Productivity of varieties of winter triticale with the use of nitrogen fertilizers in the flat irrigated zone of Dagestan

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Abstract. The purpose of the research is to study the responsiveness of winter triticale varieties to the use of nitrogen fertilizers, which makes it possible to identify the potential productivity of various varieties in the conditions of the flat irrigated zone of Dagestan. Some elements of the technology for growing new varieties of winter triticale have been studied on meadow-chestnut soil under irrigated conditions in the flat zone of Dagestan. A comprehensive assessment of the effect of nitrogen fertilizers on the stages of organogenesis, the formation of the main structural indicators and the yield of winter triticale varieties is given. The article presents the results of the effects of nitrogen fertilizers on the development and formation of the crop of new varieties of winter triticale. The reaction of varieties of winter triticale to fractional and single application of nitrogen nutrition was determined.

1. Introduction

At present, the issues of expanding and strengthening the forage base of the republic are of particular importance, and the main source of valuable feed for livestock in Dagestan is grain crops. Cereals provide a lot of valuable fodder products for livestock.

Winter triticale has high potential productivity and adaptation in a changing climate and the ability to meet the needs of a growing livestock industry with high-quality valuable feed.

Winter triticale, which is an intermediate crop between rye and wheat, combines grain quality indicators, yield, resistance to diseases and pests characteristic of wheat and winter hardiness, resistance to adverse environmental factors characteristic of rye. Culture is cultivated in the agriculture of the republic not in due measure [2;5]. The State Register of Breeding Achievements approved for use currently includes 50 varieties of winter triticale, of which over the past 10 years only 6 have been released in the North Caucasus Federal District. The cultivation of new varieties of winter triticale is especially important in conditions of risky farming [6;8].

2. Materials and methods

In 2019-2020, on the meadow-chestnut soil of the experimental field of the Federal State Budgetary Educational Institution of Higher Education, the Dagestan State Agrarian University conducted research to study the responsiveness of winter triticale varieties to the use of nitrogen fertilizers, which made it possible to identify the potential productivity of the crop. The following combination of fertilizer rates was studied: N<sub>35</sub>; N<sub>65</sub>; N<sub>95</sub>; N<sub>125</sub>; N<sub>155</sub> (table 1). The plot area is 150 m<sup>2</sup> (15.0 m x 10 m),
accounting 100 m² (15 m x 6.6 m), repetition - 4 times. The experimental methodology is generally accepted [1;4]. Statistical processing of experimental data was carried out according to Dospekhov B.A. [4]. The arable layer contains 2.21% humus, P₂O₅ - 1.6 mg / 100 g of soil, K₂O - 28.5 mg / 100 g of soil. Density - 1.30 g / cm³, HB - 30.5%.

The materials of the experiments were different doses of nitrogen fertilizer and varieties of winter triticale Ullubiy, Trudyaga, Khleborob released in the North Caucasus Federal District.

Structural indicators of grain yield of the studied varieties of winter triticale were determined in the laboratory of seed production and biotechnology, the breeding and seed center of the FSBEI HE Dagestan State Agrarian University analyzer Inframatic 9500, Perten. Seed samples were taken according to GOST R 50436-92, experiments were carried out at t - 22-24 °C.

| Varieties (factor A) | Fertilizer rate (Factor B) |
|----------------------|---------------------------|
|                      | Without fertilizer - B₁    |
|                      | N₃₁     , B₂              |
|                      | N₁₆₅ , B₃                |
|                      | N₉₁ , B₄                 |
|                      | N₁₂₅ , B₅                |
|                      | N₁₅₅ , B₆                |
|                      | N₉₁ + N₆₅ , B₇           |
|                      | N₉₁ + N₆₅ , B₈           |
| Trudyaga             | Without fertilizer - B₁    |
|                      | N₃₁     , B₂              |
|                      | N₁₆₅ , B₃                |
|                      | N₉₁ , B₄                 |
|                      | N₁₂₅ , B₅                |
|                      | N₁₅₅ , B₆                |
|                      | N₉₁ + N₆₅ , B₇           |
|                      | N₉₁ + N₆₅ , B₈           |
| Ullubiy              | Without fertilizer - B₁    |
|                      | N₃₁     , B₂              |
|                      | N₁₆₅ , B₃                |
|                      | N₉₁ , B₄                 |
|                      | N₁₂₅ , B₅                |
|                      | N₁₅₅ , B₆                |
|                      | N₉₁ + N₆₅ , B₇           |
|                      | N₉₁ + N₆₅ , B₈           |
| Khleborob            | Without fertilizer - B₁    |
|                      | N₃₁     , B₂              |
|                      | N₁₆₅ , B₃                |
|                      | N₉₁ , B₄                 |
|                      | N₁₂₅ , B₅                |
|                      | N₁₅₅ , B₆                |
|                      | N₉₁ + N₆₅ , B₇           |
|                      | N₉₁ + N₆₅ , B₈           |

3. Results and Discussion

As is known, nitrogen fertilizer is one of the effective means of increasing the productivity of winter crops [3;7].

