Research Article

ISAH Indian Journal of Arid Horticulture

Year 2025, Volume-7, Issue-2(July-December)

Assessing drought resilience through morphological adaptations and survivability of citrus rootstocks

Vishvajeet Singh[1], Akhilesh Kumar Srivastava[2*], Om Prakash[3], Arbind Kumar Gupta[4], Paramanand Prajapati[1], Shivam Chaurasia[1], Aadarsh Pandey[5] and Dhirendra Rajpoot[6]

[1]Research Scholar; [2]Professor & Head; [3]Assistant Professor; Department of Fruit Science, [4]Assistant Professor, Department of Natural Resource Management, Banda University of Agriculture and Technology, Banda, Uttar Pradesh

[5]Research Scholar, Department of Horticulture, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand

[6]Research Scholar, Department of Fruit Science, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh

ARTICLE INFO

Received:19 September 2025

Accepted: 25 September 2025

Keywords: Abiotic stress, Drought, Citrus rootstock, Citrus morphology, Survivability.

doi:10.48165/ijah.2025.7.2.8

ABSTRACT

Understanding rootstock-specific morphological responses is key to selecting resilient genotypes for water-limited orchards. A controlled pot experiment was conducted during the year 2024–25 at Banda University of Agriculture and Technology, Banda, using seven citrus rootstocks (Rangpur lime, Cleopatra mandarin, Rough lemon, Sour orange, NRCC RS-3, RS-4, RS-6) subjected to four water stress levels (control, 0.4, 0.6, and 0.8 bar) for 240 days. Plant mortality increased with stress, reaching 55.16% at 0.8 bar, with Cleopatra mandarin showing the highest mortality at 88.89%. Compared to the control, plant height, stem diameter, leaf number, leaf area, and root length declined by 26.1%, 26.3%, 46.8%, 15%, and 32%, respectively, at 0.8 bar. Rough lemon and Rangpur lime performed better, maintaining heights of 56.24 cm and 54.02 cm, leaf areas of 25.57 cm² and 23.64 cm², and root lengths of 28.02 cm and 25.94 cm. Significant interactions were noted in canopy traits, with Rough lemon having the highest leaf number (127.58) and minimal loss (45.9%), while Cleopatra mandarin showed the greatest canopy reduction (52.5% leaf loss). Although root length interactions were non-significant, Rough lemon had the least reduction (27.8%) under stress, indicating strong root plasticity. Rough lemon, Sour orange, and Rangpur lime exhibited superior drought resilience through greater canopy retention and root plasticity. These rootstocks are promising candidates for improving drought tolerance and sustaining productivity in water-limited citrus orchards.

Introduction

Citrus is one of the most important fruit crops worldwide, cultivated in over 140 countries and contributing significantly to global fruit production, trade, and rural livelihoods. However, citrus production is highly vulnerable to abiotic stresses, particularly drought, which has a devastating impact on plant growth, development, and fruit yield and quality (Wu *et al.*, 2013; Modica *et al.*, 2025). Severe water stress during the developmental stage can lead to fruit drop and produce lower-quality fruits due to increased evapotranspiration losses. Climate change is intensifying drought frequency and severity, further challenging citrus productivity in water-limited regions (Hayat *et al.*, 2022).

Corresponding author's Email: srivastavahort@yahoo.com (Dr. A.K. Srivastava)

Additionally, drought creates an imbalance between root water uptake and water loss through transpiration, resulting in dehydration and further reducing photosynthetic rates (Garcia-Sanchez *et al.*, 2007; Arbona *et al.*, 2005). These factors significantly impact citrus production, particularly in developing countries. Rootstock selection is a key strategy to mitigate drought effects because rootstocks differ in root architecture, hydraulic conductance, and hormonal signalling that regulate water uptake and stomatal control (Santana-Vieira *et al.*, 2016; Balfagón *et al.*, 2022). Studies have shown that drought-tolerant rootstocks maintain higher relative water content and membrane stability efficiently, thereby supporting better scion growth and yield under water stress (Morade *et al.*, 2025). As a result, plant breeders aim to develop rootstocks that exhibit high water-use efficiency to mitigate the effects of climate change on crop production (Berdeja *et al.*, 2015). These rootstocks are designed to enhance survivability and promote sustainable growth, providing resistance for citrus crops against both biotic and abiotic stresses (Garcia-Sanchez *et al.*, 2007; Rodriguez-Gamir *et al.*, 2010). This study evaluates the response of multiple citrus rootstocks under controlled water-deficit conditions to identify genotypes with superior drought tolerance and to improve rootstock recommendations for sustainable citrus production.

Material and Methods

The present investigation was conducted during the years 2024–2025 at the Hi-Tech Nursery of Banda Agriculture and Technology in Banda, Uttar Pradesh. This study involved seven rootstocks and four levels of water stress, replicated three times using a factorial completely randomised design (CRD). The seven rootstocks used were Rangpur lime (*Citrus limonia* Osbeck), Cleopatra mandarin (*Citrus reshni* Tanaka), Rough lemon (*Citrus jambhiri* Lush.), Sour orange (*Citrus aurantium* L.), NRCC RS-3 (Rough lemon × Troyer citrange), NRCC RS-4 (Rough lemon × Trifoliate orange), and NRCC RS-6 (Rough lemon × Trifoliate orange). The water stress levels were classified as control (at field capacity level), 0.4 bar, 0.6 bar, and 0.8 bar soil moisture tensions. A tensiometer was used to ensure that the moisture levels were consistently monitored and maintained throughout the study.

