RESEARCH REGARDING THE INFLUENCE OF NITROGEN AND PHOSPHORUS FERTILIZERS ON WINTER WHEAT, IN THE PEDOCLIMATIC CONDITIONS IN CENTRAL OF MOLDAVIA

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Abstract. Winter wheat is one of the agricultural plants that reacts positively to the application of fertilizers in all soil and climatic conditions in our country. Factors that influence the effectiveness of fertilizers and create dosing difficulties, require the organization of a certain long-term experience for complex research of complex interactions plant x soil x fertilizer x climate and their effect on plant productivity, established in Secuieni in 1975. This paper presents the obtained results in a long-term experience with chemical fertilizers (NP) in winter wheat crop, located in Agricultural Research and Development Station Secuieni Neamț (A.R.D.S. Secuieni, Neamț), during 2019-2021. The experience takes place in the experimental field of the unit, on a typical cambic faezoom (chernozem) soil, with medium texture, and its an bifactorial type (N x P) and were placed according to the method of subdivided plots, in five repetitions: the factor A phosphorus, with the following graduations: P0, P20, P40, P60 and P120 and factor B nitrogen, with the following graduations: N0, N20, N40, N60, N80 and N120. The winter wheat culture is part of a three-year crop rotation with beans – winter wheat - corn. Following in rotation after beans, no nitrogen fertilizers were applied at the establishment of the crop. The variety studied is the Glosa variety, created at N.A.R.D.I. Fundulea (National Institute for Agricultural Research and Development Fundulea). In the climatic conditions of the two experimental years (2019-2021) the yields obtained from the application of chemical fertilizers varied depending on the applied dose. In the first year of testing, the yield varied in very high limits, from 3232 kg ha⁻¹ in the non-fertilized version and up to 6525 kg ha⁻¹ in the version fertilized with N120P60. In the second year, the minimum yield was obtained in the version in which no fertilizer was applied dose, of 6133 kg ha⁻¹, and the variant in which the fertilizer doses of N120P20 were applied obtained the highest yield, of 9429 kg ha⁻¹. On average, the factors studied greatly influenced winter wheat yield, which varied within large limits, between 4683 kg ha⁻¹ (N0P0) and 7787 kg ha⁻¹ (N120P120).

Keywords: winter wheat, fertilisation, climate, yield, long-term experience

INTRODUCTION

Applying mineral fertilizers on winter wheat, helps the poor developed radicular system extend over a reduced volume of soil and has a small capacity of solubilisation and absorption nutritive elements reserves from the soil. The winter wheat maximum consumption of these fertilizers takes place in a short period of time, starting from the elongation of the straw until maturity, and in this period the plants absorb over 80% of the phosphorus and 80% of the necessary nitrogen (Hera and Borlan, 1980; Bâlteanu, 1998; Oancea, 1998, Burlacu and Popescu, 2007; Mihăilă et al., 1996; Petcu et al., 2003; Lupu, 2007).

To evaluate as accurately as possible the response of crops to fertilization, indices are used and described in the literature (Novoa, 1981; Cassman, 2002). In agronomic studies, the highlighting of these indices is generally based on the yields obtained and on the total amount of nitrogen absorbed from the soil (Dobерmann, 2005).

The fertilization in an important part of the cultivation technologies. The results obtained by the agricultural research and practice have highlighted the influence of this technological link on the qualitative, and quantitative, but even on the economical side of resulted crops (Lupu, 2014).

In the last period, the investigations conducted in different countries have followed the influence of improving technological elements on fertilization, soil tillage and crop rotations with legumes and perennial grasses, which determine the increase in the content of organic carbon from soil and the reduction of soil erosion (Lal, 2004; Wright, 2007; Bazzoffi, 2009; Rusu, 2009).

Globally, the use of nitrogen fertilizers has reached 100 billion kg annually, and more than half of this amount being used for the production of cereals (wheat, rice, corn, etc.) (Ladha, 2016).

