Impact of Fertilisation on the Growth and Development of the Root System and of the Aerial Vegetative System in Bird's-foot-trefoil (*Lotus corniculatus* L.)

Ilie Toth[1], Neculai Dragomir[1], Dorin Camen[1], Carmen Dragomir[1], Rechițean Dorin, Anca Sala[1], Florin Neciu[1]

[1]*Faculty of Animal Science and Biotechnologies, 300645, Timişoara, Calea Aradului, no. 119, România*

Abstract
In all conventional agricultural systems based on the application of mineral or organic fertilisers, their impact is assessed depending on the final product (production of green matter or of seeds) and on its quality. At plant level, the impact of fertilisers differentiates depending on the structure and morphological features of the plants. This paper presents the differentiated impact of applying organic and mineral fertilisers on the growth and development of the root system and of the aerial vegetative system in bird's-foot-trefoil.

Keywords: common bird's-foot-trefoil (*Lotus corniculatus* L.), organic and mineral fertilisers, root system, aerial vegetative system.

1. Introduction

Applying nitrogen fertilisers on legume species has been thoroughly studied due to the efficacy of these fertilisers on yield and to its ability of fixing nitrogen symbiotically. In field experiments, the best results in bird's-foot-trefoil were on acid soils using lime amendments and small amounts of nitrogen fertilisers and moderate amounts of phosphorus and potassium fertilisers [1-5].
The paper points out the influence of organic and mineral fertilisers on plant weight in bird's-foot-trefoil, on aerial vegetative system and on root system.

2. Materials and methods

Research was carried out between 2013 and 2014 on the experimental field of the Centre for Research in Grasslands and Fodder Crops of the Banat's University of Agricultural Science and Veterinary Medicine "King Michael I of Romania" from Timisoara, Romania.
To do so, we used an experimental setting based on a bifactorial experiment (3x5) made up of the following factors: A. organic fertilisers (**a1** = no fertilisation, **a2** = 20 t/ha animal manure, **a3** = 40 t/ha animal manure); B. mineral fertilisers (**b1** = no fertilisation, **b2** = ammonia nitrate N100, **b3** = potassium nitrate N100 **b4** = complexes (13:10:15) N100, **b5** = superphosphate P100).
The 15 experimental variants were set with three replicates after the sub-divided plot method. Fertilisation with animal manure was done in the fall of 2013 (November) by incorporation in the soil with the basic tillage.
Fertilisation with mineral fertilisers was done in each vegetation year, at the beginning of spring and of vegetation in bird's-foot-trefoil.
The biological material used in sowing was the native bird's-foot-trefoil cultivar Danitim (*Lotus corniculatus* L.). Before sowing, we checked the seed germinating capacity and then established the seeding rate (20 kg/ha).
After sowing, in the second half of March, we rolled the soil with a ring roller.

* Corresponding author: illestoth@yahoo.com

During the experiment, we made observations, measurements and analyses regarding the growth of the root system and of the aerial vegetative system.

We measured the weight of whole plants, of the aerial vegetative system and of the root system with KERN ABS digital scales.

We also took digital photos with a SONY – Cyber-shot type camera, 7.2 mega pixels, and we archived the photos for each plant.

The data thus obtained were statistically processed through variance analysis/F test, STUDENT test, DUNCAN test, and linear/square/multiple linear/square correlations.

3. Results and discussion

Studies show that, in bird's-foot-trefoil, fertilising with organic and mineral fertilisers has different effects on plant growth and development. Thus, applying animal manure has no positive influence on plant total weight. On the contrary, for a rate of 40 t/ha, there was a significant decrease of plant weight compared to the control (no fertilisation) variant (Table 1).

Table 1. Influence of organic fertilisers on growth and development in *Lotus corniculatus* L.

Variants	Aerial system (g/plant)	Roots system (g/plant)	Whole plant (g/plant)
a1 – control	2.9	3.63	6.75
a2 – 20 t/ha animal manure	2.17°	3.79	6.11
a3 – 40 t/ha animal manure	1.18°°°	2.29°°	3.71°°°
DL 5%	0.62	0.75	1.40

This decrease was more consistent in the aerial vegetative system than in the root system, where weight decrease was higher in the variant treated with 20 t/ha animal manure.

Applying unilaterally mineral fertilisers influenced positively plant growth and development in bird's-foot-trefoil (Table 2).

Table 2. Influence of mineral fertilisers on growth and development in *Lotus corniculatus* L.