Seeds of the rootstocks were collected from ICAR-CCRI in Nagpur, ICAR-IARI in New Delhi, ARS in Sri Ganganagar, Rajasthan, and the Department of Fruit Science, Banda University of Agriculture and Technology, Banda, U.P. and then sown in nursery beds at the Hi-Tech nursery. One-month-old seedlings were transplanted into polybags. At 11 months of age, these seedlings were further transplanted into plastic pots (each with a soil capacity of 10 kg) and placed in a net house for establishment.

After 240 days of irrigation with different water stress treatments, various measurements were taken, including plant mortality (%), plant height (cm), stem diameter (mm), number of leaves, number of shoots, leaf area (cm^2), and root length (cm). Plant mortality percentage was calculated as the proportion of dead plants. Plant height was measured from the soil surface to the apex of the plant using a meter scale, while stem diameter was assessed with Vernier callipers at 5.0 cm above the soil surface on representative plants. Leaf area was recorded using a leaf area meter, and root length was measured with a meter scale at the end of the experiment.

The collected data were analysed using a two-factor analysis within a completely randomised design (CRD) with three replications, and a critical difference (CD) was calculated at a 5% probability level. Statistical analysis was conducted using OP Stat software, provided by CCS Haryana Agricultural University, Hisar, Haryana (Sheoran *et al.*, 1998).

Results and Discussion

***Plant mortality (%)*:** Plant mortality significantly increased with rising levels of water stress across all citrus rootstocks (Table 1). No mortality was observed under control conditions, while the maximum mortality rate of 55.16% was recorded under 0.8 bar of stress. Cleopatra mandarin exhibited the highest average mortality at 39.17%, followed by NRCC RS-4 at 35.97%, while Rough lemon had the lowest mortality rate at 15.14%. A notable interaction between rootstock and water stress revealed that Cleopatra mandarin under 0.8 bar of stress had the highest mortality rate, reaching 88.89%. Cleopatra mandarin shows high sensitivity to water deficits, indicating poor drought adaptability (Syvertsen & Garcia-Sanchez, 2014). In contrast, Rough lemon demonstrates greater drought tolerance, likely due to its vigorous root system and efficient water absorption (Castle *et al.*, 2010). Recent studies suggest that drought-tolerant rootstocks enhance survival through improved ABA signaling, antioxidant defense, and root growth plasticity (Morade *et al.*, 2025).

***Plant height (cm)*:** Plant height declined progressively with increasing water stress (Table 1), with a mean reduction of 26.1% at 0.8 bar compared to the control. Rough lemon (56.24 cm) and Rangpur lime (54.02 cm) maintained significantly greater mean heights, while Cleopatra mandarin recorded the lowest (41.91 cm). Interaction between rootstocks and water stress showed the significant effects indicated maximum height in Rough lemon under control (62.98 cm), 0.4 bar (59.30 cm), 0.6 bar (53.77 cm) and 0.8 bar (48.89 cm), which was closely followed by Rangpur lime and Sour orange. Whereas the minimum height was obtained in the Cleopatra mandarin under all four water stress levels, *i.e.*, 50.07 cm, 45.37 cm, 39.78 cm, and 32.44 cm under control, 0.4 bar, 0.6 bar and 0.8 bar, respectively. Balal *et al.* (2011)

reported that plant height is largely genetically controlled, but its expression is strongly modulated by environmental conditions. Water stress limits shoot elongation primarily by reducing cell expansion and photosynthesis (Romero *et al.*, 2018; Taiz *et al.*, 2015). Consistent with these findings, Wu *et al.* (2008) observed a 25% reduction in citrus seedling height under water deficit. The superior performance of Rough lemon and Rangpur lime under stress indicates their value as drought-tolerant rootstocks, likely due to better hydraulic conductivity and osmotic adjustment that sustain shoot growth (Sohail *et al.*, 2024).

***Stem diameter (mm)*:** Under conditions of water stress, the stem diameter experienced a substantial reduction of 26.3% at 0.8 bar when compared to the control group (Table 1), highlighting the critical impact of limited moisture on plant growth. Among the rootstocks tested, Rough lemon showed the largest average stem diameter at 7.92 mm, while Cleopatra mandarin had the smallest at 5.31 mm. However, the interaction among the rootstocks was not significant, indicating a consistent reduction pattern across all types. Decreases in stem diameter due to water deficit are typically linked to reduced cambial activity and a shift in the allocation of resources toward thickening the shoots (Hsiao & Xu, 2000). The ability of Rough lemon and NRCC RS-3 to maintain a larger stem girth under stress suggests that they have better hydraulic conductivity, which contributes to improved resilience to drought. Additionally, it is known that cambial activity and resource allocation decline during drought conditions (Chaves *et al.*, 2003), and more tolerant rootstocks likely support secondary growth by maintaining vascular function and xylem integrity (Costa *et al.*, 2025).

***Number of leaves and shoots*:** The results indicated that the number of leaves and shoots was significantly influenced by both the type of rootstock and the level of water stress applied, as well as the interaction between these two factors (Table 2). It was observed that the mean leaf count decreased progressively with increasing water stress, starting from an average of 108.04 leaves in the control group to just 57.48 leaves at the highest stress level of 0.8 bar. Rough lemon (97.98) and Cleopatra mandarin (88.21) maintained the highest mean leaf numbers, while Sour orange recorded the lowest (69.30). Similarly, mean shoot number decreased from 13.12 under control to 8.81 at 0.8 bar, with Rough lemon producing the maximum shoots (12.21) and NRCC RS-4 the fewest (10.12).

