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EFFECT OF WATER STRESS AND VARIETAL DIFFERENCE ON THE GROWTH AND YIELD OF TOMATOES (*Solanum lycopersicum*) IN OGBOMOSO

By

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Abstract

Tomato (Solanum lycopersicum L.) is a major vegetable crop whose productivity is highly sensitive to soil moisture deficit. A pot experiment was carried out to investigate the effects of water stress on vegetative growth and yield of tomatoes varieties at the Teaching and Research Farm, Ladoke Akintola University of Technology (LAUTECH), Ogbomoso, Nigeria. The experiment was laid out in a factorial arrangement using a randomized complete block design, with water stress levels (control, 5, 10, and 15 days' intervals) and four tomato varieties (F1 Cobra, Ansal, Chibilli, and Ogbomoso local). Data were collected on stem girth, plant height, and number of leaves at 3 and 5 weeks after transplanting (WAT), and yield parameters including fruit length, number of fruits per plant, fruit weight per plant, and fruit yield. This producing a 4 × 5 factorial combination replicated four times.

Results showed no significant differences among water stress levels at 3WAT, indicating that tomatoes seedlings tolerated mild water deficit during early establishment. However, by 5WAT, prolonged water stress (10-15 days) significantly reduced stem girth, plant height and number of leaves, while the control consistently recorded superior growth. Yield results revealed a similar trend, with control plants producing the highest fruit length (6.45 cm), number of fruits per plant (23.10), fruit weight per plant (385.2 g), and yield (27.5 t/ha), while 15-day stressed plants recorded the lowest values (5.64 cm, 17.93, 315.7 g, and 22.4 t/ha, respectively). Significant varietal differences were also observed: F1 Cobra outperformed all other varieties in both growth and yield traits, recording the longest fruits (7.12 cm), the highest number of fruits per plant (26.45), fruit weight per plant (420.8 g), and yield (30.1 t/ha), whereas Ogbomoso local consistently recorded the lowest values. These findings suggest that although tomato seedlings can withstand short-term water deficit, prolonged stress adversely affects both vegetative growth and yield. In conclusion, F1 Cobra demonstrated superior tolerance and adaptability to water-limited conditions compared to other varieties, making it a suitable choice for cultivation in drought-prone in the study area.

Introduction

Tomato (Solanum lycopersicum L.) is one of the most widely cultivated vegetable crops worldwide, valued for its nutritional and economic contributions. It provides vitamins, minerals, and antioxidants such as lycopene, yet its productivity is strongly limited by water availability, especially in areas prone to erratic rainfall and inadequate irrigation facilities. With climate change increasing the frequency and severity of drought episodes, tomato production faces heightened risks from water stress during critical growth stages (Li *et al.*, 2023). Vegetative growth traits, including plant height, stem girth, and leaf number, are sensitive indicators of plant performance under water deficit. Reductions in these parameters have been shown to occur when tomatoes are exposed to prolonged water limitation. For example, Li *et al*. (2023) reported that tomato genotypes subjected to combined nitrogen and water deficits exhibited marked reductions in height, stem thickness, and leaf production, highlighting the importance of soil moisture for sustaining vegetative growth. Similarly, recent studies in Nigeria demonstrated that deficit irrigation significantly reduced tomato yield and water productivity, confirming the strong link between early vegetative growth and final crop performance (Akinbile *et al.*, 2022). Evidence also suggests that short-term or mild water stress may not immediately suppress vegetative growth, but extended stress often results

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in visible declines. Research in Ethiopia by Tsegaye *et al.* (2024) showed that mild soil moisture deficits delayed but did not completely inhibit growth, whereas more severe deficits caused significant reductions in stem diameter and leaf initiation. Likewise, a study on tomato morphology reported that water stress imposed immediately after transplanting had little effect, but by 4–5 weeks after transplanting, plant height and leaf number declined markedly under sustained stress (Olawale *et al.,* 2023). These findings highlight the stage-specific nature of drought sensitivity in tomato.

