

## Efficiency of spring sulphur fertilization of winter oilseed rape hybrid varieties in diverse conditions of nitrogen fertilization

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### Abstract

In conditions of insufficient sulphur supply to plants, sulphur fertilization increased (on average 200 kg ha<sup>-1</sup>) the yield of seeds of winter oilseed rape varieties. The applied sulphur rate of 15 kg S ha<sup>-1</sup> had the most beneficial effect on rape yield. There was no interaction between sulphur and nitrogen fertilization. The effect of sulphur on seed yield was observed at every nitrogen dose. The net and marginal productivity of 1 kg S was the highest (13,4 kg seeds) at the fertilization rate of 15 kg S ha<sup>-1</sup>, meanwhile every kilogram of sulphur applied additionally gave considerably lower and insecure increase of seed yield. The productivity of 1 kg S and 1 kg N was diversified by the environment conditions (experimental years and localities). The hybrid cultivars, in opposition to open pollinated variety, were characterized by the highest efficiency of nitrogen applied in moderate rate (to 120 kg N ha<sup>-1</sup>), but the efficiency of applied sulphur at all cultivars was similar.

Key wards: winter oilseed rape, sulphur and nitrogen fertilization, agronomic effectiveness

### Introduction

In Poland, rape is the most important oilseed crop. Winter oilseed rape has a high requirement for sulphur. Over a half of cultivated soils in Poland has low concentration of this element. Sulphur influences utilization of the other nutrients, in particular nitrogen (Zhao i in. 1995). Decreased sulphur input from the atmosphere and reduction of sulphur from fertilization have caused deficiency of this nutrient in many plants, especially in rape and in consequence contributed to the reduction of yield (McGrath and Zhao 1995, Haneklaus et al. 1999, Wielebski et al. 2000).

**The aim of investigations was to estimate the efficiency of spring sulphur and nitrogen fertilization of winter oilseed rape hybrid varieties.**

### Material and Methods

This study was based on the results of a three year (2006-2008) exact field experiment, in which the influence of spring nitrogen (60; 120, 180 kg N ha<sup>-1</sup>) and sulphur (0; 15; 30, 60 kg S ha<sup>-1</sup>) fertilization on the yield of winter oilseed rape varieties – open pollinated variety (Bojan) and two hybrids: composite (Kaszub) and restored (Kronos) was studied. The field trials were performed in three places characterized by different soil conditions: on heavy soils in Lagiewniki (N 51 ° 46' E 17 ° 14'), lighter soils in Zielecin (N 52 ° 10' E 16 ° 22') and light soils in Malyszyn (N 52°44' E 15°10'). All places are located far off industrial centres, and soils were characterized by low content of assimilable sulphur (from 0,45-0,95 mg SO<sub>4</sub> / 100 g of soil). In spring sulphur was applied to soil in the form of sulphate of ammonium, and nitrogen was applied in the form of ammonium nitrate (-S) or ammonium sulphate and ammonium nitrate (+S). Both compounds were applied at the beginning of spring vegetation (BBCH 30). Higher nitrogen doses (120 and 180 kg N ha<sup>-1</sup>), as well as the sulphur dose of 60 kg S ha<sup>-1</sup> were divided into two parts, and the second part was applied at the beginning of budding (BBCH 51).

### Results and Discussion

The estimation of sulphur content in the youngest leaves, conducted at the beginning of flowering (BBCH 61), showed in all localities and years of investigations, insufficient content on supervisory, not fertilized with sulphur, objects (0,36-0,46 % S).

In conditions of insufficient sulphur supply to plants, sulphur fertilization increased the yield of seeds. The average increase of seed yield in the three-year experimental period was approximately 200 kg ha<sup>-1</sup>, and it was similar for all applied sulphur rates. There was no interaction between sulphur and nitrogen fertilization. The effect of sulphur on seed yield was observed at every nitrogen dose (fig. 1). In conditions of sulphur deficiency in soil, the seed yield increase of winter rape caused by sulphur fertilization, is confirmed by other authors (McGrath and Zhao 1996, Zukalova et al. 2001, Jankowski et al. 2008).

