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EFFECT OF IRRIGATION INTERVALS, FERTILIZATION LEVELS AND THEIR INTERACTION ON TARO (*Colocasia esculenta* L.) I- VEGETATIVE GROWTH AND ITS CHEMICAL COMPOSITION

BY

Abo-Sedera*, F.A.; Amer, S.S.A.; Badr, L.A.A.* and El-Zohery, S.S.M.****
* Faculty of Agric., Moshtohor Zagazig Univ. Tukh Kalubia, ARE.
** Vegetable Res. Dept, Hort. Res. Inst. Agric. Res. CenteR, Egypt.

ABSTRACT

Two field experiments were conducted at the Experimental Farm of Faculty of Agriculture, Moshtohor, Zagazig University during the two successive summer seasons of 1997 and 1998 to study the effect of irrigation intervals, fertilization levels and their interactions on vegetative growth characters and its chemicals composition. The irrigation intervals, were (½, 1, 1 ½ and 2) weeks and fertilization treatments were zero (NPK), (30N + 16P_2O_5 + 48 K_2O), (60N + 32 P_2O_5 + 72 K_2O), (90N + 48 P_2O_5 + 96 K_2O) and (120N + 64 P_2O_5 + 120 K_2O) Kg/Fed. Obtained results show that, irrigation interval (½week) or fertilization level (120N + 64 P_2O_5 + 120 K_2O) Kg/Fed each alone or their combination had the best effect on all studied vegetative growth characters, i.e. plant height, number of leaves, leaf area, fresh weight of lamina, petiole and total plant as well as dry matter of plant. Also, photosynthetic pigments i.e chlorophyll (a, b and total) besides the total carotenoides In this respect, the content of NPK in different plant parts as well as, total hydrolizable carbohydrates were increased in case of using irrigation interval one week combine with fertilizer level (90N +48 P_2O_5 + 96 K_2O) Kg/Fed.

INTRODUCTION

Taro (*Colocasia esculenta* L.) plants require large amount of water and demands excess amounts of fertilizers because it stays a long period in the soil from planting to harvesting. Thus, irrigation is one of the important factors which affect greatly the vegetative growth of plant. In addition, irrigation water available in Egypt is the main limiting factor for extension of agriculture. Also, fertilization is very important for growth as well as chemical composition of taro plant parts. In this regard, many investigators mentioned the favourable effect of irrigation on vegetable plants growth. Among them, El-Beheidi *et al.* (1976) they working on carrot, reported that extending the irrigation intervals from 7 up to 21 day by intervals had dwarfing effect on growth. Moreover, Abou-Hadid (1978) on taro plants, found that plant height was increased with increasing the soil water content. Similar results were obtained by Carrilo-Urutia (1979) on plant height of taro plant. As for the number of leaves, El-Mansi *et al.* (1975), Hartman *et al*

(1986) all working on carrot, and Ravi and chowdhury (1991) on taro, they found that leaves numbers were increased at the highest level of water Regarding, the leaf area, Abou-Hadid (1978) and Ravi and chowdhury (1991) they reported that leaf area increased with increasing soil water content. Also, fresh weight/plant was highest by decreasing the irrigation intervals (Abd-El-Rahman, 1990 on carrot, Steyn *et al.*, 1992 and Foti *et al.*, 1995 on potato).

Concerning the effect of irrigation on dry matter content, Carrilo-Urrutia (1979) on taro, and El-Mansi *et al.* (1975) on carrot, they found that corms dry weight and dry matter of both plant foliage and roots were increased with the highest level of water supply. Regarding the photosynthetic pigments Abd El-Rahman (1990) on carrot found that increasing quantity of supplied water up to the highest used level reflected a depressing effect on all photosynthetic pigments (a, b and total) chlorophyll besides the carotenoides. However, NPK content was increased with increasing water supply up to the highest used level (Abd El-Rahman, 1990 on carrot). As for, carbohydrates content, of plant organs it was highest with increasing the soil moisture tension at all growth stages (Biswas *et al.*, 1997 on sweet potato)

Concerning, the effect of NPK fertilizers on growth characters of taro plants, Hossain and Rashid (1982) and Bhuyan and Quasem (1983) all working on taro, mentioned that increasing nitrogen fertilizer from 0 up to 80 kg/ha gave the highest plant height. Similar results were obtained by Verma *et al* (1996). In addition Abd El-Hamed (1993) found that plant height was increased with increasing potassium application. Also, leaves numbers of taro plants were increased with increasing N levels (Jacobs and Clarke 1993). Similar results were obtained by Verma *et al* (1996) In addition, Bioumy (1991) found that NPK fertilizer gave the maximum number of leaves of cassava plants. With regard to the effect of NPK on leaf area Galeev and Simonov (1987) on potato found that NPK fertilizers increased leaf area. Also, Midan *et al* (1987) on sweet potato Abd El-Hamed (1993) on taro they found that fresh weight/plant significantly increased with potassium application

Concerning the dry matter, Mandal *et al* (1982), Barroso *et al* (1986) and Jacops and Clarke (1993) working on taro, they obtained that using N fertilizer due to increase the dry matter of taro plant and tabers. However, Abd-El-Hamed (1993) on taro found that dry weight of leaf blades increased with K application,. With regard to photosynthetic pigments in plant foliage, Afifi *et al* (1989) on cow pea, and Abd El-Rahman (1990) on carrot, they reported that photosynthetic pigments were increased with increasing the level of N,P and K fertilizers. As for, NPK content Mohankumar and sandanadan (1990), they found that NPK uptake by taro plants increased with increasing fertilizers rates Also, total hydrolizable carbohydrates content, was increased with increasing NPK fertilization rates (Abd-El-Rahman,1990) on carrot plant foliage

Therefore, this trial was conducted to study the effect of irrigation intervals, NPK fertilizers level and their interaction on growth characters and chemicals composition of taro plant parts

MATERIALS AND METHODS

This investingation was carried out at the Experimental Farm of Faculty of Agriculture, Moshtohor, Zagazig University during the two successive summer seasons of 1997 and 1998 to study the effect of water regime, levels of NPK fertilization and their interaction on the growth characters and its chemicals composition of taro plant parts. The soil texture is clay loam with PH 7.7.

