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Effect of Potassium Foliar Application and Fertigation on Biological Aspects and Plant Growth Biomass of PepperP (*Capsicum annuum*).

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ABSTRACT

Two field experiments were carried out at a private farm, Damietta, Egypt to study the effect of foliar application and fertigation on the biological aspects as (plant height, number of leaves and root length and plant growth biomass (i.e., fresh and dry and shoot/root ratio and relative growth rate) as well as chlorophyll contents of pepper. Four foliar potassium treatments ((K_0 (control), K_1; 2kg fed^{-1} , K_2; 4kg fed^{-1}, and K_3; 6kg fed^{-1})) combined with three fertigation treatments (K_0 (control), K_1; 66kg fed^{-1} K_2; 132kg fed^{-1}) were arranged in a split-plot design with three replicates. The results showed that plant height and root length increased significantly by potassium fertigation and foliar application compared to the control. In contrast, potassium fertigation and foliar application had no significant effect on leaf area and leaf area index in both seasons. Pepper fresh and dry weights decreased by increasing K fertigation compared to the control, while potassium foliar application (K-leaf) significantly increased pepper fresh and dry weights with increasing potassium compared to the control except with the treatment of 6 kg fed^{-1} in both seasons. Potassium fertigation and foliar application had no significant effect on chlorophyll A, B, total carbohydrates and total phenols. While vitamin C increased by increasing potassium fertigation. The treatment of 50% in the recommended dose recorded the highest vitamin C values in both seasons and the potassium foliar application with K- leaf at the rate of 4 kg k fed^{-1} gave the highest vitamin C values in both seasons.

Keywords: Fertigartion, foliar, pepper, potassium, vitamin C , total carbohydrates

INTRODUCTION

Potassium is an essential nutrient for enhancing the productivity and quality of vegetable crops (Bidari and Hebsur, 2011). It contributes to enzyme activation for cell's metabolic processes such as respiration, protein synthesis, photosynthesis, sugars translocation, carbohydrates formation, regulation of activities of the essential elements, regulation of plant stomata and water use, regulation and maintenance of electrochemical equilibrium in cells and control in plants and many other processes needed to maintain plant growth and reproduction (Hsiao and Lauchli, 1986; Mahmoud *et al.*, 2019). On the other hand, the soil content of K varies from place to place based on the physicochemical properties of the soil. Potassium exists principally in the soil in four forms; water-soluble, exchangeable, non-exchangeable (fixed) and mineral K. The largest soil content of potassium is the soil minerals such as mica and feldspar, and which contributed to almost 90 to 98% of total potassium. These fractions exist in dynamic constancy among themselves and these forms, in turn, control the K nutrition in crops. The exchangeable or readily available potassium is around 2% of total potassium. It exists in soil in two forms, solution and exchangeable K on the cation exchange sites (Brady and Weil, 2002). Potassium is also contained in organic matter and within the soil microbial population which is also a source of potassium. It supplies very little of the potassium needed for plant growth. The dynamics of potassium in soil depend on the magnitude of stability among its various forms and are mainly influenced by the physicochemical properties of soil. Although potassium is not a component of any plant structures or compounds, it plays a part in many important regulatory roles in the plant.

Sweet pepper (*Capsicum annuum*) is an important vegetable crop grown extensively throughout the world especially in temperate countries such as Egypt. The cultivated area of pepper, in Egypt, reached 91404 feddans (fed. 4200 m^2), which produced 655841 tons with an average of 7.175 tons feddan^{-1} Khalil and Hatem, (2014).

