RESPONSE OF SWEET PEPPER TO SOME GROWTH REGULATORS 1- PHOTOSYNTHETIC PIGMENTS AND ANATOMICAL TRUCTURE

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ABSTRACT

Pots experiments were carried out at the farm Kafr El-Sheikh, Faculty of Agriculture during the two successive summer seasons of 1992 and 1993. The main objective of this study was to recognize the responses of sweet pepper (*Capsicum annuum* L.) California wonder variety to foliar applications of several concentrations of some growth regulators, i.e., kinetin cycocel (ccc), ethrel and morphactin (CME) beside the control (water spray) on photosynthetic pigments and anatomical characteristics. The results are summarized as follows:

Physiological studies: All growth regulators increased concentrations of photosynthetic pigments of leaf.

Anatomical studies: These four growth regulators affected significantly structure of root, stem and leaf of sweet pepper plants.

INTRODUCTION

Family Solanaceae is one of the most important economic families which includes about 85 genera and more than 2200 species, many of its plants are grown as vegetable crops such as tomato, pepper, potatoes, eggplant etc.

One of the most important genera is Capsicum of which the under investigation in one of its edible species.

California Wonder (*Capsicum annuum* L.) a nonpungent cultivar, is widely produced in Egypt during summer season for local market as it needs a relatively long growing season of high temperature.

Consumed fresh pepper in one of the best means for supplementing ascorbic acid (Vitamin C), whereas it is considered one of the higher nutritional value crops, particularly in vitamins.

It is a favourite vegetable throughout the year and it is used as fresh, cooking, pickle food and may be stuffed with rice and minced meat cooked.

During the past 10 years, the use of plant growth regulators has increased more than other agricultural chemical groups (Davis and Curry, 1991). Growth regulators are used on a wide variety of ornamental crops to improve rooting, increase shoot formation, shorten internodes, and induce flowering. The effect of some of theses compounds on pests has been investigated on many crops, (Osbrne and Chase, 1990).

The application of the plant growth regulators might improve the growth of plants and fruit set leading to increasing fruit yield and fruit quality.

Therefore, certain experiments were carried out to study the effect of some growth regulators, i.e., kinetin, cycocel (CCC), ethrel and morphactin (CME) on morphological, physiological and anatomical characteristics as well as yield and its components besides fruit quality of sweet pepper (*Capsicum annuum*L.) California Wonder variety.

MATERIALS AND METHODS

The present experiments were carried out during the late summer of 1992 and 1993 seasons in clay pots 30 cm inner diameter in the glasshouse of the Department of Agricultural Botany, Faculty of Agriculture, Kafr El-Sheikh Tanta University. The aim of this work was to study the effects of 4 growth regulators with different concentrations on morphological, physiological and anatomical characteristics of sweet pepper *Capsicum annuum* L., var California wonder.

1. Photosynthetic pigments:

Leaf pigments, i.e. chlorophyll a, b and cartenoids of the fifth leaf from the shoot tip were determined at 30 and 60 days after transplanting date i.e., 15 and 45 days after application of the plant growth regulators. (Wettstein, 1957).

2. Anatomical studies:

The effect of growth regulators on the anatomical structure of leaves (lamina), stems and roots was studied after 15 days after application Specimens 1 cm long were taken from the fifth internode and the fifth leaf including the midrib. Concerning the roots 1 cm samples from the subapical part of secondary root tip were cut.

Sections were stained then cleared in xylol and mounted in Canada balsam and prepared for microscopic examination (Ghamrawi and Zaher, 1953).

RESULTS AND DISCUSSION

1. Photosynthetic pigments:

Data presented in Tables (1 and 2) show that kinetin at all levels significantly increased photosynthetic pigments concentrations (Chl. a, Chl. b, Chl. a + b and carotenoids) at two sampling dates (15 and 45 days after application) in both seasons. The increase in carotenoids was not significant at 25 and 50 mg/L at the second sampling date in the first season. In fact, the increase in photosynthetic pigments occurred due to a corresponding increase in Lamina thickness. In addition, cytokinin

increase a number of chloroplast in young leaves by increasing both intensity of cell growth phytohormones and the activity of cytoplasm ribosomes, thus chlorophyll synthesis is stimulated (Borzenkova and Mokronosov, 1976).