The experimental design was split plot design with four replicats. It included 20 treatments which were the combination of four irrigation treatments within five fertilization levels. The irrigation treatments were arranged in the main plots while the fertilization levels were distributed randomly in the sup plots. Each experimental plot included four ridges 3.5 m in length and 80 cm in width with an area about 11.2 m^2, where three ridges were planted and the fourth one was left without planting as a guard ridge between plots to prevent fertilizers and water movements from any plot to other one. Cormels (seed pieces) were planted in Feb. 11^{th} and 12^{th} in 1997 and 1998 respectively. Cormels were cultivated in the bottom of the ridge at the distance of 30 cm in between and 7-10 cm deep in the soil. All the plot were equally irrigated. After two months from planting, the water regime began for the different irrigation treatments as indicated in Table (1). Soil samples were randomly taken regularly before each irrigation time from 20 plots for every irrigation treatment to determinate the soil moisture at irrigation as % of field capacity. Surface irrigation was used through weir to regulate the rate of water flow and to calculate the quantity of water applied for each plot by using the following equation mentioned by Khurmi (1990).

$$Q = \frac{Ca_1 a_2}{\sqrt{a_1^2 - a_2^2}} + \sqrt{2gh}$$

where:

Q = Quantity of water flowing through the venturiflume
C = Coefficient of discharge = 0.7
a_1 = area of flow in channel = $b_1 h_1$
a_2 = area of flow in throat = $b_2 h_2$
b_1 = width of channal
b_2 = width of throat
h_1 = depth of water in throat
h_2 = different of depths of water
$h = h_1 - h_2$
g = acceleration equal to 9-8/m/Sec.

The mechanical and chemical analysis of soil were determined according to the method described by Jackson (1965) (Table 2).

Data in Table (3) illustrated average monthly temperature, relative humidity (%) and quantity of rainfall at Kalubia Governorate in the region surrounding the experimental site through the two seasons of study

Experimental treatments:

(I) Irrigation intervals treatments:

(1) half week
(2) one week
(3) one and half week
(4) two weeks

(II) Fertilization levels treatments:

(1) Zero N + Zero $P_2 o_5$ + Zero K_2o referred as level (1)
(2) 30 N + 16 $P_2 o_5$ + 48 K_2o (Kg/Fed) referred as level (2)
(3) 60 N + 32 $P_2 o_5$ + 72 K_2o (Kg/Fed) referred as level (3)
(4) 90 N + 48 $P_2 o_5$ + 96 K_2o (Kg/Fed) referred as level (4)
(5) 120 N + 64 $P_2 o_5$ + 120 K_2o (Kg/Fed) referred as level (5)

Ammonium sulphate (20.5 % N), calcium super phosphate (16% $P_2 O_5$) and potassium sulphate (48 – 52% K_2o) fertilizers were used as sources of N,P and K respectively. The first portion was added two months after planting, while the second and third portions of fertilizers were added three and four months after planting respectively. All agricultural practices were carried out as commonly followed in the district.

Data recorded:

(I) Vegetative growth characters:

At 260 days after planting, five plants were taken from each experimental plot and the following characters were measured.

(1) plant height.
(2) Number of leaves/plant.
(3) Leaf area (cm^2).
(4) Fresh weight of whole plant (g).
(5) Fresh weight of lamina (g).
(6) Fresh weight of petiole (g).
(7) Fresh weight of corms (g).
(8) Dry weight (%) of lamina.
(9) Dry weight (%) of petiole.
(10) Dry weight (%) of corms.
(11) Dry weight (%) of whole plant.
(12) dry matter content of whole plant (g).

(II) Chemical composition of various plant parts.:

(1) Photosynthetic pigments:

They were determined as chlorophyll (a, b and total) as well as carotenoids in plant leaves, colorimatricolly as described in the A.O.A.C (1970).

(2) Mineral elements.

Total nitrogen, phosphorus and potassium content was determined according to the methods described by Pregl (1945), John (1970) and Brown and Lilleland (1946), respectively.

(3)Total hydrolizable carbohydrates:

It was assyed in plant faliage using method described by Dubois *et al.* (1936).

All data were subjected to statistical analysis according to Gomez and Gomez (1983).

Table (1): Water regime for the different irrigation treatments during seasons of 1997 and 1998.

Treatments	Irrigation interval (weeks)	Number of Irrigations/ season	Quantity of water (m^3/fed.)		Mean
			1997	1998	
1	½	64	16908.09	17455.04	17181.56
2	1	28	9838.51	11159.79	10499.15
3	1 ½	19	8783.84	8562.82	8673.33
4	2	13	6926.53	7289.96	7108.24

Table (2): Mechanical and chemical analysis of soil.

Mechanical analysis (%):									
Coarse sand		Fine sand		Silt	Clay	Organic matter		Texture	F.C.
7.43		15.77		34.88	40.42	1.50		Clay loam	43.54
Chemical analysis as meq/100gm. Soil:									
Co3	Hco3	Cl	So4	Ca	Mg	Na	Available		
							N	P	K
0.00	1.99	1.42	0.67	1.28	0.70	1.70	82.51	20	0.31

F.C. = field capacity

RESULTS AND DISCUSSION

A. Morphological characters:

1- Effect of irrigation intervals:

Data in Tables (4, 5) revealed that increasing water supply, i.e irrigation every ½ week by intervals throughout the growing seasons increased all the studied vegetative growth parameters of taro plants expressed as plant height, number of leaves/plant, leaf area, Lamina and petiole fresh weight and fresh weight of corms, as well as, fresh weight of whole plant during both seasons of study. In this respect, the highest increment in the aforementioned growth parameters was obtained as a result of highest used quantity of water supply (16908 and 17455 m^3) in both seasons respectively.

