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Effect of different levels of smoke water on germination and some growth characteristics of cucumber under drought stress conditions

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Abstract

This study evaluated the efficacy of smoke-water on the seed germination and seedling growth of cucumber. The experiment was conducted as a factorial in the form of a completely randomized design in 3 replications. The first factor included different levels of drought stress at three levels: 0, -0.5 and -0.10 MPa and the second factor included three levels of water smoke including 0, 1:500, 1:1000, 1:2000 and 1:5000 (V: V). According to the obtained results, drought stress had a negative effect on the germination and growth characteristics of cucumber. While, all concentrations of smoke extracts significantly improved the traits studied in this experiment. The highest percentage of germination was observed in the conditions without stress and different levels of water smoke. In the conditions of drought stress, the use of water smoke increases the germination percentage and growth characteristics of greenhouse cucumber. Therefore, it is recommended to use a concentration of 1:5000 water smoke for cucumbers.

Keywords: *Cucumis sativus*, Plant derived smoke, Seedling vigour

Introduction

Water shortage causes a substantial decline in crop yields due to the negative effects on plant growth through physical damage, physiological disruption, biochemical change, and reproduction problems (Das *et al*., 2024). Therefore, the development of new technology is urgently needed to maintain crop yields under severe water-deficit stress. After tomato, cabbage, and onion, cucumber (*Cucumis sativus* L., Cucurbitaceae) is the fourth most popularly grown vegetable worldwide (Alam *et al*., 2024). The germination process is considered an important phase in the plant life cycle which permits the plant to continue growing and produce a new generation (Abou El-Nour, 2021). Smoke influences germination of species from various plant families regardless of whether they are native to fire-frequented habitats. Aerosolized smoke and smoke water (derived from burning vegetation and channelling smoke through water) are well-documented germination-promoters (Sreekissoon *et al*., 2021).

Materials and methods

In order to investigate the effect of salinity stress and water smoke on the indicators of seed germination and seedling growth of Nagin cucumber plant, a factorial experiment was carried out in the form of a completely randomized design with three replications. The first factor included different levels of drought stress at three levels: 0, -0.5 and -0.10 MPa and the second factor included three levels of water smoke including 0, 1:500, 1:1000, 1:2000 and 1:5000 (V: V). After surface disinfection of with 1% sodium hypochlorite, the seeds (10 seeds) were transferred to the relevant petri dishes and the water smoke and salinity treatments were added to the petri dishes. For the control treatment, only distilled water was added. In this experiment, the method of Van Staden *et al*. (2004) was used to prepare water smoke. The Petri dishes were placed in an incubator with a temperature of 20 °C. The number of germinated seeds was recorded daily at a certain hour for 14 days. On the 14 day of the experiment, the length, fresh and dry weight of the seedling, stem and root, germination percentage and seed vigor index were measured.

Results and discussion

According to the results obtained from the comparison of averages, drought stress, unlike water smoke, had a negative effect on seed germination and growth characteristics of cucumber plants. As the concentration of water smoke increased, these characteristics increased (Table 1). Moisture condition is an important factor affecting seed germination. In order to carry out the germination process, the seeds must absorb enough water. The soluble substances in the culture medium, including polyethylene glycol (PEG), reduce the absorption of water by the seeds, reduce the hydrolysis of the stored material of the seeds, and subsequently delay or stop the germination (Guo, *et al*., 2024). Plant derived smoke stimulate and promote germination response as it increases seed sensitivity to endogenous GA3 (Pandey *et al*, 2024) and therefore enhance seed germination. Smoke, however, not only influences germination but importantly it also stimulates seedling vigor (post-germination growth) (Gupta *et al*., 2024). The results of this research showed that in drought stress conditions, water smoke (1:5000) significantly increased seed germination, seedling growth and root growth.