In the last decades the intensive agriculture has led to growth 7 times of the amount of nitrogen used in agriculture. However, the various practices applied on agriculture, had repercussions on the environment (water and air), causing even significant losses of nitrogen. The administrated nitrogen on plants, more than 50% of is not recovered by those (Lassaletta, 2014). The largest losses occur through leaching and cause marine waters (Beman, 2005) and eutrophication of freshwaters (London, 2005). The ozone layer in the stratosphere is being severely affect by the nitrogen oxide emissions (Ramos, 1996).
It is well known that nitrogen influences the growth and development of plants. Knowledge of the physiological mechanisms that contribute to the absorption and use of nitrogen are particularly important to increase the efficiency of use of this chemical element. Nitrogen use efficiency (NUE) is defined as the amount of nitrogen in total nitrogen applied to a crop that is absorbed and recovered by plants (Agapie, 2021).

This paper presents the experimental results obtained for wheat cultivation in the period 2019-2021, in the experiment with differently doses of nitrogen and phosphorus, located in the experimented field of the Agricultural Research and Development Station Secuieni (A.R.D.S. Secuieni, Neamț).

MATERIAL AND METHODS

The present paper aims to analyze the influence of the application of nitrogen and phosphorus fertilizers on winter wheat crops, in the period 2019-2021, in the pedoclimatic conditions of the A.R.D.S. Secuieni. The experience takes place in the experimental field of the unit, on a typical cambic faeoziom (chernozem) soil, with medium texture, characterized as being well supplied with phosphorus (P₂O₅ - 39 ppm) and mobile potassium (K₂O - 161 ppm), moderately supplied with nitrogen, the soil nitrogen index being 2.1, weakly acidic, with pH values (in aqueous suspension) of 6.29 and poorly fertile, with a humus content of 2.3%. The experiments were of a bifactorial type (N x P) and were placed according to the method of subdivided plots, in five repetitions:

Factor A: doses of P₂O₅ (kg ha⁻¹) – a₁ – 0 active substance (a.s.); a₂ – 40 a.s.; a₃ – 80 a.s.; a₄ – 120 a.s.; a₅ – 160 a.s.;

Factor B: doses of N (kg ha⁻¹) – b₁ – 0; b₂ – 40 a.s.; b₃ – 80 a.s.; b₄ – 120 a.s.; b₅ – 160 a.s.;

In the period 2019-2021, the fertilization was done with ammonium nitrate and superphosphate, and the amount of fertilizer used corresponded to the dose of phosphorus and nitrogen. Also, this experience is part of a crop with 3 crops (beans, wheat, corn) and a rotation of 3 years, in which winter wheat is grown after beans. The yields of winter wheat variety grown in the period 2019-2021 being the result the complex action of an agrofund created by the long application of nitrogen and phosphorus fertilizers. In the field, in this case, the cultivation technology specific to the conditions in Central of Moldavia was used, and the data obtained was interpreted statistically according to the method of variance analysis (Ceapoiu, 1968).

Analyzing the vegetation period of the winter wheat in the first year of experimentation (2019), we notice that it was characterized as being warmer from a thermal point of view and very dry from a pluviometric point of view (Figure 1).

![Figure 1. Average temperature (°C) during the winter wheat vegetation period, A.R.D.S. Secuieni, 2019-2021](https://www.lssd-journal.com)
which different doses of fertilizer were applied, both based on nitrogen.

Compared to the non-fertilized variant, very significant production increases were obtained in all variants in which the fertilizer doses of N\textsubscript{120P\textsubscript{120}} were applied obtained the highest yield, of 9429 kg ha\textsuperscript{-1} (Table 1).

On average, in the two years, the factors studied influenced to a very large extent the winter wheat yields, which varied in very wide limits, being between 4683 kg ha\textsuperscript{-1} (N\textsubscript{0P\textsubscript{0}}) up to 7787 kg ha\textsuperscript{-1} (N\textsubscript{120P\textsubscript{120}}). Compared to the non-fertilized variant, very significant production increases were obtained in all variants in which different doses of fertilizer were applied, both based on nitrogen and phosphorus (Figure 3).

