The Relationship between the Root System and Nodule Forming Capacity of Birdsfoot Trefoil Plants (*Lotus corniculatus* L.)

Ilie Toth[1], Neculai Dragomir[2], Dorin Camen[1], Marinel Horablaga[1,2], Marcela Dragoș[2], Maria Sauer[3], Anca Sala[1], Dorin Rechițean[2]

[1]USAMVB Timișoara, Calea Aradului, Nr. 119, Timișoara
[2]SCDA Lovrin, Str. Principală, Nr. 200, Lovrin
[3]SCDCOC Caransebeș, Drumul Reșiței, Km 2, Caransebeș

Abstract
The research carried out refers to a study of 460 individual birdsfoot trefoil (*Lotus corniculatus* L.) plants in order to show relations between the cultivated seeds size and the weight of the root system, on one hand, and between the radicular system and the nodosity formation capacity of the root system (number and weight), on the other hand. The results obtained have revealed the existence of direct positive relations between these properties of the birdsfoot trefoil plants. The magnitude of these attributes values is determined by the size of the seeds used for sowing.

Keywords: individual plants, *Lotus corniculatus*, seed size, simple and multiple correlations.

1. Introduction

Lotus corniculatus L. is a perennial fodder species of the Fabaceae family, well represented in spontaneous flora of Romania [1]. Compared to other perennial legumes, birdsfoot trefoil is well adapted to different natural conditions, both on acid soils and on more alkaline soils [2, 3]. An important feature of this species is the ability to absorb phosphorus and potassium in the conditions of poorer soils content in these elements [4,5].
Some research has highlighted the influence of the seed size on the plant's vigor during vegetation and the effect on production capacity [6-9].
This paper highlights the existing relationships between seed size, radicular system and nodular ability of birdsfoot trefoil, by highlighting simple and multiple correlations between these attributes.

2. Materials and methods

The research was carried out in the experimental fields of U.S.A.M.V. Timişoara within the Research Center for Grasslands and Fodder Plants. Studies have been conducted on individual plants of the birdsfoot trefoil (*Lotus corniculatus*), sown in plastic pots and raised in the vegetation house (Photo 1).

Photo 1. Nodosites formed on the root system of *Lotus corniculatus* L., obtained from medium seed Ø (1.25, 1.4) - (a4xb7), year I. (Original picture)

* Corresponding author: Name, Tel, Fax, Email

In these pots were sown the seeds of the Nico variety. Before sowing, the seeds were selected and divided into six groups of sizes by seed diameter, as follows: a1 - dimensional unselected seeds, a2 - very small seeds (Ø = 0,05-1,00 mm), a3 - small seeds (Ø = 1.01-1.25 mm), a4 - medium seeds (Ø = 1.26-1.40 mm), a5 - large seeds (Ø = 1.41-1.50 mm), a6 - very large seeds (Ø> 1.51 mm). From each dimensional group of seeds, 100 plants were produced, on which, during growth and development the following determinations were carried out: weight of root system, number and weight of formed nodosities, height of plants, weight of vegetative mass (stem, leaves, and inflorescences).

Photo 2. The nodosities formed on the root system of the *Lotus corniculatus* L., obtained from very large seeds Ø (1.5, 1.6) - (a6xb7), year I. (Original picture)

Nodulation capacity as well as other determinations, were made at the beginning of the flowering phase of plants. The nodosities taken from the root system were weighed with a Sartorius digital balance (BP 221s type), and for ease of size and dimensional determination of the nodosities, they were photographed and the images were processed using Image J software [10]. Grouping of nodosities was done using Microsoft Excel software (Home - Sort & Filter menu).

To establish the relationship between the root system size and the nodular capacity, the data obtained was processed by the variant analysis and simple and multiple correlations between these attributes were determined.

3. Results and discussion

As a result of the studies carried out over a long period of time, the existence of a large variability of the seed size of birdsfoot trefoil was highlighted, with limits between 0.50-1.50 mm diameter [1, 6-9]. This seed size variability strongly influences the growth and development of the birdsfoot trefoil plant.

Thus, the results obtained on the root system showed a significant reduction in the weight of the roots in plants obtained from small seeds, with a diameter of 0.50-1.25 mm, and a significant increase in plants obtained from seeds with a diameter of over 1.25 mm (Figure 1).

