Study Concerning Nitrogen Balance in Some Fodder Systems II: The Silo Maize Based Fodder System

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Abstract
Nitrogen balance in silo maize based fodder systems that also contain some species of fodder legumes (red clover and winter vetch) is positive and it ensures some nitrogen amounts remained in the soil for the crops to follow in the crop rotation. Among the studied fodder systems, we noticed the fodder system Wf (winter fodder) → Sm (silo maize) → Wf (winter fodder) → Sm (silo maize) cultivated successively for two years; in this fodder system, we obtained an extra 40 kg/ha nitrogen in the variant not fertilised with nitrogen and 167 kg/ha in the variant fertilised with nitrogen.

Keywords: fodder system, legumes, nitrogen balance, silo maize.

1. Introduction
The fodder system in which a land is continually cultivated does not mean completely excluding mineral and organic fertilisation: it is based on optimising the processes of growth and development in plants, on optimal management of all mineral resources in the soil, and on valorising them through the cultivation technology of each crop apart [1]. In this context, the study of the dynamics of nitrogen in these systems aims at determining nitrogen balance that expresses the soil mineralisation potential and its capacity of supplying the nitrogen necessary to plant nutrition. According to [2], in most agricultural areas of Romania, the balance of the main plant nutrients (N, P, K) is negative. Reducing the nitrogen deficit in the soil can also be done through the contribution of the legume species that fix atmospheric nitrogen through symbiosis [1, 3-5].

The paper points out the benefits of cultivating silo maize in the continuous culture system with other fodder species on soil nitrogen balance.

2. Materials and methods
Research was conducted at the B.U.A.S.V.M. in Timișoara, between 2008 and 2011, on a cambic chernozem moderately gleyied whose pH is 6.21. The trial setting was made up of a structure of fodder species cultivated successively on the same land for two years (2009-2011) in the following fodder systems based on silo maize:
- Silo maize (Sm) (2009) → Silo maize (Sm) (2010), Sm → Sm
- Silo maize (Sm) (2009) → Winter fodder (Wf) (2010) → Silo maize (Sm) (2010), Sm → Wf → Sm

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- Italian ray grass (Ir) (2009) → Silo maize (Sm) (2009) → Winter fodder (Wf) (2010) → Silo maize (Sm) (2010), Ir → Sm → Wf → Sm These fodder systems have been cultivated and valorised after the following cultivation technology:
  - In the system Sm → Sm, the silo maize was sowed in each of the two years, according to the conventional cultivation technology, as monoculture;
  - In the system Sm → Wf → Sm, winter fodder, made up of winter vetch and triticales, was sowed in September 2009 and, after harvesting it, at mid May 2010, we sowed silo maize;
  - In the system Wf → Sm → Wf → Sm, winter fodder (Wf) was sowed in the falls of 2008 and 2009, and silo maize (Sm) was sowed right after harvesting them;
  - In the system Ir → Sm → Wf → Sm, Italian ray grass (Or) was sowed in the fall of 2008 and was mowed only once and harvested at the beginning of May 2009, after which we sowed silo maize (Sm); in the fall of 2009, we sowed winter fodder (Wf), and after harvesting it, in May 2010, we sowed silo maize (Sm).

As shows the crop structure introduced in the trial, nitrogen balance was determined for the two agricultural years, i.e. between September 2009 and September 2010 in the two fertilisation variants (N0 and N+).

3. Results and discussion

At the end of the vegetation period in the crops of the crop rotation, soil roots and vegetal debris on the soil from harvesting are decomposed by micro-organisms. In this mineralisation process, micro-organisms in the soil turn organic nitrogen into ammonia nitrogen (NH₄⁺) and further on into nitrates (NO₃⁻), forms of nitrogen that can be assimilated by the plants’ roots.

The degree of mineralisation of the nitrogen depends on the ratio C: N [6]. Thus, when cultivating some fodder legumes (*Vicia villosa* and *Trifolium incarnatum*) after silo maize, the ratio was between 10:1 and 20:1 [7]. Grass crops have a higher ratio (25:1) and a lower degree of decomposition and mineralisation. If immobilisation is higher than mineralisation, then, over some time, there is a deficit of nitrogen in the crops of the crop rotation. Legumes, whose C: N ratio is lower (below 25:1) influences more the mineralisation of the nitrogen in the biomass of the vegetal debris incorporated in the soil. Our research showed that in all fodder systems we studied in which there was silo maize and winter fodder (Vicia villosa + Triticales) in the crop structure, nitrogen balance after two years of continuous cultivation of the land was positive in both non-fertilised variants and nitrogen fertilised variants.

In the fodder system Sm → Sm, cultivated as monoculture for two years, though the nitrogen balance was positive, exceeding nitrogen was, in the two variants, the lowest among all the studied fodder systems: 8 kg/ha in the first year and 51 kg/ha in the second year (Table 1).

