PNA Newsletter 2012/1

Dear reader,

We are pleased to present you the second edition of the PNA Newsletter!

The PNA Newsletter is to appear on a regular basis to update our subscribers on the latest potassium nitrate trial results and product characteristics, advantages and benefits, along with application methods and crop nutrition recommendations, and many more relevant issues.

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Main topic in this edition

- The high potential of potassium nitrate in enhancing crop water use efficiency.

The high potential of potassium nitrate in enhancing crop water use efficiency

Summary

According to FAO publications, by 2050, food production is projected to increase by about 70 percent globally and nearly 100 percent in developing countries. This incremental demand for food, together with the demand from other competing uses, will place unprecedented pressure on many agricultural production systems across the world (High Level Expert Forum, 2009). FAO estimates that some 1,2 billion people live in countries and regions defined as “water-scarce”, and the situation is projected to worsen rapidly, with the number of people rising to 1,8 billion by 2025, partly as a result of population growth. Addressing the yield growth challenge may require the expansion of irrigated areas as well as the wider use of management practices that will improve the water use efficiency for irrigation purposes. Improving the water use efficiency in plants is one way to target larger yields per any water quantity.

Numerous researchers have established that potassium nitrate fertiliser, when applied by fertigation or by foliar feeding, has a positive effect on the proper functioning of plants, optimizes their performance and increases their water use efficiency (WUE).

This phenomenon occurs because potassium participates in the physiological processes of over 60 different enzymes and is directly involved in the water management of the plant since it reduces water loss through plant transpiration.

When compared with ammonium as a nitrogen source, nitrate has been found to improve photosynthesis and to increase biomass production rate which directly improves the WUE.

1. What is water use efficiency (WUE)?

The definition of WUE is:

$$\text{Water use efficiency} = \frac{\text{Dry (or fresh) matter produced}}{\text{Water transpired by the plant}}$$

In words: More biomass production per every unit of water consumed by the plant.

2. How does potassium nitrate enhance the WUE?

Potassium, by being involved in the physiology of over 60 different enzymes, is directly involved in the water management of the plant since it maintains turgor, reduces water loss and wilting, and improves drought tolerance.

Additionally, potassium increases root growth, builds cellulose, aids in photosynthesis, helps to

translocate sugars and starches within the plant, increases the protein content and grain starch of plants, and helps to retard crop diseases and nematodes. As such, potassium contributes to achieve optimal crop performances under local constraints that can cause water shortage.

Nitrate has been shown to directly promote WUE as compared to the ammonium form of nitrogen. Photosynthesis and biomass production rates were found to be markedly higher in nitrate fed plants, while the transpiration rate was higher in ammonium fed plants. Furthermore, nitrate fertilisation has been shown to directly counteract the deleterious effect of chloride on many crops.

When applied together, potassium and nitrate have a synergistic effect which facilitates their uptake by the plant. Under the same irrigation rate conditions, the application of potassium nitrate and its derivatives, by either fertigation or by foliar spray, directly enhances the fruit mass and quality of numerous crops which implies that this combined treatment actually increases the WUE of the applied irrigation water.

3. Some evidences for the effect of potassium nitrate on WUE

A few studies (Fournier et al, 2005; Lips et al, 1990) measure the direct effect of potassium and nitrate on the WUE by measuring the fresh or the dry matter production (Figures 1 and 2).