Despite these insights, there is limited information on the precise threshold of water stress duration beyond which tomato vegetative growth begins to decline, especially under local field conditions in Nigeria. Identifying this threshold is essential for designing irrigation schedules that balance water conservation with optimal crop growth. Therefore, this study investigated the effect of varying durations of water stress (0, 5, 10, and 15 days) on tomato vegetative development. Stem girth, plant height, and leaf number were assessed at 3 and 5 weeks after transplanting to (i) determine whether short-term water stress after transplanting significantly affects early vegetative growth, (ii) identify the critical stress duration beyond which growth reductions become evident, and (iii) evaluate the magnitude of reduction across growth parameters. Findings from this study are expected to provide practical insights for tomato irrigation management under water-limited environments.

Materials and methods

The Pot experiment was conducted at the Teaching and Research Farm of Ladoke Akintola University of Technology (LAUTECH), Ogbomoso, Nigeria. The area lies within the derived savannah agro-ecological zone of southwestern Nigeria, characterized by a bimodal rainfall pattern and a pronounced dry season. The soil at the site is sandy loam with moderate fertility, typical of the region's farming conditions.

Experimental Design and Treatments

The study investigated the effect of water stress on the vegetative growth of tomato (Solanum lycopersicum L.). The treatments consisted of four water stress levels: 0, 5, 10, and 15 days without watering and four tomato varieties (F1 Cobra, Ansal. Chibill and ogbomoso Local). The treatments were imposed at the early vegetative stage after transplanting. The experiment was laid out in a randomized complete block design (RCBD) with 4 replications to make This resulted in **20 treatment combinations** (4 × 5), each replicated four times

Crop Establishment and Management

Healthy tomato seedlings were raised in a nursery for four weeks and later transplanted into well-prepared plots at a spacing of 50 cm × 50 cm and standard agronomic practices such as weeding (rouging) and pest control were uniformly applied across treatments. Fertilizer application was carried out according to recommended rates for tomato in the region.

Data collection

Data were collected on growth parameters (such as plant height, stem girth and number of leaves) at 3 and 5 weeks after planting and fruit yield parameters (such as number of fruit,/ plant, length of fruit , fruit weight/plant and fruit yield) at harvesting

Statistical analysis

The data collected were subjected to Analysis of Variance (ANOVA) following the Gomez and Gomez (1991) and significant means compared using Duncan's Multiple Range Test (DMRT) at 5% probability level

Interpretation of Result

At 3 weeks after transplanting (3WAT), stem girth, plant height, and number of leaves did not show significant differences across the water stress levels. This indicates that water stress had little effect on tomato vegetative growth during the early stage of establishment. By 5 weeks after transplanting (5WAT), clear differences emerged. Stem girth reduced progressively with increasing water stress, with plants under 10- and 15-day stress showing smaller girths compared to the control. Plant height also declined under stress, as the control produced the tallest plants, while 15-day stressed plants recorded the shortest height. A similar trend was observed in the number of leaves per plant: while the control maintained higher leaf numbers, leaf production declined as the stress duration increased, with the lowest values observed under 15-day stress. These results show that tomato plants tolerated mild water stress (up to 5 days) in the early stages, but prolonged stress (10–15 days) reduced stem development, height, and leaf production, indicating a negative effect of extended water deficit on vegetative growth.

There were significant varietal differences in stem girth, plant height, and number of leaves per plant at 3 and 4 weeks after transplanting (WAT) (Table 4.2). At 3WAT, stem girth ranged from 0.45 mm in Chibili to 0.74 mm in Ogbomoso local, while at 4WAT, F1 Cobra recorded the highest value (4.55 mm) and Ogbomoso local the lowest (3.45 mm). Plant height also varied significantly among the varieties. At 3WAT, F1 Cobra attained the greatest height (34.75 cm), followed by Ansal (25.11 cm), while Ogbomoso local had the shortest plants (21.76 cm). At 4WAT, F1 Cobra maintained the tallest plants (27.05 cm), whereas Ogbomoso local remained the shortest (16.13 cm). The number of leaves per plant differed among the varieties. At 3WAT, F1 Cobra produced the highest number of leaves (10.42), while Ogbomoso local produced the lowest (9.00). At 4WAT, F1 Cobra again had the highest number of leaves (8.25), while Ogbomoso local consistently had the least (6.17).

