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DYNAMICS OF SOME CHEMICAL AND PRODUCTIVE INDICATORS OF ANNUAL SPRING CEREALS UNDER THE CONDITIONS OF CENTRAL BALKAN MOUNTAINS IN BULGARIA

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Abstract. The comparative evaluation of annual spring forage cereals under the conditions of Central Balkan Mountains in Bulgaria (Troyan region) proved that over the period from 2002 to 2004, the highest dry matter yield was harvested from sudan–grass, followed by sorghum–sudan–grass hybrid and millet. All of them exceeded the standard crop (maize) by 37.71%, 29.29% and 21.04%, accordingly. The highest value **(**11.39%**)** of crude protein content was observed for oats and of crude fat content–for millet. Maximum values of crude ash, calcium and phosphorus in dry mass had the oats. The highest crude protein yield (0.74 t/ha) was obtained from millet, and it was 12.12% higher than maize (standard crop).

Key words**:** annual spring cereals, dry mass yields, forage chemical composition, crude protein yields, Central Balkan Mountains, Bulgaria.

Introduction

The unfavorable climate changes both on regional, and on global scale, in recent years has brought about the factor aridity of natural conditions. In this connection, in numerous regions of Bulgaria a good deal of research has been done with the objective of determining the conditions and factors that form forage crops yields [MIHOV *et al.*, 1996; GRAMATIKOV, 2002]. The studies on annual forage cereals are of particular interest in this context [GRAMATIKOV *et al.*, 2002; KOLEV *et al.*, 2004], and also the profound analyses on assessment of their productivity, feeding value and quality parameters [PAVLOV, 1996].

So far, similar developments made for the foothill regions in Bulgaria are either insufficient or scarce, while for the specific conditions of the Central Balkan Mountains (Troyan region) none have been made.

The aim of the conducted experiment was to determine the dynamics of some chemical and bioproductive indicators of annual spring cereals under the conditions of Central Balkan Mountains in Bulgaria (Troyan region).

Material and Methods

The experiment was sown every year in the experimental field of RIMSA, Troyan, during the 2002–2004 periods on light grey pseudopodzolic soil, without irrigation on 387 m above sea level.

The block design method was used in four replications and harvest plot size of 6 m^2.

The agro–technical management over the growing season was carried out in accordance with biophysiological and technological requirements of the particular crop. As variants the following species and cultivars of annual spring cereals were studied:

1–Maize cv. Hybrid 509 (Standard);
2–Sorghum–Sudan–grass hybrid;
3–Sudan–grass (D. Stefanov's selection number);
4–Oats cv. Obraztsov Chiflik 4 and 5–Millet cv. Biserka.

The sowing of the different crops was made at interrow spaces as follows: maize–40 cm, sorghum– sudan–grass hybrid–15 cm, and for sudan–grass, oats and millet–12 cm.

The sowing depth of the crops with smaller seeds like sorghum–sudan–grass hybrid, sudan–grass, oats and millet was 3–5 cm, while for maize it was 6–8cm.

The sowing rates were the follows: for maize–15 viable seeds per 1m^2, for sorghum–sudan–grass hybrid–40 v.s./m^2, for sudan–grass–50 v.s./m^2, for oats–450 v.s./m^2 and for millet–400 v.s./m^2.

The phosphorus (as double superphosphate) and the potassium (as potassium sulphate) fertilizers were applied

once, before the main soil cultivation.

Thus for sudan–grass and oats the rate was $P_{60}K_{60}$ active substance (a.s.) per 1ha, and for sorghum–sudan–grass hybrid, maize and millet–$P_{80}K_{60}$. Nitrogen fertilizer (as ammonium nitrate) was input once, before annual sowing, at a following rates: for sorghum–sudan–grass hybrid, maize and sudan–grass–of 100 kg/ha a.s., and for oats and millet–of 80 kg/ha a.s.

The harvesting for green forage utilization was done by cutting of the cereal crops at the heading phonological stage one harvesting of the studying crops.

Was completed annualy.

In the experiment the following indicators were studied: dry mass yields (in t/ha), yield structural components (in %), plants height (in cm), weed infestation rate (in %). The dynamics of these bioproductive indicators has already been published. [LINGORSKI *et al.*, 2005].

