IMPACT OF SALINE AND WATER STRESS ON THE PRODUCTION OF GRAFTED PASSION FRUIT

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ABSTRACT: Passion fruit (*Passiflora edulis*) plays an essential role in agriculture in Northeastern Brazil. In this sense, the objective of this research was to evaluate the productive performance of cv. SCS437 Catarina (*P. edulis* f. flavicarpa Degener) grafted on cv. UFERSA.BRS RM 153 (*Passiflora foetida* L.) under abiotic stress. An experiment was carried out under field conditions under four irrigation depths (L) (L1 = 40%, L2 = 60%, L3 = 80% and L4 = 100% of field capacity) and four levels of electrical conductivity (EC) of irrigation water (S) (S1 = 1.5, S2 = 3.0, S3 = 4.5 and S4 = 6.0 dS m^{-1}), constituting seven treatments, T1 (L1S1), T2 (L2S1), T3 (L3S1), T4 (L4S1), T5 (L4S2), T6 (L4S3) and T7 (L4S4), and four replicates in randomized blocks. Total yield (RT), commercial yield (RC) and pulp yield (RP) were evaluated. The plants showed significant gains in total and commercial production and pulp yield under saline stress of up to 4.5 dS m^{-1}.
KEYWORDS: *Passiflora foetida* L.; abiotic stress; salinity. UFERSA BRS RM 153; SCS437 Catarina.

IMPACTO DO ESTRESSE SALINO E HÍDICO NA PRODUÇÃO E FISIOLOGIA DO MARACUJÁ ENXERTADO

RESUMO: O maracujazeiro (*Passiflora edulis* f. flavicarpa Degener) desempenha um papel essencial na agricultura do Nordeste brasileiro. Nesse sentido, o objetivo desta pesquisa foi avaliar o desempenho produtivo da cv. SCS437 Catarina (*P. edulis*) enxertada na cv. UFERSA.BRS RM 153 (*Passiflora foetida* L.) sob estresse abiótico. Foi conduzido um

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experimento em condições de campo sob quatro lâminas de irrigação (L) (L1 = 40%, L2 = 60%, L3 = 80% e L4 = 100% da capacidade de campo) e quatro níveis de condutividade elétrica (CE) da água de irrigação (S) (S1 = 1,5, S2 = 3,0, S3 = 4,5 e S4 = 6,0 dS m^{-1}), constituindo sete tratamentos, T1 (L1S1), T2 (L2S1), T3 (L3S1), T4 (L4S1), T5 (L4S2), T6 (L4S3) e T7 (L4S4), e quatro repetições em blocos casualizados. Avaliou-se rendimento total (RT), rendimento comercial (RC) e rendimento de polpa (RP). As plantas apresentaram ganhos significativos na produção total, comercial e rendimento de polpa sob estresse salino de até 4,5 dS m^{-1}.
PALAVRAS-CHAVE: *Passiflora foetida* L.; estresse abiótico; salinidade. UFERSA BRS RM 153; SCS437 Catarina.

INTRODUCTION

Brazil is the leading global producer of yellow passion fruit (*Passiflora edulis* Sims), with over 70% of national output concentrated in the Northeast (IBGE, 2022). To enhance fruit quality and yield, EPAGRI developed the cultivar SCS437 Catarina, adapted to the southern coastal region, with an average productivity of 24 t ha^{-1} (PETRY et al., 2022). However, its sensitivity to salinity restricts its cultivation in the Northeast, where saline stress is a major constraint. Lima et al. (2023) report that salinity levels above 0.3 dS m^{-1} severely reduce production.

In semi-arid regions, groundwater—often the main water source—commonly exhibits high electrical conductivity, exceeding the tolerance thresholds for passion fruit: 1.3 dS m^{-1} in soil (DIAS et al., 2011) and 2.1 dS m^{-1} in irrigation water (SOARES et al., 2002). Salinity imposes osmotic stress that limits water uptake and stomatal opening, as well as ionic stress from toxic ion accumulation in plant tissues, affecting growth, metabolism, and fruit quality (OLIVEIRA, FALEIRO & JUNQUEIRA, 2018).

