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CONCENTRATION OF N, P, K, AND DRY MASS IN SUNFLOWER INBREDS AS DEPENDENT UPON MINERAL NUTRITION

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SUMMARY

Element concentration and the organic matter synthesis were studied in five sunflower inbreds. Plant material was obtained from the Institute of Field and Vegetable Crops, Faculty of Agriculture, Novi Sad. The sunflower inbreds were characterized by the same growing season. The plants were grown by the method of water cultures using various concentrations of nutrient solution (1/8 and 1/2 strength of that described by Reid–York serving as control (1), and 2 and 3 times higher than the control solution).

Dry mass of above–ground part and root, as well as concentration of certain elements of mineral nutrition were examined. The results obtained show that dry mass of above–ground part and root depended upon inbred line and variant of mineral nutrition. On average, the highest dry mass was found in the inbred O–CMS–31, the lowest in O–CMS–25 and O–CMS–41. Also, significant differences in concentration of the elements analyzed, depending on inbred line, were established. On average, the highest N concentration was recorded in the line O–CMS–31, the lowest in O–CMS–6, the lowest in O–CMS–21. Also, concentration of N, P, and K in plant tissue increased as concentration of all elements in nutrient solution increased.

INTRODUCTION

The requirements for different elements of mineral nutrition are different in certain plant genotypes. This problem has been elucidated from both theoretical and practical standpoints. The literature data available in most part deal with maize, sugar beet, and wheat problems while relatively little work has been published on the genetic specificity of mineral nutrition in sunflower (Harvey, 1939; Madhok and Walker, 1969; Foy et al., 1974; Sarić and Škorić, 1981; Kastori and Stanković, 1985; Krstić and Sarić, 1987).

As it is well–known, certain plant species are characterized by lower or higher concentration of mineral elements when they are grown under the same conditions. The diferences thus obtained are due to different genotype characters. Although new indicators for establishing the presence of the genetic specificity of mineral nutrition in plants have been defined, concentration of elements in plant tissue represents one of most frequently used. This particular parameter shows and therefore indicates the efficiency in uptake of certain ions by different genotypes. Consequently, studies with parameters such as concentration of N, P, and K, as well as dry mass of plant tissue were conducted in an attempt to analyze the response of sunflower inbreds to different concentrations of nutrient solution.

