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Low root temperature influence on water uptake

The Talia plastic soil cover was shown to dampen the effects of extreme conditions in the root system mainly soil temperature and soil moisture. Extreme fluctuations in root temperature, has long term memory in root water transport as seen in the above figure.

The root zone serve as a reservoir and conduit for gasses and nutrients solution. Optimization of plant production is dependant on optimizing the various interacting factors. The whole soil and plant root system under the Talya cover is very much depends on the interplay of the many factors that are involved, rather than just one or two main factors. A complete different soil environment is developed with time after cover of soil physical, chemical and biological activity due to prevent extreme wetting and drying allowing active surface roots to avoid abrupt changes that even after their removal, their effect has a long memory in plant root behavior.

The functions of the root system are: mechanical support, water uptake, nutrients uptake, source and sink for organic compounds and plant hormones.

Required conditions for plant mechanical support is quick root proliferation since soil compaction isa limiting factor for root penetration, oxygen diffusion limitation stops root elongation within10 seconds of initiation of oxygen deficiency.

Keeping active roots and continuous root growth and elongation, facilitate the uptake of phosphate and other nutrients from the soil solution, mainly nitrate, ammonium from mineral or organic sources.

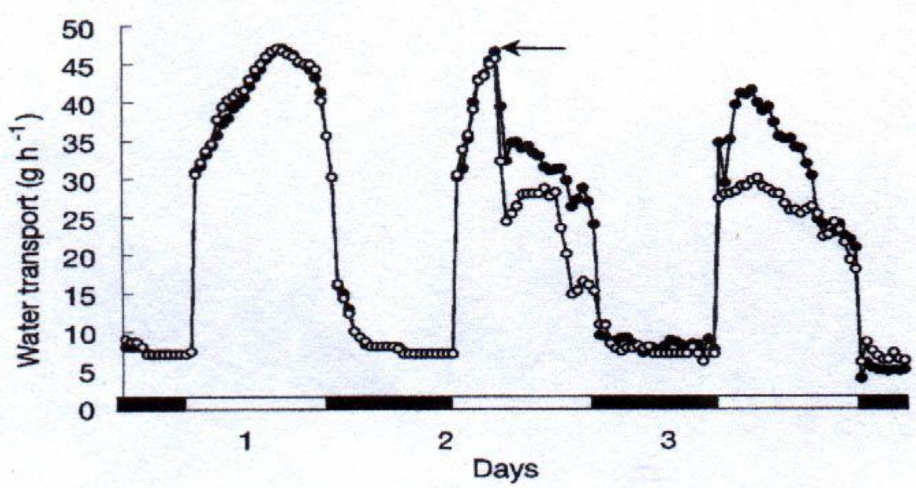

Fig. 2 Effect of low root temperature on the water transport in cucumber plants. Root temperature was either lowered (2 °C per h) from 20 °C to 10 °C gradually (●), or dropped to 10 °C in one step (○) on day 2 as indicated by the *arrow*. Signals were collected every 60 s and averaged over 15 min to give hourly mean values. *Shaded* and *unshaded* bars indicate night- and daytime, respectively

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The above figure from Lee et al.,(2004), demonstrate that the chilling effect that was imposed on day 2 of the experiment has it effect on reduction uptake on the next day grown without water stress, and that the root "memorizes" in it's transpiration pattern whether it was gradually cold or abrupt cold. Talya cover prevents roots exposure to extreme cold conditions.

Roots exert a profound influence on the soil with which they are in contact. Roots also affect the soil indirectly through the activities of the specific microbial communities that are established in the rhizosphere .Mineral nutrient supply influence the size and the morphology of the root system· These effects are due to the type of the nutrient, the concentration range near the root, the form of field application, the soil type and of the soil environmental conditions. The root is the first organ to emerge from the germinating seed. Root elongation is a continuous process essential for a healthy plant growth of the upper part. Any reduction in the rate of root elongation has its influence on the growth and function of aerial organs that at the end is translated to restriction on plant development and production. The most extreme example of root restriction is the Bonsai (literally "plant in a tray"), a plant growing system that is based on severe limitation on plant root growth by confining the roots to a small rigid wall container, In the field, continuous root elongation is needed for mechanical anchor, water uptake, nutrients uptake, escaping drought conditions, maintaining plant growth at cold or hot events. Environmental conditions known to impair root growth are: Soil compaction, shortage of water, saline and sodic soils, shortage in soil aeration, extreme soil temperatures, and shortage or excess of plant macro nutrients and shortage or excess of heavy metals that cause toxicity and access of exchangeable aluminum (in soils with low pH).

Water acquisition

"*.. he would be like a tree planted on a water stream, that will bear it's fruit on time and it's leaves will not dessicate*" (Psalms. 1, 3) The depth of roots proliferation varies with environmental factors like soil temperature, soil compaction, soil moisture and zone of nutrients concentration. Deep rooting is essential to secure water in relatively dry soil conditions but when water and nutrients supply is secured, plants are satisfied with shallow rooting. Sand compaction is very hard to relieve. Talya system is expected to have specific benefit on sand dunes and sandy soils.

Response of root growth to local nutrients concentration

PHOSPHATE AND NITROGEN FERTILIZERS

Nutrients uptake

All mineral nutrients usually enter the plant through the roots. There is a distinctive selectivity by the root in allowing and rejecting mineral elements. Potassium is positively selected while sodium entry is restricted by many plants

The uptake and transport of plant nutrients is very sensitive to any change in the root environment. Temperature, compaction, salinity and aeration influence root elongation and with it nutrients uptake and translocation within the plant.

