DENSITY AND REDUCTION OF THE STAND AT ALFALFA VARIETIES  
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Abstract: With purpose to study the density and reduction of stand at 9 alfalfa varieties (Europe, Prista 2, Prista 3, Prista 4, Obnova 10, Pleven 6, Dara, Multifoliate and Dama) during 2006–2009 period in IFC–Pleven is carried out an experimental activity. The average density of stand at studied alfalfa varieties during the first year of development was 1313 plants/m². The reduction during next three years was disproportionally and was the strongest pronounced during the second year–by 58.3% to the density of the stand in the previous year. During the third experimental year the reduction of alfalfa was still strong pronounced albeit with a lower value (51.1%) and during the fourth year it was 5 times less than that during the previous two years at average value of 10.6%. In the end of four–year experimental period the reduction at different varieties was in limits from 68.6% (Obnova10) to 85.7% (Dara) at average value for the species of 81.8%. It is established correlations with high negative value among the stand density and root mass weigh/plant (r= −0.811) and diameter of root collar (r= −0.692), and a correlation with medium negative value between the stand density and number of stems/plant (r= −0.488).

Key words: alfalfa, varieties, stands density, reduction

Introduction  
The productivity and nutritive value of alfalfa defined her as a leading perennial legume forage crop [SAUVANT et al., 2002; ĐUKIĆ, 2002; RADOVIĆ et al., 2004; DINIĆ and DORDEVIĆ, 2005].

High productivity of the alfalfa is provided by using different agricultural practices, agro–ecological conditions, varieties, etc. [STANISAVLIJEVIć et al., 2008; STANISAVLIJEVIć et al., 2008a].

According to other authors the stand density was the main factor determinant the yield [RUMBAUGH, 1963; HANSEN and KRUEGER, 1973; BOLGER and MEYER, 1983; VOLENEC et al., 1987; LAMM et al., 2005] and longevity of alfalfa [MIN et al., 2000; DOLÈZAL and SKLÁDIANKA, 2008; HAKL et al., 2010] reported that the alfalfa productivity could be described by three components: [VOLENEC et al., 1987] plants per unit area, number of stems per plant, productivity per stem. The conducting such type of experiments was difficult as for the determination of the first two components is necessary violation of the entirety of stand [VOLENEC et al., 1987].

The alfalfa density was highest in the year of the crop establishment and it is reduced in the subsequent years [MACLINOFF and k., 1981; CORUH and TAN, 2006].

The reduction was not linear [HAKL et al., 2011] and in result of their investigations the researchers stated different trends. According to Min [MIN et al., 2000] the decrease in the number of plants was much greater during the first than in other years.

The studies of other authors showed that the reduction was extremely strong from the 1st to 2nd year and slower in the next three years [SUZUKI, 1991; HAKL et al., 2011].

Volonec [VOLENEC et al., 1987] observed a decrease in the stand density during the first 2–3 years after sowing due to strong intraspecific competition.

It is found and significant differences in the decrease of density depending on the varietal identity [SARRAC, 1987; MIN et al., 2000; LIU et al., 2005; LLOVERAS et al., 2006].

The purpose of experimental work was to study the density and reduction of stand at alfalfa varieties.
Material and methods
The subject of the study were 9 alfalfa varieties: Europe (France), Prista 2 (Obraztsov Chiflik, Ruse), Prista 3 (Obraztsov Chiflik, Ruse), Prista 4 (Obraztsov Chiflik, Ruse), Obnova 10 (IFC, Pleven), Pleven 6 (IFC, Pleven), Dara (IFC, Pleven), Multifoliate (Obraztsov Chiflik, Ruse) and Dama (IFC, Pleven).

The experimental activity is carried out during 2006–2009 period in IFC–Pleven on slightly leached chernozem.

The sowing is done in the spring of 2006 at row spacing 11.5 cm and sowing rate 2.5 kg/da, in 4 replications and plot size of 5 m².

It is used the block method.

For determination of alfalfa density (number of plants/m²) at harvest of the spring, summer and autumn regrowths (early flowering stage) are taken soil monoliths with dimensions 20x200x30 cm (width/length/depth).

Results and discussion
In meteorological regard the study years are distinguished with variable conditions. The variation of amount of rainfall by years was considerably as

<table>
<thead>
<tr>
<th>Year</th>
<th>SpR</th>
<th>SumR</th>
<th>AR</th>
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<tbody>
<tr>
<td>2006</td>
<td>100</td>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td>2007</td>
<td>150</td>
<td>200</td>
<td>250</td>
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<tr>
<td>2008</td>
<td>200</td>
<td>250</td>
<td>300</td>
</tr>
<tr>
<td>2009</td>
<td>250</td>
<td>300</td>
<td>350</td>
</tr>
</tbody>
</table>

The annual average daily temperature of air (12.7°C) and less sum of rainfall (541 mm) compared to the same for the previous 20–year period (12.2°C and 562 mm).

