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STUDY OF FORAGE YIELDS AND BOTANICAL CHANGES OF SOME DROUGHT TOLERANT PERENNIAL GRASSES BY FOOTHILL REGIONS OF CENTRAL BALKAN MOUNTAINS

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Abstract: During the 2010-2012 period in RIMSA, Troyan (Bulgaria) the comparative testing of two drought tolerant perennial grasses (switchgrass, indiangrass) with traditional grasses (orchard grass, smooth bromegrass, perennial ryegrass, tall fescue) was performed. It was found that the best adaptability had the switchgrass. In the double regime of harvesting it was obtained 1.96 t ha^{-1} green mass and 0.70 t ha^{-1} dry matter, which exceeded the standard (orchard grass) by 28.95% and 52.17%, respectively. All tested perennial grasses predominated over the weed plants and weed infestation increased from I to II haymaking.

Key words: perennial grasses, drought tolerance, forage productivity**,** botanical composition**,** Central Balkan Mountains.

Introduction

In the last 10-20 years has increasingly seen the adverse effects of global warming on plant species. This suggests the timely establishment of herbage fodder species suitable for growing under dry conditions *(Wilkins and Vidrich, 2000)*.

The testing of different meadow species (grasses and legumes) is very important for the animal feeding in the dry summer period of the year – from June to August *(Walton, 1983; Frame, 1986; Posler et al., 1993; Lodge, 1994; Gordon and Newmann, 1997; Frame et al., 1998; Paul et al., 2002)*.

In a changing of climate some researchers focus to examination of perennial grasses such as ensuring the receipt of sustainable and environmentally-friendly forage production. Switchgrass (*Panicum virgatum* L.) is a native perennial warm season grass spread to all of the United States except California and the Pacific Northwest. The species is widespread also in Canada and Mexico. Switchgrass has great growth adaptability. It can grow in different weather conditions and soil types. Switchgrass has different application – as livestock

forage (for pasture and hay production), for erosion control and as biofuel source. That perennial grass has also an ornamental importance *(USDA NRCS, 1991; Vogel et al., 2002; Barnes et al., 2003; USDA NRCS, 2007; USDA NRCS, 2009)*.

Indiangrass (*Sorghastrum nutans* L. Nash) is a native, warm-season grass of good value as a livestock forage grass. Production runs high when managed in a pure stand. Indiangrass may form patches of sod and occur in bunches; it endures a wide range of weather extremes and is easily established from seed. Suited to all soil types except those saturated for an extended period, Indiangrass is considered to be an excellent native grass in the USA for most purposes. In the United States the indiangrass cultivates singly, or in mixtures with other perennial grasses, provide livestock forage on rangeland, pastureland, and hayland. Its forage quality is high when green and fair when matures *(USDA NRCS, 1991; Barnes et al., 2003; Owsley, 2011)*.

The object of this study was to compare the forage production of two introduced drought tolerant grasses (switchgrass and indiangrass from the USA) with native traditional perennial grasses (orchard grass, smooth bromegrass, perennial ryegrass, and tall fescue) by soil-climatic conditions of Troyan foothill region (Central Balkan Mountains).

Materials and Methods

The experiment was carried out on an area situated at 385 m above sea level in the experimental field of RIMSA, Troyan (Central Northern Bulgaria) during the 2010-2012 period. The soil-type of trial area was light-gray forest (pseudopodzolic).

The soil-cultivating process included the following: ploughing (in autumn of 2009), disk harrowing and cutting (in spring of 2010). The trial area was pressed by roll pressors once after the sowing (at the end of April).

The experiment was accomplished in four repetition. The different perennial grasses were sowed broadcast by hand. All tested grasses had 5 m^2 harvested plot. The following perennial grasses as variants were investigated: 1. Orchard grass (Standard), 2. Smooth bromegrass, 3. Tall fescue, 4. Perennial ryegrass, 5. Switchgrass, 6. Indiangrass.

The sowing rates of different grass species were as follows: orchard grass cv. Dabrava – 22 kg ha^{-1}, smooth bromegrass cv. Nika – 35 kg ha^{-1}, tall fescue cv. Albena – 8 kg ha^{-1}, perennial ryegrass cv. Sredets – 25 kg ha^{-1}, switchgrass cv. Shawnee – 10 kg ha^{-1} and indiangrass cv. Oto – 13 kg ha^{-1}. Due to unsuitable soil-climatic conditions of the region the sowing rates were increased with 15%.