Table 1-Comparison of the average effect of different levels of dryness and water smoke on germination and some morphological characteristics of cucumber

	GP (%)	WFS(g)	WDS(g)	WFR(g)	WDR(g)	WFP(g)	WDP(g)	HS(cm)	HR(cm)	HP(cm)	VI	VII
D_1W_1	93.3^{a}	0.16^{bcd}	0.067^{de}	0.030^{d}	0.0045^{d}	0.199^{c-e}	0.071^{de}	4.54^{ab}	6.28^{f}	11.74^{d}	10.94^{e}	0.185^{d}
D_1W_2	100^{a}	0.17^{bcd}	0.071^{cd}	0.031^{d}	0.0049^{c}	0.205^{b-d}	0.762^{cd}	3.89^{bc}	7.90^{d}	11.79^{d}	11.79^{d}	0.205^{c}
D_1W_3	100^{a}	9.17^{abc}	0.075^{bc}	0.033^{c}	0.0053^{b}	0.212^{bc}	0.080^{bc}	4.22^{ab}	8.55^{c}	12.78^{c}	12.78^{c}	0.212^{bc}
D_1W_4	100^{a}	0.18^{ab}	0.078^{b}	0.039^{b}	0.0059^{a}	0.225^{ab}	0.083^{b}	4.36^{ab}	9.17^{b}	13.53^{b}	13.53^{b}	0.225^{b}
D_1W_5	100^{a}	0.20^{a}	0.092^{a}	0.043^{a}	0.0060^{a}	0.246^{a}	0.098^{a}	4.74^{a}	9.61^{a}	14.35^{a}	14.35^{a}	0.246^{a}
D_2W_1	63.30^{d}	0.14^{e-h}	0.054^{g-i}	0.018^{h}	0.0035^{g}	0.159^{g-j}	0.058^{hi}	2.08^{f-h}	4.77^{h}	6.85^{hi}	4.34^{ij}	0.101^{gh}
D_2W_2	63.30^{d}	0.14^{d-g}	0.055^{gh}	0.019^{h}	0.0037^{fg}	0.167^{f-i}	0.59^{g-i}	2.27^{fg}	4.92^{h}	7.19^{gh}	4.54^{ij}	0.106^{g}
D_2W_3	89.00^{c}	0.15^{d-g}	0.057^{g}	0.022^{g}	0.0039^{ef}	0.173^{e-h}	0.061^{gh}	2.70^{ef}	5.14^{h}	7.84^{g}	6.27^{h}	0.138^{f}
D_2W_4	80.00^{c}	0.15^{c-f}	0.060^{fg}	0.025^{f}	0.0040^{e}	0.182^{d-g}	0.064^{fg}	3.14^{de}	5.57^{g}	8.71^{f}	6.97^{g}	0.146^{f}
D_2W_5	86.66^{b}	0.16^{b-e}	0.063^{ef}	0.027^{e}	0.0042^{e}	0.190^{c-f}	0.067^{ef}	3.41^{cd}	6.28^{f}	9.69^{e}	8.39^{f}	0.164^{e}
D_3W_1	43.33^{e}	0.10^{ij}	0.040^{kl}	0.010^{kl}	0.0026^{kl}	0.082^{kl}	0.042^{kl}	1.46^{jk}	3.11^{ik}	4.58^{ij}	1.98^{kl}	0.036^{ik}
D_3W_2	46.66^{e}	0.07^{kl}	0.046^{jk}	0.011^{kl}	0.0026^{kl}	0.120^{ik}	0.048^{jk}	1.82^{gh}	3.41^{ik}	5.23^{hi}	2.43^{kl}	0.056^{kl}
D_3W_3	60.00^{d}	0.120^{hi}	0.048^{jk}	0.012^{jk}	0.0029^{hi}	0.133^{jk}	0.050^{jk}	1.90^{gh}	3.91^{kl}	5.81^{jk}	3.49^{ik}	0.079^{kl}
D_3W_4	60.00^{d}	0.127^{g-i}	0.049^{i-k}	0.013^{kl}	0.0030^{h}	0.141^{j-k}	0.052^{jk}	1.98^{gh}	4.14^{ij}	6.13^{ij}	3.67^{jk}	0.084^{hi}
D_3W_5	60.00^{d}	0.13^{f-i}	0.051^{h-j}	0.016^{kl}	0.0030^{h}	0.147^{h-j}	0.054^{ij}	2.02^{f-h}	4.36^{ij}	6.38^{ij}	3.83^{jk}	0.088^{hi}

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