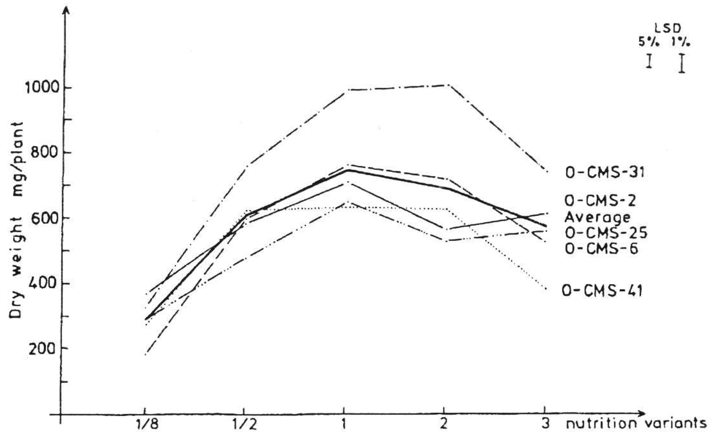

Fig. 1. Dry weight of above-ground part in sunflower inbred lines

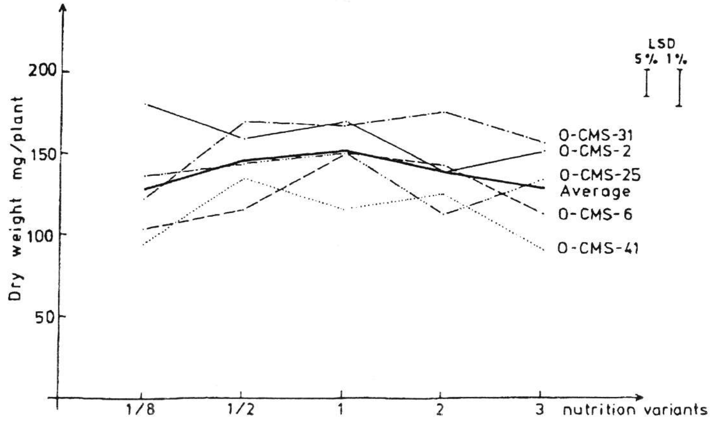

Fig. 2. Dry weight of root in sunflower inbred lines

MATERIAL AND METHODS

Five sunflower inbreds (O–CMS–2, O–CMS–6, O–CMS–25, O–CMS–31, and O–CMS–41) were grown by the method of water cultures under the greenhouse conditions for 25 days. The following concentrations of nutrient solution were used: 1/8 and 1/2 strength of that described by R e i d and Y o r k (1958), full nutrient solution (1), and 2 and 3 times higher concentration than that of the control solution. Dry mass of above–ground part and root, as well as concentration of certain elements were examined. Dry mass was determined by drying at 105°C while the Kjeldahl method was employed for N analysis, P was analyzed spectrophotometrically after G e r i c k e and K u r m i e s (1955), and K by flame photometry.

The data obtained were processed statistically (LSD – test).

RESULTS AND DISCUSSION

Dry mass. Dry mas of both above–ground part (Fig.1) and root (Fig.2) depended not only upon inbred line but also upon nutrition variant employed. On the average and irrespective of nutrition variant, the highest dry mass of above–ground part was found in the line O-CMS-31, whereas the lowest in the lines O–CMS–41 and O–CMS–25. Besides the inbred line effect, a considerable effect of mineral nutrition on dry mass of above–ground part was established. On average, the highest dry mass was obtained with the nutrition variant 1 (control) while when mineral elements were either reduced or increased in nutrient solution, dry mass of above–ground part was reduced. The same tendencies were obtained in root dry mass when mineral nutrition was considered, but variation range was considerably smaller than that in aboveground part.

Nitrogen concentration. Variations of N concentration in both above–ground part (Fig.3) and root (Fig.4) as dependent on mineral nutrition and inbred line were recorded. Averages of both above–ground part and root show that nitrogen concentration increased as element concentration of nutrient solution increased. Maximum value was obtained in variants 2 and 3 where no statistically significant differences were found. The highest nitrogen concentration of both above–ground part and root was obtained in the line O–CMS–31, the lowest in O–CMS–2.

Phosphorus concentration. On average, the highest phosphorus concentration in above–ground part (Fig.5) and root (Fig.6) were recorded in nutrition variant 2. By comparing the inbred lines analyzed, one can see that irrespective of nutrition variant, with the exception of 1/8, the highest concentration in above–ground part was obtained in the line O–CMS–6, and in root in the lines O–CMS–41 and O–CMS–31. While no statistically significant difference, with the exception of variant 1, was found between above–ground part of the lines O–CMS–2, O–CMS–31, and O–CMS–41, significant differences were recorded when root was analyzed and the lowest concentration was obtained in the line O–CMS–2.

Potassium concentration. By comparing the potassium concentrations of above–ground part (Fig.7) with that of root (Fig.8), one can see that concentration in the inbred lines increased as potassium concentration in nutrient solution increased. Also, the