It has occupied an essential rank in Egyptian agriculture due to its high income and nutritional values for human health (Ghoname *et al.*, 2010). Consumption of pepper fruit has increased because it is a source of nutrients and antioxidants (high antioxidant activity has been strongly correlated with the prevention of cardiovascular diseases, cancer, diabetes and agerelated disorders) (Chu *et al.*, 2002) (Mardanluo *et al.*, 2018) and vitamin C (Simonne *et al.*, 1997). Adequate plant nutrition plays an important role in vigorous plant growth. It increased yield and fruit quality. However, laterly the contribution of plant nutrition on the content of phytochemical compounds received more attention. The Solanaceae vegetable crops of pepper generally take up large amounts of nutrients from the soil (Mengel and Kirkby, 1980). The availability of K during plant growth is often lacking because of its destitute uptake by roots and the competitive absorption inhibition by calcium and magnesium elements. But, Nowadays, in

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Egypt, potassium fertilizers became highly expensive ones of input factors in production processes (ton ~ 650 $), so many farmers minimizing the used amount to the minimum dose. In addition to use any other newly and cheapest potassium sources through a foliar application as a stimulative dose to overcome such problem and to maximize their net repay to cover the additional cost of this K fertilizer source. Therefore, foliar K application could be a supplemental way to increase K element in plant tissues. The benefit of foliar fertilizing compared to soil fertilizing is that the utilization of nutrients does not depend on the soil moisture content, the pH of the soil and other chemical and physical properties (Kostadinov and Kostadinova, 2014). The effects of foliar nutrition are rapid. Increasing plant vegetative growth, yield as well as fruit quality and chemical composition due to increasing potassium fertilization levels have been reported by many workers on different crops Nassar *et al.,* (2001) and Fawzy *et al.*, (2005) on sweet pepper. In addition, Some previous studies have studied the effects of K fertilizers on pepper yield (Golcz *et al.*, 2012) and pepper fruit quality (Shehata *et al.*, 2018). K fertilizer had positive effects on the growth, yield and quality of the fruit of pepper plant (Botella *et al.*, 2017; Abdelaziz & Abdeldaym, 2018). On the other side, peppers have a high K demand and the harvested fruit removes a large amount of K from the soil. Pepper has the greatest requirement for potassium (40%) and nitrogen (31 %) about the total amount of absorbed nutrients. Soil K status influences K uptake by plant roots (Gupta, 2002). Potassium also involves in facilitates the uptake of nitrogen by plants (Akram *et al*., 2007). High potassium could increase shriveling of harvested pepper and reduce shelf life. In general, the amount of K removed by plants depends on the production level, soil type, and the retention or removal of crop residues (Yadvinder *et al*., 2005). The main aim of this study was the assessment of foliar application and fertigation supply on morphological parameters and plant biomass of pepper plants.

MATERIALS AND METHODS

Two field experiments were carried out at Kafr El-manazla, Kafr Saad, Damietta Governorate, Egypt during two successive seasons of 2019 and 2020 to study the effect of soil addition from potassium rates and foliar application of K-leaf on Pepper (*Capsicum Annium*) c.v TOMMY F1. A split plot with a completely randomized block design of three replications was adopted. The main plots were assigned to the three rates of K fertigation (K_0 (control), K_1; 66kg fed^{-1} K_2; 132kg fed^{-1}). The sub-plots were occupied by the four foliar K (K_0 (control), K_1; 2kg fed^{-1}, K_2; 4kg fed^{-1}, and $K_{3;}$ 6kg fed^{-1}). The treatment was replicated three times to give a total of 36 lines of experiments.

Materials:

Sulphate of potash was used as a source of potassium. The formation of sulfate of potash is potassium oxide (K_2O 51 %), and sulfuric anhydride (SO_3 46%), which was obtained from Research Cairo. Fertilizer of phosphoric acid (60 % P_2O_5) was used as a phosphorus source for all treatments as recommended by the Egyptian Ministry of Agriculture. Fertilizer of ammonium nitrate (33.5% N) was used as a source of nitrogen as recommended by the Egyptian Ministry of Agriculture. The seedlings of pepper (*Capsicum annium*) were brought from the nursery in Kafr El Battekh, Damietta Governorate, Egypt.

Methods:

All the methods which were used in the current study are illustrated as the following: Two field experiments were carried out at Kafr El Manazla at Damietta Governorate (31°32′N and 31°70′E) in Northern Egypt, during two spring seasons 2019 and 2020. This investigation aims to study the effect of potassium rates on the growth and yield of pepper and soil properties after harvesting. Irrigation from Kafr El Manazla channel from which has water supply from the Nile branch. The region has a sub-tropical climate with hot, dry summers and cool wet winters.

