

STUDY OF FORAGE PRODUCTIVE AND QUALITATIVE INDICATORS OF SOME ANNUAL SPRING LEGUMES IN FOOTHILL REGIONS OF CENTRAL NORTHERN BULGARIA

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Abstract: During the 2002-2004 period in RIMSA, Troyan (in Central Northern Bulgaria) annually was sown a field experiment with some spring legumes for green forage production. The comparative study showed that a highest dry mass yield had the white lupine (7.72 t/ha) - 97.95% above the standard crop (field pea) productivity. The highest values (21.30 and 20.50%) of crude protein content were observed for common vetch and white lupine. A maximum crude fat content had field pea, followed of chickling vetch, soybean and common vetch. The highest crude protein productivity had the white lupine, and it was with 106.58% higher than field pea.

Key words: annual spring legumes, dry mass yields, forage chemical composition, crude protein yields, foothill regions, Central Northern Bulgaria.

Introduction

In the last years the drought, as one of the principal factors determining to a great extent the productivity of the annual and perennial forage crops usually grown under nonirrigated conditions, necessitated to carry out a number of experiments (*Pavlov, 1996; Gramatikov, 2002; Zhivkov, 2002; Kertikov, 2003; Chourkova, 2006a; 2009*). Their objective of principle was to limit and overcome the arising arid conditions of production (*Chourkova, 2006b; 2007*). In this connection a start was made to search for environment – friendly foothill regions providing natural optimal conditions of water supply for development of annual legume forage crops.

The objective of this study was to determine the values of some chemical and productive indicators of annual spring legume crops for green forage production under the soil-climatic conditions of Central Northern Bulgaria (Troyan region).

Materials and Methods

The experimental activity covered the period 2002-2004. It was carried out in the experimental field of RIMSA, Troyan under nonirrigated conditions, on a soil subtype of light grey pseudopodzolic soil and 387 m above sea level. The trials were laid out by the block method with four replications of the treatments and a size of one harvest plot of 10 m². As variants the following species and varieties of annual spring legume forage crops were studied: 1. Field pea cv. Pleven 4 (Standard); 2. Common vetch cv. Obrazets 666; 3. White lupine cv. Lucky; 4. Chickling vetch cv. Strandzha; 5. Bitler vetch cv. Borina, 6. Horse bean cv. Polycarpe and 7. Soybean cv. Srebrina.

The basic and surface soil cultivations were made according to the technological requirements for growing of the different crops. The sowing of the legumes was made at interrow spaces as follows: for field pea – 12 cm, for common vetch – 12 cm, for white lupine – 15 cm, for chickling vetch – 15 cm, for bitler vetch – 15 cm, for horse bean – 30 cm and for soybean – 15 cm. The sowing depth of the crops was 3-5 cm for common vetch, white lupine, chickling vetch, bitler vetch and soybean, while for field pea and horse bean it was 6-8 cm. The sowing rates were the follows: for field pea – 120 viable seeds per 1 m², for common vetch – 260 v.s./m², for white lupine - 100 v.s./m², for chickling vetch - 140 v.s./m², for bitler vetch - 300 v.s./m², for horse bean – 40 v.s./m² and for soybean - 35 v.s./m².

The present experiment was carried out without mineral fertilization. The green forage harvesting of the different legume crops was made at the phenological stage of full flowering – early pod formation. Annually was completed one harvesting of the studying crops.

In this experiment the following indicators was studied: dry mass yields (in t/ha), yield structural components (in %), plants height (in cm), weed infestation rate (in %). The dynamics of the aforesaid bioproductive indicators was published by now (*Lingorski and Kertikov, 2005*). In relation with the aim of the present 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 550⁰C), crude fat in % (after Soxlet), calcium in % (after Stotz - complexometrically), phosphorus in % (by the vanadium - molybdenum method of Gericke and Kurmis) and correlation between calcium and phosphorus content. On the basis of crude protein content and dry mass yields the productivity of crude protein in t/ha for each legume crop was calculated.

Results and Discussion

The obtained data regarding to the dry mass yields for any year and mean for the 2002-2004 period are showed in Table 1. It is obviously that the maximum yield (8.75 t/ha) during the first year of the experiment (2002), was obtained from white lupine. It was superior in productivity to the standard treatment (spring pea) by 118.20%. A relatively high yield, by 28.93% and 26.18% above the standard, was also obtained from common vetch and horse bean. The dry mass yield harvested from chickling vetch was equal to that from standard treatment (4.06 and 4.01 t/ha), while the bitler vetch and soybean were inferior by 21.30% and 30.92%, respectively.

