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GROWTH, CHEMICAL COMPOSITION, SEED YIELD AND SEED QUALITY OF SUMMER SQUASH PLANTS AS AFFECTED BY SOME MACRO- AND MICRONUTRIENTS INTERACTIONS

I- EFFECT OF COPPER AND MOLYBDENUM FOLIAR SPRAY UNDER DIFFERENT LEVELS OF NITROGEN FERTILIZER

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ABSTRACT: *Two field experiments were carried out during the summer seasons of 2001 and 2002, as an attempt to investigate the effects of some macro- and microelements interactions on growth, chemical composition and yield of summer squash (Cucurbita pepo, L. Iskandrani) plants. The experiments studied the effects of 250 ppm copper and/or 100 ppm molybdenum as foliar spray under different nitrogen levels (0, 30, 60 and 90 kg/fed.) as soil application and their interactions. The obtained results revealed that, increasing N level up to 90 kg/fed. significantly increased growth characters of squash plants represented by stem length, number of leaves, leaf area and leaf dry matter content (%). The highest significant growth characters mean values were observed by using the highest N rate (90 kg/fed.). Applying copper and/or molybdenum significantly increased growth characters. The interaction between 250 ppm Cu and 100 ppm Mo led to the highest significant increment in growth characters, compared with each element alone. Application of different N levels accompanied with Cu and/or Mo positively affected growth parameters. In this respect, the combination of 90 kg/fed. N with 250 ppm Cu and 100 ppm Mo gave the maximum mean values of growth characters. A significant increase in the concentration of photosynthetic pigments (chl. a, chl. b, chl. a+b and carotenoids), total soluble sugars, total carbohydrates, total protein and minerals (N, P, K, Cu and Mo) was observed in response to increasing N level. The highest level of N (90 kg/fed.) caused the highest significant increase in photosynthetic pigments, total soluble sugars, total carbohydrates, total protein, N, P, K and Mo concentrations, but significantly decreased copper concentration compared with the control. Spraying squash plants with Cu and/or Mo markedly enhanced chemical parameters. In this regard, Mo was more effective in increasing most of these characters compared with Cu. The interactive effects of 250 ppm Cu and 100 ppm Mo led to the highest significant increases in all studied chemical components. Applying N fertilizer at different levels accompanied with Cu and/or Mo significantly increased all chemical compounds under study. The treatment, which included 90 kg/fed. N plus 250 ppm Cu and 100 ppm Mo gave the* *greatest significant increment in photosynthetic pigments, total soluble sugars, total carbohydrates, total protein, N, P and K concentrations, but decreased Cu and Mo concentrations. The combination of 60 kg/fed. N with 250 ppm Cu and 100 ppm Mo caused the highest significant mean values of Cu and Mo concentrations. Raising N rate significantly increased matured fruits yield and its characteristics and markedly enhanced seed yield and its quality. Spraying squash plants with 250 ppm Cu and/or 100 ppm Mo significantly increased matured fruits yield, seed yield and their quality. The combination between the two micronutrients (Cu and Mo) gave the highest significant increase in squash yield. The interaction effects of N at different levels plus Cu and/or Mo positively affected matured fruits yield and seed yield, especially under higher N rates.*

The highest N level 90 kg/fed. accompanied with 250 ppm Cu and 100 ppm Mo seemed generally, to be the most favorable and optimal treatment for most of growth characters, chemical components, yield and its attributes.

Key words: *Cucurbita pepo, L. Iskandrani, nitrogen, Leaf area, Total carbohydrates, Potassium concentration, Copper, Chlorophyll, Seed yield.*

INTRODUCTION

Summer squash (*Cucurbita pepo*, L.) being an important fresh marketable vegetable crop grown in Egypt, requires much attention as regards its seed production. Whereas, the production of seeds for growers and seed trade have become a very specialized industry.

It is well known that mineral nutrients have specific and essential functions in plant metabolism, furthermore, fertilizers are important factors for the growth and development of vegetable crops. Csizinszky *et al.* (1987) mentioned that increased fertilizer levels resulted in corresponding increases in squash growth, chemical parameters, yield and its components.

It could be say that nitrogen is the single element which most frequently limits plant growth in natural system (Pearcy *et al.*, 1989). Nitrogen is an essential macroelement that plays an important role in vegetative growth characters. The main function of nitrogen that serves as constituents of proteins and nucleic acids (Marschner, 1986). Furthermore, it is well known as a major constituent of amino acids, chlorophyll and phytohormones (Saeed, 2002). Increasing the nitrogen supply provided a dilution effect on all micronutrients uptake.

In this respect, several workers revealed that application of nitrogen led to significant increase in growth, chemical composition and yield in squash plants (Eid, 1980; Buwalda, 1987; Hueit and Dettmann, 1991 and Abd El-Fattah and Sorial, 2000).

Micronutrients play an important role in plant physiology and metabolism processes. They are needed in relatively very small amounts for adequate plant growth and development. In this respect, Valk *et al.* (1989) revealed that increasing organic matter (nitrogen) fertilizers in the soil without adding micronutrients had adverse effects on plant contents of Cu and B.

Copper has been established as an essential microelement for plant growth and is now recognized as a component of the phenolase enzymes, lactase and ascorbic acid oxidase enzymes (Brown and Clark, 1977). Moreover, most of the function of copper as a plant nutrient are based on the participation of enzymatically bound copper in redox reaction, since the rate of photosynthesis, can also be related to the role of copper in chloroplasts, in addition, its effect on the formation and chemical composition of cell wall (Marschner, 1986). Furthermore, El-Aref and Hamada (1998) showed that Cu stress reduced the expression of some enzymatic bands of alcohol dehydrogenase and esterase, moreover, the content of soluble carbohydrates is considerably lower than normal during the vegetative growth.

Nitrogen application accentuates copper deficiency, and when the nitrogen supply is large, the application of copper fertilizer is required for maximum yield. In addition, N has specific effects on copper availability and mobility (Marschner, 1986). Furthermore, many studies on the status of nutrients in the Egyptian soils and their availability to growing plants have revealed that there is a remarkable deficiency in some of these micronutrients, such as Cu, Zn, B and Mo (Balba, 1979).

The positive effects of copper on growth, chemical parameters and yield of squash plants were observed by Mutwali (1980) and Abed *et al.* (1984).

The requirement of plants for molybdenum is lower than that for any of the other micronutrients. The requirement of higher plants depends on the form of nitrogen supply. The functions of Mo as a plant nutrient are related to the valency changes it undergoes as a metal component of enzymes, such as xanthine oxidase/dehydrogenase, aldehyde oxidase, sulfite oxidase, nitrate reductase and nitrogenase (Marschner, 1986). Molybdenum appears to have similar catalytic functions in all of these enzymes, and even the protein components of the enzymes are similar (Nicholas *et al.*, 1962).

The role of molybdenum as a micronutrient in the growth characters, chemical parameters and yield of squash plants was reported by many researchers such as Sorokina (1970) and Sidhu *et al.* (1984).

This investigation aimed to evaluate the effect of foliar spray with micronutrients (Cu and/or Mo) under different levels of macronutrients fertilization (N) and their interactions on growth characters, chemical components, matured fruits yield and seed yield of squash plants.

MATERIAL AND METHODS

This study was carried out at the Experimental Farm, Faculty of Agriculture, Alexandria University during the two successive summer seasons of 2001 and 2002. Two field experiments were performed to investigate the effects of some macro- and microelements interactions on the growth characters, chemical composition and yield (matured fruits yield and seed yield) of summer squash plants. The experiments evaluated the effects of the soil application with different levels of nitrogen (N) fertilizer and foliar spray with copper (Cu) and/or molybdenum (Mo).

The soil of the experimental sites was silty clay loam in texture with pH 8.14 and 8.38 and EC of 3.11 and 3.28 m mohs/cm and contained 0.164 and 0.179% N, 0.054 and 0.063% P as well as 0.069 and 0.075% K, in first and second seasons, respectively.

Seeds of summer squash, Iskandrani cultivar, were obtained from Vegetable Crops Department, Faculty of Agriculture, Alexandria University. Seeds were sown on August 4, 2001 and August 2, 2002, for the two experiments, respectively. Spacing between plants within rows was 40 cm. Five dry seeds were placed in each hill, in the dry soil, and irrigation was followed. Thinning of the growing seedlings was practiced, 15 days after sowing, to leave only two seedlings per hill.

