I. M. El-Gamal / ICEHM2000, Cairo University, Egypt, September, 2000, page 525- 533

INTERACTION BETWEEN COBALT AND SALINITY ON THE PLANT GROWTH

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ABSTRACT

An Experiment was designed to study the interaction effect of Co salt and salinity on the growth of two tomato varieties differing in their salt tolerance. Three seedlings of each plant were transplanted to each pot, and the pots were irrigated with nutrient solution of Arnon having different levels of NaCl and Cobalt . After 5 weeks the plants were harvested. It was observed that dry matter yield of shoots, roots and whole plant for both two varieties consistantely decreased with increasing NaCl concentration. There was a significant interaction between NaCl salinity and cobalt levels on the dry matter yields of shoots, roots and whole plant for both two varieties.

Key words = Cobalt, Salinity, Sodium chloride,

INTRODUCTION :

Salinity is known to retard plant growth through its influence on several facts of plant behaviour like osmotic adjustment, ion uptake, protein and nucleic acid synthesis. Photosynthesis , enzyme activities and hormonal balance. Plants subjected to saline conditions after the early seeding stage rapidly resumed normal growth rate when the stress was removed but plants subjected to stress during the early seeding stage did not. Dumbroff and Cooper (1974) on the other hand state that the toxic effects of Co on crops grown on the field are not likely to occur, on the contrary, "favourable effects can be expected as a result of cobalt application". Cobalt probably is essential element, the adequate supply might be necessary to maintain a high production, Pettersson (1976). A concentration of 1.5 mM Co gave maximum

beneficial effects without injury to the cut flower , while 2.0 mM Co was toxic to the leaves. Venkatarayappa et al. (1980) . With oats in soil-pot experiments, obtained slight yield increases by adding small amounts of Co to the soil. In addition there was a significant interaction between NaCl salinity and cobalt levels on the dry matter yields of shoots, roots, and whole plant (Nikolic, 1956).

The best beneficial effect of both treatments on plant growth was obtained at 150 mM NaCl and 0.25 ppm cobalt. The effect of 4 levels of NaCl (180. 420, 1310 and 19200 ppm) in the irrigation water on yield and content of the leaves was correlated with yield; this correlation was better when older leaves were sampled, Cerda et al (1977).

The aim of the present study is to investigate the interaction between cobalt and salinity on the growth of two tomato varieties differing in their salt tolerance such as Edcawy and Monymaker.

MATERIALS AND METHODS

An experiment was first conducted to examine the sensitivity of tomato plants to cobalt.

There were selected varieties of tomatos, i.e. Edcawy and Monymaker which showed a wide range of salt tolerance which were used in this study . The sand culture technique was used, and polyethylene pots were irrigated with nutrient solution of (Arnon, 1938) having different levels of cobalt as Co $S0_4.7H_20$ within the period extending from 5 to 12 weeks. The plants treated with cobalt received 0, 0.25, 0.50, 0.75, 1.5, 3 and 5 ppm. At the end of the experiment the plants were harvested, separated into shoots and roots, rinsed with redistilled water and were oven dried at 27°C for dry weight determination . On the other hand, tomato plants were grown and received 7 ppm cobalt for 12 weeks from planting. Thereafter, the concentration of cobalt in the nutrient solution increased stepwise daily till the concentration of cobalt reached 25 ppm, when the visible toxic symptoms were observed. On the other hand, the second experiment was designed to study the interaction between salinity and cobalt on the growth for two tomato varieties differing in their salt tolerance such as Edcawy and

Monymaker. Three seedlings of each plant were transplanted to each pot, and the pots were irrigated with nutrient solution of Arnon (1938) having different levels of NaCl and cobalt . Sodium chloride was added in different concentrations, i.e., 0.00 control, 75,125, 200 and 300 mM. Cobalt was added as $CoS0_4.7H_20$ in 5 levels such as, 0.00,0.50,1.50,3 and 5 ppm. Plants were harvested after 5 weeks from transplanting . Each treatment was replicated three times . The material was oven dried at 72°C and analysed.

RESULTS AND DISCUSSIONS

PLANT TOLERANCE TO COBALT

The relative tolerance to cobalt concentration of Monymaker tomato varieties which showed a wide range of salt tolerance was estimated using sand culture experiment. Data reported in Table (1) and figure (1) show that increasing cobalt concentrations in the cultural media up to 0.5 ppm stimulated the growth of dry matter yield for both two varieties. Whenever, beyond that levels the dry matter yield of both two varieties were adversely affected by cobalt treatment and this effect was more pronounced on shoots than roots. These results are similar to those found by Pettersson (1976) and Kabata and Pendias (1984).

