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The Impact of Silicon in Mitigating Drought Adverse Effects In Basil (*Ocimum spp*) Plant

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ABSTRACT

Basil is an important medicinal and aromatic plant with very wide range of uses. Water stress has a crippling effect on growth and productivity of basil plants; therefore a pot experiment was carried out to study the response of growth and chemical composition of four basil varieties (Thai basil, Camphor basil, Red Rubin, and Lemon basil) to exogenous application of silicon (0, 25, 50 ppm) under different irrigation regimes (Irrigation at 3, 6, and 9 days intervals) in a split split-plot design. The results showed that although basil varieties varied significantly in their performance under the different irrigation regimes, but prolonging irrigation intervals had a significant negative effect on plant height, number of branches per plant, leaves/stem ratio, leaf area, fresh and dry herb per plant, chlorophyll content, essential oil percentage and essential oil yield per plant in all evaluated varieties. Chemical parameters in terms of total carbohydrates, total phenoles and proline contents increased with prolonging irrigation intervals in all varieties. Foliar application of silicon improved all growth and chemical parameters in all basil varieties especially under severe irrigation conditions. The best results were obtained when plants treated with 50 ppm of silicon. Methyl chavicol, linalool, eugenol were the major constituents of basil essential oil.

Key words: *Basil plant, Drought stress, Silicon, Growth, Volatile oil, Chemical composition*

1. INTRODUCTION

In recent years, the lack of irrigation water has become a major obstacle to expanding the area cultivated with aromatic and medicinal plants in Egypt. Many important physiological processes such as enzymes activity, respiration, photosynthesis, leaf enlargement and essential oil accumulation and its constituents in aromatic and medicinal plants are affected by a reduction in leaf water potential (Lawlor and Tezara, 2009; Heikal, 2017; Malika *et al*., 2019; Azad *et al*., 2021; Nazari *et al*., 2023; Bistgani *et al*., 2024). Therefore, maintaining a relatively high water content in the protoplasm insure the maintenance of growth and function for most plants. Abiotic stresses, in particularly drought stress, represent the main limiting factors of plant cell division and growth (Bnhassan-Kesri *et al*., 2002; Tardieu *et al*., 2014; Bistgani *et al*., 2024). Drought stress diminished plant growth, essential oil content and oil yield of many plants as *Artemisia annua* L. (Heikal, 2017), *Matricaria recutita* L. (Jeshni *et al*., 2017), *Ocimum gratissimum* L. (Vilanova *et al*., 2018), sweet basil (*Ocimum basilicum* L.) (Taha *et al*., 2020 ; Consentino *et al*., 2023; Rahimi *et al*., 2023).

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Basil (*Ocimum spp*) is a medicinal and an important edible vegetable plant of the Lamiaceae family. It has a great diversity in terms of morphology and secondary compounds, especially for essential oil content (Makri and Kintzios 2008; Rahimi *et al*., 2023). The fragrance of the basil varies due to the varying types and quantities of essential oils in the plants. The *Ocimum* genus includes several herbaceous and shrub species such as *O. gratissimum*, *O. carnosum*, *O. sanctum*, *O. kilimandscharicum*, *O. americanum*, and *O. basilicum* that is considered the most important economic species. Basil is a long-day plant and grows naturally in tropical and subtropical regions (Makri and Kintzios 2008). Basil leaves and essential oil are used to treat headache, cold, as well as severe diseases like diarrhea and kidney failure. The active ingredients of this plant are used to treat flatulence and strengthen the digestive system (Avetisyan *et al*., 2017; Shahrajabian *et al*., 2020). The basil leaves are added to many foods as a flavoring agent and to aid digestion, and to protect food from spoilage (Singletary, 2018).

Basil plants are sensitive to drought stress. Moderate and severe water stress reduced dry matter yields by 15% and 28%, respectively, while the proline and essential oil contents were enhanced under severe water stress (Asghari *et al*., 2023). In a study carried out by Kalamartzis *et al*.(2023) on the effect of drought stress on landraces of basil (*Ocimum basilicum* L.) plants, they reported limited water availability resulted in a 20% reduction in dry matter yield and a 21% reduction in essential oil yield, meanwhile proline content increased, while chlorophyll content decreased under extreme stress. Therefore, finding ways to improve plant tolerance to drought stress is very useful for growth and essential oil production. Improving drought tolerance of commercial varieties of aromatic and medicinal plants is a promising approach, but it is long-term and expensive. Recently, a variety of new strategies have been devised to ameliorating plant performance under abiotic stresses. Numerous studies have indicated that exogenous application of anti-stress compounds such as salicylic acid (Damalas, 2019), L-ornithine (Hussein *et al*., 2019 and Masri *et al*., 2024), and silicon (Patel *et al*., 2021; Xu *et al*., 2023; Masri *et al*., 2024) enhanced the crop drought tolerance. Silicon enhances the drought tolerance in crops because it diminishes the oxidative damage of functional molecules and exaggerating anti-oxidative defense abilities as well as it helps in building cell strength and induces dehydration tolerance at tissue or cellular levels by improving the water status (Gong *et al*., 2005; Gao *et al*. 2006; Cooke and Leishman, 2011; Patel *et al*., 2021; Irfan *et al*., 2023; Prisa, 2023; Xu *et al*., 2023). Spraying fennel plants with silicon (7.5 mM) enhanced leaf area, plant height, seed yield and essential oil content under drought stress conditions (Asgharipour and Mosapour, 2016). Foliar application of silicon (250 ppm) to sweet basil plant nullify the deleterious effects caused by drought on plant growth, photosynthesis pigments, essential oil content and oil yield (Farouk and Omar,2020). Esmaili *et al*. (2022) found that application of nano-silicon complexes (3.0 mM) to feverfew plant limited tissue dehydration (35%) and the development of oxidative damage (30%) under drought stress conditions and restored the growth (25%) and yield of plant essential oils (30%). Therefore, this study was carried out to investigate the performance of agronomical characters and essential oil composition of four basil cultivars (*Ocimum spp*) under different irrigation levels and silicon treatments.

2. MATERIALS AND METHODS

2.1. Plant materials

Commercially available seeds of four basil (*Ocimum spp*) cultivars (Red rubin, Thai, Camphor, and Lemon) were purchased from Sekem Company, Egypt. Red Rubin basil (*Ocimum basilicum* 'Purpurascens' 'Red Rubin') is an improved variety of Dark opal basil. It has unusual reddish-purple leaves, and a stronger flavor than sweet basil, making it most appealing for salads and garnishes. It is a fast-growing annual herb that reaches a height of approximately 70 cm. Thai basil (*O.basilicum* var. *thyrsiflora*); it may sometimes be called anise basil or licorice basil, in reference to its anise- and licorice-like scent and taste. Thai basil is sturdy and compact growing up to 45 cm and has shiny green, slightly serrated, narrow leaves with a slight spiciness lacking in sweet basil. Camphor basil (*O. kilimandscharicum*), it also called fever plant or African basil with strong camphor odor. It is perennial woody shrub, grows up to 1.2 m with ovate leaves, and bears creamy white flowers. Camphor basil is a commercial source of camphor and it has too strong flavor for culinary use. It is also used internally for stomach aches, malaria, and other fever infections. Lemon **basil** (*Ocimum* × *africanum*) is a hybrid between basil (*O. basilicum*) and American basil (*O. americanum*). The herb contains citral and limonene, therefore actually does smell very lemony, tastes sweeter. It is sometimes called hoary or Lao basil. The herb is grown primarily in northeastern Africa and southern Asia for its fragrant lemon scent, and used in cooking. Lemon basil stems can grow to 20–40 cm tall. It has white flowers and the leaves are similar to sweet basil leaves, but tend to be narrower with slightly serrated edges.

