FORAGE PRODUCTIVITY AND WEED INFESTATION OF ANNUAL EARLY–SPRING MIXTURE UNDER DIFFERENT SOWING DATES

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Abstract. During the 2011–2012 periods in the Research Institute of Mountain Stockbreeding and Agriculture (RIMSA) in Troyan (Bulgaria) the effect of sowing time on some bio–productive indicators (green mass and dry matter yields, weed infestation) of the forage from annual early–spring cereal–legume mixture from oats and field pea was performed. As variants the following periods of sowing were studied: 1. 10th–20th March (Standard); 2. 21st–30th March; 3. 1st–10th April; 4. 11th–20th April. It was established that the optimum time for sowing of annual early spring peas and spring oats mixed crop was the period from 10th to 20th March. Then was received most plant production (1.84 t.ha−1 green mass and 0.41 t.ha−1 dry matter), which exceeded the other sowing periods from 7.07% (21st–30th March) to 27.72% (11th–20th April) and from 1.6 to 8.13%, respectively. In the different sowing times the weed infestation of crops varied and was a highest in early spring sowing (10th–20th March)–from 8.40 to 9.26%.

Key words: early–spring crop, cereal and legume mixture, sowing time, forage productivity, weed infestation, foothill region, Central Balkan Mountains.

Introduction

The annual early–spring mixtures in Bulgaria are sown as secondary crops after harvesting of winter crops.

They are used for obtaining of green forage, silage, and hay meal.

For components cereals are used oats, barley and by legumes–pea, narrow–leaved vetch, grass pea vine and others [PUTNOKY et al., 2013; BAGIU et al., 2012; RATA et al., 2013].

The early–spring mixtures are very suitable for catch crops or fore crops.

The actuality for the use of annual summer monocultures and mixtures is related to observables present climatic changes in both regionally and globally aspect [BROUSHOTIS, 1989; BRADNARTH et al., 2001; BUTNARIU et al., 2003, 2006, 2012, BOSTAN et al., 2013].

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

Therefore in the recent years in some regions of Bulgaria were carried out studies to establish the conditions and factors for yield formation and forage quality indicators of some annual field crops [PAVLOV, 1996; GRAMATIKOV, BUTNARIU et al., 2008, 2012, 2013; GRAMATIKOV et al., 2002].

In the conditions of foothill areas of the Central Balkan Mountains so far is established only suitability of some annual spring cereal and legume monocultures and mixtures [LINGORSKI and KERTIKOV, 2005; LINGORSKI, 2011a; BUTNARIU, 2012, LINGORSKI, 2011b, BOSTAN et al., 2012].

The absence of research for most optimum sowing time under the foothill areas of the Central Balkan Mountains was a prerequisite for need to carry out them.

The objective of this study was to investigate the most optimal time for sowing of annual early–spring mixture of oats and field pea cultivated in soil–climatic conditions of foothill areas of Central Balkan Mountains (Troyan region).

Material and Methods

Annually the experiment was laid out during 3 years (2010, 2011 and 2012) in early spring in the experimental field of RIMSA, Troyan on light grey pseudopodzolic soil by the block method.
with 4 replications and size of harvest plot of 5 m².

On the experimental area was sown annual cereal and legume mixture of spring oats and spring field pea.

As variants the following periods of sowing during 10 days were studied:
1. 10th–20th March (Standard);
2. 21st–30th March;
3. 1st–10th April;
4. 11th–20th April.

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

The inter–row spacing was 12 cm and the sowing depth was 5–7 cm.

The sowing rates for the components of the mixture were as follows: for spring oats cv. Obraztsov chiflik 4–250 germinable seeds m⁻² and for spring field pea cv. Pleven 4–120 germinable seeds m⁻².

The weight ratio of cereal to legume component in the mixture was 1:3.

Due to unfavourable soil (low–productive with heavy loam structure) and heavy weather conditions during the winter (low air temperatures), the sowing rates were increased by 10%.

The experimental areas of separate variants (sowing times) were harvested at the beginning of pea flowering.

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

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

The weed infestation of the crop was determined by weight from average fresh samples for each replication and variant, recording separately the % participation of the 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 forage and dry matter yields average for the 2010–2012 period.