During two years of investigation plots were cut in phase of beginning of flowering in the first cut. The next regrowth (II cut) in 2011 was harvested when

the grasses reached a height of 20-25 cm. Due to adverse weather conditions in 2012 only one cutting was conducted.

The characteristics of green mass productivity and dry matter production (t ha^{-1}) and weed infestation of the grass stand (%) were recorded annually. The dry matter was obtained with subsequent drying of average samples of green mass at 105^0C to constant weight and on the basis of % dry matter in them it was recalculated per 1 ha. The weed infestation of the grass stands were determined by weight from average fresh samples for each replication and variant, recording separately the % participation of the sown perennial grasses and the weeds (as a total).

The herbage yield data of green and dry mass productivity was performed using analysis of variance. It were used $LSD_{0.05}$ (least significant differences at $P<0.05$), $LSD_{0.01}$ (least significant differences at $P<0.01$) and $LSD_{0.001}$ (least significant differences at $P<0.001$) regard to green mass and dry matter yields average for the 2011-2012 period.

Results and Discussion

In the year of sowing (2010) it was found significant weed infestation of the experimental area with annual (bristle-grass) and perennial weed species (mostly horse mint). Therefore there have been two cuts (on July 9 and September 5) without determination of green and dry mass yields.

During the 2011 were accomplished two cuttings of all tested grasses (at June 9 and the July 28). The data in the Table 1 shows that in I cut in 2011 a maximum green mass (1.77 t ha^{-1}) was obtained from switchgrass and it exceeded the standard (orchard grass) with 21.23%, while the other tested grasses were a less productive and exceeded it from 1.37% (smooth bromegrass) to 10.96% (tall fescue). In the II cut switchgrass achieved highest yields of green mass (0.66 t ha^{-1}) which exceeded other tested grasses from 19.14% (switchgrass) to 74.46% (perennial ryegrass), and the standard grass species (orchard grass) with 40.42%. However, total for the year a maximum yield was obtained again by switchgrass, which exceeded the standard grass with 25.91%, while the other tested grasses were more low-productive.

With regard to the obtained dry mass (Table 2) in I and the II cut the highest yields were reported in switchgrass – 0.54 and the 0.24 t ha^{-1}, which were more than the orchard grass (standard) with 28.57 and 50.00%, respectively. In I cut the other studied grasses were also more high-productive than the standard - from 11.90% for tall fescue and indiangrass to 26.19% for smooth bromegrass.

In the II cut with the exception of perennial ryegrass (25.00% less) the other grasses were more productive than the standard species. The highest annual yield of dry matter was reported by switchgrass - 0.78 t ha^{-1}, which over-yielded of standard with 34.48%.

Table 1. Green mass yields (in t ha^{-1} and in %) of perennial grasses by years and average for the 2011-2012 period

Variant (Perennial grass)	Ist cut		IInd cut		Total	
	t ha^{-1}	%	t ha^{-1}	%	t ha^{-1}	%
2011						
1. Orchard grass (Standard)	1.46	100.00	0.47	100.00	1.93	100.00
2. Smooth bromegrass	1.48	101.37	0.51	108.51	1.99	103.11
3. Tall fescue	1.62	110.96	0.52	110.64	2.14	110.88
4. English ryegrass	1.52	104.11	0.31	65.96	1.83	94.82
5. Switchgrass	1.77	121.23	0.66	140.42	2.43	125.91
6. Indiangrass	1.46	100.00	0.57	121.28	2.03	105.18
2012						
1. Orchard grass (Standard)	1.12	100.00	-	-	1.12	100.00
2. Smooth bromegrass	1.13	100.89	-	-	1.12	100.89
3. Tall fescue	1.47	131.25	-	-	1.47	131.25
4. English ryegrass	1.11	99.11	-	-	1.11	99.11
5. Switchgrass	1.50	133.93	-	-	1.50	133.93
6. Indiangrass	1.38	123.21	-	-	1.38	123.21
Average for the 2011-2012 period						
1. Orchard grass (Standard)	1.29	100.00	0.47	100.00	1.52	100.00
2. Smooth bromegrass	1.30	100.77	0.51	108.51	1.55	101.97
3. Tall fescue	1.54	119.38	0.52	110.64	1.80	118.42
4. English ryegrass	1.31	101.55	0.31	65.96	1.47	96.71
5. Switchgrass	1.63	126.36	0.66	140.42	1.96	128.95
6. Indiangrass	1.42	110.08	0.57	121.28	1.70	111.84

$LSD_{0.05}$ (34.75%); $LSD_{0.01}$ (48.13%); $LSD_{0.001}$ (66.40%)

In 2012 were carried out only one cut of all tested grasses - at June 6 (of var. 1, 2, 3 and 4) and at August 1 (of var. 5 and 6). In this year highest green mass yield was obtained for switchgrass (1.50 t ha^{-1}), which exceeded the standard by 33.93%, followed by tall fescue - over of 31.25%. Indian grass and smooth bromegrass had more yields with 23.21% and 0.89%, respectively. Only the perennial ryegrass had lower yield than the standard species – with 0.89%.

