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THE USE OF AMMONIUM SULPHATE HAS AN ADJUVANT EFFECT ON THE PRODUCTIVITY OF OILSEED RAPE (*Brassica napus* L.)

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Abstract

Oilseed rape (Brassica napus L.) is the second most common oil crop grown in the world, after soybean. The aim of the study was to investigate the adjuvant effect of leaf treatment with ammonium sulphate together with a plant growth regulator (PGR) on the seed yield and quality of canola, cv. DK Implement CL. The experiment was set up in the region of Plovdiv, Bulgaria in the period October 2020 - June 2021. The test variants included: 1 - untreated control, 2 - Plant growth regulator (1 l/ha) + Ammonium sulphate (1 l/ha), 3 - Plant growth regulator (1.5) l/ha + Ammonium sulphate (2 l/ha), 4 - Plant growth regulator (1 l/ha), 5 - Plant growth regulator (1.5 l/ha), 6 - Tilmor (1.2) l/ha, and 7 - Carax (1.5 l/ha). It was established that the application of ammonium sulphate has a positive effect on the plant growth, grain yield, oil and moisture content, and 1000 kernel weight.

Key words*: adjuvant, ammonium sulphate, Brassica napus, oil content, rapeseed yield.*

INTRODUCTION

Winter rape (*Brassica napus*) is one of the most important oil-protein crops in the world (Sikorska et al., 2021). Oilseed rape is the main raw material which is used for producing edible oil and it is a high-protein source in animal nutrition (Ahmad et al., 2007; Malhi et al., 2006). The chemical composition of seeds depends mainly on the genetic factor, but it could also be affected by environmental and agrotechnical conditions (Sikorska et al., 2021).
The application of foliar fertilizers has a positive effect on the content of crude fat (Ahmad et al., 2012; Chwil, 2016; Jankowski et al., 2016) and total protein (Ahmad et al., 2007; Malhi et al., 2006; Sattar et al., 2011) in oilseed rape.
According to Jankowski et al. (2016) the foliar application of micronutrients is particularly beneficial for the plant. Winter rapeseed shows a high demand for sulphur (Sienkiewicz-Cholewa & Kieloch, 2015). Sulphur is the fourth major plant nutrient after nitrogen, phosphorus and potassium and according to Havlin et al. (2004) this element is essential for synthesis of the amino acids like cysteine, and methionine, a component of vitamin A and activates certain enzyme systems in plants
Kotecki et al. (2005) emphasize that sulphur is responsible for the synthesis of chlorophyll and amino acids, it activates enzymes important in the metabolism of energy and fatty acids, increases the resistance of plants to diseases and pests, has a positive effect on other nutrients, mainly nitrogen, and also limits the lodging of plants.
According to Khan et al. (2011) canola has a higher sulphur requirement than most cereals and to meet that demand, additional sulphur may be needed in a balanced fertilizer program. Zao et al. (2003) showed that as a result of insufficient nutrition of plants with sulphur, the synthesis of sulphur amino acids is limited, which inhibits the process of protein formation and promotes the accumulation of non-protein forms of nitrogen. According to Muhammad et al. (2017) the foliar treatment with sulphur had a positive effect on the yield of rapeseed grown on a S-deficient soil.
Fertilizers that supply (S) in the sulphate form are immediately available to crops (Kandil & Gad, 2012). Sulphur requirement and metabolism in plants are closely related to N nutrition (Reuveny et al., 1980), and N metabolism is also strongly affected by the S status of the plant (Janzen and Bettany, 1984; Duke and Reisenauer, 1986).
This motivated us to investigate the effect of foliar application of ammonium sulphate on the growth and yield of oilseed rape, when it is applied together with a Plant growth regulator.

MATERIALS AND METHODS

Plant material

Oilseed rape cv. Implement CL is preferred as a test object because of its very fast initial development in the fall and yield stability year after a year, regardless of soil and meteorological conditions. It is resistant to cracking of the pods and this reduces yield losses before and during harvesting as well as decreases the number of self-seeding. The variety demonstrates a very good resistance at low temperatures and tolerance to virus diseases (TuYV). It has a very good production potential and excellent oil content.

