Performance of oats (Avena sativa) in response to preceding alfalfa (Medicago sativa) on mineral fertilization versus organic manuring on Chernozem soil

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ABSTRACT

Residual effect of crops on the performance of succeeding crops is well documented, but their comparisons through inorganic fertilization versus organic manuring is conspicuously missing. In this background, grain and straw oats (Avena sativa L.) yield in response to mineral versus organic manures on alfalfa grown soil was studied in field trial in the Institute of Forage Crops, Pleven, Bulgaria. Alfalfa (Medicago sativa L.) was used for forage (4 years) and seeds (3 years), and fertilized with mineral nitrogen fertilizer in form of ammonium nitrate and well matured cattle manure. Productivity of oats was influenced by both, type of fertilization and whether or not grown alfalfa grown as predecessor. When oats was cultivated after alfalfa for forage, grain yield of oats was higher by 18.68% and 9.84% for straw as compared to alfalfa for seeds. Alfalfa for forage appeared to be better predecessor, and more tolerant with regard to productivity of the next crop such as oats in comparison to alfalfa for seeds. The applied manure as organic fertilizer have long lasting (4 years) positive effect on both yields of experimented crops and soil fertility.

Key words: Alfalfa, Mineral fertilization, Oats, Organic agriculture, Predecessor, Yield

Material and Methods

The experiment was carried out in the experimental field of the Institute of Forage Crops, Pleven, Bulgaria on
RESULTS AND DISCUSSION

The results of the experiment suggested that fertilization as well as the purpose of use of predecessor affected the productivity of the next crop. During the experimental year, despite the large amount of rainfall in May and June, early spring drought occurred in April (6.9 mm) also adversely affects both, growing and development of oats. Grain yield from oats sown after alfalfa with purpose of use for forage was found be greater in the variants with manure as compared to unfertilized control (Table 1). For doses of 140 and 70 kg/ha of manure there were 33 and 180 kg/ha, respectively, more grain as compared to mineral nitrogen fertilized alfalfa.

Higher yields after alfalfa, fertilized with manure were due to the ready humus substances applied in the soil with manure and the largest amount of organic carbon (Bulluck et al. 2002, Edmeades 2003, Kelling and Schmitt 2003). Vasileva and Kostov (2015a) established the higher increase of 4.58% of grain yield with mean dose of applied manure. Also it was found out twice higher content of humic acids in the soil after manure fertilized alfalfa.

Humic acid is one of the most biochemically active elements in humus. Taking into account to the biochemically active nature of humic acid and its ability to form both, soluble and insoluble complexes with various metals, minerals and organics, nutrients are mobilized in forms that the plants can accept. Enchev and Kikindonov (2015) concluded even in unfavorable climatic conditions the use of organic nitrogen fertilizers based on humic acids had a positive effect on the productivity of grain sorghum. The biochemically active nature of humic acid works to enhance formation of root mass as well. Soil humus was found to be humic type of humus for both areas of alfalfa grown for forage and seeds (Vasileva and Kostov 2015b). The
increase of humic acids content after mineral fertilization in our study varied from 27.8 to 50.0%, and after manure from 50.0 to 172.2%. The highest percent of increase was with the dose of 140 kg/ha for both, mineral and manure applications. The results obtained strongly suggested that alfalfa grown 4 years for forage prepared the soil for the next crop in regard to quantity and quality of humus and better physical and chemical characteristic of soil fertility.

Oats grain yields obtained after mineral fertilized for alfalfa grown for forage did not statistically differ from those of the control. This is related to the lesser amount of humus accumulated in soil after fertilization of alfalfa with mineral nitrogen fertilizer at higher doses.

Oats grain yields obtained after manured alfalfa was found is higher as compared to those of the control. The root system of alfalfa penetrates to great depth, improving soil structure and providing large amounts of available nitrogen for the next crop. Manure had positive effect on humus, which reflected on the development and productivity of oats. Very surprisingly the oats yields at highest doses showed low values as compare to middle dose for two types of growing alfalfa. This phenomenon can possible be explained only with highest yields of alfalfa and extraction of more nutrients from soil during cultivation of alfalfa for 3-4 years. So, at higher manure doses amount of new development of root system cannot compensate loss of nutrients from soil.