To overcome these challenges, *P. foetida* L. cv. UFERSA.BRS RM 153 has emerged as a promising rootstock due to its greater salinity tolerance (SOUZA et al., 2023). Other species such as *P. morifolia*, *P. gibertii*, and *P. alata* also show potential as rootstocks (CHAVES et al., 2004; SILVA et al., 2011).

Salinity's effects on yield are variable. Cavalcante et al. (2011) observed a reduction in fruit weight at EC 2.5 dS m^{-1}, while Andrade (1998) reported no significant effects on fruit quality at the same level. Grafting cv. SCS437 Catarina onto UFERSA.BRS RM 153 may enhance tolerance and productivity under saline and water stress. This study aimed to evaluate this grafting combination's productive performance.

MATERIAL AND METHODS

The experiment was conducted in the field, installed in February 2021 at Sítio Cumaru, Upanema/RN, located at the geographic coordinates of 5° 33' 34.66" south latitude, 37° 11' 56.11" west longitude. The climate of the region is BSwh' (semiarid, hot and dry), according to the Köppen classification. The data for this study were collected in the second year of cultivation, between January and August 2022, except for the physiology data, obtained in August and October 2021. The seedlings were produced at the "Seedling Production Unit" of UFERSA/Mossoró. The UFERSA BRS RM-153 cv. was used as rootstock and the SCS437 Catarina cv. was used as graft. The grafting method used was full cleft grafting. During the seedling production process and after grafting, the seedlings remained in a greenhouse under 50% shade and were irrigated daily.

Sixty days after grafting, they were transplanted into the field. Before planting, soil collection and analysis were carried out to determine the fertilization of the foundation and covering; the values are shown in Table 1. The plants were trained in vertical espaliers. The holes were prepared with soil material from the first 10 cm and mixed with 2.0 L of sheep manure with a C/N ratio of 19:1, plus 200 g of monoammonium phosphate (MAP – 10-52-00).

Table 1: Physical-chemical characterization of soil (0 – 20 cm)

Chemical characterization								
P	K	Ca	Mg	Na	SB	EC	OM	pH
dm^{-3}	.... $cmol_c$ dm^{-3}				....	$dS\ m^{-1}$	$g\ kg^{-1}$	(H_2O)
8.6	0.51	7.7	0,6	0,1	8,91	0,07	6,9	8,1
Physical characterization								
Sand			Silt			Clay		
....%..								
78.0			6.0			16.0		

Sum of bases (SB); Electrical conductivity: EC; Organic matter: OM.

The experiment was conducted in a completely randomized block design (CRD) with four replications. Eight plots were arranged per block, one border and seven treatments, each with six plants, five useful and one border, totaling 192 plants in a spacing of 3 m between rows x 4 m between plants (830 plants/hectare). The treatments were formed by combining different irrigation depths (L) and salinity levels (S). Seven treatments were constituted, being: T1 (L1S1), T2 (L2S1), T3 (L3S1), T4 (L4S1), T5 (L4S2), T6 (L4S3) and T7 (L4S4) where "L" represents the irrigation depths (L1 = 40%, L2 = 60%, L3 = 80% and L4 = 100% of crop evapotranspiration) and "S" the electrical conductivity (EC) of the irrigation water (S1 = 1.5, S2 = 3.0, S3 = 4.5 and S4 = 6.0 dS m^{-1}).

The salinity levels of the irrigation water were obtained from tubular well water with the addition of NaCl, $CaCl_2.2H_2O$ and $MgCl_2.6H_2O$ salts, in the equivalent proportion of 7:2:1 (Table 2) and the chemical characterization of irrigation water according to electrical conductivity (EC) is in the table 3.

Table 2: Sodium (NaCl), calcium (CaCl) and magnesium chloride ($MgSO_4$) in grams per m3.

EC	**NaCl**	**CaCl**	**$MgSO_4$**
dS.m^{-1}	.... g/m^3		
1.5	0	0	0
3.0	818	0	123
4.5	1373	294	308
6.0	1929	588	492

Electrical conductivity: EC.

Table 3: Chemical characterization of irrigation water according to electrical conductivity (EC).

