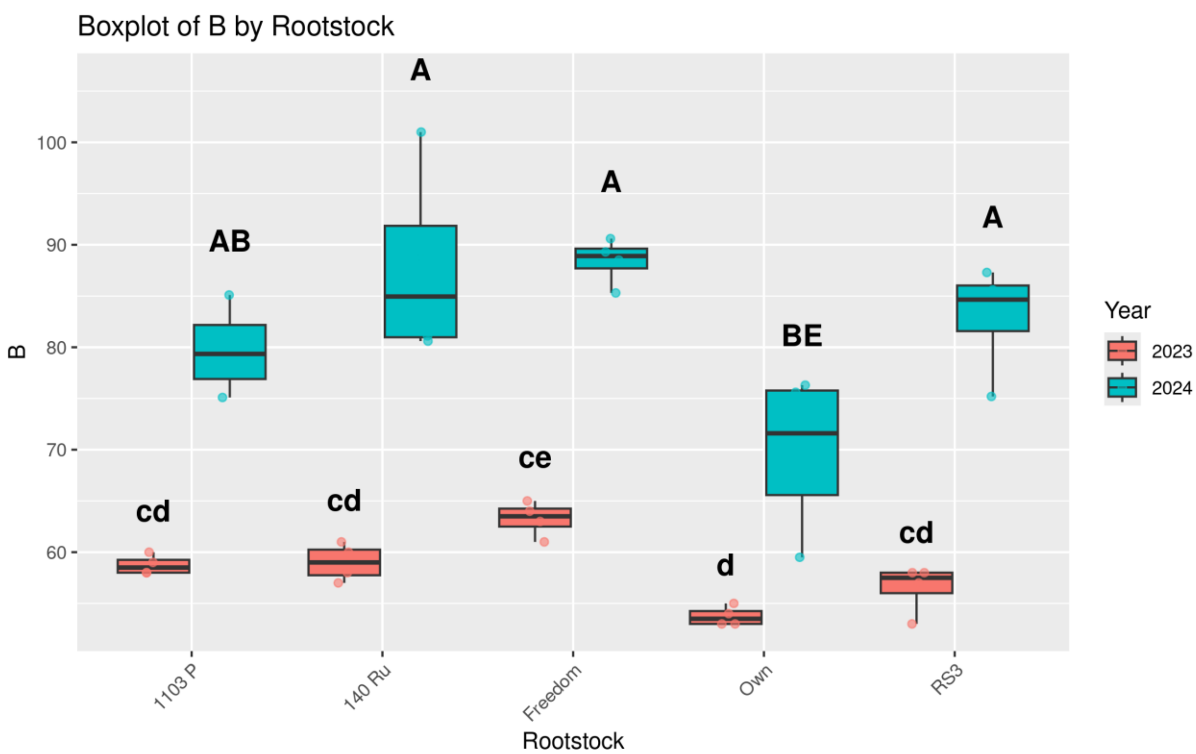

Figure 2 A. Barbera grapevine petiole boron at bloom timing in 2023 and 2024

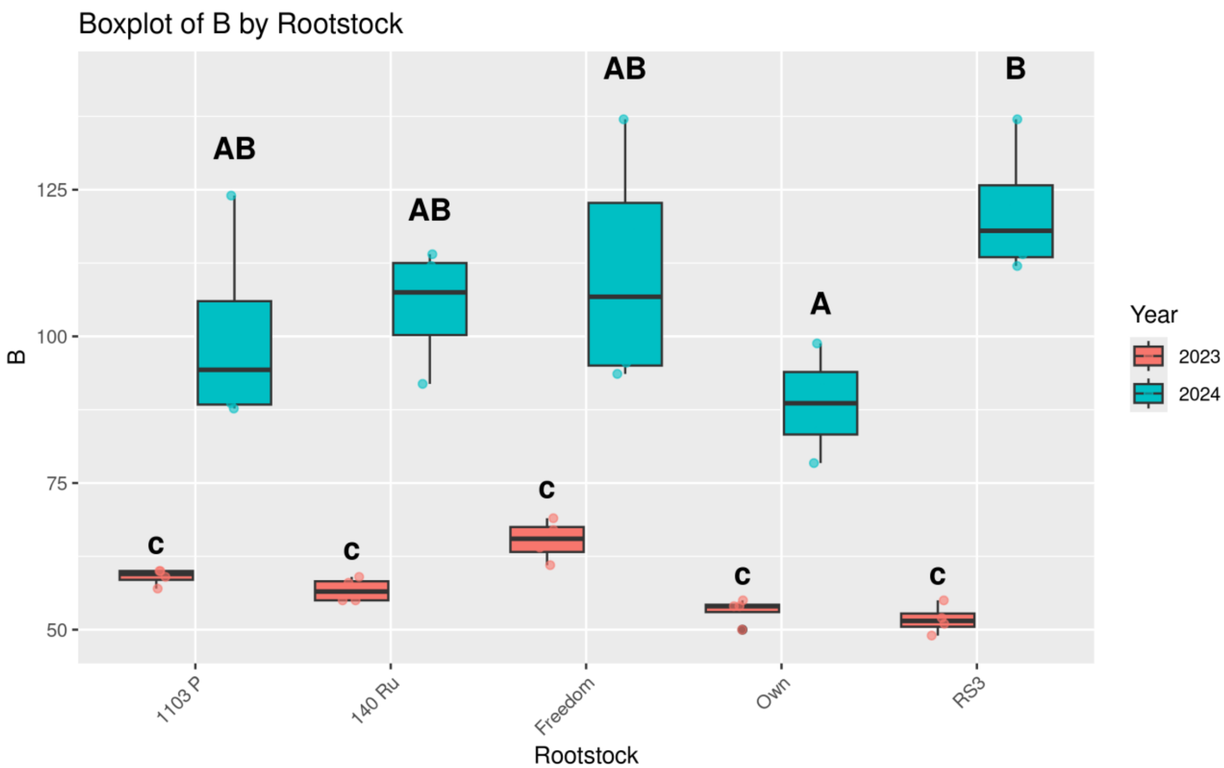

Figure 2 B. Colombard grapevine petiole boron at bloom timing in 2023 and 2024

