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Effect of Some Soil Amendments on Fruit and Seed Yield of Sweet Pepper under Water Stress Conditions: 2-Yield and Quality Parameters

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ABSTRACT

A field experiment aimed to study the response of deficit irrigation water under both traditional and drip irrigation systems combined with soil amendments, on yield and quality. The experiment tested 30 treatments arranged in strip split plot design. The horizontal plots were allocated to the irrigation systems (surface and drip irrigation), whereas the vertical plots were devoted to the irrigation regimes of 40, 60 and 80% of the irrigation water requirement (IWR), while the sub plots were included five soil amendments (without, 250, 500 kg.fed^{-1} potassium silicate ore and 35, 70kg.fed^{-1} potassium humate). The results showed that the drip irrigation system produced significantly higher values of No. of flowers/plant, fruit setting %, early yield, total fruit yield and total seed yield per fed. compared to surface irrigation system. Results indicated that significantly highest values were recorded from the irrigation regime at 80% following irrigation at 60 % of the irrigation water requirement (IWR). Results also showed that, the higher values were obtained from soil amendments at 70 kg/fed from potassium humate following with 500 kg/fed from potassium silicate. In addition, the results showed that a higher average for all the above parameters were obtained from soil amendments at 70 kg/fed from potassium humate following with 500 kg/fed from potassium silicate under drip irrigation system at 80% (6922 m^3/fed.) following irrigation at 60% of IWR (5192 m^3/fed.). Finally, we recommend this treatment because it saves water irrigation (4091and 5821 m^3/fed. respectively) and obtains the best yield with improved quality of pepper fruits.

Keywords: Irrigation system, irrigation regime, deficit irrigation, soil amendments, soil conditioner, fruit and seed yield.

INTRODUCTION

In recent years, water scarcity is one of the factors limiting agricultural production in arid and semi-arid areas. Egypt will suffer from severe water shortage, the misuse of water resources and inefficient irrigation techniques are among the important factors for the country's water security. In this regard, irrigation system plays an important role in agriculture; drip irrigation can be more beneficial than surface irrigation. This innovative irrigation technique is known for its high water use efficiency (WUE) and significant water savings compared to traditional irrigation methods (Anbese, 2020). Therefore, the precise timing of irrigation water applications is an important decision tool to meet water requirements of crops, prevent yield loss due to water stress and maximize efficiency. Use of irrigation water leads to beneficial use and conservation of scarce water resources (Valipour, 2015). The drip irrigation treatment gave better fruit yield than the surface irrigation. Drip irrigation has a positive effect on the fruit yield despite providing less water (Marana-Santacruz *et al*., 2018 and Abdelshafy *et al*., 2021). The mean value of WUE in the drip irrigation system was higher than in the surface irrigation system in both seasons. Darwish *et al.* (2021) showed that the drip irrigation system had the highest value in terms of fruit yield, total seed yield and 100 seed weight. In addition, Gireesh *et al.* (2020) reported that the treatment with irrigation at 80% of irrigation water requirement (IWR) and 100% of recommended fertilizer application, showed improved both yield and fertilizer use efficiency.

In addition, the application of soil amendments (humate or silicate potassium) will open up considerable prospects and another important decision tool for meeting plant water requirements as it improves the properties of the soil thereby improving WUE and preventing yield losses due to water stress. Humic acid (HA) as soil amendments is one of the best natural materials because it improved the soil properties such as aeration, aggregation, water holding capacity, permeability, ions transport and availability through pH buffer, and improved soil workability, support resistance to drought. HA maintains vitamin and amino acid content in plant tissues and increases the rate of nutrient absorption in response to the absorption of humic substances. In addition, the biological effects of HA accelerate plant cell division and stimulate growth and seed viability (Tan, 2003 and Shiva *et al*., 2015). Barakat *et al.* (2015) found that green pods weight of bean plants, total yield, dry pods, weight of 100 seeds, and total seeds yield responded positively to potassium humate as soil application at 100 kg/fed. The application of HA as soil amendments significantly increased the yield characteristics compared with the control (AbdEllatif *et al*., 2017 and El-Sayed *et al*., 2019). Potassium silicate ore is a chemical compound extracted from feldspar ore, similar in its use to bentonite and zeolite, except that it differs in the

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absence of Al, but it contains K, Si, and low amount of Fe, Zn, and Mg, and it helps in holding water. Zeolites can lead to higher water retention. Abd El-Basir and Swelam (2017) found that zeolite as a soil agent significantly improved pepper yield and fruit quality parameters compared with control. In addition, silicon is classified as a beneficial element. This factor limits the effects of abiotic and biotic stresses in plants. Many researchers have demonstrated the importance of silicon in resisting osmotic pressure (Etesami and Jeong, 2018).

Therefore, the main objective of this study was to select the best efficiency of the irrigation system and the best shortage of irrigation water with soil additions on the yield and fruit quality of sweet pepper plants.

MATERIALS AND METHODS

This study was conducted in a private farm located in Shirbin district, Dakahlia Governorate, Egypt, during 2017 and 2018 seasons. The aim of the study was to investigate the response of three levels of irrigation water shortages; traditional and drip irrigation methods in combination with potassium humate and silicate ore as a soil improver, on yield and fruit quality parameters of sweet pepper plants (*Capsicum annum* L.) cv. "California Wonder".

The experiment tested 30 treatments arranged in strip split plot design. The horizontal plots were allocated to the irrigation systems (surface and drip irrigation), whereas the vertical plots were devoted to the irrigation regimes of 40, 60 and 80% of the irrigation water requirement (IWR), while the sub plots were included five soil amendments (without, 250, 500 kg.fed^{-1} potassium silicate ore and 35, 70 kg.fed^{-1} potassium humate).

Soil analysis test:

Data in Table (1) show some physical and analytical chemical properties of the experimental soil were determined before transplanting according to A.O.A.C. (2000).

Table 1. Some physical and chemical analysis of the experimental soil.

Sand (%)	Silt (%)	Clay (%)	Texture class	O. M. g/kg	$CaCO_3$ g/kg	FC %	EC dS/ m	pH	Available nutrients (mg/kg) N	P	K	Zn	Fe	Mn
22.56	33.15	44.29	Clay	1.83	1.88	33.5	0.98	7.95	48.9	5.16	215	1.66	11.72	7.33

The experimental unit area is 16.8 m^2, including 4 ridges 6 m long and 0.7 m wide. California Wonder seedlings are transplanted on the 15th of March in both seasons at spacing 40 cm on one side of the ridges.

The recommendation of fertilization according to the Egyptian Ministry of Agriculture for surface irrigation and drip irrigation as well as the monthly total fertilizer requirement for pepper/fed. is shown in Table (2).

The experiment treatments were arranged as follows:

Irrigation water treatments:

All experimental plots in each block were divided into two horizontal groups i.e. (surface and drip irrigation systems), then each group was divided vertically into three main groups applied with irrigation regimes i.e. 40, 60 and 80% of IWR. IWR were calculated using the Penman-Monteith (PM) procedure of FAO (Allen *et al*., 1998 and Doorenbos and Pruitt, 1977).