The significant interaction of rootstocks and water stress revealed that Rough lemon maintained higher leaf counts (127.58, 108.69, 86.74, and 68.92 under control, 0.4 bar, 0.6 bar and 0.8 bar, respectively) and shoot numbers (14.25, 12.99, 11.25 and 10.33 under control, 0.4 bar, 0.6 bar and 0.8 bar, respectively) under severe stress. While Cleopatra mandarin showed the steepest decline in the number of leaves (dropping from 120.75 leaves under control to 57.33 at 0.8 bar with 52.5% reduction) and shoots (dropping from 13.71 shoots under control to 8.00 at 0.8 bar with 41.6% reduction), indicating its greater susceptibility to water stress. These findings demonstrate that tolerant rootstocks like Rough lemon and Rangpur lime sustain 50–55% of their canopy and more than 70% of their shoot number even at 0.8 bar moisture stress, thereby preserving greater photosynthetic potential and vegetative growth under drought conditions, whereas sensitive rootstocks lose more than 50% of leaf and more than 40% of shoot production, severely limiting canopy development.

The interaction of rootstocks and water stress highlights genotype-specific differences, suggesting that tolerant rootstocks, *viz.,* Rough lemon, Sour orange and Rangpur lime, maintain canopy development more effectively under progressive stress, a key trait for maintaining source strength and long-term productivity in water-limited orchards. Water stress significantly reduces leaf and shoot production due to inhibited bud break and reduced assimilate allocation under limited water (Chaves *et al.*, 2003; Taiz *et al.*, 2015). However, rootstocks like Rough lemon maintained higher leaf and shoot numbers across stress levels, demonstrating better photosynthetic capacity, root–shoot signaling, and carbohydrate availability, which promote vegetative growth during drought (Morade *et al.*, 2025; Sohail *et al.*, 2024).

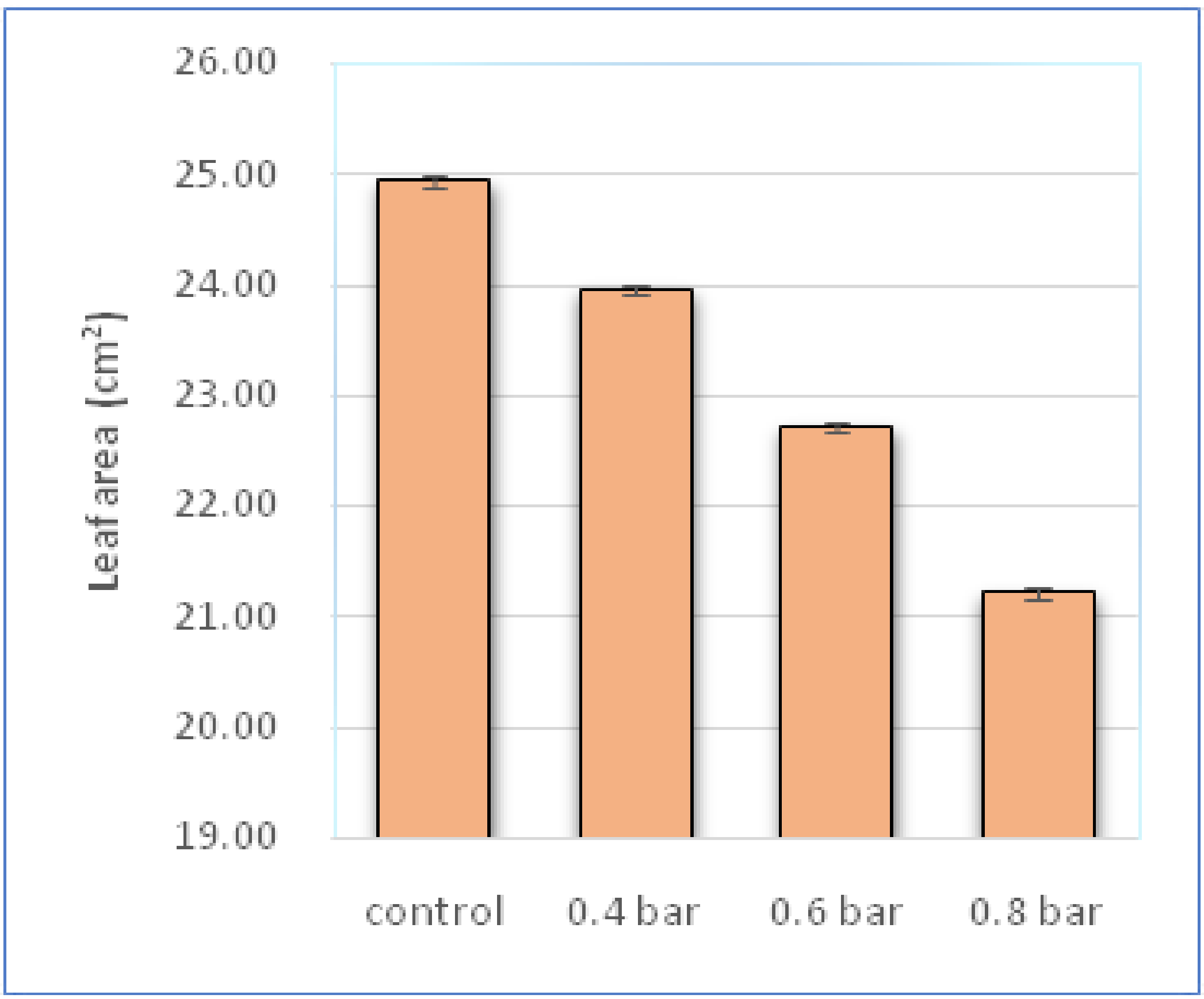
***Root length (cm)*:** Root length was significantly influenced by both the rootstock and the level of water stress, although the interaction between these factors was not statistically significant. Under control conditions, the average root length measured 29.55 cm, but as water stress increased to 0.8 bar, the average root length decreased to 19.98 cm (Fig. 2a). This decline represents a 32% reduction. Rough lemon maintained the highest mean root length (28.02 cm), followed by Rangpur lime (25.94 cm), whereas Cleopatra mandarin recorded the lowest (20.77 cm) (Fig. 2b). Although the interaction effect of rootstocks with water stress levels on root length was statistically non-significant, a clear trend of reduction with increasing water stress was observed (Fig. 2c). Rough Lemon maintained the highest root length across allstress levels, with 32.33 cm under control and 23.33 cm at 0.8 bar, showing a 27.8% reduction. Sour Orange (declined from 29.97 cm under control to 19.91 cm at 0.8 bar) and NRCC RS-3 (declined from 30.47 cm under control to 20.33 cm at 0.8 bar) followed similar patterns with reductions of 33.6% and 33.3%, respectively. The minimum root length was recorded in Cleopatra Mandarin at 0.8 bar (16.77 cm), corresponding to a 32.9% decline from the control (25.00 cm). The decline in root elongation is due to reduced cell division, inhibited meristematic activity, and lower carbohydrate allocation under water deficit (Chaves *et al.*, 2003; Taiz *et al.*, 2015). Rough lemon and Rangpur lime show greater root length under stress, indicating superior root plasticity and better drought avoidance (Morade *et al.*, 2025; Costa *et al.*, 2025). Despite reduced root growth across all genotypes, their relative ranking remained stable under stress.

