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EFECT OF ELEMENTS FROM SCANDIUM AND LANTHANID GROUPS ON GROWTH AND MORPHOLOGICAL CHARACTERS OF YOUNG SUNFLOWER PLANTS

Bai Bao-Zhang, R. Kastori
and N. Petrović

Jilin Agricultural University, Changchum, FR China
Faculty of Agriculture, Novi Sad, Yugoslavia

SUMMARY

The effect of the preparation "Agricultural Happy NL-1", which contains elements from scandium and lanthanid groups on some morphological and physiological characters of young sunflower plants was studied. Different concentrations of the preparation and treatments were used.

The presence of the elements from scandium and lanthanid groups in the nutritive solution considerably affected the growth and development of sunflower plants. The lower concentrations of these elements, at the stages of two pairs of leaves, increased the length and mass of stem, the area of cotyledons, the length, volume and mass of roots and chloroplast pigments content in leaves. The highest studied concentracion ($100\,\mu g \cdot g^{-1}$) increased the mass and specific mass of leaves. At the stage of four pairs of leaves, all parametrs had highest values with the concentration of $50\,\mu g \cdot g^{-1}$ of the preparation in the nutritive solution.

The pre-sowing treatment of seeds with low concentrations of the preparation (2000 or $3000\,\mu g \cdot g^{-1}$), for plant growth in soil culture, increased the following parameters: the height and mass of stem, the mass and area of leaves, chloroplast pigment content in leaves and root mass. Seed treatment with the highest concentration ($5000\,\mu g \cdot g^{-1}$) was inhibitory.

The obtained results showed that certain concentrations of the elements from scandium and lanthanid groups may affect favorably the growth of young sunflower plants, although these elements are not considered essential.

INTRODUCTION

It has been observed in numerous trials that the salts of certain elements or mineral fertilizers, in dependence of their concentration, chemical structure and method of application may either stimulate or inhibit seed germination and initial growth of plants (S z a b o, 1974; D u r a n t et al. 1974; K a s t o r i, 1984). So far, effects of essential macro and micro elements have mostly been studied. The effect of non-essential elements on geramination and initial plant growth is less known. The elements from scandium and lanthanid groups fall in the latter group, although first papers concering their effect on plants were published almost half a century ago (Z h o u, 1984). Considering the above, as well as the fact that the application of these elements by some authors (N i n g, 1983, 1984; H u n g et al. 1983; N i n g et al., 1985; X i e and Y u, 1986) has rendered some positive results with respect to yield and quality of some crops, we found it interesting to

study the effect of these elements on the growth and some physiological characters of young sunflower plants.

MATERIALS AND METHODS

In this experiment, we studied the effect of a preparation manufactured by Shangqio Chemical Industry, Henan Province, FR China, bearing the commercial name "Agicultural Happy NL-1". This preparation contains elements from the scandium group (Sc, Y, La, Ac) and lanthanides (Ce, Pr, Nd, Pm, Sm, Eu, Cd, Tb, Dy, Ho, Er, Tm, Yb and Lu). The trials were conducted in water and soil cultures with the sunflower hybrid NS-H-43.

Experiment in water culture. - Sunflower seeds were germinated in quartz sand in a thermostat, at the temperature of 25°C. When the seedlings reached the height of 4-5 cm, they were transferred to the Hoagland nutritive solution with different concentration of the preparation: 0, 5, 10, 50 and 100 $\mu g \cdot g^{-1}$. The effect of the preparation on some morphological and physiological characters of young sunflower plants was followed during the stages of two and four pairs of leaves. The following parameters were measured: length and mass of stem; area; mass and specific mass of leaves; cotyledon area; mass, length and volume of roots and the content of chloroplast pigments in leaves. In both experiments leaf area was determined photoelectrically and pigment concentration spectrophotometrically in acetone extract. The results were statistically proccessed by determining the least significant difference.

Experiments in soil culture. - Sunflower seeds were sown in pots filled with a chernozem soil of low alkaline reaction (pH 7,14), wich contained: 2.06% of humus, 0,14% of N, 1.46% of $CaCO_3$, 38,0 mg of P_2O_5 and 34,9 mg K_2O in 100 g of soil. Prior to sowing the seed was kept for 24 hours at room temperature in the solutions of the preparation with the concentracion of: 0, 1000, 2000, 3000, 4000 and 5000 $\mu g \cdot g^{-1}$. As in the previous experiment the measurements were perfomed at the stages of two and four pairs of leaves. The following parametrs were measured: height and mass of stem; mass and area of leaves, root mass and the content of chloroplast pigments in leaves.

