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THE INFLUENCE OF BALANCED MINERAL FERTILIZATION ON NET ASSIMILATION RATE DURING THE GROWING PERIOD OF MAIZE CULTIVATED ON TWO SOIL TYPES

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Summary. The influence of balanced mineral fertilization on net assimilation rate during maize ontogenesis was examined.Two groups of hybrids were used throughout the experiments: hybrids with middle early ripeness (400 FAO) and late ripeness hybrids (700 FAO). A seven-year field experiment was carried out on Chromic Luvisol (WRBSR FAO,1998) at the experimental station of G.Lozen and on Calcic Chernozem (WRBSR, FAO, 1998) at the experimental station of Kovachitza. It was found that the effect of mineral fertilization on the average values of net assimilation rate was more strongly expressed in maize cultivated on Chromic Luvisol (WRBSR, FAO, 1998). The trend of dependency showed a maximum of net assimilation rate at fertilizer concentrations of 214 $kg.ha^{-1}$ and 150 $kg.ha^{-1}$ for N and P, respectively. When maize was grown on Calcic Chernozem (WRBSR, FAO, 1998), the effect of mineral fertilization was more slightly expressed. Regression equations describing this dependency in specific soil-climatic growth conditions were worked out.

***Key words*:** maize, net assimilation rate, mineral fertilization, hybrids.

Abbreviations: PhP – photosynthetic parameters; NAR – net assimilation rate; B_1, B_2, B_3, B_4, B_5 - mineral fertilization levels.

INTRODUCTION

The influence of balanced mineral fertilization on productivity of agricultural cultures during ontogenesis is manifested mainly in optimization of photosynthetic parameters (PhP) – leaf area index, dry biomass, net assimilation rate. This optimization leads to an increase 9 in the photosynthetic apparatus activity and optimal utilization production possibilities of agroecosystems (Dimitrov and Toncheva, 2003; James et al., 2004; Mikova et al., 2005; Dimitrov et al., 2006).

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The productivity of agrophytocenoses determined by the quantitative values of PhP and their evaluation in specific soil-climatic conditions allow receiving the optimal yields of agricultural systems (Dimitrov et al. 2006; Dimitrov and Stoyanov 2007).

The objective of this study was to evaluate the effect of different rates of mineral fertilizer application on net assimilation rate during the growing period of maize cultivated on two soil types.

MATERIALS AND METHODS

The investigations were carried out during seven years of stationary field experiments on uniform methods in two experimental stations: G. Lozen on Chromic Luvisol (WRBSR FAO, 1998) and Kovachitza on Calcic Chernozem (WRBSR, FAO, 1998).The maize plants were grown as a monoculture under a non-deficient water regime, crop density 70000 plants.ha^{-1}(for hybrid FAO 400) and 55000 plants.ha^{-1} (for hybrid FAO 700).All treatments were arranged in randomized complete block design with six replicates. The field experiments included five levels of nitrogen fertilization: B_1 – Control without fertilization; B_2 – 125 %; B_3 – 100 %; B_4- 75 % and B_5 – 50 %. The rate of fertilization for B_3 (100 %) was determined on a balanced basis to form a crop which ensures grain yield of 10000 kg.ha^{-1}. The fertilizer rates were as follows: B_1 – 0; B_2 – N - 267 and P - 187 kg.ha^{-1}; B_3 – N - 214 and P - 150 kg.ha^{-1}; B_4 – N -160 and P - 112 kg.ha^{-1} and B_5 – N -107 and P -75 kg.ha^{-1} (the experimental station of G.Lozen); B_1 – 0; B_2 – N - 207 and P - 125 kg.ha^{-1}; B_3 – N - 166 and P - 100 kg.ha^{-1}; B_4 – N -124 and P - 75 kg.ha^{-1} and B_5 – N - 83 and P - 50 kg.ha^{-1} (the experimental station of Kovachitza), respectively. The values of NAR were calculated according to the method of Vernon A. J. and Allison C. S. In the present study, the influence of mineral fertilization on net assimilation rate was investigated in four phenophases: 10-11 leaf, flowering, milk ripeness and wax ripeness. The statistical package SPSS was used for statistical analysis.

RESULTS

During cultivation of maize (FAO 400 hybrid) on Calcic Chernozem, application of different rates of mineral fertilizers increased net assimilation rate (NAR) values (5.48 – 7.05 g.m^{-2}.day^{-1}) at the stage of 10th–11th leaf. In the next phonological stages of development this was slightly manifested as at the stage of wax ripeness the mineral fertilization led to a decrease of NAR (Fig. 1). When a late maize hybrid was used (700 according to FAO), the positive effect of mineral fertilization was observed only at the stages of 10th–11th leaf and milk ripeness with a maximum at the following fertilization rates: B_4 – N - 124, P - 75 kg.ha^{-1}; B_5 – N - 83, P - 50 kg.ha^{-1} and B_2 – N - 207 and P - 125 kg.ha^{-1}; B_3 – N - 166, P - 100 kg.ha^{-1} (Fig. 2). When growing corn hybrid (FAO-400) on Chromic Luvisol NPP values increased with increasing the rate of mineral fertilizers at the stages of 10th–11th leaf and flowering with a maximum of nitrogen fertilization in B_2 – N - 267 and P - 187 kg.ha^{-1}. The effect of mineral fertilization on the late hybrids was highest at the stages of milk ripeness and wax ripeness with a maximum in the variant B_4 – N -160, P - 112 kg.ha^{-1} and B_5 – N -107, P -75 kg.ha^{-1}(Fig. 3 and Fig. 4), respectively.