Table 1. Impact of varying water stress levels on the plant mortality (%), plant height (cm) and stem diameter (mm) of citrus rootstocks

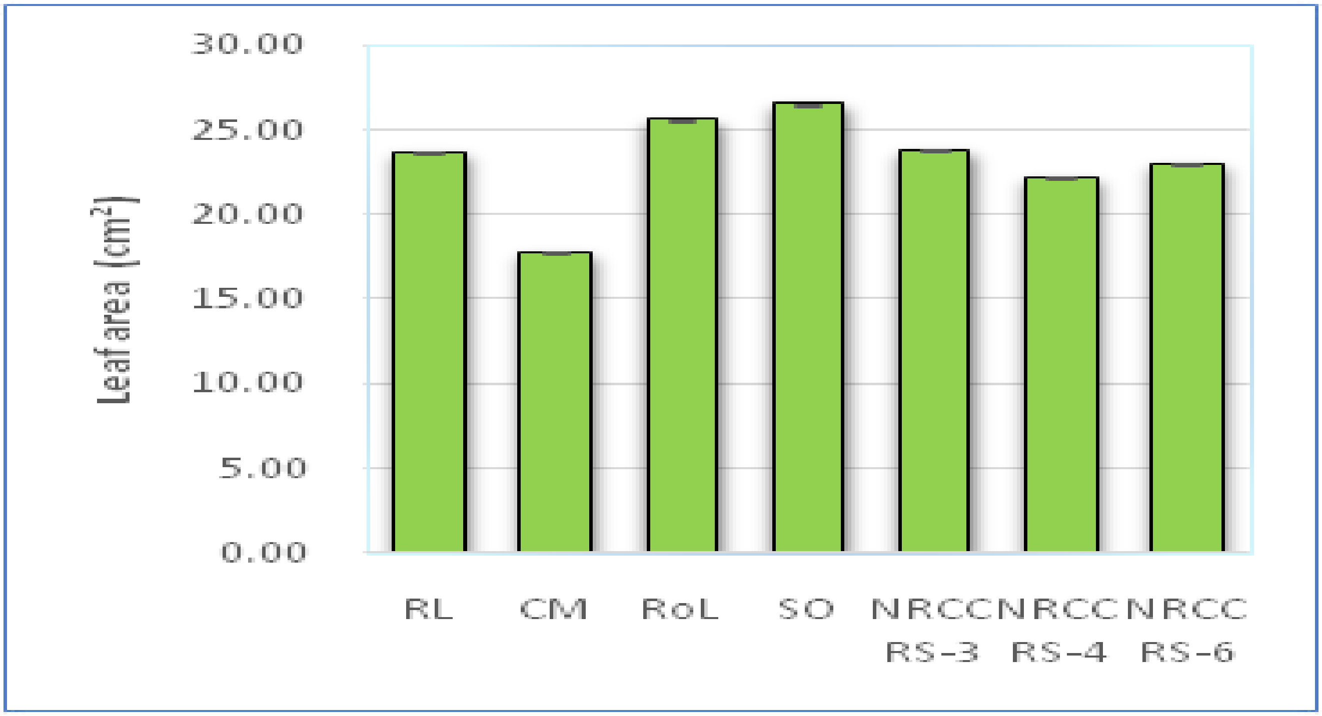
Rootstocks (R)	Water stress levels (W)														
	Plant mortality (%)					Plant height (cm)					Stem diameter (mm)				
	Control	0.4 bar	0.6 bar	0.8 bar	Mean (R)	Control	0.4 bar	0.6 bar	0.8 bar	Mean (R)	Control	0.4 bar	0.6 bar	0.8 bar	Mean (R)
Rangpur Lime	0.00	13.33	25.00	36.11	18.61	60.97	57.24	51.98	45.88	54.02	7.58	7.10	6.65	5.71	6.76
Cleopatra Mandarin	0.00	23.33	44.44	88.89	39.17	50.07	45.37	39.78	32.44	41.91	6.10	5.74	5.21	4.19	5.31
Rough Lemon	0.00	6.67	15.00	38.89	15.14	62.98	59.30	53.77	48.89	56.24	8.72	8.38	7.67	6.90	7.92
Sour Orange	0.00	26.11	44.44	50.00	30.14	60.05	56.62	49.83	45.91	53.10	7.22	6.73	6.05	5.17	6.29
NRCC RS-3	0.00	15.00	28.89	55.56	24.86	59.55	55.95	50.18	46.60	53.07	8.23	7.77	7.09	6.25	7.34
NRCC RS-4	0.00	32.78	50.00	61.11	35.97	58.00	53.11	47.00	39.97	49.52	7.03	6.45	5.91	5.03	6.11
NRCC RS-6	0.00	26.11	36.11	55.56	29.44	59.00	54.87	49.15	43.57	51.65	7.34	6.81	6.13	5.25	6.38
Mean (W)	0.00	20.48	34.84	55.16		58.66	54.64	48.81	43.32		7.46	7.00	6.39	5.50	
Factors	CD at 5%					CD at 5%					CD at 5%				
R	8.76					0.50					0.181				
W	6.62					0.38					0.137				
R×W	17.51					0.99					NS				

