Nitrogen cycling and utilisation at different nitrogen and water supply in a long-term experiment at the Lysimeter Station in Szarvas

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Abstract

The investigation of the nitrogen cycling and utilisation is important not only from the point of view of economical, but also from ecological aspect.

The effect of 4-4 different water- and nutrient supply were examined in lysimeters and on plots at the Lysimeter Station of the Research Institute for Fisheries, Aquaculture and Irrigation in Szarvas. It was studied 16 treatment-combination on the water- and nutrient cycling and utilisation of maize, connecting to a two-factor long-term experiment.

It was stated that with the increasing water supply the productivity of water improves, i.e. the evapotranspiration per 1 kg yield decreases. The specific nitrogen requirement also decreased with the raising yield coming from the increase of the harvest index.

In case of drought the nutrient uptake of maize moderated, owing to this the accumulation of the highest nitrogen doses increases in the soil. However at optimum water supply there was no nitrate accumulation in the soil neither in case of applying higher dose of fertiliser.

Introduction

More and more important is to take into consideration besides the economical point of view also the ecological influences of the agricultural plant production. To evaluate the economical and ecological consequences of the agricultural cultivation it has to be known the requirement of plants, the ecological conditions and the impacts of all elements of the production technology on the plants and on the environment, namely the metabolism processes between the plant and soil, and their ecological influences.

The effect of different water and nutrient supply are examined on the water and nutrient cycling in long-term experiments in lysimeters and on field plots in Szarvas.

Materials and methods

The experiments have been carried out at the Lysimeter Station of the Research Institute for Fisheries, Aquaculture and Irrigation in 16 treatment-combinations of 4 different water and 4 nutrient supply connecting to a two-factor long-term experiment, which has been operated since 1972. The number of replication is 4. The size of the lysimeters is 1 m³, which are built in the middle of each plot. The vertical and horizontal water movement can be excluded, because of the lysimeters are closed from every side, so the water and nutrient cycling can be measured more exactly than on the plots. The amount of leaching water is measured at every lysimeters, and its quality is analysed.

The type of the soil is chernozem meadow, which is very well supplied with phosphorous and potassium, and has medium nitrogen content. The humus content is 2,5-3 %, and the clay content 50 %. Its natural water capacity is 40 volume percent, half of which is disposable water.

Results

On the bases of 20 years data the water consumption of maize varies between 250-550 mm depending first of all on the available water, the climatic condition and the duration of the growing season (*Figure 1*). In the examined province there is a positive correlation between the evapotranspiration and yield, which can be described by a linear function.The

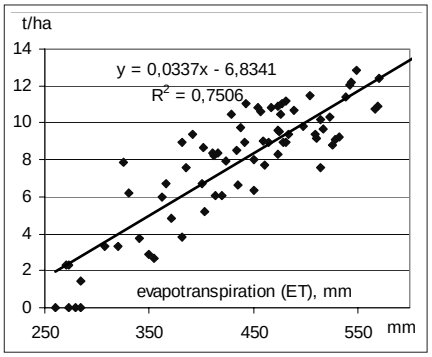

Figure 1: **Relationship between the ET and the dry grain yield of maize**

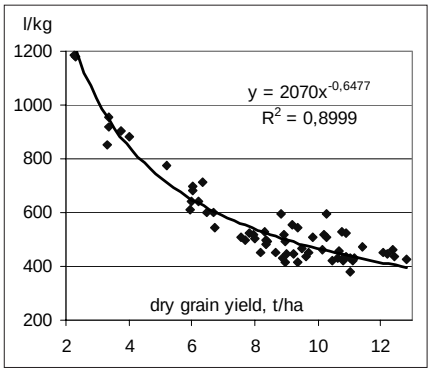

Figure 2: **Relationship between the maize grain yield and the specific water consumption**

increase of yield is much higher than the evapotranspiration, because of this the water consumption per one unit of yield decreases; it means the productivity of water improves (*Figure 2*).

The ration of the grain yield and the by-products (leaf, stem, corn-cob) also improves with the enhancing yield, i.e. the harvest index increases (*Figure 3*).

The *Figure 4* illustrates the connection between the dry grain yield of maize and the nitrogen uptake by plant. In the figure can be seen, that with the raising grain yield the nitrogen content of maize also increases, but not to the same ratio than the yield because of the increase of the