In relation with the aim of this article the following indicators were studied: dry mass chemical composition, including a content of: crude protein in % (after Kjeldahl), crude fibre in % (after Heteron and Jensen), crude ash in % (through dry ashing in a muffle oven at temperature of 550°C), crude fat in % (after Soxlet), calcium in % (after Stotz–complexometrically) and phosphorus in % (by the vanadium–molybdenum method of Gericke and Kurmis).

On the basis of crude protein content and dry mass yields the productivity of crude protein in t/ha for each cereal crop was calculated.

Results and Discussion

The data listed in *Table 1* (for dry mass yields) presented that in 2002 there was lowest dry mass yield from maize (standard) compared with the remaining cereals studied.

The Sudan–grass, millet and sorghum–Sudan–grass hybrid exceeded the standard by 83.61, 80.05 and 30.40%, accordingly, while this parameter was lowest for oats–with 18.53%.

Table 1.

Dry mass yields (in t/ha) of some annual spring cereals for years and average for the 2002–2004 periods

Variant	2002		2003		2004		*Average*	
(Cereal crop)	t/ha	%	t/ha	%	t/ha	%	t/ha	%
1. Maize (Standard)	4.21	100.00	3.31	100.00	10.30	100.0	5.94	100.00
2. Sorghum–Sudan–grass hybrid	5.49	130.40	4.85	146.52	11.23	109.03	7.19	121.04
3. Sudan–grass	7.73	183.61	7.17	216.62	9.65	93.69	8.18	137.71
4. Oats	4.99	118.53	5.45	164.65	4.54	44.08	4.99	84.01
5. Millet	7.58	180.05	6.00	181.27	9.46	91.84	7.68	129.29
LSD at 5%; 9.82%; LSD at 1%;14.28%; LSD at 0.1%; 21.42%								

In the second year of the study (2003) all the tested cereals exceeded again the standard in yielding capacity. The dry mass obtained from them ranged from 4.85 t/ha for the sorghum–Sudan–grass hybrid to 7.17 t/ha for the Sudan–grass, i.e. in excess of the standard (maize) by 46.52 and 116.62%, accordingly. The other cereal crops (oats and millet) occupied an intermediate condition–too many with 64.65 and 81.27% compared to the standard.

In the last year (2004) of the experimental period only for sorghum–Sudan–grass hybrid higher yields than the standard crop were read–11.23 t/ha, i.e. 9.03% higher. Lower yields were recorded for the other cereal crops, by 6.31% for Sudan–grass to 55.92% for oats.

Regarding to the same year is obviously that the dry mass yields were highest because was best supplied with rainfall moisture. The increase of yields compared with the year 2002 results ranged from 24.90% for Sudan–grass to 104.50% in sorghum–Sudan–grass hybrid, and compared with the year 2003 ones–from 34.70% to 131.80%, respectively.

On average for the 2002–2004

periods the highest dry mass yield was harvested from Sudan–grass–8.18 t/ha, and it was 37.71% higher than that from maize (standard crop).

The similar results with exceeding towards the standard were the sorghum–Sudan–grass hybrid and the millet–by 21.04 and 29.29%, respectively.

The oats yield was with 15.99% less than the standard crop yield.

The dynamics of some forage biochemical indicators on average for the experimental period (2002–2004) are indicated in *Table 2*.

The obtained data showed that the studied spring cereals were different values from crude protein content.

The highest value (11.39%) was observed for oats, and it exceeded the standard crop (maize) with 0.41 percentage points.

The protein content of millet and sorghum–sudan–grass hybrid had similar values but they were less with 1.30 and 1.82% in comparison with the standard.

In the sudan–grass forage the least crude protein was established–8.31%.

Table 2.

Dry mass chemical composition (in %) of some annual spring cereals average for the 2002–2004 period

Variant (Cereal crop)	Crude protein, %	Crude fat, %	Crude fibre, %	Crude ash, %	Calcium, %	Phosphorus, %	Ca:P
1. Maize (Standard)	10.98	2.97	25.00	7.31	0.892	0.194	4.598
2. Sorghum–Sudan–grass hybrid	9.16	2.46	26.30	6.15	0.660	0.162	4.074
3. Sudan–grass	8.31	2.13	26.65	7.86	0.803	0.190	4.226
4. Oats	11.39	2.94	23.42	8.15	0.912	0.223	4.090
5. Millet	9.68	3.21	21.93	7.70	0.790	0.159	4.968

The content of crude fat in forage had near values and varied from 2.13% for sudan–grass to 3.21% for millet, whereas the other crops occupied an intermediate position.