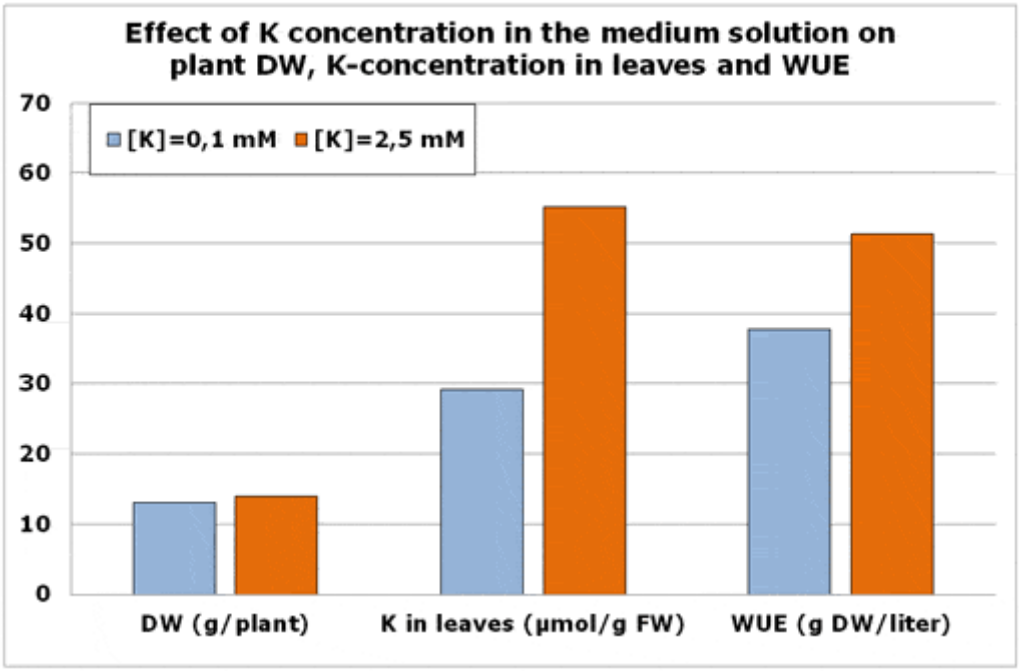

Figure 1. *When the K concentration in the nutrient solution of sunflower was increased from 0,1 mM K to 2,5 mM K, then the dry weight also increased, leaves showed higher K concentrations and WUE was greater (Fournier et al, 2005).*

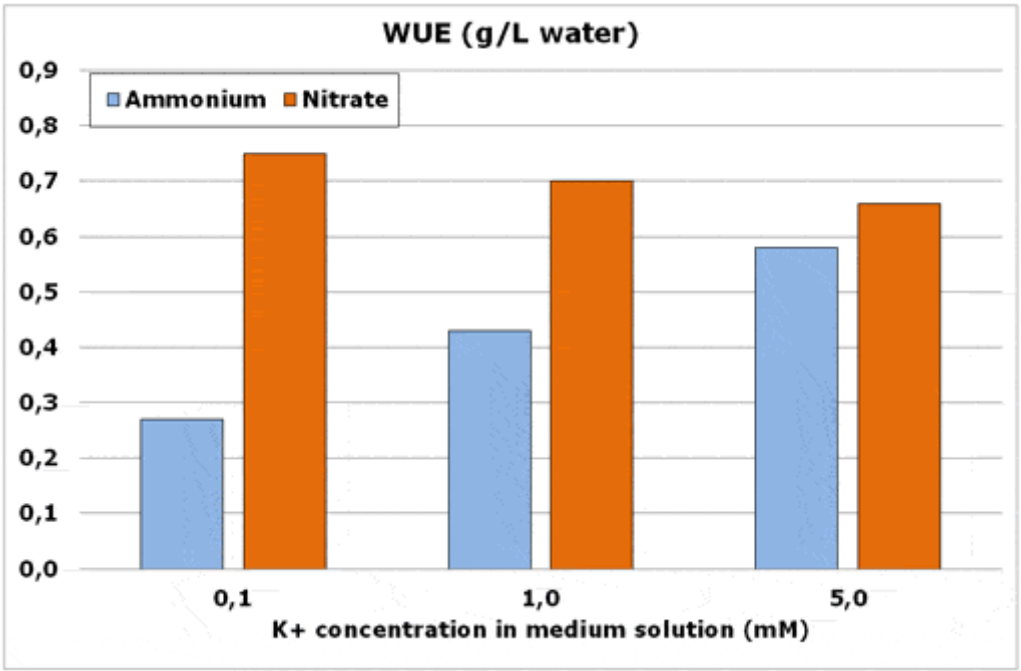

Figure 2. *The WUE of the wheat was greater when plants were fed with nitrate compared to ammonium as the nitrogen source, when grown under three different K concentrations in the nutrient solution (Lips et al, 1990).*

Other studies examined how potassium and nitrate increase the WUE. One way to increase the WUE is by decreasing the water loss through plant transpiration. Various studies show that under harsh conditions, potassium deficiency in plants causes high plant transpiration compared to plants with adequate potassium levels (Figure 3; Skogley, 1976 and Figure 4; Benlloch-Gonzalez et al, 2008).