Table 2. Impact of varying water stress levels on the number of leaves and number of shoots of citrus rootstock

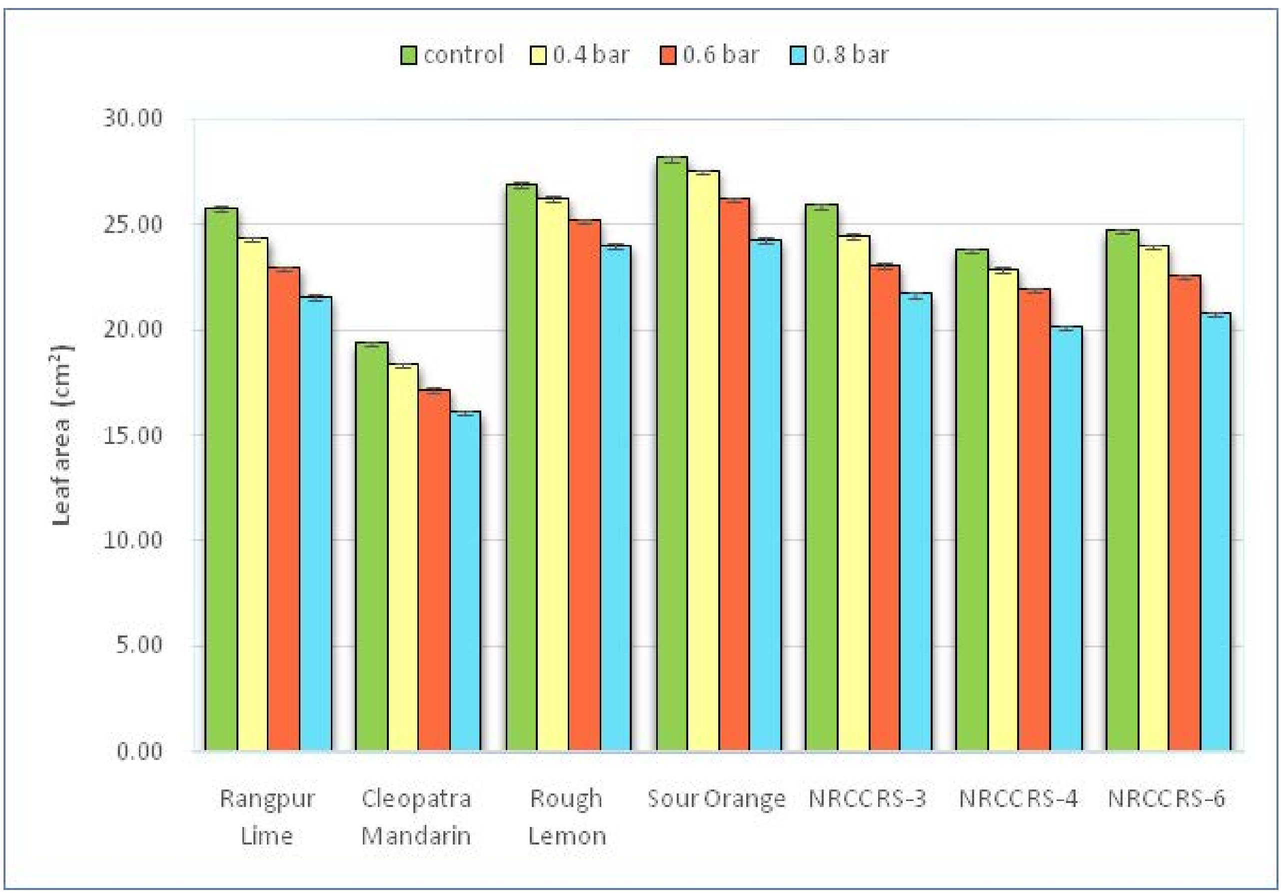
Rootstocks (R)	Water stress levels (W)									
	Number of leaves					Number of shoots				
	Control	0.4bar	0.6 bar	0.8 bar	Mean (R)	Control	0.4 bar	0.6 bar	0.8 bar	Mean (R)
Rangpur Lime	91.50	80.64	69.05	52.95	73.54	13.40	12.11	10.52	9.37	11.35
Cleopatra Mandarin	120.75	97.92	76.84	57.33	88.21	13.71	10.67	9.63	8.00	10.50
Rough Lemon	127.58	108.69	86.74	68.92	97.98	14.25	12.99	11.25	10.33	12.21
Sour Orange	88.47	76.11	63.94	48.67	69.30	12.95	11.50	10.05	8.93	10.86
NRCC RS-3	118.08	98.53	81.60	60.12	89.58	12.85	11.33	9.96	8.56	10.68
NRCC RS-4	99.87	89.75	73.62	55.97	79.81	12.10	10.91	9.33	8.12	10.12
NRCC RS-6	110.00	96.72	79.58	58.41	86.18	12.60	11.10	9.57	8.33	10.40
Mean (W)	108.04	92.62	75.91	57.48		13.12	11.52	10.04	8.81	
Factors	CD at 5%					CD at 5%				
R	2.79					0.231				
W	2.11					0.175				
R×W	5.57					0.462				