RESULTS

The presence of elements from scandium and lanthanid groups in the nutritive solution favorably affected the growth of young sunflower plants at both stages of growth (Table 1). At the stage of two pairs of leaves, the most favorable effect on most of the studied parametrs was obserwed with the concentrations from 5 to 50 $\mu g \cdot g^{-1}$. The exceptions were the mass and the specific mass of leaves which were highest with the highest studied concentrations of 100 $\mu g \cdot g^{-1}$. A significant increase of the specific mass of leaves in the presence of a high concentration of the preparation was also determined in soybeans in an earlier investigation of ours. At the stage of four pairs of leaves, all parameters studied had highest values with the concentration of 50 $\mu g \cdot g^{-1}$. The content

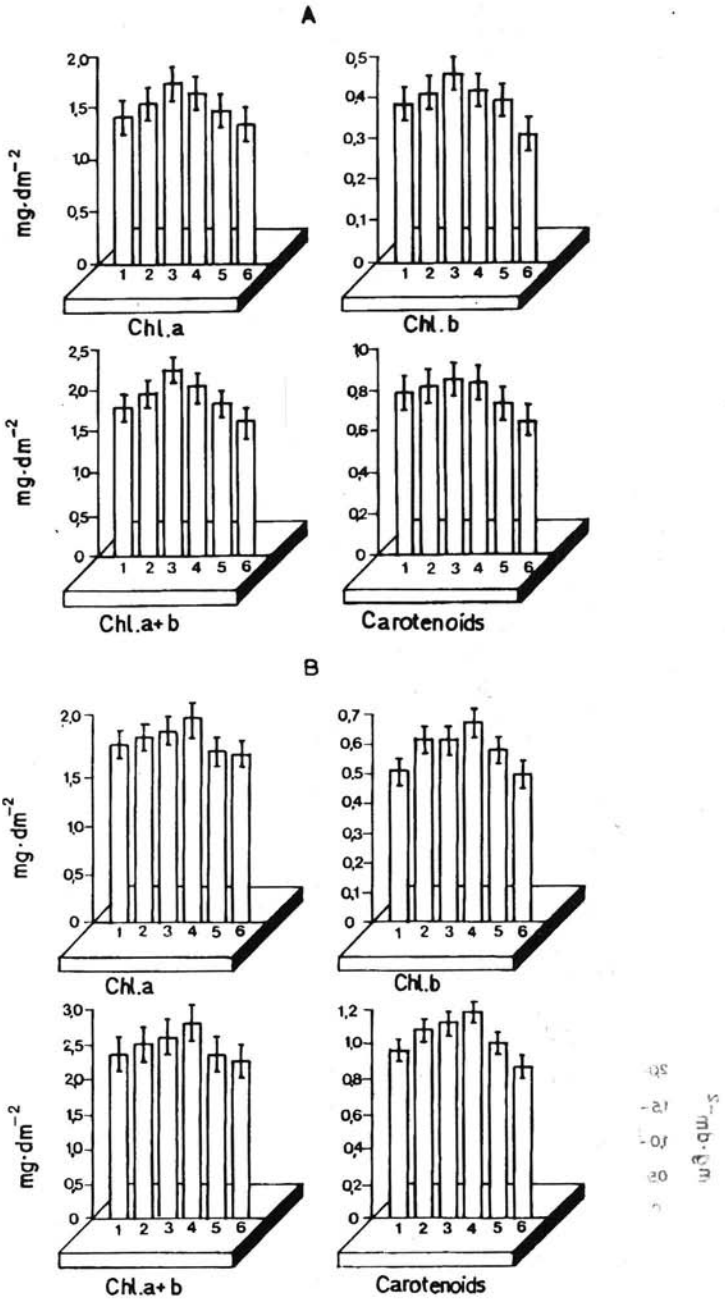

Fig. 1. Chloroplast pigment content in leaves of young sunflower plants grown in nutritive solution containing different concentrations of elements from scandium and lanthanid groups at the stage of two (A) and four (B) pairs of leaves. 1 - control; 2 - 5; 3 - 10; 4 - 50; 5 - 100 $\mu g/g$