Soil physical and chemical properties of the field experimental samples according to Chapman and Pratt, (1971) are shown in Table 1. Before the two experiments, soil samples were taken from the upper layer, (30 cm).

Table 1. Physical and chemical properties of the experimental soil in both seasons.

Soil properties		Season 2018/2019	Season 2019/2010
Mechanical analysis	Coarse Sand	14.6%	8.15%
	Fine Sand	10.17%	5.6%
	Silt	32.24%	48.51%
	Clay	42.99%	37.74%
	Texture Class	Clay	Silt clay loam
Chemical analysis	pH (1:2)	7.75	7.95
	EC %	0.47	0.18
	OM %	2.02	3.36
	Ca^{++}(meq L^{-1})	3.7	2.3
	Mg^{++}(meq L^{-1})	7.5	1.8
	K^+ meq L^{-1}) soulable	1.27	0.74
	K^+ ppm available	357	299
	Na^+ (meq L^{-1})	1.27	0.39
	$SO_4{}^{2-}$ (meq L^{-1})	3.14	2.43
	CO_3^- (meq L^{-1})	0	0
	HCO_{3--} (meq L^{-1})	8.4	2.2
	Cl^- (meq L^{-1})	2.2	0.6

Experimental Design and Treatments:

This experiment was adopted in a split-plot design with three replicates containing 12 treatment that was the combination between 3 potassium rates (0, 66 and 132 kg fed^{-1}.) were assigned in main plots and 4 foliar application of k-leaf (0, 2, 4, 6 kg fed^{-1}) which were allocated in sup plots.

- Pepper plant height (Cm) was taken at 80 and 90 day from planting in first and scond sesson respectively while cuts were taken at 65, 83, and 105 day from planting in both seasons.

Some physiological analysis:

The chlorophyll content of leaf tissue: The photosynthetic pigments (Chlorophyl a, b and carotenoids) were estimated by following method: A 50 mg sample of fresh leaves (4th leaf), which were soaked in 10 ml methanol alcohol (95%) in dark bottels for 24h. Optical density was read, at 470, 647 and 665 nm, with a spectrophotometer. The chlorophyll content was estimated by the formulae given by Goodwine, (1965), which are expressed, as follows:

$$\text{chl a (mg/g)} = 12.25 \times (OD665) - 2.79 \times (OD647) \times \frac{V}{W \times 1000}$$

$$\text{chl b (mg/g)} = 21.50 \times (OD647) - 5.10 \times (OD665) \times \frac{V}{W \times 1000}$$

$$\text{Carotenoids} = \frac{(1000 \times (OD470) - (1.8 \times \text{chl a}) - (85.02 \times \text{chl b})}{198} \times \frac{V}{W \times 1000}$$

Where, OD= Optical density, V = Final vol. of 95 (%) methanol (10ml) and W = Weight of sample taken (0.05g).

Chlorophyll content was measured after 80 and 90 day from planting in first and scond sesson respectively.- Vitamin C (mg/100g): It was drtermind as according to the method reported in AOAC, (2007). determined by using the die 2, 6 dichlorophenol indophenols, method as de-scribed by Ranganna(1979). Total carbohydrates quantitative estimation in dry fruit of Pepper by spectrophotometer using anthrone method. Percentage of total carbohydrate present in fruits was determined by (Hedge & Hofreiter , 1962):

Total carbohydrate present % = x/0.2×100

x = the corresponding focus on optical density is on the standard curve.

