The effect of superabsorbent polymer application on spring wheat productivity

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Poland is a country located in Central Europe. Polish climate is characterized by high variability of weather and significant fluctuations in the course of the seasons in consecutive years. One of the negative features of Poland's climate is the periodic occurrence of atmospheric droughts, which can be long-lasting. For example, in 2018, drought has affected a third of Poland's crops. Recently, superabsorbent polymers (hydrogels) are increasingly being tested to manage water and salt stresses in a number of field and horticultural crops (Khodadadi Dehkordi et al. 2013, Montesano et al. 2015, Dar et al. 2017). Superabsorbents are hydrophilic polymers that can absorb large amounts of water or aqueous solutions (Zohourian-Mehr and Kabiri 2008) and are not soluble in water (Vashuk et al., 2001). One gram of hydrogel can absorb even 1000 g of water, but in practice shall not apply hydrogels of absorbance more than 600g/1g. In present studies, hydrogel of water absorbance to 550g/1g was used. Hydrogels can reduce water runoff and increase infiltration rates in field agriculture. The use of hydrophilic polymers improves soil water retention properties and thus crop productivity (Dar et al., 2017).

In order to determine the effects of superabsorbent on spring wheat productivity, field and pot trials were conducted. The field trial was carried out in years 2015 and 2016 at the Agricultural Experimental Station "Kępa" in Osiny, Poland, in a randomized block design with 4 replications, on soil of the very good rye complex. In the experiment, crosslinked acrylic polymer was used at the following doses: I - control - without hydrogel, II - 10, III - 20 and IV - 30 kg·ha^{-1}. The size of the plot was 100 m^2. Each year, the seeds of spring wheat cv. 'Kandela' were sown. The sowing date and agro-technical treatments were applied according to the recommendations for spring wheat cultivation specified in the latest instruction of the Institute of Soil Science and Plant Cultivation – State Research Institute (IUNG-PIB). Visual observations were made of plant growth during the season. Before the harvest, the plant samples were collected to determine the yield structure. The harvesting of crops was carried out at full maturity. The yield was calculated to a 15% grain moisture.

The pot experiment using the same hydrogel and spring wheat cultivar was carried out in years 2015 - 2017 in the experimental greenhouse of IUNG-PIB in Puławy, Poland. The factors were as follows: A - hydrogel dose per pot, I - control - without a hydrogel, II - 1.4 g; III - 2.8 g; IV - 4.2 g hydrogel per pot, B - humidity levels: 1) 40%, 2) 50% and 3) 70% of water holding capacity (WHC). In the research, the grain yield and yield components were evaluated.

The aims of the research were: i) to evaluate the effects of superabsorbent on the grain yield and yield components of spring wheat, ii) to determine the optimal doses of hydrogel, as well as iii) to determine the role in superabsorbent effectiveness differences depending on the degree of water deficiency.

Fig. 1 shows the effects of superabsorbent dose on grain yield and thousand grain weight of spring wheat in field trials.

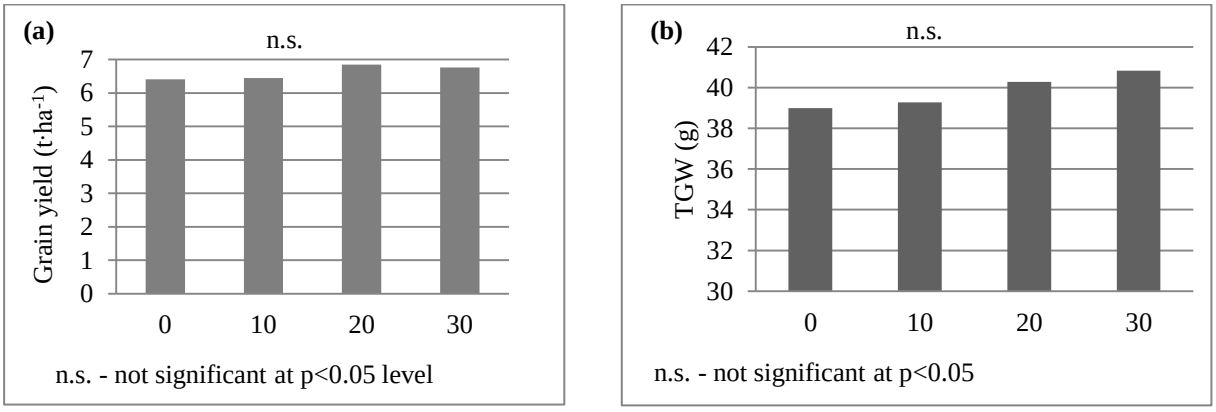

Figure 1. Grain yield (a) and thousand grain weight (TGW) (b) of spring wheat depending on the superabsorbent dose (means from years 2015-2016) in field trials.

Tab. 1 shows the effects of superabsorbent dose and humidity level on spring wheat grain yield in pot trials.

Table 1. Grain yield of spring wheat (g/pot) in pot experiments (means values of 2015-2017).

Factor		A				
		1	2	3	4	Mean
B	1	34.21	34.36	38.25	39.58	36.60a
	2	28.74	29.28	31.49	30.03	29.89b
	3	16.99	19.19	21.13	18.74	19.01c
Mean		26.65	27.61	30.29	29.45	-

a, b, c – statistically different at $p<0.05$.

The effect of hydrogel on grain yield of spring wheat varied by year. On average, from two years of research, the increase in yields was not significant, although the tendency to higher wheat yields on plots with doses of 20 and 30 $kg \cdot ha^{-1}$ was noticeable (Fig. 1). The positive effect of the hydrogel application on the 1000 grain weight of spring wheat was the main reason of the mentioned tendency. The results of pot experiments indicate that the drought stress has an impact on the hydrogel effectiveness activity. Under high water deficient conditions, the increase in grain yields was notably higher in pots with higher hydrogel doses.

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