Table (3): Average monthly temperature, relative humidity (%), and quantity of rainfall at Kalubia Governorate in the region surrounding the experimental site through the two seasons of the experimental work.

Seasons	1997					1998				
	Temperature (C°)			Relative humidity %	Quantity of rainfall (m m)	Temperature (C°)			Relative humidity %	Quantity of rainfall (m m)
Month	Min.	Max.	Mean			Min.	Max.	Mean		
February	5.10	18.00	11.00	62.86	0.00	8.3	20.20	14.25	64.23	0.00
March	7.20	19.70	13.43	62.00	0.00	7.96	21.40	14.68	58.91	0.40
April	10.00	23.20	16.56	61.00	0.00	13.40	29.70	21.50	57.00	0.00
May	15.00	31.40	23.26	54.50	0.00	17.40	32.46	24.93	55.33	0.27
June	20.00	33.70	26.79	59.00	0.00	19.53	34.53	27.03	57.66	0.00
July	20.12	33.61	26.86	62.00	0.00	20.73	35.36	28.04	58.66	0.00
August	18.90	32.40	25.60	65.00	0.00	20.58	35.56	28.06	57.62	0.00
September	18.10	31.40	25.60	62.00	0.00	20.43	35.76	28.09	56.58	0.00
October	16.90	29.70	24.06	62.00	0.00	18.46	32.03	25.24	57.16	0.00

Table (4): Effect of irrigation intervals , NPK fertilization levels and their interaction on vegetative growth characters of taro plants during season of 1997.

1997 Season												
Treatments		Plant height (cm)	No. of leaves/ Plant	L.A. /plant (cm^2)	Fresh weight (g)			Dry matter %				D.M. Content/plant (g)
Irrigation interval (weeks)	NPK Fertilizer levels				Lamina	Petiole	Total plant	Lamina	Petiole	Corm	Whole plant	
½		112.82	9.49	5572.48	227.74	650.32	1449.06	13.23	5.12	15.24	11.19	124.51
1		83.05	4.17	3636.81	134.70	169.85	587.82	13.82	6.95	15.73	12.16	70.30
1 ½		59.94	3.55	893.26	33.83	16.05	121.53	14.83	7.18	15.87	12.62	15.47
2		46.36	1.96	242.71	8.68	10.50	68.40	17.97	7.56	17.10	14.21	9.06
L.S.D. at 0.05 level		1.22	0.32	272.87	9.31	4.83	9.26	0.51	0.24	0.09	0.14	1.30
	1	68.71	2.98	1904.72	74.20	175.08	1397.83	12.32	5.21	14.35	10.62	32.97
	2	74.24	4.42	2328.99	88.64	204.24	530.38	14.10	6.82	14.84	11.91	50.67
	3	77.18	5.32	2801.58	109.60	223.67	602.05	15.30	7.18	16.48	12.98	61.25
	4	78.17	5.46	2904.76	115.83	226.27	615.32	16.68	7.40	17.22	13.76	64.28
	5	79.41	5.78	2991.53	117.92	229.13	637.94	16.41	6.89	17.04	13.44	65.0
L.S.D. at 0.05 level		1.0	0.28	299.75	7.90	3.67	11.69	0.52	0.24	1.15	0.19	1.33
½	1	100.35	7.06	4272.57	157.25	548.25	1038.25	11.65	4.45	13.92	10.00	75.52
	2	113.68	9.02	5209.64	203.05	620.12	1376.39	12.63	5.31	14.46	10.80	116.73
	3	115.05	10.20	5996.07	253.33	690.75	1589.22	13.62	5.53	16.20	11.53	142.45
	4	116.89	10.31	6124.45	261.44	696.00	1609.01	14.43	5.56	16.40	12.13	145.79
	5	118.12	10.87	6259.69	263.62	696.50	1632.19	13.81	4.27	15.98	11.51	142.05
1	1	79.10	2.04	2546.17	109.25	134.50	425.13	11.89	5.11	14.33	10.44	41.86
	2	82.62	4.31	3239.18	118.31	174.50	580.22	13.46	7.11	14.61	11.72	66.00
	3	83.93	4.52	3974.08	140.00	175.05	613.46	13.73	7.56	16.31	12.53	75.75
	4	84.20	4.81	4151.51	150.76	177.25	629.22	14.68	7.67	16.77	13.04	80.70
	5	85.41	5.18	4273.12	155.20	188.00	691.09	15.33	7.31	16.77	13.10	87.20
1 ½	1	51.92	1.84	654.60	24.75	11.50	84.00	12.33	5.22	14.5	10.63	9.47
	2	54.75	2.63	710.43	27.08	14.87	103.97	13.81	7.38	14.64	11.94	12.17
	3	62.63	4.33	967.31	35.01	16.09	131.44	14.80	7.75	16.51	13.01	16.78
	4	64.30	4.37	1025.31	40.41	18.27	142.40	17.00	8.05	16.80	13.95	19.37
	5	66.10	4.58	1108.65	41.90	19.53	145.88	16.25	7.50	16.91	13.55	19.54
2	1	43.50	1.00	145.53	5.55	6.07	43.67	13.43	6.08	14.67	11.39	5.04
	2	45.91	1.72	156.70	6.12	7.50	60.97	16.51	7.48	15.65	13.21	7.79
	3	47.12	2.25	268.88	10.06	12.87	74.11	19.06	7.90	17.68	14.88	10.02
	4	47.27	2.37	317.78	10.73	13.56	80.67	20.62	8.33	18.90	15.95	11.27
	5	48.00	2.50	324.67	10.95	12.50	82.61	20.25	8.00	18.62	15.62	11.21
L.S.D. at 0.05 level		2.00	0.56	599.50	15.81	7.35	23.39	N.S	0.48	0.31	0.39	4.63

L.A. = leaf area D.M. dry matter

Table (5): Effect of irrigation intervals , NPK fertilization levels and their interaction on vegetative growth characters of taro plants during season of 1998.