The experiments included 16 treatments, which were all possible combinations of four nitrogen levels (0, 30, 60 and 90 Kg/fed.), as soil application treatment and four micronutrient treatments, as foliar spraying. The four micronutrient treatments were:

1- Control (without micronutrients spray)
2- Cu spray at 250 ppm
3- Mo spray at 100 ppm
4- Cu at 250 ppm plus Mo at 100 ppm (together)

The experimental layout used was split-plot in randomized complete blocks design with four replications. Nitrogen fertilizer levels were arranged in the main plots, whereas, the four micronutrient treatments were assigned at random in sub-plots. Each sub-plot contained three rows, 4.5 m in length and 1.2 m apart. The sub-plot area was 16.2 m^2.

Nitrogen fertilizer, in form of ammonium nitrate (33.5% N), was applied directly as soil application treatment in three equal portions at 21, 35 and 49 days after planting. The experimental unit were fertilized with equal amounts of calcium superphosphate (15.5% P_2O_5) at rate of 200 kg/feddan, applied as soil application in two equal portions: the first before planting and the other 42 days after planting, and potassium sulphate (48% K_2O) at rate of 50 kg/fed. in two equal split applications, applied 3 and 6 weeks after planting.

Copper sulphate ($CuSo_4$. $5H_2O$ = 25% Cu) and amonium molybdate ($HMoO_4^-$ = 50% Mo), were used as a source of copper and molybdenum, respectively, and the respective treatments were sprayed by Cu and/or Mo solution two occasions, 36 and 50 days after planting. Few drops of triton-B were added to the spraying solution as wetting agent.

Irrigation, pest control and other cultural practices were carried out whenever they were needed and as commonly recommended in the commercial summer squash growing.

Data Recorded:

1- Vegetative Growth Characters:-

During the growing period, randomized samples of five plants were obtained from each experimental unit, after eight weeks from planting and the following data were recorded: stem length (cm), number of leaves, leaf area $(cm)^2$/plant and leaf dry matter content % (at 70°C for 72 hrs.).

2- Chemical Analysis:-

At the same sample (after eight weeks from sowing), four plants were randomly taken from each experimental unit, to measure the following chemical characters:

a- Photosynthetic pigments estimated following the method of Wettestein (1957), then calculated as mg/g dry weight.

b- Total soluble sugars and total carbohydrates concentrations of dry leaves determined colorimetrically using the phenol sulfuric acid method of Dubois *et al.* (1956).

c- Total nitrogen concentration in dry leaves measured using semimicro-kjeldahl method according to Ling (1963).

d- Phosphorus and potassium determined in dried leaves as described by Chapman and Pratt (1961).

e- Copper and molybdenum concentrations estimated using the atomic absorption spectrophotometer according to Allen (1973).

f- Total protein concentration calculated by multiplication total nitrogen by 6.25.

3- Total Yield

a- Matured Fruits Yield and its Characteristics:-

Matured fruits of summer squash were harvested at the end of seasons from each experimental unit and the following characteristics of fruits were recorded:

- Number of fruits per plant.
- Average fruit length (cm).
- Average fruit diameter (cm).
- Average fruit weight (g).

b- Seed Yield and its Quality:-

Seed yield was estimated as total weight (in grams) of the extracted seeds from the matured fruits, produced by each experimental unit and the following characteristics of seed yield were measured:-

- Seed yield per plant (in grams).

- Seed yield per feddan (in tons).
- Seed index (weight of 100 seeds in gram).
- Dry matter content (%) of seeds.
- Seed germination percentage.

The collected data were statistically analyzed, using Costat Softwere Program (1985). Treatments means were compared based on the revised L. S. D. test at 0.05 level, according to the procedure outlined by Al-Rawi and Khalaf-Allah (1980).

RESULTS AND DISCUSSION

1-Vegetative Growth Characters

Data presented in Table (1) show that increasing the level of nitrogen fertilizer markedly increased all studied vegetative growth characters of squash plants as expressed by stem length, number of leaves, leaf area and leaf dry matter content (%), in both seasons. These results are in agreement with those obtained by Eid (1980) who reported that increasing N level up to 90 kg/fed. consistently increased the growth of squash plants in terms of stem diameter as well as fresh and dry weights/plant. Furthermore, Hueit and Dettmann (1991) stated that total dry matter of zucchini squash plants was very responsive to N application.

The results in the same Table reveal that the significant increases in leaf number and leaf area were corresponding to the increase in N levels, meanwhile, the application of N up to 60 kg/fed. significantly increased stem length and leaf dry matter content (%) compared with the control plants, in both seasons. Furthermore, there were no significant differences between the effects of N at 60 and 90 kg/fed. on stem length and leaf dry matter content (%). In this connection Saeed (2002) found that fertilizing squash plants with N increased significantly the vegetative growth characters, however, the highest two N levels (80 and 120 kg/fed.) did not significantly differ in their effects on most of the studied growth character of squash plants.

Data in Table (1) demonstrate that the application of N fertilizer at the highest concentration (90 kg/fed.) had the highest increase in all studied growth parameters, comparing with untreated plants and other N levels. This increase reached to 60.28%, 56.52%, 130.80% and 19.09% for stem length, number of leaves, leaf area and leaf dry matter content (%), respectively, compared with their controls. The increase in plant growth may be attributed to the beneficial effect of N on stimulating the meristmatic activity of cells for producing more tissues (Marschner, 1986). Similar results were obtained by Buwalda (1987) who stated that N application positively affected the relative growth rate of squash plants. Ahmed (1994) indicated that the highest values of fresh and dry weights/plant, plant height and number of leaves/plant of squash plants were obtained by applying N fertilizer at 80 kg/fed. In addition, Table (1): Vegetative growth characters of squash plants as affected by copper and molybdenum under different levels of nitrogen and their interactions, in 2001 and 2002 seasons.

Treatments		Stem length (cm)		No. of leaves per plant		Leaf area (cm^2)		Leaf dry matter content (%)	
kg N /fed.	Micro-elements (ppm)	2001	2002	2001	2002	2001	2002	2001	2002
0		14.93 C	16.16 C	11.27 D	11.39 D	2045 C	2137 C	11.21 B	11.18 B
30		18.10 B	18.73 B	13.99 C	13.88 C	2600 C	2681 C	11.50 B	11.57 B
60		22.80 A	23.38 A	15.87 B	15.87 B	3961 B	4061 B	13.14 A	13.03 A
90		23.93 A	24.52 A	17.64 A	17.49 A	4720 A	4832 A	13.35 A	13.32 A
	Control	18.33 C	18.91 C	13.51 C	13.41 D	2826 C	2905 C	10.90 D	10.87 D
	Cu (250)	19.50 B	20.10 B	14.46 B	14.41 C	3246 B	3330 B	12.15 C	12.09 C
	Mo (100)	20.03 B	20.89 B	14.74 B	14.75 B	3329 B	3446 B	12.57 B	12.54 B
	Cu+Mo	21.89 A	22.88 A	16.06 A	16.07 A	3924 A	4059 A	13.58 A	13.61 A
0	Control	14.70 i	15.53 i	10.24 h	10.34 k	1888 h	1925 i	10.33 f	10.25 e
	Cu	14.83 hi	15.87 i	11.52 gh	10.64 ij	1966 h	2062 hi	10.93 ef	10.88 e
	Mo	14.97 hi	16.40 hi	11.56 gh	11.61 ij	1976 h	2069 hi	11.10 def	11.11 e
	Cu+Mo	15.20 hi	16.83 hi	11.75 gh	11.95 hij	2349 gh	2491 ghi	12.46 cd	12.48 cd
30	Control	16.83 ghi	17.20 ghi	13.14 efg	12.94 ghi	2373 gh	2474 ghi	10.44 ef	10.61 e
	Cu	17.43 fghi	17.93 fghi	13.67 ef	13.57 fgh	2546 fgh	2607 ghi	11.18 def	11.17 de
	Mo	18.57 efgh	19.30 efgh	14.01 def	13.97 efg	2552 fgh	2629 ghi	11.37 de	11.45 de
	Cu+Mo	19.57 defg	20.50 defg	15.15 def	15.05 def	2930 efg	3013 fgh	13.03 bc	13.05 bc
60	Control	20.67 cdef	21.17 def	15.13 def	14.98 ef	3370 def	3443 efg	11.55 de	11.43 de
	Cu	22.60 bcd	23.03 bcd	15.59 cde	15.47 cde	3772 de	3904 cdef	13.18 bc	13.02 bc
	Mo	22.47 bcd	23.10 bcd	15.64 cd	15.74 cde	3924 cd	4023 bcde	13.64 abc	13.52 abc
	Cu+Mo	25.47 ab	26.20 ab	17.11 bc	17.29 bc	4777 abc	4875 bc	14.17 ab	14.14 ab
90	Control	21.13 cde	21.73 cde	15.54 cde	15.39 def	3674 de	3778 def	11.27 de	11.19 de
	Cu	23.13 bcd	23.57 bcd	17.04 bc	16.94 bcd	4701 bc	4748 bcd	13.31 bc	13.29 bc
	Mo	24.10 abc	24.77 abc	17.73 b	17.69 b	4864 ab	4942 ab	14.16 ab	14.06 ab
	Cu+Mo	27.33 a	28.00 a	20.93 a	19.96 a	5639 a	5858 a	14.66 a	14.75 a

Values marked with same alphabetical letter(s), within a comparable group of means, do not significantly differ using revised L.S.D. test at 0.05 level.

