Study of Some Morphological, Biochemical and Anatomical Variations in *Capsicum annuum*L. Induced by Different Irrigation Water

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Abstract:

*Capsicum annuum*L. (ornamental pepper) is one of important plant in botany study. The experiment was doing in green house in department of biology in Babylon University in Winter in 2019. One month old plants were used, and three types of irrigated water used: tap water, treated waste water and textile waste water.Ornamental pepper appeared different variations in themorphological, biochemical traits and anatomicalstructure of stem and leaves.Each of plant's length , leaf area, , numbers of fruits,flowers, and leaves were effected and the highest numbers were recorded within plants that irrigated with treated wastewater, while textile wastewater induced significant variations in content of catalase, super oxidase dismutase, malondialdahide and glutathione . On the anatomical level, results showedchanges in the structure included : disappear of stoneś cells in third group, as well as increased each of diameter of xylem vessel and vascular bundle length. In the leaves; both lower and upper surfaces of leaf showed several variations in stomata length , width and frequency.

Key words: *capsicumannuum*, irrigation, morphological , biochemical ,wastewater.

Introduction:

The ornamental pepper plant, Capsicum sp., has been used as an ornamental plant for centuries. This solanacea genus contains roughly twenty different species that are found within a tropical and subtropical regions[1]; it originated in the American tropics[2].It is well known for its wide range of applications since, in addition to being useful for both food and medicine, it also makes a lovely beautiful plant[3, 4]. The fruits of the pepper plant contain large concentrations of volatile oil and fixed oil[7], as well as capsaicin, carotenoids, flavonoids, vitamins C and E [5].

The usage of ornamental pepper (Capsicum sp.) as a decorative plant dates back thousands of years. About twenty species of this solanacean genus are found in tropical and subtropical regions of the world. [1] and the American Tropics were where it originated. [2]. It is well-known for its several applications since it is crucial for both food and medicine in addition to being a beautiful plant to look at [3, 4] Pepper is known for its high vitamin A, C, and E content. [5], antioxidants, flavonoids, and capsaicin [6], Fixed oil and volatile oil [7] that can be discovered in its fruits.

All the but full the rainbow's colors are present in ornamental peppers, and some plants can even carry four or five colors simultaneously [8]. As a result, the fruit has a variety of shapes [9]. These characteristics are based on genetic data from flower cross-pollinations

[10], as well as on the effects of environmental conditions where the plant is grown. Water makes up between 50 and 97 percent of a plant's body, which makes irrigation one of the key influencing variables [11].Due to water resources are few, it is vital to control water consumption [12].This research looked at how *Capsicum annuum*L. responded to irrigation with tap water, treated sanitary waste water, and textile waste water.

Material and methods:

The same Capsicum annuum plants were selected at one month of age during the winter of 2019 and then placed in pots (plant/pot). These plants were divided into three groups and given three months of irrigation with tap water (control group) and treated waste water (second group) from Al Muamira station in Babylon city, while the third utilized irrigation water from Hilla's textile waste.

By measuring pH, Electrical conductivity, Total Dissolved Solids, and salinity with a multi-meter of the Type Hana, Oakton, U.S., it was possible to ascertain the characteristics of each type of water. Salinity was assessed in accordance with the 2003 guideline for water analysis [14], while total hardness, calcium, magnesium, chloride, and sulfate concentrations were determined using the standard method of water analysis [13].

The identification of the fundamental characteristics of soil included: pH, Total Dissolved Solids , Electrical conductivity, and Salinity. These characteristics were investigated using techniques for dry and semiarid soil [15], while employed the titration method to determine organic matterconcentration [16].

The morphological characteristics of Capsicum annuum, such as the number of each leaf, flower, and fruit, as well as the length of the plant and the area of the leaves, were identified after three months of irrigation.

The content of each of Super Oxide Dismutase (SOD) [18], Catalase [17], Total Protein(TP) [19], Glutathione [21], MDA [20], Proline [22], and total Chlorophyll content [23] were some biochemical responses that were studied.

The way of handling [24] of preparing plant samples was used to determine the anatomical variances of stems and leaves, which were then studied under a microscope.

Results and Discussion.

Water characters are very differ from one resource to another, due to numerous factors, initially return to the characteristics of this water, which in the current study were relatively acceptable, thus can use as more suitable substitute sources to provide plants with irrigation [25]. The second concerned the Hila Textile Factory, whose primary manufacturing stages have been restricted to finishing stages for a number of years. They utilized neither starch nor dyes, which release ions or organic matter, during this time. [26].The treated waste water caused increasing in shoot length, leaf area and number of leaves, flowers and fruits. This rise results in a higher concentration of organic matter, important elements like calcium and magnesium, and other dissolved ions like nitrate and phosphorus. [27]. The good growth in plants that irrigated with textile wastewater may due to moderate concentrations of ions and these results are agree with other studies on effect of diluted textile waste water [28, 29].

Table (1) showed the main variations of irrigated water types, showing elevated levels of every study ion in treated waste water .Soil was fertile, non-saline and suitable to grow ornamental plants as its general features are explained in Table (2).