Our studies have shown that nitrogen fertilizers introduced into the soil are quickly fixed in it in the form of organic compounds, as a rule, increasing the productivity of the crop. Therefore, even with the introduction of sufficiently high doses of fertilizers, the main source of nitrogen for winter triticale remains the soil, where nitrogen in the total removal is about 90%. The applied fertilizers undergo profound changes in the soil and mainly act as an activating agent for the processes of mineralization of nitrogen-containing organic substances [9-10].

In 2019, due to an increase in precipitation and sharp climate fluctuations in the autumn-winter period, winter triticale crops were weakened due to disease damage, which affected crop productivity.
According to our research, in 2020, all the studied varieties of winter triticale received the largest grain yield compared to 2019 and averaged 4.96 t/ha for the Trudyaga variety, 5.14 t/ha for the Ullubiy variety, and 5.14 t/ha for the Khleborob variety. – 5.04 t/ha, respectively.

The results of the experiments have shown that the yield of winter triticale grains on meadow-chestnut soil increases with the introduction of calculated norms of nitrogen fertilizers. On the variants with the introduction of nitrogen fertilizers, an increase in yield by 0.35 - 1.17 t/ha in relation to B\textsubscript{1} was noted. The maximum yield, according to our research and the limiting area of the response curve of the productivity of winter triticale varieties, is achieved with option B\textsubscript{5} with an application rate of 125 kg/ha of nitrogen. On variants B\textsubscript{6}, B\textsubscript{7}, and B\textsubscript{8}, with an increase in the rate of fertilizer application to 155 kg/ha, a decrease in the productivity of winter triticale is observed (table 2).

### Table 2. Productivity of new varieties of winter triticale when applying nitrogen fertilizers in the conditions of the flat irrigated zone of Dagestan, (t/ha).

| Nitrogen fertilizers (factor B) | 2019  | 2020  | Average for 2019-2020 | Increase, t/ha |
|--------------------------------|-------|-------|-----------------------|---------------|
| **Trudyaga**                   |       |       |                       |               |
| Without fertilizer - B\textsubscript{1} | 3.08  | 4.16  | 3.62                  | -             |
| N\textsubscript{35}. B\textsubscript{2} | 3.54  | 4.40  | 3.97                  | 0.35          |
| N\textsubscript{65}. B\textsubscript{3} | 4.80  | 4.96  | 4.88                  | 1.26          |
| N\textsubscript{95}. B\textsubscript{4} | 4.98  | 5.01  | 4.99                  | 1.37          |
| N\textsubscript{125}. B\textsubscript{5} | 5.55  | 5.61  | 5.58                  | 1.95          |
| N\textsubscript{155}. B\textsubscript{6} | 5.51  | 5.60  | 5.53                  | 1.90          |
| N\textsubscript{95} + N\textsubscript{35}. B\textsubscript{7} | 4.97  | 5.23  | 5.10                  | 1.48          |
| N\textsubscript{95} + N\textsubscript{65}. B\textsubscript{8} | 4.72  | 4.91  | 4.81                  | 1.19          |
| **Average**                   | 4.63  | 4.96  | 4.79                  | 1.17          |
| **Ullubiy**                   |       |       |                       |               |
| Without fertilizer - B\textsubscript{1} | 3.23  | 4.31  | 3.77                  | -             |
| N\textsubscript{35}. B\textsubscript{2} | 3.69  | 4.57  | 4.13                  | 0.36          |
| N\textsubscript{65}. B\textsubscript{3} | 4.96  | 5.11  | 5.03                  | 1.27          |
| N\textsubscript{95}. B\textsubscript{4} | 5.13  | 5.18  | 5.16                  | 1.39          |
| N\textsubscript{125}. B\textsubscript{5} | 5.72  | 5.76  | 5.74                  | 1.97          |
| N\textsubscript{155}. B\textsubscript{6} | 5.67  | 5.71  | 5.68                  | 1.91          |
| N\textsubscript{95} + N\textsubscript{35}. B\textsubscript{7} | 5.14  | 5.38  | 5.26                  | 1.49          |
| N\textsubscript{95} + N\textsubscript{65}. B\textsubscript{8} | 4.97  | 5.16  | 5.06                  | 1.29          |
| **Average**                   | 4.81  | 5.14  | 5.01                  | 1.24          |
| **Khleborob**                 |       |       |                       |               |
| Without fertilizer - B\textsubscript{1} | 3.10  | 4.17  | 3.63                  | -             |
| N\textsubscript{35}. B\textsubscript{2} | 3.56  | 4.42  | 3.99                  | 0.36          |
| N\textsubscript{65}. B\textsubscript{3} | 4.82  | 4.97  | 4.89                  | 1.26          |
| N\textsubscript{95}. B\textsubscript{4} | 5.00  | 5.04  | 5.02                  | 1.39          |
| N\textsubscript{125}. B\textsubscript{5} | 5.57  | 5.64  | 5.60                  | 1.97          |
| N\textsubscript{155}. B\textsubscript{6} | 5.52  | 5.61  | 5.56                  | 1.93          |
| N\textsubscript{95} + N\textsubscript{35}. B\textsubscript{7} | 4.97  | 5.46  | 5.21                  | 1.58          |
| N\textsubscript{95} + N\textsubscript{65}. B\textsubscript{8} | 4.83  | 5.02  | 4.92                  | 1.28          |
| **The average**               | 4.67  | 5.04  | 4.85                  | 1.22          |