Experimental design

The experiment was conducted on the field in the region of Plovdiv from October 2020 till June 2021. Oilseed rape was sown on 26 August 2020 with a row spacing of 25 cm and 10 cm spacing within the row. The experiment was laid out in randomized complete block, having four replications. The size of every plot was 24 m². The ammonium sulphate, a plant growth regulator (PGR) containing trinexapac-ethyl, and two reference products were applied two times during the vegetation via foliar spray. The first application was done on 18 October 2020, BBCH 16 (Majority), the second application was on 5 March 2021, BBCH 31 (Majority). Seven test variants were examined: 1 - untreated control; 2 - PGR (1 l/ha) + Ammonium sulphate (1 l/ha); 3 - PGR (1.5 l/ha) + Ammonium sulphate 2 l/ha; 4 - PGR1 (l/ha); 5 - PGR (1.5 l/ha); 6 - Tilmor (1.2 l/ha); 7 - Carax (1 l/ha). The plant regulator which was selected for the combined application with AS was Modus (250 g/l trinexapac-ethyl). As reference products, two PGRs with fungicidal properties were used. Tilmor contains tebuconazole (160 g/l) with the addition of prothioconazole (80 g/l). Carax® is an innovative combination of mepiquat chloride 210 (g/l) and metconazole (30 g/l).

Biometry and analysis of the yield

The analysis of the biometry of the treated plants was performed by measuring the height of 5 plants per a block plot 5 times during the vegetation (BBCH 16; BBCH 18; BBCH 31; BBCH 61; BBCH 69-71). The yield was harvested on 29 June 2021. The oil content was analysed in a certified laboratory according to BS EN ISO 659:2009 (Reference method). Seed moisture was measured with Pfeuffer HE 50 Grain Moisture Meter.

Statistical Analysis

The data were presented as means ± SD of 4 replicates. The experimental results were statistically processed with the SPSS program using a one-way ANOVA dispersion analysis using Duncan's comparative method, with the validity of the differences determined at a 95% significance level. The different letters (a, b, c, d) after the average show statistically significant differences between the analyzed variants.

RESULTS AND DISCUSSIONS

In order to analyse the effect of the tested substances on the plant growth 5 measurements of the plant height were done. The data are presented in Figure 1. The plants were with the same height on the day of the first measurement. One month later, the differences between the tested variants were obvious. The untreated plants were the highest followed by the plants treated with a PGR + AS in the lower doses. More than 3 months after the first application and measurement the plants treated with AS were as high as the control. At that time the second application was performed. On 5 March (before flowering), plants from variant 2 were shorter than the control plants by 17% and the plants from variant 3 - by 24% respectively. The reduction of the height in variant 4 was by 11%, and in variants 5, 6, and 7 - by 11%, 2%, and 6% respectively. The last measurement was on 16 April (after flowering). Plants treated with PGR 1 l/ha + AS 1 l/ha were shorter by 22% compared to the control. The plants, which were supplied with the higher dose of PGR and ammonium sulphate, were by 28% shorter. The other tested variant were also shorter than the control and higher than the ammonium sulphate supplied plants. According to Armstrong & Nicol (1991) when the plants are shorter and erect, they produce an even, compact pod canopy, and as a result, ripening is more uniform, pod shattering is reduced and harvesting is more efficient.