2.2. Experimental procedures and design

Two pot experiments were carried out during the 2022 and 2023 seasons at the Experimental Nursery of the Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, Giza, Egypt. The Experiment location was 22.50 m above sea level and it is situated within 30°, 02´ N latitude and 31°, 13´ E longitude. Experimental soil samples were taken from 0-30 cm depths and mixed to homogenize them, air dried, softened and passed through a sieve with holes diameter of 2 mm. The physical and chemical characteristics of the pot soil (Table 1) were determined according to the method of Jackson (1958). Seeds of basil were sown on 15th March in both seasons in sandy loam soil in nursery beds inside greenhouse. Seedlings at the age of 30 days (10-12 cm in height) were transplanted to plastic pots (25 cm top diameter, 18 cm base diameter, 20 cm height), packed with sieved sandy loam soil in both seasons. One plant in each pot was irrigated regularly at an interval of 3 days for two weeks after transplanting. Each pot received 3 g of kristalon NPK (19:19:19) twice; the first after transplanting and the second one month later. Irrigation and silicon treatments on basil cultivars were started two weeks later of seedlings transplanting. The experiment was carried out in a split split-plot arrangement based on a completely randomized design (CRD) with three replicates in pots under field conditions in the 2022 and 2023 seasons. Drought stress was the main plot factor in three levels: normal (irrigation cycle of 3 days), moderate (irrigation cycle of 6 days), and severe (irrigation cycle of 9 days). The sub-plot factor was silicon treatments (Si) in three levels (0, 25, and 50 ppm). Foliar application of silicon as well as the control treatment (Spraying with tap water) started 15 days after transplanting and immediately before irrigation. Each drought stress treatment received three sprayings of silicon until run off with an interval of about two weeks between sprays. The four basil cultivars were considered sub sub-plot factor. Each level of sub sub-plot was represented by ten pots for each replicate.

2.3. Measured characters

2.3.1.Growth and physiological parameters

Data of different plant characters were recorded on the first week of July at the early bloom stage (about 3 months from transplanting) in both seasons. The observations for growth traits (plant height, leaf area, fresh leaves yield per plant, leaves-stem ratio (FW/FW), herb fresh and dry weights) as well as physiological traits including essential oil (%), and total chlorophyll were recorded on plants for each basil cultivar in each replicate under different combinations of drought and silicon treatments and the average of them was used as the final data for statistical analysis. Fresh weight of herb per plant (leaves and stems) was dried at 105 °C for 24 hr. and the dry weights (g) were recorded. Total chlorophylls content was determined in the fresh leaves using chlorophyll meter; model SPAD-502 (Spectrum Technologies Inc., Plainfield, IL), which SPAD unit = 10mg/100g fresh weight of leaves (Netto *et al.*, 2005). Essential oil content was determined according to British Pharmacopoeia (1963) by hydro distillation of 100 g fresh leaves for three hours. The essential oil percentage was estimated as follows: Essential oil (%) = (reading measured pipette/sample weight) × 100.

Table (1): Physicochemical properties of experimental soil.

Texture	Electrical conductivity (dS m^{-1})	pH	Organic matter (%)	K (mg kg^{-1})	P (mg kg^{-1})	N (mg kg^{-1})
Sandy loam	1.38	7.65	1.20	11.52	20.45	92.85

2.4.Chemical analysis

Total contents of carbohydrates, phenols and proline were determined in air dried samples of leaves only in the second season under different irrigation intervals but not sprayed with silicon and under different silicon levels with normal irrigation (3 days interval). Total carbohydrates were determined according to Dubois *et al*. (1956) in homogenized samples (0.2g). Total phenols were determined and analyzed according to the methods described by Swain & Hillis (1959). Proline was detected according to Handa *et al*. (1983).

2.5. Essential oil composition

The constituents of essential oil were determined in oil samples collected across the two seasons and obtained from basil cultivars grown under different irrigation intervals without silicon. The essential oil samples were dried over anhydrous sodium sulfate and were subjected to GC/MS analysis according to Adams (1995) to determine their main constituents at the Central Laboratory of Faculty of Agriculture, Cairo University.

2.6. Statistical analysis

Collected data were statistically analyzed using analysis of variance of the split- split plot design according to procedures outlined by Gomez and Gomez (1984) using MSTAT-C computer package (Freed *et al*., 1989). Treatment mean comparisons were performed using least significant difference (LSD) at 5% level of probability.

3. RESULTS AND DISCUSSION

3.1. Growth and physiological parameters

3.1.1.Main effects

Data presented in **Table 2** show the effects of irrigation intervals, silicon and basil varieties on growth traits, chlorophyll content and essential oil content in 2022and 2023 seasons. Prolonging irrigation intervals had a significant negative ($P \leq 0.05$) effect on plant height, number of branches per plant, leaves/stem ratio, leaf area, fresh and dry herb per plant, chlorophyll content, essential oil percentage and essential oil yield per plant in both seasons. The highest mean values for those studied traits were measured in plants irrigated each three days in both seasons, thereafter further prolongation in irrigation intervals decreased the mean values of all studied traits. Fresh weight of herb was decreased by about 15.74 and 23.68 % by prolongation of irrigation intervals from 3 days to 6 days and 9 days, respectively in the first season, corresponding to 14.80 and 24.02 %, respectively in the second one. The highest percentage of essential oil (0.20 and 0.18 %) was determined in plants irrigated each 6 days in the first and second seasons, respectively. Prolongation of irrigation intervals from 3 days to 6 days and 9 days, respectively decreased the essential oil yield by about 5.26 and 31.58 %, respectively in the first season, corresponding to 5.88 and 29.41 %, respectively in the second one. This reduction in essential oil yield was mainly due to the reduction in herb yield under drought conditions. However, water deficit in aromatic and medicinal plants has adverse effect on many important physiological processes such as enzymes activity, respiration, photosynthesis, leaf enlargement and essential oil accumulation (Heikal, 2017; Malika *et al*., 2019; Azad *et al*., 2021; Nazari *et al*., 2023; Bistgani *et al.*, 2024). The adverse effects of drought stress on growth and essential oil yield of different medicinal and aromatic plants were reported by many researchers (Heikal, 2017; Jeshni *et al*., 2017; Vilanova *et al*., 2018; Taha *et al*., 2020; Consentino *et al*., 2023; Rahimi *et al*., 2023).

Spraying basil plants with silicon had a significant positive ($P \leq 0.05$) effect on plant height, number of branches per plant, leaves/stem ratio, leaf area, fresh and dry herb per plant, chlorophyll content, essential oil percentage and yield per plant in both seasons. The highest mean values for the studied traits were measured in plants sprayed with 50 ppm of silicon in both seasons. Using silicon at 25 ppm and 50 ppm significantly increased fresh weight of herb per plant by about 12.88 and 22.37 %, respectively in the first season, corresponding to 13.42 and 22.53 %, respectively in the second season, in comparison with the untreated plants and increased essential oil percentage to 0.02 and 0.03%, respectively in both seasons. The increases in herb yield and oil percentage due to silicon treatment led to an increase in the essential oil yield in both seasons. Silicon plays an important role in the absorption of beneficial elements such as zinc, calcium, magnesium and

Table (2): Main effects of irrigation intervals, silicon and varieties on growth, chlorophyll and essential oil of basil plant during 2022 and 2023 seasons

Treatments	Plant height (cm)	No. Branches/plant	Leaves/ Stem Ratio (FW)	Leaf area (cm2)	Herb fresh weight/ plant (g)	Herb dry weight/ plant (g)	SPAD (unit) Chlorophyll	Essential oil %	Essential oil yield/ plant (g)
						2022 season			
Irrigation intervals (days)									
3	47.48	12.35	2.61	17.16	106.27	34.58	41.93	0.18	0.19
6	43.97	11.84	2.42	12.20	89.54	30.86	40.37	0.20	0.18
9	40.92	10.11	2.30	9.54	81.11	29.61	41.46	0.16	0.13
L.S.D.at 5%	1.76	0.88	0.09	0.79	7.52	3.45	1.52	0.01	0.01
Silicon (ppm)									
0	39.75	10.11	2.28	12.29	82.60	28.01	39.60	0.16	0.14
25	44.32	11.47	2.48	13.07	93.24	32.00	41.44	0.18	0.17
50	48.31	12.72	2.58	13.54	101.08	35.05	42.73	0.19	0.19
L.S.D.at 5%	1.68	0.75	0.07	0.74	6.38	2.55	1.46	0.01	0.02
Basil varieties									
Thai basil	40.53	10.27	2.04	9.18	79.60	26.33	42.77	0.21	0.17
Camphor basil	44.82	11.15	2.28	12.04	89.83	30.56	41.33	0.16	0.15
Red Rubin basil	43.71	12.06	2.97	18.14	108.14	38.60	39.48	0.19	0.21
Lemon basil	47.44	12.26	2.48	12.50	91.66	31.25	41.44	0.15	0.14
L.S.D.at 5%	1.58	0.69	0.06	0.71	6.25	2.57	1.38	0.01	0.02
						2023 season			
Irrigation intervals (days)									
3	47.73	11.99	2.54	16.52	101.67	33.07	41.29	0.16	0.17
6	42.74	11.58	2.35	11.90	86.62	29.85	39.90	0.18	0.16
9	39.93	9.60	2.24	8.78	77.25	28.19	40.30	0.15	0.12
L.S.D.at 5%	1.82	0.92	0.10	0.83	8.15	3.82	1.68	0.01	0.01
Silicon (ppm)									
0	38.87	9.80	2.23	11.79	79.04	26.79	38.76	0.15	0.12
25	43.89	11.19	2.38	12.50	89.65	30.76	40.87	0.17	0.15
50	47.64	12.18	2.51	12.91	96.85	33.57	41.86	0.18	0.17
L.S.D.at 5%	1.72	0.84	0.08	0.77	7.22	2.67	1.54	0.01	0.02
Basil varieties									
Thai basil	39.92	10.03	1.93	8.89	77.78	25.73	42.02	0.19	0.15
Camphor basil	44.04	10.81	2.25	11.41	86.41	29.38	40.57	0.15	0.13
Red Rubin basil	42.80	11.64	2.93	17.39	102.28	36.52	38.67	0.18	0.18
Lemon basil	47.11	11.75	2.39	11.90	87.57	29.86	40.73	0.14	0.13
L.S.D.at 5%	1.65	0.78	0.07	0.74	6.84	2.62	1.43	0.01	0.02

