



ПОВИШАВАНЕ НА ДОБИВА И КАЧЕСТВОТО ПРИ ПШЕНИЦА И ТРИТИКАЛЕ ЧРЕЗ ЛИСТНО ТОРЕНЕ IMPROVING THE YIELD AND QUALITY OF WHEAT AND TRITICALE BY FOLIAR FERTILIZATION

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Резюме

Торенето има основна роля в агротехниката на зърнените култури. Азотният дефицит е един от основните фактори, които оказват влияние върху добива и качеството на пшеницата и тритикалето. Изследването е проведено с цел да се оцени ефектът от прилагането на N торове върху добива, агроморфологическите показатели и качеството на зимна пшеница и тритикале. Различни видове N торове (почвени и листни) са прилагани в различни етапи на растежа, състоящи се от 7 комбинации. При двата пшеничени сорта листното прилагане на N има положителен ефект върху добива от зърно, съдържанието на протеин и мокър gluten. Най-висок добив от зърно се наблюдава при пшеничния сорт Олга (5836 kg/ha) с прилагане на седмата комбинация. Същото третиране предизвиква най-висока доходност (4904,67 kg/ha) и най-високо съдържание на протеин (14,57%) в другия сорт пшеница – подобрена Оговсатка. Най-голям положителен ефект върху добива от семена от тритикале показаха комбинации 2 и 3, а листното прилагане на N не засяга съдържанието на протеин и мокър gluten. Получените резултати от това проучване потвърждават, че листното прилагане на N в критичните етапи от растежа на пшеницата и тритикалето допринася за постигането на оптимален добив и качество.

Abstract

Fertilization plays one of the most important roles among agrotechnical practices in cereal production, having direct and indirect effect on important agronomic traits. Nitrogen deficiency is one of the main factors affecting yield and quality of wheat and triticale. The research was carried out in order to assess the effect of N-fertilizer application on the yield, agromorphological traits and quality of two winter wheat and one triticale cultivars. Different types of N-fertilizers (soil and foliar) were applied at different growth stages, comprising 7 treatment combinations. In both wheat cultivars, foliar application of N had positive effect on the seed yield, protein content and wet gluten. The highest seed yield was observed in the *Oлга* wheat cultivar (5836 kg/ha) with application of treatment 7. The same treatment induced highest yield (4904.67kg/ha) and highest protein content (14.57%) in the second wheat cultivar – *Подобрена Оговсатка*. Treatments 2 and 3 showed the highest positive effect on the triticale seed yield, while foliar application of N did not affect the protein and wet gluten content. The results obtained by this study confirmed that foliar application of N at critical growth stages in wheat and triticale contributes to achieving optimal yield and quality.

Ключови думи: пшеница, тритикале, добив, качество.

Key words: wheat, triticale, yield, quality.

INTRODUCTION

Efficient production of cereals mainly depends on the choice of appropriate variety for specific environmental conditions and the agrotechnical practices applied in order

to increase yield and quality. Many experiments carried out until present have confirmed that adequate and balanced nutrient supply (mainly nitrogen) of cereals is essential for enhancing crop productivity and its quality and can directly

and indirectly modify the efficiency of other agrotechnical measures (Negrilă and Negrilă, 1995; Popescu et al., 1997).

Because the soil application of NPK may lead to some losses of these fertilizers (Dinnes et al., 2002 and Follet and Delgado, 2002), in the past decades it was confirmed that foliar fertilization is preferable option and may reduce such losses (Brar and Brar, 2004; Kinaci and Gulmezoglu, 2007; Cakmak, 2008 and Babaeian et al., 2011). This mode of application is more effective and less costly (El-Fouly and El-Sayed, 1997), it prevents environmental pollution (Abou El-Nour, 2002, Bozorgi et al., 2011) and promotes root absorption of the nutrients. Furthermore, the timing of foliar treatment during the vegetative growth stages is critical for its optimum efficiency.