Table 1. Dry mass yields (in t/ha) of some annual spring legumes for years and average for the 2002-2004 period

Variant (Legume crop)	2002		2003		2004		Average	
	t/ha	%	t/ha	%	t/ha	%	t/ha	%
1. Field pea (Standard)	4.01	100.00	3.94	100.00	3.74	100.00	3.90	100.00
2. Common vetch	5.17	128.93	4.34	110.15	3.40	90.91	4.30	110.26
3. White lupine	8.75	218.20	5.91	150.00	8.49	227.00	7.72	197.95
4. Chickling vetch	4.06	101.25	3.71	94.16	3.12	83.42	3.63	93.08
5. Bitler vetch	3.14	78.30	3.45	87.56	2.83	75.67	3.14	80.51
6. Horse bean	5.06	126.18	5.00	126.90	6.23	166.58	5.43	139.23
7. Soybean	2.77	69.08	2.67	67.77	2.89	77.27	2.78	71.28

LSD at 5%

14.84%

LSD at 1%

20.83%

LSD at 0.1%

29.40%

In 2003 the white lupine was again distinguished as the highest yielding (5.91 t/ha), by 50.00% more than the yield from the standard crop. The horse bean ranked immediately after white lupine with 5.00 t/ha, by 26.90% above the field pea, while common vetch was higher yielding than the same variant by only 10.15%. The dry mass yield from soybean and bitler vetch in the second year was also inferior to that from the standard.

In the last year of the study (2004) only white lupine and horse bean showed higher productivity than field pea. The yields obtained from these two crops were considerably ahead of the rest in value characteristics. They were superior in dry mass productivity to the standard crop by 127.00% and 66.58%.

The other studied crops (bitler vetch, soybean, chickling vetch and common vetch) were considerably inferior in productivity to the field pea.

On average for the experimental period (2002-2004) with maximum dry mass yield (7.72 t/ha) was white lupine - 97.95% above the standard crop. Comparatively less dry mass, but more with 39.23 and 10.26% than field pea was obtained by horse bean and common vetch, while the soybean, bitler vetch and chickling vetch had less productivity.

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 legumes were different values of crude protein content. The highest value (21.30%) was observed for common vetch, and it exceeded the standard crop (field pea) with 1.74 percentage points. The protein content of white lupine had a similar value (20.50%) and was more with 0.94% in comparison with the standard. The horse bean, soybean and chickling vetch had near values of crude protein content and they ranged to 17.44, 17.71 and 18.05%. The least value of this indicator was established for bitler vetch – 15.91%.

The content of crude fat in forage had near values for common vetch, soybean, chickling vetch and field pea (from 3.01% to 3.71%) as well as for white lupine, bitler vetch and horse bean (from 2.68% to 2.75%). The difference between maximum (for field pea) and minimum value (white lupine) towards this indicator was 1.13 points.

Table 2. Dry mass chemical composition (in %) of some annual spring legumes average for the 2002-2004 period

Variant (Legume crop)	Crude protein, %	Crude fat, %	Crude fibre, %	Crude ash, %	Calcium, %	Phosphorus, %	Ca:P
1. Field pea (Standard)	19.56	3.71	23.51	8.27	1.059	0.286	3.703
2. Common vetch	21.30	3.01	22.99	8.26	0.985	0.303	3.251
3. White lupine	20.50	2.68	21.74	7.95	0.880	0.295	2.983
4. Chickling vetch	18.05	3.34	24.15	8.24	0.894	0.275	3.251
5. Bitler vetch	15.91	2.72	21.17	7.97	0.814	0.277	2.939
6. Horse bean	17.44	2.75	22.36	8.27	1.205	0.306	3.938
7. Soybean	17.71	3.21	23.15	8.58	1.349	0.226	5.969

Because of the equal harvesting stage the crude fibre content varied also in comparatively little limits and ranged from 21.17% (for bitler vetch) to 24.15% for chickling vetch.

Towards to crude ash content the studied forage crops also they were not considerable differences and the values were from 7.95% for white lupine to 8.58% for soybean. The crude ash for other crops (bitler vetch, chickling vetch, common

vetch, horse bean and field pea) varied in near limits - from 7.97 to 8.27 percentage points.

It was established that the phosphorus and calcium content in dry mass varied comparatively within narrow limits for different crops. So, the highest content of phosphorus was observed for common vetch and horse bean - 0.303 and 0.306%, while for calcium by field pea, horse bean and soybean – between 1.059 and 1.349%.

