Indian Journal of Ecology (2020) 47 Special Issue (12): 167-172

Manuscript Number: 469
NAAS Rating: 4.96

Effect of Nitrogen Fertilizer and Spraying of Copper on Growth and Yield of Squash (*Cucurbita pepo* L.)

Mahmood Howedy Menajid and Mohammed Obed Sallume

Department of Soil Sciences and Water Resources, College of Agriculture, University of Anbar, Anbar, Iraq
E-mail: ag.mohammed.obed@uoanbar.edu.iq

Abstract: A two-factorial experiment of a randomized complete block design with three replications was conducted to determine the effect of nitrogen and copper fertilizer on growth and yield of squash. The two factors were nitrogen fertilizer in two forms i.e., Urea and Di ammonium phosphate (DAP) with an application rate of 120 kg ha^{-1} and spraying of copper (Cu 24.5%) with four levels (C0 = distilled water; C1=5, C2=10 and C3=15 mg l^{-1}) on plant shoot at (5-15 mg l^{-1}).The studied growth component represented by the length of the plant, leaf area and dry weight. The obtained results showed that the nitrogen fertilizer (urea) significantly increased the plant length, leaf area and dry weight in the first season, while the total yield significantly increased for both seasons. The spraying of Cu (10 mg l^{-1}) led to a significant increase in plant length and dry weight in the first season whilst the leaf area had increased in both seasons. The yield significantly increased as a result of spraying Cu (5 mg l^{-1}) in the first season while chlorophyll (SPAD) had increased in the second season. The application of 15mg l^{-1} increased the Cu concentration in each of the soil, leaves and fruits in both seasons. The interaction between nitrogen fertilizer and spraying of copper (10 mg l^{-1}) led to a significant increase in the leaf area for the first season while the interaction of 15 mg l^{-1} with DAP fertilizer significantly increased the leaf area in the second season. Moreover, the interaction between urea fertilizer and spraying of Cu (15 mg l^{-1}) significantly increased chlorophyll (SPAD) for both seasons and the total yield had increased in the first season, in addition to increasing the concentration of N and Cu in the soil, leaves and fruits.

***Keywords*:** Nitrogen, Urea, DAP, Copper spray, Squash

Squash (*Cucurbita pepo* L.) is one of the important Cucurbit family crops and it is highly ranked in economic importance globally, grown in Iraq in the spring and autumn seasons. Since the highest economic returns are the goal of planting crops, which associated with the highest quality, and the lowest costs. Therefore, determining and understanding the suitable conditions that affect the soil and the plant functions are required to achieve economic returns. Due to the neutral effect of nitrogen fertilizers, it prefers to use in Iraqi soils. The soils in Iraq recognized by its low total nitrogen content ranges between 0.031-0.239% (Ali et al 2014). The chemical sources of nitrogen provide the soil with nitrogen elements quickly, thereby filling the nitrogen deficiency in the plant (Kadhum 2011). Besides the nitrogen importance, micronutrients are as important as macronutrients and participate in vital metabolic processes in the plants. The copper element is one of the necessary elements for plant growth. It ranges in the soils between 6-144 mg kg^{-1}, mostly in the form of crystalline sheets of primary and secondary minerals (Benni 2014). Copper plays a vital role in many biological processes inside the plant through its contribution in the synthesis of the chloroplast. Moreover, it participates in the biological processes of protein formation in addition to its role in the photosynthesis process and the chlorophyll formation; it is also involved in the synthesis of some enzymes, such as cytochrome oxidase and ascorbic acid oxidase. Growth and yield improvement have been reported by Yruela (2009), in a study on the effect of the source of nitrogen urea and ammonium sulfate on garlic plant, the study found that the highest yield of garlic was obtained by adding ammonium sulfate. (Nori et al 2012, Al-Tohafey et al 2009) found that the effect of copper at four levels 0, 2.5, 5, 10 mg l^{-1} on tomato plant the concentration of 5 mg l^{-1} achieved the highest rate for both early yield and total yield in addition to the yield per plant. The objective of this study was to determine the effect of two nitrogen fertilizer sources and spray of copper on some soil and Squash plant properties.