Surface irrigation system:

The surface irrigation part is irrigated with water then plants were seedlings. After one month, water was added according to the irrigation regimes of 80% (8810 m^3/fed.), 60% (6608 m^3/fed.) and 40% (4405 m^3/fed.) of IWR as average (Table, 3 A) through a pipe extending from the main irrigation source to the experimental plots. The amount of water is calculated by the water counter at the end each pipe and the irrigation system was done with a closed line system.

Table 2. Monthly total fertilizer requirement for pepper/fed.

Month	Monthly Total Fertilizer Requirement kg/fed. Drip Irrigation N	P	K	Micronutrients	Surface irrigation N	P	K	Micronutrients
March	15.0	15.0	5.0	3.0	25.0	20.0	5.5	0.0
April	20.0	5.0	5.0	3.0	20.0	6.0	5.5	5.0
May	20.0	5.0	7.0	3.0	20.0	6.0	7.7	5.0
June	15.0	5.0	20.0	3.0	15.0	6.0	16.5	5.0
July	10.0	0.0	15.0	2.0	10.0	0.0	16.5	0.0
August	5.0	0.0	15.0	0.0	10.0	0.0	7.0	0.0
Seasonal	85.0	30.0	67.0	14.0	100.0	38.0	58.7	15.0

Drip irrigation system:

A drip irrigation system with 4 L/h GR drippers is implemented in the middle of the soil beds Irrigation was carried out according to irrigation regimes of 80 % (6922 m^3/fed.), 60% (5192 m^3/fed.) and 40 % (3461 m^3/fed.) of IWR as average (Table, 3 B) and controlled by counter located at the beginning of the pipes to control in the amount of water.

Soil amendments:

Potassium silicate ore: A chemical compound extracted from feldspar ore, similar in its use to zeolite, except that it differs in the absence of Al, but it contains K, Si, and low amount of Fe, Zn, and Mg, and it helps in holding water. The chemical composition of potassium silicate ore is as follows: K% (11.5), Si % (55), Ca % (3.5), Fe % (7.3), Na % (2.1), S % (0.5), Mg % (2.3), Al% (6.1), Cl% (0.5) and KN.H.%. (11.2).

In addition, the chemical composition of potassium humate is as follows: pH (8.5), EC (0.04) dS/m, O.M (230) g/kg, N % (3.5), P % (Nil), K % (11), Ca % (0.5), Mg % (0.025), S% (0.5) as well as Zn (100), Cu (20), Fe (2400) and Mn (1700) mg/kg.

Potassium silicate ore was applied at the rates of 250 and 500 kg.fed^{-1} and potassium humate was applied at the rates of 35 and 70 kg.fed^{-1}.

Potassium silicate ore or Potassium humate were applied to soil, supplemented in equal doses, the first dose before transplanting and incorporated into the soil and the second dose after 30 days from transplanting with the beginning of the irrigation.

Table 3 A. Surface Irrigation water requirement for pepper Monthly Means of Years 2017-2018 under the conditions of Dakahlia governorate, Egypt.

Month	Surface irrigation water requirement (IWR)							
	2017				2018			
	Monthly Total Irrigation Req. m^3/fed.				Monthly Total Irrigation Req. m^3/fed.			
	100%	80%	60%	40%	100%	80%	60%	40%
March	591.2	473.0	354.7	236.5	668.3	534.6	401.0	267.3
April	1184.1	947.3	710.5	473.6	1268.0	1014.4	760.8	507.2
May	1972.8	1578.2	1183.7	789.1	2021.1	1616.9	1212.7	808.4
June	2003.2	1602.6	1201.9	801.3	2072.6	1658.1	1243.6	829.0
July	2021.0	1616.8	1212.6	808.4	2023.8	1619.0	1214.3	809.5
August	1915.0	1532.0	1149.0	766.0	1909.5	1527.6	1145.7	763.8
September	1191.9	953.5	715.1	476.8	1182.6	946.1	709.6	473.0
Seasonal	10879.3	8703.4	6527.6	4351.7	11146.0	8916.8	6687.6	4458.4

Table 3 B. Drip Irrigation water requirements for pepper Monthly Means of Years 2017-2018 under the conditions of Dakahlia governorate, Egypt.

Month	Drip irrigation water requirements (IWR)							
	2017				2018			
	Monthly Total Irrigation Req. m^3/fed.				Monthly Total Irrigation Req. m^3/fed.			
	100%	80%	60%	40%	100%	80%	60%	40%
March	464.5	371.6	278.7	185.8	525.1	420.1	315.1	210.0
April	930.4	744.3	558.2	372.2	996.3	797.0	597.8	398.5
May	1550.1	1240.1	930.1	620.0	1588.0	1270.4	952.8	635.2
June	1573.9	1259.1	944.3	629.6	1628.5	1302.8	977.1	651.4
July	1588.0	1270.4	952.8	635.2	1590.1	1272.1	954.1	636.0
August	1504.7	1203.8	902.8	601.9	1500.3	1200.2	900.2	600.1
September	936.5	749.2	561.9	374.6	929.2	743.4	557.5	371.7
Seasonal	8548.0	6838.4	5128.8	3419.2	8757.5	7006.0	5254.5	3503.0

Sampling and collecting data:

1- **Flowering and fruit yield parameters:** The following parameters were recorded as follows:
- No. of flower/plant.
- Fruit setting%
- Early fruit yield/fed.
- Total fruit yield/fed.
- Total seed yield/fed.

2- Fruit quality parameters:
- **Total chlorophyll and carotenoids** were calorimetrically determined according to Goodwine (1965).
- **Dry matter %**
- **Total soluble solids (TSS%)** was estimated according to A O A C (2000).
- **Vitamin C** was analyzed according to A O A C (2000).
- **Total soluble sugars** were determined according to Sadasivam and Manickam (1996).
- **Total carbohydrates** spectrophotometrically measured according to Sadasivam and Manickam (1996).

Statistical analysis

All statistical analyzes were performed using the analysis of ANOVA technique and Duncan's method was used to compare the differences between the mean values of the treatments according to the methods described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

1. Flowering and Yield Parameters:

Effect of irrigation system

The results in Table (4)) indicate that the irrigation system has a significant effect on the flowering and yield parameters (number of flowers/plant, % fruit set, early yield, total fruit yield and total seed yield). Maximum and significant flowering and yield parameters were observed with the drip irrigation system. This means that drip irrigation provides low levels of water and nutrients when needed by plants at frequent intervals in the root zone, providing increased access to nutrients compared to the conventional technique of irrigation. This treatment increase photosynthetic movement to the pepper storage organs, resulting in an increased fruits weight of sweet pepper (Antony and Singandhupe, 2003). However, the lower yield obtained by the surface irrigation method may be due to water stress during the critical growth period, combined with lower availability of plant nutrients because of excessive leaching of plant nutrients in surface addition. In the same subject, Thabet and Zayani (2010); Yahaya *et al.* (2012); Thabet (2013); Kumari and Kaushal, 2014; Iqbal *et al.* (2014); Lodhi *et al.* (2014); Asif *et al.* (2016); Walters and Jha (2016); Marana-Santacruz *et al.* (2018) on pepper; and Abdelshafy *et al.* (2021) on potato and Darwish *et al.* (2021) on some snap bean cultivars.

