RESPONSE OF WINTER COMMON WHEAT VARIETIES TO FOLIAR FERTILIZATION

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Abstract

In 2021/2022 – 2022/2023, an experiment with two varieties of winter common wheat was conducted at the training and experimental field of the Department of Plant Production at the Technical University - Varna. During their spring vegetation, combined mineral and foliar fertilization were applied. Soil fertilization was carried out with ammonium nitrate with a fertilizer rate of 12 kg/da (active substance) in phase BBCH 23-29. Three fertilizer products were used for foliar fertilization. They were applied twice with a dose of 300 ml/da in phases BBCH 29-39 and BBCH 51-59. An unfertilized control was also included in the experiment for comparative analysis. The response of the studied varieties to the used foliar fertilizers is expressed by the obtained yields and the protein content in the grain. Foliar fertilization under favorable weather conditions increases the productivity and protein content in the grain of the varieties Marilyn and Nikodim. Under these conditions, the effect of the fertilization factor is large. Under unfavorable weather conditions, the share of the variety factor is significant. Under favorable conditions of the year the average yields obtained in the fertilizer variants compared to the unfertilized controls are higher, while for the protein content this dependence is observed in the year with unfavorable conditions. The Nikodim variety shows higher average grain yield values in most fertilization variants, which suggests that this variety may be more reactive to different types of fertilization. The Marilyn variety shows lower variability in the results, which suggests greater resistance, albeit with lower average yields under some types of fertilization, but with higher protein content.

Key words: *year, foliar fertilization, wheat, varieties, yield, protein*

INTRODUCTION

A main task of agriculture worldwide is solving the food problems of the human population. Wheat ranks first in the group of cereals. It has been the object of enormous-scale scientific researches and is one of the most widely distributed crops worldwide (Igrejas et al., 2020; Erenstein et al., 2022)

A prerequisite for the expression of the genetic potential with regard to the quality and quantity indices of each variety is the use of suitable agronomy practices in combination with the meteorological conditions typical for the region. Since meteorological conditions are not controllable, the main way for realization of the cultivars' production potential is improvement of the growing conditions through various agronomy practices (Woźniak & Rachoń, 2020; Rebouh et al., 2023; Gong et al., 2025).

Increasing yield is associated with the depletion of nutrients contained in the soil through absorption by plants. The restoration of nutrients occurs through the use of mineral fertilizers. In order to increase the productivity of agricultural crops with less fertilizer input, it is necessary to develop more effective solutions for fertilization systems. Such is foliar fertilization, the effectiveness of which can be greater than that of soil application (Niu et al., 2021; Ishfaq et al., 2022; Januszkiewicz et al., 2023).

Foliar fertilization delivers nutrients directly to the leaves of plants and serves as a complement to conventional soil fertilization methods. It can supplement the uptake of macronutrients during short or critical growth phases. It also compensates for nutrient deficiencies that may be caused by soil or environmental limitations (Murtaza et al., 2022; Bărdaş et al., 2024; Balachandra et al., 2025).

Foliar fertilization during the growing season is a necessary element of agricultural cultivation to achieve high yields and quality. This is an effective way to stimulate and realize the potential of cultivated crops, optimally respond to their nutritional needs and quickly supply them with the missing nutrients. The effectiveness of foliar fertilization depends directly on environmental conditions such as application time, humidity, air temperature, wind speed (Solanki et al., 2020; Ducatti & Tironi, 2024; Ferrari et al., 2025; Sultonov et al., 2025).

The aim of the present study was to determine the response of two winter common wheat varieties, expressed through their yield and grain protein content, to foliar fertilization during their spring growing season.

MATERIAL AND METHODS

The study was conducted during the period 2021/2022 – 2022/2023 at the experimental field of the Department of Plant Production at the Technical University - Varna. The experiment was conducted using the fractional plot method in two replications with an experimental area of 10 m^2. During the years of the study, two varieties of winter common wheat (*Triticum aestivum* L.) were grown, which were sown at the optimal time for the region with a seeding rate of 600 germinating seeds/m^2. The studied varieties are Marilyn and Nikodim, selection of the Dobrudzha Agricultural Institute - General Toshevo. During their spring vegetation, a combination of mineral and foliar fertilization was applied. Soil fertilization was carried out with ammonium nitrate with a fertilizer rate of 12 kg/da (active substance) in phase BBCH 23-29. Three fertilizer products were used for foliar feeding: Agroocean Laminactive, Trainer and B&B Marine. They were applied twice with a dose of 300 ml/da in phases BBCH 29-39 and BBCH 51-59. An unfertilized control was also included in the experiment for comparative analysis. The response of the studied varieties to the used foliar fertilizers was expressed by the obtained yields (t/ha) and the protein content in the grain (%). Statistical data processing was done using Statistica 10 and Microsoft Excel.

