Preliminary Ruminant Digestibility Evaluation of some Romanian Winter Barley Genotypes Grown on Two Levels of N fertilization

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Abstract
The aim of the study was to evaluate the effects of nitrogen N levels on ruminant digestibility of 18 different Romanian barley genotypes grown in 2013/2014 year. The experiment was designed as randomized blocks and two levels of N were tested: 46 and 92 kg ha^{-1} (blocks N-46 and N-92) and compared to control block N-0, without nitrogen. The grains were analyzed for chemical composition and in vitro ruminant digestibility IVOMD. The resulted grains yield (t/ha) was significantly lowered by the 92 kg ha^{-1} N level. The same N fertilization level had a significant effect on increasing the crude protein content. But the mean IVOMD coefficient (%) of all genotypes was significantly decreased for both the N levels (84.45 for N-46, and 83.19 for N-92 compared to 86.92 for N-0).

Keywords: barley, ruminant digestibility

1. Introduction

Barley is a cereal grain which is commonly used in intensive dairy and beef diets for rapid growth and production [1]. Cultivar type, agronomic practices, such as seeding rate, nitrogen fertilizer rate, and other management practices (e.g., early seeding and maturity at harvesting) are the main factors influencing barley quality [2]. These factors also have an effect on both the yield and chemical composition of the grain produced, especially on starch and protein content of the grain [1]. As livestock feedstuff barley need to have relatively higher protein content and lower starch concentration. The starch is rapidly digested within the rumen [3] and induces acidosis and an alteration of the rate and extent of barley digestion [4, 5,]. If barley is intended to malting in beer industry then the protein must be low (9.5-11.5%) and the starch high (over 60%). Barley with an unacceptable high protein content for malting can still be used by livestock feed manufacturers.

Of all the soil nutrients, nitrogen (N) has the greatest impact on barley plant growth [6] and a successful fertilization program is to match plant-available N with barley crop needs. The addition of N fertilizer will increase also the protein content not only the barley yield. There are a lot of recommendations with regard to N fertilization of barley. Bulman [7] and Delogu [8] have reported that application of nitrogen fertilizers up to 80 kg N ha^{-1} increased barley yield. In Iran, Alazmani [9] obtained the best yield at 225 kg N ha^{-1}. Akdeniz [10] recommended 90 kg N ha^{-1} for cultivation of Turkish winter barley varieties under arid condition, but Shahnaj [11]

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recommended 180 kg N ha^{-1} in Ethiopia. In Canada, McKenzie [12] recommended that the rate of N when using urea (46-0-0) fertilizer should not exceed 50 lb. N/acre, when direct seeding into soil with medium moisture. Verbeten [13] in USA presented that 70-100 lb. N/acre (from all sources) will likely achieve reasonable yield, protein and plumpness, and even 10-60 lb. N/acre is sufficient.

The optimum level of N varies from location to location. It depends on the climate and soil of the location as well as the variety used. A number of general purpose barley genotypes are available in Romania, with some ones suited to different agro-climatic areas of the country. Because the yield attributes and quality of barley seed are dependent on appropriate dose of applied N, it is indicate to determine it on experimental studies like this one. And because we intend to recommend the proper genotypes as feedstuff for ruminants we set this preliminary study for investigation of the influence of N fertilizer level on the ruminant in vitro organic matter digestibility (IVOMD) in some winter barley genotypes tested in the field conditions of South-Eastern Romania.

2. Materials and methods

Eighteen winter barley genotypes have been tested in 2013-2014 year, at National Agricultural Research and Development Institute (NARDI Fundulea, Romania). The tested barley genotypes were: a) the six-rowed barley - Dana, Cardinal FD, Univers, Ametist, Smarald, Simbol, F 8-20-10, F 8-19-10, F 8-3-01, Onix, F 8-10-12, and the two-rowed barley - Andreea, Artemis, DH 267-66, Gabriela, DH 314-1, DH 315-10 and DH 267-36. The barley lines (code name) are still tested for stabilization, but the barley varieties (proper name) have been presented in other papers for their yield, stability and drought tolerance [14, 15]. Till present these genotypes have not been characterized for their N fertilizer needs in relationship with ruminant feed usage. In the experiment they were nominated V1-V18 in the above mentioned order.

The experiment was based on the split plot method. The field trial included all 18 genotypes, in a randomized block design, with 3 replications.