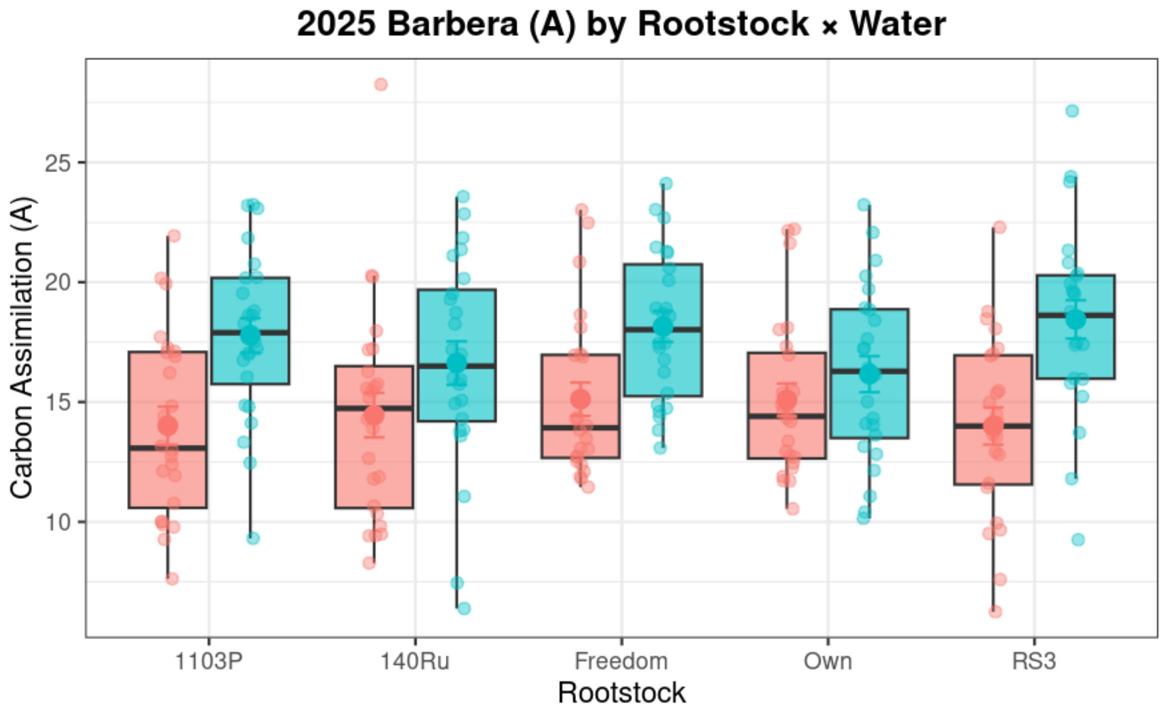

Figure 3 A. Midday leaf carbon assimilation rate for Barbera vines in 2025 with red colored boxes represent the severe water deficit treatment and blue colored boxes represent the moderate water deficit treatment.