RESULTS AND DISCUSSION

The years in which the study was conducted differ in the amounts and distribution of precipitation during the wheat vegetation (Figure 1). Precipitation in autumn (in the germination and tillering phases) and in the spring critical period are decisive for its growth and development. The average annual precipitation amounts for October-March, forming the autumn-winter soil moisture reserve in the first year of the study, are higher by 186.50 mm compared to the second. Meteorological conditions turned out to be better for the simultaneous germination and development of plants. While in the second studied year, sowing was carried out under extremely dry conditions. Formation of the wheat crop was observed only in December. In the months of April, when the plants are in the spindle phase and May, when the plants move to the next phase of development (heading-flowering), the measured amounts of precipitation are high in both years. The weather conditions in the first year (2022) were more favorable during this part of the vegetation. In June (grain filling), precipitation in the first harvest year was again higher.

Overall, the distribution of precipitation during the wheat growing season in the years studied was uneven. The total amount was 510 mm for 2021-2022 and 302 mm for 2022-2023.

The studied years also differ in terms of temperature. The average temperature for the entire vegetation determines the second year as warmer – 10.9^{0}C, and for the first year it is 9.4^{0}C. The largest differences are in the winter months of December and January, and in March.

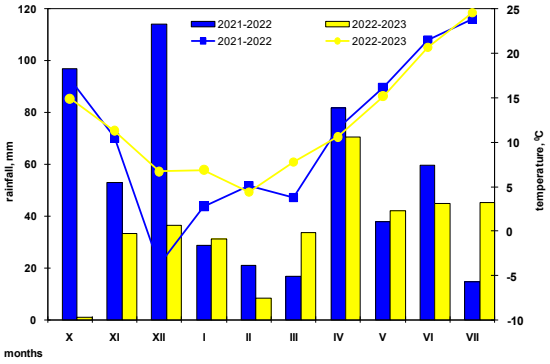

Figure 1. Meteorological conditions during the study.

The main differences between the two years of study are in the first half of the wheat growing season. Good moisture storage and favorable temperatures have helped to form much higher yields in the first studied year (Figure 2). The differences in the yields obtained between the two varieties in the control variants are not large. They deepen when applying foliar fertilization during the spring vegetation. The greatest variation is observed when applying the fertilizer product Trainer, but the difference in the average yields obtained between the two varieties is the smallest. The application of Agroocean Laminactive and B&B Marine has led to the formation of higher productivity in the Nikodim variety. The variation in grain yield values is the least in the variants with Agroocean Laminactive and close in the variants with B&B Marine. Under favorable weather conditions in the first studied year, foliar fertilization during the spring vegetation increases the productivity of the Marilyn and Nikodim varieties. This increase in the fertilizer variants compared to the control is higher compared to the following year. Their reaction to the fertilizer products used is different. For the Marilyn variety, a significant improvement in yield values was obtained with the use of Trainer, and for the Nikodim variety - with Agroocean Laminactive.

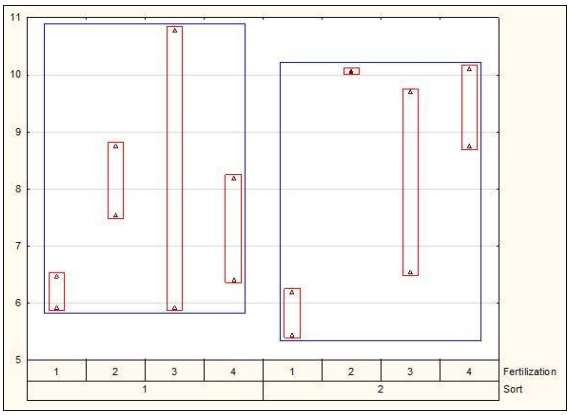

Figure 2. Yield variation (t/ha) in 2021-2022.