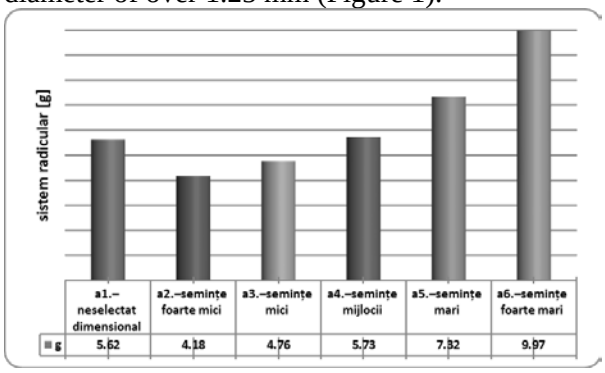

Figure 1. Influence of seed size on the root plant root system of birdsfoot trefoil plants (*Lotus corniculatus* L.)

In agricultural practice, from the observations made, it has been found that the birdsfoot trefoil plants, resulting from the sowing of large seeds, grow in a shorter period of time, ensure uniformity of the culture and show greater vigor in the stages of growth and development.

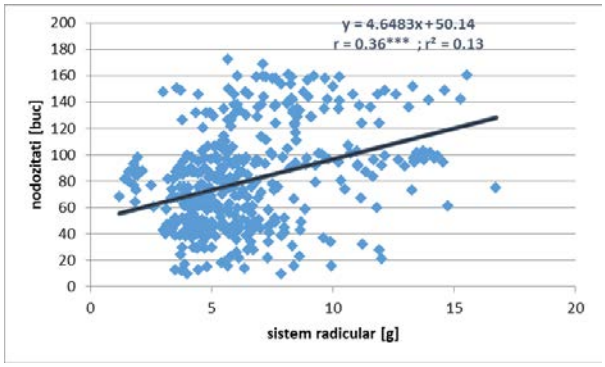

Figure 2. The correlation between the root system (g) and number of nodosities (pcs)

The study of growth and development of the 460 individual plants studied, in the second year of vegetation (at the first harvest), shows that between the development of the root system and the number of formed nodosities there is a direct positive relationship given by the calculated determinant coefficients ($r^2 = 0.13$) and correlation coefficients ($r^2 = 0.36$). The contribution of root

system development (weight) to the increase of the number of nodosities/plant is 13% (Figure 2).

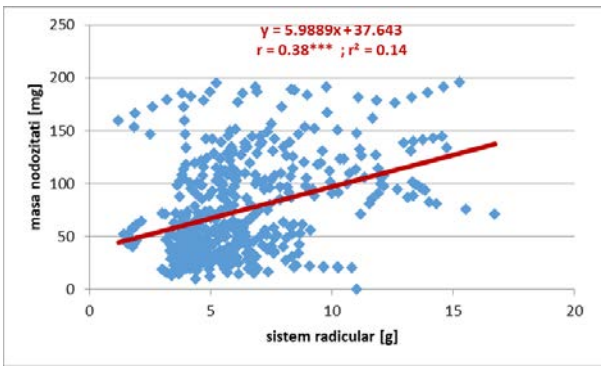

Figure 3. The correlation between root system (g) and weight of nodosities (mg)

Also, there is a positive relationship between the radicular system and the weight of nodosities formed, by which the radicular system contributes with 14% to the increase in the weight of the nodosities (Figure 3).

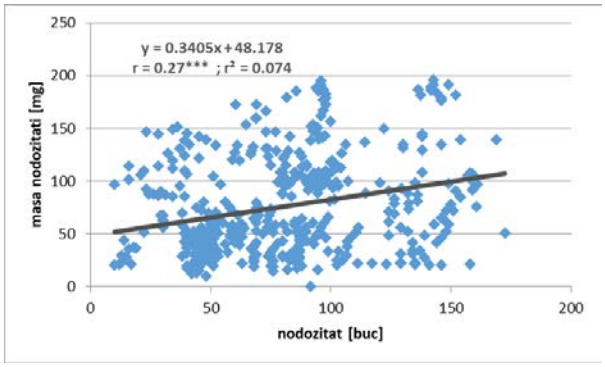

Figure 4. The correlation between the number of nodosities (pcs) and the weight of nodosities (mg)

In the formation of nodosities in the plants of birdsfoot trefoil there is a direct relationship between the number of nodosities and the weight of the nodosities. This relation, established at the level of the individual plants studied, is evidenced by the two determined parameters: the determinant coefficient (r2 = 0.074) and the correlation coefficient (r2 = 0.27).