Effect of irrigation regimes

Concern to the effect of irrigation regime, the data in Table (4) showed that when irrigation is increased, the flowering and yield parameters were increased. The highest mean values of flowering and yield parameters scored with the highest irrigation regime at 80% followed by 60% of IWR. As for fruit setting %, the highest value is recorded at 40% IWR, followed by 60 % IWR in drip irrigation versus surface irrigation during both seasons.

An increase in the number of fruits is the main factor to increase the yield. The significant effect of this lack of water is to reduce photosynthesis, leading to leaf senescence. In addition, the decrease in average fruit yield of pepper due to water stress could be attributed to its negative effects on total leaf area and fresh and dry weight per plant. Also, lack of irrigation water at fruit initiation stages not only restricts foliage and plant growth, but also reduces fruit number, thereby reducing dry matter and accordingly early and total yield. Average fruit weight is closely related to the lack of soil water in the root zone. These results confirm the findings of Rocha *et al.* (2018); Yang *et al.* (2018); Ahmed *et al*. (2019); Ayas (2019); Colak *et al.* (2019); Debbarma *et al.* (2019); Kiruthiga *et al.* (2019); Oliveira *et al.* (2019); Vinayak *et al.* (2019); Abdelkhalik *et al*. (2020) and Gireesh *et al*. (2020) on pepper.

Effect of soil amendments

The data in Table (4) show that the highest average values of No. of flowers, % fruit set, early yield. and total fruit yield as well as the total seed yield obtained from soil amendment with 70 kg.fed^{-1} potassium humate followed by 500 kg.fed^{-1} potassium silicate in two seasons. While the lowest mean values are recorded with untreated plants. These results may be due to the positive effects of humic acid as a soil improver, improving pepper plants growth, more dry matter accumulation and stimulating formation of metabolites, that moved to fruits. In addition, its beneficial effect in improving plant growth characteristics leads to increased fruit yield. In this way, the positive effect of humic acid on plant growth is due to humic acid contains many elements, which improves soil fertility and consequently increased growth and productivity of plants (El-Sayed *et al.* 2019). Similar results with humic acid as soil amendments were obtained by Karakurt *et al*. (2009) on pepper; Asri *et al*. (2015) on tomato; Barakat *et al.* (2015) on bean; AbdEllatif *et al.* (2017) on tomato and Akladious and Mohamed (2018) on pepper.

As for to potassium silicate as a soil additive, it has been used as soil additions to improve the physicochemical properties of the soil (Kralova *et al.* 1994). On sweet pepper, Abd El-Basir and Swelam (2017) showed that Zeolite significantly enhanced yield and its components compared to the control. In addition, these outcomes might be because of potassium silicate compound contained both K and Si components, Similar results with potassium silicate as soil amendments were obtained by Sudradjat *et al.* (2016) on chili pepper; Sukkaew *et al.* (2016) on pepper and Kotb (2019) on sweet pepper.

Table 4. Effect of irrigation system, irrigation regime as well as soil amendments on flowering and yield parameters during 2017 and 2018 seasons.

Treatments	No. of flower /plant		Fruit setting %		Early fruit yield ton/fed		Total fruit yield ton/fed.		Total seed yield/ /fed.(kg)	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Irrigation system										
Surface irrigation	35.78b	39.40b	59.21a	57.07a	2.75b	2.89b	12.61b	13.76b	158.09b	176.73b
Drip irrigation	39.31a	44.31a	64.27a	59.32a	4.11a	4.27a	15.82a	17.51a	272.03a	299.65a
F. test	**	**	*	N.S	**	**	**	**	**	**
Irrigation regimes										
80%	41.63a	45.87a	60.48b	57.09b	4.17a	4.35a	16.54a	18.00a	273.03a	300.93a
60%	38.37b	42.63b	61.34ab	57.83ab	3.53b	3.69b	14.63b	16.06b	222.13b	246.57b
40%	32.63c	37.07c	63.40a	59.66a	2.58c	2.71c	11.47c	12.86c	150.02c	167.06c
F. test	**	**	**	**	**	**	**	**	**	**
Soil amendments										
0	34.06d	38.89e	62.75a	56.90a	2.85c	2.99c	12.33d	13.34c	169.93d	188.50d
K Si 250	36.94c	41.22d	61.64a	59.21a	3.32b	3.48b	13.77c	15.36b	206.65c	230.69c
K Si 500	39.00a	43.00b	61.45a	57.75a	3.65ab	3.78ab	15.02a	16.35a	232.71ab	255.17ab
K H 35	38.00b	42.17c	61.66a	59.38a	3.51ab	3.65ab	14.44b	16.19a	220.86a	243.15bc
K H 70	39.72a	44.00a	61.20a	57.73a	3.81a	4.00a	15.52a	16.95a	245.16	273.44a
F. test	**	**	N.S	N.S	**	**	**	**	**	**

Means followed by the same letter within each column do not significantly differed using Duncan's Multiple Rang Test at the level of 5%.

Effect of interactions:

Irrigation system and irrigation regimes

The results in Table (5) showed the values of the above parameters increased significantly in the plants irrigated with the irrigation systems and irrigation regimes (40, 60 and 80% of IWR). In this respect, the highest values early and total yield of bell pepper were recorded when plants were irrigated at 80% of IWR under drip irrigation system. While the lowest were recorded with 40% of IWR under surface irrigation in both season. In the same subject, Erdem *et al.*(2006); Onder *et al.* (2005) and Abdelshafy *et al*. (2021) on potato.

Table 5. Effect of double_interaction between irrigation system X irrigation regime on flowering and yield parameters during 2017 and 2018 seasons.

Treatments		No. of flower /plant		Fruit setting%		Early fruit yield ton/fed.		Total fruit yield ton/fed.		Total seed yield /fed. (kg)	
		2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Surface irrigation	80%	43.53c	17.50c	59.14cd	55.54b	3.46c	3.63c	14.66c	15.80c	204.15c	226.19c
	60%	40.00d	17.26d	59.48cd	57.28ab	2.81d	2.96d	12.97d	14.25d	161.80d	181.81d
	40%	34.67f	16.85e	59.02d	58.39ab	1.97e	2.09e	10.19e	11.23e	108.32e	122.18e
Drip irrigation	80%	48.20a	19.26a	61.82bc	58.64ab	4.88a	5.07a	18.42a	20.19a	341.92a	375.67a
	60%	45.27b	18.97b	63.21b	58.38ab	4.25b	4.41b	16.30b	17.87b	282.45b	311.34b
	40%	39.47e	18.52d	67.79a	60.94a	3.20c	3.32c	12.75d	14.48d	191.73c	211.94c

Means followed by the same letter within each column do not significantly differed using Duncan's Multiple Rang Test at the level of 5%.

Irrigation system and soil amendments

Data in Table (6) clarify that flowering and yield parameters were significantly increased under both irrigation system with all soil addition. Drip irrigation with the addition of 70 kg.fed^{-1} potassium humate to the soil followed by addition with 500 kg.fed^{-1} potassium silicate were recorded the highest values of all the parameters mentioned. In the same direction, Omer *et al.* (2020).

Table 6. Effect of double interaction between irrigation system X soil amendments on flowering and yield parameters during 2017 and 2018 seasons.