<table>
<thead>
<tr>
<th>Cumulated nitrogen fertiliser doses</th>
<th>INPUTS (kg/ha)</th>
<th>OUTPUTS (kg/ha)</th>
<th>Nitrogen balance (+) (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertilisation</td>
<td>Soil nitrogen</td>
<td>Root nitrogen</td>
<td>NFB</td>
</tr>
<tr>
<td>Fertilisation N₀</td>
<td>84</td>
<td>52</td>
<td>-</td>
</tr>
<tr>
<td>Fertilisation N₂₀₀</td>
<td>200</td>
<td>89</td>
<td>70</td>
</tr>
</tbody>
</table>

The positive nitrogen balance in the fodder system Sm → Wf → Sm materialised in exceeding nitrogen amount of 12 kg/ha in the variant not fertilised and 128 kg/ha in the variant treated with nitrogen (Table 2).
Table 2. Nitrogen balance in the fodder system Sm → Wf → Sm

<table>
<thead>
<tr>
<th>Nitrogen fertiliser doses</th>
<th>INPUTS (kg/ha)</th>
<th>OUTPUTS (kg/ha)</th>
<th>Nitrogen balance (±) (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fertilisation</td>
<td>Soil nitrogen</td>
<td>Root nitrogen</td>
</tr>
<tr>
<td>N₀</td>
<td>-</td>
<td>133</td>
<td>144</td>
</tr>
<tr>
<td>N₂₀₀</td>
<td>250</td>
<td>137</td>
<td>190</td>
</tr>
</tbody>
</table>

The highest amount if exceeding nitrogen was in the fodder system Wf → Sm → Wf → Sm (Table 3). In this fodder system, at the end of the cultivation period, the amount of nitrogen accumulated in the soil after two years was 40 kg/ha in the variant not fertilised and 167 kg/ha in the variant fertilised with nitrogen. In this fodder system, the contribution of the legume (associated with Triticales) cultivated in the crop rotation in each of the two years was major, which determined a higher degree of decomposition and mineralisation of the organic matter in the soil.

Table 3. Nitrogen balance in the fodder system Wf → Sm → Wf → Sm

<table>
<thead>
<tr>
<th>Nitrogen fertiliser doses</th>
<th>INPUTS (kg/ha)</th>
<th>OUTPUTS (kg/ha)</th>
<th>Nitrogen balance (±) (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fertilisation</td>
<td>Soil nitrogen</td>
<td>Root nitrogen</td>
</tr>
<tr>
<td>N₀</td>
<td>-</td>
<td>181</td>
<td>262</td>
</tr>
<tr>
<td>N₂₀₀</td>
<td>300</td>
<td>190</td>
<td>320</td>
</tr>
</tbody>
</table>

In the fodder system Ir → Sm → Wf → Sm, there was a positive nitrogen balance in both studied variants: an exceeding amount of nitrogen of 29 kg/ha in the variants not treated and an exceeding amount of nitrogen of 95 kg/ha in the variants fertilised with nitrogen (Table 4).

Table 4. Nitrogen balance in the fodder system Ir → Sm → Wf → Sm

<table>
<thead>
<tr>
<th>Nitrogen fertiliser doses</th>
<th>INPUTS (kg/ha)</th>
<th>OUTPUTS (kg/ha)</th>
<th>Nitrogen balance (±) (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fertilisation</td>
<td>Soil nitrogen</td>
<td>Root nitrogen</td>
</tr>
<tr>
<td>N₀</td>
<td>-</td>
<td>177</td>
<td>151</td>
</tr>
<tr>
<td>N₂₀₀</td>
<td>300</td>
<td>184</td>
<td>221</td>
</tr>
</tbody>
</table>

Research carried out by [8] showed that, in the legumes in the crop rotation, 75-80% of the vegetal debris was decomposed and mineralised into nitrogen eight weeks after harvesting. Thus, the silo maize crop in the crop rotation benefited of 50% of the amount of nitrogen resulted from the decomposition and mineralisation of the vegetal debris in these crops. The studied carried out by [7] show that, in rye monoculture, the content of inorganic nitrogen from the soil decreases from 62 to 37% in two consecutive years compared to legume monocultures. After [9], a significant diminution of inorganic nitrogen from the soil was also recorded in monocultures of fodder grasses compared to the mixture of grasses and legumes cultivated in crop rotations.
4. Conclusions

Introducing winter fodder (*Vicia villosa* and *Triticales*) in the crop structures of fodder systems based on silo maize, nitrogen balance is positive, with an exceeding amount of nitrogen at the end of the two years of continuous cultivation between 8 and 40 kg/ha in the variants not treated and between 51 and 167 kg/ha in the variants fertilised with nitrogen.

References

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