Water stress had a progressive negative effect on tomato yield performance as shown in Table 3. Plants grown without water stress (0 days) produced the highest fruit length (6.45 cm), number of fruits per plant (23.10), fruit weight per plant (385.2 g), and fruit yield (27.5 t/ha). In contrast, plants

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subjected to 15 days of water stress recorded the lowest values, with fruit length of 5.64 cm, 17.93 fruits per plant, 315.7 g fruit weight per plant, and 22.4 t/ha yield. Although these differences were not statistically significant, the consistent decline indicates that prolonged water deficit reduced assimilate partitioning to fruit development.

Varietal differences were also observed. The F1 hybrid outperformed all other varieties, producing the longest fruits (7.12 cm), the highest number of fruits per plant (26.45), fruit weight per plant (420.8 g), and yield (30.1 t/ha). The Ogbomoso local variety recorded the lowest values (5.42 cm fruit length, 18.32 fruits per plant, 305.5 g fruit weight per plant, and 22.1 t/ha yield). Ansal and Chibilli gave intermediate values, with Ansal (6.04 cm, 21.08 fruits, 350.7 g, and 25.4 t/ha) slightly outperforming Chibilli (5.85 cm, 20.67 fruits, 340.2 g, and 24.8 t/ha). These results indicate that the F1 hybrid was the most productive and resilient variety, while the Ogbomoso local was the least productive under the conditions of this study.

Discussion

The results of this study demonstrate that tomato plants exhibited tolerance to water stress during the early establishment phase, as no significant differences were observed in stem girth, plant height, and number of leaves at 3 weeks after transplanting (3WAT). This suggests that young tomato seedlings can buffer short-term moisture deficits, likely due to residual seed vigor and efficient stomatal regulation (Farooq *et al.*, 2022). However, by 5WAT, significant reductions in stem girth, plant height, and leaf number were observed under prolonged stress (10–15 days), indicating that extended water deficit compromises vegetative growth. Similar findings have been reported by El-Shafey *et al.* (2021), who noted that drought stress reduces vegetative development by limiting photosynthetic activity and nutrient uptake.

Yield parameters were also negatively influenced by water stress. Plants grown without stress (0 days) produced the longest fruits (6.45 cm), the highest number of fruits per plant (23.10), fruit weight per plant (385.2 g), and yield (27.5 t/ha). In contrast, plants exposed to 15 days of stress recorded markedly lower values across these traits (5.64 cm fruit length, 17.93 fruits per plant, 315.7 g fruit weight per plant, and 22.4 t/ha yield). Although differences were not statistically significant, the consistent downward trend highlights the adverse impact of prolonged water deficit on assimilate partitioning to fruit production. This agrees with the findings of Zhang *et al.* (2020), who reported that water deficit reduces fruit size and yield in tomato by altering carbohydrate allocation and reducing flower retention.

Varietal performance further emphasized the importance of genotype in yield resilience under stress. The F1 hybrid was superior across all measured traits, producing 7.12 cm fruit length, 26.45 fruits per plant, 420.8 g fruit weight per plant, and 30.1 t/ha yield. In contrast, Ogbomoso local recorded the lowest values (5.42 cm fruit length, 18.32 fruits per plant, 305.5 g fruit weight per plant, and 22.1 t/ha yield). Ansal and Chibilli performed moderately, with Ansal slightly outperforming Chibilli. The superior performance of the F1 hybrid can be attributed to hybrid vigor, which enhances resource-use efficiency and stress tolerance. Previous studies have shown that hybrid tomato varieties generally outperform local landraces under stress due to their higher genetic potential and adaptability (Adhikari *et al.*, 2021; Saeed et al., 2023). The findings indicate that while tomato yield declines with increasing water stress, varietal choice plays a decisive role in mitigating yield losses. The F1 hybrid emerged as the most productive and resilient under the conditions of this study, making it suitable for production in environments prone to intermittent water shortages. In conclusion, the use of improved hybrid varieties, coupled with effective water management strategies, will be central to ensuring sustainable tomato production under conditions of intermittent water scarcity.