1998 Season												
Treatments		Plant height (cm)	No. of leaves/ plant	L.A. /plant (cm^2)	Fresh weight (g)			Dry matter %				D.M. Content/ plant (g)
Irrigation interval (weeks)	NPK Fertilizer levels				Lamina	Petiole	Total plant	Lamina	Petiole	Corm	Whole plant	
½		159.09	7.78	8922.48	197.37	1137.37	1962.98	18.19	6.05	16.33	13.52	175.28
1		111.18	6.55	4810.64	110.78	489.15	905.39	18.80	7.29	17.71	14.58	105.45
1 ½		60.28	5.07	1233.10	26.45	85.09	190.13	19.80	7.63	17.91	15.11	22.79
2		53.55	3.53	504.09	11.47	33.73	98.86	20.07	7.71	18.17	15.11	12.48
L.S.D. at 0.05 level		3.14	0.38	215.34	4.42	21.92	25.01	0.58	0.48	2.02	0.74	5.40
	1	85.80	3.36	3161.82	71.82	384.26	631.17	15.07	6.23	16.24	12.51	52.66
	2	92.80	4.45	3646.20	82.16	411.81	752.65	17.66	6.66	17.48	13.92	70.80
	3	97.38	5.58	3862.18	87.11	449.91	813.18	18.79	7.60	17.90	14.74	82.91
	4	100.76	7.20	4228.54	93.20	457.04	843.62	22.13	7.81	18.18	15.78	90.93
	5	103.37	7.57	4439.18	98.30	478.65	906.08	22.42	7.55	17.86	15.94	97.72
L.S.D. at 0.05 level		3.73	0.50	231.54	4.99	19.44	31.15	0.69	0.40	0.53	0.60	5.54
	1	144.52	5.00	7886.32	171.20	1036.62	1616.95	13.46	5.05	15.0	11.17	121.31
	2	156.10	5.68	8215.50	189.30	1117.46	1915.66	16.7	5.32	15.84	12.61	155.51
½	3	161.12	7.25	8926.97	194.16	1170.00	2017.52	17.81	6.57	16.75	13.71	183.20
	4	165.40	10.41	9399.50	208.14	1180.37	2061.85	21.54	6.75	16.93	15.07	198.14
	5	168.30	10.59	10184.25	224.15	1182.42	2202.92	21.46	6.55	17.16	15.05	218.25
	1	101.82	4.91	3426.20	84.80	426.35	716.71	14.17	6.13	16.47	12.25	67.49
	2	104.62	5.19	4741.7	103.33	430.47	844.67	17.75	6.86	17.68	14.09	97.27
1	3	112.50	6.45	4843.4	116.64	497.45	926.34	18.62	7.86	18.0	14.76	110.96
	4	117.47	8.08	5516.2	122.50	504.5	968.95	21.8	7.89	18.31	15.99	112.35
	5	119.50	8.14	5525.7	126.63	586.97	1070.31	21.65	7.72	18.12	15.82	129.17
	1	51.95	3.50	946.45	22.28	44.44	115.79	16.23	6.86	16.57	13.22	13.36
	2	58.65	4.12	1121.87	25.15	69.32	160.65	18.0	7.06	17.92	14.32	18.67
1 ½	3	60.60	5.40	1148.35	25.88	97.63	209.32	19.24	7.94	18.28	15.15	24.65
	4	63.40	5.93	1453.0	29.41	106.49	231.74	22.5	8.29	18.60	16.46	28.58
	5	66.80	6.42	1495.88	29.52	107.58	233.17	23.05	8.00	18.16	16.40	28.71
	1	44.90	2.06	388.42	9.0	29.65	75.25	16.43	6.88	16.91	13.40	8.47
	2	51.85	2.81	505.75	10.87	30.0	89.65	18.21	7.4	18.48	14.69	11.75
2	3	55.30	3.25	530.0	11.75	34.57	99.54	19.48	8.03	18.57	15.36	12.81
	4	56.80	4.37	545.41	12.75	36.81	111.96	22.68	8.33	18.90	15.61	14.65
	5	58.90	5.15	550.87	13.0	37.61	117.93	23.54	7.92	18.02	16.49	14.74
L.S.D. at 0.05 level		N.S	1.01	463.09	9.99	38.88	62.31	N.S	N.S	N.S	N.S	11.09

L.A. = leaf area D.M. dry matter

Regarding the effect of irrigation on dry matter content, the same data showed that dry matter content of plant was increased with increasing soil moisture content, i.e irrigation at short intervals (½ week) during the growing period. On the other hand, the dry matter % of different plant parts (leaf and corms) was significantly decrease with increasing the amount of water applied or decreasing the irrigation intervals up to ½ week in both seasons of study. Obtained results are in agreement with those obtained by Abou-Hadid (1978), Carrilo-Urrutia (1979) and Ravi and Chowdhury (1991) on taro plant who reported that increasing soil water content increased plant height, number of leaves and total leaves area/plant. In addition, Khalak and Kumaraswamy (1992), Shoch *et al* (1992), Steyn *et al* (1992), Kumar and Minhas (1993) and Foti *et al* (1995) on potato and El-Mansi *et al* (1975), El-Beheidi *et al* (1976) and Hartman *et al* (1986) and Abd El-Rahman (1990) on carrot added that fresh and dry weight of different plant parts were increased as a results of increasing soil moistare content. Such improving effect of irrigation on vegetative growth my be due to the main role of water in increasing the cell size of plant, accelerating the physiological process of plant and also increasing the available nutrients in root zone which led to increasing the uptake of macronutrients by plant Tables (7,8).