The N supply was spread in the form of urea in one application, in spring (March-April), at the 2-3 leaf stage of barley. The first block N-0 (control block) had no fertilizer (0 kg N/ha), the second block (N-46) had 46 kg ha^{-1} N (100 kg ha^{-1} urea) and the third (N-92) had 92 kg ha^{-1} N (200 kg ha^{-1} urea). The field conditions are described in Table 1 and a foliar fungicide treatment was also included.

The barley grains yield (t/ha) was recorded and the thousand seeds weight (g) by Seed Counter, also. An averaged conditioned barley grains sample for each genotype, resulted from the 3 replications, was tested for crude protein, starch content and digestibility for ruminants by in vitro method (IVOMD).

Crude protein and starch content were determined by near-infrared reflectance spectroscopy (NIRS) using Infratec 1241 Grain Analyzer (Foss Tecator, Sweden).

Table 1. Description of the environmental conditions at NARDI Fundulea for barley field trial

Region	Soil type	Year	Field block	Nitrogen fertilization (kg ha^{-1} N)		Preceding crop	Rainfall (October - June) mm
				Autumn	Spring		
South-East Romania	Chernozem pH:6.3-6.8, humus: 3%	2014	block N-0	0	0	Peas	484.4
			block N-46	0	46	Peas	
			block N-92	0	92	Peas	

IVOMD was determined by in vitro method of Tilley-Terry [16] at National Institute for Animal Biology and Nutrition (IBNA Institute Balotesti). Briefly, the samples of barley grains were grounded at 1 mm granulation, 0.5 g weighed into 100 ml tube and incubated at 39°C for 48 h, first with 50 ml of diluted rumen fluid, and then with 50 ml of 2‰ pepsin solution. IVOMD coefficient (%) was calculated as percent of organic matter (OM) digested knowing the residue OM and the barley sample OM.

The experimental data were statistically processed by two-way analysis of the variance (ANOVA) using StatView software.

All analyzed characteristics were significantly different at level p=0.05. The differences between values were tested by Tukey test.

3. Results and discussion

Influence of N fertilizer on barley yield

From Tabel 2 it can be observed that the overall thousand seeds weight is not influenced by nitrogen fertilization and only the 92 kg ha^{-1} N level produce a significant lowering of the grain yield (mean of all genotypes).

Table 2. The production of N fertilized barley

	Fertilization level			SEM	P-value
	N-0	N-46	N-92		
grains yield (t/ha)	6862^{a}	6620^{a}	5617^{b}	0.630	p<0.05
thousand seeds weight (g)	39.4^{c}	40.6^{c}	39.9^{c}	0.751	p>0.05

Values in rows with different letter differ significantly (P≤0.05)

Influence of N fertilizer on barley crude protein and starch

The barley chemical composition is presented in Figure 1 and Figure 2. As presented in Table 3 the barley from the N-92 block had the greatest mean content of crude protein but the lowest average content of starch. The increased protein content of the N-92 block was significantly differed compared to N-0 block. It is normal that crude protein increases as soil nitrogen fertilizer increases [10, 13]. The starch content was not modified as N level increased.

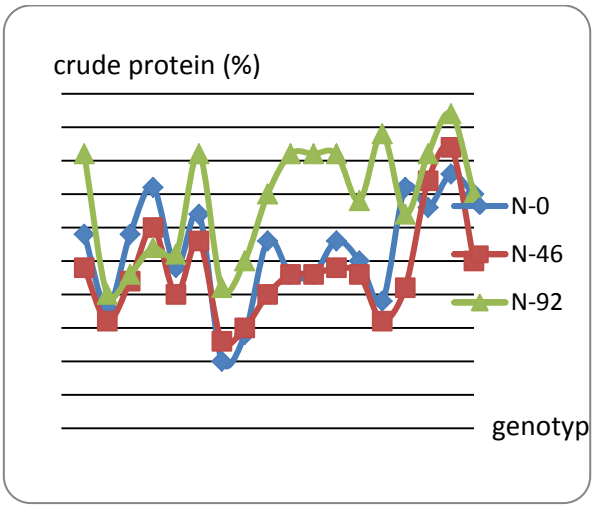

Figure 1. The crude protein of the barley genotypes from the N fertilization experiment

