EFFECT OF THE SOWING TIME ON SOME BIO–PRODUCTIVE PARAMETERS OF ANNUAL SUMMER FORAGE MIXTURE

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Abstract. During the 2010–2012 periods in the Research Institute of Mountain Stockbreeding and Agriculture (RIMSA) in Troyan the effect of sowing time on some bio–productive parameters of the forage from annual summer mixture was performed. It was established that the most optimal time for sowing of annual summer mixture from sorghum–Sudan grass hybrid and horse bean grown under the foothill conditions of Central Balkan Mountains (Troyan region) is period from 1st to 10th of July. The received forage amounted to 2.20 t. ha⁻¹ green mass and 0.50 t. ha⁻¹ dry matter, which exceeded the later sowing periods from 7.55% (from 11th to 20th July) to 61.93% (from 1st to 10th August) and from 16.28 to 65.98%. There was a least weed infestation of mixture at last sowing period (from 1st to 10th August) and reached 3.03–3.85%.

Keywords: annual summer mixture, cereal and legume crop, sowing time, forage parameters

Introduction
The annual crops are often cultivated in mixtures. They give higher yields of green mass and hay and have a better forage quality and acquiesce of farm animals.

With a greater application in the practice are cereal and legume mixtures and they giving higher crude protein yields compared with the monocultures. The actuality for use of annual summer monocultures and mixtures is related to observables present climatic changes in both regionally and globally aspect [DROUSHOTIS, 1989; BRAUNWART et al., 2001; TWIDWELL, 2002].

The sowing date is an important part of technology of annual monocultures and mixtures [TWIDWELL et al., 1992; ALVIM et al., 1994; ANNICCHIARICO and IANNUCCI, 2007; KOSTRZEWSKA et al., 2012].

Therefore in recent years in some regions of Bulgaria were carried out studies to establish conditions and factors for yield formation and forage quality parameters of some annual field crops [PAVLOV, 1996; GRAMATIKOV, 2002; GRAMATIKOV et al., 2002; KOLEV and IVANOVA, 2004]. The annual summer mixtures in Bulgaria are sown as a secondary crops after harvesting of winter or early–spring or after cereal monocultures. By components are used species comprising late spring mixtures and suitable for cultivation in corresponding region. In conditions of foothill areas of Central Balkan Mountains so far is established only suitability of some annual summer cereal–legume mixtures [LINGORSKI and KERTIKOV, 2007]. The absence of research for most optimal sowing period under foothill areas of Central Balkan Mountains was a prerequisite for need to carry out them. The objective of this study was to investigate most optimal time for sowing of annual summer mixture of sorghum–Sudan grass hybrid and horse been cultivated under soil–climatic conditions of foothill region of Central Balkan Mountains.

Material and methods
Annually experiment was laid out during 3 years (2010, 2011, 2012) in summer in experimental field of RIMSA, Troyan on light–grey forest (pseudopodzollic) soil by block method with 4 replications and size of harvest plot of 5 m². On experimental area was sown annual summer cereal and legume mixture of sorghum–Sudan grass hybrid and horse bean. As variants following periods of sowing were studied:

1. 1st–10th July (Standard);
2. 11th–20th July;
3. 21st–30th July;
4. 1st–10th August.

Before sowing necessary kinds of pre–sowing tillage (shallow ploughing, diskig,
rotary cultivation) were conducted up to obtaining of a garden status of soil. The trial plots were rolled after sowing.

The inter-row spacing was 30 cm for horse bean and 15 cm for sorghum–sudan grass hybrid and sowing depth was 3–5 cm. The sowing rates for different components of mixture were as follows: for sorghum–sudan grass hybrid cv. Vercors–15 germinable seeds m⁻² and for horse bean cv. Polycarpe–40 germinable seeds m⁻². The weight ratio of cereal to legume component in mixture was 1:3.

Due to unfavorable soil (low-productive with heavy loam structure) and weather conditions during summer (insufficient rainfall combined with high air temperatures), sowing rates were increased by 15%. The experimental areas of separate variants (sowing times) were harvested at ear formation of sorghum–sudan grass hybrid.

The characteristics of green and dry mass productivity (in t. ha⁻¹); weed infestation of mixed crop (in %) was recorded annually.

The yielding capacity was determined by cut method with subsequent drying at 105°C of average samples of fresh mass to constant weight and on basis of per cent of dry matter in them it was recalculated per 1 ha.

The weed infestation of crop was determined by weight from average fresh samples for each replication and variant, recording separately percent participation of sown crops and weeds (as a total). The herbage yield data of green and dry mass productivity was performed using analysis of variance. It were used LSD₀.₀₅ (least significant differences at P<0.05), LSD₀.₀₁ (least significant differences at P<0.01) and LSD₀.₀₀₁ (least significant differences at P<0.001) regard to green mass and dry matter yields average for periods 2010–2011.

**Results and discussion**

The harvesting of crops for different variants (sowing times) was done as follows: in 2010 for var. 1–on September 9, for var. 2–on September 17, for var. 3–on September 28, for var. 4–on October 4; in 2011: for var. 1–on September 10, for var. 2–on September 15, for var. 3–on September 20, for var. 4–on September 26.