EC	Na	Ca	Mg	K	Cl	S04	HCO3
dS m^{-1}	.... $cmol_c$ dm^{-3}						
1.50	5.0	8.0	2.0	0.12	8.1	0.3	7.0
3.00	19.0	8.0	3.0	0.12	22.1	1.3	6.9
4.50	28.5	12.0	4.5	0.12	35.6	2.8	6.9
6.00	38.0	16.0	6.0	0.12	49.1	4.3	6.8

Total Yield (RY), Commercial Yield (CY) and Pulp Yield (PY) were evaluated. The collected data were subjected to analysis of variance using the F test ($p \leq 0.05$) and regression analysis was performed for the contrasts of slides within S1 (CEa=1.5 dS m^{-1}) and salinity within slide L4 (100% of ETc), using Excel applying the linearized model ($Y = a + b Xn$, where n = 1, 1.2, 2, 2.5 and 3) in the transformation of the data with variation of n from 1.5 to 3.0, for better adjustment of the curve and the quadratic polynomial model.

RESULTS AND DISCUSSION

The results obtained in this study for total production (Y), commercial yield (CY), and pulp yield (PY) revealed significant variations in response to increasing salinity. When contextualized alongside the findings of Viana et al. (2012), who also investigated the effects of saline irrigation on passion fruit production, similar patterns emerge. In the present study, varying irrigation depths at an electrical conductivity (EC) of 1.5 dS m^{-1} did not result in significant differences ($p \leq 0.05$) for the assessed variables. However, different salinity levels within the 100% irrigation depth significantly affected production ($p \leq 0.05$). Notably, increasing EC from 1.5 to 3.0 dS m^{-1} and to 4.5 dS m^{-1} led to production increases of 12.1% and 10.2%, respectively. Conversely, at 6.0 dS m^{-1}, a 13.9% reduction was observed relative to 1.5 dS m^{-1} (Figure 1A).