nitrogen from the growing medium and consequently enhances the growth of plants (Pavlovic *et al*., 2021). Basil varieties varied significantly in growth traits and the contents of chlorophyll and essential oil in both seasons (Table 2). The Red Rubin basil variety exhibited the highest herb fresh yield per plant (108.14 and 102.28 g) and their essential oil yield (0.21 and 0.18 g) in the first and second seasons, respectively. The superiority of the Red Rubin basil variety in essential oil yield was due to its superiority in herb fresh yield rather than its essential oil content. Variability in growth and essential oil content among basil varieties was recorded by Makri and Kintzios 2008; Rahimi *et al*., 2023.

3.2. Interaction effects

Concerning the interaction between irrigation and silicon treatments in both seasons **(Table 3),** the results indicated that plant height, number of branches per plant, leaf area, fresh and dry weight of herb per plant and chlorophyll content were significantly ($P \leq 0.05$) affected by the interaction between them in both seasons. Increasing irrigation interval from 3 to 6 and 9 days significantly diminished all previous mentioned traits in both seasons. Foliar application of silicon especially at the rate of 50 ppm enhanced growth and chlorophyll content either under non-stress and stress conditions. Irrigation of basil plants every 9 days without spraying diminished the herb fresh yield by about 21.50% and 22.42% in the first and second seasons, respectively as compared to non-treated plants with silicon under 3 days irrigation interval. However, spraying plants with 50 ppm of silicon alleviated the adverse effects of water deficit, since it reduced the reduction of herb fresh yield per plant to 2.63% and 3.76% in the first and second seasons, respectively. Similar trends were observed for the other growth traits and chlorophyll content in both seasons. Once the plant absorbed silicon, it is deposited in cells and acts to strengthen the plant and enhances its natural defensive properties. With tougher internal structures, plants are better able to withstand environmental stress conditions such as drought. Furthermore, it is the intermediate compound in the arginine biosynthesis where the pathway divaricates to the production of compounds, such as proline that serve as osmoprotective substance in plants (Ali *et al*., 2016).

The interaction between irrigation intervals and basil varieties **(Table 4)** was significant ($P \leq 0.05$) for plant height, number of branches per plant, leaves/stem ratio, leaf area, fresh and dry weights of herb per plant and chlorophyll content in both seasons. Results indicated that although all evaluated basil varieties showed variability among each other in their performance with respect to growth traits and chlorophyll content but all of them adversely affected by prolongation irrigation interval from 3 days to 6 and 9 days during the two seasons. The highest value of branches number per plant (13.24 and 12.93), leaves/stem ratio (3.08 and 2.95), leaf area (22.67 and 21.98 cm^2), herb fresh weight per plant (127.28 and 119.02 g), herb dry weight per plant (43.17 and 40.37 g) and essential oil yield per plant (0.24 and 0.21 g) were obtained for the basil variety Red Rubin under non-stress conditions (irrigation every 3 days) in the first and second seasons, respectively. The variety Camphor basil was the most adversely affected under stress conditions of irrigation every 9 days since its herb fresh weight per plant reduced by about 29.45% and 31.38% as compared to non-stress condition in the first and second seasons, respectively. The variety Thai basil showed the least reduction in herb fresh weight per plant (18.38% and 18.86%) under stress condition of irrigation every 9 days. All evaluated basil varieties gave the highest percentage of essential oil when watered every 6 days in both seasons. Although, water stress proved to alter the secondary metabolites accumulation in medicinal plants (Marchese *et al*., 2010) but a moderate water deficit has sometimes proved beneficial for the accumulation of biologically-active compounds in medicinal and aromatic plants (Heikal, 2017).

The interaction between silicon and basil varieties **(Table 5)** was significant ($P \leq 0.05$) for plant height, number of branches per plant, leaves/stem ratio, leaf area, fresh and dry weights of herb per plant and chlorophyll content in both seasons. However, the interaction was insignificant for essential oil percentage and essential oil yield per plant in both seasons. Results showed that even though the four evaluated basil varieties showed variability among each other in all studied characters under the three different levels of silicon but all of these varieties well performed for all traits with increasing level of silicon up to 50 ppm in both seasons. The plants of Red Rubin variety gave the highest value of leaves/stem ratio (3.10 and 3.05), leaf area (18.90 and 18.05 cm^2), herb fresh yield per plant (119.07 and 112.32 g), herb dry yield per plant (43.20 and 40.72 g) and consequently essential oil yield per plant (0.24 and 0.21 g) when treated with silicon at 50 pm in the first and second seasons, respectively. Lemon basil showed greater plant height (53.83 and 53.56 cm) and branches number per plant (13.66 and 12.99) when treated with 50 ppm of silicon in the first and second seasons, respectively than the other levels. The role of silicon in enhancing growth and yield of different medicinal and aromatic plants especially under drought stress conditions was

Table (3): Interactive effect of irrigation intervals X siliconon growth, chlorophyll and essential oil of basil plant during 2022 and 2023 seasons.

Irrigation intervals (days)	Silicon (ppm)	Plant height (cm)	No. Branches	Leaves/ Stem ratio	Leaf area (cm2)	Herb fresh weight/ plant (g)	Herb dry weight/ plant (g)	SPAD Chlorophyll	Oil %	Oil yield/plant (g)
						2022 season				
	0	43.36	11.29	2.44	15.82	92.52	29.66	41.21	0.16	0.15
3	**25**	47.71	12.41	2.66	17.50	108.17	35.20	41.84	0.18	0.19
	50	51.38	13.35	2.74	18.15	118.11	38.87	42.74	0.19	0.22
	0	39.75	10.53	2.28	11.90	82.65	28.15	39.58	0.18	0.15
6	**25**	42.88	11.75	2.45	12.15	90.91	31.35	40.26	0.20	0.18
	50	49.27	13.25	2.54	12.55	95.06	33.09	41.28	0.21	0.20
	0	36.14	8.52	2.12	9.15	72.63	26.20	38.00	0.15	0.11
9	**25**	42.37	10.24	2.34	9.55	80.63	29.44	42.22	0.17	0.13
	50	44.27	11.58	2.45	9.93	90.08	33.20	44.18	0.18	0.16
LSD at 5%		2.45	1.12	ns	1.18	11.15	4.23	2.24	ns	ns
						2023 season				
	0	42.84	11.00	2.39	15.29	88.53	28.37	39.78	0.15	0.14
3	**25**	48.67	12.14	2.56	16.83	104.00	33.82	41.74	0.17	0.18
	50	51.68	12.83	2.66	17.44	112.48	37.00	42.35	0.18	0.20
	0	38.90	10.20	2.24	11.63	79.91	27.22	38.92	0.17	0.13
6	**25**	41.63	11.59	2.32	11.95	87.09	30.02	40.00	0.18	0.16
	50	47.70	12.96	2.49	12.13	92.88	32.32	40.79	0.19	0.18
	0	34.86	8.20	2.07	8.46	68.68	24.78	37.59	0.14	0.10
9	**25**	41.39	9.85	2.28	8.71	77.87	28.43	40.88	0.16	0.13
	50	43.55	10.76	2.38	9.18	85.20	31.38	42.44	0.17	0.14
LSD at 5%		2.76	1.17	ns	1.21	11.34	4.42	2.36	ns	ns