MATERIAL AND METHODS

A field experiment was conducted during the two successive seasons of 2014 and 2015. The soil was classified as silty clay loam (Typic Torrifluvent), at Abi Gharib city. Some of the characteristics of the soil before planting are listed in Table 1. The crop was cultivated by adopting the raised bed system. Each bed represents treatment. The treatment dimensions were 3.5 x 3 m width and length respectively. The distance between the adjacent beds was 1 m separated by channels of 0.75 m width to prevent fertilizer leakage. The squash seeds were planted immediately after irrigation, three seeds per pit were used to ensure the germination. The distance between the adjacent plants was 0.50 m. The number of plants per plot was 24 plants distributed on four rows and on both sides of the beds with a plant density of 15,000 plants per hectare. A two-factorial experiment of a randomized complete block design with three replications was conducted. The two factors were nitrogen fertilizer in two forms i.e., Urea and Di-ammonium phosphate (DAP) with an application rate of 120 kg ha^{-1} and spraying copper (copper sulfate fertilizer 24.5% Cu) on plant shoot at (5-15 mg l^{-1}), with four levels (C0 = distilled water; C1, C2 and C3=5,10 and 15 mg l^{-1} respectively). Nitrogen fertilizers were added twice according to the banding method near the cultivation rows with a distance of 0.20m with two doses, the first dose was added after an appearance of four branches while the second dose was added at the beginning of the flowering stage. The copper sulfate was added as a foliar spray at three times on the vegetative part, namely 17, 30, 60 days after. Potassium fertilizer was added as potassium sulfate (46% K2O) at a rate of 42 kg K ha^{-1}, while the phosphate fertilizer was added to all experimental plots with an application rate of 70 kg P ha^{-1} as TSP fertilizer (22% P), both of the aforementioned fertilizers were added during soil preparation. All operations related to plant were performed i.e., thinning the plants after two leaves appearance, hoeing, manually weeding and pest control by using chlorpyriphos insecticide for prevention the Cucumber beetle at 2 ml l^{-1}. The irrigation was carried out according to the plant water requirements, once weekly.

RESULTS AND DISCUSSION

The results listed in Table 2 show that the addition of different nitrogenous fertilizers had a significant effect on the traits of the plant length, leaf area and dry weight. Urea fertilizer significantly superior in all the aforementioned traits compared to di-ammonium phosphate fertilizer, probably due to the role of nitrogen in the formation of amino acids especially tryptophan and methionine which are considered to be one of the main sources of some plant hormones, including (oxins and cytokines). Moreover, nitrogen gave a state of hormonal balance within the plant and increases the process of cell division and elongation then leads to an increase in the length of the plant. The nitrogen increases the rate of plant absorption of nutrients; or creating a state of balance between processed carbohydrates and nitrogen C/N Ratio from the soil by reducing soil pH, which increased the size of the vegetative group. This will lead to an increase in the leaf area, the number of branches per plant and dry weight. Hamail (2014) also indicated to some vital stimulants in the Cucumber plant with the interaction between ammonium sulfate and calcium nitrate at the level of 50 +

Table 1. Soil physical and chemical properties before planting

Parameter		Unit	Value
pH 1:1			7.80
EC		ds m^{-1}	3.60
O.M.		gm kg^{-1}	9.00
CEC		cmol kg^{-1}	30.30
Bulk density		mg m^{-3}	1.32
Cations	Ca^{+2}	mmol L^{-1}	9.85
	Mg^{+2}		9.58
	Na^{+}		21.65
	K^{+}		0.33
Anions	SO_4^{-2}	mmol l^{-1}	5.31
	HCO_3^{-}		2.61
	CO_3^{-2}		1.5
	Cl^{-}		12.48
Available N		mg kg^{-1}	84.00
Available P			9.40
Available K			155
Soil separates	sand	gm kg^{-1}	166
	silt		469
	clay		364
Soil texture		Silty clay loam	

Table 2. Effect of N fertilizer types on growth characteristics of squash

N fertilizer	Plant length (cm)	Leaf area (cm^2)	Dry weight (t ha^{-1})
First season			
Urea	52.95	278.5	2.7
DAP	46.2	218.17	1.99
CD (p=0.05)	1.59	38.56	0.23
Second Season			
Urea	57.4	289.33	1.23
DAP	53.62	273.77	1.24
CD (p=0.05)	5.65	42.91	0.12

Table 3. Effect of spray copper on growth characteristics of squash

Cu (mg l^{-1})	Plant length (cm)	Leaf area (cm^2)	Dry weight (t ha^{-1})
First season			
0	48.46	202.17	1.26
5	50.15	258.00	2.10
10	50.23	273.17	3.20
15	49.46	260.00	2.12
CD (p=0.05)	2.25	54.53	0.33
Second season			
0	53.48	239.61	1.19
5	65.58	296.16	2.06
10	57.08	319.30	3.82
15	54.91	298.11	1.94
CD (p=0.05)	8.00	60.68	0.72

50% in addition to a significant effect on the leaf area.