Variants	Aerial system (g/plant)	Root system (g/plant)	Whole plant (g/plant)
b1 – Control	0.83	1.26	2.15
b2 – ammonia nitrate	1.74*	2.59**	4.48**
b3 – potassium nitrate (14:0:46)	3.16***	4.96***	8.33***
b4 – N:P:K complex (13:10:15)	3.22***	4.56***	8.18***
b5 – superphosphate	1.47	2.83***	4.48**
DL 5%	0.83	0.75	1.53

When applying ammonia nitrate, the weight increases significant (in the aerial vegetative system) and significantly distinct in the plant root system. In exchange, when applying potassium nitrate and complex fertilisers, the increases in growth were very significant – two to four times more than in the control variants. In the variant fertilised with superphosphate, there were higher increases in growth (very significant) in the root system.

By applying combined organic fertilisers (20 t/ha) and N:P:K mineral fertilisers, the plant weight increase of 5 times with a difference to the control of 5.47 g/plant (Table 3).

Fertilising with organic fertilisers (40 t/ha) and potassium nitrate resulted in a double increase with a difference of 3.01 g/plant compared to the control variant (ensured statistically).

Data synthesised in Table 3 show the growth rate in bird's-foot-trefoil (root system, aerial vegetative system, and whole plant). The combination of organic and mineral fertilisers influenced positively the growth and development of bird's-foot-trefoil plants compared to the unilateral way of applying these fertilisers.

Table 3. Combined influence of organic and mineral fertilisers on growth and development in *Lotus corniculatus* L.

Organic fertilisers	Mineral fertilisers	Aerial system (g/pl)	Root system (g/pl)	Whole plant (g/pl)
a1 – no fertilisation (CONTROL)	b1 – no fertilisation (CONTROL)	0.84	1.29	2.26
	b2 – ammonia nitrate	2.47*	3.43**	6.21**
	b3 – potassium nitrate (14:0:46)	6.42***	5.95***	12.22***
	b4– N:P:K complex (13:10:15)	3.75***	4.26***	8.63***
	b5– superphosphate	1.03	3.25*	4.42
a2 – 20 t/ha animal manure	b1 – no fertilisation (CONTROL)	0.89	1.07	1.99
	b2 – ammonia nitrate	2.27	3.34**	5.80**
	b3 – potassium nitrate (14:0:46)	1.01	4.49***	5.40*
	b4– N:P:K complex (13:10:15)	4.56***	6.53***	11.54***
	b5– superphosphate	2.13	3.53**	4.42
a3 – 40 t/ha animal manure	b1 – no fertilisation (CONTROL)	0.77	1.43	2.19
	b2 – ammonia nitrate	0.48	0.99	1.50
	b3 – potassium nitrate (14:0:46)	2.06	4.43***	7.38***
	b4– N:P:K complex (13:10:15)	1.34	2.88	4.38
	b5– superphosphate	1.26	1.72	3.12

DL 5% = 2.65 g/pl; DL 1% = 3.52 g/pl; DL 0.1% = 4.56 g/pl

The study of the correlations pointes out the existence of some direct relationships between seed size and weight upon sowing and some size features of common bird's-foot-trefoil seed quality and plant vigour (Table 3). Thus, as far as seed size is concerned, it correlates more with seed germination and duration of germination (r=0.95* and r=0.99**) and the weight of the aerial

4. Conclusions

Applying organic fertilisers in excessive rates can influence negatively the growth and development of bird's-foot-trefoil plants;

Mineral fertilisation, particularly potassium nitrate and complex fertilisers, had a beneficial effect on bird's-foot-trefoil plants;

Combined fertilisation, 20 t/ha animal manure with complex N:P:K fertilisers (13:10:15) had the strongest positive effect on growth and development in bird's-foot-trefoil plants.

5. Reference

1. Denton, M, D.,Sasse, C.,Tibbett, M., and Ryan, M.H.: Root distributions of Australian herbaceous perennial legumes in response to phosphorus placement, Funct. Plant Biol, 33, 1091-1102, doi: 10.1071/fp06176, 2006.

2. B. Felderer, K. M. Boldt-Burisch, B. U. Schneider, R. F. J. Hüttl and R. Schulin

Root growth of *Lotus corniculatus* L. interacts with P distribution in young sandy soil – Biogeosciences, 10, 1737-1749, 2013. Doi: 10.5194/bg-10-1737-2013.

3. Margarita L. Himmelbauer, Violeta Vateva, Ljudmila Lozanova, Willibald Loiskandl, Svetla Rousseva - Root characteristics of *Lotus corniculatus* L. and *Bromus inermis* L. grown on eroded rangeland in a semi-arid area of South Bulgaria. International Symposium "Root Research and Applications" RootRAP, 2–4 September 2009, Boku – Vienna, Austria.

4. Forde, B. & Lorenzo, H. 2001. The nutritional control of root development. Plant and Soil, 232,51–68.

5. H. L. Kristensen & K. Thorup-Kristensen - Effects of vertical distribution of soil inorganic nitrogen on root growth and subsequent nitrogen uptake by field vegetable crops.Soil Use and Management, December 2007,23,338–347 doi: 10.1111/j.1473-2743.2007.00105.x.