During the first year of alfalfa development the density of stand at harvest of the spring regrowth was on average 1509 plants/m² (Figure 1).

With the greatest density was variety Dara, followed by Pleven 6 and Multifoliate and with the least one was Obnova 10—a trend which is reserved and at harvest of the summer and autumn regrowths.

The reduction of the stand in the end of the first year of alfalfa development was on average by 25.6% as it was the most pronounced for Multifoliate (47.1%) and the weakest—for Obnova 10 (13.9%).

For variety Europe the reduction was 23.0% and it was below the average of group.

Figure 1. Density of the stand at alfalfa varieties, plants/m²
The variation in alfalfa density during the second year of its development at different varieties was less than during the first year. The average number of plants/m² at harvest of the spring, summer and autumn regrowth was 746, 463 to 433 respectively. With the highest values of that parameter in all regrowths was variety Dama and with the lowest ones—Obnova 10. The decrease of stand density within the second year was significantly more pronounced compared to the previous year and was by 42.0%. The greatest was the stand reduction at Dara and the least—at Pleven 6.

Compared to the first two years the reduction of alfalfa stand during the third experimental year was in the least degree (19.9%). A greater number of plants per unit area in the three regrowths are found again at Dama at average density of alfalfa stand from 268 plants/m² during the year.

The average number of plants harvested in the spring regrowth during the fourth year was 267 and compared with the same value during the first experimental year the decline was substantially (by 82.3%). With progress of the vegetation the dropping out of plants from the stand continued in the summer and autumn regrowths as the alfalfa density was 241 and 209 plants respectively.

With the highest density in all regrowths was variety Pleven 6 and with the lowest one—Prista 3.

The reduction of alfalfa during the fourth year was similar to that of the previous year and was by 21.6%.

The presented data in Table 1 showed the average density of stand at studied alfalfa varieties during the four years of cultivation. The average number of harvested plants/m² during the first year was 1313.

The variety Dara, Pleven 6 and Prista 2 is distinguished with the greatest density and Obnova 10—with the least one. The variation coefficient as an important statistical parameter giving possibility to establish the relative equalization of the traced indicator defined its variation during the first year as strong (21%) and as medium during the second, third and fourth year (respectively 13, 13 and 11%).

<table>
<thead>
<tr>
<th>Varieties</th>
<th>2006 Average density plants/m²</th>
<th>2007 Average density plants/m²</th>
<th>Reduction to 2006</th>
<th>2008 Average density plants/m²</th>
<th>Reduction to 2007</th>
<th>2009 Average density plants/m²</th>
<th>Reduction to 2008</th>
<th>Reduction to 2006</th>
<th>Reduction to 2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe</td>
<td>1337</td>
<td>587</td>
<td>–56,1</td>
<td>247</td>
<td>–58,0</td>
<td>228</td>
<td>–7,5</td>
<td>–82,9</td>
<td></td>
</tr>
<tr>
<td>Prista 2</td>
<td>1379</td>
<td>598</td>
<td>–56,6</td>
<td>292</td>
<td>–51,2</td>
<td>245</td>
<td>–16,1</td>
<td>–82,2</td>
<td></td>
</tr>
<tr>
<td>Prista 3</td>
<td>1270</td>
<td>522</td>
<td>–58,9</td>
<td>246</td>
<td>–52,8</td>
<td>199</td>
<td>–19,3</td>
<td>–84,3</td>
<td></td>
</tr>
<tr>
<td>Prista 4</td>
<td>1177</td>
<td>533</td>
<td>–54,7</td>
<td>263</td>
<td>–50,7</td>
<td>216</td>
<td>–17,8</td>
<td>–81,6</td>
<td></td>
</tr>
<tr>
<td>Obnova 10</td>
<td>734</td>
<td>394</td>
<td>–46,2</td>
<td>229</td>
<td>–42,0</td>
<td>230</td>
<td>+0,7</td>
<td>–68,6</td>
<td></td>
</tr>
<tr>
<td>Pleven 6</td>
<td>1562</td>
<td>571</td>
<td>–63,4</td>
<td>292</td>
<td>–48,8</td>
<td>294</td>
<td>+0,6</td>
<td>–81,2</td>
<td></td>
</tr>
<tr>
<td>Dara</td>
<td>1730</td>
<td>557</td>
<td>–67,8</td>
<td>285</td>
<td>–48,9</td>
<td>247</td>
<td>–13,2</td>
<td>–85,7</td>
<td></td>
</tr>
<tr>
<td>Multifoliate</td>
<td>1354</td>
<td>516</td>
<td>–61,9</td>
<td>223</td>
<td>–56,9</td>
<td>238</td>
<td>+6,9</td>
<td>–82,4</td>
<td></td>
</tr>
<tr>
<td>Dama</td>
<td>1270</td>
<td>646</td>
<td>–49,1</td>
<td>332</td>
<td>–48,7</td>
<td>255</td>
<td>–23,3</td>
<td>–80,0</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>1313</td>
<td>547</td>
<td>–58,3</td>
<td>268</td>
<td>–51,1</td>
<td>239</td>
<td>–10,6</td>
<td>–81,8</td>
<td></td>
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</tbody>
</table>