This happens due to the fact that potassium is the main osmotic solute in plants. Its accumulation in the cell leads to osmotic water uptake and generates the cell turgor required for growth and for stomatal opening. At whole plant level, potassium is also involved in the osmotic water absorption by the root, root hydraulic conductivity, and the control of leaf transpiration.

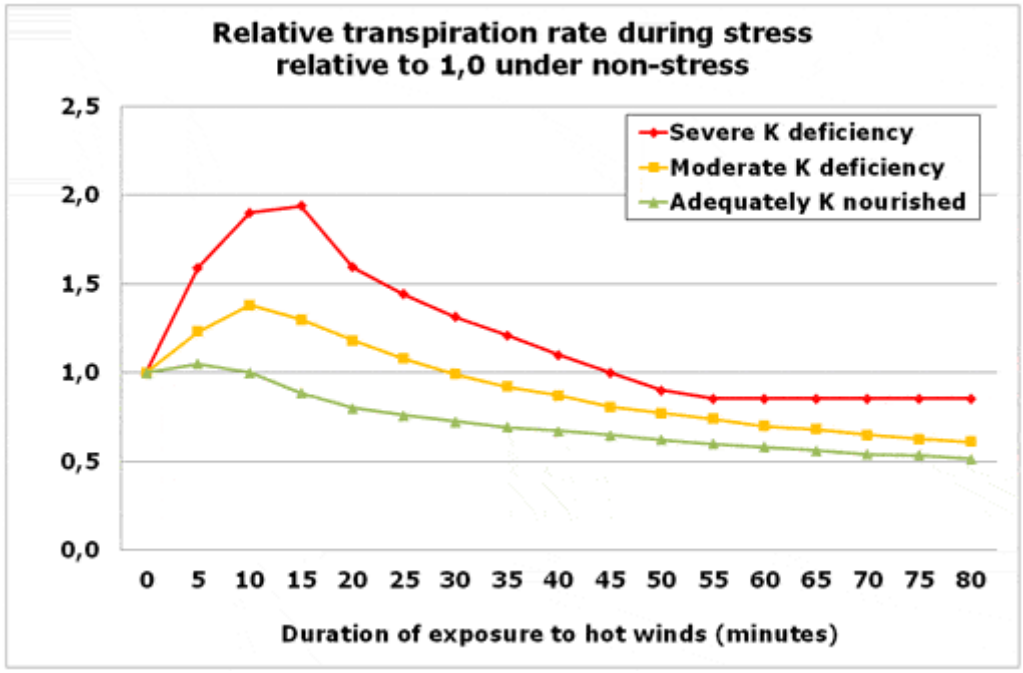

Figure 3. *The potassium status of the plant determines the recovery rate from a drought stress. Relative evaporation is lowest and the recovery rate is fastest when plants are adequately fed with K (Skogley, 1976).*