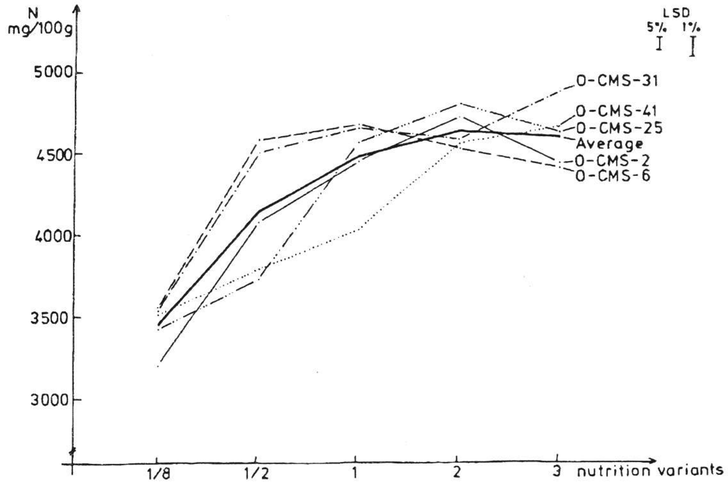

Fig. 3. Concentration of nitrogen in above-ground part of suflower inbred lines

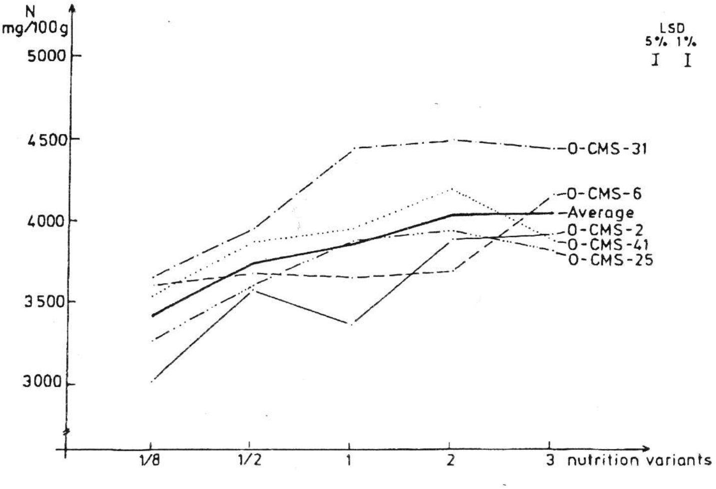

Fig. 4. Concentration of nitrogen in root of sunflower inbred lines

smallest variation of concentration of this element in both above–ground part and root was observed with 1/8 variant while differences among the genotypes were greater with the remaining variants of mineral nutrition. Differences in concentration of this element were remarkably greater in the inbreds O–CMS–31 and O–CMS–6, whereas they were reduced in O–CMS–25 and O–CMS–2, not only in above–ground part but also in root.

The results obtained confirmed a hypothesis that genetic factors (genotype specificity) and growing conditions affects the organic matter synthesis and element concentration. Dry mass of above–ground part and root depended on inbred line and concentration of nutrient solution. The highest dry mass accumulation was obtained with the full nutrient solution (1–N); however, a specific response of each inbread was also obtained. The inbred O–CMS–31 was characterized by an increased dry mass per plant, whereas O–CMS–25 and O–CMS–41 by reduced. Our results on dry mass are in agreement with the literature data available. H a r v e y (1939) obtained differences between individual hybrids in response to nitrogen and dry matter accumulation. F o y et al. (1974) found differences between 13 sunflower genotypes in organic matter synthesis and content of micro and macro–elements. Differences in synthesis of fresh mass of above–ground part of 6 sunflower genotypes grown under field conditions with different phosphorus supply (0 and 80 kg P/ha) were reported by H a n t e r et al. (1988).

However, a relationship between percentage of elements of mineral nutrition in nutrient solution and their concentration in inbred lines, as well as differences in concentration of elements need a further explanation.

Averages of nitrogen concentration depending upon the mineral nutrition ranged from 3,400 to 4,600 mgN/100 g dry mass in above–ground part, and maximum amount was recorded in variant 2–N. In root however, variation ranged from 3,450 to 4,000 mgN/100 g and maximum amount with 3–N was obtained. By comparing his own results with those on the activity when the same inbreds and nutrition variants were used, P o p o v i ć (1987) found that optimum concentrations of nitrogen in nutrient solution were 3–N (nitrate–reductase) and 1–N (glutamine–synthetase – GS, glutamate–synthetase–GOGAT, and glutamate–dehydrogenase–GDH), showing that these concentrations have an inhibitory effect. The author also pointed out a relationship between the activity of enzymes of nitrogen metabolism and protein synthesis in sunflower inbreds. In other words, the lines with a higher activity of these enzymes also showed a higher protein content.

The data on phosphorus concentration show that the genetic specificity is not reflected only upon concentration of individual ions but also upon their distribution into individual plant organs. For example, the line O–CMS–41 had the highest phosphorus concentration in root, and with regard to above–ground part, a higher concentration was recorded in the line O–CMS–6. The differences in phosphorus distribution into individual plant organs point out a specific nature of the processes of uptake, movement, and metabolism (S a r i ć and Š k o r i ć, 1981). Consequently, the line O–CMS–6 exhibited a more intensive phosphorus metabolism.

Also, the results on potassium concentration indicate statistically significant differences between the inbred lines analyzed. Root and above–ground part of O–CMS–6 and O–CMS–31 showed a higher concentration of this element than the remaining lines. By analyzing the anatomy of root and leaf of the sunflower inbreds under consideration,

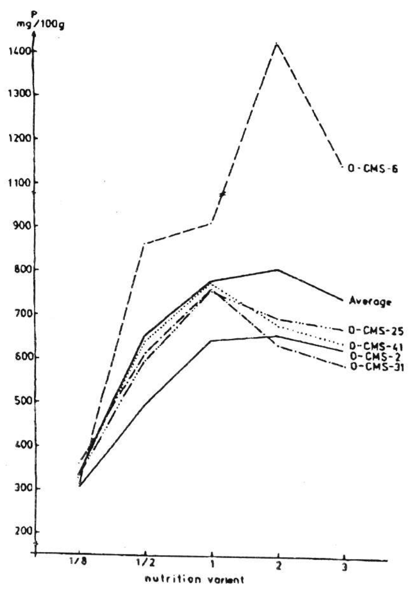

Fig. 5. Concentration of phosphorus in above-ground part of sunflower inbred lines

