Geophysical Research Abstracts,
Vol. 11, EGU2009-1398, 2009
EGU General Assembly 2009

CLIMATE CHANGE: PRECIPITATION AND PLANT NUTRITION INTERACTIONS ON POTATO (Solanum tuberosum L.) YIELD IN NORTH-EASTERN HUNGARY

DR. M. László PhD
RISSAC-HAS, Agrochemistry, Budapest, Hungary (marton@rissac.hu, +36 1 3558491)

Abstract: It is widely well known that annual temperatures over Europe warm at a rate of between 0.1 0C decade-1 and 0.4 0C decade-1. And most of Europe gets wetter in the winter season between +1% and +4% decade-1. In summer there is a strong gradient of change between northern Europe (wetting of up to +2% decade-1) and southern Europe (drying of up to 5% decade-1). The droughts and the floods were experienced at Hungary in the early eighties as well as today. So among the natural catastrophes, drought and flooding caused by over-abundant rainfall cause the greatest problems in field potato production. The crop is demanding indicator plant of climate factors (temperature, rainfall) and soil nitrogen, phosphorus, potassium and magnesium status. This publication gives the results achieved in the period from 1962 to 2001 of a long term small– plot fertilization experiment set up on acidic sandy brown forest soil at Nyírlugos in the Nyírség region in North-Eastern Hungary. Characteristics of the experiment soil were a pH (KCl) 4.5, humus 0.5%, CEC 5-10 mgeq 100g-1 in the ploughed layer. The topsoil was poor in all four macronutrient N, P, K and Mg. The mineral fertilization experiment involved 2 (genotypes: Gülbaba and Aranyalma) x 2 (ploughed depths: 20 and 40 cm) x 16 (fertilizations: N, P, K, Mg) = 64 treatments in 8 replications, giving a total of 512 plots. The gross and net plot sizes were 10x5=50 m2 and 35.5 m2. The experimental designe was split-split-plot. The N levels were 0, 50, 100, 150 kg ha-1 year-1 and the P, K, Mg levels were 48, 150, 30 kg ha-1 year-1 P2O5, K2O, MgO in the form of 25% calcium ammonium nitrate, 18% superphosphate, 40% potassium chloride, and powdered technological magnesium sulphate. The forecrop every second year was rye. The groundwater level was at a depth of 2-3 m. From the 64 treatments, eight replications, altogether 512- experimental plots with 7 treatments and their 16 combinations are summarised of experiment period from 1962 to 1979. The main conclusions were as follows: 1. The experiment years (1962-1963, 1964-1965, 1966-1967, 1968-1969, 1970-1971, 1972-1973, 1974-1975, 1976-1977, 1978-1979) were characterised by frequent extremes of climate. Seven years had an average rainfall, one year had an over rainfall and one year had a very dry by Hungarian traditional and RISSAC-HAS (Márton 2001b) new potato ecological standards. 2. The unfavorable effects of climate anomalies (drought, over-abundance of water in the topsoil) on the yield formation, yield quantity of potato depended decisively on the time of year when they were experienced and the period for which they lasted. 3. Precipitation deficiency (droughts) in the winter could not be counterbalanced by average rainfall during the vegetation period, and its effect on the yield was similar to that of summer drought. 4. Yield was influenced by rainfall to a greater extent than by 0-150 kg ha-1 nitrogen and NP, NK, NPK, NPKMg combinations. 5. Drought and over rainfall negative effects were decreased by increasing N- doses and its combinations of potassium, phosphorous and magnesium from 13 to 32%. 6. It was found the polynomial correlation between rainfall and yield could be observed in the case of N: Y'=380.18-2.95x+0.0056x2, n=72, R2=0.95, NP: Y'=387.19-3.04x+0.0059x2, n=72, R2=0.96, NK: Y'=381.65-2.95x+0.0056x2, n=72, R2=0.95, NPK: Y'=390.87-3.07x+0.0060x2, n=72, R2=0.96 and NPKMg: Y'=390.45-3.06x+0.0059x2, n=72, R2=0.96 nutrition systems. The optimum yields ranges between 17-20 t ha-1 at 280-330 mm of rainfall.