COBALT TOXICITY SYMPTOMS :

Increasing the rate of cobalt application stepwise in the medium up to 25 ppm led to toxicity to tomato plants.

Whenever the condition progressed , 12 ppm cobalt , the white spotting was not confined to the middle parts , but involved parts scattered over the entire leaf.

Excessive amounts of cobalt in the cultural media up to 20 ppm led to scorching the brown spotting and leaves appeared mottled . On the other hand leaves exhibited epinastic curling and dark reddish – brown discolouration of veins , including the major veins . Severe damage was observed by excessive amounts of cobalt up to 25 ppm.

The leaves became brown , withered and fall from the plant.

SALINITY AND COBALT INTERACTION IN PLANTS

Data in tables (2 and 3) reveal that the dry matter yield of shoots , roots and whole plant of both two varieties consistantely decreased with increasing NaCl concentration.

These results are in agreement with those obtained by O'Leary (1974) and Rush and Epstein (1981) .

Whenever the relative yield of shoots , roots and whole plants of Edcawy were les affected upon increasing NaCl concentrations than that of Monymaker. These results are similar to those found by Bernstein (1964).

A comparison of the yields of the two varieties , show that Monymaker gave higher yields at a concentration ranging from 0.00 to 125 mM NaCl for shoots and from 0.0 to 200 mM NaCl for roots and whole plants . On the contrary, at higher concentrations of NaCl , Edcawy produced more dry matter yields than Monymaker, indicating that Edcawy variety was more salt tolerant than another variety .

On the other hand, the increasing levels of cobalt up to 1.5 ppm was associated with significant increase in dry matter yield of both two varieties . In addition, increase in cobalt beyond that level was, however , followed by a significant decrease in the dry matter yield of both varieties . Increasing the dry matter yield as a result of cobalt applications was also observed by Nikolic (1956), who obtained slight yield increases by adding small amount of cobalt to the soil.

It can be also seen that there was a significant interaction between NaCl – salinity and cobalt levels on the dry matter yields of shoots , roots and whole plant for both two varieties .

Thus it could be concluded that the best beneficial effect of both treatments on plant growth was obtained at 200 mM NaCl and 1.5 ppm cobalt for both Edcawy and Monymaker varieties. These results are in agreement with those found by Nikolic (1956) and Shalhevet and yaron (1973) .

Table (1): Influence of different concentrations of cobalt appliction(ppm) on the dry matter yield of tomato Varieties