Table (4): Interactive effects of irrigation intervals X varieties on growth, chlorophyll and essential oil of basil plant during 2022 and 2023 seasons

Irrigation intervals (days)	Varieties	Plant height (cm)	No. Branches	Leaves/ Stem Ratio (FW)	Leaf area (cm2)	Herb fresh weight/ plant (g)	Herb dry weight/ plant (g)	SPAD (unit) Chlorophyll	Oil %	Oil yield/plant (g)
						2022 season				
3	**Thai basil**	44.20	11.27	1.97	12.20	87.15	27.20	42.51	0.19	0.17
	Camphor basil	49.90	12.00	2.64	16.15	107.79	34.77	42.24	0.17	0.18
	Red Rubin basil	46.94	13.24	3.08	22.67	127.28	43.17	41.91	0.19	0.24
	Lemon basil	48.89	12.88	2.75	17.61	102.85	33.17	41.05	0.16	0.16
6	**Thai basil**	39.94	10.78	2.16	8.93	80.51	26.74	42.55	0.22	0.18
	Camphor basil	44.64	11.44	2.23	11.17	85.65	29.33	39.23	0.18	0.15
	Red Rubin basil	43.13	11.93	2.92	17.35	101.38	36.35	38.37	0.21	0.21
	Lemon basil	48.15	13.22	2.37	11.35	90.61	31.03	41.33	0.18	0.16
9	**Thai basil**	37.44	8.77	2.00	6.40	71.13	25.04	43.24	0.22	0.16
	Camphor basil	39.92	10.00	1.98	8.80	76.05	27.57	42.52	0.14	0.10
	Red Rubin basil	41.04	11.00	2.91	14.42	95.76	36.28	38.14	0.18	0.17
	Lemon basil	45.28	10.67	2.33	8.55	81.52	29.56	41.95	0.12	0.09
LSD at 5%		2.17	1.07	0.11	1.14	10.76	3.98	2.06	ns	ns
						2023 season				
3	**Thai basil**	43.50	11.08	1.92	12.08	84.82	26.47	42.05	0.17	0.15
	Camphor basil	50.07	11.39	2.56	15.20	104.55	33.73	41.86	0.16	0.17
	Red Rubin basil	46.18	12.93	2.95	21.98	119.02	40.37	40.99	0.17	0.21
	Lemon basil	51.17	12.56	2.71	16.80	98.29	31.69	40.24	0.16	0.16
6	**Thai basil**	39.39	10.67	1.97	8.53	79.72	26.47	42.10	0.20	0.16
	Camphor basil	43.20	11.33	2.25	10.80	82.95	28.41	39.03	0.17	0.14
	Red Rubin basil	42.27	11.56	2.96	17.00	97.39	34.92	37.61	0.19	0.18
	Lemon basil	46.10	12.77	2.21	11.27	86.43	29.60	40.87	0.17	0.15
9	**Thai basil**	36.87	8.33	1.90	6.07	68.82	24.23	41.91	0.21	0.15
	Camphor basil	38.84	9.70	1.93	8.23	71.74	26.01	40.81	0.12	0.09
	Red Rubin basil	39.95	10.44	2.88	13.20	90.44	34.26	37.40	0.18	0.16
	Lemon basil	44.07	9.93	2.25	7.63	78.00	28.28	41.09	0.11	0.08
LSD at 5%		2.31	1.14	0.13	1.17	11.05	4.11	2.15	ns	ns

Table (5): Interactive effect of silicon X varieties on growth, chlorophyll and essential oil of basil plant during 2022 and 2023 seasons

Silicon (ppm)	Varieties	Plant height (cm)	No. Branches	Leaves/Stem Ratio (FW)	Leaf area (cm2)	Herb fresh weight/ plant (g)	Herb dry weight/ plant (g)	SPAD (unit) Chlorophyll	Oil %	Oil yield/plant (g)
						2022 season				
0	**Thai basil**	37.74	9.16	1.89	8.67	74.42	24.44	41.45	0.19	0.14
	Camphor basil	38.88	9.56	2.11	11.42	78.13	26.45	38.95	0.15	0.11
	Red Rubin basil	41.28	11.06	2.75	17.33	95.68	33.36	37.96	0.18	0.17
	Lemon basil	41.10	10.67	2.36	11.74	82.16	27.78	40.02	0.14	0.11
25	**Thai basil**	40.79	10.32	2.04	9.23	79.96	26.44	43.03	0.21	0.17
	Camphor basil	45.20	11.00	2.33	12.23	92.50	31.39	41.61	0.16	0.15
	Red Rubin basil	43.89	12.10	3.07	18.20	109.65	39.24	39.38	0.19	0.21
	Lemon basil	47.39	12.44	2.48	12.60	90.83	30.91	41.72	0.15	0.14
50	**Thai basil**	43.05	11.33	2.20	9.63	84.41	28.09	43.82	0.22	0.19
	Camphor basil	50.39	12.89	2.40	12.47	98.86	33.84	43.43	0.17	0.17
	Red Rubin basil	45.95	13.02	3.10	18.90	119.07	43.20	41.09	0.20	0.24
	Lemon basil	53.83	13.66	2.61	13.17	101.98	35.07	42.58	0.16	0.17
LSD at 5%		2.24	1.11	0.13	1.18	11.07	4.12	2.11	ns	ns
						2023 season				
0	**Thai basil**	37.43	8.77	1.80	8.62	72.15	23.68	40.36	0.17	0.12
	Camphor basil	37.42	9.44	2.09	10.67	74.38	25.15	39.25	0.13	0.10
	Red Rubin basil	40.53	10.67	2.75	16.73	90.53	31.58	36.50	0.17	0.16
	Lemon basil	40.09	10.32	2.29	11.15	79.10	26.74	38.93	0.13	0.11
25	**Thai basil**	39.92	10.10	1.89	8.80	78.43	25.94	42.82	0.20	0.15
	Camphor basil	44.89	10.90	2.20	11.63	89.82	30.47	40.45	0.15	0.14
	Red Rubin basil	43.08	11.82	3.00	17.40	104.01	37.25	38.77	0.18	0.19
	Lemon basil	47.69	11.94	2.44	12.15	86.35	29.37	41.44	0.15	0.13
50	**Thai basil**	42.40	11.22	2.10	9.27	82.77	27.55	42.88	0.21	0.17
	Camphor basil	49.80	12.08	2.45	11.93	95.05	32.53	42.00	0.16	0.16
	Red Rubin basil	44.80	12.44	3.05	18.05	112.32	40.72	40.74	0.19	0.21
	Lemon basil	53.56	12.99	2.44	12.40	97.27	33.47	41.82	0.15	0.15
LSD at 5%		2.29	1.15	0.15	1.22	11.16	4.17	2.18	ns	ns

reported by many researchers (Farouk and Omar, 2020; Pavlovic *et al*., 2021; Esmaili *et al*., 2022; Irfan *et al*., 2023).

The interaction effects among irrigation intervals, silicon levels and basil varieties (the second order interaction) in 2022 and 2023 seasons are shown in **Tables 6 and 7.** It was significant ($P \leq 0.05$) for plant height, number of branches per plant, leaves/stem ratio, leaf area, fresh and dry weights of herb per plant and chlorophyll content in both seasons. However, it was insignificant for essential oil percentage and yield per plant in both seasons. The four basil cultivars showed variability in their performance under different combinations of irrigation intervals and silicon levels in both seasons. Prolonging irrigation interval from 3 to 9 days without treating plants with silicon had the greatest adverse impact on the growth of all basil cultivars in both seasons. Moreover, the cultivar Lemon basil showed the greatest reduction in herb fresh yield (25.28 and 25.88%) and herb dry yield (15.95 and 16.62%), while the cultivar Red Rubin showed the lowest ones in herb fresh yield (18.71 and 16.11%) and herb dry yield (8.85 and 5.94%) in the first and second seasons, respectively. However, irrigating plants every 9 days combined with silicon at 50 ppm greatly improved the growth traits of all cultivars. The alleviating effect of silicon in water stressed plants was associated with improving physiological processes through increasing the content of photosynthetic pigments and maintaining water retain in plants tissues as well as its role in strengthen the plant and enhance its natural defensive properties. Therefore, silicon application could effectively improve basil growth under water stress conditions as reported by Farouk and Omar (2020) and Esmaili *et al*. (2022).