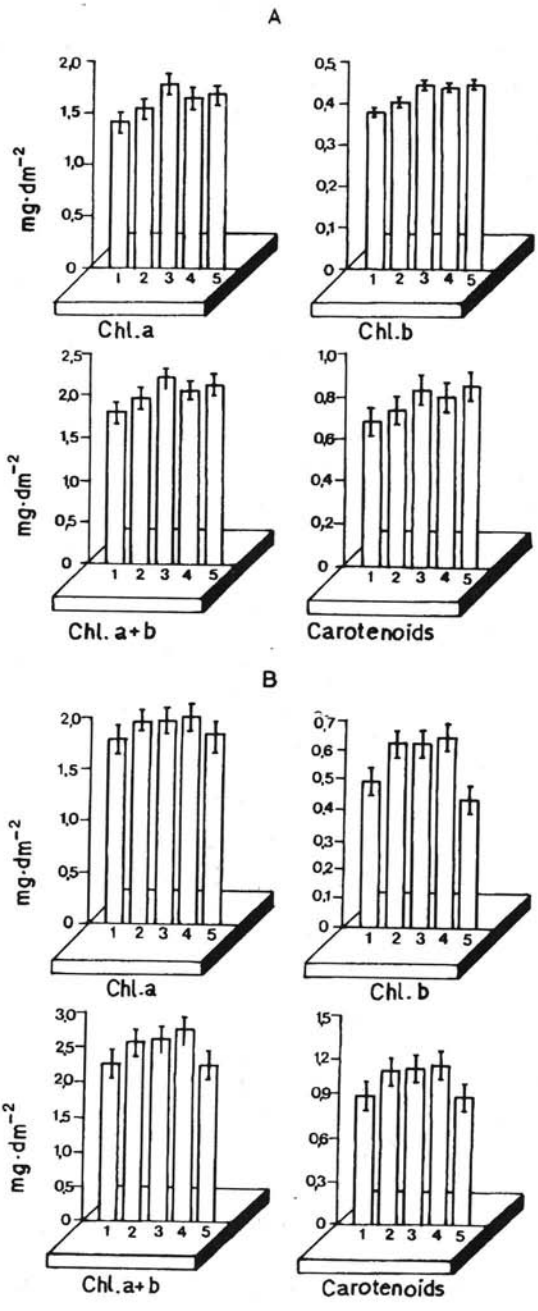

Fig. 2. Effect of pre-sowing treatment of seed with different concentrations of elements from scandium and lanthanid groups on chloroplast pigments content in leaves of young sunflower plants at the stage of two (A) and four (B) pairs of leaves. 1 - control; 2 - 1000; 3 - 2000; 4 - 3000; 5 - 4000; 6 - 5000 $\mu g/g$

of chloroplast pigments, chlorophyll a and b and carotenoids at the stage of two pairs of leaves were highest with the concentration of 10 $\mu g \cdot g^{-1}$ of the preparation and at the stage of four pairs of leaves, the content were highest with the concentration of 50 $\mu g \cdot g^{-1}$. The highest concentration of chloroplast pigments coincided in most cases with the concentrations of the preparation which brought the highest values of most of the studied parameters (Fig. 1 A and B).

Tab. 1. - The growth of young sunflower plants in nutritive solution containing different concentrations of elements from scandium and lanthanid groups

Parametar	Concentration $\mu g \cdot g^{-1}$					LSD	
	0	5	10	50	100	5%	1%
			Stage of two pairs of leaves				
Stem length ($cm \cdot plant^{-1}$)	20.42	25.72	27.17	25.28	23.50	1.7	2.2
Stem dry mass ($mg \cdot plant^{-1}$)	64.33	84.22	88.11	83.78	81.78	7.3	9.5
Leaf area ($cm^2 \cdot plant^{-1}$)	33.29	36.24	36.88	36.84	36.14	2.4	3.1
Leaf dry mass ($mg \cdot plant^{-1}$)	75.92	84.79	80.07	88.32	90.98	8.6	11.1
Specific leaf mass ($mg \cdot dm^{-2}$)	163.03	166.82	163.80	170.61	176.30	14.2	18.5
Cotyledon area ($cm^2 \cdot plant^{-1}$)	15.90	17.18	15.79	13.93	14.23	1.6	2.1
Root dry mass ($mg \cdot plant^{-1}$)	38.67	43.45	44.33	47.67	41.06	4.0	5.2
Root volume ($cm^3 \cdot plant^{-1}$)	0.64	0.80	0.90	0.92	0.84	0.05	0.06
Root length ($cm \cdot plant^{-1}$)	15.90	17.18	15.79	13.93	14.23	1.2	1.6
			Stage of four pairs of leaves				
Stem length ($cm \cdot plant^{-1}$)	46.27	48.65	53.05	54.30	50.01	3.7	4.8
Stem dry mass ($mg \cdot plant^{-1}$)	424.87	466.39	508.84	552.39	468.50	47.5	61.7
Leaf area ($cm^2 \cdot plant^{-1}$)	114.99	115.20	126.53	129.20	121.49	10.6	13.8
Leaf dry mass ($mg \cdot plant^{-1}$)	248.42	274.50	293.95	309.51	249.88	21.8	28.3
Specific leaf mass ($mg \cdot dm^{-2}$)	201.74	231.23	228.24	242.83	207.67	18.6	24.2
Root dry mass ($mg \cdot plant^{-1}$)	113.18	126.80	134.07	146.22	115.86	10.7	13.9
Root volume ($cm^3 \cdot plant^{-1}$)	1.70	2.08	2.44	2.83	1.81	0.12	0.16

