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Changes in Sulfur Supply and Need for Oilseed Rape in the Czech Republic

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S u m m a r y

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Within the last decade a sharp decline in sulfur inputs to soils from fertilizers to 30 % and from air emissions to about 15 % has occurred in the Czech Republic. In most regions the annual atmospheric sulfur deposition dropped below 20 (in two regions even below 7) kg S ha^{-1} and the active balance of sulfur in plant production has changed to negative. Winter oilseed rape is a very sensitive crop to sulfur deficiency and its acreage has increased in our country more than 3 times from 1990. The total sulfur requirement for growth of this crop is now more than five times higher than 20 years ago.

Introduction

In the past the supply of sulfur (S) from air emissions and fertilizers in many industrialized countries was more than sufficient to meet the requirement of plants for this nutrient (CECCOTTI & MESSICK 1994). Sulfur inputs to soils were high also in former Czechoslovakia and this element was not recommended for fertilization of crops (NEUBERG & al. 1990, 1995).

The decline in atmospheric S deposition since the late 1980s is often stated as the most important reason for the increasing occurrence of sulfur deficiency of crops in many northwestern European countries. Especially under high nitrogen dressing this has become a major nutritional problem for plant production (SCHNUG & HANEKLAUS 1994, MCGRATH & al. 1996, ERIKSEN 1997, SCHNUG & al. 2001). This paper describes the development and the main changes in sulfur supply from

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fertilizers and air emissions to soils and the consequences for oilseed rape growing in the Czech Republic.

Material and Methods

Statistical yearbooks and our long-term experimental material were used to investigate the change in sulfur inputs to agricultural lands in the Czech Republic from 1950. Sulfur was applied to soils mainly in the forms of ammonium sulfate and superphosphate. It was considered as "ballast" element in NPK fertilizers and was not taken into account as nutrient.

Sulfur emissions from the atmosphere to soils all over the country are well monitored within the ground-level layer using a network of about 550 measuring stations (STATISTICAL ENVIRONMENTAL YEARBOOK 2000). The total annual sulfur deposition in the Czech Republic since 1985 and in the particular regions since 1991 were expressed in kg per ha of land and evaluated from the point of plant nutrition.

Sulfur requirements for winter oilseed rape (*Brassica napus*) were calculated from the annual harvested areas, average seed yield and S need of crop to produce 1 ton of seeds. 15 kg S was considered as an average amounts which rape needs to produce 1 ton of seeds.

Results and Discussion

Sulfur supply to soils in the Czech Republic from NPK fertilizers had been continuously increasing till a peak exceeding 50 kg S ha^{-1} in the eighties of the last century (Fig. 1). According to ŠILAR 1973 sulfur inputs from NPK fertilizers were about 37 kg S ha^{-1} yr^{-1} of agricultural land in the period 1964 to 1968. A drastic change occurred after 1990 (Fig. 1) because of the significant reduction of NPK fertilizer consumption in the country as a result of the important social changes and price liberalization. At the same time S inputs from farm manure production also sharply decreased. The number of dairy cows decreased in the period of 1990 to 1996 from 1.2 to 0.7 millions (STATISTICAL ENVIRONMENTAL YEARBOOK 2000).

Atmospheric sulfur deposition from different sources had increased rapidly in the Czech Republic since 1950 and peaked at about 2.171 million tons SO_2 in 1986. At that time the industrialized western areas of the country became one of the most polluted areas in the world. In North Bohemia the annual deposition reached even values of about 500 kg S ha^{-1}. Concern was therefore focused mainly to record negative effects of SO_2 and the deposition of other air pollutants on the environment and to diminish the harmful effects on crops and natural ecosystems (PREININGEROVÁ 1994). As a result of the clean-air policy, the reduction of heavy industry and the declining emission of SO_2 from power stations burning fossil fuels, the supply of S to soils dramatically decreased all over the country. Within the last decade the annual sulfur deposition has been reduced from about 140 to less than 20 kg S ha^{-1} (Fig. 2) and thus sulfur input to soils was reduced to only 15 % of that 10 years ago. Nevertheless the big differences in sulfur deposition between the regions of the Czech Republic still exist (Table 1).

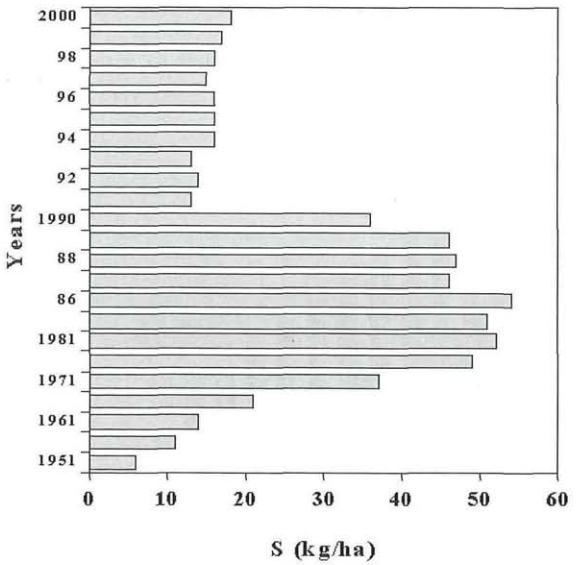

Fig. 1. Sulfur input from NPK fertilizers in the Czech Republic.