In accordance with the obtained fresh mass the highest dry matter yield by regrowths (Table 2) was obtained in switchgrass. Thus, in the only cut it amounted to 0.62 t ha^{-1} (in 77.14% mote than orchard grass). The other tested grasses exceeded the standard from 14.28% (perennial ryegrass) to 62.86% (indiangrass). Maximum average two-years (2011-2012) plant production in double regime of cutting was obtained for switchgrass. Thus, the obtained green mass per year reached 1.96 t ha^{-1} and dry matter 0.70 t ha^{-1}, which exceeds the standard (orchard grass) by 28.95% and 52.17%, respectively. The other tested grasses occupied an intermediate position regard to this indicator. The productivity of grasses decreased from I to II cut.

Table 2. Dry matter yields (in t ha^{-1} and in %) of perennial grasses by years and average for the 2011-2012 period

Variant (Perennial grass)	Ist cut t ha^{-1}	Ist cut %	IInd cut t ha^{-1}	IInd cut %$^{-1}$	Total t ha^{-1}	Total %
2011						
1. Orchard grass (Standard)	0.42	100.00	0.16	100.00	0.58	100.00
2. Smooth bromegrass	0.53	126.19	0.18	112.50	0.71	122.41
3. Tall fescue	0.47	111.90	0.19	118.75	0.66	113.79
4. English ryegrass	0.52	123.81	0.12	75.00	0.64	110.34
5. Switchgrass	0.54	128.57	0.24	150.00	0.78	134.48
6. Indiangrass	0.47	111.90	0.21	131.25	0.68	117.24
2012						
1. Orchard grass (Standard)	0.35	100.00	-	-	0.35	100.00
2. Smooth bromegrass	0.44	125.71	-	-	0.44	125.71
3. Tall fescue	0.48	137.14	-	-	0.48	137.14
4. English ryegrass	0.40	114.28	-	-	0.40	114.28
5. Switchgrass	0.62	177.14	-	-	0.62	177.14
6. Indiangrass	0.57	162.86	-	-	0.57	162.86
Average for the 2011-2012 period						
1. Orchard grass (Standard)	0.38	100.00	0.16	100.00	0.46	100.00
2. Smooth bromegrass	0.48	126.31	0.18	112.50	0.57	123.91
3. Tall fescue	0.47	123.68	0.19	118.75	0.57	123.91
4. English ryegrass	0.46	121.05	0.12	75.00	0.52	113.04
5. Switchgrass	0.58	152.63	0.24	150.00	0.70	152.17
6. Indiangrass	0.52	136.84	0.21	131.25	0.62	134.78

$LSD_{0.05}$ (41.40%); $LSD_{0.01}$ (57.33%); $LSD_{0.001}$ (79.10%)

In a double harvesting of two introduced drought tolerant warm season grasses (switchgrass and indiangrass) the distribution of obtained green mass by cuts was as follows: 83.16% and 83.53% for the I cut and respectively 16.84% and 16.47% for the II regrowth. The distribution of dry matter by different cuts (I and II) was 82.86% (for switchgrass), 83.87% (for indiangrass) and 17.14%, 16.13% of the annual production, respectively.

The weed infestation of grass stands of the studied perennial grasses by cuttings and by years is shown in Figure 1 and Figure 2. It is seen that in all double cuttings in 2011 (Figure 1) the sown grasses predominated over the weed plants. Thus, in I cut presence of grass plants varied from 72.22% (indiangrass) to 86.27% (perennial ryegrass) and in II cut – from 51.43% (smooth bromegrass) to 78.00% (tall fescue).