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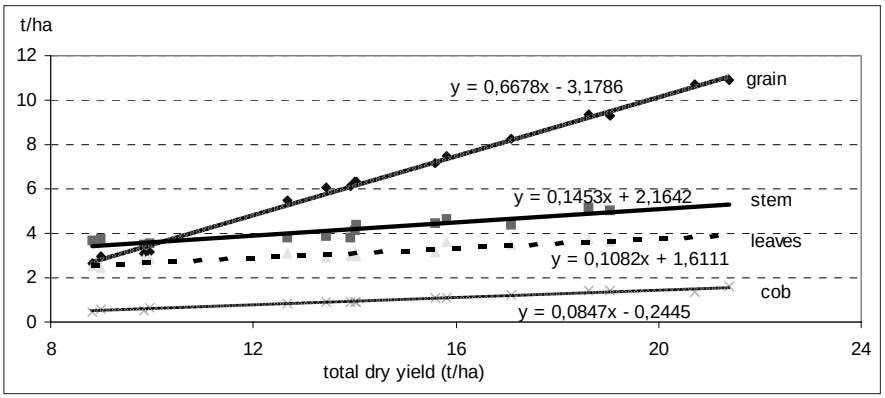

Figure 3: **Relation between the total dry matter and the increase of different parts of plant, Szarvas, Hungary**

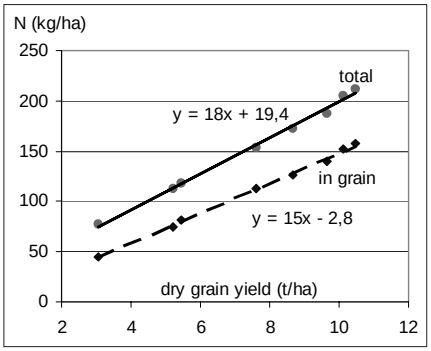

Figure 4: **Grain N and total N content of maize as a function of the yield average**

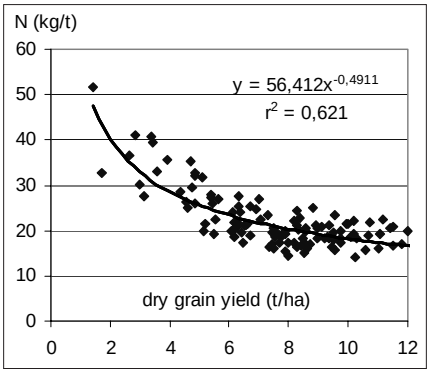

Figure 5: **Relationship between the maize dry grain yield and the specific N-requirement**

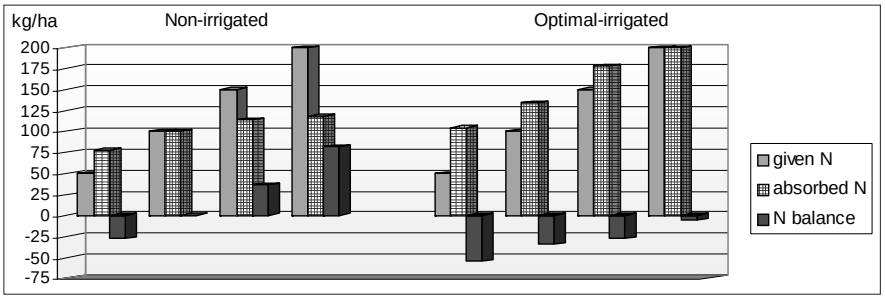

Figure 6: **Nitrogen balance of maize in several years average**

harvest index. Consequently of this the specific nitrogen content, namely the nitrogen requirement decreases with the increasing yield, which relation can be characterised by a hyperbolic function (*Figure 5*).

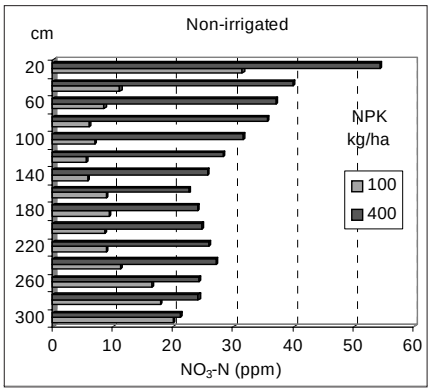

Figure 7: **The NO_3-N profile of the soil in the non-irrigated and in the optimal-irrigated treatments**

In the non-irrigated and optimum-irrigated treatments the difference between the given nitrogen fertiliser and the nitrogen content of plant was investigated. The *Figure 6* shows, that the higher nitrogen doses (150-200 kg/ha) are not taken up by the maize in the non-irrigated treatment, so this nutrient accumulates in the soil. The N-balance was in equilibrium at 200 kg/ha nitrogen dose at the optimal water supply.

At favourable water supply the nutrient uptake by maize increases, the optimal fertiliser dose is higher, and the amount of accumulation is lower in the soil than in the non-irrigated one. Because of this connection the danger of nitrate leaching is less at optimum irrigation, even in case if the quantity of the infiltration water is more. The *Figure 7* demonstrates that the NO_3-N content of the soil is higher in the non-irrigated treatment - mainly at the 400 kg/ha NPK dose - than at optimum water supply, namely at favourable water supply there is no nitrate accumulation in the soil even at higher nitrogen application.