Nitrogen fertilizers had a significant impact on the yield of winter triticale. On average for the research sites, the increase in yield depending on the application of nitrogen fertilizers for the Ullubiy variety was 36.8%, for the Khleborob variety - 35.6% and the Trudyaga variety - 33.7%.
On average, over two years of research, in the variety Ullubiy, the maximum increase in yield and grain yield of winter triticale was obtained in the variant with a norm of 125 kg/ha of nitrogen (5.74 t/ha) (figure 1). An increase in nitrogen doses to 155 kg/ha did not lead to a further increase in crop yield increase. At the same time, fractional application of nitrogen nutrition in the norm $N_{95} + N_{35}$ and $N_{95} + N_{65}$ contributed to the formation of an increase in grain yield of 39 and 34%, however, the increase obtained with fractional application of fertilizers was slightly lower than in option $B_5$ with the application of 125 kg/ha of nitrogen.

Figure 1. The effect of nitrogen nutrition on the yield increase (%) of winter triticale grain Ullubiy on average for 2019-2020.

The yield of winter triticale variety Trudyaga is interconnected with the use of nitrogen fertilizers. At the same time, the highest yield was noted on variant $B_5$ and averaged 5.58 t/ha over two years. It should be noted that the fractional application of nitrogen nutrition had a significant impact on the productivity of the Trudyaga variety. On the experimental variants with fractional use of nitrogen nutrition $B_7$ and $B_8$, the increase in yield was 40.0-32.6%.

In the Khleborob variety, the maximum grain yield was obtained in the variant with the introduction of nitrogen at a rate of 125 kg/ha and amounted to 5.60 t/ha. It should be noted that in the variants with the introduction of fractional nitrogen nutrition ($N_{95} + N_{35} - B_7$; $N_{95} + N_{65} - B_8$), almost the same yield was obtained, which confirms the weak response of the Khleborob variety to the fractional application of nitrogen nutrition.

Currently, in many agricultural enterprises, the problem of reducing and eliminating unproductive losses of fertilizers is not given due attention. This forces us to look for ways to rationally use mineral fertilizers that do not lead to loss of resources.

In this regard, a calculation was carried out on the payback of nitrogen fertilizers. The results of the research showed that the payback of fertilizers is the highest in those variants of the experiment where low nitrogen rates are used ($35 \text{ kg/ha - } B_2$, $65 \text{ kg/ha - } B_3$). A further increase in nitrogen doses leads to unproductive losses, which ultimately leads to a decrease in grain production per unit of nitrogen fertilizer used.

According to our research, in the winter triticale of the Ullubiy variety, the maximum payback of the crop was noted in the variant with the application of 65 kg/ha of nitrogen fertilizer and amounted to 23.9 kg of grain per 1 kg of nitrogen. At high application rates (125-155 kg/ha), it decreased to 16.9 and 12.18 kg of grain per 1 kg of nitrogen, respectively. At the same time, the grain yield of the Ullubiy variety increases with an increase in the dose of nitrogen. The maximum yield was achieved on option $B_5$ (125 kg/ha of nitrogen), with an increase in yield of 52%. On variants with the introduction of nitrogen fertilizers, its fractional payback decreased. In the variant with the application of $N_{90} + N_{30} - B_7$ and $N_{90} + N_{60} - B_8$ kg/ha, it reached 15.9 and 13.1 kg of grain per 1 kg of nitrogen, respectively.
4. Conclusion
The impact of nitrogen fertilizers on the yield of winter triticale depends on their effect on different levels of yield. The yield of winter triticale for all varieties reaches its maximum when nitrogen is applied at 125 and 155 kg/ha and is maintained at this level until 155 kg/ha is applied. Therefore, by optimizing the conditions of nitrogen nutrition for winter triticale, it is possible to regulate the production process of the crop, achieve high yields and eliminate unproductive losses of nitrogen.

The use of nitrogen fertilizers fractionally and one-time reflects the possible potential of winter triticale varieties, increases the structural indicators of crop yield.

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