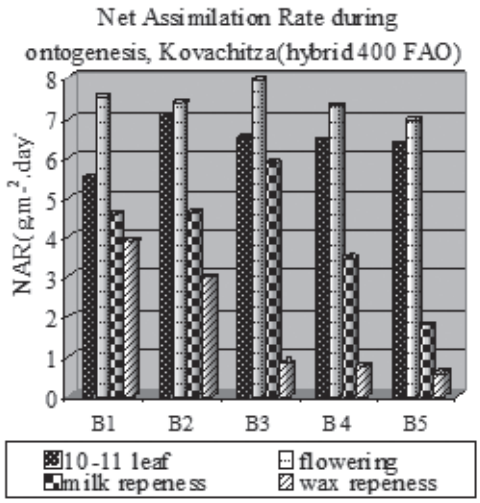

Fig. 1

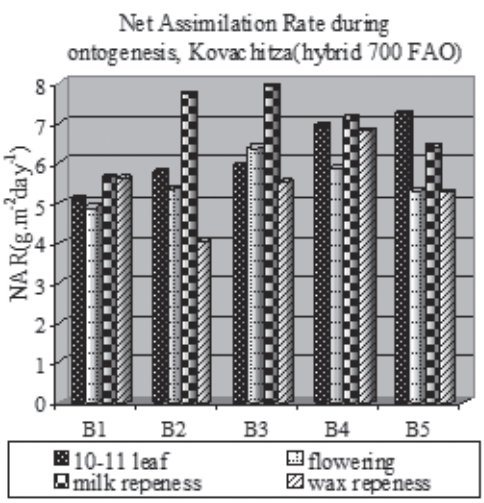

Fig. 2

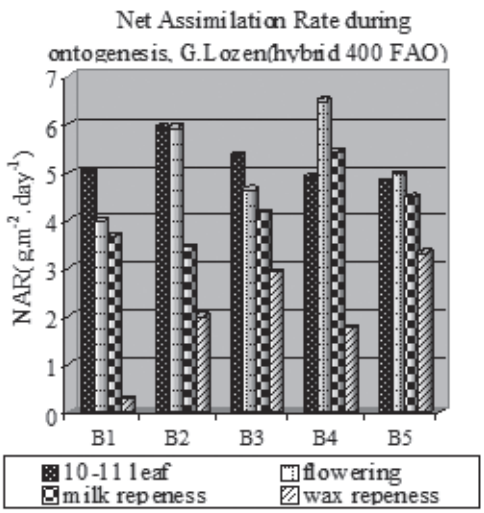

Fig. 3

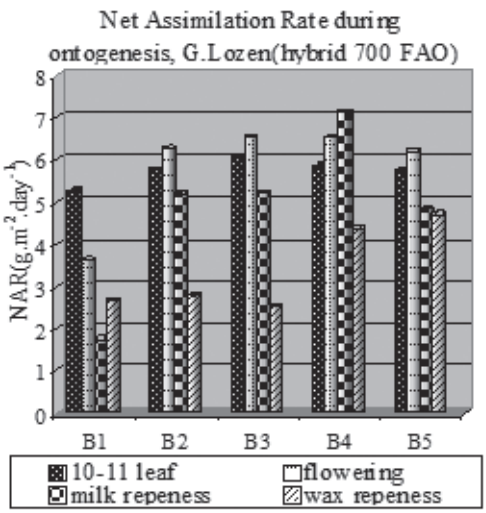

Fig. 4

Phenophases: 10 -11 leaf; flowering; milk ripeness and wax ripeness
B_1 – without fertilizer application; B_2 – 125%; B_3 – 100%; B_4 – 75%; B_5 – 50%.

Fig. 1–4. The effect of mineral fertilization on net assimilation rate of maize cultivated on two soil types: Kovachitza (Calcic Chernozem) and G. Lozen (Chromic Luvisol).

Mineral fertilization had a stronger influence on the values of NAR in maize growing on Chromic Luvisol**.** The *parabolic trend line,* determining this dependency peaked at N - 214 and P - 150 kg.ha^{-1} for both groups of maize hybrids. Mineral fertilization of maize, growing on Calcic Chernozem had no influence on the mean values of NAR in the medium early maturity hybrids. When late hybrids were used, this influence was slightly expressed (Fig. 5, 6).