Table (1): Effect of some growth regulators on photosynthetic pigments concentrations of sweet pepper leaves (*Capsicum annuum* L. var. California wonder) during 1992 season.

Growth regulators (mg/L)		Pigments concentrations (mg/dm^2)							
		15 days after application				45 days after application			
		Chl. a	Chl. b	Ch. (a+b)	Carotenoids	Chl. a	Chl. b	Ch. (a+b)	Carotenoids
Control		1.20	0.89	2.09	0.81	1.88	0.80	2.68	1.59
Kinetin	25	1.95	1.49	3.44	1.40	3.32	2.20	5.52	1.84
	50	2.00	1.79	3.79	1.60	3.50	2.42	5.82	1.67
	100	2.66	2.36	5.02	1.90	3.80	2.07	5.87	2.00
CCC	500	1.50	1.64	3.14	1.20	2.23	1.13	3.46	1.85
	1000	1.69	1.31	3.00	1.44	2.33	1.30	3.63	1.67
	2000	1.93	1.31	3.24	1.44	2.53	1.30	3.83	1.84
Ethrel	100	2.06	1.79	3.86	1.25	3.18	2.09	5.30	2.10
	200	1.74	1.30	3.04	1.26	2.69	1.84	4.52	2.05
	400	1.85	1.46	3.31	1.20	3.00	2.30	5.27	1.95
CME	2.5	3.15	2.89	6.04	2.47	3.13	2.28	5.41	2.24
	5	2.18	1.42	3.60	1.71	3.04	2.23	5.27	2.13
	10	2.39	2.05	4.43	1.99	2.75	2.06	4.81	2.32
L.S.D.	5%	0.20	0.39	0.51	0.38	0.37	0.31	0.65	0.32

Table (2): Effect of some growth regulators on photosynthetic pigments concentrations of sweet pepper leaves (*Capsicum annuum* L. var. California wonder) during 1993 season.

Growth regulators (mg/L)		Pigments concentrations (mg/dm^2)							
		15 days after application				45 days after application			
		Chl. a	Chl. b	Ch. (a+b)	Carotenoids	Chl. a	Chl. b	Ch. (a+b)	Carotenoids
Control		1.26	0.80	2.12	1.05	1.79	0.90	2.69	1.45
Kinetin	25	2.10	1.64	3.37	1.59	2.70	1.88	4.58	2.01
	50	2.11	1.31	3.42	1.73	2.70	1.97	4.67	1.94
	100	2.22	1.99	4.21	2.02	2.78	2.08	4.86	1.85
CCC	500	1.80	1.23	3.03	1.60	2.95	1.89	4.84	1.76
	1000	1.81	1.23	3.04	1.62	2.08	1.87	3.95	1.76
	2000	1.81	1.55	3.36	1.60	2.21	1.91	4.12	1.80
Ethrel	100	1.92	1.50	3.42	1.73	3.15	2.44	5.59	2.00
	200	1.90	1.23	3.13	1.88	2.40	1.81	4.21	2.13
	400	1.90	1.55	3.45	1.59	2.70	1.89	4.59	1.91
CME	2.5	3.15	2.38	5.53	2.71	3.70	2.11	5.81	2.21
	5	2.59	2.29	4.88	1.36	3.32	2.35	5.67	2.19
	10	2.23	2.01	4.24	2.02	3.23	2.11	5.34	2.13
L.S.D.	5%	0.34	0.42	0.64	0.32	0.60	0.40	0.56	0.23

The plants treated with CCC at 500, 1000 and 2000 mg/L significantly increased photosynthetic pigments (Chl. a, Chl. b, Chl. a + b and carotenoids concentrations) at two sampling dates (15 and 45 days after application) during both seasons, except in case of carotenoids at the second sampling date during the first season. It is concluded that the favourable effects of cycocel on the concentration of photosynthetic pigments of pepper plant leaves may be due to the assumption that CCC retards chlorophyll that breakdown via inhibition of chlorophyllase enzyme (Gaber *et al*., 1983).