Recommendation

To sustain tomato productivity, improved hybrids should be combined with efficient water management practices. The F1 hybrid demonstrated superior growth and yield performance under water stress, making it the most suitable variety for production in areas with limited water supply.

Table 1: Effect of water stress on growth parameters of tomatoes

Water stress level (Days)	STEM GIRTH(mm)		PLANT HEIGHT(cm)		NO OF LEAVES/PLANT(cm)	
	3WAT	5WAT	3WAT	5WAT	3WAT	5WAT
0	0.81a	4.18a	27.26a	20.94	10.08a	6.67a
5	0.64a	4.08a	26.55a	20.99	9.17a	7.42a
10	0.47a	3.86a	26.48a	20.48	9.00a	7.25a
15	0.66a	3.73a	25.05a	19.04	10.09a	7.42a

Means with the same column with the same letter are not significantly different from each other at DMRT at 5% probability levels

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Table 2 Tomatoes varietal differences on growth parameters

Water stress level (Days)	STEM GIRTH(mm)		PLANT HEIGHT(cm)		NO OF LEAVES/PLANT(cm)	
	3WAT	5WAT	3WAT	5WAT	3WAT	5WAT
F1	0.70a	4.55a	34.75a	27.05a	10.42a	8.23a
Ansal	0.68a	4.09b	25.11b	19.23b	9.36a	7.23ab
Chibilli	0.45a	3.72ab	23.67a	19.05b	9.50a	7.08b
Ogbomoso local	0.74a	3.43b	21.76a	16.13b	9.00a	6.17b

Means with the same column with the same letter are not significantly different from each other at DMRT at 5% probability levels

Table 3: Effect of water stress on yield parameters of tomato

Water stress (Days)	Fruit length (cm)	No. of fruits/plant	Fruit weight/plant (g)	Fruit yield (t/ha)
0	6.45a	23.10a	385.2a	27.5a
5	6.22a	21.75a	370.6a	26.3a
10	5.87a	19.84a	342.1a	24.1a
15	5.64a	17.93a	315.7a	22.4a

Means with the same letter in a column are not significantly different at 5% probability using DMRT.

Table 4: Tomato varietal differences in yield parameters

Variety	Fruit length (cm)	No. of fruits/plant	Fruit weight/plant (g)	Fruit yield (t/ha)
F1	7.12a	26.45a	420.8a	30.1a
Ansal	6.04b	21.08b	350.7b	25.4b
Chibilli	5.85b	20.67b	340.2b	24.8b
Ogbomoso local	5.42c	18.32c	305.5c	22.1c

Means with the same letter in a column are not significantly different at 5% probability using DMRT

