ROOT DEVELOPMENT AND NUTRIENT UTILISATION BY BRASSICA NAPUS AS AFFECTED BY SULPHUR SUPPLY

H. M. HELAL, E. SCHNUG

Institute of Plant Nutrition and Soil Science, Federal Research Centre of Agriculture (FAL), Braunschweig, Federal Republic of Germany

M. A. GADALLA, M. A. ABDELSAMAD

Soils and Water Department, Atomic Energy Authority, Cairo, Egypt

ABSTRACT

The effects of sulphur nutrition on Brassica napus roots are not fully understood. This is attributed partly to the difficulty of quantifying root turnover and root mortality. The reported pot experiments aimed at evaluating the activity of the root system as dependent on sulphur supply.

In nutrient solution culture sulphur supply was varied between 20 and 500 µM during a nine weeks growth period. Subsequently the plants were analysed for nutrient contents and root characteristics. In addition to counting root length, the physiologically active root part was estimated by a root protein index.

Together with sulphur supply not only the total root length but also root viability increased considerably. In response, the uptake and utilisation of sulphur and nitrogen were enhanced significantly. The results suggest that adequate sulphur nutrition retards root mortality. Possibly related mechanisms are discussed.

INTRODUCTION

The influence of nutrient supply on root turnover is not fully understood. This is especially valid for sulphur which is a significant component of root membranes as well as root enzymes. Both constituents are of special significance for root integrity and root activity.

The lack of knowledge on root viability and its dependence on the nutrient supply is attributed partly to the dynamic nature of root development with simultaneous formation of new root members and senescence of others (Helal 1991, Helal and Sauerbeck 1989). Accordingly, individual roots may differ considerably with respect to age and physiological activity. Unfortunately, optical root counting techniques (Tennant 1975) do not differentiate between physiologically active and less active roots or even between living and dead ones. Referring to the rapid decomposition of the proteins of senescing roots, Helal (1992) introduced a root protein index for assessing root viability. Based on this concept, the present pot experiments aimed at evaluating the development and activity of the root system of Brassica napus as affected by sulphur supply.

EXPERIMENTAL

Brassica napus seeds were planted in 7 l drainable plastic pots under greenhouse conditions. Each pot contained 11.5 kg washed sand to support 5 plants. The pots were watered with a full nutrient solution of varied S supply (S_1 = 20 µM, S_2 = 100 µM, S_3 = 500 µM) composed of:

2 mM	KCl	12 µM	Fe chelate
1 mM	$Ca(NO_3)_2$	7 µM	$MnSO_4$
0.5 mM	NH_4NO_3	2 µM	H_3BO_3
0.5 mM	$MgCl_2$	0.5 µM	$CuSO_4$
0.5 mM	KH_2PO_4	0.1 µM	Ammonium molybdate
0,2 mM	NaCl		

For the lowest S level, sulphur was supplied as micronutrient sulphates. To achieve higher S supply (S_2,. S_3) $MgSO_4$ substituted for $MgCl_2$.

After 9 weeks the plants were harvested for yield determination, elemental analysis and root investigation. The whole root system was removed from the pots and sampled for root counting and for determination of root protein content. The determination of root length was carried out by intersect counting as described by Tennant (1975). Root protein content was determined by Kjeldahl analysis after removal of low molecular compounds by ethanol/water extraction. The protein content of the root was used as an index for evaluating the viable root part (Helal 1992).

RESULTS AND DISCUSSION

Typical sulphur deficiency symptoms were not observed during this experiment, even under the lowest S level applied.. Nevertheless as indicated in table 1, dry matter yield and root length as well as nitrogen and sulphur uptake increased significantly with the sulphur supply.

TABLE 1. Growth, root development and nutrient uptake by Brassica napus as affected by sulphur supply

S supply µM	20	100	500
Shoot dry wt., g/pot	41.1	68.2	74.0
Root length, m/pot	275	359	342
Viable roots, %	48.0	61.1	67.2
S uptake, mg/g dry wt.	3.20	4.71	5.11
S uptake, mg/pot	131	320	377
S uptake, mg/m root	0.48	0.89	1.10
N uptake, mg/g	36.0	31.1	29.6
N uptake, g/pot	1.48	2.12	2.19
N uptake, mg/m root	5.44	5.91	6.40

Table 1 demonstrates furthermore a multiple S/N interaction. Improved sulphur supply enhanced not only the uptake of nitrogen but also its physiological utilization (dry weight per unit nitrogen).

Of special interest is the effect of sulphur on the root system. Sulphur not only increased the root length but also enhanced the root efficiency (nutrient uptake per unit root). The mechanism of this effect is not clear. The significance of sulphur for root membranes and root integrity (Stuiver et al. 1981) suggests however that adequate sulphur supply may retard root mortality. The favourable effect of sulphur on root viability (table 1) supports this interpretation. Further research is required, however, to clarify related root mechanisms.

ACKNOWLEDGEMENT

This work was carried out within the German/Egyptian joint project 'Optimizing Water and Fertilizer Use in Desert Agriculture' supported by the International Büro, KFA Jülich.

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