### Table 1. Yield recorded for winter wheat under pedoclimatic conditions from ARDS Secuieni

<table>
<thead>
<tr>
<th>No.</th>
<th>Factors studied</th>
<th>Factor A- phosphorus</th>
<th>Yield kg ha\textsuperscript{-1} 2019-2020</th>
<th>Yield kg ha\textsuperscript{-1} 2020-2021</th>
<th>Average yield kg ha\textsuperscript{-1}</th>
<th>Relative yield</th>
<th>Diff. kg ha\textsuperscript{-1}</th>
<th>Semnif.</th>
</tr>
</thead>
<tbody>
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<td>6133</td>
<td>4683</td>
<td>100</td>
<td>Mt.</td>
<td>-</td>
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<td>112</td>
<td>577</td>
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<td>1432</td>
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</tr>
<tr>
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<td>N\textsubscript{160}</td>
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<td>6134</td>
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<td>1451</td>
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</tr>
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<td>1736</td>
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<td>N\textsubscript{120}</td>
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<td>N\textsubscript{160}</td>
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<td>9416</td>
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<td>N\textsubscript{0}</td>
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<td>7539</td>
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<td>N\textsubscript{40}</td>
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<td>9096</td>
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<td>159</td>
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<td>***</td>
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<td>23</td>
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<td>N\textsubscript{80}</td>
<td>6169</td>
<td>8958</td>
<td>7564</td>
<td>162</td>
<td>2881</td>
<td>***</td>
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<td>24</td>
<td>P\textsubscript{160}</td>
<td>N\textsubscript{120}</td>
<td>5975</td>
<td>9039</td>
<td>7507</td>
<td>160</td>
<td>2824</td>
<td>***</td>
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<td>25</td>
<td>P\textsubscript{160}</td>
<td>N\textsubscript{160}</td>
<td>6319</td>
<td>9061</td>
<td>7690</td>
<td>164</td>
<td>3007</td>
<td>***</td>
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</tbody>
</table>

DL\textsubscript{5}% | 275 | 103 | 189 |
DL\textsubscript{1}% | 366 | 137 | 252 |
DL\textsubscript{0,1}% | 477 | 176 | 327 |
The application of nitrogen fertilizers (after the averages of five graduations of phosphorus fertilizers) determined the winter wheat yield of 4399-5898 kg ha\(^{-1}\) in 2019-2020, 6827-8668 kg ha\(^{-1}\) in 2020-2021, and after the average of 2019 - 2021 - of 5613 until 7283 kg ha\(^{-1}\). The yield made in the non-fertilized version with nitrogen (according to the averages of five graduations of phosphorus fertilizers) were of 4399 kg ha\(^{-1}\) in 2019-2020; 6278 kg ha\(^{-1}\) in 2020-2021, and 5613 kg ha\(^{-1}\) after the average of the period 2019-2021. Yield increases by applying nitrogen fertilizers (average) were 619 kg ha\(^{-1}\) (11%) at the dose of N\(_{40}\) and 1670 kg ha\(^{-1}\) (30%) at the dose of N\(_{160}\) (Table 2).

### Table 2. The influence of nitrogen fertilizers on winter wheat yield

<table>
<thead>
<tr>
<th>Nitrogen dose (kg ha(^{-1}))</th>
<th>Yield (kg ha(^{-1}))</th>
<th>Relative yield</th>
<th>Dif. kg/ha</th>
<th>Semnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>N(_0) (control)</td>
<td>4399</td>
<td>5613</td>
<td>100 Mt</td>
<td>-</td>
</tr>
<tr>
<td>N(_{40})</td>
<td>4940</td>
<td>6232</td>
<td>111 619***</td>
<td>***</td>
</tr>
<tr>
<td>N(_{80})</td>
<td>5328</td>
<td>6735</td>
<td>120 1122***</td>
<td>***</td>
</tr>
<tr>
<td>N(_{120})</td>
<td>5669</td>
<td>7138</td>
<td>127 1525***</td>
<td>***</td>
</tr>
<tr>
<td>N(_{160})</td>
<td>5898</td>
<td>7283</td>
<td>130 1670***</td>
<td>***</td>
</tr>
<tr>
<td>DL 5%</td>
<td>123</td>
<td>46</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>DL 1%</td>
<td>164</td>
<td>61</td>
<td>113</td>
<td></td>
</tr>
<tr>
<td>DL 0.1%</td>
<td>213</td>
<td>79</td>
<td>146</td>
<td></td>
</tr>
</tbody>
</table>

The application of phosphorus fertilizers (nitrogen fertilizers, after the averages of five graduations) led to the winter wheat yield of 4035-5868 kg ha\(^{-1}\) in 2019-2020, 7145-8647 kg ha\(^{-1}\) in 2020-2021, and 5590 - 7204 kg ha\(^{-1}\) after the average of the period 2019-2021. The yields made in the non-fertilized phosphorus variants (according to the averages of five graduations of nitrogen fertilizers) were of 4035 kg ha\(^{-1}\) in 2019-2020, 7145 kg ha\(^{-1}\) in 2020-2021, and 5590 kg ha\(^{-1}\) average of the period 2019-2021. Yield increases by applying phosphorus fertilizers (average 2019-2021) were 810 kg ha\(^{-1}\) (14%) at the dose of P\(_{80}\) and 1614 kg ha\(^{-1}\) (29%) at the dose of P\(_{160}\) (Table 3).