RESULTS AND DISCUSSION

Data in Table (2) show that plant height increased significantly by potassium fertigation especially at T2 (50%) from recommended does which recorded 98.3 and 97.7 cm in the first and second season. Potassium foliar application with (k-leaf) has a positive effect on plant height compared to the control and the highest plant height values(95.9 and 99.2 cm) were found at the treatment of 4 kg fed^{-1}. In addition, the interaction between treatments significantly affects pepper plant height but no constant trend was found. The maximum value for plant height was 111 cm in the 1st season (T2 F4) and 106.3 cm in the 2nd season (T1 F3, T2 F2). The increase in plant height may be attained due to increased cell division and elongation at a higher level of nitrogen and phosphorus. (Fawzy *et al*., 2012). Moreover, many studies proved that K plays a major role in many physiological and biochemical processes such as cell division and elongation and metabolism of carbohydrates and protein compounds (Hsiao and Läuchli, 1986 and Marschner, 1995). These results are in agreement with (Botella *et al*., 2017; Kaur *et al*., 2017).

Root length was affected significantly by foliar application and fertigation of potassium as it increased compared to the control in both seasons. That may be due to the beneficial effects of potassium which were attributed to increased root growth leading to enhanced uptake of water and mineral nutrients [Chartzoulakis and Klapaki, (2000) and Shafeek; El-Zeiny, A.H. and Ahmed, M.E. (2005); Supanjani & Lee, (2006)], optimal water adjustment in the cell wall, and efficient translocation of sugars from source to sink [Kato, Taniguchi, Shinmura and Horibata, (2004)]. The highest root length values were recorded at the foliar application of 4 kg fed^{-1}in both seasons. Potassium fertigation has no significant effect on leaf area and leaf area index in both seasons. Also, foliar application of potassium didn't affect significantly on leaf area and leaf area index in both seasons.

Table 2. effect of foliar application and fertigation of K on vegetative parameters of plant.

Character Treatments		Plant height (cm)		Root length (cm)		Leaf Area (cm2)		Leaf Area index (cm2/m2)	
		1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
(A) Mean values as affected by different levels of fertigation									
Fertigation	T1	93.1	97.2	24.3	24.5	5174	5078	180	151
	T2	98.3	97. 7	29.9	26.3	7053	6833	245	141
	T3	89.8	93.6	26.1	25.6	3537	6322	123	130
LSD		1.45	0.46	1.68	0.4	Ns	Ns		
(B) Mean values as affected by different rates of foliar application									
Foliar	F1	92.0	93.2	27.0	27.7	5430	5775	189	119
	F2	95.3	98. 8	28.0	25.3	5749	6702	200	144
	F3	95.9	99.2	28.1	27.9	5944	7019	206	138
	F4	95. 7	95.5	24.0	27.7	5894	6128	205	126
LSD	***	0.2	0.6	2.4	0.35	Ns	Ns	Ns	Ns
(C) Interaction sign									
A × B	T1 F1	96.5	93.5	23.5	26.0	6143	4998	213	103
	T1 F2	105.0	96.0	28.0	25.5	5707	11059	198	228
	T1 F3	85.5	106.3	23.0	36.3	5573	6021	194	124
	T1 F4	85.5	93.0	22.5	30.0	3272	7293	114	150
	T2 F1	94.0	89.0	25.5	24.0	7241	5803	251	119
	T2 F2	87.8	106.3	26.0	26.0	7540	4922	262	101
	T2 F3	100.2	92.3	34.2	22.3	2952	6594	103	136
	T2 F4	111.0	103.0	34.0	33.0	10478	4894	364	101
	T3 F1	85.5	97.0	23.0	33.0	2908	6523	101	134
	T3 F2	93.0	94.0	30.0	24.5	4001	5077	139	104
	T3 F3	90.0	93.0	27.0	25.0	3307	7491	115	154
	T3 F4	90.5	90.5	24.5	20.0	3932	6199	137	128
LSD	A×B	3.08	2	-	0.87	Ns	-	-	-

Obtained data in Table (3) explain that K fertigation has a significant effect on plant fresh and dry weights. As fresh and dry weights were decreased by increasing K fertigation compared to the control. Also, potassium foliar application (K-leaf) significantly affected fresh and dry weights where they increased with increasing potassium compared to the control except with treatment of 6 kg fed^{-1}in both seasons. The interaction between K fertigation and potassium foliar application (K-leaf) had no constant trend. These results are in contrast with that of El-Bassiony *et al*., (2010) which found that the highest values of fresh and dry weightss of leaves of sweet pepper plants with increasing potassium where it may be due to the role of potassium element in metabolism and many processes needed to sustain and promotion plant vegetative growth and development. While Zain and smail, (2016) found that fresh and dry weights decreased with increasing potassium levels in rice plant.