3.3. Chemical parameters

3.3.1. Total carbohydrates

Total carbohydrates content was notably increased with prolongation of irrigation intervals from 3 days up to 9 days in leaves of all four evaluated basil varieties although these varieties vary in their carbohydrates content **(Fig.1).**

The highest percent of total carbohydrates (53.63, 54.42, 56.65, and 50.38%) was determined in leaves of Thai basil, Camphor basil, Red rubin and Lemon basil varieties, respectively when irrigated every 9 days. Increasing total carbohydrates under drought conditions was reported by Heikal (2017) in *Artemisia annua* plant and Rahimi *et al.* (2023) in different basil genotypes. In regards to the results of exogenous foliar applications of silicon, it improved the total carbohydrates in basil leaves in all four basil varieties **(Fig. 4)** when compared with control (no silicon application). Foliar application of silicon at 50 ppm recorded the highest content of carbohydrates (53.45, 56.78, 58.75, and 49.88 %) in Thai basil, Camphor basil, Red Rubin and Lemon basil varieties, respectively. The role of silicon in enhancing carbohydrates content in plants that is grown under drought stress was reported by Irfan *et al. (*2023).

3.3.2.Proline content

Proline has been suggested as an evaluating indicator for selecting drought-resistant varieties due to its increases proportionately faster than other amino acids in plants under water stress. The results showed that the proline content increased with the increase in drought stress **(Fig. 2).** The highest increase in proline among the studied basil varieties belonged to Red Rubin variety (5.22 and 5.40 mg/g D.W.) in moderate (6 days interval) and sever (9 days interval) stress conditions, respectively. Variable increasing in proline content in basil varieties under drought stress conditions was reported by Rahimi *et al.* (2023) and they also mentioned that although it has been shown that proline accumulation is linearly related to increasing drought stress, it is not always true to say that genotypes with higher proline content are always drought-tolerant. The results of exogenous foliar applications of silicon **(Fig. 5**) showed that application of silicon variably increased the proline content in all four basil varieties The highest increase in proline content among studied basil varieties was for Red Rubin variety (7.22 mg/g D.W.) when sprayed with 50 ppm of silicon. Increasing proline content in plants treated with silicon was reported by Irfan *et al. (*2023).

3.3.3.Total phenols

The total phenols increased with prolongation of irrigation interval **(Fig. 3).** The highest phenol was observed under severe drought stress for all basil varieties. The highest phenols belonged to Red rubin variety (141.25 mg GAE/g D.W). Different studies also showed an increase in total phenols content in basil plant under drought stress.

Table (6): Interactive effect of irrigation intervals X silicon X varieties on growth, chlorophyll and essential oil of basil plant during 2022 season.

Irrigation intervals (days)	Silicon (ppm)	Varieties	Plant height (cm)	No. Branches	Leaves/ Stem Ratio (FW)	Leaf area (cm2)	Herb fresh weight/ plant (g)	Herb dry weight/ plant (g)	SPAD (unit) Chlorophyll	Oil %	Oil yield/ plant (g)
3	0	Thai basil	41.43	10.15	1.91	11.40	83.09	25.76	41.93	0.17	0.14
		Camphor basil	43.00	10.67	2.28	14.65	86.69	27.74	41.73	0.15	0.13
		Red Rubin	45.00	12.33	2.92	21.00	105.49	34.81	41.10	0.18	0.19
		Lemon basil	44.00	12.00	2.65	16.22	94.81	30.34	40.07	0.15	0.14
	25	Thai basil	44.33	11.65	1.95	12.20	87.05	27.16	42.37	0.19	0.17
		Camphor basil	51.00	12.00	2.83	16.80	113.71	36.61	42.00	0.17	0.19
		Red Rubin	47.00	13.00	3.12	23.00	130.44	44.35	41.93	0.19	0.25
		Lemon basil	48.50	13.00	2.72	18.00	101.47	32.67	41.05	0.16	0.16
	50	Thai basil	46.83	12.00	2.05	13.00	91.30	28.67	43.23	0.21	0.19
		Camphor basil	55.70	13.33	2.80	17.00	122.97	39.97	43.00	0.18	0.22
		Red Rubin	48.83	14.40	3.21	24.00	145.90	50.34	42.70	0.20	0.29
		Lemon basil	54.17	13.65	2.88	18.60	112.27	36.49	42.03	0.17	0.19
6	0	Thai basil	37.50	9.67	1.92	8.60	75.09	24.78	41.43	0.20	0.15
		Camphor basil	38.83	10.00	2.13	11.00	78.85	26.81	38.13	0.17	0.13
		Red Rubin	41.53	11.45	2.71	17.00	95.81	33.53	37.77	0.19	0.18
		Lemon basil	41.15	11.00	2.34	11.00	80.84	27.49	41.00	0.17	0.14
	25	Thai basil	39.33	10.67	2.22	9.00	81.09	26.92	42.90	0.22	0.18
		Camphor basil	42.37	11.00	2.25	11.10	86.85	29.70	38.77	0.18	0.16
		Red Rubin	43.67	12.00	2.99	17.20	102.85	37.03	38.20	0.21	0.22
		Lemon basil	46.15	13.33	2.34	11.30	92.84	31.75	41.15	0.18	0.17
	50	Thai basil	43.00	12.00	2.35	9.20	85.36	28.51	43.33	0.23	0.20
		Camphor basil	52.73	13.33	2.31	11.40	91.25	31.48	40.80	0.19	0.17
		Red Rubin	44.20	12.35	3.07	17.85	105.47	38.50	39.15	0.22	0.23
		Lemon basil	57.15	15.33	2.44	11.75	98.14	33.86	41.85	0.18	0.18
9	0	Thai basil	34.30	7.67	1.83	6.00	65.09	22.78	41.00	0.21	0.14
		Camphor basil	34.80	8.00	1.93	8.60	68.85	24.79	37.00	0.12	0.08
		Red Rubin	37.30	9.40	2.62	14.00	85.75	31.73	35.00	0.17	0.15
		Lemon basil	38.15	9.00	2.10	8.00	70.84	25.50	39.00	0.09	0.06
	25	Thai basil	38.70	8.65	1.95	6.50	71.73	25.25	43.83	0.23	0.16
		Camphor basil	42.23	10.00	1.92	8.80	76.94	27.85	44.07	0.14	0.11
		Red Rubin	41.00	11.30	3.11	14.40	95.67	36.35	38.00	0.18	0.17
		Lemon basil	47.53	11.00	2.38	8.50	78.18	28.30	42.97	0.12	0.09
	50	Thai basil	39.33	10.00	2.21	6.70	76.56	27.10	44.90	0.23	0.18
		Camphor basil	42.73	12.00	2.08	9.00	82.36	30.06	46.50	0.15	0.12
		Red Rubin	44.83	12.30	3.01	14.85	105.85	40.75	41.43	0.19	0.20
		Lemon basil	50.17	12.00	2.50	9.15	95.54	34.87	43.87	0.14	0.13
LSD at 5%			3.14	1.56	0.26	1.58	13.24	5.17	2.68	ns	ns

Table (7): Interactive effect of irrigation intervals X silicon X varieties on growth, chlorophyll and essential oil of basil plant during 2023 season.

