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# The influence of soil-climatic conditions and years on the yield winter wheat

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**Abstract** The long-term stationary fertilizer trials were performed at three ecologically different sites to study the subsequent effects of manure and full dressing on the yields of winter wheat grown after red clover. In the variant without any fertilization (neither manure nor fertilizers) for the past 47 to 51 years, the basic grain yields were decreasing with the higher altitude (four-year average varied from 8,09 to 3,39 t.ha$^{-1}$). Statistically significant difference was also recorded between grain and precipitation in May up to June. The share of factors, which affected significantly the grain yield, changed in experimental years and entered into interactions, particularly with weather as well as with a fertilization.

**Key words:** *winter wheat, fertilization, ecologically diferent sites, yield*

## Introduction

Many factors determining the potential yields of the main product, i.e. grain, are involved in the formation of highly productive winter wheat stands. The final commercial yield, its structure and quality, its structure and quality, is the result of the concurrence of these factors during growth and development of the stand (Petr et al. 1980, Kunzová et al. 2004; 2006). Environmental factors act upon living organisms in a complex way, often time making it practically impossible to determine exactly the individual effect of particular factor. Temperature, erratic precipitation and varying soil water balance (Vučić, 1991) are known to be the three main reasons for the instability of wheat yields.

## Material and methods

Long-term stationary nutritional experiments, were established before 52 years at five sites but currently they continue at 3 sites only, Ivanovice (sugar beet prod. area, 225 m a. s. l.), Čáslav (sugar beet prod. area, 263 m a. s. l.) and Lukavec (potato production area, 620 m a. s. l.)

The experiments were carried out with uniform methods and supervised by RICP Prague-Ruzyně. Crop rotations have been unified since year 1963 at all sites. The design of the experiment included 12 treatments combining increasing rates of nitrogen with P, K and Mg fertilization (+ manure every four years) in four replicates. Mineral fertilization included three levels: $N_1$-$N_2$-$N_3$ (40-80-120) kg.ha$^{-1}$, 60 kg.ha$^{-1}$ $P_2O_5$ and 60 kg.ha$^{-1}$ $K_2O$.

Table 1 The precipitation in the long-term experiments (2003-2006)

| Site | IVANOVICE | | | ČÁSLAV | | | LUKAVEC | | |
|---|---|---|---|---|---|---|---|---|---|
| | (mm) | | | (mm) | | | (mm) | | |
| Year | April | May | June | April | May | June | April | May | June |
| 2003 | 27 | 52 | 13 | 30 | 102 | 15 | 26 | 106 | 64 |
| 2004 | 11 | 16 | 99 | 35 | 46 | 77 | 40 | 48 | 132 |
| 2005 | 50 | 108 | 50 | 35 | 79 | 20 | 43 | 75 | 56 |
| 2006 | 77 | 70 | 121 | 58 | 85 | 97 | 67 | 100 | 164 |

Table 2 The temperature in the long-term experiments (2003-2006)

| Site | IVANOVICE | | | ČÁSLAV | | | LUKAVEC | | |
|---|---|---|---|---|---|---|---|---|---|
| | (°C) | | | (°C) | | | (°C) | | |
| Year | April | May | June | April | May | June | April | May | June |
| 2003 | 9,0 | 17,0 | 21,1 | 8,3 | 16,1 | 20,4 | 6,6 | 14,6 | 19,3 |
| 2004 | 12,5 | 13,7 | 17,4 | 9,7 | 12,2 | 16,2 | 8,0 | 10,6 | 14,9 |
| 2005 | 10,0 | 14,1 | 17,2 | 10,0 | 14,1 | 16,8 | 8,2 | 12,8 | 15,7 |
| 2006 | 10,3 | 14,5 | 18,5 | 9,1 | 13,6 | 17,5 | 7,3 | 12,3 | 16,6 |

Evaluation of yields, of their structure and quality, agrochemical analyses of crops and soil were done annually by standard methods.

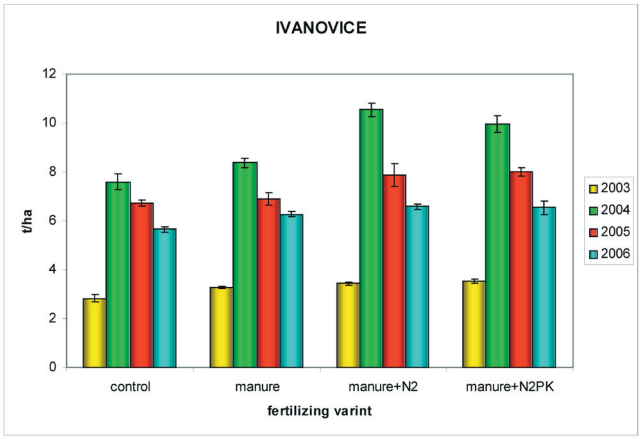


Fig. 1 The average braun yields of winter wheat (cv. Contra) in the basic variant of long – term stationary trials (Ivanovice)