Table 3. Effect of foliar application and fertigation of K on pepper plant fresh and dry weights.

Character Treatments		Plant F.W (gm)		Plant D.W (gm)	
		1st season	2nd season	1st season	2nd season
(A) Mean values as affected by different levels of fertigation					
Fertigation	T1	235.21	444.87	96.73	107.19
	T2	230.45	328.02	84.85	97.43
	T3	169.76	320.7	71.08	95.52
LSD	***	0.24	9.21	0.2	0.47
(B) Mean values as affected by different rates of foliar application					
Foliar	F1	206.97	330.47	71.17	98.69
	F2	224.73	440.07	87.19	101.82
	F3	210.64	378.7	94.23	107.2
	F4	178.22	308.87	84.28	92.56
LSD	***	1.34	2.99	0.45	0.55
(C) Interaction sign					
A × B	T1 F1	215.63	341.39	90.38	84.99
	T1 F2	301.89	391.48	134.62	129.23
	T1 F3	198.76	375.11	94.48	125.91
	T1 F4	144.58	311.5	67.43	96.62
	T2 F1	144.29	335.72	63.84	108.34
	T2 F2	298.6	327.62	61.85	91.6
	T2 F3	287.24	376.05	92.03	98.76
	T2 F4	191.66	272.67	121.66	83.02
	T3 F1	175	314.31	59.29	102.73
	T3 F2	159.71	241.1	65.09	92.63
	T3 F3	145.91	384.95	96.17	96.62
	T3 F4	198.41	342.45	63.76	98.05
LSD	A×B	2.34	1.12	0.93	1.98

Data in Table 4 showed that the fertigation and foliar application of K had no significant effect on chlorophyll A and B. Chlorophyll A and B decreased by increasing potassium fertilizers compared to the control. The highest values for Chlorophyll A and b were recorded with the control treatment in both seasons respectively. These results are in contrast with that of El-Bassiony *et al.,* (2010) and Hussein *et al.,* (2012). These results may be due to high potassium concentration which reduces magnesium uptake (Heenan and Campbell, 1981)and reflected on chlorophyll content with chlorosis appears in plant

Data in Table 5 observed that the fertigation and foliar application of K had a significant effect on vitamin C in both seasons where it increased by potassium fertigation increasing and the treatment of 50% of recommended dose recorded the highest vitamin c values in all cuts in both seasons. While the potassium foliar application with K-leaf at the rate of 4 kg k fed^{-1} gave the highest vitamin C values in all cuts in both seasons. In addition, the interaction between potassium fertigation and foliar application had no constant trend and The highest average values for vitamin C were (823.4, 6029.4) mg. 100gm^{-1} in both seasons respectively were found at the treatment of 4kg k fed^{-1} and 50% of the recommended dose.

Table 4. Effect of foliar application and fertigation of K on Chlorophyll A, Chlorophyll B and Carotenoids.

Character Treatments		Chlorophyll A (mg. g^{1-})		Chlorophyll B (mg. g^{1-})	
		1st season	2nd season	1st season	2nd season
(A) Mean values as affected by different levels of fertigation					
Fertigation	T1	1.64	1.97	0.65	0.75
	T2	1.14	1.63	0.59	0.58
	T3	1.033	1.47	0.41	0.52
LSD	***	Ns	Ns	ns	Ns
(B) Mean values as affected by different rates of foliar application					
Foliar	F1	1.043	1.77	0.73	0.64
	F2	0.97	1.66	0.5	0.62
	F3	0.9	1.59	0.55	0.56
	F4	0.83	1.73	0.41	0.62
LSD	***	Ns	ns	Ns	Ns
(C) Interaction sign					
A × B	T1 F1	1.62	2.49	1.13	0.92
	T1 F2	0.6	1.7	0.64	0.7
	T1 F3	0.86	2	0.45	0.75
	T1 F4	0.68	1.68	0.37	0.62
	T2 F1	1.5	1.38	0.6	0.48
	T2 F2	1.55	1.85	0.58	0.66
	T2 F3	0.83	1.58	0.93	0.54
	T2 F4	0.68	1.69	0.25	0.62
	T3 F1	1.21	1.43	0.45	0.53
	T3 F2	0.77	1.42	0.28	0.51
	T3 F3	1.01	1.19	0.28	0.4
	T3 F4	1.14	1.83	0.62	0.62
LSD	A×B	-	ns	-	-