Irrigation intervals (days)	Silicon (ppm)	Varieties	Plant height (cm)	No. Branches	Leaves/ Stem Ratio (FW)	Leaf area (cm2)	Herb fresh weight/ plant (g)	Herb dry weight/ plant (g)	SPAD (unit) Chlorophyll	Oil %	Oil yield/plant (g)
3	0	**Thai basil**	41.00	10.00	1.92	11.85	81.15	25.16	41.07	0.15	0.12
		Camphor basil	42.67	10.33	2.24	13.50	84.50	27.04	40.87	0.14	0.12
		Red Rubin	44.50	12.00	2.79	20.80	97.45	32.16	38.63	0.16	0.16
		Lemon basil	43.20	11.67	2.59	15.00	91.00	29.12	38.53	0.15	0.14
	25	**Thai basil**	44.00	11.24	1.88	12.00	84.65	26.41	42.07	0.18	0.15
		Camphor basil	52.00	11.85	2.67	15.90	111.40	35.87	41.87	0.16	0.18
		Red Rubin	46.03	12.80	2.96	22.00	121.45	41.29	42.00	0.17	0.21
		Lemon basil	52.63	12.67	2.72	17.40	98.50	31.72	41.00	0.16	0.16
	50	**Thai basil**	45.50	12.00	1.96	12.40	88.65	27.84	43.00	0.19	0.17
		Camphor basil	55.53	12.00	2.76	16.20	117.75	38.27	42.85	0.17	0.20
		Red Rubin	48.00	14.00	3.11	23.15	138.15	47.66	42.35	0.18	0.25
		Lemon basil	57.67	13.33	2.82	18.00	105.36	34.24	41.20	0.16	0.17
6	0	**Thai basil**	37.33	9.15	1.71	8.20	73.15	24.14	41.00	0.18	0.13
		Camphor basil	36.93	10.00	2.15	10.50	75.25	25.59	38.93	0.15	0.11
		Red Rubin	41.15	11.00	2.85	16.60	92.38	32.33	36.17	0.18	0.16
		Lemon basil	40.20	10.65	2.24	11.20	78.85	26.81	39.57	0.16	0.13
	25	**Thai basil**	38.37	10.67	1.97	8.40	81.00	26.89	42.30	0.20	0.16
		Camphor basil	41.10	11.00	2.13	10.80	84.20	28.80	39.00	0.17	0.14
		Red Rubin	42.60	11.67	2.93	17.00	97.15	34.97	37.70	0.19	0.18
		Lemon basil	44.43	13.00	2.23	11.60	86.00	29.41	41.00	0.17	0.15
	50	**Thai basil**	42.47	12.20	2.24	9.00	85.00	28.39	43.00	0.21	0.18
		Camphor basil	51.57	13.00	2.46	11.10	89.40	30.84	39.15	0.18	0.16
		Red Rubin	43.07	12.00	3.10	17.40	102.65	37.47	38.97	0.20	0.21
		Lemon basil	53.67	14.65	2.15	11.00	94.45	32.59	42.03	0.17	0.16
9	0	**Thai basil**	33.97	7.15	1.78	5.80	62.15	21.75	39.00	0.19	0.12
		Camphor basil	32.67	8.00	1.87	8.00	63.38	22.82	37.95	0.10	0.06
		Red Rubin	35.93	9.00	2.60	12.80	81.75	30.25	34.70	0.18	0.15
		Lemon basil	36.87	8.65	2.04	7.25	67.45	24.28	38.70	0.08	0.05
	25	**Thai basil**	37.40	8.40	1.83	6.00	69.65	24.52	44.10	0.21	0.15
		Camphor basil	41.56	9.85	1.81	8.20	73.85	26.73	40.47	0.13	0.10
		Red Rubin	40.60	11.00	3.10	13.20	93.42	35.50	36.60	0.18	0.17
		Lemon basil	46.00	10.15	2.36	7.45	74.54	26.98	42.33	0.11	0.08
	50	**Thai basil**	39.23	9.45	2.10	6.40	74.65	26.43	42.63	0.22	0.17
		Camphor basil	42.30	11.25	2.12	8.50	78.00	28.47	44.00	0.14	0.11
		Red Rubin	43.33	11.33	2.93	13.60	96.15	37.02	40.90	0.18	0.17
		Lemon basil	49.33	11.00	2.35	8.20	92.00	33.58	42.23	0.13	0.12
	LSD at 5%		3.42	1.73	0.33	1.76	13.62	5.41	2.83	ns	ns

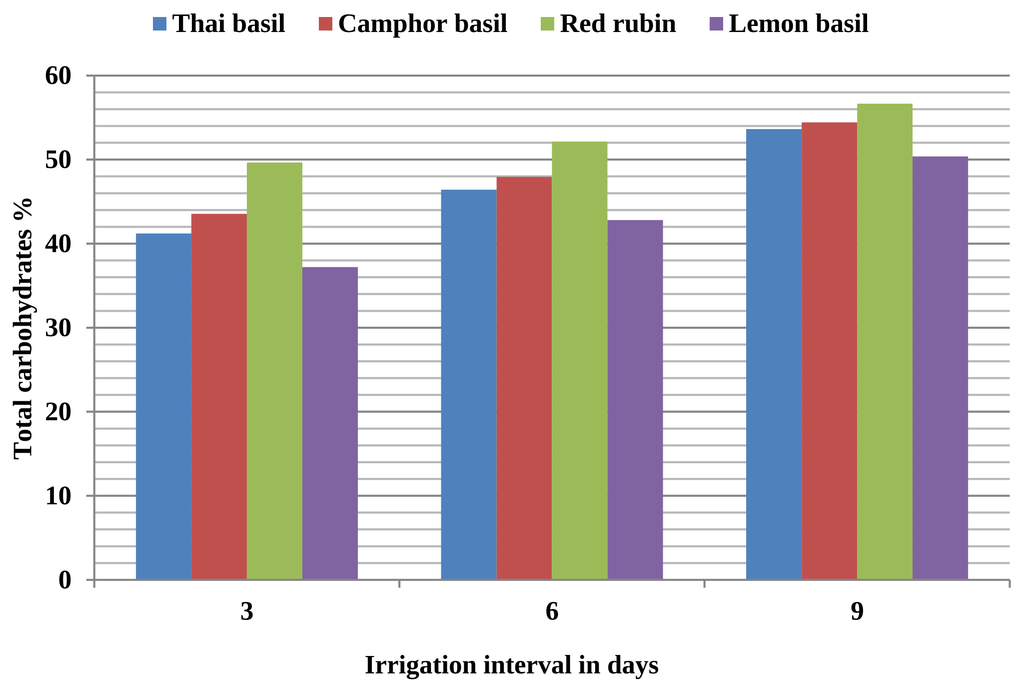

Fig.(1): Effect of irrigation intervals on total carbohydrates conten in leaves of four basil varieties plants.

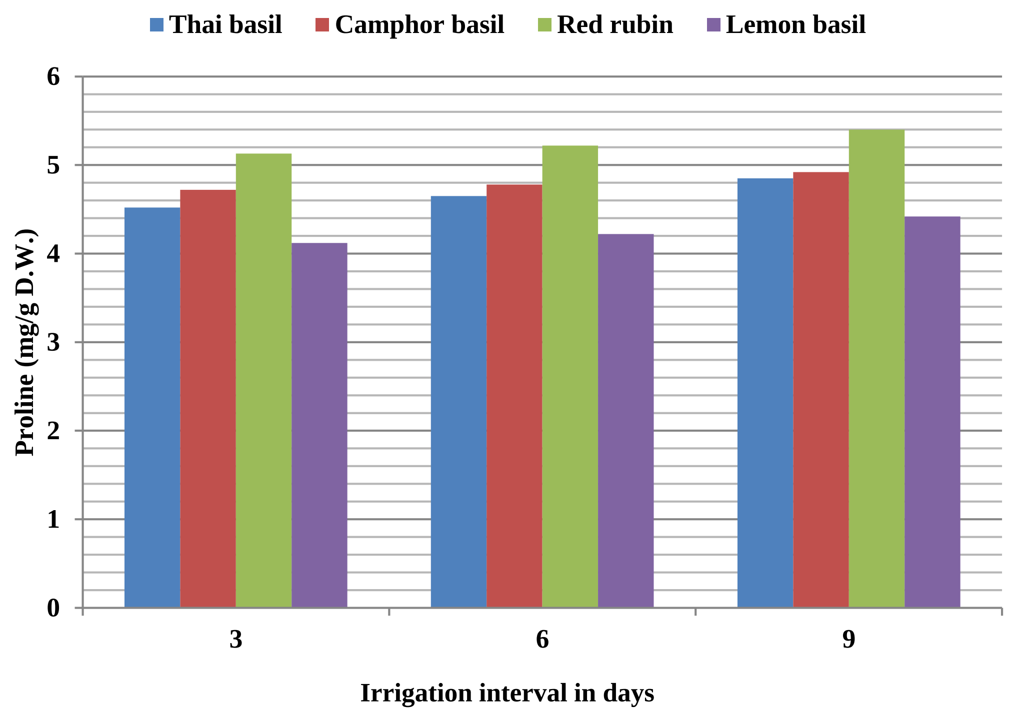

Fig.(2): Effect of irrigation intervals on proline conten in leaves of four basil varieties plants.