A.2- Effect of fertilization levels:

Data in Tables (4, 5) show clearly that all the studied growth parameters i.e plant height, number of leaves/plant, leaf area and fresh weight of lamina and petiole as well as fresh weight of whole plant were significantly increased with increasing fertilizers level up to the highest used level i.e, (120 Kg N + 64 Kg P_2O_5 + 120 Kg K_2O/fed). Similar results trend was obtained in case of dry matter content for different plant parts i.e lamia petiole and corms. In this respect, the forth used levels of fertilization (90 Kg N + 48 Kg P_2O_5 + 96 Kg K_2O/fed) resulted in the highest dry matter percentage during both seasons of study, Moreover, increasing the fertilizers levels than this rate tended to be of decreasing effect in this respect.

Obtained results are true during both seasons of study, such results are in harmony with those reported by Makram (1958), Hossain and Rashid (1982) Mandal *et al.* (1982), Pardales *et al.* (1982), Bhuyan and Guasem (1983), Barroso *et al.* (1986), Mohankamar and Sadanadan (1989), Ruiz *et al* (1989), Abd El-Hamed (1993), Jacobs and Clark (1993) and Verma *et al* (1996) all working on taro plant.

Obtained results are attributed to the role of such macro elements in increasing the cell division and cell size and consequently increased plant growth. Also, the main role of such nutrients in increasing the photosynthetic pigments Table (6) which increased the photosynthetic assimilation which is necessary for cell formation and division and consequently plant growth.

A.3-Effect of interaction between irrigation intervals and fertilization levels:

Data in Tables (4, 5) indicated that all the studied growth aspects were significantly affected as a result of increasing both the amounts of water and N, P and K fertilizers applied during both seasons of study. In this respect, the

maximum increments in all the studied growth parameters were obtained in case of irrigation every ½ week by intervals combined with the highest used levels of NPK fertilizers (120 Kg N + 64 Kg P_2O_5 + 120 Kg K_2O/Fed).

Obtained results are in agreement with those of Abd El-Rahman (1990) on carrot, who reported that the highest irrigation treatment (2280 m^3/Fed) combined with (40 Kg N + 32 Kg P_2O_5 + 100 Kg K_2O/Fed) resulted in the highest plant growth rate.

B. Chemical composition:

B.1- Photosynthetic pigments:

B.1.1- Effect of irrigation intervals:

It is obvious from data in Table (6) that increasing the irrigation intervals from ½ up to 2 weeks led to a significant decrease in chlorophyll a, b and total chlorophyll as well as the carotenoids content of plant leaves. These results are true during both seasons of study. In this respect, the maximum values of assayed photosynthetic pigments were connected with the highest used amounts of water i.e irrigation every ½ week by intervals. Abd El-Rahman (1990) on carrot found that increasing quantity of supplied water up to the highest used level reflected a depressing effect on all photosynthetic pigments besides the carotenoids.

Obtained results may be attributed to the increase of macronutrients uptake which are considered the major constituents of photosynthetic pigments.

B.1.2- Effect of fertilization levels:

Data in Table (6) indicated that increasing the fertilization level up to the highest used one (120 Kg N + 64 Kg P_2O_5 + 120 Kg K_2O /Fed) increased gradually chlorophyll a, b and total chlorophyll as well as carotenoids content of plant leaves during both seasons of growth.

Obtained results are in agreement with those found by Afif *et al* (1989) on cow pea and Abd El-Rahman (1990) on carrot. Such results were expected due the main role of such macronutrients in constitution of photosynthetic ingredients.

B.1.3- Effect of interaction between irrigation intervals and fertilization levels:

Data in Table (6) reveal that the maximum values of all measured photosynthetic pigments, i.e chlorophyll a, b and total as well as carotenoids were obtained as a results of the combination between irrigation every ½ week by intervals and application of the highest used levels of fertilization (120 N + 64 P_2O_5 + 120 K_2O) Kg/Fed . In this regard, such increament did not reach the levels of significancy in case of carotenoids substances during the second season only.

B.2- Plant nutritional status:

B.2.1- Effect of irrigation intervals:

Data illustrated in Table (7, 8) show that increasing the amounts of water supplied to the plants either through increasing the number of irrigations or shortening the irrigation intervals i.e from 2 to ½ week during the growing season led to a significant increase in the uptake of nitrogen, phosphoras and potassium

Table (6): Effect of irrigation interval ,NPK fertilization levels and their interaction on photosynthetic pigments of taro plants (mg/100g fresh weight) during seasons of 1997 and 1998.