Table 1. Development of total sulfur deposition in regions of the Czech Republic (S kg ha^{-1} yr^{-1}).

	Prague	Central Bohemia	South Bohemia	West Bohemia	North Bohemia	East Bohemia	South Moravia	North Moravia
1991	394.3	110.4	26.1	75.0	484.2	97.4	37.6	82.2
1992	419.5	85.1	22.2	49.4	442.4	81.6	37.8	72.7
1993	332.6	72.7	22.2	50.1	410.7	75.8	33.4	69.5
1994	305.7	66.1	18.8	43.6	394.3	62.1	25.1	56.8
1995	249.2	61.2	12.1	31.2	357.5	53.9	15.8	45.4
1996	156.4	63.5	11.9	33.3	279.5	46.7	15.5	42.8
1997	106.5	71.0	10.0	24.9	146.6	46.9	11.7	35.4
1998	63.1	46.7	7.0	17.0	94.1	23.4	5.8	27.4
1999	16.2	12.4	7.0	16.1	58.4	12.9	5.0	18.8

In North Bohemia S deposition decreased during a period of ten years by more than 400 kg S ha^{-1}, and is still over 50 kg S ha^{-1} yr^{-1}. On the other hand, the lowest emissions in East Bohemia and East Moravia regions further decreased to 7 or even 5 kg S ha^{-1} yr^{-1}, respectively.

Such a big change is positive from the ecological point of view, but negative from the point of view of plant nutrition. Once the main input of sulfur for crops was removed, the active sulfur balance in crop production changed to negative and crops began to suffer from sulfur deficiency (ZELENÝ & ZELENÁ 1997).

The decrease of sulfur deposition in the Czech Republic was much more drastic in comparison to western European countries. For example, in Germany the desulfurization of emissions within the last 2 decades led to a decrease of atmospheric S deposition from about 40 to less than 10 kg ha^{-1} S per year.

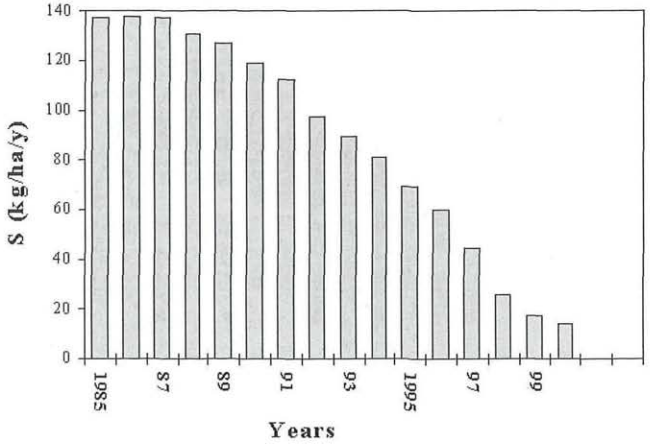

Fig. 2. Total sulfur deposition in the Czech Republic.

Declining atmospheric SO_2 emissions due to the desulfurization of fumes from power stations since the late 1980's are often stated as the most important reason for the increasing S deficiency and had a major effect on the productivity of agricultural crops (SCHNUG & al. 2001). The need for sulfur application has been examined in a large number of trials. A survey carried out on S response trials in Western European countries has shown that more than 80 % of the trials with oil seed rape responded positively to sulfur fertilization (MCGRATH & al. 1996, PEDERSEN & al. 1998). In our first field trial conducted at the RICP station at Pernolec in West Bohemia region, where a negative S balance was expected, we found that sulfur treatment increased oilseed rape yields up to 6.7 %. BALÍK & al. 2001 confirmed these results for S fertilization of rape on sandy soils and soils with limited manure application.

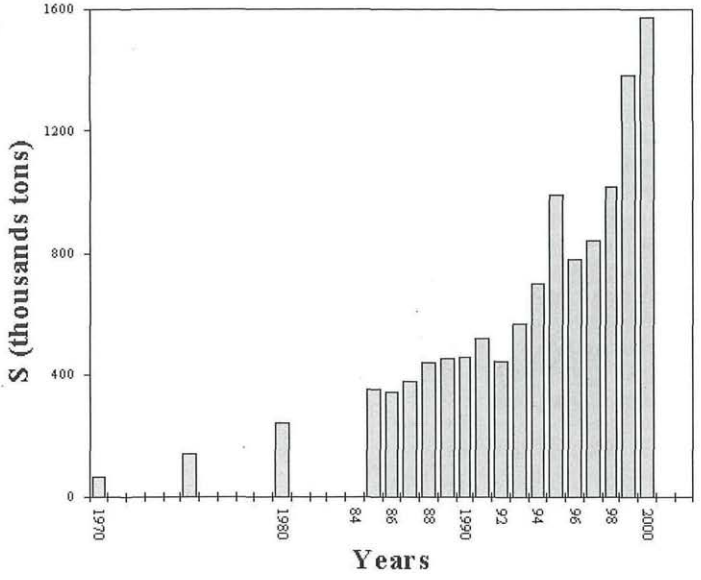

Fig. 3. Total oilseed requirement for sulfur in the Czech Republic.

Winter oilseed rape is an important crop in the Czech Republic and its acreage has been growing very quickly. Within the last decade its harvested area was extended more than three times, to nearly 350 thousands ha in 2000. Total sulfur requirement for this crop increased about five times compared to twenty years ago (Fig. 3).

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