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Root elongation and P uptake

Phosphate is hardly moving in the soil when spread as granular fertilizer. If a source of available P is encountered by the root, it respond in local proliferation around the P source.

Most of the P taken up by a plant is due to lateral roots development. The main P uptake region was found around the root tip. A dense root matt under Talya cover better uses soil phosphate due to dens rooting under the cover.

Since the top soil in the field under Talya cover, usually contain the highest amount of P, and is maintained in moist and aerated condition, roots will continue to take up phosphate without soil constrains. The P uptake by the root is dependant not only on soil solution P concentration as measured by soil extraction.

The type of N source near the root has a profound effect on P uptake.

Under natural aerobic conditions most of the nitrogen is converted to nitrate that becomes the main source of N to plant roots. Under oxygen deficiency condition in the soil the oxidized $N\text{-}NO_3$ is reduced to N_2, while the organic nitrogen is released as NH_4^+ cation to the soil. Plants can use both sources but the general plant performance, dry matter production and the ionic balance of nutrients uptake is affected mainly by the form of N available in the root zone.. The uptake of P, Fe, Mo, and Zn is dependent on the pH in the root vicinity. This pH is a function of the proportion of ammonium to nitrate uptake by the plant. The control of the N form that is taken by the roots has a major effect on root growth and its uptake of water and nutrients.

Roots as Source and sink for organic compounds and plant hormones

The amount of total carbon, fixed from the atmosphere that is moving to the roots, varies between plant species. In legume plants carbon translocation to the root might reach 60 to 70% of total photosynthetic carbon fixation. The variation among plants is significant. When roots plays a function of carbohydrate storage to allow next year propagation, roots become the main carbon storage of the plant.

The wide range of chemicals produced in roots has its affect not only on usage by man but mainly to protect the plants from the numerous soil microorganisms and soil creatures leaving in the soil.

Hormone activity

The balance of hormones present in the growing and elongating roots, IAA, ABA, cytokines, gibberellins (GA) and ethylene, actually ends up with controlled root growth. Any change in environmental condition near the growing root is translated to increase or a decrease in these internal compounds and as a result root elongation rate is determined.

Temperature and root growth

The basic needs for root elongation are: moisture, air and Ca. Since root growth involves many physiological reactions, the optimum temperature for root growth is specific for each species\and even cultivars. The following conditions are posing risk for shallow rooting plants in open field conditions: 1- Cold night with a following bright day. Under such conditions sensitive plants like cucumbers and melons cover the soil by their foliage, delay soil heating while transpiration start with sun break. Total loss of plants due to desiccation was observed as cucumbers and melon refuse water entry to the root below 13°C.

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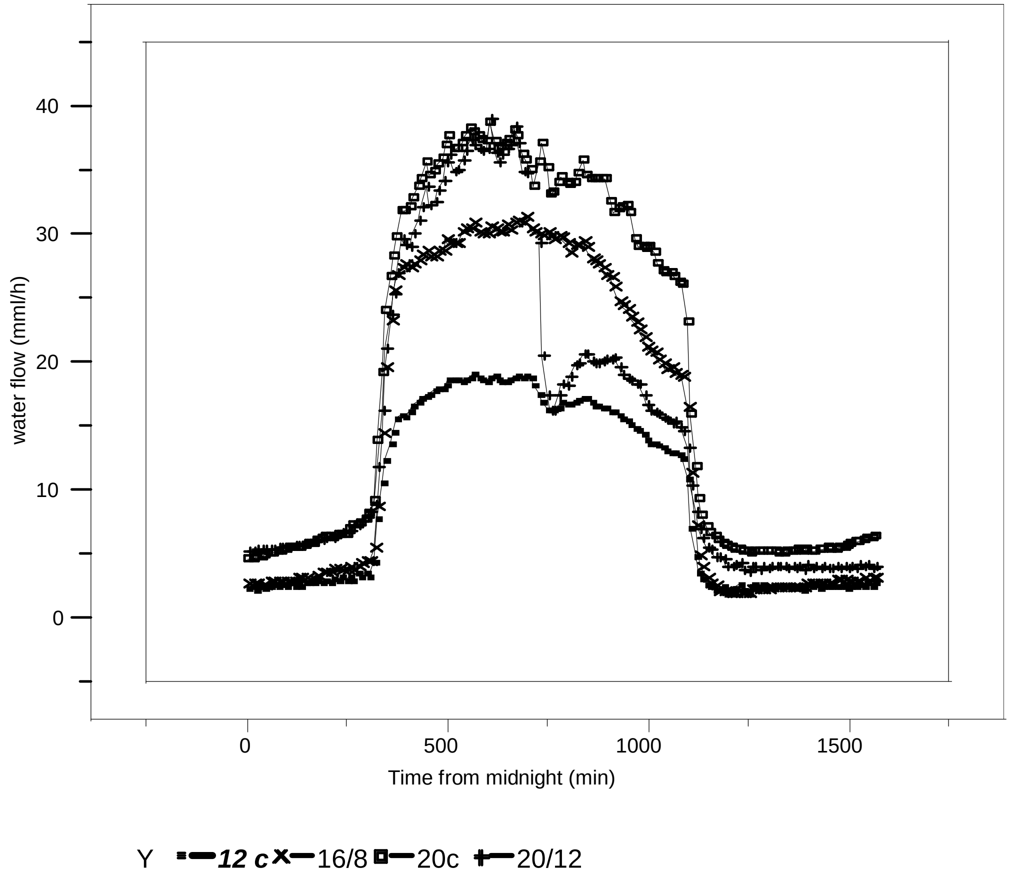

Root temperature influence on water transport through tomato plant stem. Ali et al.1996

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