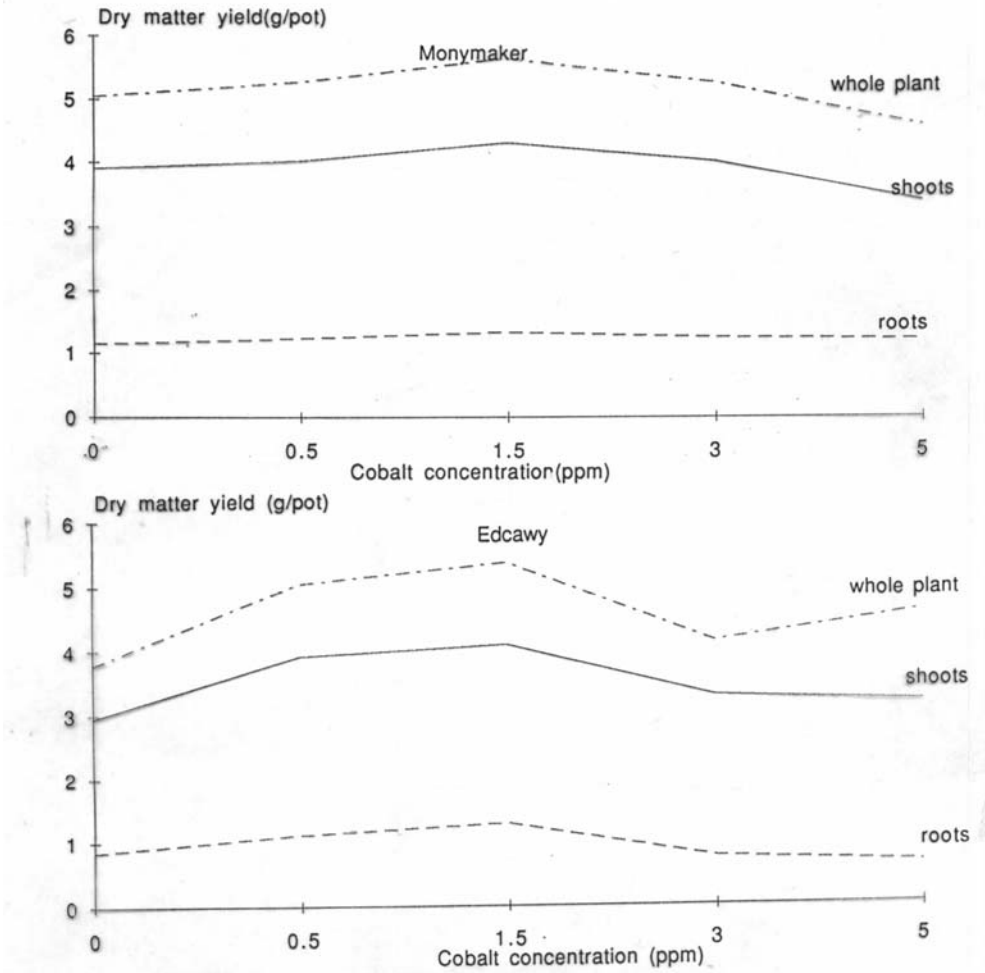
cobalt Concentration (ppm)	Edcawy			Monymaker		
	shoots	roots	whole plant	shoots	roots	whole plant
0.0	3.54	.91	4.45	5.34	1.5	6.84
.25	3.70	.93	4.63	5.39	1.54	6.93
0.5	3.74	1.80	5.91	5.81	1.93	7.74
.75	4.11	.87	4.28	4.80	1.31	6.11
1.5	3.41	.83	3.64	7.73	1.25	5.98
3.0	2.81	.73	3.34	3.93	1.11	5.04
7.0	2.61	0.59	2.69	2.87	0.92	3.79
L.S.D. 0.05	0.25	0.07	0.28	0.35	0.11	0.50

Table (2): Influence of different concentrations of Co and NaCl on the dry matter yield (g/Pot) of tomato plant(Monymaker Variety)

Nacl Concentration (mM)	Cobalt Concentration (ppm) 0.0	0.5	1.5	3.0	5
			Shoots		
0.0 mM	5.3	5.4	5.6	5.4	4.8
75 mM	4.8	4.99	5.4	5.1	3.8
125 mM	4.7	4.81	4.5	4.2	3.7
200 mM	2.8	2.93	3.7	3.3	2.8
300 mM	1.9	1.99	2.3	2.0	1.73
Average	3.9	4.02	4.3	4.0	3.4
L.S.D. 0.05	NaCl=0.30	Cobalt=0.28	Cobalt×NaCl	=0.6o	
			Roots		
0.0 mM	1.8	1.9	2.0	1.8	1.8
75 mM	1.6	1.8	1.7	1.8	1.7
125 mM	0.9	0.9	1.0	0.9	0.9
200 mM	0.8	0.8	0.9	0.9	0.9
300 mM	0.6	0.7	0.9	0.8	0.7
Average	1.1	1.2	1.3	1.2	1.2
L.S.D.. 0.05	NaCl=0.08	Cobalt=0 .07	Cobalt×NaCl	=0.16	
			Whole Plant		
0.0 mM	7.1	7.3	7.6	7.2	6.6
75 mM	6.4	6.8	7.3	6.9	5.6
125 mM	5.6	5.7	5.5	5.1	4.6
200 mM	3.6	3.6	4.6	4.2	3.7
300 mM	2.5	2.7	3.2	2.8	2.4
Average	5.0	5.3	5.6	5.2	4.6
L.S.D. 0.05	NaCl=0.29	Cobalt =0.26	Cobalt×NaCl	= 0,62	

Table (3): Influence of different concentrations of Co and NaCl on the dry matter yield (g/Pot) of tomato plant(Edcawy Variety)

