

Productivity and quality of fodder sorghum hybrids S. Sioux and Grazer N grown on family farms

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Summary

The objective of this study was to evaluate the yield and fodder quality of interpolated fodder sorghum as a second (additional) crop. The research was carried out on 4 family farms in lowland of northern Croatia between the Sava and Drava rivers. The area is densely populated, but the agricultural land is fragmented, unsuitably managed and utilized, and consists of different soil types.

During the three-year trial carried out in different locations and conditions, the average green matter (GM) yield was 85.4 t ha^{-1} (73.0 – 93.3), while the dry matter (DM) yield was 14.11 t ha^{-1} (12.93-15.17).

The mean crude fiber (CF) on DM concentration basis was 29.8 % (57.4 NDF, 28.8 % ADF and 13.8 % ADL), crude protein (CP) constituted 11.28 %, digestible crude protein (DCP) stood at 7.75 % and 6.38 MJ NEL. On average there were 1093 kg ha^{-1} DCP and 90.00 GJ NEL.

Keywords: fodder sorghum, interpolation, green matter yield, dry matter yield, forage quality, digestible crude protein, netto energy of lactation

Introduction

The lowland Northern Croatia is densely populated, but the agricultural land is fragmented into small plots, unsuitably managed and utilized. Consequently, in the area the livestock is traditionally housed and stall-fed throughout the year. Fodder (green forage, hay) is mostly produced from grasses and clovers, infrequently from grass-clover mixtures and seldom from interpolated winter and second crops grown on arable land.

Interpolated winter and second (additional) crops are generally well incorporated in the sequence of high quality and high yielded forage production and utilization, as well as fodder sorghum hybrids. They could be sown after winter, early or late spring crops. They are utilized in late summer depending on the sowing term and rainfalls, when there is a shortage of green forage on clover fields and grasslands due to usual drought and high

temperatures. They are harvested in several cuts, fed directly from field until the autumn frost (Šoštarić-Pisačić, 1956; Martin and Leonard, 1967; Čížek, 1970; Šoštarić-Pisačić et al. 1972; Đorđević et al. 1972; Štafa 1988; Štafa et al. 1993, 1994, 1997, 1999, Korošec 1998), while surpluses are ensiled. These results are in a higher production of high quality forage per ha throughout vegetation.

The paper considers yield, quality and harvest term of hybrids S. Sioux and Grazer N grown as second crops (after winter cereal and pea mixtures) over the same area throughout vegetation.

Materials and methods

Characteristics and fertility potentials of fodder sorghum hybrids (S. Sioux in 1999 and 2000; Grazer N in 2001) were determined on four family farms (Gal-Kapela Podravska, Ludbreg, Mlinar - Veliki Bukovec, Mužinić - Križevčec, D. Zelina, Uher - Grabovac, Virovitica).

Fodder sorghum was sown in a sequence of fodder cropping as additional crop, after having harvested the green fodder of winter pea (cv. Maksimir winter) and cereals (tritikale-cv. Clercal, wheat-cv. Sana and Žitarka).

Soils of different types and fertility (alluvial semigley - Gal and Mlinar, eutric cambisol brown eutrich-Uher, Pseudogleys of sloping terrains (Bogunović et al. 1996) were examined in the area of a rather humid continental climate with large temperature oscillations (the annual average temperature is from 9.9 in Križevci to 11.3 °C in Virovitica and Zagreb) and precipitation throughout the vegetation (from 470.9 mm in Virovitica to 504.1 mm in Koprivnica).

After the winter mixtures had been harvested, the soil was ploughed up to the depth of 15 cm and fertilized with NPK 8:26:26 at the rate of 400 kg ha⁻¹. After having been sown at the seed rate of 21 kg ha⁻¹ using a cereal drill with 50 cm interlinear row distance, the area was treated with Radazin WP-50 at 2.0 kg ha⁻¹. After each harvest, the crop was top dressed with CAN (calcium ammonium nitrate 27% N, 30 kg ha⁻¹ of pure N) at the rate of 110 kg ha⁻¹.