The data for alfalfa density during the second and third year of development is characterized by unidirectional in regard to maximum (at variety Dama) and minimum (at variety Obnova 10 and Multifoliate) at average density of the stands from 547 to 268 plants/m².
It is obviously the significant decrease in the number of plants harvested per unit area in result of the total reduction of stand consequence dropping of many individuals.

The established average density of alfalfa stand during the fourth year was 239 plants.

During the last experimental year the highest value of the considered parameter is observed at Prista 6 and the lowest value— at Prista 3.

The reduction in alfalfa density during the four years of cultivation was as follows:
– the decrease in stand density was the most pronounced during the second year of alfalfa development and was by 58.3% to the density in the previous year. The highest was the percentage of dropped individuals at variety Dara (67.8%) and the lowest— at variety Obnova 10 (46.2%).
– during the third experimental year the reduction of alfalfa was still strong pronounced albeit with a lower value (51.1%) to the previous year. In the greatest degree is reduced variety Europe and in the least one— again Obnova 10.
– the ascertained reduction during the fourth year was 5 times less than that during the previous two years at average value for all varieties of 10.6%. During the present year the strongest reduction was at variety Dama and the weakest one— at Europe. At three of studied varieties the reduction had a positive value because of that the parameter is calculated on the basis of average values for the density for each experimental year.

In comparing the average density of alfalfa during the first and fourth year of development is found reduction at the different varieties in limits from 68.6% (Obnova 10) to 85.7% (Dara) at average value for the species of 81.8%.

That value was similar to the reported from [HAKL et al., 2011] decrease in the end of fourth year of 90.6% for the condition of Czech as and reported reduction from Grains Research and Development Corporation (Australian government, 2004) for alfalfa from 75% for Australia.

The less dropping at the variety with the lowest density on average for the cultivation period (Obnova) was in confirmation of the found from [HALL et al., 2004; HAKL et al., 2011].

The stand density was one of the most important factors related to the main parameters of root morphology [HAKL et al., 2007; HAKL et al., 2011].

It is found negative dependencies among the considered parameter and root mass quantity [HANSEN and KRUEGER, 1973; LI et al., 2011], diameter of root collar [HANSEN and KRUEGER, 1973; HAKL et al., 2011] and number of stems/plants [RUMBAUGH, 1963; BOLGER and MEYER, 1983; VOLENEC et al., 1987; KEPHART et al., 1992].

<table>
<thead>
<tr>
<th>Correlations among the stand density and parameters of alfalfa root system</th>
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<tbody>
<tr>
<td>Root mass weigh/plant</td>
</tr>
<tr>
<td>Diameter of root collar</td>
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<tr>
<td>Number of stems/plant</td>
</tr>
</tbody>
</table>

The results from the present study showed correlations with high negative value among the stand density and root mass weigh/plant (r=–0.811) and diameter of root collar (r=–0.692), and correlation with medium negative value between stand density and number of stems/plant (r=–0.488) (Table 2).

Looking the data by years it could note that in more cases the values were...
lower during the first year and subsequently in time they increased which was in confirmation of the reported from [HAKL et al., 2011] .

Conclusions
The average density of stand at studied alfalfa varieties during the first year of development was 1313 plants/m².

The reduction during next three years was disproportionately and was the strongest pronounced during the second year—by 58.3% to the density of the stand in the previous year.

During the third experimental year the reduction of alfalfa was still strong pronounced albeit with a lower value (51.1%) and during the fourth year it was 5 times less than that during the previous two years at average value of 10.6%.

In the end of four–year experimental period the reduction at different varieties was in limits from 68.6% (Obnova10) to 85.7% (Dara) at average value for the species of 81.8%.

The variety with the lowest density (Obnova) is reduced in the least degree.

It is established correlations with high negative value among the stand density and root mass weigh/plant ($r=0.811$) and diameter of root collar ($r=0.692$), and a correlation with medium negative value between the stand density and number of stems/plant ($r=−0.488$).

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