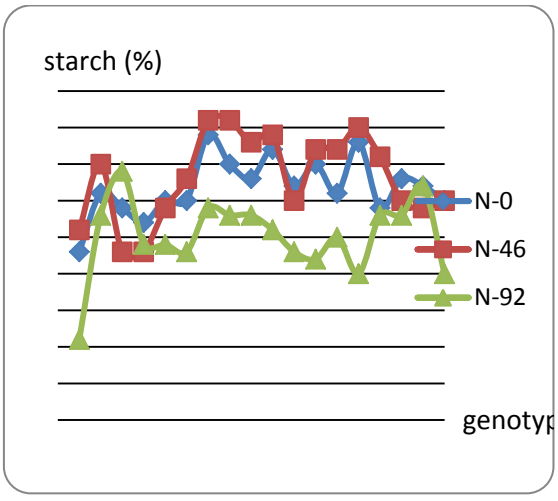

Figure. 2. The starch of the barley genotypes from the N fertilization experiment

Table 3. The chemical composition of fertilized barley (mean values of all genotypes)

	Fertilization level			SEM	P-value
	N-0	N-46	N-92		
Crude protein (%)	12.7^{a}	12.3^{a}	13.4^{b}	0.460	p<0.05
Starch (%)	61.2^{c}	61.3^{c}	60.5^{c}	0.352	p>0.05

Values in rows with different letter differ significantly (P≤0.05)

Relationship between N level and IVOMD

The IVOMD value is presented for each genotype in Figure 3 and the mean genotypes value per block is calculated in Table 4. Our barley ruminant digestibility values are similar with values presented by other authors: 83% [17], 88%

[18], 81.9-91.2% for Poland cultivars [19] or 81.97-89.17 for Turkish cultivars [10]. It can be observed that the IVOMD coefficient was lowering as N fertilizer level was increasing. The influence of N fertilizer on IVOMD has a significant effect on both N-46 and N-92 barley blocks comparing with control block, but was no significant difference between these 2 levels of fertilization.

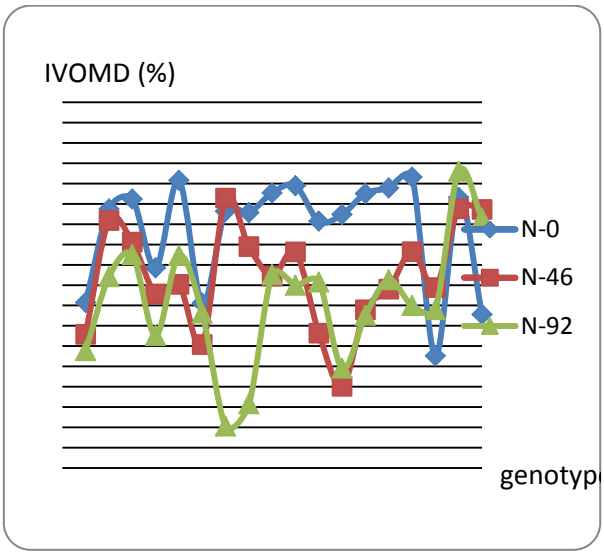

Figure 3. The digestibility (IVOMD%) of the barley genotypes from the N fertilization experiment

Table 4. The IVOMD of the barley in the 3 fertilization blocks (mean values of all genotypes)

	Fertilization level			SEM	P-value
	N-0	N-46	N-92		
IVOMD (%)	86.92[a]	84.45[b]	83.19[b]	0.67	p<0.05

Values in rows with different letter differ significantly (P≤0.05)

There were no significant interaction between types (six or two-rowed) and IVOMD as can be seen in Table 5. But the IVOMD is variable among cultivars. The Tukey test for all genotypes and both N levels indicate that the V15 and V17 lines are the most digestible of all genotypes, and the Simbol (V6), Andreea (V12) and Dana (V1) varieties are the less digestible ones. These results are preliminary and they will be evaluated in the future cultivation experiments.

Table 5. The IVOMD comparison between the barley genotypes

	six-rowed	two-rowed	SEM	p
IVOMD (%)	84.66[a]	85.17[a]	0.441	p>0.05

Values in rows with different letter differ significantly (P≤0.05)

4. Conclusions

The increasing of the N fertilizer level determined an increase of the crude protein concentration but a decrease of the IVOMD coefficient. The grain yield was lowered as N level was increasing. By repeated future experiments it will be settled an adequate N level for yield and IVOMD and also, few genotypes will be indicated as ruminant feed stuff.

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