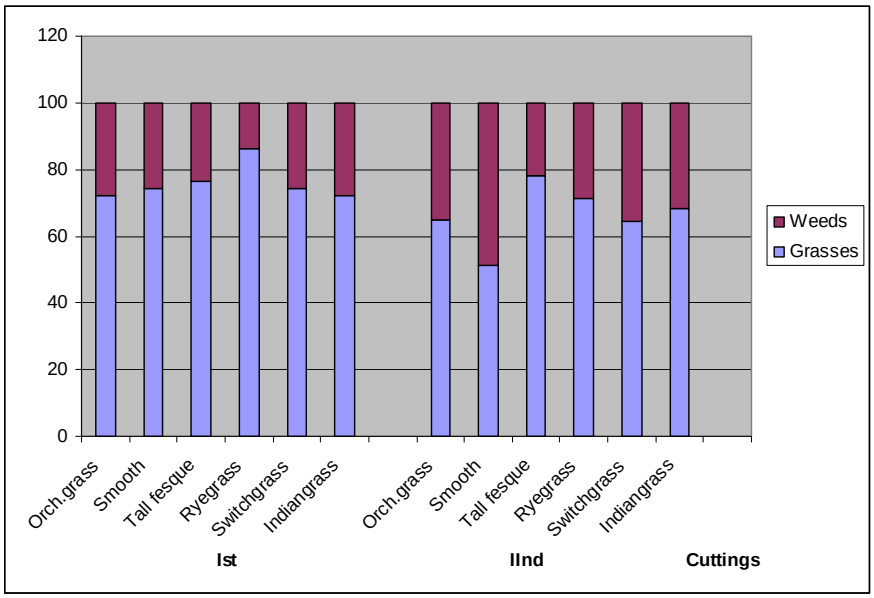

Figure 1. Weed infestation (in %) of perennial grasses by cuttings in 2011

And in 2012 (Figure 2), the all tested grasses prevailed again over the weeds, reaching 90.90, 84.60 and 73.87%. In both years and in the same grasses the weed infestation increased from I to II cut.

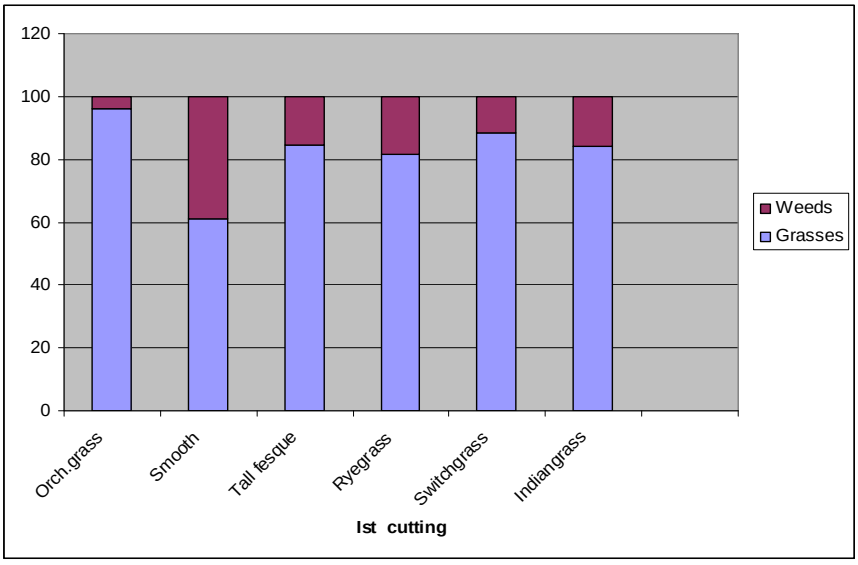

Figure 2. Weed infestation (in %) of perennial grasses in 2012

Conclusion

In the foothill conditions of Central Northern Bulgaria (region of Troyan) best bio-productive and botanical parameters shows the switchgrass. In the double cut regime it was received 1.96 t ha^{-1} of green mass and 0.70 t ha^{-1} of dry matter, which exceeded the standard (orchard grass) by 28.95% and 52.17%, respectively. All tested perennial grasses predominated over weeds but weed infestation increased from I to II cut.

Ispitivanje prinosa krme i botaničkih promena nekih višegodišnjih trava tolerantnih na sušu u regionu podnožja Centralnih Balkanskih planina

V. Lingorski

Rezime

U periodu 2010-2012, u institutu RIMSA u Trojanu (Bugarska), uporedno su ispitivane dve višegodišnje trave (divlji sirak, indijanska trava) tolerantne na sušu sa tradicionalnim travama (ježevica, bezosni vlasen, engleski ljulj, visoki vijuk).

Utvrđeno je da je najbolju prilagodljivost imao divlji sirak. U dvostrukom režimu žetve dobijeno je 1,96 t ha^{-1} zelene mase i 0,70 t ha^{-1} suve materije, koji je premašio standard (ježevica) od 28,95% i 52,17%.

Sve testirane višegodišnje trave dominiraju nad korovskim biljkama, a pojava korova povećana je od I do II košenja.

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