Use of optimum N (+PK) fertilizer doses positively influences baking quality traits in winter wheat and reduces quality variation caused by environmental factors. Well balanced fertilization with nitrogen and phosphorus improves the protein content in wheat grain, but also influences the gluten formation (Hera et al., 1986; Brucher and Moroy, 1988). Considering triticale, the nitrogen is the most frequently lacking nutrient for its optimum production. Previous studies revealed significant increase of triticale grain protein content (Tababtabaei and Ranjbar, 2012) and improved baking quality of spring triticale (Knapowski et al., 2009) under application of different doses of N.

However, from breeding point of view it is difficult to achieve high yield, simultaneously with high grain protein content, as these traits are in contrast. Sinclair and De Witt (1995) and Bhatia and Rabson (1976) showed that a simultaneous increasing of yield and protein concentration by breeding is incompatible from the energetic point of view. For best growth and development, plants require specific amount of certain nutrients in specific form at appropriate time (Sajid et al., 2008).

Numerous studies have shown the usefulness of foliar fertilization on grain crops (Díaz-Zorita et al., 2001; Kinaci and Kinaci, 2001, 2003; Demirer et al., 2004). Due to the lack of information on the effects of new commercial foliar fertilizers on wheat and triticale in R. Macedonia, this study has been conducted in order to determine the effects of various fertilizers applied in different growth stages on grain yield and quality of these cereal crops.

MATERIALS AND METHODS

The experiment was conducted at the production fields of Crveni Bregovi, Macedonia, during the growing season 2010/11. Two soft wheat varieties (Olga and Podobrena Orovcanika) and one triticale variety (Agrounija), often used in the large scale production, were used for testing of new foliar fertilizers produced by Alkaloid AD, Skopje. A randomized complete block design with three replications was used. Plot size was 5m² with a sowing density of 500 grains/m². Standard agrotechnical measures were applied with no autumn soil application of fertilizer. All

treatments included soil application of 200kg/ha KAN (27% N) in tillering phase, and the first one with no additional fertilization was used as a control (Table 1). The other treatments (7 in total) consisted of various combination of dose and application time of the fertilizers Magnisal 6 and amonium nitrate NH₄NO₃ (17.5% N) applied by foliar spraying. Magnisal VI (NPK 31:0:0 + ME) is fertilizer released by Alkaloid AD Skopje in 2010, consisted of ammonium, nitrate and amid form of N and helated form of Fe and Mg. After the harvest, the influence of these treatments was evaluated on three important characters: grain yield, protein content and wet gluten content. The data for the three replications were analyzed for variance using the statistical package R. The differences between means were compared by Tukey's hsd test. Statistical significance was considered at P<0.05.

RESULTS

Different treatment combinations of fertilizers affected all investigated characteristics of wheat cultivars. In wheat cultivar Olga, the treatments 7 and 5 resulted with significantly higher yield (5836 kg/ha and 5777.67 kg/ha, respectively) compared to other treatments (Table 2). Lowest mean value was obtained from the treatment 1 (3260 kg/ha). Protein content and wet gluten content showed significantly higher value under treatment 6 (11.97% and 29.80), both significantly different from values obtained by other treatments. On the other hand, the first treatment, where only KAN was applied at tillering stage, had lowest influence on these characters thus resulting with the lowest values.

Regarding the grain yield, wheat cultivar Podobrena Orovcanika expressed highest values under treatment 6 (4599.33 kg/ha) and 2 (4455.33 kg/ha), but without significant difference compared to most of the other treatments. Concerning the quality, Podobrena Orovcanika showed almost equal response to the treatments 3-7 (over 14% protein content and over 35.5 wet gluten content), while the mean values of the first and second treatment were significantly lower than the others (Table 3).