Treatments		No. of flower/plant		Fruit setting%		Early fruit yield ton/fed.		Total fruit yield ton/fed		Total seed yield /fed. (kg)	
		2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Surface irrigation	0	32.78g	36.33g	60.23bc	55.94a	2.21f	2.34f	11.01g	11.68d	123.44f	138.04g
	K Si 250	35.33f	38.78f	58.72c	59.80a	2.64ef	2.79ef	12.19f	14.00c	151.73e	170.99f
	K Si 500	37.00de	40.44de	59.07c	54.90a	2.95de	3.08de	13.34de	13.97c	171.58de	189.14ef
	K H35	36.11ef	39.89ef	59.02c	58.45a	2.80de	2.94de	12.77ef	14.36c	161.28de	179.89ef
	K H70	37.67cd	41.56d	59.02c	56.26a	3.13cd	3.31cd	13.73d	14.79c	182.42d	205.58e
Drip irrigation	0	35.33f	41.44d	65.28a	57.86a	3.50c	3.65c	13.65d	14.99c	216.42c	238.95d
	K Si 250	38.56c	43.67c	64.55a	58.62a	4.00b	4.16b	15.35c	16.72b	261.57b	290.40c
	K Si 500	41.00a	45.56ab	63.83a	60.60a	4.34ab	4.48ab	16.70ab	18.73a	293.85a	321.19ab
	K H35	39.89b	44.44bc	64.31a	60.31a	4.21ab	4.35ab	16.11bc	18.01ab	280.43ab	306.40bc
	K H70	41.78a	46.44a	63.38ab	59.20a	4.49a	4.69a	17.30a	19.10a	307.90a	341.29a

Means followed by the same letter within each column do not significantly differed using Duncan's Multiple Rang Test at the level of 5%.

Irrigation regimes and soil amendments

The data in Table (7) indicated that it was significantly increased in response to all soil amendments treatment in the two growing seasons compared to with control under irrigation regimes. The highest mean values were obtained with the addition of 70 kg/fed. potassium humate followed by the addition 500 kg/.fed. potassium silicate with irrigation at 80 % IWR during two seasons. Similar results with humic acid or potassium silicate as soil amendments were obtained by Youssif *et al.* (2018); El-Sayed *et al.* (2019) on sweet pepper; Kotb (2019) and Mahmoud *et al.* (2019) on potato; Qin (2017) on pepper; Abd El-Haleim (2020) on sugar beet and recently, Rad *et al.* (2022) on rapeseed plants.

Table 7. Effect of double interaction between irrigation regimes X soil amendments on flowering and yield parameters during 2017 and 2018 seasons.

Treatments		No. of flower/plant		Fruit setting %		Early fruit yield ton/fed		Total fruit yield ton/fed		Total seed yield/fed. (kg)	
		2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
80%	0	36.67g	40.83hi	62.54a-d	57.08a	3.22e-h	3.38efg	13.81gh	14.62d-g	197.10ghi	216.76fgh
	K Si 250	41.50cd	45.83cd	59.73cd	56.82a	4.14abc	4.32abc	16.20cd	17.75abc	270.65bcd	299.74bc
	K Si 500	43.33ab	47.33ab	60.27a-d	57.65a	4.53a	4.73a	17.63ab	19.24a	301.88ab	332.77ab
	K H35	42.67bc	46.67bc	59.66d	58.29a	4.35ab	4.52ab	16.94bc	18.90ab	286.44abc	313.86abc
	K H70	44.00a	48.67a	60.19a-d	55.61a	4.61a	4.79a	18.14a	19.48a	309.10a	341.52a
60%	0	35.00h	40.00ij	64.08ab	57.78a	3.05f-i	3.20fgh	13.30hi	14.34efg	183.78hij	203.52ghi
	K Si 250	37.33g	41.83gh	62.27a-d	58.64a	3.39d-g	3.55d-g	14.28fg	15.75cde	210.84fgh	236.61efg
	K Si 500	40.00e	43.83ef	59.88bcd	56.94a	3.73cde	3.89cde	15.20ef	16.58cd	238.36def	263.18de
	K H35	38.67f	43.00fg	61.07a-d	60.09a	3.55def	3.71def	14.75efg	16.89bc	223.66efg	249.03def
	K H70	40.83de	44.50de	59.41d	55.70a	3.92bc	4.08bcd	15.63de	16.71c	254.01cde	280.53cd
40%	0	30.50l	35.83m	61.64a-d	55.83a	2.29k	2.41i	9.89m	11.05h	128.92l	145.21k
	K Si 250	32.00k	36.00m	62.92a-d	62.17a	2.43jk	2.55i	10.83lm	12.59gh	138.46kl	155.74k
	K Si 500	33.67ij	37.83kl	64.20ab	58.67a	2.69h-k	2.73hi	12.22jk	13.22fg	157.90jkl	169.55ijk
	K H35	32.67jk	36.83lm	64.26a	59.77a	2.63ijk	2.71hi	11.63kl	12.77fgh	152.47jkl	166.55jk
	K H70	34.33hi	38.83jk	64.00abc	61.89a	2.89g-i	3.13gh	12.78ij	14.64def	172.36ijk	198.26hij

Means followed by the same letter within each column do not significantly differed using Duncan's Multiple Rang Test at the level of 5%.

Irrigation system, irrigation regimes and soil amendments

With regard to the interaction treatments among irrigation system, irrigation regime and soil application of potassium humate or silicate at different rates, data presented in Table (8) indicated that the irrigation of sweet pepper plants at 80% of IWR under drip irrigation with the soil addition at 70 kg.fed^{-1} potassium humate followed by 500 kg.fed^{-1} potassium silicate significantly increased all mentioned parameters and scored the highest mean values comparing with plants irrigated with 40% of IWR under surface irrigation in both seasons.

These results may be attributed to the effective roles of soil amendments as potassium humate or potassium silicate with drip irrigation system and irrigation regime. This treatment increases water uptake and improves essential elements absorption and availing them in the different plant physiological and biochemical processes such as photosynthesis etc. and production of various assimilates and solutes that are important to form good new plant organs and consequently improving vegetative growth and yield traits. Also, the role of increasing irrigation regimes to 80% IWR by drip irrigation provides low levels of water and nutrients required by at frequent intervals in root area of plants, which increase the availability of nutrients compared to the surface irrigation system, leading to increased fruit yield of sweet pepper plants. Such results are consistent with those obtained by El-Sayed *et al.* (2019) on sweet pepper. Also, in the same context, Awwad *et al.* (2015) on maize and Rad *et al.* (2022) on rapeseed.

2. Fruit Quality Parameters:

Effect of irrigation system

Data in Table (9) showed a significant effect on the fruit quality of sweet pepper *i.e.* dry matter %, total chlorophyll, carotene, total sugar, carbohydrates and vitamin C as affected by the irrigation system (surface and drip). The drip irrigation system recorded the highest mean values of all fruit quality compared to the values recorded with surface one. These results are in good accordance with those reported by Amer *et al.* (2016) and Abdelshafy *et al.* (2021) on Potato.

Effect of irrigation regimes

The obtained data in Table (9) showed that with increasing irrigation regimes up to 80% of IWR gave a significant increase for all fore cited attributes as compared with the lowest level at 40 % of the irrigation water requirement (IWR), during two seasons. These increases might be because of the available with more water enhances nutrient availability which improves macro nutrients absorption that reflected on increase in chlorophyll, carotene, total sugar, carbohydrates, and vitamin C of sweet pepper fruit. These findings are consistent with Albuquerque *et al.* (2012); El-Said (2015); Patil and Das (2015); Kumar *et al.* (2016); Kuscu *et al.* (2016); Dhotre *et al.* (2018) on pepper and Shabbir *et al.* (2020) on tomato.