The green fodder yield was determined on the basis of two (Uher, Mužinić) or three harvesting terms (Gal, Mlinar) at 150-200 cm sward height by sampling 10 m² in four repetitions.

The DM was determined by drying 1.0 kg of green fodder at 105°C. The chemical composition was determined according to the A.O.A.C. method

(1984) and yields were recalculated to the 1 ha area. The daily milk production and milk quality was also recorded.

Results

The variations in the GM yield of fodder sorghum S. Sioux (1999 and 2000) and Grazer N (2001) depended on the location, the soil fertility and the agrotechnology applied (the sowing term of May-June, number of harvests: two or three yearly).

The highest mean GM yield (table 1) achieved on the Gal and Mlinar family farms (90.0 and 93.3 t ha⁻¹ respectively) was significantly higher (P<0.01) compared to Mužinić (73.0 t ha⁻¹). The green fodder yield achieved on the Uher family farm (85.3 t ha⁻¹) was also significantly higher (P<0.05) compared to Mužinić.

Table 1: Green fodder yield of fodder sorghum hybrids (additional crop) on family farms.

Tablica 1: Urodi zelene mase hibrida krmnog sirka (naknadni usjev) na obiteljskim gospodarstvima

| Family farm Obiteljsko gospodarstvo | Total green fodder yield (t ha ⁻¹) Ukupni prinosi zelene mase sirka u t/ha | | | |
|--|---|--------|--------|--------|
| | Year - Godina | | | |
| | 1999 | 2000 | 2001 | X |
| 1. Mužinić-D.Zelina | 80.0* | 60.0** | 79.0** | 73.0** |
| 2. Mlinar-M.Bukovec | 70.0** | 100.0 | 110.0 | 93.3 |
| 3. Uher-Virovitica | 93.0 | 83.0** | 80.0** | 85.3* |
| 4. Gal-Ludbreg | 100.0 | 80.0** | 90.0** | 90.0 |
| X | 85.8 | 80.8 | 89.7 | 85.4 |
| LSD 0.05 | 9.60 | 11.97 | 7.53 | 6.78 |
| LSD 0.01 | 13.79 | 17.20 | 10.78 | 9.50 |

In the period under review, the average GM yield (85.4 t ha⁻¹) varied from 80.8 t ha⁻¹ to 89.7 t ha⁻¹.

The mean DM yield (table 2) of 14.11 t ha⁻¹ varied from 12.93 (Mužinić) to 15.17 t ha⁻¹ (Mlinar).

The highest mean DM yield achieved on the Mlinar family farm (15.17 t ha⁻¹) was significantly higher compared to Uher (P<0.05) and Mužinić (P<0.01). The mean DM yield achieved on the Uher and Gal family farms was significantly higher (P<0.05 and P<0.01 respectively) compared to Mužinić.

Table 2: Dry matter yield of fodder sorghum hybrids S. Sioux and Grazer N (additional crop) on family farms.

Tablica 2: Prinosi suhe tvari hibrida krmnog sirka S. Sioux i Grazer N (naknadni usjev) na obiteljskim gospodarstvima.

| Family farm / Obiteljsko gospodarstvo | Total dry matter yield (t ha ⁻¹) Ukupni prinosi suhe tvari sirka u t/ha | | | |
|--|--|-------|-------|-------|
| | Year - Godina | | | |
| | 1999 | 2000 | 2001 | X |
| 1. Mužinić-D.Zelina | 14.4 | 10.2 | 14.2 | 12.93 |
| 2. Mlinar-M.Bukovec | 11.9 | 16.0 | 17.6 | 15.17 |
| 3. Uher-Virovitica | 14.9 | 13.3 | 13.6 | 13.93 |
| 4. Gal-Ludbreg | 16.0 | 12.8 | 14.4 | 14.40 |
| X | 14.30 | 13.08 | 14.95 | 14.11 |
| LSD 0.05 | 1.31 | 1.39 | 2.16 | 0.97 |
| LSD 0.01 | 1.88 | 2.00 | NS | 1.32 |

The chemical composition (table 5) DM based was: 10.0 % ash, 1.9 % fat (oil), 29.8 % fiber and 47,02 % NET. The energy value converted into starch value was 55.45 %, while in kg DM 6,38 MJ NEL. The high green fodder yield and quality at 150-200 cm of sward height resulted in a high digestible protein yield per hectar of area.