(a)



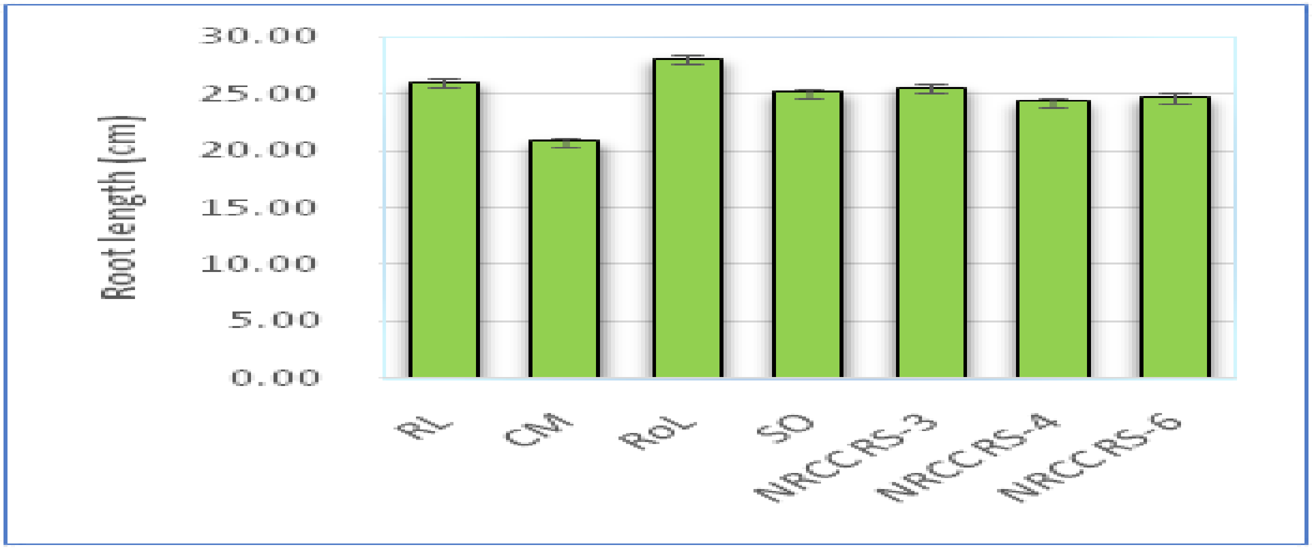
(b)



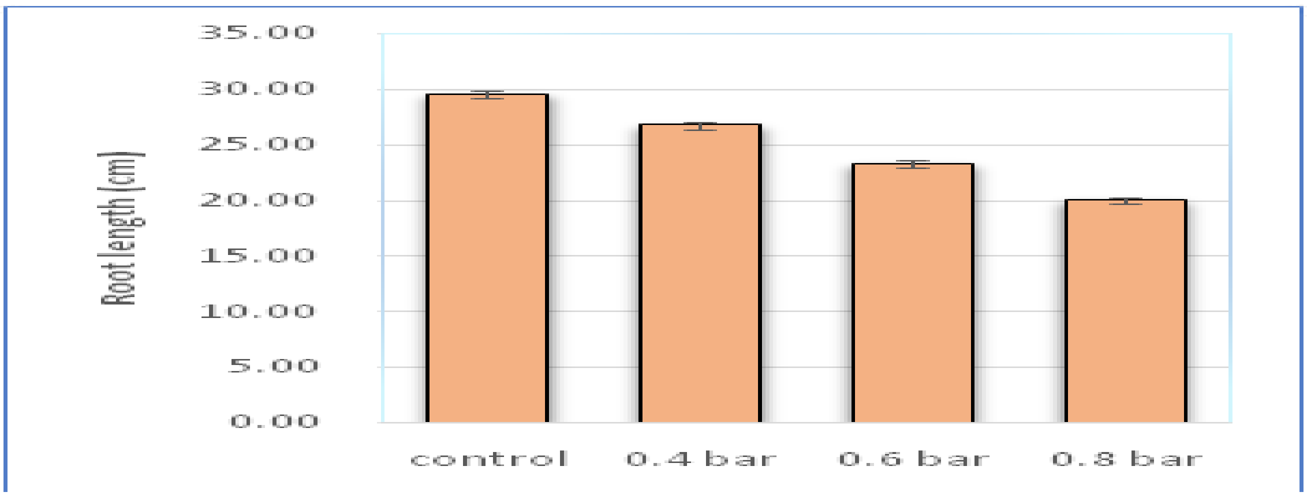
(c)