Table 8. Effect of triple interaction among irrigation system X irrigation regime X soil amendments on flowering and yield parameters during 2017 and 2018 seasons.

Treatments			No. of flower /plant		Fruit setting %		Early fruit yield ton/fed.		Total fruit yield ton/fed.		Total seed yield /fed. (kg)	
			2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Surface irrigation	80%	0	35.00klm	38.67kl	59.91e-h	56.02a	2.53l-q	2.68n-r	12.14no	12.93h-k	143.67n-s	158.59o-r
		K Si 250	39.00fgh	43.33ghi	58.14h	57.78a	3.42g-k	3.59g-m	14.31i-l	16.24efg	202.40i-l	224.62i-m
		K Si 500	40.33ef	45.00e-h	59.44e-h	54.83a	3.78e-i	3.96e-i	15.69e-h	16.61d-g	224.14g-j	249.05h-k
		K H35	39.67efg	44.fgh33	58.80fgh	56.58a	3.60f-j	3.78f-l	15.03g-j	16.61d-g	213.68h-k	234.62h-l
		K H70	41.00de	46.3def3	59.41e-h	52.47a	3.95d-h	4.13d-h	16.15d-g	16.62d-g	236.86ghi	264.08ghi
	60%	0	33.33mno	37.00lmn	61.87c-h	55.72a	2.39m-r	2.53o-s	11.78nop	12.19i-l	134.33o-t	150.42p-s
		K Si 250	35.67kl	39.00kl	59.69e-h	60.65a	2.68k-p	2.83m-q	12.62mn	14.52f-i	153.13m-r	174.91n-q
		K Si 500	37.67hij	41.33ij	58.23h	54.73a	2.98i-n	3.13k-p	13.51klm	14.36f-i	174.28k-o	193.69l-q
		K H35	36.33jk	40.67jk	59.47e-h	59.86a	2.83j-o	2.98m-p	13.06lmn	15.16fgh	162.28l-q	183.73m-q
		K H70	38.33ghi	42.00ij	58.14h	55.45a	3.17h-m	3.31i-o	13.87j-m	15.00f-i	184.97j-n	206.31k-o
	40%	0	30.00r	33.33p	58.92fgh	56.07a	1.69r	1.80s	9.12s	9.92l	92.33t	105.12s
		K Si 250	31.33pqr	34.00p	58.34gh	60.96a	1.83qr	1.95rs	9.64rs	11.25jkl	99.65st	113.45rs
		K Si 500	33.00nop	35.00nop	59.55e-h	55.14a	2.10o-r	2.14qrs	10.81o-r	10.94kl	116.31q-t	124.69rs
		K H35	32.33opq	34.67op	58.78fgh	58.92a	1.96pqr	2.08qrs	10.21qrs	11.31jkl	107.88rst	121.31rs
		K H70	33.67mno	36.33mno	59.51e-h	60.85a	2.25n-r	2.48p-s	11.18opq	12.75h-l	125.41p=t	146.35qrs
Drip irrigation	80%	0	38.33ghi	43.00hi	65.18a-e	58.15a	3.91d-h	4.08s-i	15.48f-i	16.30efg	250.53fgh	274.93fgh
		K Si 250	44.00bc	48.33bcd	61.31d-h	55.87a	4.87abc	5.06abc	18.09bc	19.26bcd	338.91abc	374.85abc
		K Si 500	46.33a	49.67ab	61.11d-h	60.46a	5.27a	5.50a	19.57a	21.88ab	379.63a	416.49a
		K H35	45.67ab	49.00abc	60.53d-h	59.99a	5.09ab	5.27ab	18.84ab	21.18abc	359.19ab	393.10ab
		K H70	47.00a	51.00a	60.97d-h	58.75a	5.26a	5.44a	20.12a	22.35a	381.34a	418.96a
	60%	0	36.67ijk	43.00hi	66.29a-d	59.84a	3.71e-i	3.87e-k	14.81g-k	16.50d-g	233.22ghi	256.63g-j
		K Si 250	39.00fgh	44.67fgh	64.85a-f	56.63a	4.11c-g	4.27c-g	15.94efg	16.98def	268.54efg	298.31efg
		K Si 500	42.33cd	46.33def	61.54c-h	59.15a	4.48a-e	4.64b-e	16.89cde	18.81cde	302.43cde	332.67cde
		K H35	41.00de	45.33efg	62.67b-h	60.33a	4.27b-f	4.43c-f	16.44def	18.63cde	285.03def	314.33def
		K H70	43.33c	47.00cde	60.68d-h	55.95a	4.68a-d	4.85a-d	17.39cd	18.42cde	323.04bcd	354.74bcd
	40%	0	31.00qr	38.33lm	64.36a-g	55.59a	2.88j-o	3.01l-p	10.67pqr	12.19i-l	165.50l-p	185.29b-q
		K Si 250	32.67n-q	38.00lm	67.50abc	63.37a	3.03j-m	3.16j-p	12.02no	13.93g-j	177.27j-o	198.03l-p
		K Si 500	34.33lmn	40.67jk	68.85a	62.20a	3.27h-l	3.31i-o	13.64klm	15.51fgh	199.50i-m	214.42j-n
		K H35	33.00nop	39.00kl	69.74a	60.62a	3.29g-l	3.34h-m	13.04lmn	14.23f-i	197.05i-m	211.79j-n
		K H70	35.00klm	41.33ij	68.50ab	62.92a	3.53f-j	3.79f-l	14.38h-l	16.54d-g	219.31h-k	250.16g-k

Means followed by the same letter within each column do not significantly differed using Duncan's Multiple Rang Test at the level of 5%.

Table 9. Effect of irrigation system, irrigation regime and soil amendments on fruit quality parameters during 2017 and 2018 seasons.

Treatments	Total chlorophyll mg.g^{-1}		Carotene mg.g^{-1}		Total sugar%		Carbohydrates %		V.C mg.100g		TSS %		Dry matter %	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Irrigation system														
Surface irrigation	1.036b	1.060b	0.182b	0.188b	8.42b	8.69b	18.30b	18.90b	83.50b	84.74b	5.73b	5.92b	17.20b	17.77b
Drip irrigation	1.090a	1.115a	0.203a	0.209a	8.58a	9.08a	19.53a	20.19a	87.44a	90.34a	6.17a	6.37a	18.92a	19.56a
F. test	**	**	**	**	**	**	**	**	**	**	**	**	**	**
Irrigation regimes														
80%	1.136a	1.161a	0.223a	0.231a	8.81a	9.41a	19.96a	20.62a	88.92a	91.13a	6.59a	6.80a	18.38a	18.97a
60%	1.077b	1.104b	0.199b	0.206b	8.71b	9.02b	19.13b	19.78b	86.08b	88.16b	6.08b	6.29b	18.12b	18.76b
40%	0.976c	0.998c	0.154c	0.159c	7.97c	8.22c	17.65c	18.24c	81.43c	83.32c	5.16c	5.34c	17.68c	18.27c
F. test	**	**	**	**	**	**	**	**	**	**	**	**	**	**
Soil amendments														
0	1.005e	1.028e	0.167e	0.173e	8.17e	8.45e	18.02e	18.63e	82.61e	84.82e	5.44e	5.62e	17.82d	18.42d
K Si 250	1.052d	1.077d	0.188d	0.194d	8.45d	8.71d	18.77d	19.38d	85.02d	86.98d	5.85b	6.04b	17.97c	18.61c
K Si 500	1.086b	1.110b	0.202b	0.208b	8.30b	9.07b	19.24b	19.85b	86.55b	88.69d	6.14d	6.33d	18.16ab	18.74b
K H 35	1.069c	1.094c	0.195c	0.202c	8.65c	9.00c	19.02c	19.66c	85.78c	87.80c	6.00c	6.20c	18.10b	18.71b
K H 70	1.102a	1.129a	0.210a	0.216a	8.92a	9.20a	19.51a	20.21a	87.40a	89.40a	6.30a	6.51a	18.25a	18.86a
F. test	**	**	**	**	**	**	**	**	**	**	**	**	**	**