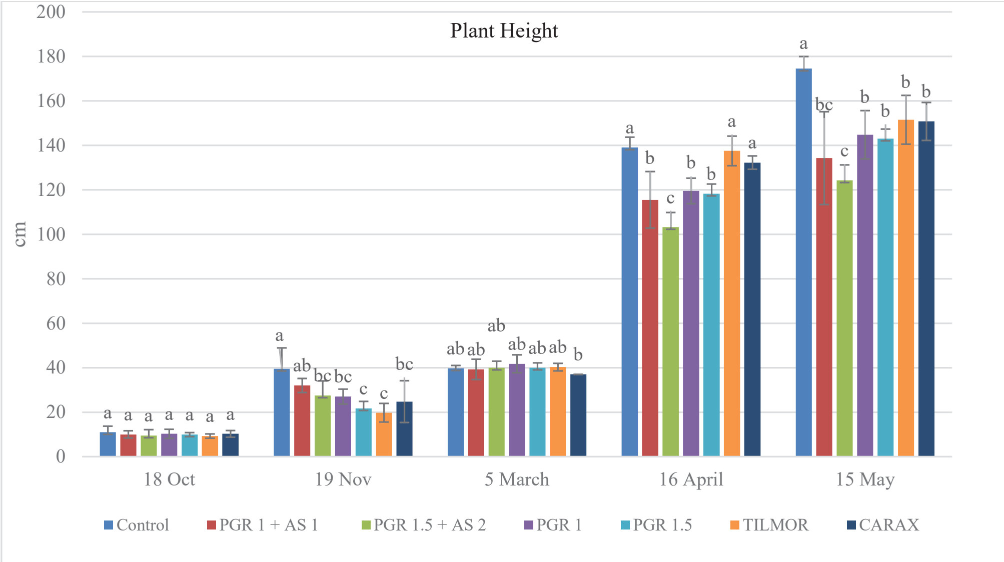

Figure 1. Plant height (cm) on the day of the first foliar spray with the test products and several times after that

In our experiment we use the Ammonium sulphate as an adjuvant - to improve the action of the PGR. Plant growth regulators are used worldwide in many crop species (Tidemann et al., 2020). Their application is followed by a variety of beneficial effects including increased yield, breaking of bud dormancy, fruit maturation prevention or initiation, and, of particular interest here, plant height management and lodging mitigation are observed (Dahnous et al. 1982; Green 1986; Rademacher, 2015).

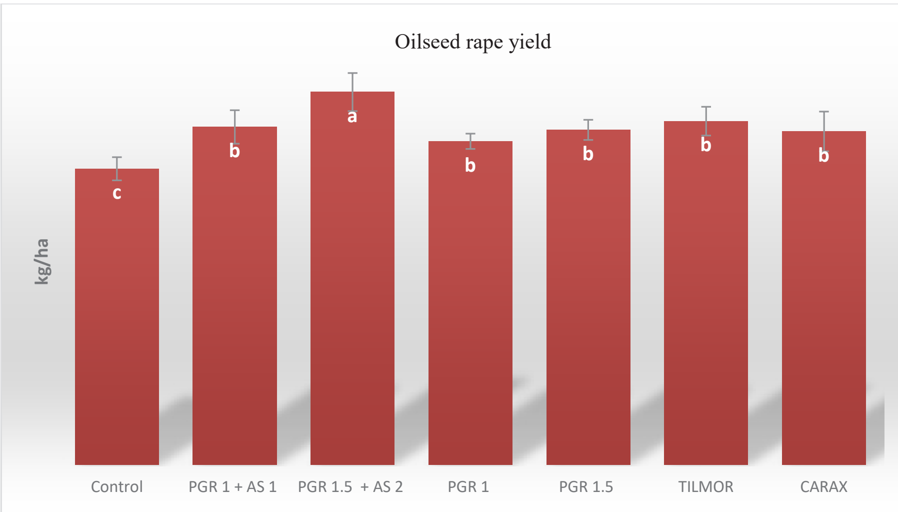

Figure 2. Oilseed rape seed yield (kg/ha)

The data regarding the grain yield of oilseed rape are presented in Figure 2. The yield from the plants treated with ammonium sulphate in the dose of 1 l/ha was 14% higher than the untreated control. The increase after the application of PGR + AS in dose of 2 l/ha was by 25%. The variants treated only with PGR provided 9% (in the dose of 1 l/ha) and 13%

(1.5 l/ha) more grain. The results obtained are in line with the data presented by Anjum et al. (2016). According to the authors, foliar application of 1% Ammonium sulphate water solution is able to increase the canola yield by 27%. Muhammad et al. (2017) also analysed the effect of Ammonium sulphate foliar application on oilseed rape yield. They examined three different concentrations (1%, 0.3%, and 0.2% solution) and declare that more grain yields were obtained with the application of 1% and 0.3% ammonium sulphate solution in comparison to the untreated control. They also observed that the number of leaves and branches generally increased with the increasing levels of Ammonium sulphate as foliar spray although there was no significant difference between the variants.