RL: Rangpur Lime; CM: Cleopetra Mandarin; RoL: Rough Lemon; SO: Sour Orange

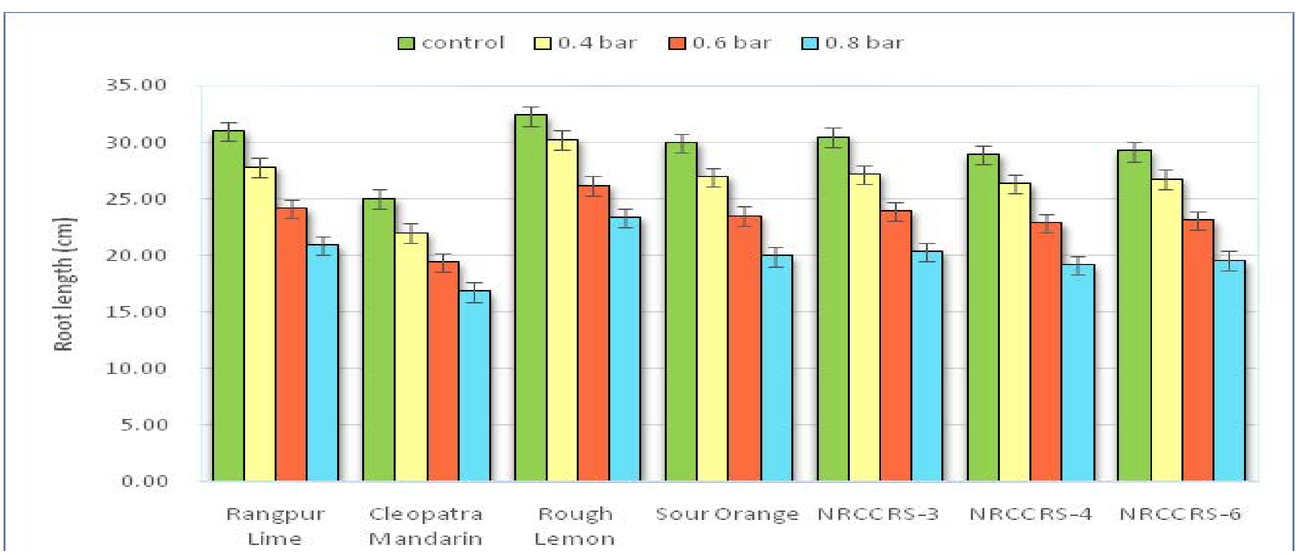
Fig. 1a. Effect of water stress on leaf area (cm^2); **(b)** Leaf area (cm^2) of citrus rootstocks under water stress; **(c)** Interaction effect of citrus rootstock and water stress on leaf area (cm^2)



(a)



(b)



(c)

RL: Rangpur Lime; CM: Cleopetra Mandarin; RoL: Rough Lemon; SO: Sour Orange

Fig. 2a. Effect of water stress on root length (cm); **(b)** Root length (cm) of citrus rootstocks under water stress; **(c)** Interaction effect of citrus rootstock and water stress on root length (cm)

Conclusion

Our research shows that tolerant rootstocks are crucial for maintaining canopy growth and long-term productivity in water-limited environments. Water stress negatively affects citrus survival and growth, but the impact varies by rootstock. Rough lemon and Rangpur lime have lower mortality rates and better growth, demonstrating superior drought adaptation. While Sour Orange, NRCC RS-3 and NRCC RS-6 showed moderate drought adaptation. In contrast, Cleopatra mandarin and NRCC RS-4 are highly susceptible, making them unsuitable for arid areas. We recommend using Rough lemon and Rangpur lime in drought-prone orchards to enhance tree survival and stabilise yields. Future breeding should focus on rootstocks with improved hydraulic efficiency and deep rooting abilities to reduce yield losses from climate variability. These insights can help growers select the best rootstocks for sustainable and productive orchards.

Acknowledgments

The authors greatfully acknowledge the authorities of Banda University of Agriculture and Technology, Banda, Uttar Pradesh for providing the necessary facilities, support and guidance to conduct the research.

Conflict of Interest

The authors declare no conflict of interest.

Data Sharing

All relevant data are within the manuscript.

References

Arbona, V., Iglesias, D.J., Jacas, J., Primo-Millo, E., Talon, M and Gomez-Cadenas, A. 2005. Hydrogel substrate amendment alleviates drought effects on young citrus plants. *Plant Soil,* 270: 73–82.

Balal, R. M., Ashraf, M. Y., Khan, M. M., Jaskani, M. J. and Ashfaq, M. 2011. Influence of salt stress on growth and biochemical parameters of citrus rootstocks. *Pakistan Journal of Botany*, 43: 2135-2141.

Balfagón, D., Terán, F., de Oliveira, T. D. R., Santa-Catarina, C., and Gómez-Cadenas, A. 2022. Citrus rootstocks modify scion antioxidant system under drought and heat stress combination. *Plant Cell Reports*, 41: 593–602. https://doi.org/10.1007/s00299-021-02744-y

Berdeja, M., Nicolas, P., Kappel, C., Dai, Z.W., Hilbert, G., Peccoux, A., Lafontaine, M., Ollat, N., Gomes, E. and Delrot, S. 2015. Water limitation and rootstock genotype interact to alter grape berry metabolism through transcriptome reprogramming. *Horticulture Research*, 2:15012.