Abd El-Fattah and Sorial (2000) reported that increasing N level up to 90 kg/fed. significantly increased vegetative growth characters in squash plants. The necessity of nitrogen for squash growth has been demonstrated by Conde (1987), since nitrogen supply was desirable for vegetative growth and dry matter accumulation in squash plants (Doikova *et al.*, 1997).

Concerning the effect of micronutrient treatments on growth characters of squash plants, data in Table (1) show clearly that spraying squash plants with 250 ppm copper or 100 ppm molybdenum significantly increased all studied growth characters compared with untreated plants. There were no significant differences between the effect of Cu or Mo each alone on stem length, number of leaves (first season) and leaf area. Results in the same Table reveal that spraying squash plants with 250 ppm Cu and 100 ppm Mo together caused the highest significant increases in the studied parameters over that obtained from the application of each microelement alone. This increase was about 19.42%, 18.87%, 38.85% and 24.59% for stem length, number of leaves, leaf area and leaf dry matter content (%), respectively, compared with untreated plants. The second season showed the same trend. The obtained results are in accordance with those found by Mutwali (1980) who reported that dry matter content of squash plants was increased by the application of Cu. Abed *et al.* (1984) stated that the maximum increase in cucumber plant growth was obtained by applying 500 ppm Cu. The positive effect of Mo spraying on growth characters was observed by Sorokina (1970) on cucumber plants and Singh *et al.* (1992) on peas.

Data illustrated in Table (1) show the interaction effects between N, Cu and/or Mo on squash growth characters. Under all N levels foliar spraying with Cu at 250 ppm or Mo at 100 ppm increased all studied growth characters compared with the control. Treating squash plants with N, Cu and Mo together positively affected growth parameters, in this connection, soil application with N at 90 kg/fed. accompanied with foliar spraying with Cu at 250 ppm and Mo at 100 ppm, seemed to be the most favorable treatment and gave the highest significant increment in growth characters. This highest increase was 85.91%, 104.39%, 198.68% and 41.92% for stem length, number of leaves, leaf area and leaf dry matter content (%), respectively, compared with untreated plants. The second season followed the same trend. In this regard, Marschner (1986) reported that nitrogen application accentuates copper deficiency and when the nitrogen supply is large, the application of copper fertilizer is required for maximum growth, since nitrogen has specific effect on copper availability and mobility.

2- Chemical Analysis

a- Photosynthetic Pigments

Results presented in Table (2) indicate that chl. a, chl. b, chl. a+b and carotenoids were significantly increased by applying N as soil fertilizer in

Table (2): Photosynthetic pigments, total soluble sugars, total carbohydrates and protein concentrations of squash plants as affected by copper and molybdenum treatments under different levels of nitrogen and their interactions, in 2001 and 2002 seasons.

Treatments: kg N /fed.	Treatments: Micro-elements (ppm)	Chlorophyll a (mg/g dry weight)		Chlorophyll b (mg/g dry weight)		Chlorophyll a+b (mg/g dry weight)		Carotenoids (mg/g dry weight)		Total soluble sugars (mg/g dry weight)		Total carbohydrates (mg/g dry weight)		Protein concentration (mg/g dry weight)	
		2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
0		2.95 C	3.15 C	0.75 C	0.81 C	3.69 C	3.96 C	0.86 C	0.95 C	12.89 D	12.10 D	109.78 D	106.76 D	97.55 D	105.20 D
30		3.52 B	3.80 B	1.26 B	1.50 B	4.78 B	5.30 B	1.32 B	1.61 B	21.81 C	20.59 C	131.94 C	130.70 C	185.28 C	189.40 C
60		4.88 A	5.14 A	1.71 A	1.90 A	6.59 A	7.04 A	1.86 A	2.31 A	27.29 B	26.17 B	144.51 B	141.59 B	222.30 B	227.66 B
90		5.13 A	5.28 A	1.84 A	2.05 A	6.97 A	7.32 A	1.98 A	2.23 A	31.55 A	30.35 A	163.21 A	161.26 A	252.33 A	258.80 A
	Control	3.50 D	3.76 D	1.07 C	1.30 C	4.57 D	5.07 D	1.21 B	1.47 C	18.72 C	17.80 C	124.79 D	122.98 D	166.61 D	171.99 D
	Cu (250)	3.88 C	4.07 C	1.31 B	1.46 BC	5.19 C	5.53 C	1.42 B	1.63 BC	21.33 BC	20.42 BC	132.18 C	130.18 C	183.72 C	188.96 C
	Mo (100)	4.39 B	4.60 B	1.42 B	1.56 B	5.81 B	6.15 B	1.49 B	1.81 B	23.93 B	22.86 B	141.57 B	138.94 B	191.33 B	201.28 B
	Cu+Mo	4.69 A	4.93 A	1.75 A	1.94 A	6.45 A	6.86 A	1.90 A	2.19 A	29.56 A	28.14 A	150.90 A	148.22 A	215.80 A	218.83 A
0	Control	2.76 g	2.86 h	0.54 e	0.63 i	3.30 k	3.49 k	0.62 h	0.69 g	10.47 k	10.11 k	102.70 k	99.75 m	90.25 i	95.81 m
	Cu	2.78 g	2.96 gh	0.76 de	0.79 hi	3.54 ij	3.75 ij	0.82 gh	0.85 g	10.78 ij	10.34 k	105.21 ij	103.42 lm	93.81 i	101.31 lm
	Mo	2.92 g	3.13 g	0.81 de	0.85 hi	3.73 i	3.98 i	0.88 gh	0.87 g	12.66 hij	11.75 ij	112.42 hij	108.31 klm	95.25 i	108.94 kl
	Cu+Mo	3.33 f	3.64 f	0.87 de	0.96 h	4.20 h	4.60 h	1.12 fg	1.39 f	17.65 fgh	16.21 ghi	118.79 ghi	115.57 ijk	110.88 h	114.75 k
30	Control	2.96 g	3.43 f	0.94 d	1.28 g	3.90 hi	4.71 gh	1.17 efg	1.42 f	16.09 ghi	15.43 hij	121.35 gh	120.11 hij	154.56 g	155.88 i
	Cu	3.37 f	3.60 f	1.31 c	1.48 fg	4.68 g	5.08 g	1.30 def	1.57 ef	21.25 efg	20.12 fgh	127.49 fgh	126.25 ghi	180.50 f	184.63 h
	Mo	3.75 e	3.99 e	1.36 c	1.55 efg	5.11 f	5.54 f	1.33 def	1.67 def	22.97 def	21.49 efg	136.32 ef	135.79 efg	189.00 f	198.38 g
	Cu+Mo	3.98 de	4.16 d	1.44 c	1.70 cdef	5.42 ef	5.86 ef	1.46 cde	1.79 de	26.94 cde	25.32 def	142.58 def	140.63 ef	217.06 e	218.69 f
60	Control	4.09 d	4.38 d	1.37 c	1.59 def	5.46 ef	5.97 e	1.49 cde	1.94 cd	22.34 defg	21.52 efg	130.39 fg	128.95 fgh	194.88 f	204.31 g
	Cu	4.55 c	4.77 c	1.53 bc	1.74 cdef	6.08 d	6.51 d	1.77 bc	2.14 bc	24.94 de	23.71 def	139.67 ef	136.32 fg	222.56 e	224.63 ef
	Mo	5.18 b	5.44 b	1.65 bc	1.88 cd	6.83 c	7.32 c	1.85 b	2.37 b	237.81 cd	26.44 cde	148.50 cde	144.67 cde	226.69 de	233.25 de
	Cu+Mo	5.68 a	5.96 a	2.29 a	2.38 b	7.97 ab	8.34 a	2.34 a	2.77 a	34.06 ab	32.99 ab	159.49 bc	156.43 bc	245.06 bc	248.44 c
90	Control	4.19 d	4.38 d	1.44 c	1.71 cdef	5.63 e	6.09 e	1.57 bcd	1.83 cde	25.99 de	24.12 def	144.72 cde	143.12 de	226.75 de	231.94 e
	Cu	4.82 c	4.96 c	1.64 bc	1.83 cde	6.46 cd	6.79 d	1.77 bc	1.96 cd	28.33 bcd	27.49 bcd	156.33 bcd	154.73 bcd	238.00 cd	245.25 cd
	Mo	5.71 a	5.82 a	1.87 b	1.94 c	7.58 b	7.76 b	1.91 b	2.32 b	32.27 bc	31.75 bc	169.04 ab	166.97 b	254.38 b	264.56 b
	Cu+Mo	5.78 a	5.95 a	2.41 a	2.70 a	8.19 a	8.65 a	2.68 a	2.79 a	39.60 a	38.05 a	182.75 a	180.23 a	290.19 a	293.44 a