Key words: climate change, rainfall, potato, N, NP, NK, NPK, NPKMg, yield

Introduction: Climate change was recognized as a serious environmental issue. The build up of greenhouse gases in the atmosphere and the inertia in trends in emissions means that we can expect significant changes for at least the next few decades and probably for the future time. Annual temperatures over Europe warm at a rate of between 0.1 0C decade-1 and 0.4 0C decade-1. And most of Europe gets wetter in the winter season between +1% and +4% decade-1. In summer there is a strong gradient of change between northern Europe (wetting of up to +2% decade-1) and southern Europe (drying of up to 5% decade-1). The urgent need is to understand what might be involved in adapting to the new climates. And we must increasingly get the following question: how do we respond effectivelly to prevent damaging impacts and take advantage of new climatic opportunities. This question requires detailed in information regarding expected impacts and effectíve adaptive measures. Climate change at Hungary was initiated about of 1850 (Márton 2001b). Nowadays among the natural catastrophes, drought and flooding caused by over-abundant rainfall and cause the greatest problems in field crop production in this region (László et al. 2000a, Márton et al. 2000). The droughts and the floods were experienced in the early eighties as well as today have drawn renewed attention to the analysis of this problem (László 2001, Márton 2001a, Márton 2001c).

Potatoes are one of the most important crops in the agricultural systems of many World countries but little research in the field of climate change impact assessment has been undertaken. Potatoes are sensitives to the prevailing weather conditions (precipitation) and, hence, it is important to evaluate the effects of anthropogenic climate change on their production. The crop is demanding indicator plant of soil nutrient status too. Has a particularly high requirement for supply of soil nitrogen, phosphorus, potassium and magnesium (Láng 1973, Szemes és Kádár 1990, Kádár és Szemes 1994, Johnston 2000, Kádár et al. 2000, László 2000, László et al. 2000b, 2000c, Márton 2000a, 2000b). The tubers remove 1.5 times as much potassium as nitrogen and 4 or 5 times the amount of phophate. This paper describes climate change, mainly precipitation and N, NP, NK, NPK and NPKMg effects on potato yield on a acidic sandy brown forest soil at long term field experiment scale under North- Eastern Hungarian climate conditions at Nyírlugos from 1962 to 1979.

Material and Method: Effects of climate changes, especially rainfall quantity and distribution on certain crop fertilization factors (N, P, K, Mg and potato yield) were studied in a long-term field experiment on acidic sandy brown forest soil at Nyírlugos in North- Eastern Hungary set up in 1962 and 2001. Ploughed layer of the experiment soil had a pH (KCl) 4.5, humus 0.5%, CEC 5-10 mgeq 100g-1. The topsoil was poor in all four macronutrient N, P, K and Mg. The mineral fertilization experiment involved 2 (Gülbaba and Aranyalma genotypes) x 2 (20 and 40 cm ploughed depths) x 16 (N, P, K, Mg fertilizations) = 64 treatments in 8 replications, giving a total of 512 plots. The gross and net plot sizes were 10x5=50 m2 and 35.5 m2. The experimental designe was split-split-plot. The N levels were 0, 50, 100, 150 kg ha-1 year-1 and the P, K, Mg levels were 48, 150, 30 kg ha-1 year-1 P2O5, K2O, MgO in the form of 25% calcium ammonium nitrate, 18% superphosphate, 40% potassium chloride, and powdered technological magnesium sulphate. The forecrop every second year was rye. The groundwater level was at a depth of 2-3 m. Ecological and experimental dates were estimated by Hungarian traditional, RISSAC-HAS (Márton 2001b) new potato standards and MANOVA. From the 64 treatments, eight replications, altogether 512- experimental plots with 7 treatments and their 16 combinations are summarised of experiment period from 1962 to 1979.

Results and Discussion: The experiment years (1962-1963, 1964-1965, 1966-1967, 1968-1969, 1970-1971, 1972-1973, 1974-1975, 1976-1977, 1978-1979) were characterised by frequent extremes of climate. Seven years had an average rainfall, one year had an over rainfall and one year had a very dry.

The unfavorable effects of climate anomalies (drought, over-abundance of water in the topsoil) on the yield formation, yield quantity of potato depended decisively on the time of year when they were experienced and the period for which they lasted. Droughts in the winter or summer half-year had much the same effect on yield. Precipitation deficiency in the winter could not be counterbalanced by average rainfall during the vegetation period, and its effect on the yield was similar to that of summer drought. It was also concluded that economic yields could not be achieved with poor N, P, K and Mg nutrient supply even with a normal quantity and distribution of rainfall.