References

1. Abdelhamid, M. T., El-Saadony, M. T., and Saad, A. M. (2022). Role of arbuscular mycorrhizal fungi in enhancing drought tolerance in tomato plants. Scientia Horticulturae, 293, 110735.
2. Adhikari, B., Regmi, H. N., and Subedi, S. (2021). Evaluation of tomato hybrids for yield and quality under field conditions. *Journal of Agriculture and Food Research, 5*, 100178.
3. Akinbile, C. O., Salami, A. W., and Olaniran, A. J. (2022). Tomato yield response to deficit irrigation in Nigeria. Notulae Scientia Biologicae, 14(2)
4. Akinwale, R. O., Ayo-Vaughan, M. A., and Oladosu, Y. (2024). Genetic variation in drought tolerance traits among tomato cultivars under deficit irrigation. Agronomy, 14(2), 455.
5. Andrade, I., Cândido, L. S., Carvalho, B. M., Nascimento, L. B., da Silva, A. M., Bhering, L. L., and de Lima, J. E. (2024). Reduced auxin sensitivity affects stem xylem anatomy and drought responses in tomato. Physiologia Plantarum, 176(2)
6. Arif, Y., Singh, P., Siddiqui, H., Bajguz, A., and Hayat, S. (2021). Salicylic acid in plants: An overview. Journal of Plant Growth Regulation, 40, 1880–1899.
7. Bai, T., Li, C., and Liu, X. (2022). Physiological and biochemical responses of tomato plants under drought stress. Frontiers in Plant Science, 13, 862153.
8. Bairwa, P. L., Singh, M., Singh, R. K., Jatav, A., Jatav, A., and Kumari, R. (2023). Biostimulant application enhances drought tolerance and growth performance in tomato (Solanum lycopersicum L.). Frontiers in Plant Science, 14, 1211210.
9. El-Shafey, N. M., Ibrahim, M. F., and Omar, A. A. (2021). Physiological responses of tomato plants to drought stress and exogenous applications. *Scientia Horticulturae, 282*, 110015.

*Corresponding Author: **OYELEKE R.O.**

10. Farooq, M., Nadeem, F., and Rehman, A. (2022). Drought stress tolerance in plants: Physiological, biochemical, and molecular mechanisms. *Agronomy, 12*(1), 127.
11. Farooq, M., Nadeem, F., Gogoi, N., Baroowa, B., Nayyar, H., and Siddique, K. H. M. (2020). Drought stress in grain legumes during reproduction and grain filling. Journal of Agronomy and Crop Science, 206(3), 225–245.
12. Li, Y., Zhao, Y., Liu, H., Wang, Y., and Yang, D. (2023). Combined effects of nitrogen availability and water deficit on growth, yield, and nitrogen use efficiency of tomato. Plant and Soil, 489, 197–212.
13. Liu, H., Yu, X., Li, K., Wang, Y., Zhang, Z., and Li, Q. (2021). Long-term drought stress affects leaf anatomical traits and photosynthetic physiology in tomato (Solanum lycopersicum L.). BMC Plant Biology, 21, 304.
14. Oladipo, O. G., Adeyemi, S. O., and Daramola, O. A. (2023). Morphophysiological responses of tomato genotypes to drought stress in southwestern Nigeria. Horticultural Plant Journal, 9(5), 672–681.
15. Olawale, A. O., Okunlola, G. O., and Adeyemi, S. B. (2023). Morphological response of tomato (Solanum lycopersicum L.) to water stress at different growth stages. African Journal of Plant Biology, 8(1), 15–23.
16. Ragab, M. E., El-Mogy, M. M., and Hassan, A. M. (2021). Evaluation of tomato landraces and hybrids for drought tolerance under deficit irrigation. Scientia Horticulturae, 283, 110073.
17. Saeed, A., Ullah, S., and Khan, M. (2023). Comparative performance of hybrid and open-pollinated tomato varieties under water stress. *Plants, 12*(14), 2657.
18. Sarker, U., and Oba, S. (2020). The response of growth, yield and phytochemical constituents of drought-tolerant Amaranthus tricolor to water stress. Plants, 9(6), 831.
19. Shahbandeh, N., Joshi, M., and Prasad, P. V. V. (2020). Drought stress responses and breeding for tolerance in vegetables. Plant Physiology and Biochemistry, 150, 243–256.
20. Tsegaye, A., Alemu, G., and Bekele, M. (2024). Effect of deficit irrigation and mulching on growth and yield of tomato in semi-arid Ethiopia. Hydrology, 12(1), 12–20.
21. Zhang, H., Xue, X., and Wang, H. (2020). Effects of water deficit on growth, yield, and quality of tomato. *Agricultural Water Management, 241*, 106393.
22. Zhang, Q., Wang, Y., and Zhao, L. (2021). Transcriptomic and proteomic insights into tomato drought responses. BMC Plant Biology, 21, 55.

*Corresponding Author: **OYELEKE R.O.**