Values marked with same alphabetical letter(s), within a comparable group of means, do not significantly differ using revised L.S.D. test at 0.05 level.

different levels compared with untreated plants. The positive effect of nitrogen on photosynthetic pigments concentration was also observed by El-Gamal (1996) and El-Ghinbihi and Ali (2001) on potato and Barakat and Gabr (1998) on tomato who found that the application of N fertilizer significantly increased chlorophyll concentration.

Increasing N level increased photosynthetic pigments significantly, the highest increase was observed by using 90 kg/fed. N. This increment reached to 73.90%, 145.33%, 88.89% and 130.23% for chl. a, chl. b, chl. a+b and carotenoids, respectively, compared with their controls. Moreover, no significant differences were detected between the application of 60 and 90 kg/fed. N in photosynthetic pigments values. Results in the second season showed the same trend. Similar results were recorded by Selim and El-Ghinbihi (1999) who revealed that increasing N concentration caused a significant increase in the concentration of chl. a, chl. b, chl. a+b and carotenoids in sugar beet leaves. Moreover, Abd El-Fattah and Sorial (2000) observed that total chlorophyll and carotenoids contents of squash plants significantly increased with increasing N levels.

As shown from obtained data (Table 2) foliar spraying squash plants with 250 ppm copper or 100 ppm molybdenum significantly affected photosynthetic pigments compared with the control plants, in this regard, Mo was more effective in increasing chl. a, chl. b, chl. a+b and carotenoids concentrations compared with Cu. With respect to the interaction between copper and molybdenum, data in the same Table reveal that the usage of 250 ppm Cu accompanied with 100 ppm Mo gave the highest significant increment in photosynthetic pigments, in both seasons. This highest increase was 34%, 63.55%, 41.14% and 57.02% for chl. a, chl.b, chl. a+b and carotenoids, respectively, compared with untreated plants. In this connection, Mutwali (1980) found that leaf chlorophyll concentration of squash plants was increased by the application of copper. Moreover, Ibrahim *et al.* (1980) and Abd El-Fattah and Sorial (1998) reported that treating onion plants with Cu increased chlorophyll concentration. The rate of photosynthesis, can be related to the role of copper in chloroplasts formation (Marschner, 1986).

Concerning the interactions between nitrogen and copper or molybdenum on photosynthetic pigments, results in Table (2) demonstrate that increasing N levels accompanied with 250 ppm Cu or 100 ppm Mo markedly increased chl. a, chl b., chl. a+b and carotenoids compared with untreated plants. In this concern, the combinations between different N levels and Mo at 100 ppm had more pronounced effects on photosynthetic pigments compared with different N levels and Cu at 250 ppm. The combinations between N levels and both micronutrients led to highly significant increases in photosynthetic pigments mean values. The maximum mean values of chl. a, chl. b, chl. a+b and carotenoids were obtained by applying 90 kg/fed. N accompanied with 250 ppm Cu and 100 ppm Mo. These findings were true in both seasons.

These results are in accordance with those obtained by Abd El-Fattah and Sorial (1998) who mentioned that treating onion plants with 90 kg/fed. N plus 250 ppm Cu significantly increased chl. a+b and carotenoids. The role of molybdenum in chlorophyll formation under different nitrogen sources was discussed by Hewitt and Gundry (1970) who reported that when nitrogen is supplied in the absence of molybdenum, plants grow poorly and have a low chlorophyll content.

b-Total Soluble Sugars and Total Carbohydrates Concentrations

The results recorded in Table (2) show that, increasing N fertilizer rates up to 90 kg/fed. significantly increased total soluble sugars and total carbohydrates concentrations in squash leaves compared with the control plants. The application of N fertilizer at the highest level (90 kg/fed.) caused the highest significant increase in total soluble sugars (144.76%) and total carbohydrates (48.67%), compared with untreated plants. The second season followed the same trend. These results are in agreement with those recorded by Eid (1980); Khalil (1987) and Ahmed (1994) who mentioned that increasing N application rate significantly increased total carbohydrates concentration in leaves of squash plants. Abd El-Fattah and Sorial (2000) observed that increasing N levels significantly increased total soluble sugars and total carbohydrates in squash leaves. In addition, El-Ghinbihi and Ali (2001) reported that applying N fertilizer significantly increased total soluble sugars in potato leaves.

Analysis of variance indicate that, spraying squash plants with Cu at 250 ppm or Mo at 100ppm increased total soluble sugars and total carbohydrates concentrations compared with control plants, this increment was significant in total carbohydrates concentration, in both seasons. Similar results are reported by Ibrahim *et al.* (1980) as well as Abd El-Fattah and Sorial (1998) who revealed that Cu treatments increased reducing sugars and carbohydr-ates concentration in onion plants.

With respect to the combined effect of copper and molybdenum together on total soluble sugars and total carbohydrates concentrations, data in the same Table point out that this treatment significantly promoted these parameters and gave the highest significant increase in the mean values compared with untreated plants and plants sprayed with Cu or Mo each alone.

It was observed that the interactions between N in different levels and Cu at 250 ppm or Mo at 100 ppm markedly enhanced total soluble sugars and total carbohydrates concentrations compared with control plants. Increasing N rates accompanied with 250 ppm Cu or 100 ppm Mo significantly increased total soluble sugars and total carbohydrates concentrations, in both seasons. In this connection, the treatments of N plus Mo were more effective in increasing total soluble sugars and total carbohydrates than the treatments of N plus Cu.

Concerning the combined effect of nitrogen, copper and molybdenum together on total soluble sugars and total carbohydrates, data in Table (2) show that increasing N rates accompanied with Cu and Mo significantly increased these characters, however, the application of N at 90 kg/fed. plus 250 ppm Cu and 100 ppm Mo led to the greatest significant increment in total soluble sugars (278.22%) and total carbohydrates (77.95%) compared with untreated plants. These findings were true in both seasons. These results are in accordance with those obtained by Abd El-Fattah and Sorial (1998) who mentioned that the interaction between N and Cu significantly increased reducing sugars in onion bulbs.

c- Total Protein Concentration

Data presented in Table (2) indicate that applying N fertilizer at different levels significantly enhanced total protein concentration in squash leaves. The highest significant increase in total protein concentration (158.67% and 146.01%) was obtained by using 90 kg/fed. N in the first and second seasons, respectively, comparing with untreated plants. Similar results are demonstrated by Abu-Gerab (1987) who mentioned that the highest N rate (90 kg/fed.) increased protein concentration in onion plants. Furthermore, Abd El-Fattah and Sorial (2000) on squash reported that protein concentration significantly increased by increasing N levels.