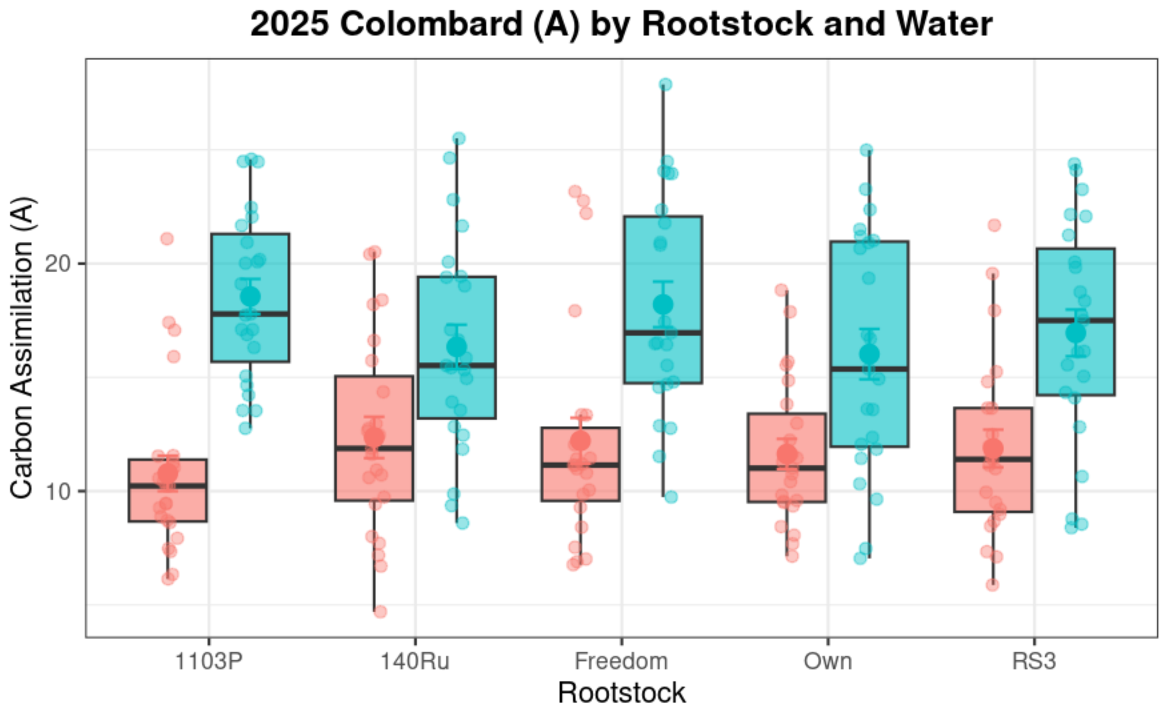

Figure 3 B. Midday leaf carbon assimilation rate for Colombard vines in 2025 with red colored boxes represent the severe water deficit treatment and blue colored boxes represent the moderate water deficit treatment.