Results and Discussion

The harvesting of crops for different variants (sowing times) was done as follows:

– in 2010 for var. 1–on June 4, for var. 2–on June 16, for var. 3–on June 23, for var. 4–on June 25;
– in 2011 for var. 1–on June 22, for var. 2–on June 27, for var. 3–on June 30, for var. 4–on July 4;
– in 2012: for var. 1–on June 12, for var. 2–on June 16, for var. 3–on June 19, for var. 4–on June 21.

The data for obtained forage yields by years and average for the 2010–2012 periods are shown in Table 1.

It is seen that in 2010 the green and the dry weight (dry mass) yields obtained from the various periods of sowing constantly decreased from the first to the last period–from 2.65 t. ha⁻¹ (var. 1) to 1.69 t. ha⁻¹ (var. 4) and respectively from 0.42 t.ha⁻¹ to 0.31 t.ha⁻¹.

As regard to forage productivity, the optimal sowing time was from 10th to 20th March, and the yields excess from others later periods ranged from 11.32% (for var. 2) to 36.23% (for var. 4) in green mass and from 6.33 to 26.90% of the dry mass, respectively.

In 2011 the green and dry mass yields obtained from the various periods of sowing progressively decreased from the second to the last period and ranged from 2.00 t.ha⁻¹ (var. 2) to 1.77 t.ha⁻¹ (var. 4) and from 0.49 to 0.34 t.ha⁻¹, respectively.

As yields of fresh and dry mass, the optimal time for sowing during the same year was again from 10th to 20th March (Standard).
Its excess toward obtained yields from others earlier sowing times was in the range from 2.44% (compared to var. 2) to 13.66% (compared to var. 4) in green mass and from 9.26 to 37.04% of dry matter, respectively.

In 2012 the yields of green and dry mass of different sowing times also decreased from the first to the last period and ranged from 0.83 t.ha⁻¹ (var. 1–Standard) to 0.54 t.ha⁻¹ (var. 4) and from 0.28 to 0.15 t.ha⁻¹, respectively.

### 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>2010</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. 10ᵗʰ–20ᵗʰ March (St.)</td>
<td>2.65</td>
<td>100.00</td>
<td>0.42</td>
<td>100.00</td>
</tr>
<tr>
<td>2. 21ᵗˢ–30ᵗʰ March</td>
<td>2.35</td>
<td>88.68</td>
<td>0.39</td>
<td>92.86</td>
</tr>
<tr>
<td>3. 1ˢᵗ–10ᵗʰ April</td>
<td>2.11</td>
<td>79.62</td>
<td>0.32</td>
<td>76.19</td>
</tr>
<tr>
<td>4. 11ᵗʰ–20ᵗʰ April</td>
<td>1.69</td>
<td>67.37</td>
<td>0.31</td>
<td>73.81</td>
</tr>
<tr>
<td>2011</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. 10ᵗʰ–20ᵗʰ March (St.)</td>
<td>2.05</td>
<td>100.00</td>
<td>0.54</td>
<td>100.00</td>
</tr>
<tr>
<td>2. 21ᵗˢ–30ᵗʰ March</td>
<td>2.00</td>
<td>97.56</td>
<td>0.49</td>
<td>90.74</td>
</tr>
<tr>
<td>3. 1ˢᵗ–10ᵗʰ April</td>
<td>1.83</td>
<td>89.27</td>
<td>0.35</td>
<td>64.81</td>
</tr>
<tr>
<td>4. 11ᵗʰ–20ᵗʰ April</td>
<td>1.77</td>
<td>86.34</td>
<td>0.34</td>
<td>62.96</td>
</tr>
<tr>
<td>2012</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. 10ᵗʰ–20ᵗʰ March (St.)</td>
<td>0.83</td>
<td>100.00</td>
<td>0.28</td>
<td>100.00</td>
</tr>
<tr>
<td>2. 21ᵗˢ–30ᵗʰ March</td>
<td>0.77</td>
<td>92.77</td>
<td>0.24</td>
<td>85.71</td>
</tr>
<tr>
<td>3. 1ˢᵗ–10ᵗʰ April</td>
<td>0.77</td>
<td>92.77</td>
<td>0.23</td>
<td>82.14</td>
</tr>
<tr>
<td>4. 11ᵗʰ–20ᵗʰ April</td>
<td>0.54</td>
<td>65.06</td>
<td>0.15</td>
<td>53.57</td>
</tr>
<tr>
<td>Average for the experimental period</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. 10ᵗʰ–20ᵗʰ March (St.)</td>
<td>1.84</td>
<td>100.00</td>
<td>0.41</td>
<td>100.00</td>
</tr>
<tr>
<td>2. 21ᵗˢ–30ᵗʰ March</td>
<td>1.71</td>
<td>92.93</td>
<td>0.37</td>
<td>90.24</td>
</tr>
<tr>
<td>3. 1ˢᵗ–10ᵗʰ April</td>
<td>1.57</td>
<td>85.33</td>
<td>0.30</td>
<td>73.17</td>
</tr>
<tr>
<td>4. 11ᵗʰ–20ᵗʰ April</td>
<td>1.33</td>
<td>72.28</td>
<td>0.27</td>
<td>65.85</td>
</tr>
</tbody>
</table>