The pre-sowing seed treatment with different concentrations of the studied preparation affected positively the growth of the above-ground parts of young sunflower plants, i.e., stem and leaves, as well as the mass of roots. At the stage of two pairs of leaves, the most favorable effect of the pre-sowing seed treatment was recorded with the concetration of 2000 $\mu g \cdot g^{-1}$. At the stage of four pairs of leaves, the concentration of 3000 $\mu g \cdot g^{-1}$ was most favorable (Table 2). The same concentrations rendered the highest chloroplast pigments content in leaves (Fig. 2 A and B).

Tab. 2. Effect of pre-sowing treatment of seed with different concentrations of elements from scandium and lanthanid groups on the growth of young sunflower plants

Parametar	Concentration $\mu g \cdot g^{-1}$						LSD	
	0	1000	2000	3000	4000	5000	5%	1%
				Stage of two pairs of leaves				
Stem length (cm·plant^{-1})	17.44	18.32	19.46	18.92	15.75	15.62	1.6	2.1
Stem dry mass (mg·plant^{-1})	51.01	52.71	67.41	62.00	51.13	50.27	6.4	8.3
Leaf area (cm^2·plant^{-1})	26.01	26.79	29.39	26.88	25.15	23.45	2.7	3.5
Leaf dry mass (mg·plant^{-1})	65.33	69.93	79.53	71.61	64.93	7.1		9.2
Root dry weight (mg·plant^{-1})	33.80	34.99	41.03	36.18	32.26	29.63	2.9	3.8
				Stage of four pairs of leaves				
Stem length (cm·plant^{-1})	40.50	43.68	49.71	50.42	40.75	39.07	4.8	6.3
Stem dry mass (mg·plant^{-1})	377.73	416.57	465.06	491.22	382.26	369.53	35.4	46.0
Leaf area (cm^2·plant^{-1})	110.03	112.24	122.23	127.61	117.29	99.82	11.4	14.7
Leaf dry mass (mg·plant^{-1})	234.33	241.71	289.32	293.96	263.45	207.01	28.3	36.8
Root dry mass (mg·plant^{-1})	106.19	114.54	120.70	122.08	108.18	98.09	14.1	18.4

DISCUSION

On the basis of the present knowledge of the physiological and biochemical roles of particular elements, it is impossible to explain satisfactorily the favorable effect of scandium and lanthanid groups on the growth and development of sunflower plants. These elements are neither counted in essential elements for higher plants, nor it is known that they take part in vital processes in living organisms in general. Numerous investigations, however, indicate that non-essential elements may stimulate the metabolism and thus the growth, development, chemical structure and yield of plants. For example, P e t r o v i ć (1980) determined the favorable effect of nickel, K a s t o r i and P e t r o v i ć (1984) of fluor, D i e h l (1983) of lead, P a i s (1983, 1985) of titane, on the

growth and yield of some crops. It can only be guessed how these and the non-essential elements stimulate vital processes in plants.

Perhaps they affect the hydration of coloids of the protoplasm, or act antagonistically or synergistically with some essential elements. In any case, on the basis of the known facts on the role of certain elements in plant nutrition, their effect on vital processes of plants could only be indirect. Hower, it is not impossible that some elements considered abiogenic are soon found to play a significant role in plant metabolism, including the elements from scandium and lanthanid groups. The more so, N i n g (1984) found that rare earth elements may affect the activity of numerous enzymes: nitrate-reductase, dehydrogenase, peroxidase etc., the content of chloroplast pigments, the uptake of mineral substances, the intensity of photosynthesis, etc.

CONCLUSIONS

The effect of the preparation "Agricultural Happy NL-1", which contains elements from scandium and lanthanid groups on some morphological and physiological characters of young sunflower plants was studied. Different concentrations of the preparation and treatments were used.

The presence of the elements from scandium and lanthanid groups in the nutritive solution considerably affected the growth and development of sunflower plants. The lower concentrations of these elements, at the stages of two pairs of leaves, increased the length and mass of stem, the area of cotyledons, the legth, volume and mass of roots and chloroplast pigments content in leaves. The highest studied concentration (100 $\mu g \cdot g^{-1}$) increased the mass and specific mass of leaves. At the stage of four pairs of leaves, all parameters had highest values with the concentration of 50 $\mu g \cdot g^{-1}$ of the preparation in the nutritive solution.