Treatments		1997 Season				1998 Season			
		Chlorophyll			Carotenoids	Chlorophyll			Carotenoids
Irrigation interval (weeks)	NPK Fertilizer levels	a	b	Total (a + b)		a	b	Total (a + b)	
½		208.90	118.40	227.30	200.15	227.40	129.15	356.55	197.55
1		146.85	83.90	230.75	168.25	161.75	86.90	248.65	175.95
1 ½		98.75	65.95	164.70	112.35	107.40	70.85	178.25	154.40
2		56.65	47.50	104.15	104.95	70.45	57.20	127.65	144.10
L.S.D. at 0.05 level		4.39	2.31	4.59	4.47	7.44	2.66	7.20	4.72
	1	92.43	51.87	144.31	111.62	102.68	62.75	165.12	137.87
	2	111.93	65.12	177.06	131.50	126.12	73.93	200.06	161.81
	3	132.87	79.87	212.75	153.06	148.56	89.81	238.37	167.62
	4	147.50	97.81	245.31	165.25	163.81	100.87	264.68	183.50
	5	154.18	100.0	254.18	170.68	167.56	103.06	270.62	189.18
L.S.D. at 0.05 level		6.14	2.85	6.49	3.52	6.40	3.14	7.61	5.07
½	1	155	88	244	152.25	168	96	264	162
	2	178	102	281	179.25	194	110	304	192
	3	225	129	354	206.25	246	140	387	199
	4	240	134	374	229.00	261	147	409	211
	5	246	137	383	234.00	266	150	416	223
1	1	118	54	172	137.25	129	71	200	148
	2	138	77	216	167.50	153	80	233	173
	3	139	83	222	173.75	155	85	240	178
	4	164	101	266	181.00	183	97	280	188
	5	174	103	277	182.00	187	101	288	193
1 ½	1	58	34	92	80.25	63	42	105	130
	2	81	42	123	90.25	88	53	142	142
	3	108	63	171	120.25	119	74	193	147
	4	119	94	213	130.00	132	91	223	175
	5	127	97	224	141.00	133	93	226	177
2	1	38	30	68	77	49	39	89	110
	2	50	38	89	89	68	52	120	141
	3	58	44	102	112	73	59	132	146
	4	66	61	127	121	78	67	145	160
	5	70	63	133	126	83	68	151	164
L.S.D. at 0.05 level		12.29	5.71	12.98	7.05	12.80	6.28	15.22	N.S

Table (7): Effect of irrigation interval , NPK fertilization levels and their interaction on N, P and K content of taro plants

Treatments		1997 Season Minerals uptake/plant parts (mg)											
		N				P				K			
Irrigation interval (weeks)	NPK Fertilizer levels	Lamina	Petiole	Corm	Total	Lamina	Petiole	Corm	Total	Lamina	Petiole	Corm	Total
½		1070	1006	2159	4264	126	122	249	496	1129	968	1413	3528
1		678	428	1319	2453	69	47	145	262	693	465	892	2050
1 ½		222	47	354	623	21	5	45	70	193	47	274	516
2		63	157.39	223	310	6	3	29	38	56	26	238	321
L.S.D. at 0.05 level		**70.06**	**157.39**	**127.25**	**233.22**	**9.20**	**7.15**	**13.95**	**3650**	**74.08**	**48.66**	**95.66**	**140.05**
	1	236	208	528	972	27	21	67	115	268	176	385	855
	2	358	342	868	1615	43	42	104	190	410	349	576	1335
	3	557	427	1069	2077	57	50	123	229	510	413	727	1690
	4	683	449	1237	2367	71	52	141	265	673	466	857	1997
	5	709	455	1368	2534	78	56	149	283	689	480	976	2142
L.S.D. at 0.05 level		**53.13**	**61.47**	**153.57**	**180.75**	**4.51**	**4.86**	**11.35**	**44.24**	**55.88**	**54.29**	**10.81**	**138.20**
	1	468	623	1120	2211	57	60	149	266	550	511	801	1963
	2	726	282	1933	3592	92	116	230	439	901	858	1238	3000
½	3	1167	1140	2320	4718	133	139	270	542	1242	1023	1510	3776
	4	1480	1183	2650	5314	165	143	292	601	1448	1206	1718	4373
	5	1509	1203	2773	5486	180	150	304	634	1500	1240	1798	4530
	1	371	188	725	1284	41	22	85	148	405	163	518	1087
	2	545	427	1089	2199	64	47	126	238	564	474	699	1739
1	3	747	496	1317	2561	68	53	140	260	698	549	844	2092
	4	854	514	1555	2923	85	56	178	318	896	561	1021	2478
	5	873	515	1911	3300	89	59	195	343	903	576	1373	2850
	1	85	14	166	265	9	2	22	32	96	18	129	244
	2	131	42	259	433	14	4	34	51	137	42	185	365
1 ½	3	244	48	402	694	20	5	51	75	191	51	306	549
	4	302	63	463	829	29	6	58	91	263	61	367	697
	5	349	66	480	896	32	8	59	98	275	65	382	722
	1	18	7	100	126	2	1	13	16	21	10	92	125
	2	29	16	192	237	3	2	25	30	34	20	179	234
2	3	71	24	239	334	6	3	32	41	66	28	246	341
	4	94	34	276	402	8	4	37	49	79	34	323	436
	5	105	37	309	452	12	5	40	57	81	37	349	466
L.S.D. at 0.05 level		**106.26**	**122.95**	**307.14**	**361.51**	**9.02**	**9.72**	**22.71**	**88.49**	**111.77**	**108.58**	**221.63**	**276.41**

Table (8): Effect of irrigation interval , NPK fertilization levels and their interaction on N, P and K content of taro plants.