Our results about the oilseed rape yield are in line also with the achievements of Balik et al. (2006). They observed an increase of the yield in the nitrochalk treatment by 49% and by 60% in the ammonium nitrate + ammonium sulphate treatment respectively, compared to the untreated control.

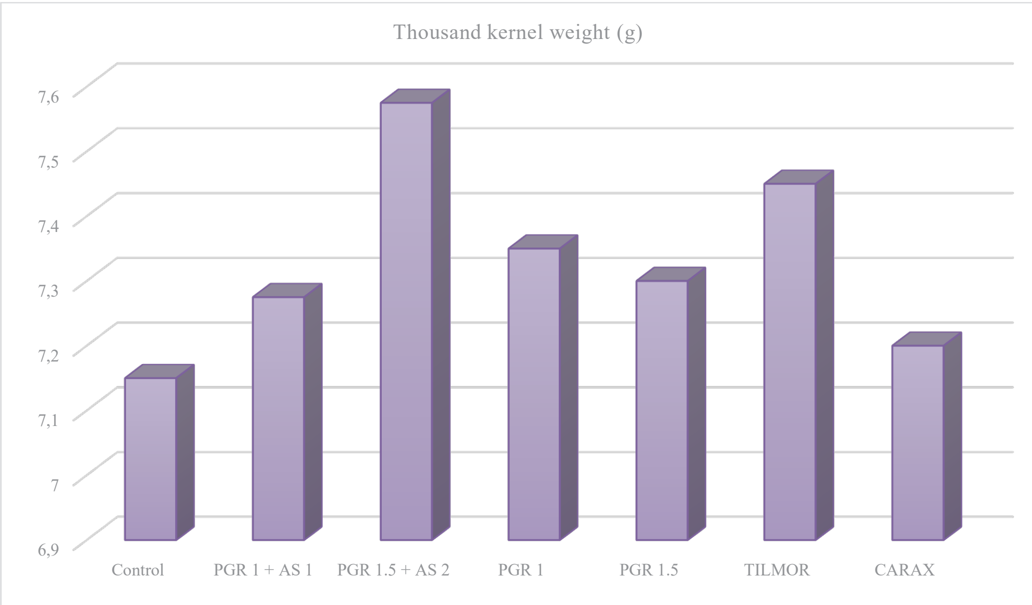

Figure 3. Thousand kernel weight (g) of oilseed rape grain

The data about the analysis of 1000 kernel weight is presented in Figure 3. Although the differences between the variants are not statistically significant, the plants treated with PGR + Ammonium sulphate in the dose of 2 l/ha, provided the heaviest seeds.

Anjum et al. (2016) also reported about the increased weight of 1000 seeds after foliar application of Ammonium sulphate. The results are also in agreement with the findings of Sharifi (2012) and Sattar et al. (2011). The authors reported that increasing levels of sulphur led to an enhancement of thousand grain weights. Canola is an oil seed crop and it response positively to sulphur application due to which its grain yield increases (Malik et al., 2004) (Figure 4).

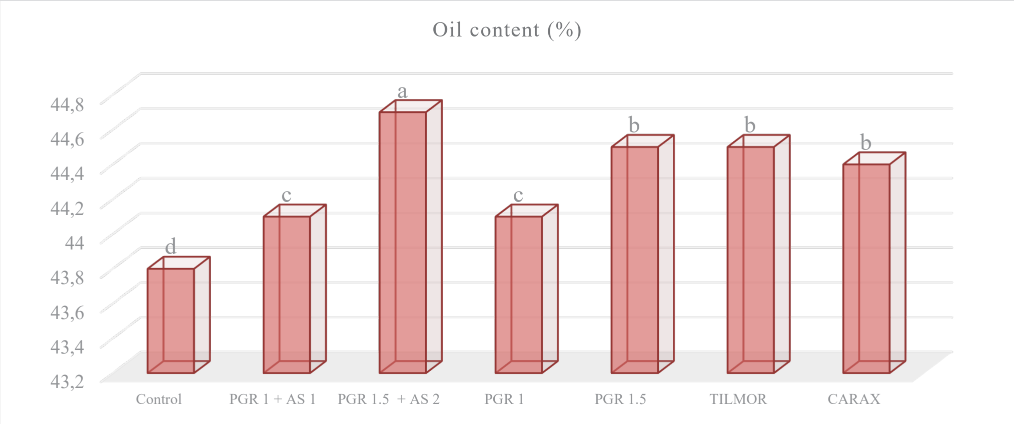

Figure 4. Oil content of oilseed rape grain (%)