The spraying of different concentrations of copper in the first season had no significant differences between the plant length attribute for the sprayed concentrations and control. The spraying copper significantly increased the leaf area in both seasons compared to the control treatment. The concentration of 10 mg l^{-1} gives a significant increase in dry weight for both seasons; this can be attributed to the role of sprayed copper in increasing the accumulation of carbohydrates for the plant leading to an increase in the dry weight of the plant. While there were no significant differences with the spraying of copper on the plant in the traits of plant length and dry weight compared to the control treatment. The interaction between urea and spraying of copper with different concentrations gave a significant difference in the length of the plant and dry weight traits, compared to the interaction between the di-ammonium phosphate and the copper. While there were no significant differences during the second season. The nitrogen application from urea fertilizer and bilateral ammonium phosphate did not significantly affect the total chlorophyll and plant yield, whereas urea fertilizer was significantly superior to the bilateral aluminum phosphate fertilizer in the total yield (Table 5). This might be due to the high nitrogen content in urea fertilizer 46% and to the role of the important processes that nitrogen performs in the formation of chlorophyll that increased the flowering percentage consequently increase the total yield, these findings accord with (Al-Kilani 2017, Muhammad et al 2007).

The evidence shows that the spraying copper at different concentrations did not significantly effect on the total chlorophyll and total yield (Table 6). Regarding the second season, it was noted that the concentration of 5 mg l^{-1} was significantly increased the total chlorophyll trait. While there were no significant differences in the plant per yield and total yield during the second season. The interaction between the urea fertilizer and copper spraying at the level of 15 mg l^{-1} was significantly higher in the total chlorophyll trait compared to other interactions for both seasons, also noted that the interaction between urea fertilizer and copper spraying with a concentration of 15 mg L^{-1} significantly superior in the yield per plant and the total yield in the first season. Zhu and Qiang (2012) also found the same results. However, in the second season, no significant effect was observed between the different intervention factors. The urea fertilizer for both seasons significantly superior to di-ammonium phosphate fertilizer in terms of nitrogen concentrations in leaves, fruits and soil (Table 8). This probably due to the urea supply the nitrogen in two forms i.e., ammonium and nitrate higher than the di-ammonium phosphate fertilizer which provides the

Table 4. Effect of the interaction between N fertilizers and Cu spraying on growth characteristics of squash

N fertilizer	Cu (mg l^{-1})	Plant length (cm)	Leaf area (cm^2)	Dry weight (t ha^{-1})
First season				
Urea	0	51.33	219.76	0.68
	5	53.76	282.67	2.78
	10	53.96	324.33	4.25
	15	52.56	287.33	2.86
DAP	0	45.4	184.67	0.31
	5	45.53	233.33	2.82
	10	46.5	222	2.84
	15	46.36	232.67	2.85
CD (p=0.05)		NS	77.12	0.47
Second Season				
Urea	0	52.33	228.57	0.03
	5	58.23	307.82	1.83
	10	62.1	344.34	3.23
	15	56.96	276.6	2.9
DAP	0	54.63	309.82	0.27
	5	54.93	171.39	1.56
	10	52.06	294.27	2.64
	15	52.86	319.61	1.4
CD (p=0.05)		NS	85.82	0.41

Table 5. Effect of N fertilizer type on the yield trait and total chlorophyll content of squash

N fertilizer	Total chlorophyll (SPAD)	Yield per plant (Kg $plant^{-1}$)	Total yield (t ha^{-1})
First season			
Urea	94.86	1.19	8.15
DAP	88.37	1.09	6.25
CD (p=0.05)	NS	NS	1.87
Second season			
Urea	37.78	0.74	10.66
DAP	68.73	0.7	7.65
CD (p=0.05)	9.84	0.2	2.87

Table 6. Effect of Cu spraying on yield characteristics and total chlorophyll of squash

Cu (mg l^{-1})	Total chlorophyll (SPAD)	Yield per plant (Kg $plant^{-1}$)	Total yield (t ha^{-1})
First season			
0	88.92	0.7	6.52
5	94.51	1.24	6.21
10	94.65	1.15	6.74
15	88.39	1.48	7.33
CD (p=0.05)	NS	0.5	NS
Second season			
0	37.5	0.6	8.59
5	73.61	0.76	10.96
10	69.16	0.79	11.36
15	68.74	0.73	10.48
CD (p=0.05)	13.92	NS	NS