Table1. Main characteristics of used water in irrigation

Studied Parameters	pH	TDS (mg/l)	E.C (µs/cm)	Chloride (mg/l)	Magnesium (mg/l)	Calcium (mg/l)	Total Hardness (mg/l)	Salinity (mg/l)	Alkalinity (mg/l)	Sulphate (mg/l)	Organic matter (%)
Tap water	8.2	937	1180	339.89	99.42	272.54	680	1123	100	56.863	0.06
Treated wastewater	8.4	1710	2400	479.85	128.66	352.71	880	2070	280	223.53	0.27
Textile wastewater	8.8	1170	1647	279.91	52.634	144.38	360	1420	200	109.8	0.12

Table2. Important characters of soil that used in this experiment

Parameters	pH	E.C (µs/cm)	TDS (mg/l)	Salinity (mg/l)	Organic matter (%)
Concentration	8.6	3000	2130	2680	1.76

Table (3) demonstrated how the kind of irrigation water greatly affects the phonological responses of plants. Increases in shoot length, leaf area, and quantity of leaves, blooms, and fruits were brought on by the treated waste water.This rises the concentration of organic materials and other dissolved ions, such as nitrate and phosphorus, as well as important elements like calcium and magnesium. When compared to the control group, however, the textile waste water exhibits superior growth.

Table 3 Some of phonological features of *Capsicumannuum*irrigated with different water types

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Irrigated water	Numbers of			plant height (cm)	area of leaf (cm^2)
	Flowers	Fruits	leaves		
Tab water	9	2	21	10.5	3.6
Treated wastewater	15	4	41	19	9.1
Textile wastewater	12	2	28	15.5	4.8

The findings shown in Table (4) clarified why there were non-significant differences in the degree of biochemical reactions in both treated and textile waste water. Comparing the groups, it is evident that group 2 had the highest chlorophyll content because of the water's high levels of magnesium and organic matter. These findings indicate that such irrigated water did not inflict significant stress on the plants. In group 3, the leaves of ***Capsicum annuum*ca** showed increased quantities of both glutathione and catalase.

Table 4. Biochemical variation in *Capsicum annuum*ca used by irrigated water

Irrigated water	Moisture content (%)	Chlorophyll content (SPAD)	potine (mg/g.D.W)	Proline (µmole/g.D.W)	SOD (U/ml)	CAT (U/ml)	GSH (µg/ml)	MDA (nmol/ml)
Tab water	88.3	23.1	24.2	4.838	3.343	51.54	13.1	4.37
Treated Wastewater	81.8	32.4	23.92	6.941	3.683	46.19	33.74	3.88
Textile wastewater	85.5	24.2	23.15	5.364	2.89	58.9	49.31	3.03

Plants responded anatomically differently to varied environmental conditions. For instance, there would be reduced leaf area when there was a shortage of certain essentials like water and minerals. Anatomical reactions of leaves were displayed in Table (5). There were no appreciable differences between the three groups, while leaves of plants irrigated with treated waste water had fewer stomata in terms of both breadth and length.

Table 5. Variations in the upper and lower of ornamental pepper leaves irrigated with different water types (measured in µm)

Irrigated water	upper surface			lower surface		
	Frequency of Stomata	length of stomata	width of stomata	frequency of stomata	Length of stomata	width of stomata
Tab water	21	27.5-30	18.75--22.5	23	22.5-30	20-50
Treated Wastewater	29	20-32.5	5-20	34	20-27.5	15-20
Textile wastewater	26	22.5-27.5	17.5-20	30	20-27.5	17.5-22.5

Table (6) describe the primary stem anatomical changes brought on by the type of irrigation water. In the group that used textile-treated waste water for irrigation, the stone (sclerenchyma toes) cells were not present in the chlorenchema of the stem.

Table 6. Stem anatomical variations of Ornamental pepper responses to irrigated water (minimum –maximum values, measured in µm).

Character / Water type	Stone cells	Phloem length	Xylem diameter	Vascular bundle length	Parenchy-ma layers	Collenchyma layers	Epidermis thickness	Cuticle thickness
Tab water	+	50-87.5	22.5-37.5	175-450	3-5	1-6	17.5-25	7.5-10.5
Treated wastewater	+	30-75	22.5-55	325-425	3-6	1-7	12.5-22.5	2.5-10
Textile wastewater	-	55-112.5	20-47.5	175-500	3-7	1-7	15-25	5-10

Plants responded anatomically differently to varied environmental conditions. For instance, there would be reduced leaf area when there was a shortage of certain essentials like water and minerals. [31]. Due to the increased need to minimize water loss, plants that were irrigated with tab water had thicker cuticles and epidermal layers than plants that were irrigated with treated waste water because of the higher levels of organic matter in the soil. Because the cuticle can halt the start of cellular dehydration under stressful conditions, it is believed to play a significant role in plant tolerance [32]. Each of [33, 34, 35] established that salinity raised the stem's xylem diameter; this finding is in excellent agreement with a recent pepper study. The missing of stone cell missed from chlorenchema of stem in the group that irrigated with textile treated waste water is a good indicator on a biotic stress on plant, especially in the anatomical structure of stem.

Disclosure statement

The authors declare that there is no conflict of interests regarding the publication of this paper.

Authors' contributions

R.L.H.AL-Jaryan: Performed the laboratory experiment and analyzed the data. S.O.H. Al-Mamoori: Validated the data, read and edited the manuscript draft. N.M. Naji: Performed the laboratory experiment and analyzed the data. S.M.H.Al-Amery: Supervised the experiment, validated the data, and read the manuscript draft. B. M. H. AL-Adily: Conceptualized the research, supervised the experiment, validated the data and wrote the manuscript.

Data availability statement

Data available on request from the authors.

Funding

This study was not supported by any specific grant from funding.

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