Table 3: Digestible crude protein yield of fodder sorghum hybrids sown as additional crop on family farms.

Tablica 3: Prinosi PSB krmnog sirka sijanog kao naknadni usjev na obiteljskim gospodarstvima.

| Family farm / Obiteljsko gospodarstvo | Total digestible crude protein yield (kg ha ⁻¹) Ukupni prinosi PSB sirka u kg/ha | | | |
|--|---|------|------|------|
| | Year - Godina | | | |
| | 1999 | 2000 | 2001 | X |
| 1. Mužinić-D.Zelina | 1010 | 850 | 968 | 942 |
| 2. Mlinar-M.Bukovec | 1025 | 1121 | 1350 | 1165 |
| 3. Uher-Virovitica | 1322 | 1070 | 924 | 1105 |
| 4. Gal-Ludbreg | 1200 | 1050 | 1234 | 1161 |
| X | 1139 | 1023 | 1119 | 1093 |
| LSD 0.05 | | | | NS |
| LSD 0.01 | | | | NS |

The mean DCP yield (table 3) of 1093 kg ha⁻¹, achieved over the three years of examination, varied from the lowest of 942 kg ha⁻¹ (Mužinić) to the highest of 1165 kg ha⁻¹ (Mlinar), but the differences among the farms were not

significant. Comparing the analysed years, the mean DCP yield varied from 1023 kg ha⁻¹ (in 2000) to 1139 kg ha⁻¹ (1999), but the differences were not significant.

The average NEL value (table 4) of 90.0 GJ NEL varied from the lowest of 80.0 GJ NEL (Mužinić), compared to the significantly higher value on the rest of the farms, to the highest value achieved on the Mlinar family farm (98.0 GJ NEL).

Table 4: Yield of fodder sorghum (GJ NEL) sown as additional crop on family farms.

Tablica 4: Prinosi krmnog sirka (GJ NEL) sijanog kao naknadni usjev na obiteljskim gospodarstvima.

| Family farm / Obiteljsko gospodarstvo | Total yield of GJ NEL ha ⁻¹ Ukupni prinosi GJ NEL ha ⁻¹ | | | |
|--|--|-------|-------|-------|
| | Year - Godina | | | |
| | 1999 | 2000 | 2001 | X |
| 1. Mužinić-D.Zelina | 87.8 | 65.9 | 86.2 | 80.0 |
| 2. Mlinar-M.Bukovec | 76.9 | 103.4 | 113.7 | 98.0 |
| 3. Uher-Virovitica | 96.3 | 85.9 | 84.7 | 89.0 |
| 4. Gal-Ludbreg | 103.4 | 82.7 | 93.0 | 93.0 |
| X | 91.1 | 84.5 | 94.4 | 90.0 |
| LSD 0.05 | | | | 7.59 |
| LSD 0.01 | | | | 11.02 |

Table 5: Chemical composition of fodder sorghum hybrids (%).

Tablica 5: Kemijski sastav hibrida krmnoga sirka (%).

| | % in dry matter % u suhoj tvari | % in green matter % u zelenoj masi |
|---------------------------------|------------------------------------|---------------------------------------|
| Dry matter / Suha tvar | - | 16.52 |
| Crude protein / Sirovi proteini | 11.28 | 1.87 |
| DCP | 7.75 | 1.28 |
| Crude fiber / Sirova vlakna | 29.8 | 4.92 |
| Crude fat / Sirove masnoće | 1.9 | 0.31 |
| Ash / Pepeo | 10.0 | 1.65 |
| NET | 47.02 | 7.77 |
| MJ NEL | 6.38 | 1.054 |

Discussion

Intensive livestock, especially dairy production, characterizes the central Croatia.

Due to a lack of arable land in densely populated areas, feed for livestock is produced in all the available areas, often after harvesting the first crop by interpolation of fodder crops based on the principle of two cuts per year.

Small plots, specific soil quality and climate conditions (usual summer droughts) limit the number of crops suitable for interpolation in the area.