These results are in line with that of Hsiao and Läuchli, 1986 and Marschner, (1995) they found that increasing potassium fertilization rates significantly increased all chemical composition, i.e. total chlorophyll in leaves and vitamin C content in fruits. These results may be due to the role of potassium in plant metabolism and many important regulatory processes in the plant. Also, it could be increased mineral uptake by plants

Obtained data in Table 6 indicated that potassium fertigation has no significant effect on total phenols in both seasons. Total phenols decreased by increasing K fertigation and the highest average value was for the control. Potassium Foliar application effects also was nonsignificant on total phenols where it decreased by increasing foliar Potash and the highest value was for F2(2kg fed^{-1}). The treatment of 2kg fed^{-1} as a foliar and 50% of the recommended dose gave maximum average value for total phenols in both seasons. These results contradict the results obtained by El-Mogy *et al*., (2019) they found an increase of total phenols level with foliar K fertilizer. This might be due to the potassium role which plays a vital role in stimulating photosynthesis activity and improving the translocation of sugars into different parts of plant.

Table 5. Effect of foliar application and fertigation of K on vitamin C.

Character Treatments		VC mg/100gm							
		1st season				2nd season			
		C1	C2	C3	Average	C1	C2	C3	Average
(A) Mean values as affected by different levels of fertigation									
Fertigation	T1	157.2	910.3	771.4	626.3	4963.2	4825.4	4595.6	5147.1
	T2	200.0	957.2	842.9	666.7	6691.2	5882.0	4600.6	5638.9
	T3	159.2	928.6	828.6	638.1	5000.0	4963.2	4633.8	4632.4
LSD	***	1.4	1.7	3.0	2.0	0.6	3.2	4.0	2.6
(B) Mean values as affected by different rates of foliar application									
Foliar	F1	152.4	990.5	761.9	634.9	5686.3	4558.8	4558.8	4934.6
	F2	171.4	1066.7	895.2	711.1	5686.3	6225.5	4264.7	5392.2
	F3	209.5	1078.6	895.2	727.8	5739.2	6327.5	4362.7	5476.5
	F4	152.4	914.3	704.8	590.5	5294.1	5049.0	4215.7	4852.9
LSD	***	1.1	8.9	8.9	6.3	0.8	6.7	4.1	3.9
(C) Interaction sign									
A × B	T1 F1	114.3	1200.0	914.3	742.9	4558.8	4558.8	5000.0	4705.9
	T1 F2	171.4	1028.6	685.7	628.6	4411.8	5882.4	5147.1	5147.1
	T1 F3	171.4	1200.0	914.3	761.9	4852.9	6911.8	4705.9	5490.2
	T1 F4	171.4	1028.6	571.4	590.5	6029.4	6176.5	3529.4	5245.1
	T2 F1	171.4	971.4	514.3	552.4	7352.9	5294.1	4705.9	5784.3
	T2 F2	228.6	1200.0	971.4	800.0	7941.2	5882.4	4117.7	5980.4
	T2 F3	285.7	984.4	1200.0	823.4	6764.7	6764.7	4558.8	6029.4
	T2 F4	114.3	742.9	685.7	514.3	4705.9	4558.8	4705.9	4656.9
	T3 F1	171.4	800.0	857.1	609.5	5147.1	3823.5	3970.6	4313.7
	T3 F2	114.3	971.4	1028.6	704.8	4705.9	6911.8	3529.4	5049.0
	T3 F3	171.4	971.4	571.4	571.4	5000.0	4705.9	3823.5	4509.8
	T3 F4	171.4	971.4	857.1	666.7	5147.1	4411.8	4411.8	4656.9
LSD	A×B	-	-	-		2.15	7.43	-	

Table 6. Effect of foliar application and fertigation of K on total phenols.

