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BRIEF COMMUNICATION

The effect of local application of fertilizer on the content of cytokinins in the xylem sap of maize

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Abstract

Cytokinin content in xylem sap was higher in plants grown under local supply of fertilizers as compared to those grown under homogenous distribution of nutrients in soil. The separate assay of cytokinins in xylem exudate from split root system showed that roots, which were in contact with fertilizer mainly contributed to cytokinins transported from roots to shoots.

Additional key words: immunoassay, root exudation, *Zea mays*.

Local placement (banding) of fertilizers is known to increase crop yield. In this case the zone with extreme concentration of nutrients is created and only part of root system comes into contact with it. This technique of fertilizer application or similar phenomena (local water and salt stress) was of interest for many researchers. The local enrichment of root zone by nutrients stimulated growth of maize root system (Granato and Raper 1989, Marsh and Perzynski 1993) and ion uptake of number of cultivated and weed plants (*e.g.* Jackson *et al.* 1990, Robinson 1990, Mortley *et al.* 1991, Duke and Caldwell 1994). Similar treatment increased drought resistance (Miller *et al.* 1992, Jacobsen *et al.* 1993) and changed the time of flowering (Trapeznikov 1983). Heterogeneous distribution of nutrients results in functional specialization of root system, part of which mainly supplies plants with water while the other provides ions (Trapeznikov 1983). The above mentioned diversity of effects suggests the involvement of some regulatory systems. We reported earlier that extreme concentration of nutrients (NPK) applied to whole root system results in the increase in cytokinin content in roots. However, the export to shoot was reduced, obviously due to the decreased water flow (Kudoyarova *et al.* 1989). It was suggested

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that local increase in nutrients might affect cytokinin transport. However, this suggestion have not been confirmed experimentally. Thus the aim of the present work was to confirm this hypothesis experimentally.

One-week-old seedlings of maize (*Zea mays* L.) cv. Voronezhskaya 47 were divided in two groups. One group received nutrients in traditional way (T-plants). They were grown in pots filled with mixture of soil and sand (2:1) and fertilizer *Nitrophoska* (0.3 g kg^{-1}) was mixed with the whole volume of substrate. Plants of other group grown under local application of fertilizer (L-plants). In one pot section fertilizer *Nitrophoska* (0.3 g kg^{-1}) was mixed with the substrate while in the other section it was introduced as a layer at the depth of 10 cm. Roots were split between the sections. The vertical incision (3 - 4 cm) of stem was made (Fig. 1). Thus lower part of stem was split into two parts in order to collect root exudate separately from roots growing in different pot sections. Substrate water content was maintained at the 60 % of maximum capillary capacity. Xylem sap was collected after abundant watering of each split root system separately for 4 h (from 06:00 till 10:00) at three vegetative stages: I - appearance of the flag leaf, II - panicle sprouting, III - flowering. Cytokinins were immunoassayed as described earlier (Kudoyarova *et al.* 1993). The volume of exudate and the mass of shoots were determined. Xylem sap of 10 plants was analysed separately.

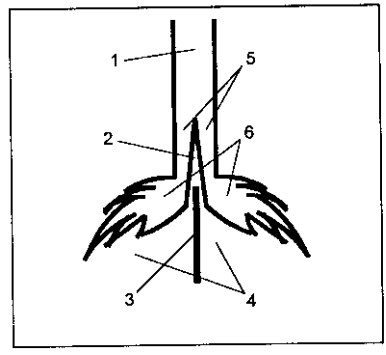

Fig. 1. The scheme of splitting roots and stem incision: 1 - whole stem, 2 - incision, 3 - partition, 4 - pot sections, 5 - split stem, 6 - split roots.

Cytokinin concentration in xylem sap collected from both root parts of plants grown under local application of fertilizers (L-plants) was higher and changed within the experiment to a lower extent as compared to that of plants which received nutrients in a traditional way (T-plants) (Table 1). However, the difference was not significant at the stage of panicle sprouting. A similar pattern was observed when amount of cytokinins transported from roots to shoots (from 06:00 to 10:00) was calculated (Table 1).

The comparison of cytokinin concentration in xylem sap collected from each part of root system separately, revealed higher concentration of cytokinins in xylem sap of roots grown in part of pot with layer of fertilizer (FR) compared to that of roots

grown in other part of pot (CR) and roots of T-plants (Table 1). These FR mainly contributed to the higher supply of shoots of L-plants with cytokinins. Nevertheless, the income of cytokinins from CR was essential due to high volume of xylem sap delivered from that part of root system.

Table 1. Xylem cytokinin concentration [ng cm^{-3}(exudate)] in T-plants and L-plants (exudate collected from whole rot system - WR, exudate collected from roots with fertilizer layer - FR, and exudate collected from other part of split root system - CR) at three vegetative stages (appearance of flag leaf - I, panicle sprouting - II, and flowering - III) and rate of cytokinin transport [ng $plant^{-1}$ h^{-1}] from roots to shoots.

			I	II	III
Concentration	T-plants	WR	8.0 ± 0.3	14.8 ± 0.6	0.4 ± 0.7
	L-plants	WR	14.0 ± 0.3	18.3 ± 0.3	16.2 ± 0.9
		FR	21.3 ± 0.6	27.5 ± 0.9	34.5 ± 3.3
		CR	5.6 ± 0.5	17.5 ± 0.6	6.7 ± 0.7
Transport	T-plants	WR	3.5 ± 0.2	6.3 ± 0.2	0.3 ± 0.3
	L-plants	WR	5.8 ± 0.2	7.5 ± 0.2	4.8 ± 0.5

The best noticeable difference in the export of cytokinins from roots to shoots between T- and L-plants was observed during flowering and at the beginning of grain formation when hormonal status of plants influence crop yield to the highest extent (Michael and Beringer 1980).

Local high concentration of nutrients might lead to local dehydration of part of root system and we showed earlier that local supply of fertilizers affect also ABA transport with xylem flow (Ivanov *et al.* 1989). Our present data indicate involvement of cytokinins in response of plants to nutrient supply.

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