Results in the same Table point out the effect of copper and/or molybdenum foliar spray on total protein concentration in squash leaves, it was observed that using 250 ppm Cu or 100 ppm Mo caused significant increment in total protein concentration, in both seasons compared with the control. The combined treatment, which included Cu at 250 ppm and Mo at 100 ppm gave the maximum significant increase in total protein mean value compared with untreated plants and plants treated with copper or molybdenum each alone. In this concern, El-Aref and Hamada (1998) stated that Cu treatments induced the synthesis of 8 new protein in 6 tomato genotypes. Abd El-Fattah and Sorial (1998) showed that increasing Cu levels significantly increased protein concentration in onion bulbs. In addition, Agarwala *et al.* (1978) observed the role of molybdenum in protein synthesis.

Concerning the combined effect of macronutrient (N fertilizer) and micronutrient (Cu and/or Mo spray) treatments on total protein concentration, it was found from Table (2) that, the application of different N levels and 250 ppm Cu or 100 ppm Mo positively correlated with the concentration of total protein in squash leaves compared with the control, in both seasons. The combination treatments between nitrogen, copper and molybdenum led to significant increases in total protein concentration. In this regard, the application of 90 kg/fed. N accompanied with 250 ppm Cu plus 100 ppm Mo produced the highest significant increase in total protein concentration, this increase was 221.54% and 206.27% in the first and second seasons, respectively, compared with untreated plants. These results are in accordance with those reported by Abd El-Fattah and Sorial (1998) who mentioned that the interaction between N and Cu increased total protein in onion bulbs.

d- Mineral Concentration

Concerning the effect of N, Cu and Mo each alone or in combinations on N,P,K,Cu and Mo concentrations in squash leaves, data are given in Table (3)

Nitrogen (N), Phosphorus (P) and Potassium (K) Concentrations

It was obvious from Table (3) that N, P and K concentrations were significantly promoted with increasing N rates compared with the control. The highest increase in N (158.62%), P (116.96%) and K (86.49%) concentrations was obtained from applying of the highest N fertilizer level (90 kg/fed.) compared with untreated plants. Data also, indicate that there were no significant differences between the effect of N at 60 and 90 kg/fed. on P concentration, in both seasons. The obtained results are in harmony with those reported by Eid (1980) and Ahmed (1994) who stated that nitrogen concentration in squash leaves was significantly increased with increasing N fertilizer rates. Huelt and White (1991) mentioned that N application increased P and K concentrations in squash plants. Moreover, Selim and El-Ghinbihi (1999) found that increasing the level of N increased the concentration of P in sugar beet leaves. Abd El-Fattah and Sorial (2000) revealed that N, P and K concentrations of squash leaves were significantly increased by increasing N levels. In addition, El-Ghinbihi and Ali (2001) demonstrated that applying N fertilizer significantly increased leaf N, P and K concentrations in potato plants. The increase in N concentration with increasing N levels due to the fact that N is an important constituent of protein, chlorophyll and improved the vegetative growth which led to more absorption of N (Chaurasia and Singh, 1995).

Results in the same Table show clearly that spraying squash plants with 250 ppm copper and/or 100 ppm molybdenum positively affected the concentration of N, P and K, in both seasons. In this concern, Mo was more effective in increasing N, P and K concentrations compared with Cu, but this increase was not significant in N and P concentrations. The interaction between Cu at 250 ppm and Mo at 100 ppm led to the highest significant increment in N, P and K concentrations compared with untreated plants and plants sprayed with Cu or Mo singly. These finding were true in both seasons. In this connection, Abd El-Fattah and Sorial (1998) showed that Cu spray increased N, P and K concentrations in onion bulbs.

With respect to the combination effect of macronutrient (N) and micronutrient (Cu and/or Mo) on the concentrations of N, P and K in squash

Table (3): Mineral concentrations of squash plants as affected by copper and molybdenum treatments under different levels of nitrogen and their interactions, in 2001 and 2002 seasons.

Treatments		N (mg/g dry weight)		P (mg/g dry weight)		K (mg/g dry weight)		Cu (ug/g dry weight)		Mo (ug/g dry weight)	
kg N /fed.	Microelements (ppm)	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
0		15.61 D	16.83 D	1.71 C	1.80 C	11.55 D	12.81 D	34.0 C	36.6 C	97.5 D	100.5 D
30		29.65 C	30.30 C	2.58 B	2.73 B	14.24 C	15.35 C	37.4 B	39.1 B	121.5 B	125.3 B
60		35.57 B	36.43 B	3.32 A	3.41 A	18.96 B	19.93 B	47.0 A	49.3 A	136.3 A	140.3 A
90		40.37 A	41.41 A	3.71 A	3.83 A	21.54 A	22.57 A	31.3 D	33.5 D	110.5 C	114.3 C
	Control	26.66 C	27.52 C	2.47 C	2.55 C	14.27 D	15.34 D	25.4 D	27.0 D	87.8 C	90.0 C
	Cu (250)	29.40 B	30.23 B	2.67 BC	2.81 BC	16.06 C	17.16 C	43.1 B	45.4 B	96.5 C	99.3 C
	Mo (100)	30.61 B	32.21 B	2.95 AB	3.08 AB	17.01 B	18.01 B	34.3 C	36.8 C	121.5 B	126.0 B
	Cu+Mo	34.53 A	35.01 A	3.23 A	3.33 A	18.96 A	20.16 A	46.9 A	49.4 A	160.0 A	165.0 A
0	Control	14.44 i	15.33 m	1.42 k	1.48 k	10.14 l	11.23 k	22.0 m	24.0 m	75.0 l	78.0 k
	Cu	15.01 i	16.21 lm	1.58 ij	1.66 ij	10.65 hi	12.44 ij	39.5 f	41.0 f	90.0 gh	92.0 i
	Mo	16.24 i	17.43 lm	1.84 ij	1.97 hi	12.19 ghi	12.99 ij	33.5 i	36.5 h	110.0 f	114.0 f
	Cu+Mo	17.74 h	18.36 l	1.99 hi	2.10 gh	13.21 fg	14.56 ghi	41.0 e	45.0 d	115.0 e	118.0 ef
30	Control	24.73 g	24.94 k	2.31 h	2.46 fg	12.70 gh	13.72 hi	25.0 l	26.0 l	91.0 gh	92.0 i
	Cu	28.88 fg	29.54 i	2.36 gh	2.63 ef	13.73 fg	14.45 ghi	42.5 d	44.0 d	96.0 g	97.0 hi
	Mo	30.24 f	31.74 hi	2.76 fg	2.84 ef	14.24 ef	15.47 fgh	35.5 h	37.5 h	122.0 e	128.0 e
	Cu+Mo	34.73 e	34.99 fg	2.89 ef	3.00 de	16.29 e	17.77 def	46.5 c	49.0 c	177.0 b	184.0 b
60	Control	31.18 f	32.69 gh	2.78 fg	2.81 ef	15.26 ef	16.84 efg	33.5 i	35.0 i	100.0 fg	103.0 gh
	Cu	35.61 e	35.94 ef	3.25 de	3.31 cd	18.44 d	18.99 cde	53.5 b	57.5 b	108.0 f	112.0 fg
	Mo	36.27 de	37.32 de	3.40 cd	3.54 c	19.67 cd	20.34 bc	40.0 ef	43.0 e	145.0 d	149.0 d
	Cu+Mo	39.21 bc	39.75 c	3.85 ab	3.97 ab	22.45 ab	23.55 a	61.0 a	61.5 a	192.0 a	197.0 a
90	Control	36.28 de	37.11 def	3.37 cd	3.45 c	18.96 d	19.56 cd	21.0 m	23.0 m	85.0 hi	87.0 ij
	Cu	38.08 cd	39.24 cd	3.50 bcd	3.64 bc	21.41 bc	22.74 ab	37.0 g	39.0 g	92.0 gh	96.0 hi
	Mo	40.70 b	42.33 b	3.79 abc	3.95 ab	21.92 ab	23.23 a	28.0 k	30.0 k	109.0 f	113.0 fg
	Cu+Mo	46.43 a	46.95 a	4.17 a	4.26 a	23.88 a	24.76 a	39.0 f	42.0 ef	156.0 c	161.0 c

Values marked with same alphabetical letter(s), within a comparable group of means, do not significantly differ using revised L.S.D. test at 0.05 level.

leaves, data in Table (3) show that spraying squash plants with Cu at 250 ppm or Mo at 100 ppm under different N fertilizer rates markedly increased the concentrations of N, P and K compared with the control. The interactions between the three elements showed significant increment in N, P and K concentrations. Increasing N fertilizer levels accompanied with Cu and Mo significantly increased N, P and K concentrations. The highest significant increase in these parameters was achieved by applying 90 kg/fed. N accompanied with 250 ppm Cu and 100 ppm Mo compared with untreated plants, in both seasons. Similar results are observed by Abd El-Fattah and Sorial (1998) who reported that the combination between N and Cu significantly increased N, P and K concentrations in onion bulbs.