Character Treatments		Phenols (mg/g)							
		1st season				2nd season			
		C1	C2	C3	Average	C1	C2	C3	Average
(A) Mean values as affected by different levels of fertigation									
Fertigation	T1	0.34	0.49	0.50	0.44	6.20	0.45	0.45	2.37
	T2	0.36	0.45	0.42	0.41	5.20	0.56	0.61	2.12
	T3	0.32	0.48	0.37	0.39	4.40	0.53	0.44	1.79
LSD	***	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns
(B) Mean values as affected by different rates of foliar application									
Foliar	F1	0.35	0.40	0.40	0.38	4.50	0.53	0.50	1.83
	F2	0.39	0.56	0.48	0.48	6.30	0.55	0.50	2.45
	F3	0.32	0.47	0.41	0.40	5.70	0.50	0.50	2.23
	F4	0.29	0.46	0.44	0.40	4.60	0.47	0.50	1.86
LSD	***	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns
(C) Interaction sign									
A × B	T1 F1	0.41	0.47	0.43	0.44	5.43	0.48	0.55	2.15
	T1 F2	0.30	0.47	0.58	0.45	5.78	0.37	0.38	2.18
	T1 F3	0.33	0.57	0.45	0.45	5.88	0.38	0.36	2.21
	T1 F4	0.31	0.46	0.54	0.44	5.82	0.57	0.51	2.30
	T2 F1	0.41	0.35	0.48	0.41	4.39	0.54	0.58	1.84
	T2 F2	0.51	0.50	0.50	0.50	6.85	0.72	0.64	2.74
	T2 F3	0.30	0.44	0.32	0.35	5.70	0.61	0.67	2.33
	T2 F4	0.21	0.49	0.45	0.38	4.08	0.37	0.57	1.67
	T3 F1	0.24	0.38	0.30	0.31	3.69	0.63	0.39	1.57
	T3 F2	0.36	0.70	0.42	0.49	4.36	0.50	0.47	1.78
	T3 F3	0.32	0.41	0.45	0.39	5.56	0.52	0.47	2.18
	T3 F4	0.34	0.44	0.32	0.37	3.98	0.48	0.44	1.63
LSD	A×B	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns

Data in Table (7) illustrated that Potassium fertigation had no significant effect on total carbohydrates in both seasons. Total carbohydrates increased by increasing K fertigation and the highest average value was for T3 (100% from recommended does). Potassium foliar application also did not affect total carbohydrates significantly where it decreased by increasing foliar Potash in 1st and 2nd season except for 1st cut for 2nd season. Similar results were found with El-Mogy *et al*., (2019), higher total sugar content can be explained by the role of K as a cofactor in the activation of enzymes involved in biosynthesis and hydrolysis of carbohydrates, translocation of their diverters from leaves to fruits and neutralization of important organic acids.

Table 7 . Effect of foliar application and fertigation of K on total carbohydrate.