Grain yields from oats obtained after alfalfa for forage was found to be higher in comparison with those after alfalfa for seeds. For mineral fertilization the increase was from 22.08 to 26.53 mean values SSD %, and for manure, from 19.85 to 22.23%, respectively. This was probably due to the higher amount of available nitrogen and humic substances after a four-year cultivated of alfalfa for forage. Similar findings were reported by Gaiser et al. (2012) but the predecessor was alfalfa grown for two years and the next crop was wheat. Vasileva and Kostov (2015a, b) in the same trial found significant higher amount of accumulated dry root mass in alfalfa for forage (5166 kg/ha) as compared to that in alfalfa for seeds (3140 kg/ha). It should be mentioned that decomposition of root mass of alfalfa for seed started almost one year later. Also, regarding experimented dosages when cultivated alfalfa for forage and seeds it was obtained a decrease of the oats yield at the highest dosages for both, mineral fertilization and manure.

Sustainable yield index for grain of oats sown after alfalfa for forage and mineral fertilized was found to be higher than that of the control. Lower sustainable yield index was recorded for oats after alfalfa for forage and mineral fertilized at a dose of 210 kg/ha (Fig 1). This dose was toxic for nodulation thus the plants of alfalfa needed biologically fixed nitrogen, which increased its productivity (Vasileva et al. 2011) and later it influenced the productivity of oats.

The higher sustainable oats yield index was found when oats was sown after predecessor alfalfa for forage in comparison with alfalfa for seeds. The results obtained support conclusion that alfalfa grown for forage is more tolerant with regard to the yield of next crop, i.e. alfalfa for forage is better predecessor as compared to alfalfa for seeds. Straw yield was recorded and data are shown in Table 2. When oats were grown after alfalfa for forage the straw yields obtained were found to be higher for the variants with fertilization- for mineral it was 7.35% and for manure it was twice more- 15.97%. The same trend where observed with oats grown after alfalfa for seeds. Straw yields of oats were 7.77% after mineral nitrogen fertilization and 13.15% after manure application.

### Table 2 Response of mineral fertilization versus organic manuring on straw oats yield after predecessor alfalfa

<table>
<thead>
<tr>
<th>Variants</th>
<th>After alfalfa for forage (1)</th>
<th>After alfalfa for seeds (2)</th>
<th>To (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>straw +, to control to mineral N</td>
<td>Straw +, to C to mineral N</td>
<td></td>
</tr>
<tr>
<td>N0-Control</td>
<td>1266 kg/ha 3.08% to 1133 kg/ha 6.80%</td>
<td>11.74 %</td>
<td></td>
</tr>
<tr>
<td>MN70</td>
<td>1305 kg/ha 7.35% to 1221 kg/ha 7.77%</td>
<td></td>
<td>11.30%</td>
</tr>
<tr>
<td>MN140</td>
<td>1359 kg/ha 3.79% to 1216 kg/ha 7.33%</td>
<td></td>
<td>8.06</td>
</tr>
<tr>
<td>MN210</td>
<td>1314 kg/ha 9.79% to 1259 kg/ha 11.12%</td>
<td></td>
<td>10.41</td>
</tr>
<tr>
<td>ON70</td>
<td>1390 kg/ha 85.00% to 1282 kg/ha 13.15%</td>
<td></td>
<td>9.05</td>
</tr>
<tr>
<td>ON140</td>
<td>1398 kg/ha 39.00% to 1235 kg/ha 9.00%</td>
<td></td>
<td>18.87</td>
</tr>
<tr>
<td>ON210</td>
<td>1468 kg/ha 154.00% to 19.00%</td>
<td></td>
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</tr>
<tr>
<td>Mean value SSD</td>
<td><em>1357</em>±68</td>
<td><em>1222</em>±47</td>
<td></td>
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</tbody>
</table>

*Statistically significant difference between Groups 1 and 2 at the level of P< 0.05 (Dunkan test).
Straw yields of oats obtained after predecessor alfalfa grown for forage were 1372 kg/ha and for seeds were 1237 kg/ha. It appears that the yield was higher after alfalfa for forage than that after alfalfa for seeds. For mineral fertilization yields were from 7.85 to 11.3%. In manure treatments yield were from 9.05 to 18.87%. It appeared that alfalfa for forage is better predecessor as compared to alfalfa for seeds. Growing a pure stand of alfalfa for 4 years added a considerable amount of nitrogen to the soil. Alfalfa had a greater proportion of nitrogen stored in the roots and removing a crop still provided for the return of a substantial amount of nitrogen to the soil.

**Conclusion**

Productivity of oats was influenced by both, type of fertilization and whether or not grown alfalfa grown as predecessor. Higher sustainable yield index for biomass yield was found when oats were cultivated after manure fertilized alfalfa as compared to mineral fertilized for two purposes of use. Alfalfa for forage appeared to be better predecessor and more tolerant regarding the productivity of the next crop such as oats in comparison to alfalfa for seeds.

**REFERENCES**


