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ABSTRACT

Climate change of Hungary was initiated about of 1850. Nowadays among the natural catastrophes, drought and flooding caused by over-abundant rainfall cause the greatest problems in field crop production. 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. The potato is demanding indicator crop of climate factors (temperature, rainfall) and soil nutrient status. Has a particularly high requirement for quantity of precipitation and for supply of soil potassium, nitrogen, phosphorus and magnesium. This paper reports 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 (genotype: Gülbaba and Aranyalma) x 2 (ploughed depth: 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 technological powdered 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 new 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. 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.
4. In vegetation periods poor in rainfall yield safety in potato can not be secured by 150 kg ha-1 potassium fertilization. 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.

5. Yield was influenced by rainfall to a greater extent than by 150 kg ha-1 potassium combinations (NK, NPK, NPKMg).
6. Drought and over rainfall negative effects were decreased by increasing N- doses and its combinations of potassium, phosphorous and magnesium from 13 to 32%.
7. With the help of regression analysis it was found the polynomial correlation between rainfall and yield could be observed in the case of 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 yield ranges between 17-20 t ha-1 at 280-330 mm of rainfall.

Key words: climate change, rainfall, potassium, potato, yield

INTRODUCTION

Climate change is now 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 rest of this century. The urgent need is to understand what might be involved in adapting to the new climates. A decade ago, research asked the „what if " question. For example, what will be the impact if climate changes. Now, we must increasingly address 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. Information on adaptation is required for the range of stakeholders concerned with agriculture- from the farmers and producers, to processors, supermarkets and consumers and for government and landscape planners. Not only the local effects and options, but also the spatial implications must be understood. Will yields be maintained on the present range of farms. Where will new crops be grown. Will new processing plants be required. Will there be competition for water. Climate change at Hungary was initiated about of 1850 (Márton 2001b). Nowadays among the natural catastrophes, drought and flooding caused by over-abundant rainfall cause the greatest problems in field crop production (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 2001a, László 2001b, Márton 2001a, Márton 2001c).
Most recent agricultural impact studies have concentrated on the effects of mean changes in climate on crop production, whilst only limited investigations into the effects of climate variability on agriculture have been undertaken. The paucity of studies in this area is not least due to the considerable uncertainty regarding how climate variability may change in the future in response to greenhouse gas induced warming but also as a result of the uncertainty in the response of agricultural crops to changes in climate variability, effected most probably through changes in the frequency of extreme climatic events. Showed that changes in variance have a greater effect on the frequency of extreme climatic events than do changes in the mean values. Hence, it is important to attempt to include changes in variability in scenarios of climate change.
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 potassium, nitrogen, phosphorus and magnesium (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 and mainly potassium effects on potato yield on a acidic sandy brown forest soil at long term experiment scale under Mediterranean climate conditions at North- Eastern Hungary from 1962 to 1979.

MATERIAL AND METHOD

The effect of climatic factors, especially rainfall quantity and distribution on certain crop fertilization factors (K, N, P, 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 technological powdered 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 new standards and MANOVA. From the 64 treatments, eight replications, altogether 512- experimental plots with 7 treatments and their 16 combinations (Table 1) are summarised of experiment period from 1962 to 1979.

Table 1.
Experimental N, P, K, Mg treatments and combinations (Nyírlugos, 1962-1979)

Treatments (kg ha-1 year-1)
Control
N1 = 50 P = 48 (P2O5)
N2 = 100 K = 150 (K2O)
N3 = 150 Mg = 30 (MgO)
N, P, K, Mg combinations
Control
N1 N2 N3
N1P N2P N3P
N1K N2K N3K
N1PK N2PK N3PK
N1PKMg N2PKMg N3PKMg

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 (Table 2). Seven years had an average rainfall, one year had an over rainfall and one year had a very dry (Table 3). 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. In vegetation periods poor in rainfall yield safety in potato can not be secured by 150 kg ha-1 potassium fertilization. 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 150 kg ha-1 potassium combinations (NK, NPK, NPKMg). 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 6). With the help of regression analysis it was found the polynomial correlation between rainfall and yield could be observed in the case of 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 yield ranges between 17-20 t ha-1 at 280-330 mm of rainfall.
From 1962 to 1979 the weather was highly variable, with particularly frequent droughts and over rainfall resulting in yield losses of 13 to 32 percentin in this period. Thus it is important to analyse the consequences of possible future climate change on crop in Hungary.

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