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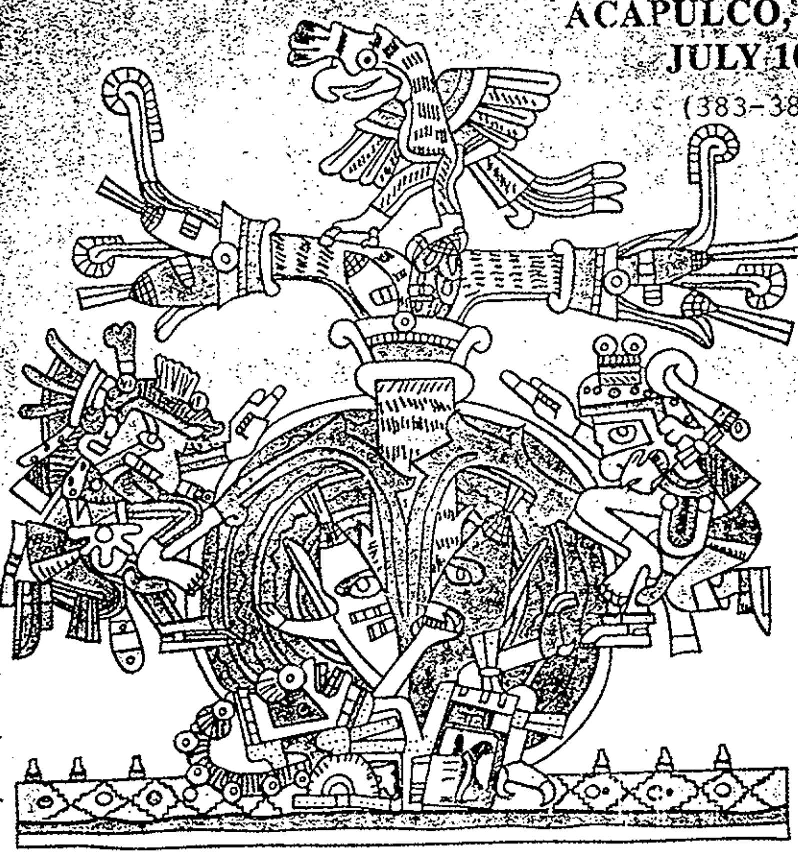

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Potassium efficiency of wheat, maize and sugar beet on a sandy clay loam soil

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Introduction. Plant species differ in their K efficiency i.e. in their ability to grow on low K soils. The reasons for different K efficiencies may be given by the size of the root system, the uptake efficiency of each root segment i.e. the influx and the growth rate of the shoot. The present investigation was planned to study K efficiency of summer wheat (*Triticum aestivum* L. cv. Planet), maize (*Zea mays* L. cv. Pirat) and sugar beet (*Beta vulgaris* L cv. Orbis).

Materials and Methods. Surface soil samples of Angelberg sandy clay loam soil, pH 7.5 and clay 33% were collected from 2 plots having 0.05 mM K (K_1) and 0.14 mM K (K_2) in soil solution (C_{Li}). K_2 soil sample was fertilized with 580 mg K/kg soil and soil solution concentration of 1.7 mM K (K_3) was obtained. Essential plant nutrients were supplied according to crop requirement. Seeds of 3 crops were sown in pots containing 2.9 kg soil at volumetric moisture content of 0.4 cm^3/cm^3 in a controlled growth chamber (light/dark regime of 16/8 hours at 25/18°C, relative humidity 60/75%, light intensity 14000 lux). Root and shoot weight, K content of plants, root length and root radius were determined 8 (13 days in case of sugar beet) and 20 days after germination. Soil and plant parameters for nutrient uptake model based on K transport by diffusion and mass flow and K uptake following Michaelis-Menten kinetics were determined as described (1).

Results and Discussion. Figure 1 shows that sugar beet could produce maximum dry matter yield at 0.05 mM K in soil solution. Increasing level of K

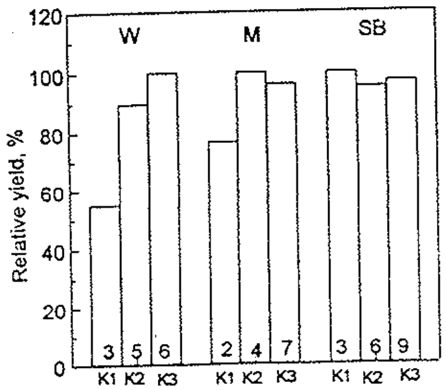

Fig.1 K efficiency (=relative yield) of wheat (W), maize (M) and sugar beet (SB) at 3 levels of soil K. The numbers in column indicate plant K content in %.

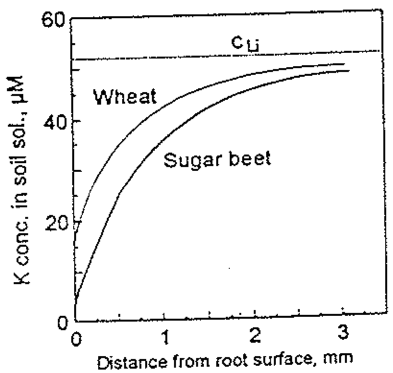

Fig.2 K depletion in the rhizosphere of wheat and sugar beet

did not affect dry matter yield, while K content of plants increased 3 times and Na content (not shown) decreased by 50%. Wheat and maize dry matter yield increased by 60 and 30%, respectively, with increase in soil solution K to 0.14 mM. These results indicate that sugar beet had a higher K efficiency than wheat and maize. The possible explanation for this could be that sugar beet had lower demand for K and/or a more efficient root system. Looking at the data in table 1 indicates that sugar beet had the lowest root/shoot ratio but highest relative shoot growth rate, therefore, resulting in a 4.5 and 2 times higher shoot demand than wheat and maize, respectively. On the other hand sugar beet had a 4 times higher K influx at K_1 than wheat and maize. The same influx would have been sufficient for maximun uptake of wheat and maize. Thus, the reason for the higher K efficiency of sugar beet was based on the higher K influx i.e. higher uptake efficiency of roots.

Table 1: Root-shoot relations and measured and calculated K influx in roots wheat, maize and sugar beet

crop	Root shoot ratio (m g^{-1})	Relative shoot growth rate (10^{-6}s^{-1})	Shoot* demand (ng s^{-1}cm^{-1})	K influx, 10^{-14}mol cm^{-1} s^{-1} measured K_1	measured K_2	measured K_3	calculated K_1	calculated K_2	calculated K_3
Wheat	133	1.8	13	9	22	21	16	24	28
Maize	89	2.5	28	10	28	48	17	35	61
Sugar beet	54	3.1	59	41	82	133	27	47	85

* amount of shoot produced per second per unit of root

In order to find an explanation for sugar beet having a 4 time higher K influx as wheat and maize, model calculation that included root hairs were run. They show (Table 1) some overestimation of K influx for wheat and maize but underestimation for sugar beet. The K concentration at the root surface (Fig.2) decreased to 3 µM for sugar beet and 16 µM for wheat. According to these calculations the higher influx of sugar beet was due to its capability to decrease the K concentration to a lower value thereby increasing the concentra gradient and so the transport to the root surface. Experiments in solution culture at constant low K concentration, however, show that wheat obtained a maximum influx and maize 50% of it at a K concentration of 5 µM (2). The reason for these discrepancies are not known. Possible explanation could be that not all roots, as assumed here, were taking up K or that only part of the root surface of wheat and maize was incontact with the soil.

Literature Cited.

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