Following a harvest of winter cereal and pea mixtures, the plots were sown with fodder sorghum hybrids S. Sioux and Grazer N. They are characterised by deep rooting, waxen cover and a low transpiration coefficient. As a result, the high quality forage was utilized in good sequence directly from the field, from mid summer and the beginning of autumn to the frost, that is in line with the results of Štafa et al. (1993, 1997, 1999). Under the less suitable conditions for growth and development (the 2000 summer drought), the hybrids achieved high GM and DM yields and met the demands of dairy farmers.

Yields and terms of utilization are depended on the agrotechnology applied, especially on the sowing terms and nitrogen fertilization. Thus, in a drought period at the beginning of July (Mlinar, 1999 and Mužinić, 2000) the sowing resulted in two high yielding harvests, while on two family farms (Mlinar and Gal) it was utilized in three harvests at the height of 150-200 cm.

At this vegetation point the sorghum is leafy and grows intensively, but the DM yield is low (16.52 % on average), as confirmed in the present paper.

At this stage of growth, the sorghum composition GM based was on average: 1.43 % CP, 4.92 % CF (out of them 2.61 NDF, 1.7 ADF and 0.37 ADL) and 7.77 % NET, that affected milk production on all the farms involved.

Conclusions

Overall, the research evidence presented in this paper suggests that

- Fodder sorghum hybrids S. Sioux and Grazer N are very well incorporated in the sequence of high quality fodder production if sown as additional crops after winter cereal and pea mixtures during May and June (Mlinar, 1999 and Mužinić, 2000), even if sown in the beginning of July due to prolonged utilization of winter mixtures.

- The utilization of both hybrids sown in May started in the second half of July. In the three harvests at 150-200 cm sward height, the average GM yield was 90.0 t/ ha⁻¹ (Gal) or 93.3 t ha⁻¹ (Mlinar), or 14.4 and 15.17 t ha⁻¹ DM yield respectively.
- At the vegetation phase of growing (150 to 200 cm) the mean DM content for both hybrids was 16.52 %. The GM based CF concentration was 4.92 on average, while the DM based was 29.8 %, out of which 57.4 % NDF, 28.8% ADF and 13.8 % LDF. The GM based CP concentration was 1.87 % or 1.28% DCP, while the DM based was 11.28 % and 7.75 % respectively. On average, 1093 kg of DCP were achieved per ha.
- The GM based NET concentration was 7.5 %, while the DM based was 47.0%
- Per 1kg of GM and DM, 1.05 and 6.38 MJ NEL respectively was determined.
- The NEL value achieved per 1 ha area was 90.0 GJ in average and varied from 80.0 (Mužinić) to 98.0 (Mlinar).

PRODUKTIVNOST I KAKVOĆA HIBRIDA KRMNOG SIRKA S. SIOUX I GRAZER N NA OBITELJSKIM GOSPODARSTVIMA

Sažetak

U nizinskom području sjeverne Hrvatske između rijeka Save i Drave koja su gusto naseljena na usitnjenim i nedovoljno uređenim površinama, različitih tipova tala, malih obiteljskih gospodarstava provedena su istraživanja interpolacije krmnog sirka kao druge kulture (naknadna kultura). Utvrđivani su prinosi i kakvoća proizvedene krme. U trogodišnjem prosjeku na četiri gospodarstva na različitim lokacijama i uvjetima postignuto je u prosjeku 85,4 (73,0 do 93,3) t/ha zelene mase, odnosno 14,11 (12,93-15,17) t/ha suhe tvari. U prosjeku u suhoj tvari (ST) je utvrđeno 29,8 % surovih vlakana (57,4 NDF, 28,8 % ADF i 13,8 % LDF), 11,28 % surovih, odnosno 7,75 % probavljivih surovih bjelančevina (PSB) i 6,38 MJ NEL u kg ST. U prosjeku je postignuto 1093 kg/ha PSB, odnosno 90,00 GJ NEL.

Ključne riječi: krmni sirak, interpolacija, prinos zelene mase, prinos suhe tvari, kakvoća krme, probavljivi surovi proteini, netto energija u laktaciji

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