Copper (Cu) Concentration

The results recorded in Table (3) point out that copper concentration was significantly increased with increasing N rates up to 60 kg/fed. Application of the highest N fertilizer rate (90 kg/fed.) significantly decreased copper concentration compared with untreated plants and other N treatments, in both seasons. The maximum significant increase in copper concentration (38.24% and 34.70%) was obtained by applying 60 kg/fed. N in the first and second seasons, respectively, compared with the control. In this concern, Haynes and Swift (1987) reported that N application as soil fertilizer increased Cu concentration in squash leaves. Furthermore, Abd El-Fattah and Sorial (1998) on onion demonstrated that increasing N levels up to 60 kg/fed. increased Cu concentration.

Regarding the effect of foliar spraying with copper and/or molybdenum on copper concentration in squash leaves, data in Table (3) reveal that the usage of 250 ppm Cu and/or 100 ppm Mo significantly increased copper concentration compared with the control, in both seasons. The combined treatment between Cu at 250 ppm and Mo at 100 ppm led to the highest significant increment in Cu concentration (84.65% and 82.96%) in the first and second seasons, respectively, compared with untreated plants followed by spraying squash plants with 250 ppm Cu alone. These results confirmed those obtained by Mutwali (1980) who reported that copper concentration in squash leaves was increased by application of copper.

Analysis of variance show that the interaction treatments between the three elements N, Cu and Mo significantly promoted the concentration of copper in squash leaves compared to the control. Increasing N rates up to 60 kg/fed. accompanied with Cu and/or Mo significantly increased Cu concentration, in both seasons. Meanwhile, the combination treatments between the highest N level (90 kg/fed.) plus Cu and/or Mo significantly decreased Cu concentration compared with the control or other N rates. The highest significant increase in copper concentration (177.27% and 156.25%) was achieved by treating squash plants with 60 kg/fed. N, 250 ppm Cu and 100 ppm Mo in the first and second seasons, respectively, compared with untreated plants, followed by the combination between 60 kg/fed. N plus 250 ppm Cu. These results are in agreement with those observed by Abd El-Fattah and Sorial (1998) who indicated that application of different N levels accompanied with Cu significantly increased Cu concentration in onion bulbs.

Molybdenum (Mo) Concentration

Results given in Table (3) show that molybdenum concentration was significantly increased with increasing N fertilizer levels up to 90 kg/fed. compared to the control. The highest significant increment (39.79% and 39.6%) in molybdenum concentration was obtained by applying N fertilizer at 60 kg/fed. in the first and second seasons, respectively, compared with untreated plants.

Data illustrated in the same Table demonstrate markedly increment in molybdenum concentration following Cu and/or Mo foliar spraying treatments comparing to the control. The highest significant increase in Mo concentration (82.23% and 83.33%) was recorded by spraying squash plants with 250 ppm Cu and 100 ppm Mo together in the first and second seasons, respectively, compared with untreated plants, followed by spraying with 100 ppm Mo alone. In addition, no significant differences in Mo concentration were detected between plants sprayed with Cu at 250 ppm and untreated plants. These results confirmed those obtained by Gunes and Post (1995) who observed that molybdenum concentration in lettuce plants increased with increasing Mo in the nutrient solution. Moreover, Kotur (1995) found that increasing Mo rate from 0 to 0.20% increased cauliflower leaf Mo concentration from 0.71 to 11.48 ug/g.

Concerning the effect of the interactions between macronutrient (N) and micronutrient (Cu and/or Mo) on molybdenum concentration, data in Table (3) reveal significant increase in Mo concentration due to the interactions between all N levels accompanied with 250 ppm Cu and/or 100 ppm Mo compared with untreated plants, in both seasons. The application of N at 60 kg/fed. accompanied with Cu at 250 ppm and Mo at 100 ppm gave the highest significant increase in Molybdenum concentration (156% and 152.56%) in the first and second seasons, respectively, comparing to the control, followed by the treatment, which included 30 kg/fed. N plus 250 ppm Cu and 100 ppm Mo.

3- Total Yield and its Components

a- Matured Fruits Yield and its Characteristics

Data recorded in Table (4) demonstrate significant increases in matured squash fruits yield expressed as number of matured squash fruits per plants and its characteristics, represented by fruit length, fruit diameter and average fruit weight, with increasing N levels, in both seasons. The application of N up to 90 kg/fed. significantly increased the number of matured fruits and its

Table (4): Number of matured fruits and fruit characteristics of squash plants as affected by copper and molybdenum under different levels of nitrogen and their interactions, in 2001 and 2002 seasons.

Treatments		Number of fruits per plant		Fruit length (cm)		Fruit diameter (cm)		Average fruit weight (g)	
kg N /fed.	Micro-elements (ppm)	2001	2002	2001	2002	2001	2002	2001	2002
0		2.44 C	2.21 C	18.07 C	17.07 C	7.12 C	6.43 C	379 C	340 D
30		2.83 B	2.74 B	19.88 B	19.51 B	10.30 B	9.66 B	441 B	408 C
60		3.70 A	3.34 A	22.05 A	21.48 A	12.65 A	12.21 A	560 A	533 B
90		3.71 A	3.46 A	22.33 A	22.18 A	12.96 A	12.48 A	570 A	547 A
	Control	2.79 C	2.55 C	19.91 C	19.00 C	9.71 C	9.02 C	423 C	398 C
	Cu (250)	3.17 B	2.95 B	20.20 B	20.02 B	10.59 B	9.95 B	490 B	456 B
	Mo (100)	3.24 B	3.01 B	20.53 B	20.03 B	10.51 B	10.15 B	479 B	454 B
	Cu+Mo	3.47 A	3.25 A	21.69 A	21.18 A	12.22 A	11.67 A	559 A	520 A
0	Control	1.93 f	1.68 k	17.34 g	15.70 l	5.87 h	5.10 h	328 l	291 i
	Cu	2.36 ef	2.25 l	18.53 efg	17.27 ghl	7.23 fgh	6.43 gh	356 hi	330 h
	Mo	2.61 de	2.33 hi	17.70 fg	17.13 hi	6.87 gh	6.30 gh	354 hi	338 h
	Cu+Mo	2.85 cd	2.60 gh	18.80 ef	18.17 fgh	8.50 efg	7.90 fg	478 ef	402 f
30	Control	2.94 cd	2.63 g	19.73 de	18.90 efgh	9.40 def	8.57 f	403 gh	368 g
	Cu	2.62 de	2.61 gh	19.33 e	19.27 defg	9.93 cde	9.23 ef	417 g	393 fg
	Mo	2.67 cde	2.75 fg	19.43 e	19.37 cdef	9.70 de	9.53 def	405 gh	382 fg
	Cu+Mo	3.08 c	2.95 ef	21.03 cd	20.50 bcde	12.17 bc	11.30 cd	540 cd	488 d
60	Control	3.57 b	3.20 de	21.60 bc	20.90 bcde	12.20 abc	11.33 cd	532 de	501 d
	Cu	3.63 b	3.28 cd	21.87 bc	21.43 bc	12.40 ab	12.03 bc	569 bcd	529 c
	Mo	3.73 ab	3.36 bcd	21.73 bc	21.23 bcd	12.33 ab	12.17 abc	567 bcd	531 c
	Cu+Mo	3.86 ab	3.53 bc	23.00 ab	22.37 ab	13.67 ab	13.30 ab	573 bcd	569 b
90	Control	2.73 cde	2.68 fg	21.07 cd	20.50 bcde	11.37 bcd	11.07 cde	428 fg	430 e
	Cu	4.07 a	3.58 bc	22.40 bc	22.10 ab	12.80 ab	12.10 bc	617 ab	571 b
	Mo	3.94 ab	3.66 ab	21.93 bc	22.40 ab	13.13 ab	12.60 abc	589 bc	566 b
	Cu+Mo	4.10 a	3.93 a	23.93 a	23.70 a	14.53 a	14.17 a	647 a	622 a

Values marked with same alphabetical letter(s), within a comparable group of means, do not significantly differ using revised L.S.D. test at 0.05 level.

characteristics, compared with the control treatment, in both seasons, however, no significant differences were detected between the effects of N at 60 and 90 kg/fed. Similar results were obtained by Hueit and Dettmann (1991) who concluded that both high and low N levels increased squash yield and improved its quality. Moreover, Saeed (2002) revealed that the average number of matured squash fruits/plant reflected positive and progressive response to the increments of applied N levels. In contrast, Eid (1980); Dweikat and Kostewicz (1989) as well as Doss and Saleh (1991) showed that N application at rate of 80 kg/fed. had no significant effects on diameter and length of squash fruits and the excessive N fertilizer rate above 8o kg/fed. significantly depressed fruit weight of zucchini squash.