Treatments		1998 Season Minerals uptake/plant parts (mg)											
		N				P				K			
Irrigation interval (weeks)	NPK Fertilizer levels	Lamina	Petiole	Corm	Total	Lamina	Petiole	Corm	Total	Lamina	Petiole	Corm	Total
½		1180	1504	1676	4361	164	301	279	744	1180	3010	2538	6729
1		776	965	1647	3389	111	154	275	542	787	1751	2397	4943
1 ½		162	214	892	1269	28	34	112	175	172	350	1201	1724
2		45	77	358	481	10	11	61	83	70	140	871	1082
L.S.D. at 0.05 level		51.04	118.91	228.61	294.72	17.87	14.50	27.20	22.07	91.14	152.24	199.04	342.67
	1	239	392	496	1128	41	71	100	213	268	862	641	1771
	2	413	516	814	1744	66	95	145	305	436	1046	1521	3003
	3	516	674	1048	2240	77	127	176	281	554	1277	1831	3673
	4	750	868	1434	3054	101	161	223	486	734	1620	2226	4580
	5	786	1000	1924	3710	108	172	264	545	769	1761	2540	5071
L.S.D. at 0.05 level		63.67	135.32	317.69	378	10.81	25.89	30.70	12.21	68.91	173.22	212.13	295.23
	1	563	919	771	2253	80	184	173	439	547	2068	1041	3657
	2	925	1186	1113	3225	143	223	229	595	869	2418	2197	5484
½	3	1100	1465	1393	3962	158	303	262	723	1180	2873	2661	6715
	4	1620	1903	2063	5587	207	391	331	930	1590	3741	3098	8430
	5	1690	2048	3041	6779	231	405	397	1033	1713	3950	3695	9359
	1	303	548	628	1540	63	85	145	293	382	1140	830	2353
	2	582	686	1198	2466	87	112	212	410	680	1408	2145	4233
1	3	775	907	1562	3245	112	161	272	546	813	1683	2478	5015
	4	1081	1161	2098	4342	146	196	347	689	1027	2093	3111	6231
	5	1139	1525	2688	5353	149	220	402	772	1032	2431	3421	6884
	1	72	64	401	538	15	11	63	90	103	142	418	663
	2	108	133	754	996	24	36	102	162	136	246	1210	1564
1 ½	3	136	241	926	1304	25	34	114	173	154	403	1317	1875
	4	244	306	1051	1603	38	44	125	208	231	476	1435	2143
	5	251	324	1330	1906	39	47	155	241	238	490	1623	2352
	1	20	36	125	182	5	6	18	30	41	97	273	412
	2	38	60	192	290	7	9	37	53	59	115	533	707
2	3	51	83	313	447	11	12	54	81	70	147	869	1086
	4	56	103	523	683	13	14	90	117	89	170	1258	1516
	5	62	104	636	802	15	16	103	135	93	173	1420	1689
L.S.D. at 0.05 level		127.35	270.65	635.39	756.48	21.63	51.78	61.41	24.42	137.83	346.44	424.26	590.47

by plant. The highest content of such assayed macroelements in different plant parts (lamina, petiole and corms) were obtained by irrigation every ½ week by intervals in two growing seasons. These results were reported by Khalak and Kumaraswamy (1992 and 1996) and Pis (1994) on potato and El-Mansi *et al* (1975), Abd Rahman 1990 on carrot. These results may be attributed the the role of water in decreasing the viscosity of soil solution and increasing the movement of such macroelements in the soil which leads to the increase in the uptake of such nutrients by plants.

B.2.2- Effect of fertilization intervals:

Data in Tables (7, 8) showed that fertilization levels had significant effect on content of NPK in different parts of plant. It noticed that the maximum increments of all aforementioned macroelements were connected with the highest used levels of NPK i.e (120 N + 64 P_2O_5 + 120 K_2O) Kg/Fed during both seasons of study. These results coincided with Ruiz *et al* (1989), Mohankumar and Sadanadan (1990), Jocobs and Clarke (1993) and Verma *et al* (1996) all working on taro plant. The concentration of such macroelements was increased in the soil especially in the root zone as a result of NPK fertilization and consequently led to increasing the macroelements absorbed or uptake by the plants.

B.2.3- Effect of interaction between irrigation interval and fertilization levels:

Data represented in Tables (7,8) clear that increasing the amount of water supplied to the plant either through shortening the irrigation intervals (½ week) or increasing the irrigation frequencies throughout the growing season and increasing the fertilization level up to the highest used one (120 N + 64 P_2O_5 and 120 Kg K_2 /Fed) resulted in the highest NPK content in different parts of plant. In this respect, Abd El-Rahman (1990) had Similar results on corrot.

B.3- Total hydrolizable carbohydrates:

B.3.1- Effect of irrigation intervals:

Data in Table (9) showed that the total carbohydrates percentage of different plant parts were increased with decreasing the irrigation intervals from 2 to 1 week. In addition, decreasing the irrigation intervals less than one week tended to decrease the total carbohydrates content of different plant parts. Obtained results are connected with the dry matter content of different plant parts. Such results are in conformity with those reported by Vaquez *et al.* (1978) on taro, El-Mansi *et al.* (1975), El-Beheidi *et al* (1976) and Abd El-Rahman (1990) on carrot.

B.3.2- Effect of fertilization levels:

Data in Table (9) showed that total carbohydrates of both plant foliage and corms were significantly increased with increasing fertilizers rate during both seasons of study. In this respect, application of (120 Kg N + 64 Kg P_2O_5 +120 Kg K_2 /Fed) reflected the maximum increments in carbohydrates content of plant foliage and corms. Obtained results are in agreement with those of Mandal *et al* (1982) and Abd El-Hamed (1993) on taro, as well as Abd El-Rahman on carrot. Such results may be due to the role of macroelements in increasing photosynthetic molecules content and consequently the photosynthetic assimilation of carbohydrates.

Table (9): Effect of irrigation interval , NPK fertilization levels and their interaction on carbohydrates percentage in different plant parts of taro.