Nacl Concentration (mM)	Cobalt Concentration (ppm) 0.0	0.5	1.5	3.0	5
			Shoots		
0.0 mM	3.70	4.80	4.95	3.45	3.39
75 mM	3.61	4.30	4.80	3.11	3.05
125 mM	2.63	3.90	3.91	3.83	3.70
200 mM	2.51	3.80	3.88	3.50	3.31
300 mM	2.25	2.70	2.80	2.40	2.30
Average	2.94	3.80	4.07	3.26	3.15
L.S.D. 0.05	NaC1=0.14	Cobalt=0.12	NaC1×Cobalt	=0.26	
			Roots		
0.0 mM	0.99	1.3	1.5	0.99	0.88
75 mM	0.93	1.25	1.43	0.91	0.97
125 mM	0.81	1.20	1.38	0.66	0.52
200 mM	0.77	0.99	1.15	0.64	0.48
300 mM	0.65	0.83	0.92	0.56	0.42
Average	0.83	1.11	1.28	0.75	0.62
L.S.D. 0.05	NaC1=0.8	Cobalt=0.7	NaC1×Cobalt	=0.12	
			Whole Plant		
0.0 mM	4.69	6.10	6.45	4.44	4.27
75 mM	4.54	5.55	6.23	4.02	3.84
125 mM	3.44	5.10	5.29	4.49	4.22
200 mM	3.28	4.79	5.03	4.14	3.79
300 mM	2.90	3.53	3.72	3.36	2.72
Average	3.77	5.63	5.34	4.11	4.54
L.S.D. 0.05	NaCl=0.16	Cobalt=0.11	NaC1×Cobalt	=0.28	



FIGURE(1)EFFECT OF Co CONCENTRATION ON THE DRY MATTER YIELD OF TOMA TO PLANT

REFERENCES

Arnon . D. I . (1938) : Microelements in culture solution experiments with higher plants . American J.Botany .25 : 322 – 328 .

Bernstein . L. (1964) : Effects of salinity on mineral composition and growth of plants. Plat Anal . Fert . Prob . 4 :25-45 .

Cerda , A; Fernandez , F.G . and Caro , M. (1977) : Effect of sodium Chloride in irrigation water on yield and quality of tomatoes . Agrochimica 21 : 295-304 . (C.E .Soils and Fert . 44 : 2753 ,1981).

Dumbroff, E.B . and Cooper , A .W .(1974) : Effects of salt stress applied in balanced nutrient solutions a several stages during growth of tomato. Bot. Gaz. 135 : 219- 224 .

Kabata – Pendias, A, and Pendias (1984) : Trace elements in soils and plants CRCP , pp. 154 –163 .

Nikolic . S . (1956) : The action of Nickel , Cobalt , and fluorine in the nutrition and fertilization of plants . Centre Intern . Engrais Chim. (Velgrade) 1 : 195 –218 .

O'Leary , J.W. (1974) : Development and reversal of plant responses to salinity and water stress. Miscellaneous publication , United States Department of Agriculture No . 1271 : 14-24 .(C.F. Soil and Fert . 37 : 2845 ,1974) .

Pettersson , O . (1976) : Heavy metal ion uptake by plants from nutrients solutions with metal ion , plant species and growth period variations . Plant and soil 45 :445-459 .

Rush , D.W . and Epstein , E. (1981) : Comparative studies on the sodium ,Potassium , and Chloride Relations of a wild malophytic and a Domestic Salt – Sensitive Tomato species. Plant physiol . 68 : 1308 –1313 .

Shalhevet ; J. and Yaron , B.(1973) : Effect of soil and water salinity on tomato growth. Plant and Soil 39 : 285 –292 .

Venkatarayappa, T.; Tsujita , K.S.; Murr, D.P. (1980) : Influences of cobaltous ion (Co^{+2}) on the postharvest behaviour of "samantha" roses. Journal of the American Society for hortic . Abs. 105:148 –151.

التأثير المتبادل للملوحة والكوبلت على نمو النبات

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الملخص العربى

أجرى هذا البحث لدراسة تأثير كل من الملوحة وعنصر الكوبلت على نمو نباتات الطماطم واستخدام لإجراء تلك الدراسة نوعان من الطماطم الأول يتحمل الملوحة Edcawy والأخرى حساس للملوحة Monymaker حيث عوملت التربة التى ينمو بها النباتات بتركيزات مختلفة من كل من محلول كلوريد الصوديوم ، وكبريتات الكوبلت .

حيث لوحظ من نتائج الدراسة ما يلى :

1- إنه بزيادة إضافة محلول كلوريد الصوديوم أدى إلى انخفاض كمية المادة الجافة فى كل من المجموع الجذرى والخضرى .

2- زيادة إضافة محلول كلوريد الصوديوم أظهر نوع نبات Edcawy (يتحمل الملوحة) استجابة لزيادة المادة الجافة بمقدار أكثر من النوع Monymaker (حساس للملوحة) .

3- أن إضافة كبريتات الكوبلت بوجه عام أدى إلى زيادة كمية المادة الجافة فى كل من المجموع الجذرى والخضرى