Sort 1 – Marilyn, Sort 2 – Nikodim
Fertilization 1 – Unfertilized control
Fertilization 2 – Agroocean Laminactive
Fertilization 3 – Trainer
Fertilization 4 – B&B Marine

In the second year of the study, the formed productivity was much lower (Figure 3). The application of foliar fertilization led to a smaller increase in average yields compared to unfertilized controls compared to the previous year. The variation in the values of the obtained yields was very diverse in both varieties. Under unfavorable conditions at the beginning of the vegetation of this studied year, Nikodim was distinguished by higher productivity, both in the unfertilized control and in the fertilizer variants. Foliar fertilization during the spring vegetation with the fertilizer product Trainer had the most favorable effect on the formation of the productivity of both varieties and led to the highest average yields from them. Under unfavorable weather conditions in the second studied year, the productivity of

both varieties increased, but much less. Their reaction to the applied fertilization was similar. Maximum yields were obtained with foliar fertilization with Trainer, and the weakest effect was the combination with Agroocean Laminactive.

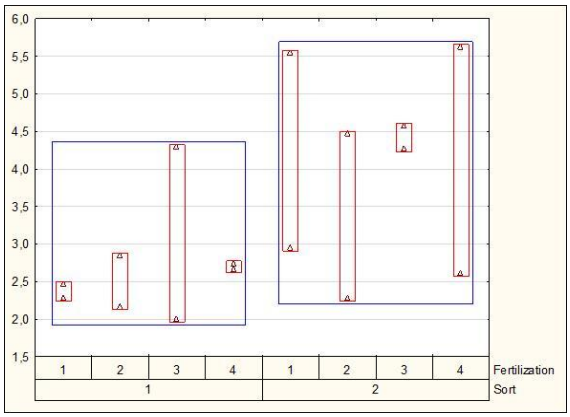

Figure 3. Yield variation (t/ha) in 2022-2023.

Foliar fertilization during the spring growing season of wheat increased the protein content in the grain in both studied varieties (Figure 4). In the first year of the study, the protein content in the unfertilized controls was close to the same values. The use of Agroocean Laminactive increased them to the maximum extent in the Marilyn variety, and B&B Marine in the Nikodim variety. Under the favorable conditions of this year, the differences in protein content between the two varieties were not large, except for the variants where the fertilizer product B&B Marine was applied.

In the first year, when the season conditions were favorable for obtaining high yields, the protein content in the grain of Marilyn and Nikodim was lower and close in value. Under these conditions, its increase in the fertilizer variants compared to the control was between 10-19%, depending on the fertilizer product used for foliar fertilization.

In the second year of the study, in the control variants, the protein content of the grain of the Marilyn variety significantly exceeds that of the Nicodim variety. The application of Agroocean Laminactive and Trainer had the most favorable effect on the Marilyn variety, and on B&B Marine it had a similar effect. In both varieties, the protein content, expressed in percentages, in the fertilizer variants compared to the control increased more this year. A greater percentage increase was reported in the Nicodim variety compared to Marilyn. Under the unfavorable conditions of this year, the differences in protein content between the two varieties are large, with the exception of the variants where the B&B Marine fertilizer product was applied.

In the second year, characterized by unfavorable conditions, the protein content in the grain of Marilyn and Nicodim was higher. Its increase in the fertilizer variants compared to the control was between 15-27%, depending on the fertilizer product used for foliar fertilization.

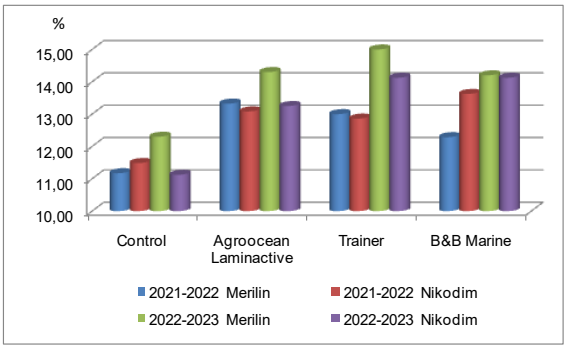

Figure 4. Protein content.

CONCLUSIONS

Foliar fertilization under favorable weather conditions increases the productivity and protein content in the grain of the varieties Marilyn and Nicodim. Under these conditions, the effect of the fertilization factor is large.

When applying foliar fertilization under unfavorable weather conditions, the productivity of both varieties increases, but to a much lesser extent. Under these conditions, the share of the variety factor is significant.

Under favorable conditions of the year, the average yields obtained in the fertilizer variants compared to the

unfertilized controls were higher, while for the protein content this dependence was observed in the year with unfavorable conditions.

The Nikodim variety shows higher average grain yield values in most fertilization variants, suggesting that this variety may be more responsive to different fertilization types.

The Marilyn variety shows lower variability in results, suggesting greater resilience, albeit with lower average yields under some fertilization types, but with higher protein content.

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