Table 7. Effect of the interaction between N fertilizer type and spraying of copper on yield and chlorophyll content of squash

N fertilizer	Cu (mg l^{-1})	Total chlorophyll (SPAD)	Yield (Kg $plant^{-1}$)	Total yield (t ha^{-1})
First season				
Urea	0	95.48	0.59	7.48
	5	96.21	1.22	7.21
	10	86.2	1.27	8.07
	15	101.56	1.67	9.85
DAP	0	93.82	0.81	5.57
	5	92.81	1.26	6.21
	10	91.64	1.02	9.4
	15	75.22	1.29	7.81
CD (p=0.05)		25.31	0.7	3.75
Second season				
Urea	0	74.26	0.56	7.99
	5	74.83	0.92	13.2
	10	67.04	0.8	11.4
	15	78.98	0.7	10.8
DAP	0	74.97	0.64	8.72
	5	72.18	0.61	9.18
	10	71.27	0.79	11.33
	15	58.1	0.76	10.89
CD (p=0.05)		19.68	NS	NS

Table 8. Effect of N fertilizer type in N and Cu concentration in the leaves, fruits of plant and soil

N fertilizer	Leaves		Fruits		Soil	
	N (%)	Cu (mg Kg^{-1})	N (%)	Cu (mg Kg^{-1})	N (%)	Cu (mg Kg^{-1})
First season						
Urea	1.55	45	1.63	10.89	64.66	4.76
DAP	1.48	36.85	1.59	10.64	60.96	4.73
CD (p=0.05)	0.02	NS	0.02	NS	2.68	NS
Second season						
Urea	1.21	35.29	1.27	8.27	50.66	3.7
DAP	1.15	28.66	1.24	8.47	47.41	3.63
CD (p=0.05)	0.01	6.42	0.02	NS	1.82	NS

Table 9. Effect of Cu spraying in N and Cu concentration in leaves and fruits of plant and soil

Cu (mg l^{-1})	Leaves		Fruits		Soil	
	N (%)	Cu (mg Kg^{-1})	N (%)	Cu (mg Kg^{-1})	N (%)	Cu (mg Kg^{-1})
First season						
0	1.34	25.71	1.49	4.27	53.35	1.16
5	1.58	33.85	1.63	9.18	60.14	2.42
10	1.56	36.07	1.63	11.97	61.12	5.86
15	1.6	46.07	1.71	17.63	62.64	9.55
CD (p=0.05)	0.03	6.68	0.03	1.72	3.79	0.72
Second season						
0	1.04	22.33	1.16	3.32	41.5	0.9
5	1.23	34.66	1.26	7.14	50.66	1.88
10	1.21	33.5	1.27	9.31	51.16	4.56
15	1.24	40.83	1.33	13.71	51.83	7.43
CD (p=0.05)	0.02	5.08	0.03	1.33	2.58	0.56

nitrogen with less amount of urea fertilizer. While there were no significant differences result of the copper concentrations in fruits and soil for both seasons.

The spraying of copper significantly increased the available copper and nitrogen content in leaves, fruits and soil (Table 9). The concentration of 15 mg l^{-1} has significantly increased the content of copper in each of the leaves, fruits and soil for both seasons, this may be attributed to spraying operations on the vegetative part of the plant, which led to an increase in chloroplast and chloroplasts, consequently an increase in the vital processes. The interaction between nitrogen from the urea fertilizer source and spraying copper with a concentration of 15 mg l^{-1} has a significant increase the content of nitrogen and copper in the leaves and fruits in addition to the soil, compare to other interactions of copper concentrations and the interactions between the nitrogen

Table 10. Effect of N fertilizer type and Cu spraying in N and Cu concentration in leaves, fruits of plant and soil