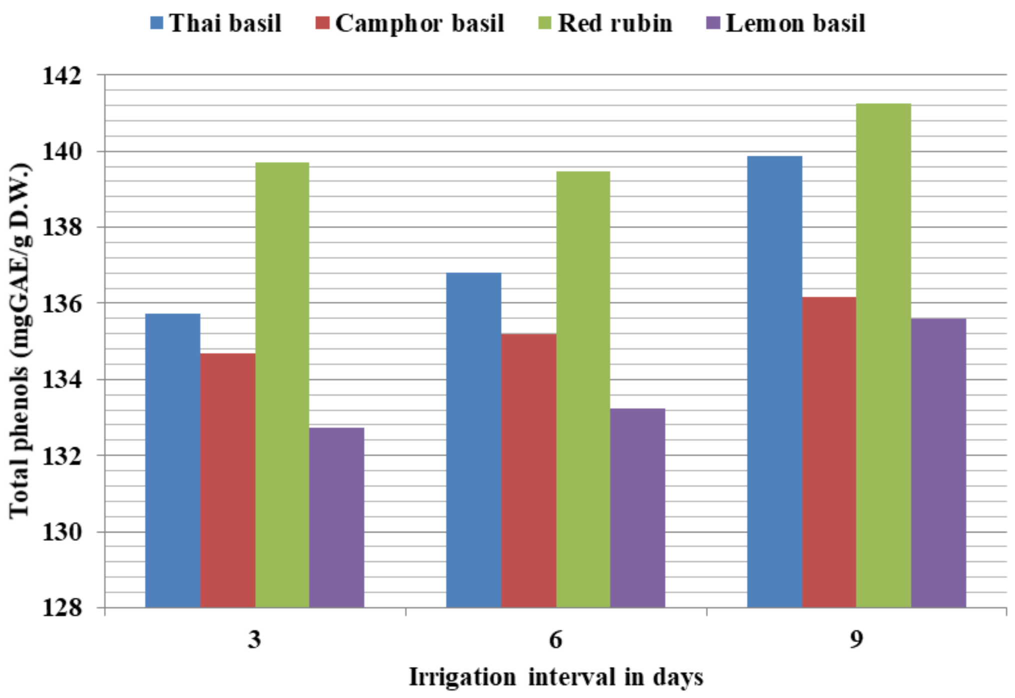

Fig.(3): Effect of irrigation intervals on total phenols conten in leaves of four basil varieties plants.

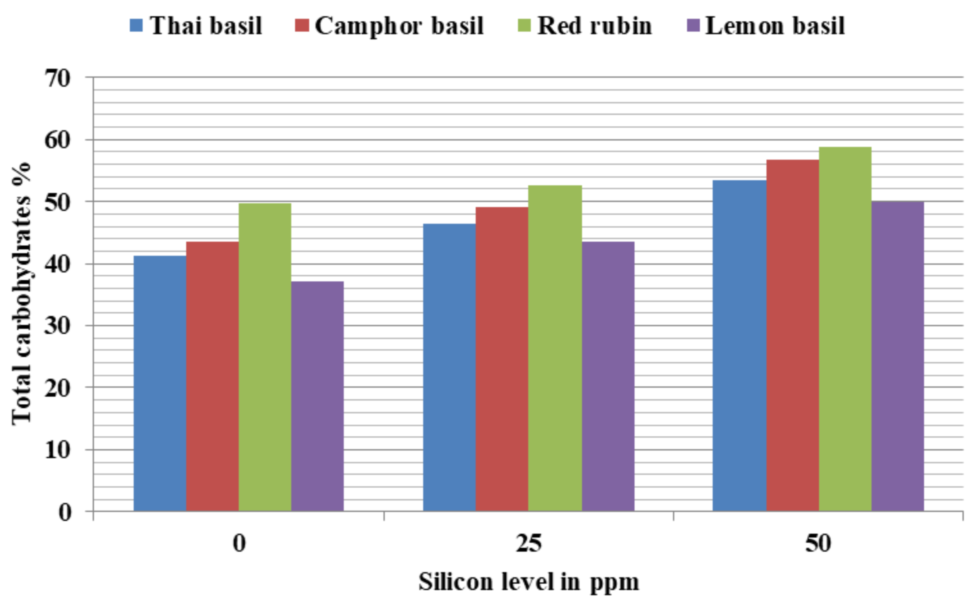

Fig.(4): Effect of foliar application of silicon on total carbohydrates conten in leaves of four basil varieties plants.

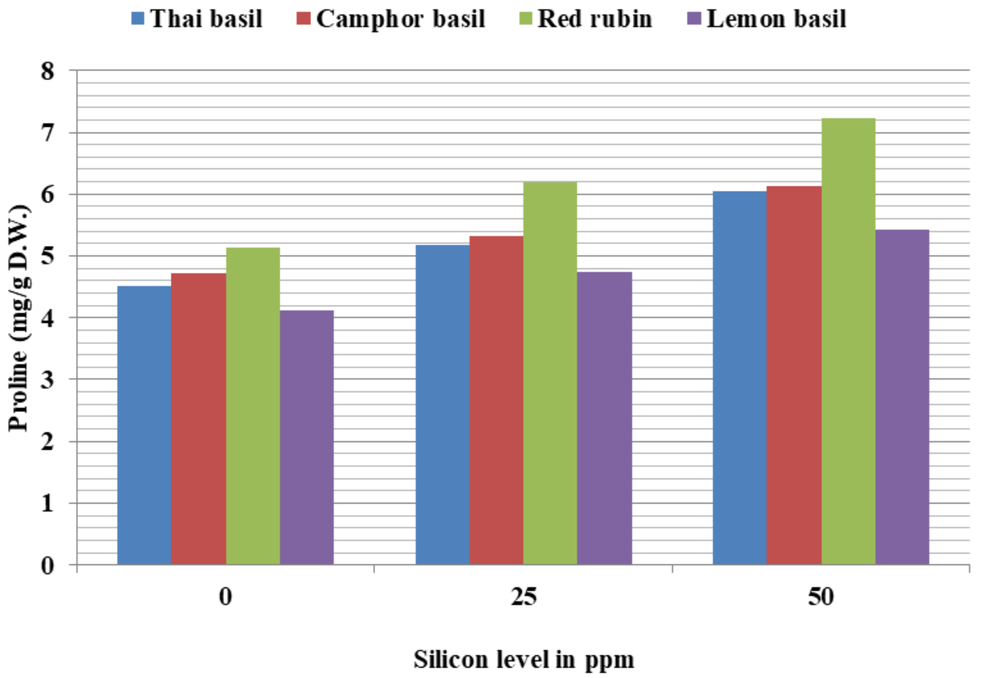

Fig. (5): Effect of foliar application of silicon on proline conten in leaves of four basil varieties plants.