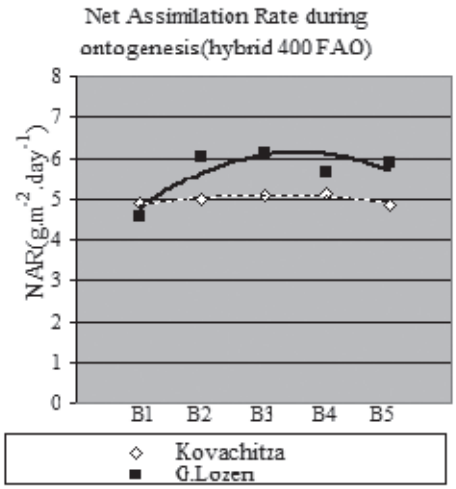

Fig. 5

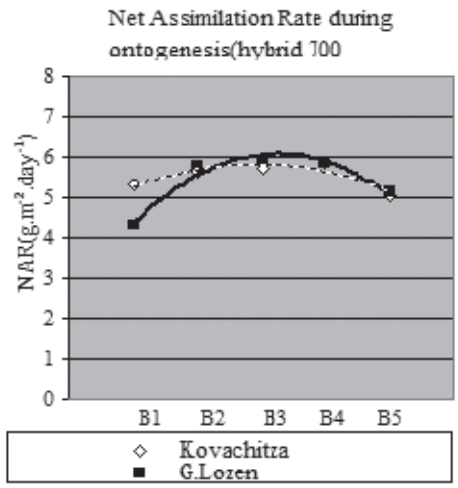

Fig. 6

B_1 – without fertilizer application; B_2 – 125%; B_3 – 100%; B_4 – 75%; B_5 – 50%.

Fig. 5–6. The effect of mineral fertilization on the average values of net assimilation rate during the growing period of maize crop cultivated on two soil types: Kovachitza (Calcic Chernozem) and G. Lozen (Chromic Luvisol).

The equations describing this dependency are:

$$Y = -0.0543x^2 + 0.3377x + 4.574$$
$$R^2 = 0.785$$

Hybrid (400 FAO) on Calcic Chernozem.

$$Y = - 0.2079x^2 + 1.4761x + 3.51$$
$$R^2 = 0.715$$

Hybrid (400 FAO) on Chromic Luvisol.

$$Y = - 0.1593x^2 + 0.928x + 4.481$$
$$R^2 = 0.811$$

Hybrid (700 FAO) on Calcic Chernozem.

$$Y = - 0.3279x^2 + 2.138x + 2.586$$
$$R^2 = 0.959$$

Hybrid (700 FAO) on Calcic Chernozem.

DISCUSSION

Mineral fertilization of medium early maize hybrids (FAO 400), growing on Chromic Luvisol had the highest impact on NAR at the stage of wax ripeness while in late hybrids (700 FAO) the highest effect of fertilization was observed at the stage of milky ripeness. In maize (400 acc. FAO) growing on Calcic Chernozem the mineral

fertilization affected to a higher extent the values of NAR at the stage of 10^{th}–11^{th} leaf and had a negative impact on NAR during wax ripeness. When a late hybrid was used (700 FAO), the positive influence of mineral fertilization was observed at the stages of 10^{th}-11^{th} leaf and milk ripeness. The absolute values of NAR during ontogenesis were higher during cultivation of maize on Calcic Chernozem, regardless of mineral fertilization and hybrid group. The effect of different doses of mineral fertilizers on average NAR was stronger in maize growing on Chromic Luvisol. This effect was negligible in early maize hybrids and slightly expressed in late hybrids cultivated on Calcic Chernozem.

REFERENCES

Dimitrov I, R Toncheva, 2003. Effects of irrigation rate, plant density and nitrogen fertilization on the corn grain yield. Ecol Fut, 2: 40–43 (in Bulg.).

Dimitrov I, R Toncheva, P Stoyanov, 2006. The effect of mineral nutrition on maize production in dependence of agroecological conditions. Agricult Sci, 39: 47–52 (in Bulg).

Dimitrov I, P Stoyanov, 2007. Formation of maximum maize leaf area index in dependence on agroecological conditions. Proceedings of international conference 60-Years institute of soil science "Nlkola Poushkarov" - Soil science – base for sustainable agriculture and environment protection, 13 – 17 May 2007, pp. 320–323 (in Bulg.).

Mikova A, I Dimitrov, P Stoyanov, 2005. The influence of mineral nutrition on the quantitative values of photosynthetic parameters of maize during ontogenesis. Soil Sci Agrochem Ecol, 40: 62–66 (in Bulg.).

James RK, B Brend, Y Xie, P Chen, 2004. Maize yield potential:critical processes and simulation modeling in a high-yieldding environment. Agricult Systems, 82: 45–56.

Vernon AJ, CS Allison, 2008. A Method for calculating net assimilation rate. Nature,

Nature 2000, 814 (23 November 1963).