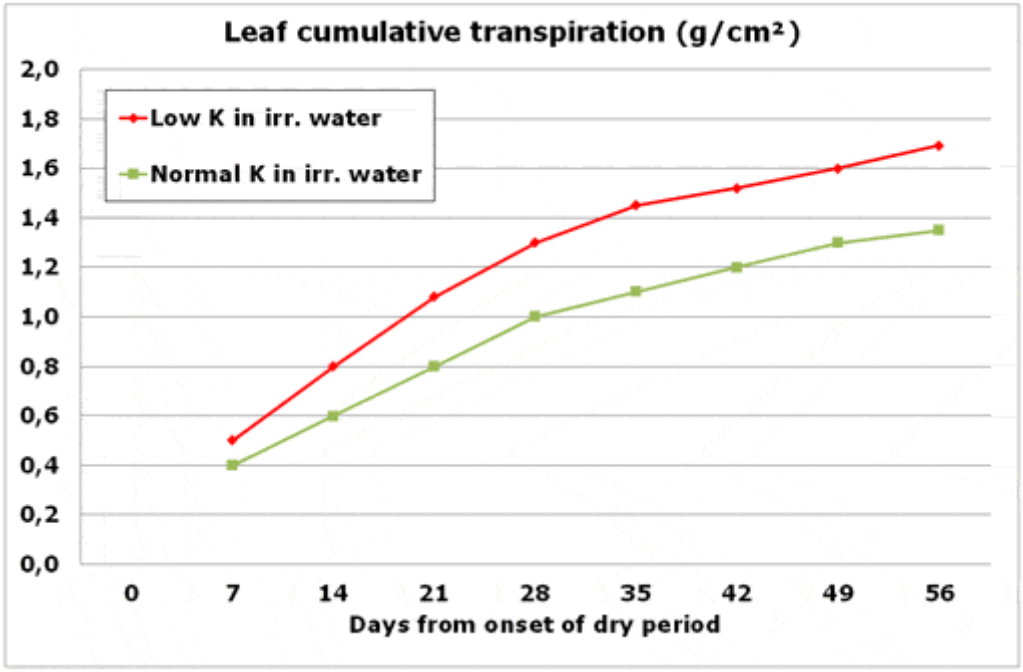

Figure 4. *Potassium deficiency increases transpiration rate in olive trees (Bennloch-González et al, 2008).*

Another way to increase the WUE is to increase the biomass production. Some experiments show

that nitrate-nitrogen is markedly more efficient than ammonium-nitrogen, regarding photosynthesis and biomass production, especially under K-deficient growing conditions (Figures 5 and 6; Lips et al, 1990).

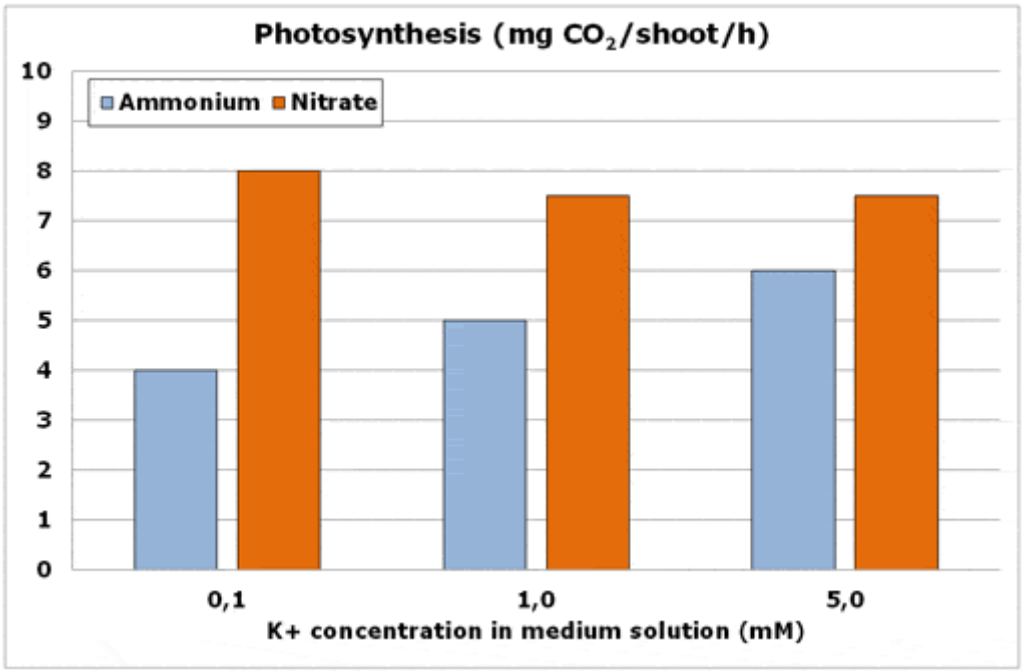

Figure 5. *Comparative effects of nitrate and ammonium on photosynthesis in wheat, when grown under three different K levels in the growing medium solution (Lips et al, 1990).*