Table 1. Soil chemistry on the rootstock experimental site at UC WSREC

Soil depth (in)	**pH**	**EC (ds/m)**	**B (ppm)**
		2021	
0-12	7.6	1.00	0.5
12-24	7.9	1.00	0.5
24-36	7.8	0.60	0.4
		2023	
0-12	7.6	1.46	1.8
12-24	7.6	1.79	1.0
24-36	7.7	1.76	0.9
		2025	
0-12	7.8	1.73	0.9
12-24	8.0	0.91	0.6
24-36	8.1	1.06	0.6

Table 2. The harvest yield components of *Vitis vinifera cv.* Barbera in 2024 and 2025

	Yield (tons/acre)		**Berry weight**		**TSS (Brix)**		**TA (g/L)**	
Water deficit	S[a]	M[b]	S	M	S	M	S	M
Rootstock				**2024**				
1103 Paulsen	6.2	9.2	1.0 a[c]	1.2 b	23.6 a	25.4 b	6.2	6.0
140 Ruggeri	8.5	8.9	1.1	1.1	23.4 a	24.6 b	6.0	6.3
Freedom	9.0	10.5	1.1 a	1.2 b	24.3 a	25.4 b	5.2	5.4
RS 3	8.9	9.3	1.0 a	1.1 b	25.5	25.6	6.6	6.3
Own root	8.1	8.0	1.2	1.2	24.1 a	25.9 b	6.1	5.6
				2025				
1103 Paulsen	8.2	15.7	1.1 a	1.4 b	25.6	24.9	6.2	6.4
140 Ruggeri	10.7	14.3	1.1 a	1.4 b	25.9	25.5	6.0	6.5
Freedom	11.5	18.5	1.1 a	1.5 b	25.6	25.1	5.7	6.3
RS 3	12.2	15.0	1.3	1.4	25.4	25.2	6.1	6.1
Own root	12.2	16.3	1.2 a	1.4 b	26.0	25.2	6.4	6.5

[a]Severe water deficit

[b]Moderate water deficit

[c]Different letters within columns represent significant differences according to Tukey's honestly significant difference at $p<0.05$.

Table 3. The harvest yield components of *Vitis vinifera cv.* Colombard in 2024 and 2025

	Yield (tons/acre)		**Berry weight**		**TSS (Brix)**		**TA (g/L)**	
Water deficit	S[a]	M[b]	S	M	S	M	S	M
Rootstock	**2024**							
1103 Paulsen	14.6	15.0	1.2 a[c]	1.3 b	19.7	19.8	6.8	6.5
140 Ruggeri	14.8	14.9	1.2 a	1.3 b	20.0	19.9	7.2	7.1
Freedom	14.7	14.4	1.2 a	1.3 b	20.3	20.9	7.0	6.9
RS 3	12.9	14.5	1.1	1.1	19.8	18.4	6.4 a	7.2 b
Own root	13.2	16.0	1.1 a	1.3 b	20.1	19.4	6.2	6.4
	2025							
1103 Paulsen	19.4	21.1	1.3	1.4	20.9	20.1	7.3	7.5
140 Ruggeri	18.0	19.5	1.3 a	1.5 b	20.9	20.5	6.9	7.5
Freedom	19.1	21.2	1.3 a	1.5 b	20.9 a	19.9 b	6.9 a	7.8 b
RS 3	15.2	20.2	1.2 a	1.4 b	21.4	21.0	6.2	6.9
Own root	15.7	21.1	1.2 a	1.6 b	21.4 a	20.1 b	6.6 a	7.4 b

[a]Severe water deficit

[b]Moderate water deficit

[c]Different letters within columns represent significant differences according to Tukey's honestly significant difference at $p<0.05$.

Table 4. Mean midday leaf water potential (bar) between bloom and harvest in 2024 and 2025

	***Vitis vinifera cv.* Barbera**		***Vitis vinifera cv.* Colombard**	
Water deficit	S[a]	M[b]	S	M
Rootstock	2024			
1103 Paulsen	-12.0	-10.3	-12.4	-11.3
140 Ruggeri	-12.4	-9.9	-13.3	-11.0
Freedom	-11.8	-9.8	-12.1	-11.5
RS 3	-11.3	-10.1	-13.0	-11.3
Own rooted	-11.3	-9.9	-13.8	-11.1
	2025			
1103 Paulsen	-12.0	-10.8	-13.1	-12.0
140 Ruggeri	-11.9	-10.8	-13.2	-11.8
Freedom	-12.1	-10.5	-12.9	-11.8
RS 3	-12.0	-11.2	-13.1	-12.3
Own rooted	-12.2	-10.9	-13.5	-12.0

[a]Severe water deficit

[b]Moderate water deficit