The soybean has the highest value (5.969) of correlation between calcium and phosphorus and the least (2.939) – the bitler vetch, while for the other crops this qualitative indicator has a medial position.

During the first year of the experiment (2002) a maximum crude protein per 1 ha (1.67 t) was obtained from a white lupine, followed by a common vetch (1.37 t), while from the standard crop only 0.82 t, i.e. with 103.66 and 67.07% less. Less crude protein yields than the standard crop were obtained from soybean, bitler vetch and chickling vetch (Table 3)

In the next year (2003) again the crudest protein (1.26 t/ha) was obtained from white lupine, followed by a horse bean (0.89 t/ha) and a common vetch (0.85 t/ha), i.e. in excess of the standard (field pea) by 75.00, 23.61 and 18.05%, respectively. The other legumes (soybean, bitler vetch and chickling vetch) had again a lower productivity than the standard crop – with 6.95 to 47.22 percentage points.

Table 3. Crude protein yields (in t/ha) of some annual spring legumes for years and average for the 2002-2004 period

Variant (Legume crop)	2002		2003		2004		Average	
	t/ha	%	t/ha	%	t/ha	%	t/ha	%
1. Field pea (Standard)	0.82	100.00	0.72	100.00	0.74	100.00	0.76	100.00
2. Common vetch	1.37	167.07	0.85	118.05	0.61	82.43	0.94	123.68
3. White lupine	1.67	203.66	1.26	175.00	1.79	241.89	1.57	206.58
4. Chickling vetch	0.70	85.36	0.67	93.05	0.59	79.73	0.65	85.53
5. Bitler vetch	0.57	69.51	0.41	56.94	0.50	67.57	0.49	64.47
6. Horse bean	0.85	103.66	0.89	123.61	1.10	148.65	0.95	125.00
7. Soybean	0.57	69.51	0.38	52.78	0.53	71.62	0.49	64.47

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 again established from white lupine and horse bean - 1.79 and

1.10 t/ha, while for the other studied legumes was less in comparison with the standard crop – from 17.57% (common vetch) to 32.43% (bitler vetch).

On average for the 2002-2004 period the highest crude protein yield was obtained from a white lupine - 1.57 t/ha, and it was with 106.58% higher than field pea (standard crop). The second and almost equal values of the crude protein yield had horse bean and common vetch – 0.95 and 0.94 t/ha (with 25.00 and 23.68% above the standard). The other crops productivity (chickling vetch, bitler vetch and soybean) was lower than field pea from 14.47 to 35.53%.

Conclusion

The comparative testing of annual spring legume forage crops conducted under the conditions of Central Balkan Mountains (Trojan region) showed that average for the 3-year period of the studying (2002-2004) with the highest dry mass productivity (7.72 t/ha) had the white lupine – with 97.95% more than field pea (standard crop). The less dry mass was obtained from horse bean and common vetch – 5.43 and 4.30 t/ha, and that was with 39.23 and 10.26% more than the standard, while the soybean, bitler vetch and chickling vetch had lower productivity.

The highest values (21.30 and 20.50%) of crude protein content were observed for common vetch and white lupine. A maximum crude fat content had field pea, followed of chickling vetch, soybean and common vetch. Maximum values of crude ash had the soybean, followed by horse bean, field pea and common vetch. The most calcium in dry mass had the soybean, horse bean and field pea and phosphorus – horse bean and common vetch.

The highest crude protein productivity had the white lupine, and it was with 106.58% higher than field pea.

Ispitivanje pokazatelja produktivnosti i kvaliteta jednogodišnjih prolećnih leguminoza u regionu centralno-severne Bugarske

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Rezime

Tokom perioda od 2002-2004 u RIMSA, Trojan (u Centralno-Severnoj Bugarskoj) na oglednom polju godišnje su posejane neke prolećne mahunarke za proizvodnju zelene krme. Upporedna studija je pokazala da je najveći prinos suve materije kod bele lupine (7.72 t/ha) - 97.95%, iznad proizvodnje standardnih useva

(stočni grašak). Najveće vrednosti (21.30 i 20.50%) sadržaja sirovih proteina posmatrane su zajedno za grahorice i bele lupine. Najveći sadržaj sirovih masti je kod stočnog graška, a zatim kod grahorice, soje i grahorice zajedno. Najveći sadržaj sirovih proteina utvrđen je kod bele lupine i to za 106.58% više nego stočni grašak.

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