Plants treated with ethrel at all concentrations used significantly increased Chl. a, Chl. b, Chl. a + b and carotenoids concentrations at all sampling dates during both seasons. The produced increase in photosynthetic pigments by ethrel may be due to the increase in Lamina thickness observed in this work. Furthermore the increase in photosynthetic pigments due to ethrel application may be attributed to an increase in the biosynthesis of these pigments and their enzymes activity (El Zawily *et al.*, 1984) on onion.

CME treatments significantly increased Chl. a, Chl. b, Chl. a + b and carotenoids at all sampling dates during both seasons. The highest increase in photosynthetic pigments was recorded at 2.5 mg/L followed by 5 and 10 mg/L, respectively at the second sampling dates during both seasons as well as the first sample at the first season. As regards the favourable effect of CME on the concentration of photosynthetic pigments may be due to the increase in Lamina thickness and leaf area observed in this work. In addition, the effect of morphactin may be interpreted also by a delay in senescence of the leaves and retarding breakdown of chlorophyll. This is in agreement with the opinion of Schneider (1970).

2. Anatomical studies:

1. The root structure:

Data in Table (3) show that kinetin decreased the diameter of root by decreasing thickness of cortex and the diameter of vascular cylinder which may be due to decreasing the size of the individual cells as previously mentioned by Sakr and El-Kady (1981) on bean. On the other hand, diameter of xylem vessels was increased due to that kinetin induces cell enlargement (Devlin and Witham, 1983).

Cycocel at all concentrations increased the diameter of root by increasing thickness of cortex tissues, diameter of vascular cylinder and xylem vessels inside the vascular. The secondary roots were increased by all levels of cycocel. Similar results were obtained by Mahmoud (1987).

The ethrel at all concentrations increased both thickness of cortex tissues, diameter of root xylem vessels and secondary roots. The work of Boovarah (1974) shows that ethrel induced radial enlargement of been cells. The diameter of vascular cylinder was not affected with ethrel at 100 and 200 mg/L, but 400 mg/L ethrel very slightly decreased the diameter of vascular cylinder which may be due to that the effect of ethrel on vascular tissue and pith was normal as control.

Table (3): Effect of some growth regulators on the root structure of sweet pepper (*Capsicum annum* L. var. California wonder) in 1993 season.

Growth regulators (mg/L)		Diameter of root (u)	Thickness of cortex tissues (u)	Diameter of	
				Vascular cylinder (u)	Xylem vessels (u)
Control		1348	392	564	24
Kinetin	25	997	287	423	30
	50	1004	283	438	28
	100	1005	266	473	30
CCC	500	1534	444	464	46
	1000	1675	466	743	42
	2000	1738	493	752	52
Ethrel	100	1460	450	560	30
	200	1464	452	560	29
	400	1526	496	534	25
CME	2.5	1069	293	483	35
	5	1039	278	483	29
	10	997	276	445	28

All concentrations of morphactin decreased diameter of root, thickness of cortex tissue and diameter of vascular cylinder. For another point of view, morphactin increased diameter of xylem vessels and organized secondary root. From these results, it could be concluded that induction of cell divisions was stimulated. So the number of primordia may increase but the organization of primordia seems to be often histologically disturbed and thus the extension growth of the root may not take place normally or retarded (Schneider *et al*., 1969).

The stem structure:

Data in Table (4) show that kinetin decreased diameter of stem, thickness of cortex layer, vascular cylinder, xylem vessels and thickness of xylem tissues. However, the number of vascular bundles was

increased. These results confirm those of Sakr and El-Kady (1981) on *Vicia faba* L.

Table (4): Effect of some growth regulators on the stem structure of sweet pepper (*Capdsicum annuum* L. var. California wonder) in 1993.