**Table 1.**

<table>
<thead>
<tr>
<th>Variant (sowing time)</th>
<th>Green mass t.ha⁻¹</th>
<th>%</th>
<th>Dry matter t.ha⁻¹</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2010</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. 1st–10th July (St.)</td>
<td>2.80</td>
<td>100.00</td>
<td>0.61</td>
<td>100.00</td>
</tr>
<tr>
<td>2. 11th–20th July</td>
<td>2.65</td>
<td>94.64</td>
<td>0.49</td>
<td>80.33</td>
</tr>
<tr>
<td>3. 21st–30th July</td>
<td>2.15</td>
<td>76.78</td>
<td>0.42</td>
<td>68.85</td>
</tr>
<tr>
<td>4. 1st–10th August</td>
<td>1.39</td>
<td>49.64</td>
<td>0.28</td>
<td>45.90</td>
</tr>
<tr>
<td><strong>2011</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. 1st–10th July (St.)</td>
<td>1.61</td>
<td>100.00</td>
<td>0.39</td>
<td>100.00</td>
</tr>
<tr>
<td>2. 11th–20th July</td>
<td>1.43</td>
<td>88.82</td>
<td>0.34</td>
<td>87.18</td>
</tr>
<tr>
<td>3. 21st–30th July</td>
<td>0.75</td>
<td>46.58</td>
<td>0.16</td>
<td>41.02</td>
</tr>
<tr>
<td>4. 1st–10th August</td>
<td>0.29</td>
<td>18.01</td>
<td>0.06</td>
<td>15.13</td>
</tr>
<tr>
<td><strong>Average for period 2010–2011</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. 1st–10th July (St.)</td>
<td>2.20</td>
<td>100.00</td>
<td>0.50</td>
<td>100.00</td>
</tr>
<tr>
<td>2. 11th–20th July</td>
<td>2.04</td>
<td>92.73</td>
<td>0.41</td>
<td>82.00</td>
</tr>
<tr>
<td>3. 21st–30th July</td>
<td>1.45</td>
<td>65.91</td>
<td>0.29</td>
<td>58.00</td>
</tr>
<tr>
<td>4. 1st–10th August</td>
<td>0.84</td>
<td>38.18</td>
<td>0.17</td>
<td>34.00</td>
</tr>
</tbody>
</table>

| LSD₀.₀₅ (39.71%), LSD₀.₀₁ (60.14%), LSD₀.₀₀₁ (81.73%) | LSD₀.₀₅ (45.58%), LSD₀.₀₁ (69.02%), LSD₀.₀₀₁ (96.62%) |

Due to prolonged drought period in July and August of 2012 (only 7.2 mm and 39.1 mm rainfall, respectively), combined with high average monthly air temperatures (24.2°C and
21.7°C, respectively), germination and development of plants was very difficult.

Thus, crops could not to reach indicated harvesting phase in experimental methodology (ear formation of sorghum–sudan grass hybrid). Therefore, yields data and weeding level not indicated for this year.

The data for obtained forage yields are shown in Table 1. It is obvious that in single harvesting in 2010, green and dry mass yields obtained from various periods of sowing progressively decreased from first to last period. Thus y varied from 1.39 t.ha⁻¹ (sowing during period August 1st to 10th) to 2.80 t.ha⁻¹ (sowing during period July 1st to 10th) and from 0.28 to 0.61 t.ha⁻¹, respectively.

Regarding productivity, optimal time for sowing was from 1st to 10th July (Standard).

The exceeding toward obtained yields from other later sowing times were in range from 5.36% (compared to var. 2) to 50.36% (compared to var. 4) for green mass and from 19.67% to 54.10% of dry matter, respectively.

In 2011, trend of yields reducing from first to last sowing period was remained.

Thus, yields ranged from 0.29 t.ha⁻¹ (sowing during period August 1st to 10th) to 1.61 t.ha⁻¹ (standard sowing period) for green mass and 0.06 t.ha⁻¹ to 0.39 t.ha⁻¹ for dry mass, respectively.

Most optimal time for sowing was again standard period (1st–10th July).

The exceeding of its productivity compared to other later sowing periods was in range of 11.18% (toward to var. 2) to 81.99% (toward to var. 4) for green mass and of 12.82% to 84.87% of dry mass, respectively.

Average for harvesting period (2010–2011) a most plant production was obtained at first sowing time (1st–10th July). Then climatic conditions (rainfall and heat) were more favorable for growth and development of sown crops in mixture.

Thus, obtained green and dry mass during this period reached the 2.20 and the 0.50 t ha⁻¹, which exceeded later periods of sowing from 7.27% (toward to var. 2) to 61.82% (toward to var. 4) and from 18.00 to 66.00%, respectively.

The performed the botanical analysis by years. It is shown that despite different sowing time of mixture, share of components (sorghum–sudan grass hybrid and horse bean) into it was more than weeds.

Thus, in 2010, sorghum–sudan grass hybrid ranged from 10.00% (var. 3) to 21.74% (var. 2), while beans in mixture in different sowing times varied by 67.39% (var. 2) to 85.00% (var. 3).

The highest weed infestation (10.87%), however, was registered in second period of sowing (July 11th to 20th), while in others sowing periods was relatively small and ranged from 3.85% (var. 4) to 5.00% (var. 3). In 2011, sorghum–sudan grass hybrid ranged.
from 8.41% (var. 1) to 21.21% (var. 4). The horse bean in mixture in different sowing times prevailed since 75.76% (var. 4) to 85.98% (var. 1). The highest weed infestation (5.61%) was registered in first period of sowing, while other tested earlier periods was a less and ranged from 3.03% (1st–10th August) to 4.55% (11th–20th July) (Fig. 1).

Conclusions
The most optimal time for sowing of annual summer mixture from sorghum–sudan grass hybrid and horse bean cultivated under foothill conditions of Central Balkan Mountains (Troyan region) was period from 1st to 10th of July.

The received forage amounted to 2.20 t.ha⁻¹ green mass and 0.50 t.ha⁻¹ dry matter, which exceeded later sowing periods from 7.55% (from 11th to 20th July) to 61.93% (from 1st to 10th August) and from 16.28 to 65.98%.

There was a least weed infestation of mixture at last sowing period (from 1st to 10th August) and reached 3.03–3.85 %.

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