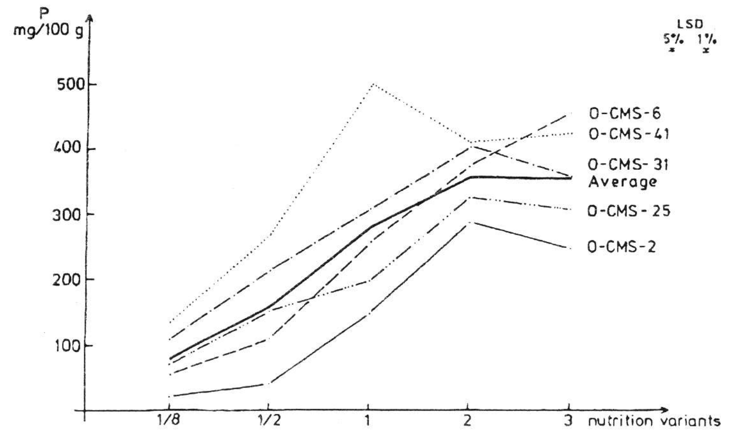

Fig. 6. Concentration of phosphorus in root of sunflower inbred lines

as well as concentration of potassium in root parts (nodal roots and radicles), M e r k u l o v (1988) found that the highest concentration of this element was in the nodal roots of the inbreds. This author also found that the line O–CMS–31 differed from the remaining inbred lines in main root diameter, cortex thickness, and diameter of central cylinder. In addition, depadence of the anatomical parameters upon mineral nutrition was reported. Irrespective of the inbreds analyzed, extreme concentrations (1/8 and 3) had a negative effect upon both morphological and anatomical parameters studied.

Differences were obtained not only between lines in content of individual ions, but also in their distribution into individual organs. Also, variation of concentration of mineral elements depended upon plant part analyzed (above–ground part and root). The smallest variation was obtained with nitrogen, then potassium, and finally with phosphorus.

CONCLUSIONS

Dry matter accumulation into above–ground part and root depended upon inbred and nutrition variant employed. On average, the highest dry mass was found in O–CMS–31, the lowest in O–CMS–25 and O–CMS–41. Significant differences in element concentrations were obtained between the inbreds. On average, the highest nitrogen concentration was obtained with O–CMS–31, the lowest with O–CMS–2. Significantly highest P and K concentrations were found in the line O–CMS–6, the lowest in O–CMS–25. On average, the concentrations of all elements increased as concentration of nutrient solution increased.

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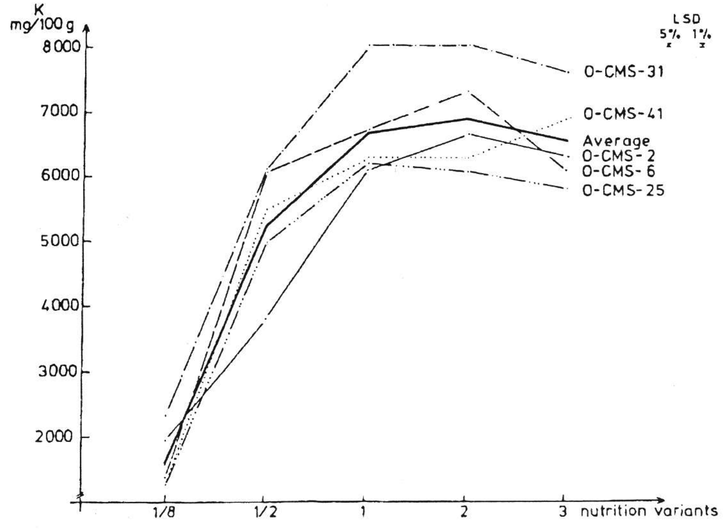

Fig. 7. Concentration of potassium in above-ground part of sunflower inbred lines