Yield was influenced by rainfall to a greater extent (Table 4) than by 0-150 kg ha-1 nitrogen and NP, NK, NPK, NPKMg combinations. Drought and over rainfall negative effects were decreased by increasing N- doses with combinations of potassium, phosphorous and magnesium from 13 to 32% (Table 5). And with the help of regression analysis it was found the polynomial correlation between rainfall and yield could be observed in the case of N: Y'=380.18-2.95x+0.0056x2, n=72, R2=0.95, NP: Y'=387.19-3.04x+0.0059x2, n=72, R2=0.96, NK:

Y'=381.65-2.95x+0.0056x2, n=72, R2=0.95, NPK: Y'=390.87-3.07x+0.0060x2, n=72, R2=0.96 and NPKMg: Y'=390.45-3.06x+0.0059x2, n=72, R2=0.96 nutrition systems. The optimum yields ranges between 17-20 t ha-1 at 280-330 mm of rainfall.

Acknowledgement: This study were supported by Research Institute for Soil Science and Agricultural Chemistry of the Hungarian Academy of Sciences (RISSAC-HAS), Budapest.

References

Johnston, A. E., 2000. Some aspects of nitrogen use efficiency in arable agriculture. K. Scogs-o. Lantbr. Akad. Tidskr. 139, 8.

Kádár, I., Márton, L., Horváth, S., 2000. Mineral fertilisation of potato (Solanum tuberosum L.) on calcareous chernozem soil. Plant Production. 49, 291-306.

Kádár, I., Szemes, I., 1994. A nyírlugosi tartamkísérlet 30 éve. MTA TAKI, Budapest, 248 p.

Láng, I., 1973. Műtrágyázási tartamkísérletek homoktalajon. MTA Doktori értekezés. MTA TMB. Budapest

László, M., 2000. Nutrition of potato (Solanum tuberosum L.) on Hungary on a chernozem soil. Acta Agronomica Óváriensis. 42, 81-93.

László, M., 2001. Year and N- fertilizer effect on winter rye (Secale cereale L.) yield in a long term field experiment. XLIII. Georgikon Days. University of Veszprém. Keszthely

László, M., Imre, K., Jose, E. M., 2000a. Effects of Crotalaria juncea L. and Crotalaria spectabilis ROTH. on soil fertility and soil conservation in Hungary. Acta Agronomica Óváriensis. In press

László, M., Silva, J. B. C., José, A. B., 2000b. Ecological friendly dragée technics on different crops and vegetables seeds. Acta Agronomica Óváriensis. In press

László, M., Silva, J. B. C., Jose, A. B., 2000c. Ecological friendly dragée technics to sustainable precision agriculture. Fertilization in the Third Millenium. CASISCF. Beijing

Márton, L., 2000a. Effects of NPK fertilizers on potato (Solanum tuberosum L.) yield. Doctoral Ph.D Dissertation. University of Veszprém, Keszthely.

Márton, L., 2000b. Effects of NPK fertilizers on potato (Solanum tuberosum L.) yield. Doctoral Ph.D Thesis. University of Veszprém, Keszthely.

Márton, L., 2001a. Climate change and N, P, K, Mg fertilization effect analysis at Tisza-river basin in a long term field experiment. Szent István University, Gödöllő, 21. p.

Márton, L., 2001b. Climate change effets on rye (Secale cereale L.) yield. Agrochemistry and Soil Science. In press

Márton, L., 2001c. Climate change and fertilization effect analysis at the Tisza- river basin on rye yield. SZINET. University of Szent István. Gödöllő.

Márton, L., Kádár, I., Estáquio, M. J., 2000. Effects of Crotalaria juncea L. and Crotalaria spectabilis ROTH on soil fertility and soil conservation. ESSC. Man and Soil at the Third Millennium. Abstract Book. 195. Valencia

Szemes, I., Kádár, I., 1990. Műtrágyázás és meszezés tartamhatásának vizsgálata savanyú homoktalajon. Növénytermelés. 39: 147-155.