LSD₀.₀₅ (14.39%), LSD₀.₀₁ (21.79%), LSD₀.₀₀₁ (35.01%) LSD₀.₀₅ (19.81%), LSD₀.₀¹ (30.00%), LSD₀.₀₀₁ (48.20%)

Regarding the forage productivity, the optimal time for sowing this year was from 1₀ᵗʰ to 2₀ᵗʰ March.

According to the obtained yields in the other later sowing periods the excess was in the range of 7.23% (compared to var. 2 and var. 3) and 34.94% (compared to var. 4) in green mass and from 14.29 to 46.43% of dry mass, respectively.

Average for experimental period (2010–2012) the greatest forage yields were reported in the standard period of sowing (1₀ᵗʰ–20ᵗʰ March).

Then were obtained 1.84 t.ha⁻¹ green mass and 0.41 t.ha⁻¹ dry matter, and exceeded other periods from 7.07% (2₁ˢᵗ–30ᵗʰ March) to 27.72% (1₁ᵗʰ–20ᵗʰ April) and from 9.76 to 34.15%, respectively.

The analysis of weed infestation of early spring mixed crop reported in **Fig. 1** shows that in three years, regardless of the sowing time is relatively weak and percentage shares of the components (spring field pea and oats) is more than the weeds.

Thus, in 2010, the oats share ranged from 16.00% (var. 3) to 32.87% (var. 1).

The spring peas in the mixture in different sowing times reached from 57.87% (var. 1) to 83.20% (var. 3).

The highest weed infestation (9.26%), however, was registered in the
first period of sowing (10\textsuperscript{th}–20\textsuperscript{th} March), while the other tested later periods decreased and ranged from 0.80\% (var.3) to 2.10\% (var.4).

In 2011, the oats ranged from 11.32\% (var. 2) to 27.35\% (var. 1).

The spring peas in the mixture in different sowing periods reached from 64.10\% (var. 1) to 84.91\% (var. 2), and the participation of the two components of the mixture during other periods of sowing occupied an intermediate position.

**Figure 1.** Weed infestation (in \%) of annual early–spring mixed crop by years

The highest weed infestation (8.55 \%) was again registered in the first period of sowing, while in the other tested later periods decreased and ranged barely from 2.18 \% (var. 4) to 4.25 \% (var. 3).

In 2012, the oats share varied from 17.60\% (var. 2) to 38.80\% (var. 3).

In the different sowing times the spring peas reached from 59.20\% (var. 3) to 77.90\% (var.2).

In other periods the percentage share of this component occupied an intermediate position.

The highest weed infestation (8.40\%) was again registered in the first period of sowing, while in the other tested later periods decreased and varied from 2.00\% (var. 3) to 5.10\% (var. 4).

**Conclusion**

In the soil and climatic conditions of Central Balkan Mountains (Troyan region) the optimum time for sowing of annual early–spring pea and oats mixed crop was the period from 10\textsuperscript{th} to 20\textsuperscript{th} March.

Then was received most plant production (1.84 t.\,ha\textsuperscript{-1} green mass and 0.41 t.\,ha\textsuperscript{-1} dry matter), which exceeded the other sowing periods from 7.07 \% (21\textsuperscript{st}–30\textsuperscript{th} March) to 27.72\% (11\textsuperscript{th}–20\textsuperscript{th} April) and from 1.6 to 8.13 \%, respectively.

In the different sowing times the weed infestation of crops varied and was a highest in early spring sowing (10\textsuperscript{th}–20\textsuperscript{th} March)–from 8.40 to 9.26 \%.

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