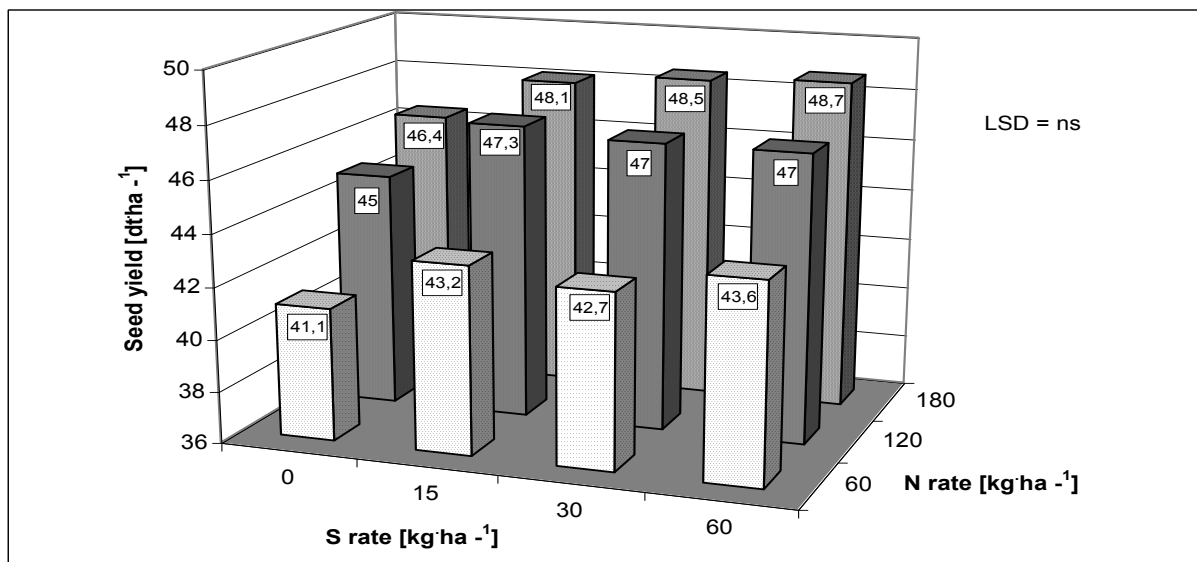


Fig. 1. Winter oilseed rape yield depending of sulphur and nitrogen fertilization [2006-2008]

In all years of investigations the graph of productivity function of sulphur fertilization was described by a curve of second degree (fig. 2). Irrespectively of the rate of nitrogen, the net efficiency of 1kg S was the highest at the lowest S rate (15 kg S/ha<sup>-1</sup>), and decreased with the increase of S fertilizer rates (fig. 3). At the fertilization rate of 15 kg S/ha<sup>-1</sup>, every kilogram of applied sulphur increased rape seeds by over 13 kg on average. Application of higher S rates gave considerably lower increases and their application was not reasonable (table 1)

Fig. 2. Diagram of a function of sulphur fertilization productivity

depending of nitrogen fertilization

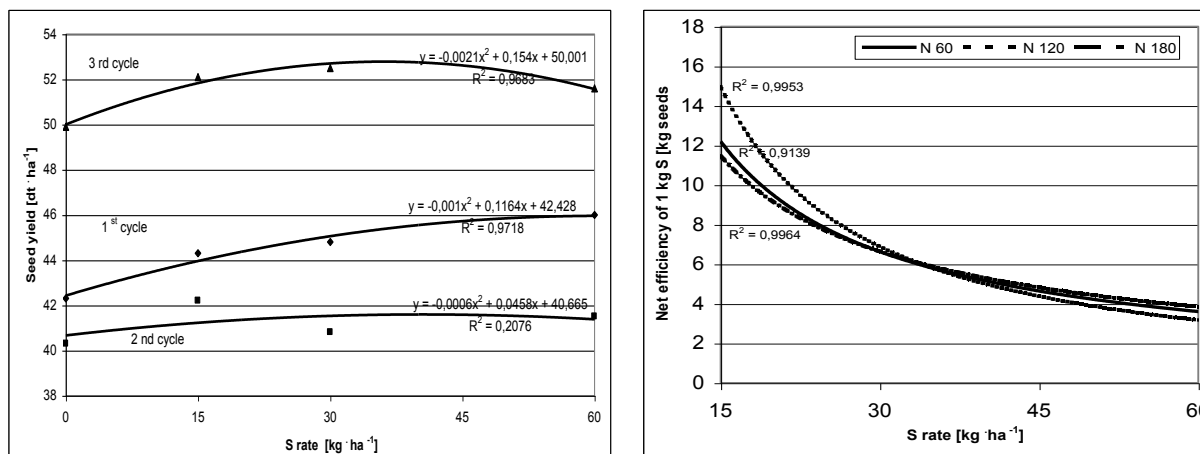


Fig. 3. Net efficiency of 1kg S [kg seeds]