Means followed by the same letter within each column do not significantly differed using Duncan's Multiple Rang Test at the level of 5%

Effect of soil amendments

Data presented in Table (9) revealed that utilization of potassium humate or silicate at different rates significantly affected in fruit quality under investigation compared with the control treatments. The rate of 70 kg.fed-1 of potassium humate increased all aforementioned parameters followed by 500 kg.fed-1 of potassium silicate compared with the other treatments. This may be due to effects of HA, including enhanced photosynthesis in plants, which is reflected in increases in the fruit quality. fruits. The results are similar to those reported by Aminifard *et al.* (2012) on pepper; Khan *et al.* (2013) on pepper; Barakat *et al.* (2015) on bean; AbdEllatif *et al.* (2017) on tomato; Kumar *et al.* (2017); Akladious and Mohamed (2018) on pepper and Taha and Osman (2018) on bean.

In addition, the increase in chemical constituent's content of plants could be attributed to the beneficial effect of using as a soil conditioner to improve soil physio-chemical properties. These results are in agreement with those found by Kotb (2019) on pepper but as a foliar application, In the same subject, Nasseem *et al.* (2011); Marodin *et al.* (2014) and Abd El-Basir and Swelam (2017).

Effect of interactions:

Irrigation system and irrigation regimes

Regarding the effect of this interaction, the data in Table (10) show a significant effect on the fruit quality of pepper i.e. (dry matter %, total chlorophyll, carotene, TSS%, total sugar, carbohydrates, and vitamin C) in two seasons. The highest mean values of fruit chemical quality were observed with drip irrigation at 80% from IWR. Such results are consistent with those obtained by Abdelshafy *et al.* (2021); Erdem *et al.*(2006) and Onder *et al.* (2005) on potato.

Table 10. Effect of double interaction between irrigation system X irrigation regime on fruit quality parameters during 2017 and 2018 seasons.

Treatments		Total chlorophyll mg.g^{-1}		Carotene mg.g^{-1}		Total sugar %		Carbohydrates %		V.C mg.100g		TSS %		Dry matter %	
		2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Surface irrigation	80%	1.108b	1.133b	0.210b	0.217b	8.73c	9.23a	19.19c	19.83c	86.67c	88.03c	6.40b	6.61b	17.50d	18.03d
	60%	1.050c	1.078d	0.189c	0.195c	8.59d	8.86b	18.51d	19.10d	84.15d	85.34e	5.86d	6.05d	17.26e	17.88e
	40%	0.949e	0.970f	0.147e	0.152e	7.73f	7.98d	17.41f	17.78f	79.69f	80.84f	4.92f	5.09f	16.85f	17.41f
Drip irrigation	80%	1.164a	1.190a	0.236a	0.244a	8.90a	9.39a	20.74a	21.42a	91.17a	94.24a	6.79a	6.99a	19.26a	19.91a
	60%	1.105b	1.130c	0.210b	0.216b	8.84b	9.17a	19.75b	20.46b	88.00b	90.98b	6.31c	6.53c	18.97b	19.64b
	40%	1.003d	1.025e	0.162d	0.167d	8.20e	8.47c	18.09e	18.69e	83.16e	85.80d	5.41e	5.59e	18.52c	19.13c

Means followed by the same letter within each column do not significantly differed using Duncan's Multiple Rang Test at the level of 5%

Irrigation system and soil amendments

The data presented in Table (11) cleared the interaction effect between the irrigation system and soil application with K silicate or humate on chemical fruit quality during 2017 and 2018 seasons. The highest mean values of fruit quality were obtained with the addition of 70 kg/fed followed by 500 kg/fed potassium silicate combined with 80% IWR compared to the untreated plants under the same treatment.

Table 11. Effect of double interaction between irrigation system X soil amendments on fruit quality parameters during 2017 and 2018 seasons.

Treatments		Total chlorophyll mg.g^{-1}		Carotene mg.g^{-1}		Total sugar %		Carbohydrates %		V.C mg.100g		TSS %		Dry matter %	
		2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Surface irrigation	0	0.978i	0.999i	0.159i	0.164i	7.93g	8.20e	17.82g	18.10i	80.88i	82.10j	5.21i	5.39h	16.97h	17.52j
	K Si 250	1.026h	1.051h	0.179g	0.184g	8.19f	8.44de	18.19f	18.75h	83.06h	84.33i	5.62h	5.80g	17.16g	17.74i
	K Si 500	1.057e	1.081e	0.190e	0.197e	8.65c	8.93bc	18.60de	19.21f	84.51f	85.85g	5.94e	6.13e	17.29ef	17.82g
	K H35	1.043f	1.069f	0.185f	0.191f	8.56d	8.85bc	18.40ef	19.03g	83.78g	84.95h	5.79f	5.99f	17.23fg	17.80h
	K H70	1.074d	1.102d	0.198d	0.204d	8.75b	9.03b	18.83d	19.43e	85.28e	86.46f	6.08d	6.27d	17.37e	17.97f
Drip irrigation	0	1.033g	1.056g	0.175h	0.181h	8.40e	8.68cd	18.55de	19.16f	84.34f	87.55e	5.67g	5.86g	18.67d	19.31e
	K Si 250	1.079d	1.104d	0.197d	0.203d	8.72bc	8.99bc	19.35c	20.01d	86.98d	89.62d	6.08d	6.29d	18.79c	19.47d
	K Si 500	1.114b	1.138b	0.213b	0.220b	8.75b	9.14ab	19.89ab	20.50b	88.60b	91.53b	6.35b	6.54b	19.03b	19.66b
	K H35	1.095c	1.119c	0.206c	0.212c	7.95g	8.88bc	19.64bc	20.30c	87.77c	90.66c	6.20c	6.41c	18.96b	19.61c
	K H70	1.131a	1.157a	0.222a	0.229a	9.08a	9.37a	20.20a	20.99a	89.53a	92.34a	6.52a	6.74a	19.14a	19.76a

Means followed by the same letter within each column do not significantly differed using Duncan's Multiple Rang Test at the level of 5%

Irrigation regimes and soil amendments

The results in Table (12) showed that with increasing irrigation levels from 40 to 80% of IWR increased all fruit quality parameters under soil amendments. The highest mean values of dry matter %, total chlorophyll, carotene, TSS%, total sugar, carbohydrates and vitamin C with the irrigation at 80% of IWR and 70 kg/fed potassium humat followed by 500 kg/fed potassium silicate. The same trend was true in the 2nd season. Similar positive results of the interaction between irrigation regimes and soil amendments on chemical fruit constituents are in accordance with those obtained by El-Saady (2017); Kotb *et al.* (2018); Kotb (2019); Mahmoud *et al.* (2019) and Abd Allah *et al.* (2021).