The pre-sowing treatment of seeds with low concentrations of the preparation (2000 or 3000 $\mu g \cdot g^{-1}$), for plant growth in soil culture, increased the following parameters: the height and mass of stem, the mass and area of leaves, chloroplast pigments content in leaves and root mass. Seed treatment with the highest concentration (5000 $\mu g \cdot g^{-1}$) was inhibitory.

The obtained results showed that certain concentrations of the elements from scandium and lanthanid groups may affect favorably the growth of young sunflower plants, although these elements are not considered essential.

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EFFETS DES ELEMENTS APPARTENANT AUX GROUPES DES SCANDIUM ET DES LANTHANIDES SUR LA CROISSANCE ET SUR LES CARACTERES MORPHOLOGIQUES DE JEUNES PLANTS DE TOURNESLOL

Bao-Zhang, B., Kastori, R. & Petrović, N.
Institute of Biology, Novi Sad, Yugoslavia

Nous avons étudié lés effets de la préparation "Agricultural Happy NL-1" (contenant des élements appartenant aux groupes des scandium et des lanthanides) sur certains caractéres morphologiques et physiologiques de jeunes plants de tournesol. Différentes concentrations ainsi que différents modes de traitment ont étè testés.

La présence d'élèments de type scandium et lanthamides ont considérablement affecté la croissance des plantes de tournesol. Les plus faibles concentrations de ces élèments au stade deux paires de feuilles, augmentent la longueur et la masse des tiges, la surface des cotyledons, la longueur, le volume et la masse des racines et le contenu en pigments chloroplastiques des feuilles. La plus forte concentration étudiée (100 μ g/g) augmente la masse et la masse spécifique des feuilles. En solution nutritive et au stade quatre paires de feuilles, tous les paramétres ont présenté des valeurs supérieures pour la concentration de 50 μ g/g.

Le traitement en prè-semis des graines avec une faible concentration (2000 ou 3000μ g/g), pour des plantes cultivées en plein sol, provoque une augmentation des paramétres suivants: Hauteur et masse de la tige, masse et surface des feuilles, contenu en pigments chloroplastiens des feuilles et masse des racines. Le traitement des graines avec la plus forte concentration (5000 μ g/g) s'est révéle inhibiteur.

Les résultats obtenus montrent que sous certaines concentrations, les éléments appartenant aux groupes des scandium et des lanthanides peuvent influer favorablement la croissance de jeunes plants de tournesol, bien que ces éléments n'appartiennent pas au groupe des éléments essentiels.

EFFETO DE LOS ELEMENTOS DEL GRUPO DEL ESCANDIO Y DEL LANTANO EN SOLUCION NUTRITIVA, SOBRE EL CRECIMIENTO Y ALGUNAS CARACTERISTICAS MORFOLOGICAS DE PLANTULAS DE GIRASOL

Bao-Zhang, B., Kastori, R. & Petrović, N.

El efecto de algunos elementos químicos del grupo del Escandio y del Lantano en la solucion nutritiva "Agricultural Happy NL-1" en algunas características morfológicas y fisiológicas de plántulas de girasol ha sido estudiado con diferentes concentraciones y tratamientos de la misma.

La presencia de estos elementos en la solución nutritiva afectó considerablemente el desarrollo de las plantas. Una baja concentración de estos elementos en el estado de dos pares de hojas aumentó la longitud y el peso de los tallos el área cotiledonar, la longitud, volumen y masa de las raices asi como el contenido en cloroplastos en las hojas. La concentración mas alta estudiada (100 $\mu g/g$) aumentó el peso y el peso específico de las hojas. En el estado de 4 pares de hojas, todes los parámetros tomaron los valores mas elevados en la concentracion de 50 $\mu g/g$.

Los tratamientos de presiembra de la semilla con concentraciones bajas (2000 o 3000 $\mu g/g$) para sembrar en suelo, influyeron, aumentado los siguientes parámetros: altura y peso del tallo, peso y área de las hojas, contenido de pigmentos cloroplásticos en las hojas y peso de la raiz. El tratamiento de semilla con la concentración mas alta (5000 $\mu g/g$) inhibió el crecimiento.

Los resultados obtenidos muestran que ciertas concentraciones de elementos químicos del grupo del Escandio y del Lantano pueden afectar favorablemente el crecimiento de las plantulas de girasol, aunque estos elementos no sean considerados esenciales.