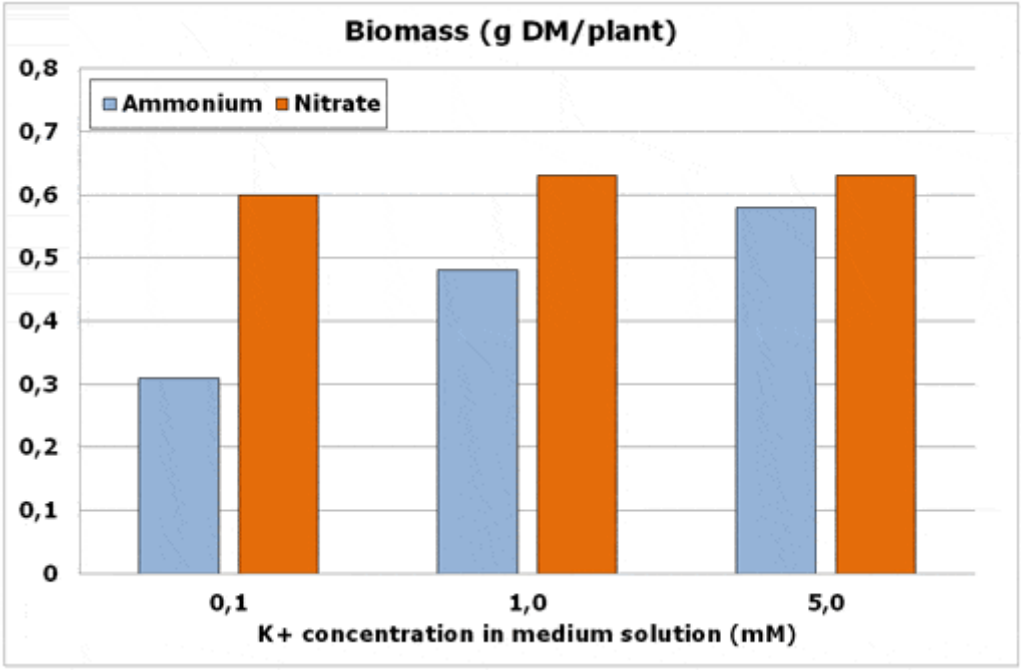

Figure 6. *Comparative effects of nitrate and ammonium on biomass production in wheat, when grown under three different K levels in the growing medium solution (Lips et al, 1990).*

Nitrate increases biomass by increasing the photosynthesis efficiency, especially when applied together with potassium.

Improved WUE as a result of potassium and nitrate applications in adequate levels, were reported in various crops including sunflower, olive tree, Douglas fir, poplar trees, tomato, orange and more.

Literature cited

High Level Expert Forum. 2009. How to Feed the World in 2050. www.fao.org/fileadmin/templates/wsfs/docs/Issues_papers/HLEF2050_Global_Agriculture.pdf

Benlloch-González, M, O. Arquero, J.M. Fournier, D. Barranco and M. Benlloch. 2008. K+

starvation inhibits water-stress-induced stomatal closure. Journal of Plant Physiology **165**:623-630.

Fournier J.M., A. Roldán, C. Sánchez, G. Alexandre and M. Benlloch. 2005. K+ starvation increases water uptake in whole sunflower plants. Plant Science **168**: 823-829.

Lips, S.H, E.O. Leidi, M. Silberbush, M.I.M. Soares and O.A.M. Lewis. 1990. Physiological aspects of ammonium nitrate fertilization. Journal of Plant Nutrition **13**:1271-1289.

Skogley, E.O. 1976. Potassium in Montana soils and crop requirements. Montana Agr.Ext. Stn. Res. Report 18.

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