Irrigation system, irrigation regimes and soil amendments

As seen in Table (13), it's clear that irrigation sweet pepper at 80% of IWR under drip irrigation resulted in the highest mean values of dry matter %, total chlorophyll, carotene, total sugar, carbohydrates and vitamin C, especially with the soil application of 70 kg.fed^{-1} potassium humate followed by 500 kg.fed^{-1} potassium silicate under drip irrigation. While the lowest values were recorded with irrigation at 40% of IWR with surface irrigation and without soil addition. These results may be due to the effective role of soil amendments such as potassium humate or potassium silicate with drip irrigation system at 80 % IWR. This treatment increases water uptake and improves essential elements absorption and availing them in the different plant physiological and biochemical processes and consequently improves the chemical constituent's traits. In addition, the availability of minerals in the soil solution due to the use of potassium humate or silicate, enhanced their uptake through the roots. These results are partially compatible with those shown by Marodin *et al*. (2014) and Abdelaal *et al*. (2020).

Table 12. Effect of double interaction between irrigation regimes X soil amendments on fruit quality parameters during 2017 and 2018 seasons.

Treatments		Total chlorophyll mg.g^{-1}		Carotene mg.g^{-1}		Total sugar %		Carbohydrates %		V.C mg.100g		TSS %		Dry matter %	
		2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
80%	0	1.046i	1.070i	0.186h	0.192i	8.56e	8.87e-h	18.58hi	19.21i	84.55i	86.82i	5.82i	6.01i	18.00g	18.61i
	K Si 250	1.133d	1.157d	0.224c	0.232d	9.08c	9.41abc	19.94cd	20.57d	88.83d	91.15d	6.57d	6.78d	18.36cd	18.95d
	K Si 500	1.165b	1.193b	0.234b	0.242b	7.80i	9.08c-f	20.42ab	21.06b	90.32b	92.77b	6.85b	7.06b	18.49ab	19.07c
	K H 35	1.152c	1.176c	0.231b	0.238c	9.20b	9.51ab	20.19bc	20.86c	89.67c	91.81c	6.73c	6.94c	18.46bc	19.08b
	K H 70	1.183a	1.210a	0.242a	0.249a	9.42a	9.69a	20.68a	21.43a	91.21a	93.12a	7.02a	7.21a	18.59a	19.15a
60%	0	1.029j	1.052j	0.177i	0.183j	8.45f	8.71f-i	18.35ij	18.98j	83.31j	85.71j	5.66j	5.85j	17.92gh	18.52j
	K Si 250	1.062h	1.094h	0.192g	0.198h	8.66e	8.91d-g	18.91gh	19.58h	85.60h	87.59h	5.97h	6.18h	17.96gh	18.74h
	K Si 500	1.099f	1.122f	0.210e	0.216f	8.86d	9.15b-e	19.48ef	20.12f	87.14f	89.11f	6.26f	6.45f	18.24ef	18.83f
	K H 35	1.079g	1.109g	0.201f	0.207g	8.62e	9.05c-f	19.18fg	19.85g	86.34g	88.46g	6.12g	6.33g	18.16f	18.79g
	K H 70	1.117e	1.144e	0.218d	0.224e	8.98c	9.26bcd	19.73de	20.39e	88.00e	89.93e	6.42r	6.63r	18.32de	18.94e
40%	0	0.941o	0.961o	0.137n	0.143o	7.49k	7.75j	17.63l	17.70n	79.96n	81.94n	4.86o	5.02o	17.54l	18.13n
	K Si 250	0.962n	0.981n	0.148m	0.152n	7.62j	7.82j	17.47l	17.99m	80.64m	82.18n	5.02n	5.18n	17.60kl	18.13n
	K Si 500	0.993l	1.014l	0.161k	0.167l	8.23h	8.49hi	17.83kl	18.39l	82.20k	84.18l	5.33l	5.49l	17.77ij	18.33l
	K H 35	0.977m	0.998m	0.154l	0.160m	8.14h	8.42i	17.69l	18.29l	81.32l	83.15m	5.15m	5.33m	17.66jk	18.25m
	K H 70	1.007k	1.034k	0.170j	0.176k	8.34g	8.64ghi	18.14jk	18.81k	83.01j	85.15k	5.48k	5.68k	17.85hi	18.51k

Means followed by the same letter within each column do not significantly differed using Duncan's Multiple Rang Test at the level of 5%

Table 13. Effect of triple interaction among irrigation system X irrigation regime X soil amendments on fruit quality parameters during 2017 and 2018 seasons.