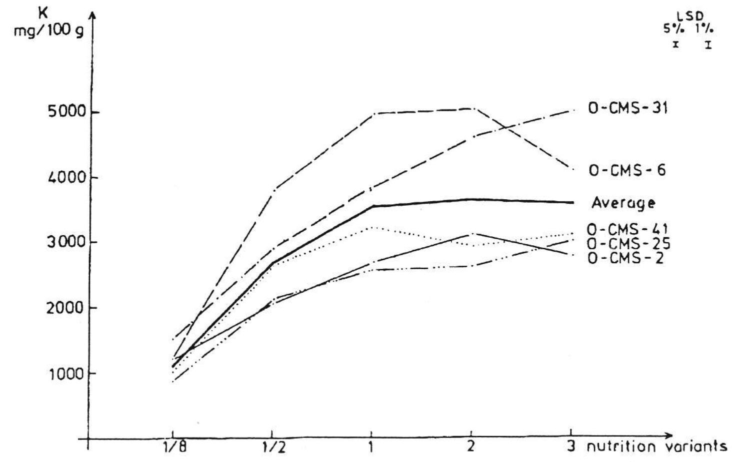

Fig. 8. Concentration of potassium in root of sunflower inbred lines

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CONCENTRATIONS EN N, P, K ET EN MATIÈRE SÉCHE CHEZ DES LIGNÉES DE TOURNESOL: DES PARAMÉTRES DÉPENDANTS DE LA NUTRITION MINÉRALE.

RÉSUMÉ:

La concentration en éléments et la synthèse organique ont été étudiées chez cinq lignées de tournesol mises à notre disposition par l'Institut des Grandes Cultures et des Cultures Maraichères de Novi Sad. Ces lignées de tournesol se caractérisent par leur appartenance au même groupe de précocité. Les plantes ont été cultivées suivant la méthode hydroponique en utilisant différentes concentrations de solutions nutritives (controles constitués par des solutions au 1/8 et au 1/2 du titrage décrit par Reid-York et solutions 2 et 3 fois plus concentrées que le controle).

la matière séche des parties aériennes et des racines ainsi que la concentration en certains éléments de la nutrition minérale ont été étudiées. Les résultats obtenus montrent que la matière séche des parties aériennes et des racines varie en fonction des lignées et des différentes nutritions minérales. En moyenne la matière séche la plus élevée a été trouvée chez O-CMS-31 tandis que les plus faibles l'ont été chez O-CMS-25 et O-CMS-41. De même, des différences significatives dans la concentration en éléments analysés ont été mises en évidence selon les lignées. En moyenne, la plus forte concentration en azote a été enregistrée chez la lignée O-CMS-31 tandis que la plus faible l'a été chez O-CMS-2, et ceci indépendemment des organes analysés. Des concentrations significativement supérieures en P et K ont été trouvées pour la lignée O-CMS-6 tandis que les plus faibles l'ont été chez O-CMS-21. La concentration en N, P et K dans les tissus des plantes augmentent lorsque la concentration de la solution nutritive en ces éléments augmente.

CONCENTRACION DE N, P, K Y MATERIA SECA EN LINEAS DE GIRASOL DEPENDIENDO DE LA NUTRICION MINERAL

RESUMEN

La concentración de elementos y la síntesis de materia organica fueron estudiadas en cinco líneas de girasol. El material vegetal fué obtenido del Instituto de cultivos extensivos y hortícolas de la Facultad de Agricultura, Novi Sad. Las líneas de girasol fueron caracterizadas en la misma estación de crecimiento. Las plantas fueron crecidas en cultivo hidropónico utilizando varias concentraciones de la solución nutritiva (1/8 y 1/2 de la concentración descrita por Reid-York sirviendo como control (1), 2 y 3 veces más alto que la solución control).

La materia seca aérea y radicular, tanto como la concentración de ciertos elementos de nutrición mineral fueron examinados. Los resultados obtenidos muestran que la materia seca aérea y radicular dependieron de la línea y del tipo de nutrición mineral. Como media, la materia seca más alta fué obtenida en la línea O-CMS-31; mientras que la más baja se obtuvo

O-CMS-25 y O-CMS-41. Fueron establecidas también, diferencias significativas en la concentracion de los elmentos analizados, dependiendo de la línea pura. Como média, las concentraciones de N más altas se encontraron en la línea O-CMS-31, mientras que las más bajas se encontraron en O-CMS-2 independientemente de la parte de la planta analizada. Unas concentraciones significativamente más altas de P y K fueron registradas en la línea O-CMS-6 y las más bajas en O-CMS-21. También, la concentración de N, P y K en el tejido de la planta se incrementú al aumentar la concentración de todos los elementos en la solución nutritiva.