Character Treatments		% Total carb							
		1st season				2nd season			
		C1	C2	C3	Average	C1	C2	C3	Average
(A) Mean values as affected by different levels of fertigation									
Fertigation	T1	6.8	12.60	12.60	10.67	4.60	4.20	6.80	5.20
	T2	9	12.60	12.60	11.40	5.40	6.40	8.20	6.67
	T3	9.8	12.60	12.60	11.67	8.00	6.40	9.20	7.87
LSD	***	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns
(B) Mean values as affected by different rates of foliar application									
Foliar	F1	9.80	12.60	12.60	11.67	4.60	7.60	9.80	7.33
	F2	9.00	12.60	10.42	7.27	6.00	7.20	8.40	7.20
	F3	9.20	12.60	9.20	10.33	7.60	4.20	9.20	7.00
	F4	6.40	12.60	10.20	9.73	6.20	6.80	8.80	7.27
LSD	***	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns
(C) Interaction sign									
A × B	T1 F1	10.20	12.60	14.80	12.53	3.6	9.20	12.60	8.47
	T1 F2	9.20	10.20	9.20	9.53	4.40	4.20	8.20	5.60
	T1 F3	7.20	9.80	8.20	8.40	6.6	6.40	8.20	7.07
	T1 F4	8.40	12.60	8.80	9.93	4.6	4.20	12.60	7.13
	T2 F1	8.40	12.60	12.60	11.20	4.80	4.20	8.20	5.73
	T2 F2	8.80	12.60	5.40	8.93	6.60	8.20	8.80	7.87
	T2 F3	12.60	12.60	12.60	12.60	3.60	4.20	6.80	4.87
	T2 F4	8.00	14.80	12.60	11.80	5.80	12.60	8.4	9.20
	T3 F1	12.60	12.60	12.60	12.60	5.40	8.20	9.20	7.60
	T3 F2	8.40	12.60	12.60	11.20	6.80	8.20	8.20	7.73
	T3 F3	9.20	12.60	10.36	7.39	11.80	4.20	12.60	9.53
	T3 F4	10.20	12.60	10.20	11.00	8.00	4.20	0.38	4.19
LSD	A×B	-	Ns	-	Ns	Ns	Ns	Ns	Ns

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تأثير الرسمدة والرش الورقي للبوتاسيوم علي المكونات الحيوية والكتلة الحيوية للنبات الفلفل.

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أجري هذا البحث تجربتين ميدانيتين في مزرعة خاصة بدمياط ، مصر لدراسة تأثير الرش الورقي والتسميد على المكونات الحيوية (ارتفاع النبات ، عدد الأوراق وطول الجذور والكتلة الحيوية لنمو النبات (طازجة وجافة ، والنبات فوق سطح التربة / جذر). النسبة ومعدل النمو النسبي)) وكذلك محتوى الكلوروفيل لنبات الفلفل (الفليفلة الحولية).). أربع معاملات للرش بالبوتاسيوم الورقي (كنترول ، 2 كجم فدان $^{-1}$، 4 كجم فدان $^{-1}$ ، و 6 كجم فدان $^{-1}$) مجتمعة ثلاث معاملات تسميد (كنترول ؛ 66 كجم فدان$^{-1}$؛ 132 كجم فدان$^{-1}$) في تصميم القطعة المنقسمة بثلاث مكررات. أظهرت النتائج أن ارتفاع النبات وطول الجذر زاد معنويا عن طريق التسميد بالبوتاسيوم والرش الورقي مقارنة بالكنترول. بينما لم يكن لتسميد البوتاسيوم والتسميد الورقي تأثير معنوي على مساحة الورقة ودليل مساحة الورقة في كلا الموسمين. كما انخفض الوزن الطازج والجاف للفلفل بزيادة التسميد بالبوتاسيوم الأرضي مقارنة بالكنترول ، بينما أدى إضافة البوتاسيوم على الأوراق (K-Leaf) إلى زيادة معنوية في الوزن الرطب والجاف للفلفل مع زيادة البوتاسيوم مقارنة مع الكنترول ما عدا معاملة 6 كجم / فدان في كلا الموسمين. لم يكن لتسميد البوتاسيوم والتسميد الورقي تأثير معنوي على الكلوروفيل أ ، ب ، الكربوهيدرات الكلية والفينولات الكلية. بينما بزيادة التسميد بالبوتاسيوم زادت قيم فيتامين ج ، وسجلت المعاملة بنسبة 50٪ من الجرعة الموصى بها أعلى قيم لفيتامين ج في جميع الجمعات في كلا الموسمين وتطبيق الرش الورقي للبوتاسيوم بمعدل 4 كجم فدان$^{-1}$ أعطت أعلى نسبة فيتامين ج في جميع الجمعات في كلا الموسمين.

الكلمات الافتتاحية: الرسمدة ،الرش،الفلفل،البوتاسيوم،فيتامين ج ،الكربوهيدرات