Treatments			Total chlorophyll mg.g^{-1}		Carotene mg.g^{-1}		Total sugar %		Carbohydrates %		V.C mg.100g		TSS %		Dry matter %	
			2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Surface irrigation	80%	0	1.019m	1.041o	0.178o	0.184p	8.42lm	8.73k	17.97opq	18.62no	82.58qr	83.99q	5.59m	5.78n	17.13op	17.68v
		K Si 250	1.106h	1.130h	0.213fg	0.220h	8.90fg	9.21g	19.19hi	19.86i	86.56j	87.99k	6.37h	6.60gh	17.48jkl	17.99s
		K Si 500	1.135fg	1.163f	0.219e	0.226fg	9.10de	9.42e	19.59fg	20.24g	87.97hi	89.64i	6.67e	6.90e	17.60ij	18.11q
		K H35	1.126g	1.149g	0.217ef	0.224g	9.01ef	9.31f	19.38gh	20.04h	87.45i	88.64j	6.55f	6.77f	17.57ijk	18.14p
		K H70	1.153de	1.181d	0.226d	0.233e	9.22cd	9.48d	19.80f	20.39fg	88.77fg	89.89hi	6.82d	7.02cd	17.69i	18.21o
	60%	0	1.003n	1.024p	0.169p	0.174q	8.34mn	8.59l	17.80qrs	18.38pq	81.86s	82.97r	5.42n	5.59o	17.05pq	17.65w
		K Si 250	1.034l	1.069m	0.183mn	0.188o	8.50jkl	8.75k	18.33mn	18.90m	83.58op	84.96o	5.73l	5.90m	17.22no	17.90t
		K Si 500	1.071j	1.095j	0.198ij	0.204k	8.70hi	8.98i	18.80jkl	19.41k	85.13l	86.22m	6.05j	6.25k	17.34lmn	17.90t
		K H35	1.053k	1.088k	0.190kl	0.196m	8.59ijk	8.89j	18.56lm	19.21l	84.34mn	85.51n	5.90k	6.11l	17.28mno	17.88u
		K H70	1.089i	1.117i	0.207h	0.213i	8.81gh	9.08h	19.05ij	19.62j	85.85k	87.01l	6.19i	6.38j	17.43klm	18.08r
	40%	0	0.912t	0.932u	0.129w	0.134v	7.04s	7.28s	16.70w	17.31u	78.19w	79.33w	4.64s	4.80s	16.72s	17.24z
		K Si 250	0.937s	0.953t	0.140v	0.144u	7.17s	7.36r	17.05v	17.49t	79.05v	80.03v	4.76r	4.89s	16.77s	17.35z
		K Si 500	0.967q	0.986r	0.154st	0.160s	8.13opq	8.39n	17.41tu	17.98rs	80.43u	81.68t	5.09p	5.25q	16.94qr	17.46y
		K H35	0.951r	0.971s	0.149tu	0.154t	8.06qr	8.34o	17.25uv	17.83s	79.56v	80.68u	4.91q	5.08r	16.82rs	17.38z
		K H70	0.979op	1.007q	0.161q	0.167r	8.23no	8.52m	17.64rst	18.28q	81.22t	82.48s	5.23o	5.42p	16.98pqr	17.61x
Drip irrigation	80%	0	1.073i	1.099j	0.194jk	0.201l	8.69hi	9.01i	19.19hi	19.80i	86.53j	89.65i	6.04j	6.23k	18.86e	19.53h
		K Si 250	1.159d	1.185d	0.236c	0.244d	9.27bc	9.60c	20.69cd	21.29d	91.09d	94.32d	6.76d	6.96de	19.24bc	19.91c
		K Si 500	1.195b	1.223b	0.250b	0.258b	6.50t	9.73b	21.25ab	21.87b	92.68b	95.90b	7.02b	7.22b	19.37ab	20.02b
		K H35	1.178c	1.203c	0.245b	0.253c	9.39b	9.74b	20.99bc	21.68c	91.90c	94.97c	6.90c	7.11c	19.36ab	20.02b
		K H70	1.214a	1.238a	0.258a	0.266a	9.63a	9.89a	21.56a	22.46a	93.64a	96.35a	7.21a	7.41a	19.49a	20.08a
	60%	0	1.056k	1.080l	0.186lm	0.192n	8.57i-l	8.86j	18.90ijk	19.58g	84.76lm	88.44j	5.90k	6.11l	18.79e	19.39j
		K Si 250	1.090i	1.118i	0.201i	0.207j	8.82gh	9.08h	19.49fgh	20.26e	87.62i	90.22h	6.21i	6.45ij	18.70ef	19.59g
		K Si 500	1.127g	1.148g	0.221e	0.228f	9.01ef	9.31f	20.16e	20.83f	89.14f	92.00f	6.46g	6.66g	19.13cd	19.76e
		K H35	1.105h	1.130h	0.212g	0.219h	8.64ij	9.21g	19.79f	20.48d	88.34gh	91.40g	6.33h	6.55hi	19.04d	19.70f
		K H70	1.144ef	1.171e	0.229d	0.235e	9.15cde	9.43q	20.41de	21.16r	90.14e	92.85e	6.64e	6.88e	19.21bc	19.79d
	40%	0	0.969pq	0.990r	0.146u	0.151t	7.94r	8.21e	17.56stu	18.10op	81.73st	84.55p	5.08p	5.23q	18.35h	19.02m
		K Si 250	0.988o	1.009q	0.155rs	0.159s	8.07pqr	8.28p	17.88pqr	18.50m	82.24rs	84.34pq	5.27o	5.46p	18.44gh	18.91n
		K Si 500	1.020m	1.042o	0.169p	0.174q	8.32mn	8.59l	18.24no	18.80m	83.97no	86.68l	5.57m	5.73n	18.60fg	19.20k
		K H35	1.002n	1.024p	0.160qr	0.165r	8.21nop	8.50m	18.14nop	18.74mn	83.08pq	85.62n	5.38n	5.57o	18.49gh	19.11l
		K H70	1.035l	1.060o	0.179no	0.185p	8.46klm	8.76k	18.63klm	19.34kl	84.80lm	87.82k	5.73l	5.94m	18.71ef	19.40i

Means followed by the same letter within each column do not significantly differed using Duncan's Multiple Rang Test at the level of 5%.

CONCLUSION

Finally, it can be recommended that the highest average of flowering and yield parameters are obtained from soil amendment at 70 kg/fed. from potassium humate followed by 500 kg/fed. from potassium silicate under drip irrigation system at 80% (6922 m^3/fed.) following irrigation at 60% of IWR (5192 m^3/fed.), because it saves irrigation water and achieves good yield and quality for pepper plants under drip irrigation conditions.

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تأثير بعض محسنات التربة على المحصول الثمري والبذري للفلفل الحلو تحت ظروف الإجهاد المائي:٢- المحصول وصفات الجودة.

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الملخص

أجريت تجربة حقلية لمعرفة مدى استجابة نبات الفلفل الحلو صنف كاليفورنيا وندر لنقص مياه الري تحت نظامي الري السطحى والري بالتنقيط مع اضافات محسنات التربة، على المحصول ومكوناته وجودة ثمار الفلفل.وكانت عدد معاملات التجربة ٣٠ معاملة مرتبة في تصميم شرائح متعامدة منشقة مرة واحدة. تم تخصيص الشرائح الأفقية لأنظمة الري (الري السطحي والري بالتنقيط)، بينما خصصت الشرائح الرأسية لمستويات الري ٤٠ % و ٦٠ % و ٨٠ % من الاحتياجات المائية (Irrigation water requirement, IWR)، بينما تضمنت القطع المنشقة خمسة معاملات أضافات للتربة وهى (بدون، ٢٥٠ كجم، ٥٠٠ كجم خام سيليكات البوتاسيوم للفدان و٣٥ كجم و ٧٠ كجم هيومات بوتاسيوم للفدان).أشارت النتائج إلى أن نظام الري بالتنقيط أنتج قيم أعلى معنوياً لعدد الأزهار، نسبة العقد، محصول الثمار المبكر، محصول الثمار الكلى للفدان ومحصول البذور الكلى للفدان مقارنة بنظام الري السطحي. وتم تسجيل أعلى القيم بشكل معنوي من معاملة ري النباتات عند ٨٠ ٪ ويليها الرى عند ٦٠% من IWR. كما أوضحت النتائج أنه تم الحصول على اعلى القيم من اضافة التربة عند ٧٠ كجم/فدان من هيومات البوتاسيوم تليها ٥٠٠ كجم/فدان من سيليكات البوتاسيوم. بالإضافة إلى ذلك ، أشارت النتائج إلى أنه تم الحصول على المعدل الأعلى لجميع الصفات المذكورة من اضافة التربة ب ٧٠ كجم / فدان من هيومات البوتاسيوم ويليه اضافة ٥٠٠ كجم / فدان من سيليكات البوتاسيوم تحت نظام الري بالتنقيط بنسبة ٨٠٪ (٦٩٢٢ م٣/فدان). ويليه الري بنسبة ٦٠٪ من الاحتياجات المائية (Irrigation water requirement, IWR) (٥١٩٢ م٣/فدان) لذلك نوصي بهذه المعاملة لأنها توفر مياه الري (٤٠٩١ و ٥٨٢١ م٣/فدان على التوالي) وتعطى أفضل محصول وجودة لثمار الفلفل.