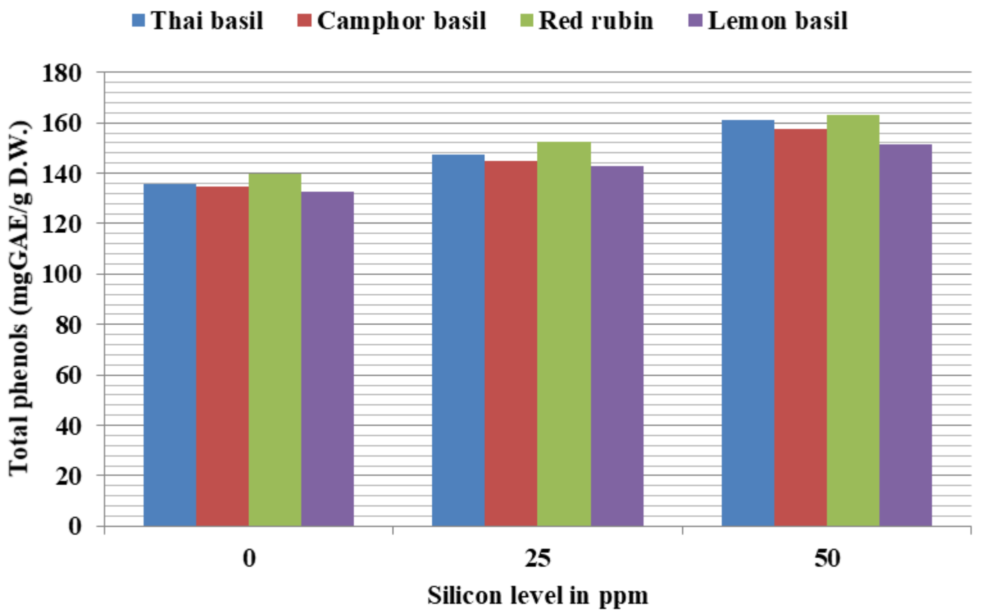

Fig. (6): Effect of foliar application of silicon on total phenols conten in leaves of four basil varieties plants.

conditions (Pirbalouti *et al*., 2017; Khakdan and Javanmard, 2022; Rahimi *et al.*, 2023). Moreover, various reports in different plants have shown that, the increase of total phenols under drought stress conditions can help with stress tolerance. Due to their skeletal structure, phenols are powerful antioxidant compounds in plant tissues under drought conditions. These compounds play an important role in eliminating the oxygen-free radicals produced in stressful conditions (Sharma *et al*., 2019). Exogenous foliar applications of silicon improved total phenols in basil leaves of all varieties as compared with non-spraying plants **(Fig. 6).** The highest phenols content was determined in plants treated with 50 ppm of silicon for al studied basil varieties. The highest phenol content belonged to Red Rubin variety (163.27 mg GAE/g D.W).

3.4. Essential oil constituents

Essential oil composition varied considerably in quality and quantity among thefour evaluated basil verities under all irrigation levels, indicating variability in their genetic makeup **(Table 8).** According to the GC-MS analysis, 19 constituents were identified; 8 of them were detected in all varieties, 4 were detected in three varieties, 3 were detected in two varieties, and 4 of them were detected in only on variety. The determined constituents were notably affected by irrigation level. The major constituents being methyl chavicol that varied from 6.27 % in Camphor basil under sever irrigation to 61.37% in Thai basil under normal irrigation, Linalool that varied from 1.86 % in Thai basil to 41.99% in Camphor basil under sever irrigation, and eugenol that varied from 1.15 % in Red Rubin under normal irrigation to 16.96% in Camphor basil under sever irrigation. The fluctuation in essential oil constituents of basil plant under different irrigation regimes was reported by Asghari *et al.* (2023).

Table (8): The essential oil constituents of four basil varieties in different irrigation regimes across 2022 and 2023 seasons

Irrigation inter val	Varieties	α-pinene	Linalool	Camphor	Methyl chavicol	Chavicol	Bornyl acetate	Eugenol	Myrcene	1,8 cineol	linaloo oxide	Isoestragole	Methyl cinnamate	Sabinene	Limonene	Cadinol	ß pinene	Terpine	methyl acetate	ß Caryphellene
3	Thai basil	0.42	3.72	3.84	61.37	1.45	1.08	1.36	0.73	8.50	0.50	1.69	6.15	1.29	0.00	4.97	0.00	0.12	0.00	0.00
	Camphor basil	0.53	31.27	7.02	11.39	5.06	4.03	12.63	7.37	0.00	0.50	4.13	5.36	0.05	0.00	0.00	1.34	0.00	0.00	0.00
	Red Rubin	3.51	11.63	7.44	25.78	4.50	1.32	1.15	0.32	18.51	3.83	0.00	0.00	0.00	7.55	0.50	0.00	0.00	12.03	1.41
	Lemon basil	1.12	2.60	4.25	27.59	14.42	16.29	5.51	1.43	1.54	0.00	14.48	2.95	0.00	3.28	0.00	0.00	0.00	0.00	0.00
6	Thai basil	0.95	2.28	3.80	60.19	4.11	2.29	1.40	1.82	9.08	0.59	4.48	6.57	1.85	0.00	2.15	0.00	0.16	0.00	0.00
	Camphor basil	0.00	34.85	9.72	9.15	10.48	2.30	13.36	10.38	0.00	0.99	3.70	9.27	0.00	0.00	0.00	1.05	0.00	0.00	0.00
	Red rubin	1.77	25.04	11.50	28.26	10.89	2.27	1.38	0.60	9.74	2.24	0.00	0.00	0.00	3.30	0.68	0.00	0.00	6.50	1.44
	Lemon basil	1.56	2.95	7.84	29.63	11.24	11.66	8.57	3.13	3.79	0.00	15.07	2.44	0.00	5.21	0.00	0.00	0.00	0.00	0.00
9	Thai basil	0.38	1.86	2.53	57.76	4.19	2.23	1.62	1.65	8.26	0.27	4.59	3.27	1.76	0.00	0.00	0.00	0.27	0.00	0.00
	Camphor basil	0.00	41.99	4.30	6.27	2.40	2.24	16.96	11.16	0.00	0.51	2.92	8.61	0.00	0.00	0.00	0.91	0.00	0.00	0.00
	Red rubin	1.30	17.02	5.64	30.82	6.02	3.45	1.61	3.02	7.43	0.99	0.00	0.00	0.00	2.73	2.03	0.00	0.00	4.29	2.58
	Lemon basil	1.88	3.47	2.38	30.76	3.75	4.52	14.20	0.00	4.14	0.00	8.48	2.25	0.00	2.85	0.00	0.00	0.00	0.00	0.00

Conclusion

This study assessed the impact of low water availability on growth of four basil cultivars plants and the influence of foliar application of silicon on stressed plants. The adverse impact of water deficit on the growth and productivity of basil plants could be alleviated by exogenous application of silicon that could protect plants against drought effects. The alleviating effect of silicon on water stressed plants was associated with improving the physiological processes through increasing the content of photosynthetic pigments and maintaining water retain in plants tissues as well as its role in strengthen the plant and enhance its natural defensive properties. The application of silicon at 50 ppm could effectively improve basil growth under water stress conditions. The current study adds new information on the effect of foliar-applied silicon on basil resistance to drought of different basil varieties under pot experiment.

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تأثير السليكون في التخفيف من آثار الجفاف الضارة على نباتات الريحان

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ملخص

يعتبرالريحان نبات طبي وعطري مهم وذو استخدامات واسعة جدًا. يؤثر الإجهاد المائي سلبًا على نمو وإنتاجية نباتات الريحان؛ لذلك أجريت تجربة أصص لدراسة استجابة النمو والتركيب الكيميائي لأربعة أصناف من الريحان (الريحان التايلاندي، وريحان الكافور، والريحان الأحمر، والريحان الليموني) للرش الورقى بالسيليكون (0، 25، 50 جزء في المليون) تحت مستويات ري مختلفة (الري على فترات 3 و6 و9 أيام) في تصميم القطع المنشقة مرتين. أظهرت النتائج أنه على الرغم من اختلاف أصناف الريحان بشكل كبير في سلوكها تحت مستويات الري المختلفة، إلا أن إطالة فترات الري كان لها تأثير سلبي كبير على صفات ارتفاع النبات وعدد الفروع لكل نبات ونسبة الأوراق إلى الساق ومساحة الورقة والوزن الطازج والجاف للمجموع الهوائى لكل نبات ومحتوى الكلوروفيل ونسبة الزيوت الطيارة ومحصول الزيت الطيار لكل نبات في جميع الأصناف التي تم تقييمها. ارتفع محتوى النبات من الكربوهيدرات الكلية والفينولات الكلية والبرولين مع إطالة فترات الري في جميع الأصناف. حسّن الرش الورقي بالسيليكون جميع صفات النمو ومجصول الزيت الطيار و المكونات الكيميائية في جميع أصناف الريحان، وخاصةً تحت ظروف الاجهاد المائى. وكانت اأفضل النتائج عند رش النباتات بـ 50 جزءًا في المليون من السيليكون. وأظهر تحليل الزيت الطيار ان مركبات Methyl chavicol, Linalool, Eugenol المكونات الرئيسية لزيت الريحان العطري.

المجلة المصرية للعلوم الزراعية المجلد (76) العدد الثانى (أبريل 2025) : 1-20 .