The difference between maximum and minimum value towards this indicator was 1.08 points.

Because of the equal harvesting stage the crude fibre content varied also in comparatively little limits and ranged from 21.93% (for millet) to 26.30–26.65% for sorghum–sudan–grass hybrid and sudan–grass, respectively.

Considering crude ash content, the forage crops that were researched had no considerable differences as well and the values ranged from 6.15% for sorghum–sudan–grass hybrid to 8.15% for oats.

The crude ash for other crops (maize, millet and sudan–grass) had almost equal values–7.31, 7.70 and 7.86 percentage points.

It was established that the phosphorus and calcium content in dry mass varied within narrow limits for different crops.

So, the highest content of phosphorus was observed for oats–0.223%, while for calcium for oats and maize–0.912 and 0.892%.

Average for the experimental period the correlation values between calcium and phosphorus were almost the same and varied from 4.074 for sorghum– sudan–grass hybrid to 4.968 for millet.

During the first year of the experiment (2002) maximum crude protein per 1 ha (0.82 t) was obtained from millet, followed from sudan–grass (0.64 t) and oats (0.63 t), while from the standard crop –0.44 t, i.e. with 86.36, 45.45 and 43.18% less (*Table 3*).

In the next year (2003) the crude protein productivity varied in narrow limits and the yields obtained from different crops ranged from 0.41 t/ha for the sorghum–sudan–grass hybrid to 0.67 t/ha for the oats, i.e. in excess of the standard (maize) by 13.89 and 86.11%, accordingly.

The other cereal crops (millet and sudan–grass) occupied an intermediate condition –52.78 and 63.89% compared to the standard.

Table 3.

Crude protein yields (in t/ha) of some annual spring cereals for years and average for the 2002–2004 period.

Variant (Cereal crop)	2002		2003		2004		*Average*	
	t/ha	%	t/ha	%	t/ha	%	t/ha	%
1. Maize (Standard)	0.44	100.00	0.36	100.00	1.17	100.00	0.66	100.00
2. Sorghum–Sudan–grass hybrid	0.55	125.00	0.41	113.89	1.00	85.47	0.65	98.48
3. Sudan–grass	0.64	145.45	0.59	163.89	0.81	69.23	0.68	103.03
4. Oats	0.63	143.18	0.67	186.11	0.42	35.90	0.57	86.36
5. Millet	0.82	186.36	0.55	152.78	0.85	72.65	0.74	112.12
LSD at 5%; 9.82%; LSD at 1%; 14.28%; LSD at 0.1%; 21.42%.								

In the last year (2004) of the experiment maximum crude protein productivity was established for the standard crop–1.17 t/ha, while for the other studied cereals was less–with 14.53 (sorghum–sudan–grass hybrid) to 27.35 percentage points (millet).

On average for the 2002–2004 period the highest crude protein yield was obtained from millet–0.74 t/ha, and it was 12.12% higher than maize (standard crop).

Second, but similar yield towards the standard had the sudan–grass–0.68 t/ha, while for the other crops (sorghum–sudan–grass hybrid and oats) were less than maize–with 1.52 and 13.64%, respectively.

Conclusion

The comparative evaluation of some annual spring forage cereals under the conditions of Central Balkan Mountains in Bulgaria (Troyan region) showed that highest dry mass productivity was from sudan–grass, followed by sorghum – sudan–grass hybrid and the millet.

They exceeded the standard crop (maize) by 37.71, 29.29 and 21.04%, respectively.

The highest value (11.39%) of crude protein content was observed for oats and of crude fat content–for millet.

Maximum values of crude ash, calcium and phosphorus in dry mass had the oats.

The highest crude protein yield (0.74 t/ha) was obtained from millet, and it was 12.12% higher than maize (standard crop).

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