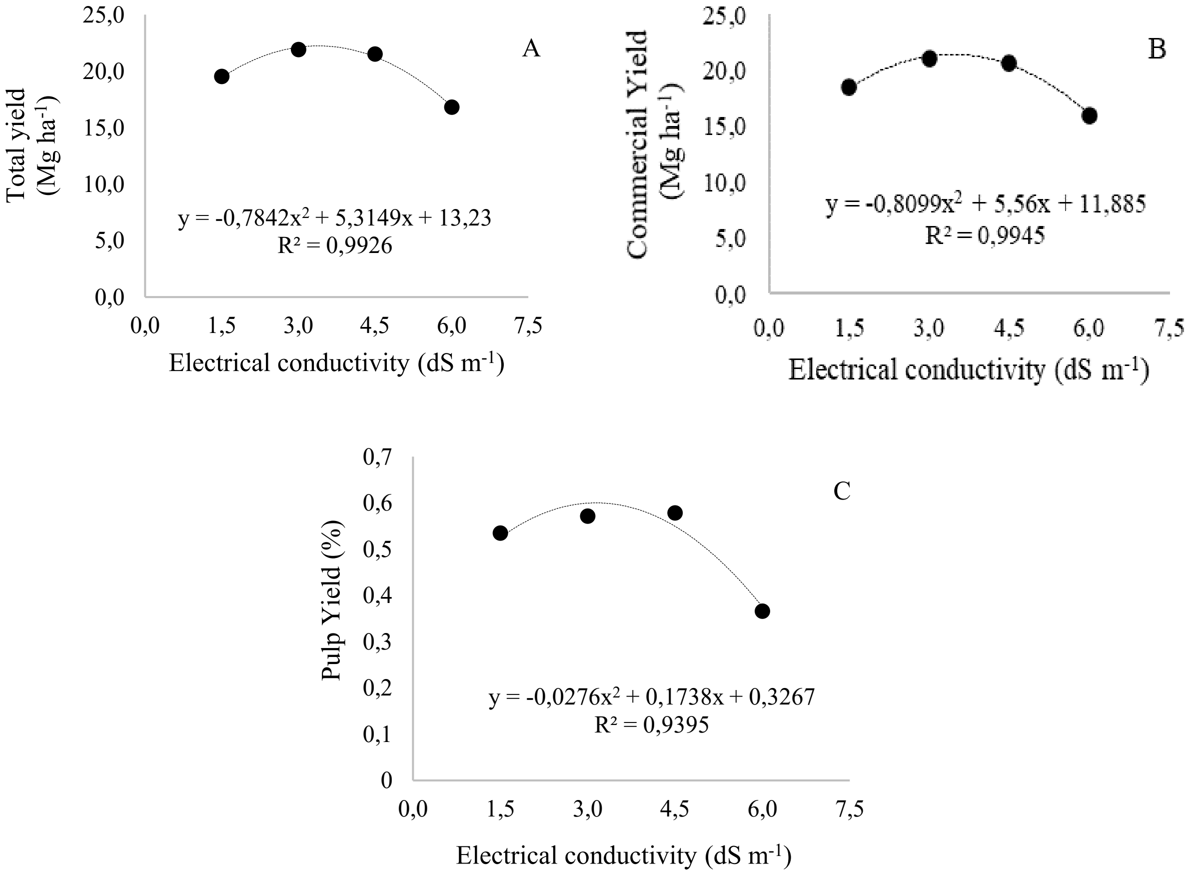

Figure 1. Total yield (Mg ha^{-1}), Commercial Yield (Mg ha^{-1}), Pulp yield (%), in passion fruit plants cv. SCS437 Catarina grafted on cv. UFERSA BRS RM-153 grown under different electrical conductivities (EC) and different water deficits. Source: Author.

These results demonstrate that increasing EC up to 4.5 dS m^{-1} may enhance production, followed by declines at higher salinity levels, consistent with Viana et al. (2012), who reported negative impacts on production at elevated salinities. However, a discrepancy arises when comparing results at 6.0 dS m^{-1}; while our study recorded a 13.9% reduction, Viana et al. (2012) observed reductions of 17.59% at 5.0 dS m^{-1} and 100% at 7.5 dS m^{-1}. Lima et al. (2023) also reported high sensitivity of cv. SCS437 Catarina to salinity, with negative effects on fruit number and yield above 0.3 dS m^{-1}. In contrast, our findings indicate that EC levels up to 4.5 dS m^{-1} improved commercial fruit quality, with significant declines only observed at 6.0 dS m^{-1}.

Commercial yield (Mg ha^{-1}) followed a similar trend, increasing by 14.1% and 12.1% at EC levels of 3.0 and 4.5 dS m^{-1}, respectively, but declining by 13.2% at 6.0 dS m^{-1} (Figure 1B). These improvements may be attributed to the use of *Passiflora foetida* L. as rootstock, which has documented salinity tolerance up to 4.0 dS m^{-1} (SOUZA et al., 2023) and appears effective up to 4.5 dS m^{-1} in this study. The strategic use of this rootstock likely contributed to the improved performance observed under moderate salinity, indicating a positive adaptive response of the grafted plants. However, the significant reduction in performance at 6.0 dS m^{-1} highlights a potential limitation in the system's tolerance, even with salinity-tolerant rootstocks. These findings support the use of rootstock selection as a promising strategy to mitigate salt stress in passion fruit cultivation.

Pulp yield (%) also followed a similar pattern. Increases of 6.8% and 8.1% were observed at EC levels of 3.0 and 4.5 dS m^{-1}, respectively. However, at 6.0 dS m^{-1}, a significant 31.6% reduction occurred compared to the yield at 1.5 dS m^{-1} (Figure 1C). The national average productivity (15.3 t/ha) and that of Rio Grande do Norte (15.6 t/ha) establish a benchmark for passion fruit productivity (IBGE, 2022). In contrast, the results of this study reveal superiority, despite notable variations in the EC of irrigation water. Productivity varied with the EC of irrigation water (Figure 3B), but all averages exceeded the national and state averages.

CONCLUSÕES

The grafting of passion fruit (*Passiflora edulis* sims) cv. SCS437 Catarina on cv. UFERSA BRS 153 promotes, in addition to greater tolerance to salinity, production gains and pulp yield up to 4.5 dS m^{-1}.

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