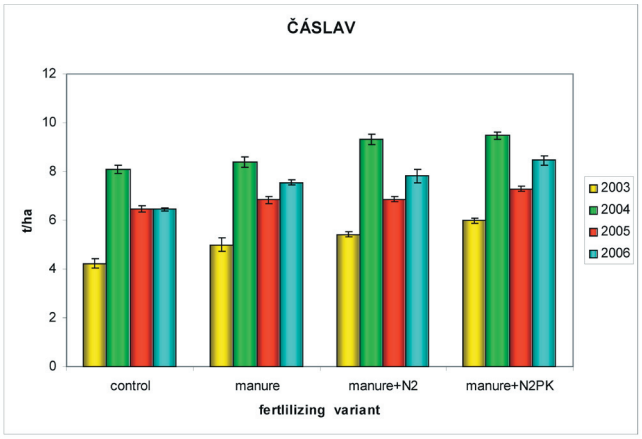


Fig. 2 The average braun yields of winter wheat (cv. Contra) in the basic variant of long – term stationary trials (Čáslav)

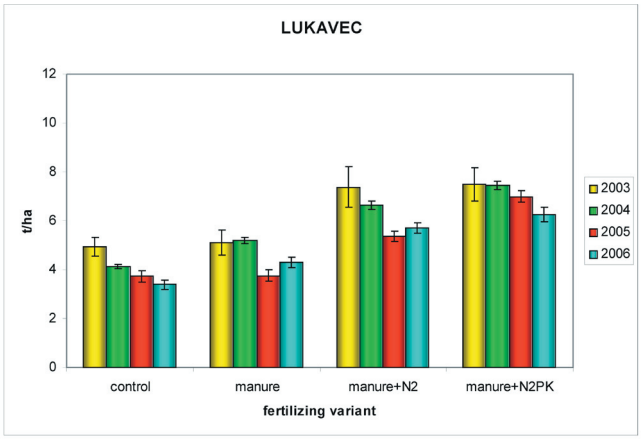


Fig. 3 The average braun yields of winter wheat (cv. Contra) in the basic variant of long – term stationary trials (Lukavec)

The long-term stationary fertilizer trials were performed at five ecologically different sites to study the subsequent effects of manure and full dressing on the yields of winter wheat grown after red clover. In the variant without any fertilization (neither manure nor fertilizers) for the past 47 to 51 years, the basic grain yields were decreasing with the higher altitude (four-year average varied from 8,09 to 3,39 $t.ha^{-1}$). The subsequent influence of manure application was not annulled even by forecrop (red clover) and represented on the average 0,58 $t.ha^{-1}$. The most marked impact was observed on gray-brown podzolic illimerized pseudogley soil with unfavourable physical properties. The yield increments achieved by the application of fertilizers rose with the higher altitude. The basic (untreated with manure) yield participated in the yield of fully dressed crops, taken as the average for all sites and years by 73,0 % subsequent effect of manure by 8,33 % and fertilizer application by 18,67 %. The effect of fertilizers increased with the higher altitude and rainfall, from 11 to 35 %. As proved, the basic soil capability determines significantly the yield achieved by full dressing. As follows from this relation, neither can the intensive application rates of fertilizers lead to high yields if no favourable conditions are given by the basic soil capability. High yields were reached on chernozem soils in Ivanovice in some years even with the variants unfertilized for a long time, provided the soil reaction was neutral, the ear number per sq. m. sufficient and the sowing term suitable. Therefore the high soil capability is the primary prerequisite for the biological maximization of yields. However, the maximum grain yields are hardly to be reached without sufficient fertilizer application, as shown by the results (Fig. 1-3).

At the stationary experiments site Lukavec in the potato growing region with brown soil of light mechanical composition, higher precipitation intensity and lower temperatures where perennial wheat followed trefoil, nitrogen uptake from soil reserves on the unfertilized variant varied in individual years in a range from 58 to 73 kg of N/ha (Table 3). The considerable differences in nitrogen uptake in individual years were especially due to the varying reserves of organically fixed nitrogen in the soil and also due to the influence of weather factors on mineralization and soil washing.

On the other hand, the perennial wheat nitrogen uptake till the harvest period was very wide at stationary experiment sites Čáslav in the sugar-beet region with medium black soil and medium rainfall levels over the monitored years 2003-2006.

Perennial wheat followed clover here and nitrogen uptake from the soil reserve was in a wide range from 88 to 141kg of N/ha.

Relations between nitrogen uptake from dry fertilizers in the heavier soil of the drier sugar-beet region and nitrogen uptake in the lighter, more permeable soil of the wetter potato growing region is evident from Table 3. Nitrogen uptake of perennial wheat decreased by one half in consequence

Table 3 Nitrogen uptake by winter wheat in the long-term experiments

| Ivanovice | | | | | Èáslav | | | | Lukavec | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| variety/year | 2003 | 2004 | 2005 | 2006 | 2003 | 2004 | 2005 | 2006 | 2003 | 2004 | 2005 | 2006 |
| control | 83 | 121 | 123 | 133 | 88 | 141 | 116 | 122 | 73 | 58 | 60 | 61 |
| manure | 99 | 132 | 113 | 145 | 107 | 152 | 121 | 151 | 77 | 77 | 58 | 79 |
| manure+$N_2$ | 106 | 213 | 157 | 166 | 123 | 174 | 141 | 171 | 129 | 102 | 99 | 108 |
| manure+$N_2$PK | 112 | 180 | 153 | 164 | 136 | 197 | 142 | 197 | 132 | 104 | 115 | 116 |

of higher losses due to soil washing caused by environmental factors at the site of the potato growing region (Lukavec 116 kg of N/ha and Čáslav 168 kg of N/ha, Ivanovice 152 kg kg of N/ha – average 2003-2006).

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