Table 1

Marginal productivity of 1 kg S [kg seeds] according to experiment factors [2006-2008]

| Factor     | S rate [kg ha <sup>-1</sup> ] |     |     | Mean |
|------------|-------------------------------|-----|-----|------|
|            | 15                            | 30  | 60  |      |
|            | N rate [kg ha <sup>-1</sup> ] |     |     |      |
| 60         | 13,6                          | -   | 2,7 | 4,5  |
| 120        | 15,4                          | -   | 0,1 | 4,3  |
| 180        | 11,2                          | 2,6 | 0,7 | 4,8  |
|            | Variety                       |     |     |      |
| Kaszub     | 13,5                          | 2,0 | 0,7 | 5,4  |
| Bojan      | 13,5                          | -   | 3,6 | 3,0  |
| Kronos     | 13,2                          | 3,2 | -   | 5,2  |
|            | Years                         |     |     |      |
| 2006       | 13,2                          | 3,3 | 4   | 6,8  |
| 2007       | 12,7                          | -   | 2,3 | 1,9  |
| 2008       | 14,7                          | 2,7 | -   | 4,8  |
|            | Location                      |     |     |      |
| Lagiewniki | 13,5                          | -   | -   | 2,6  |
| Malyszyn   | 11,3                          | 6,1 | 1,0 | 6,1  |
| Zielecin   | 15,9                          | -   | 3,1 | 4,9  |
| Mean       | 13,4                          | -   | 1,1 | 4,5  |

Table 2

Marginal productivity of 1 kg N [kg seeds] according to experiment factors [2006-2008]

| Factors    | N rate [kg ha <sup>-1</sup> ] |     | Mean |
|------------|-------------------------------|-----|------|
|            | 120                           | 180 |      |
|            | S rate [kg ha <sup>-1</sup> ] |     |      |
| 0          | 6,5                           | 2,3 | 4,4  |
| 15         | 6,8                           | 1,3 | 4,1  |
| 30         | 7,2                           | 2,5 | 4,8  |
| 60         | 5,7                           | 2,8 | 4,2  |
|            | Variety                       |     |      |
| Kaszub     | 7,2                           | 1,3 | 4,2  |
| Bojan      | 4,8                           | 4   | 4,4  |
| Kronos     | 7,5                           | 1,3 | 4,4  |
|            | Years                         |     |      |
| 2006       | 15,2                          | 1,2 | 8,2  |
| 2007       | 0,2                           | 1,7 | 0,9  |
| 2008       | 4,5                           | 3,8 | 4,2  |
|            | Location                      |     |      |
| Lagiewniki | 10,7                          | 2,3 | 6,5  |
| Malyszyn   | 5,8                           | 3,8 | 4,8  |
| Zielecin   | 3,2                           | 0,3 | 1,8  |
| Mean       | 6,5                           | 2,3 | 4,4  |

The highest marginal (6,50 kg of seeds) productivity of 1kg N was observed at the fertilization rate of 120 kg N·ha<sup>-1</sup>. The efficiency of nitrogen imperceptibly increased by the fertilization of sulphur in rates up to 30 the kg S·ha<sup>-1</sup> (table 2). The hybrid cultivars, (Kaszub and Kronos) in opposition to open pollinated variety (Bojan), were characterized by the highest efficiency of nitrogen applied at moderate rate (to 120 kg N·ha<sup>-1</sup>), but the efficiency of applied sulphur in all cultivars was similar.

The productivity of 1kg S and 1 kg N was diversified by the environment conditions (experimental years and localities). The lowest productivity of nitrogen and sulphur was shown in the second year of

investigations (2007) when the yield was the lowest because of unfavourable weather conditions, meanwhile significantly higher measures of fertilization effectiveness were observed in the two remaining experimental years (2006 and 2008), in which yields were high. More diversified and dependent on weather conditions efficiency of nitrogen and sulphur was observed on feebler soils at Malyszyn and Zielecin, whereas in conditions of good soils at Lagiewniki a greater stability of efficiency of both elements was observed.

#### Conclusions

1. In conditions of insufficient sulphur supply to plants, sulphur fertilization increased the yield of seeds. The average increase in seed yield reached approximately 200 kg ha<sup>-1</sup>.
2. There was no interaction between sulphur and nitrogen fertilization. The effect of sulphur on seed yield was observed at every nitrogen dose.
3. The net and marginal productivity of 1kg S was the highest (13,4 kg seeds) at the fertilization rate of 15 kg S ha<sup>-1</sup>, meanwhile every kilogram of sulphur applied additionally gave considerably lower and insecure increase of seed yield.
4. The productivity of 1kg S and 1 kg N was diversified by the environment conditions (experimental years and localities).
5. The hybrid cultivars, in opposition to open pollinated variety, were characterized by the highest efficiency of nitrogen applied at moderate rate (to 120 kg N ha<sup>-1</sup>), but the efficiency of applied sulphur at all cultivars was similar.

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