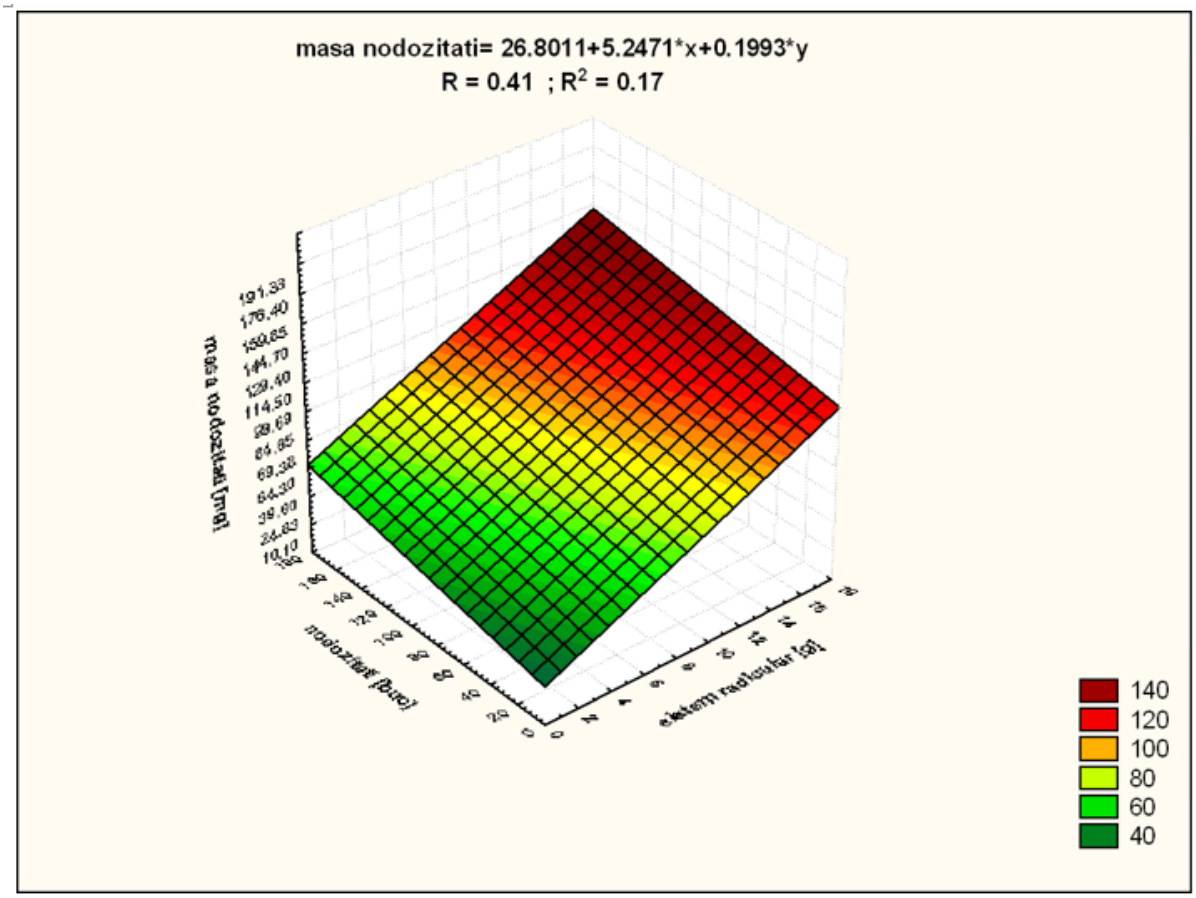

Figure 5. The correlation between the radicular system, number of nodosities (pcs) and weight of nodosities (mg)

The multiple correlation established between the root system, the number of nodosities and the weight of nodosities demonstrates a close relationship between these attributes of the birdsfoot trefoil plants. The values of the regression coefficients of the multiple equation (nodosity mass = 26.80109 + 5.247142 * radicular system + 0.199325 * number of nodosities) show that by increasing the weight of the root system by 1 g, their mass of nodosities increases by 5,2 mg, and by increasing the nodosities with a single nodosity, the weight of nodosities increases by 0.2 mg (Figure 5).

The large number of individuals studied allowed us to determine the Durbin-Watson test to highlight the significance of random character and possibly the lack of autocorrelation of residual errors. In the present case, the low value of this coefficient (0,162494) does not reveal the existence of disruptive character phenomena and thus the presence of the autocorrelation phenomenon that could distort the efficacy of the least squares correlation and the estimative value of the regression coefficients.

4. Conclusions

Birdsfoot trefoil seeds show great variability in their growth (between 0.50-1.50 mm), which influences the growth and development of plants during the vegetation period.

Following studies and determinations, there were found simple and multiple correlations between the root system and the ability to form and increase the nodosities (number and weight) in the plants of birdsfoot trefoil (*Lotus corniculatus* L.).

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