N fertilizer	Cu (mg l^{-1})	Soil		Fruits		Soil	
		N (%)	Cu (mg Kg^{-1})	N (%)	Cu (mg Kg^{-1})	N (%)	Cu (mg Kg^{-1})
First season							
Urea	0	1.51	37.28	1.54	5.63	54.43	1.66
	5	1.55	46.71	1.58	9.17	64.28	5.86
	10	1.55	39	1.62	12.13	63	5.86
	15	1.6	57	1.78	19.63	72.14	10.19
DAP	0	1.17	20.14	1.44	2.92	52.28	0.65
	5	1.56	34.71	1.68	9.2	62	2.5
	10	1.56	47.14	1.64	11.8	63.24	5.86
	15	1.58	45.42	1.64	15.63	65.14	8.91
CD (p=0.05)		0.04	12.52	0.05	2.43	5.36	1.02
Second season							
Urea	0	1.17	29	1.2	4.37	42.33	1.29
	5	1.21	36.32	1.23	7.13	50	1.82
	10	1.23	30.33	1.26	9.43	49	4.56
	15	1.26	46.33	1.38	15.26	55.4	8.15
DAP	0	0.91	15.66	1.12	2.27	40.66	0.51
	5	1.2	27	1.3	7.16	41.33	1.95
	10	1.21	36.66	1.28	9.18	41.02	4.56
	15	1.22	35.33	1.27	12.16	40.32	7.01
CD (p=0.05)		0.03	9.58	0.04	1.89	3.65	0.79

source from the di-ammonium phosphate fertilizer for both seasons respectively (Table 10). It was also observed that the same interaction above, i.e., the interaction between urea fertilizer and copper concentration of 15 mg L^{-1} had a significant effect on the content of leaves, fruits and soil of copper with for both seasons.

CONCLUSION

The most of Iraqi soils are generally calcareous characterized by low availability of N and Cu content, therefore, N source and Cu concentration are very important for zucchini squash production. According to the results of our study, the spraying of different concentrations of copper did not give significant differences between the plant length traits in the first season. Likewise, the evidence showed that the spraying copper at different concentrations did not significantly effect on the total chlorophyll and total yield. In terms of interaction, the interaction between the urea fertilizer and copper spraying at the level of 15 mg l^{-1} has positively reflected on the total chlorophyll trait compared to other interactions for both seasons .also noted that the interaction between urea fertilizer and copper spraying with a concentration of 15 mg l^{-1} significantly superior in the yield per plant and the total yield in the first season. While urea fertilizer was an obviously superiority in yield and most of the studied traits, as well as, the copper spraying at levels 5 mg l^{-1}. The results of the study may be helpful for the recommendation of optimum N source and copper spraying level in zucchini squash production in similar climatic and soil conditions.

REFERENCES

Al Kilani YA 2017. *The effect of the nitrogen source and spray of copper on the growth and yield of cucumber (Cucumis melo L.) var. Flexuosus.* Masters Theses, College of Agriculture, University of Anbar, Iraq.

Al Tohafey S, Musa MH and Alwan AF 2009. The effect of spraying with different concentrations of boron and copper in some growth characteristics and the percentage of the fruit settings obtained under the hybrid tomato (Narita) variety under greenhouse conditions. *Technical Journal* **24**(1): 161-181.

Ali NS, Hamadalla SR and Abdul Wahab AS 2014. *Soil fertility*, Ministry of Higher Education and Scientific Research, Baghdad University, Iraq, 74p.

Benni TJ 2014 Distribution of some heavy metals in the recent sediments of Al- Nasiriya area, Mesopotamia plain, south Iraq. *Iraqi Bulletin of Geology and Mining* **10**(1): 73-92.

Hamail AF, Hamada MS, Tartoura EA and Abd El-Hady MA 2014. Effect on N forms and some bio-stimulants on productivity of cucumber vegetative growth and chemical constituents. *Journal of Plant Production* **5**(2): 241-253.

Kadhum AJ, Abdullah AA and Al Shuwaili MS 2011. The effect of nitrogen fertilization and export process on the growth and yield of cucumber (local variety). *Basra Research Journal* **37**(2): 81-88.

Muhmmad N, Mumtaz AC, Muhammad A, Noor A and Muhammad Z 2007. Effect of source and method of nitrogen fertilizer application on seed yield and quality of canola (*Brassica napus* L). *Pakistan Journal Agriculture Science* **44**(1): 74-78.

Nori M, Javad A and Reza SA 2012. Effect of different sources and levels of nitrogen fertilizer on yield and nitrate accumulation in garlic (*Allium sativum* L.). *International Journal of Agriculture and Crop Sciences* **4**(24): 1878-1880.

Yruela I 2009. Copper in plants: acquisition, transport and interactions A Review. *Functional plant Biology* **36**:409-430.

Zhu Q and Qiang M 2012. Copper-based foliar fertilizer and controlled release urea improved plant growth and yield of tomato. *Scientia Horticulturae* **143**: 109-114.

Received 27 March, 2020; Accepted 15 July, 2020