Treatments		1997 Season Carbohydrates %				1998 Season Carbohydrates %			
Irrigation interval (weeks)	NPK Fertilizer levels	Lamina	Petiole	Corm	Total	Lamina	Petiole	Corm	Total
½		17.63	21.76	40.21	26.54	29.28	33.68	41.60	34.85
1		19.56	26.63	48.00	31.43	31.64	34.96	49.92	38.84
1 ½		24.63	23.54	41.39	29.67	32.65	29.34	41.72	34.57
2		21.41	21.77	35.14	26.11	29.78	26.07	36.44	30.76
L.S.D. at 0.05 level		1.38	1.53	1.35	0.77	1.48	2.10	5.57	0.97
	1	16.83	18.46	23.25	19.42	22.16	24.80	31.00	25.99
	2	19.45	21.87	36.98	26.10	28.88	28.90	39.99	32.60
	3	21.68	24.22	45.54	30.29	32.36	31.19	43.50	35.68
	4	22.69	25.72	48.87	32.44	34.92	34.34	46.86	38.79
	5	23.41	26.86	51.54	33.93	35.86	35.82	50.77	39.90
L.S.D. at 0.05 level		1.76	1.73	3.18	3.25	1.28	2.29	1.88	1.36
	1	14.08	17.16	24.20	18.47	20.64	26.13	33.95	26.90
	2	15.25	18.24	35.52	23.0	25.98	30.46	35.50	30.64
½	3	16.96	23.12	45.48	28.57	30.13	33.38	42.44	35.31
	4	20.80	24.16	46.68	30.54	34.13	38.40	47.37	39.97
	5	21.10	26.14	49.21	32.15	35.55	40.06	48.78	41.46
	1	16.88	20.32	26.27	21.15	23.71	27.27	38.09	29.69
	2	17.84	26.03	43.58	29.23	29.95	32.10	48.97	37.01
1	3	20.80	27.94	52.64	33.82	33.06	35.32	49.79	39.39
	4	20.90	28.60	56.32	35.33	35.41	39.56	53.37	42.78
	5	21.42	30.28	61.21	37.63	36.10	40.55	59.42	45.35
	1	18.98	18.90	21.95	19.94	24.32	25.55	26.85	25.57
	2	23.14	22.82	38.63	28.12	30.56	28.26	40.70	33.17
1 ½	3	26.40	23.88	47.34	31.78	35.87	29.07	44.07	36.33
	4	26.42	25.44	48.97	33.73	36.04	31.06	45.0	37.70
	5	28.24	26.38	50.06	34.89	36.47	32.80	52.01	40.42
	1	17.38	17.46	19.58	18.14	20.0	20.28	25.12	21.80
	2	21.60	20.42	30.19	24.07	29.06	24.81	34.82	29.57
2	3	22.56	21.97	36.72	27.08	30.4	27.0	37.71	31.70
	4	22.67	24.40	43.53	30.19	34.12	28.36	41.70	34.72
	5	22.88	24.64	45.70	31.07	35.35	29.90	42.87	36.04
L.S.D. at 0.05 level		N.S	3.46	N.S	N.S	2.56	N.S	N.S	N.S

B.3.3- Effect of interaction between irrigation intervals and fertilization levels:

Data in Table (9) revealed that decreasing the irrigation intervals from 2 to 1 week and increasing the applied levels of N,P and K fertilizers up to the fifth used one (120 Kg N + 64 Kg P_2O_5 + 120 Kg K_2O /Fed) reflected the highest carbohydrates content of different plant parts except for lamina which showed highest value. On the other hand, irrigation every ½ week without addition fertilizers resulted in the lowest values of total carbohydrates during both seasons of study. However, the different combination had no any significant effect. It may be due to the two studied factors of this work did not affect in the same way.

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دراسة تأثير فترات الري ومستويات التسميد وكذلك التفاعل بينهما على نمو نبات القلقاس
١ - التأثير على النمو الخضري ومكوناته الكيميائية.

فتحي أبو النصر أبوسديره، عامر سليمان سليمان عامر،
لطفي عبد الفتاح عبد الرحمن بدر، سمير شديد محمد الزهيرى
* قسم البساتين ــ كلية الزراعة بمشتهر ــ جامعة الزقازيق/فرع بنها.
** قسم بحوث الخضر ــ معهد بحوث البساتين ــ مركز البحوث الزراعية ــ مصر.

اجريت هذه الدراسة بمزرعة كلية الزراعة بمشتهر - جامعة الزقازيق خلال موسمي الزراعة الصيفيين ١٩٩٧ ، ١٩٩٨ لدراسة تأثير الري بكمياته وفتراته المختلفة والتسميد بمستويات مختلفة من كل من الأسمدة النتروجينية والفوسفاتية والبوتاسية وكذلك التفاعل بينهما على النمو الخضري والتركيب الكيمائي لنباتات القلقاس وتشير النتائج بصفة عامة الـــى:

- ادت زيادة كمية مياه الري بتقليل فترات الري (مرتين في الأسبوع) وكذلك التسميد بمعدل ١٢٠ كيلو جرام نتروجين + ٦٤ كيلو جرام فو٢ ا٥ + ١٢٠ كيلو جرام بو٢ أ/فدان سواء كل على حده او التأثير المشترك بينهما الى زيادة كل صفات النمو الخضري التي تم دراستها وهى طول النبات - عدد الأوراق - مساحة الورقة - الوزن الطازج للنصل والعنق والوزن الكلى للنبات بالإضافة الى زيادة محتوى النبات من المادة الجافة وايضا زيادة محتوى اوراق النبات من الكلوروفيل أ ، ب والكلى وايضا الكاروتينات كما زاد من امتصاص العناصر الكبرى (نيتروجين - فوسفور - البوتاسيوم) في أجزاء النبات المختلفة ومن ناحية اخرى زاد محتوى أجزاء النبات المختلفة من الكربوهيدرات الكلية عند استخدام الري مره كل اسبوع مع (٩٠ نتروجين + ٤٨ كيلو جرام + ٩٦ كيلو جرام بو٢ أ) / فدان