Castle, W. S., Baldwin, J. C., Muraro, R. P. and Grosser, J. W. 2010. Performance of 'Valencia' sweet orange trees on 12 rootstocks in a trial at Lake Alfred, Florida: 1991–2006. *HortScience*, 45(4): 523–533. https://doi.org/10.21273/HORTSCI.45.4.523

Chaves, M. M., Maroco, J. P. and Pereira, J. S. 2003. Understanding plant responses to drought – From genes to the whole plant. *Functional Plant Biology,* 30(3): 239–264.

da Silva Costa, L., Coelho Filho, M. A., Araújo da Silva, M. A., Moreira, A. S., dos Santos Soares Filho, W., Freschi, L. and da Silva Gesteira, A. 2025. Revisiting citrus rootstocks polyploidy as a means to improve drought resilience: sometimes less is more. *Plant Cell & Environment*, 48(1): 149-163.

García-Sánchez, Francisco, Syvertsen, J. P., Gimeno, V., Botía, P. and Pérez-Pérez, J.G. 2007. Responses to flooding and drought stress by two citrus rootstock seedlings with different water-use efficiency. *Physiologia Plantarum*, 130: 532 - 542. https://doi.org/10.1111/j.1399-3054.2007.00925.x

Hayat, F., Li, J., Iqbal, S., Peng, Y., Hong, L., Balal, R. M., Khan, M. N., Nawaz, M. A., Khan, U., Farhan, M. A., Li, C., Song, W., Tu, P. and Chen, J. 2022. A mini review of citrus rootstocks and their role in high-density orchards. *Plants*, 11(21): 2876. https://doi.org/10.3390/plants11212876

Hsiao, T. C. and Xu, L. K. 2000. Sensitivity of growth of roots versus leaves to water stress: Biophysical analysis and relation to water transport. *Journal of Experimental Botany*, 51(350): 1595–1616. https://doi.org/10.1093/jexbot/51.350.1595

Lambers, H., Raven, J.A., Shaver, G.R. and Smith, S.E. 2008. Plant nutrient acquisition strategies change with soil age. *Trends in Ecology & Evolution*, 23:95-103.

Modica, G., Arcidiacono, F., Puglisi, I., Baglieri, A., La Malfa, S., Gentile, A., Arbona, V. and Continella, A. 2025. Response to water stress of eight novel and widely spread citrus rootstocks. *Plants*, 14(5): 773. https://doi.org/10.3390/plants14050773

Morade, A. S., Sharma, R. M., Dubey, A. K., Sathee, L., Kumar, S., Kadam, D. M., … & Yadav, D. 2025. Phenotyping drought stress tolerance in citrus rootstocks using high-throughput imaging and physio-biochemical techniques. *BMC Plant Biology*, 25: 753. https://doi.org/10.1186/s12870-025-06823-0

Nakashima, K. and Yamaguchi-Shinozaki, K. 2013. ABA signaling in stress response and seed development. *Plant Cell Report*, 32:959-970.

Rodríguez-Gamir, J., Primo-Millo, E., Forner, J. B. and Forner-Giner, M. A. 2010. Citrus rootstock responses to water stress. *Scientia Horticulturae*, 126(2): 95-102.

Romero, P., Perez-Perez, J. G. and Garcia-Sanchez, F. 2018. Effects of regulated deficit irrigation and partial root-zone drying on the vegetative and reproductive development of field-grown 'Crimson Seedless' grapevines. *Australian Journal of Grape and Wine Research*, 24(1): 137–147. https://doi.org/10.1111/ajgw.12296

Santana-Vieira, D. D. S., Freschi, L., Almeida, L. A. H., de Moraes, D. H. S., Neves, D. M., dos Santos, L. M., … & Gesteira, A. da S. 2016. Survival strategies of citrus rootstocks subjected to drought. *Scientific Reports*, 6: 38775. https://doi.org/10.1038/srep38775

Sheoran, O. P., Tonk, D. S., Kaushik, L. S., Hasija, R. C. and Pannu, R. S. 1998. Statistical software package for agricultural research workers. Department of Mathematics Statistics, CCS Haryana Agricultural University, Hisar, Haryana. pp. 139–43.

Sohail, M., El-Beltagi, H. S., Hussain, S., Hussain, A., Ali, E., Ahmad, S., ... & Khalid, M. F. 2024. Deciphering the drought tolerance mechanisms in citrus rootstocks. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca*, 52(4): 14124-14124.

Syvertsen, J. P. and Garcia-Sanchez, F. 2014. Multiple abiotic stresses occurring with salinity stress in citrus. *Environmental and Experimental Botany*, 103: 128–137. https://doi.org/10.1016/j.envexpbot.2013.09.015

Taiz, L. Zeiger, E., Moller, I.M. and Murphy, A. 2015. *Plant Physiology and Development.* 6th Edition, Sinauer Associates, Sunderland, CT.

Wu, Q. S., Xia, R. X. and Zou, Y. N. 2008. Improved soil structure and citrus growth after inoculation with three arbuscular mycorrhizal fungi under drought stress. *European Journal of Soil Biology*, 44(1): 122-128.

Wu, Q.-S., Srivastava, A. K. and Zou, Y.-N. 2013. AMF-induced tolerance to drought stress in citrus: A review. *Scientia Horticulturae*, 164: 77–87. https://doi.org/10.1016/j.scienta.2013.09.010