Growth regulators (mg/L)		Diameter of stem (u)	Diameter of epidermal cell (u)	Thickness of cortex layer (u)			Vascular cylinder			
				Collenchyma tissues	Parenchyma tissue	Total	Diameter of vascular cylinder (u)	No. of vascular bundles	Xylem tissue	
									Thickness (u)	Diameter vessel (u)
Control		2088	16	150	134	284	1488	5	440	28
Kinetin	25	2046	17	182	98	280	1452	9	420	22
	50	197	17	163	105	268	1400	8	420	22
	100	2008	17	162	104	266	1442	9	403	21
CCC	500	2252	24	222	110	332	1540	10	513	42
	1000	2458	20	222	118	340	1738	11	550	40
	2000	3160	30	230	119	349	2402	11	564	42
Ethrel	100	2460	24	202	142	344	1724	11	502	38
	200	2030	24	194	88	282	1700	9	482	36
	400	2020	24	183	103	286	1400	9	480	34
CME	2.5	3248	32	240	130	370	2444	10	624	36
	5	2852	32	240	132	372	2044	8	602	36
	10	3160	30	240	131	371	2358	9	602	32

Diameter of stem was increased with increasing concentration of cycocel. This effect may be due to increasing the diameter of epidermal cells and thickness of cortex layer. Diameter of vascular cylinder, diameter/vessel and thickness of xylem tissues as well as number of vascular bundles in vascular cylinder were also increased. Similar results were obtained by Fouad *et al*. (1979), Mahmoud (1987) on pepper and tomato.

Ethrel increased the diameter of stem, diameter of eidermal cells and thickness of cortex layer. Diameter of vascular cylinder, diameter/vessel, thickness of xylem tissues and number of vascular bundles were increased. The highest increase was obtained with 100 mg/L. These results confirm those of Pooviah and Leopod (1974) on bean who reported that ethrel treatment caused extensive radial enlargement of cells rather than cell division in vascular region.

CME increased diameter of stem by increasing diameter of epidermal cells and thickness of cortex layer. Also diameter of vascular cylinder, thickness of xylem tissue and diameter/vessels were increased. The lowest concentration of CME gave the highest number of vascular bundles. Similar results were obtained by El-Masry *et al*. (1994) on *Orobanche crenata* and El-Nady (1994) on eggplant who concluded that morphactin increased diameter of stem.

The leaf structure:

Data in Table (5) show that kinetin caused thickening of the leaf blade with large diameter of epidermal cells and thickness of the mesophyll tissue as well as elongation of palisade cells and size of spongy tissue. These effects tended to increase as kinetin concentration increased due to that kinetin promoted enlargement and elongation of cells (Devlina and Witham, 1983).

Cycocel treatments caused large mesophyll cells by increasing size of palisade cells and spongy tissue. Diameter of epidermal cells tended to wide as cycocel concentrations increased. Similar results were recorded by Bandarenko and Ledovshii (1976), El-Kassas (1992) and El-Nady (1994) on pepper, cucumber and eggplant, respectively who reported that cycocel caused thickening of leaves.

Table (5): Effect of some growth regulators on the leaf structure of sweet pepper (*Capsicum annuum* L. var. California wonder) in 1993 season.

Growth regulators (mg/L)		Diameter of epidermal cell (u)	Thickness of mesophyll tissue (u)		Vascular bundles		
			Palisade	Spongy	No. of vascular/midrib	Thickness of xylem	Diameter/ vessel (u)
Control		15	40	78	10.5	132	10
Kinetin	25	24	70	86	13.5	133	14
	50	24	74	90	13.0	132	14
	100	24	73	96	14.5	133	15
CCC	500	20	52	92	13.0	136	14
	1000	24	60	92	13.5	139	16
	2000	24	62	100	13.0	142	20
Ethrel	100	24	60	84	12.2	142	18
	200	24	56	82	12.6	133	18
	400	24	50	82	12.6	132	10
CME	2.5	20	46	112	9.5	109	16
	5	18	45	100	9.0	92	16
	10	18	45	108	9.5	94	12

Ethrel caused thickening of the leaf blade by increasing diameter of epidermal cell. Thickness of mesophyll tissue tended to increase as a result of elongation of palisade cells and size of spongy tissue.

CME treatments caused larger mesophyll cells as larger size of spongy tissue is due to induced enlargement and increased number of cells by cell division and decreased air spaces, but thickness of palisade cells and diameter of epidermals cell were slightly increased under CME treatment similar results were obtained by Mahmoud (1987) on tomato who reported that CEL produced abnormal tomato leaflets and large cells of mesophyll.

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