Data in Table (4) indicate that spraying squash plants with Cu at 250 ppm and/or Mo at 100 ppm led to significant increments in the number of matured fruits and fruit characteristics compared with the control plants, in both seasons. Spraying squash plants with the two microelements together caused the highest significant increases in the number of matured fruits and fruit characteristics compared with the control and single microelement treatments. Furthermore, there were no significant differences between the effect of Cu or Mo each alone on the number of matured fruits and fruit characteristics, in both seasons. In this connection, Abed *et al.* (1984) observed that soaking seeds of cucumber in 500 ppm copper increased the total yield and enhanced the fruit dimension. In addition, Sidhu *et al.* (1984) found that the highest average fruit yield of muskmelon was obtained with applying Agromin (containing Zn, Cu, Mn, Mg, B and Mo) at 1.5 kg/ha.

Concerning the effect of Cu and/or Mo under different levels of N on matured fruits yield and its characteristics, data in Table (4) show that the interaction treatments between N levels accompanied with Cu and/or Mo positively affected these parameters compared with untreated plants, in both seasons. Applying N at 90 kg/fed. accompanied with foliar spraying with Cu at 250 ppm and Mo at 100 ppm seemed to be the best treatment, which significantly increased the number of matured fruits and fruit characteristics, in both seasons.

The increase in the number of matured squash fruits and its characteristics, in this study, might be due to the increase in vegetative growth characters (Table 1) and the enhancement of chemical composition in squash leaves (Tables 2 and 3) due to N, Cu and Mo application.

b- Seed Yield and its Quality

Data illustrated in Table (5) point out that squash seed yield either per plant or per feddan and its quality characteristics represented by seed index (weight of 100 seeds), dry matter content (%) of seeds and seed germination (%) were positively affected by application of different N fertilizer rates compared with the control. High N levels (60 and 90 kg/fed.) significantly

Table (5): Seed yield and its quality of squash plants as affected by copper and molybdenum treatments under different levels of nitrogen and their interactions, in 2001 and 2002 seasons.

Treatments		Seed yield per plant (g)		Seed yield per feddan (ton)		Seed index (wt. of 100 seeds, g)		Dry matter content of seeds (%)		Seed germination (%)	
kg N /fed.	Micro-elements (ppm)	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
0		26.79 C	20.83 C	254.56 C	197.85 D	10.01 D	9.88 D	91.84 D	91.51 D	77.67 B	76.58 B
30		29.64 C	22.03 C	281.53 C	209.30 C	11.48 C	11.36 C	93.27 C	93.11 C	82.50 A	81.58 A
60		42.61 B	34.29 B	404.78 B	325.72 B	12.54 B	12.46 B	94.63 B	94.46 B	85.00 A	84.42 A
90		46.49 A	38.34 A	441.61 A	364.20 A	13.78 A	13.68 A	95.59 A	95.34 A	82.67 A	82.42 A
	Control	30.33 C	23.34 D	288.09 C	221.75 D	10.44 C	10.31 C	91.17 C	90.75 C	76.00 C	75.08 C
	Cu (250)	35.77 B	28.12 C	339.84 B	267.14 C	12.25 B	12.16 B	94.44 B	94.19 B	83.33 B	82.58 B
	Mo (100)	36.72 B	29.23 B	348.88 B	277.66 B	11.99 B	11.89 B	94.26 B	94.12 B	81.83 B	81.17 B
	Cu+Mo	42.70 A	34.79 A	405.67 A	330.52 A	13.13 A	13.02 A	95.46 A	95.35 A	86.67 A	86.17 A
0	Control	16.93 g	14.10 i	160.87 g	133.98 i	8.96 h	8.81 h	88.42 g	87.58 h	73.33 de	72.00 ef
	Cu	26.98 f	20.80 h	256.31 f	197.57 h	10.39 f	10.25 fg	92.63 ef	92.32 efg	78.67 cd	78.00 cde
	Mo	27.31 f	21.21 h	259.45 f	201.50 h	10.03 gh	9.92 gh	92.76 ef	92.68 efg	77.33 cde	76.00 def
	Cu+Mo	35.95 e	27.19 g	341.62 e	258.34 g	10.67 efg	10.54 efg	93.56 de	93.45 def	81.33 bcd	80.33 bcd
30	Control	24.52 f	18.26 hi	232.91 f	173.47 hi	10.09 gh	9.98 gh	91.36 f	91.21 g	78.67 cd	78.00 cde
	Cu	27.67 f	20.33 h	262.83 f	193.01 h	11.64 def	11.49 def	93.73 de	93.47 def	84.00 abc	82.67 bcd
	Mo	28.53 f	21.08 h	271.04 f	200.30 h	11.52 def	11.41 def	93.61 de	93.48 def	81.33 bcd	80.67 bcd
	Cu+Mo	37.82 de	28.47 g	359.33 de	270.44 g	12.67 cd	12.56 cd	94.38 cde	94.28 cde	86.00 abc	85.00 abc
60	Control	40.02 cde	31.19 efg	380.16 cde	296.28 efg	11.85 de	11.74 de	92.48 ef	92.28 efg	82.67 bcd	82.00 bcd
	Cu	42.28 bcd	33.49 def	401.63 bcd	318.19 def	12.45 cd	12.39 cd	94.96 bcd	94.78 bcd	85.33 abc	84.67 abc
	Mo	43.58 bc	35.04 cde	414.04 bc	332.92 cde	12.18 d	12.12 d	94.39 cd	94.17 cde	84.67 abc	84.00 abcd
	Cu+Mo	44.56 bc	37.42 bcd	423.29 bc	355.49 bcd	13.69 bc	13.59 bc	96.68 ab	96.59 ab	87.33 ab	87.00 ab
90	Control	39.83 cde	29.82 fg	378.42 cde	283.26 fg	10.86 efg	10.72 efg	92.41 ef	91.94 fg	69.33 e	68.33 f
	Cu	46.17 b	37.87 bc	438.58 b	359.80 bc	14.53 ab	14.50 ab	96.44 ab	96.20 abc	85.33 ab	85.00 abc
	Mo	47.47 b	39.57 b	451.00 ab	375.92 b	14.22 ab	14.12 b	96.29 abc	96.14 abc	84.00 abc	84.00 abcd
	Cu+Mo	52.47 a	46.09 a	498.44 a	437.83 a	15.50 a	15.38 a	97.22 a	97.08 a	92.00 a	92.33 a

Values marked with same alphabetical letter(s), within a comparable group of means, do not significantly differ using revised L.S.D. test at 0.05 level.

increased seed yield/plant and seed yield/fed., compared with untreated plants. Meanwhile, increasing N levels significantly increased seed index and dry matter content (%) of seeds, compared with the control treatment. Furthermore, seed germination (%) was significantly improved by N fertilization at any rate compared with the control, though the differences among the three levels of N were not significant, in both seasons. In this connection, Mreish (1974) and Saeed (2002) reported that the number of seeds/fruit, total seed yield and weight of 100 seeds of squash plants were significantly increased by increasing the applied N up to 120 kg/fed.