### Table 3. The influence of phosphor fertilizers on winter wheat yield

<table>
<thead>
<tr>
<th>Phosphor dose (kg ha(^{-1}))</th>
<th>Yield (kg ha(^{-1}))</th>
<th>Relative yield</th>
<th>Dif. kg/ha</th>
<th>Semnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>P(_0) (control)</td>
<td>4035</td>
<td>5590</td>
<td>100 Mt</td>
<td>-</td>
</tr>
<tr>
<td>P(_{40})</td>
<td>5164</td>
<td>6400</td>
<td>114 810***</td>
<td>***</td>
</tr>
<tr>
<td>P(_{80})</td>
<td>5764</td>
<td>6783</td>
<td>121 1193***</td>
<td>***</td>
</tr>
<tr>
<td>P(_{120})</td>
<td>5401</td>
<td>7024</td>
<td>126 1434***</td>
<td>***</td>
</tr>
<tr>
<td>P(_{160})</td>
<td>5868</td>
<td>7204</td>
<td>129 1614***</td>
<td>***</td>
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<td>DL 5%</td>
<td>113</td>
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<td></td>
</tr>
<tr>
<td>DL 1%</td>
<td>161</td>
<td>62</td>
<td>112</td>
<td></td>
</tr>
<tr>
<td>DL 0.1%</td>
<td>215</td>
<td>79</td>
<td>147</td>
<td></td>
</tr>
</tbody>
</table>

Between the doses of nitrogen and phosphorus fertilizers applied and the winter wheat yields obtained, very close direct correlations were registered, the correlation coefficients were ensured statistically, as been very significant and distinctly significant (Figures 3 and 4).

![Figure 3 – The close bond between the nitrogen doses and the winter wheat yield, 2019 – 2021](https://www.lssd-journal.com)
The mass of one thousand grains in the winter wheat experiment varied, on average, from 42.1 g, in the variant in which the applied dose was N\textsubscript{160}P\textsubscript{80} until 46.0 g, in the variant in which the applied fertilizer dose was N\textsubscript{40}P\textsubscript{80} (Figure 5).

**CONCLUSIONS**

The winter wheat yields realized in the period 2019-2021 oscillated depending on the applied doses but also on the climatic conditions from the research years. Very close direct correlations were established between the applied fertilizer doses and the obtained productions.

The yield increase obtained after the application of the fertilizer was directly proportional to the applied dose and had values in the case of phosphorus fertilizers (810 - 1670 kg ha\textsuperscript{-1} representing 14-29%) and in the case of nitrogen fertilizers (619 - 1670 kg ha\textsuperscript{-1} representing 11-30%).

The correlation between the applied fertilizer doses, nitrogen and phosphorus, with winter wheat yield, was direct, the correlation coefficients (r) were interpreted as very significant and distinctly significant.

In the two years of experimentation, the factors studied influenced to a very large extent the winter wheat yields, which varied in very wide limits, being between 4683 kg ha\textsuperscript{-1} (N\textsubscript{0}P\textsubscript{0}), the control variant, and 7787 kg ha\textsuperscript{-1} (N\textsubscript{120}P\textsubscript{120}).

Compared to the non-fertilized version, very significant yield increases were obtained in all variants in which different doses of fertilizer were applied, both based on nitrogen and phosphorus.

**ACKNOWLEDGEMENT**

This work was financed by a grant from the Ministry of Agriculture and Rural Development through the ADER 2019-2022 program, project no. 1.5.1./04.10.2019, ADER 1.5.1. "Sustainable and conservation of soil fertility through rational application of fertilizers, under conditions of an optimized crop rotation system".

**BIBLIOGRAPHY**