In their research Ahmad et al. (2007) used a dose of 0, 10, 20, and 30 kg of S/ha. They observed that the oil content was significantly increased with the increasing doses of sulphur to 20 kg/ha but the application of 30 kg/ha of sulphur had no significant effect on the oil content. On the other hand, Subhani et al. (2003) reported, that the oil content is directly proportional to the doses of sulphur.

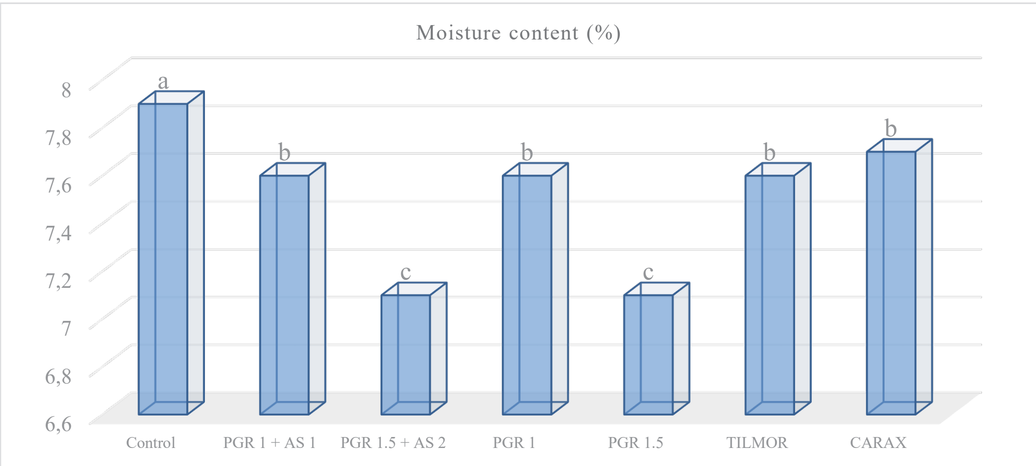

Figure 5. Moisture content of oilseed rape grain (%)

The moisture content of the oilseed rape grain was also measured (Figure 5). The results show that the moisture content was the highest in the seeds of the control plants. The moisture of PGR 1 + AS 1 was lower than the control by about 4%. Applied alone, the PGR led to the same reduction of the yield component. Both of the reference products had the same effect. The lowest value of that parameter was measured after the application of PGR 1.5 and PGR 1.5 + AS 2. Like other seeds, rapeseed is physiologically active and can be affected by moisture content, temperature and access to oxygen. The recommended storage moisture content of seeds ranges from 7 to 10 % in different countries. However, the process of drying could affect negatively the yield quality (Gawrysiak-Witulska et al., 2012).

CONCLUSIONS

The experiment aimed at investigating the adjuvant effect of ammonium sulphate applied together with a plant growth regulator product on the growth, yield and some yield components of oilseed rape. The results obtained make us believe that the application of 2 l/ha Ammonium sulphate in combination with a plant growth regulator has an adjuvant effect on the oilseed rape growth, yield, oil content and the 1000 kernel weight. We could recommend two foliar treatments (in autumn and in spring) together with a plant growth regulator to enhance the effects of the plant growth regulator and the fertilizers used and to improve the crop performance. The combination with Ammonium sulphate enhances the effect of the plant growth regulator regarding to the plant height, yield, oil and moisture content. The sole application of the PGR did has also positive effect on the crop growth and productivity but the results are more pronounced after the AS supplement, especially when the higher doses of PGR and AS were used.

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