Regarding the effects of microelements on the seed yield and its quality of squash plants, the obtained results (Table 5) show clearly that the application of copper at 250 ppm or molybdenum at 100 ppm significantly increased seed yield, either per plant or per feddan and improved all quality characteristics of seeds, compared with the control treatment. Spraying Cu at 250 ppm and Mo at 100 ppm together, caused the highest significant increment in seed yield and seed quality, in both seasons. In this concern, the results of Hill *et al.* (1979) and Reuter *et al.* (1981) emphasize the importance of adequate copper supply during fertilization for final seed and fruit yield. Similar results were also obtained by Gabal *et al.* (1985) with respect to the effect of Cu on seed yield and weight of 100 seeds of beans, and by Singh *et al.* (1992) as well as Sarkar and Ghosh (1992) with respect to the effect of Mo on seed yield of peas and sunflower plants. In addition, high but not toxic levels of molybdenum in plants are advantageous for seed productions (Gurley and Gidden, 1969).

Results presented in Table (5) reveal that the interactions between N levels and application of Cu and/or Mo treatments positively affected seed yield and its quality of squash plants. Increasing N rates accompanied with Cu and/or Mo significantly increased seed yield and its quality comparing to the control, in both seasons. Application of N at 90 kg/fed. accompanied with Cu at 250 ppm and Mo at 100 ppm led to the highest significant increment in seed yield and its quality. This increase reached to 209.92%, 209.84%, 72.99%, 9.95% and 25.46% for seed yield/plant, seed yield/fed., seed index, dry matter content (%) of seeds and seed germination (%), respectively, compared with untreated plants. The second season followed the same trend.

The obtained seed yield increases might be due to the fact that the application of macroelement (N) and microelement (Cu and/or Mo) each alone or in different combinations stimulated both vegetative growth characters (Table 1), chemical parameters (Tables 2 and 3) of squash plants and significantly increased the number of matured fruits and improved its characteristics (Table 4).

It could be concluded that, increasing N fertilizer rates up to 90 kg/fed. significantly increased growth characters, chemical parameters, matured fruits yield and seed yield. Spraying squash plants with microelement (Cu and/or Mo) showed significant increment in all studied parameters, in this respect, the combination between copper and molybdenum showed higher significant increases in the above mentioned characters than the effect of each microelement alone. Furthermore, the interaction treatments between macroelement (N) and microelement (Cu and/Mo) caused significantly higher mean values for all studied parameters compared with the application of macronutrient or micronutrient singly, in this concern, the treatment which included 90 kg/fed. N accompanied with 250 ppm Cu and 100 ppm Mo was the best favorable treatment in increasing the most of studied parameters.

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النمو والتركيب الكيماوى ومحصول البذور وجودته لنباتات قرع الكوسة تحت تأثير التداخل بين بعض العناصر الغذائية الكبرى والصغرى

١ - تأثير الرش بالنحاس والموليبدنم تحت تركيزات مختلفة من السماد النتروجينى.

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الملخص العربى

أجريت هذه الدراسة أثناء الموسمين الزراعيين ٢٠٠١ و٢٠٠٢ بالمزرعة التجريبية بكلية الزراعة - جامعة الإسكندرية وذلك لدراسة تأثير التداخل بين بعض العناصر الغذائية الكبرى والصغرى على صفات النمو والتركيب الكيماوى والمحصول لنباتات قرع الكوسة صنف اسكندرانى. وقد تم أجراء تجربتين حقليتين لدراسة تاثير الرش بالنحاس بتركيز ٢٥٠ جزء فى المليون أو الموليبدنم بتركيز ١٠٠ جزء فى المليون أو كلاهما معا مع التسميد النتروجينى بمعدلات (صفر - ٣٠ - ٦٠ - ٩٠ كجم/ فدان) وكذلك التفاعل بينهم وقد أوضحت النتائج المتحصل عليها ما يلى:

- أدت زيادة معدل التسميد النتروجينى حتى ٩٠ كجم/ فدان الى حدوث زيادة معنوية فى صفات النمو الخضرى متمثلة فى طول الساق وعدد الأوراق ومساحة الأوراق وكذلك الوزن الجاف للأوراق. كما أن استخدام التركيز العالى من السماد النتروجينى أعطى أعلى زيادة معنوية فى هذه الصفات.

- أظهر الرش بالزنك بمعدل ٢٥٠ جزء فى المليون أو الرش بالموليبدنم بمعدل ١٠٠ جزء فى المليون زيادة معنوية فى صفات النمو الخضرى. وقد أدى الرش بكل من النحاس والموليبدنم معا الى حدوث أعلى زيادة معنوية فى صفات النمو الخضرى وذلك مقارنة باستخدام كل منهما على حده.

- كما أشارت النتائج الى أن التداخل بين التسميد النتروجيني بمعدلات مختلفة والرش بالنحاس أو الموليبدنم أو كلاهما معا أدى الى حدوث زيادة واضحة فى صفات النمو الخضرى. كما أشارت النتائج الى أن المعاملة (٩٠ كجم/ فدان نتروجين + ٢٥٠ جزء فى المليون نحاس + ١٠٠ جزء فى المليون موليبدنم) أعطت أعلى زيادة معنوية فى صفات النمو الخضرى مقارنة بالمعاملات الاخرى.

- أوضحت الدراسة أن زيادة تركيز السماد النتروجيني أحدثت زيادة معنوية فى تركيز صبغات البناء الضوئى (كلوروفيل أ وكلوروفيل ب وكلوروفيل أ+ب والكاروتينيدات) وتركيز السكريات الذائبة الكلية والكربوهيدرات الكلية و البروتين الكلى وكذلك النتروجين والفوسفور والبوتاسيوم والنحاس والموليبدنم. وقد أدى استخدام التركيز العالى من النتروجين (٩٠ كجم/ فدان) الى حدوث أعلى زيادة معنوية فى تركيز صبغات البناء الضوئى والسكريات الذائبة الكلية والكربوهيدرات الكلية والبروتين الكلى وكذلك النتروجين والفوسفور والبوتاسيوم والموليبدنم بينما أدى الى حدوث نقص معنوى فى تركيز النحاس مقارنة بالنباتات الغير معاملة.

- كما أشارت النتائج أن رش نباتات قرع الكوسة بالنحاس أو الموليبدنم أدى الى حدوث زيادة معنوية فى المكونات الكيماوية وكان الرش بالموليبدنم أكثر تأثيرا على هذه الصفات من الرش بالنحاس. وقد أعطى التفاعل بين النحاس والموليبدنم أعلى زيادة معنوية فى المكونات الكيماوية تحت الدراسة مقارنة بتأثير كل منهما على حده.

- كما أظهر التداخل بين التسميد النتروجيني بمعدلات مختلفة والرش بالنحاس أو الموليبدنم أو كلاهما معا زيادة معنوية فى المكونات الكيماوية. وقد أثبتت الدراسة أن التسميد بالنتروجين بمعدل ٩٠ كجم/ فدان والرش بالنحاس بتركيز ٢٥٠ جزء فى المليون والموليبدنم بتركيز ١٠٠ جزء فى المليون أدى الى حدوث أعلى زيادة معنوية فى معظم المكونات الكيماوية لأوراق قرع الكوسة بينما أدى الى حدوث نقص فى تركيز كل من النحاس والموليبدنم.

- أشارت النتائج أن زيادة التسميد النتروجيني حتى معدل ٩٠ كجم/ فدان أعطت زيادة معنوية فى محصول الثمار الناضجة ومحصول البذور وصفات الجودة لهما.

- كمـــا أدى رش نـــباتات قـــرع الكوســـة بالنحاس أو المولبيدنم الى حدوث زيادة معنوية فى محصـــول الـــثمار الناضجة ومحصول البذور وظهرت أعلى زيادة معنوية فى هذه الصفات عند رش نباتات قرع الكوسة بالنحاس والموليبدنم معا.

- أدى الـــتداخل بين التسميد النتروجينى بمعدلات مختلفة والرش بالنحاس بتركيز ٢٥٠ جزء فـــى الملـــيون أو الموليـــبدنم بتركـــيز ١٠٠ جزء فى المليون أو كلاهما معا الى حدوث زيادة واضـــحة فى محصول الثمار الناضجة وكذلك محصول البذور خاصة تحت التركيزات العالية من السماد النتروجينى.

- وقـــد أوضـــحت الدراســـة أن المعاملة (٩٠ كجم/ فدان نتروجين + ٢٥٠ جزء فى المليون نحـــاس + ١٠٠ جزء فى المليون موليبدنم) هى أكثر المعاملات كفاءة حيث أعطت أعلى زيادة فـــى صـــفات الـــنمو الخضـــرى وفى تركيز معظم المكونات الكيماوية والمحصول لنباتات قرع الكوسة.