Other researchers also indicated that foliar application of nutrients positively influences grain yield in wheat (Yassen et al., 2010; Matilo et al., 2006; Slaton et al., 2011). Römheld and El-Fouly (1999) also reported that the efficiency of foliar feeding is higher than of soil fertilization. One reason is because the supply of the required nutrient goes directly to the location of high demand in the leaves and its relatively quick absorption. Tea et al. (2007) has proved that efficient remobilization of urea (N) to the grain after foliar fertilization on wheat at optimum timings increase grain protein content and improve bread-making quality. Mioe and Grundas (2001) observed that an increase in N-fertilization from 50 to 150 kg N ha⁻¹ caused an increase in the wet gluten content by 4%. Similar results for wet gluten content were obtained in Podobrena Orovcanika.

**Table 1.** Foliar fertilizers, application doze and time

Treatments	Tillering	Booting	Heading	Grain filling
1	200kg/ha KAN			
2	200kg/ha KAN	100kg/ha KAN		
3	200kg/ha KAN			4l/1000l/ha NH ₄ NO ₃
4	200kg/ha KAN		3l/1000l/ha Magnisal 6	
5	200kg/ha KAN		4l/1000l/ha NH ₄ NO ₃	4l/1000l/ha NH ₄ NO ₃
6	200kg/ha KAN		3l/1000l/ha Magnisal 6	3l/1000l/ha Magnisal 6
7	200kg/ha KAN		3l/1000l/ha Magnisal 6	4l/1000l/ha NH ₄ NO ₃

Table 2. Mean values of yield, protein and wet gluten content of wheat cultivar Olga treated with different fertilizers

Olga	1	2	3	4	5	6	7
Yield (kg/ha)	3260.00a	4365.67b	4811.00d	4583.33c	5777.67e	4860.67d	5836.00e
Protein Content (%)	11.03a	11.20ab	11.37b	11.30ab	11.30ab	11.97c	11.23ab
Wet Gluten Content	26.60a	26.47a	27.90b	27.73b	27.48b	29.80c	27.87b

Table 3. Mean values of yield, protein and wet gluten content of wheat cultivar Podobrena Orovčanka treated with different fertilizers

Olga	1	2	3	4	5	6	7
Yield (kg/ha)	3260.00a	4365.67b	4811.00d	4583.33c	5777.67e	4860.67d	5836.00e
Protein Content (%)	11.03a	11.20ab	11.37b	11.30ab	11.30ab	11.97c	11.23ab
Wet Gluten Content	26.60a	26.47a	27.90b	27.73b	27.48b	29.80c	27.87b

Table 4. Mean values of yield, protein and wet gluten content of Triticale cultivar Agrounija treated with different fertilizers

Agrounija	1	2	3	4	5	6	7
Yield (kg/ha)	4363,33c	5250,67f	4985,33e	4419,33d	3790,83a	4380,33c,d	3930,00b
Protein Content (%)	12.60d	11.73c	10.00a	10.63b	11.72c	12.43d	11.50c
Wet Gluten Content	29.70f	27.53d	21.57a	23.63b	26.52c	28.67e	26.37c

Unlike the wheat cultivars, triticale cultivar Agrounija had significantly higher yield under treatment 2 (5250.67 kg/ha), followed by treatment 3 (Table 4). The first treatment was most suitable for quality improvement in Agrounija, resulting with highest values for protein content (12.6%) and wet gluten content (29.7). In the investigations of Kinaci and Gulmezoglu (2007), foliar applications affected significantly the grain yield when precipitation was high. According to the same authors, foliar fertilization is not advisable in general for triticale in dry years. Foliar application of nutrients to triticale may be advantageous when there is a high risk that the necessary nutrients will be unavailable to plant roots due to adverse soil and climatic conditions (Alaru et al., 2003).

Having in mind that the fertilizers applied in this study are new and not yet experimentally tested on cereals, these preliminary one-year results may be used as a notice

for the appropriate foliar fertilization in a large scale production. Further investigation, with different split of the doses at various growth stages can be practiced to get appreciable growth and yield of wheat and triticale crops.

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