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Influence of fertilization and row spacing on seed yield and quality of *Lathyrus sativus* L.

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Abstract. Pulses provide, along with other species, a rich source of nutrients needed both for human food and animal feed. These include *Lathyrus sativus* L, a grain legume that is less cultivated worldwide, especially in Europe, but of interest because of its ecological plasticity such as tolerance to drought, waterlogging, salinity, etc.

The present research attempts to bring a novelty to the technology of growing grasspea, a less known and studied grain legume crop in Romania. The bifactorial experiment was set up at the Didactic Station, Ezăreni Farm, University of Life Sciences "Ion Ionescu de la Brad", Iaşi, arranged in randomized blocks design where several parameters (MMB, MH, quantity and quality of production, etc.) were followed.

According to the following results obtained from the research: the highest mass of 1000 grains was 165.1 g at 25 cm row spacing fertilized with $N_{92}P_{92}K_{32}$. The highest average value of hectolitre mass was 79.99 kg/hl at 37.5 cm row spacing, unfertilised, and the highest average yield obtained was 2755 kg/ha at 37.5 cm row spacing, fertilised with $N_{36}P_{36}K_{16}$.

Fertilization with $N_{60}P_{60}K_0$ at 12.5 cm row spacing yielded highest amount of crude protein content in grass pea seeds (34,8%), which was about 11% greater than control.

Keywords: fertilization, grass pea, *Lathyrus sativus* L., production, protein, row spacing.

Influența fertilizării și distanței dintre rânduri asupra producției de boabe și calității lor la *Lathyrus sativus* L.

Rezumat. Leguminoasele oferă, alături de alte specii, o sursă bogată de nutrienți necesari atât pentru hrana umană, cât și pentru hrana animalelor. Printre acestea se numără *Lathyrus sativus* L, o cultura de leguminoase pentru boabe care este mai puțin cultivată la nivel mondial, în special în Europa, dar prezintă un deosebit interes datorită plasticității sale ecologice, cum ar fi toleranța la secetă, inundare temporă, salinitatea etc.

Prezenta cercetare încearcă să aducă o noutate în tehnologia de cultivare a latirului, o cultura de leguminoase pentru boabe mai puțin cunoscută și studiată în România. Experimentul bifactorial a fost înființat la Stațiunea Didactică, Ferma Ezăreni a Universității de Științe ale Vieții „Ion Ionescu de la Brad" Iași, amplasată în blocuri randomizate, în care mai mulți parametri (MMB, MH, cantitatea și calitatea producției de boabe etc.) au fost urmărite.

Rezultate obținute în urma cercetării: cea mai mare masă a 1000 de boabe a fost de 165,1 g la distanța dintre rânduri de 25 cm și fertilizare cu $N_{92}P_{92}K_{32}$. Cea mai mare valoare a masei hectolitrice a fost de 79,99 kg/hl la distanța dintre rânduri de 37,5 cm, nefertilizat, iar cea mai mare recoltă fiind de 2755 kg/ha la distanță de rânduri de 37,5 cm și fertilizarea $N_{36}P_{36}K_{16}$.
Fertilizarea cu $N_{60}P_{60}K_{0}$ și distanța dintre rânduri de 12,5 cm a produs cea mai înaltă productivitate și conținut de proteină brută în semințele de latir (34,8%), care a fost cu aproximativ 11% mai mare decât la lotul de control.
Cuvinte-cheie: distanța dintre rânduri, fertilizare, latir, *Lathyrus sativus* L., producție de boabe, proteine.

1. Introduction

A complementary perspective for the continued improvement of key crop species to ensure the maintenance of sustainable food and feed production in the context of climate change, as well as the current energy crisis, involves targeting agricultural species that are currently less exploited globally but which have traits of interest such as tolerance to drought [15], salinity [14], short-term flooding [11]. These include *Lathyrus sativus* L, commonly called grass pea, an annual legume crop and the most important species of *Lathyrus* genus [6], which is a large genus with 160 species. Grass pea is shown both for seed production as a source for human food, as a forage crop for animal feeds, and also it is cultivated for use as a green manure or cover crops [27]. Additionally, grass pea is one of the crops with great agricultural potential, duo to its very high protein concentration of up to 34% [16], starch content [4] and hygh lysine content up to 20.4 mg/kg [22]. Typically, as with other grain legumes, protein quality is limited only by its low concentrations of methionine, cysteine and tryptophan [20].

Lathyrus sativus L. covers small areas globally, with an estimated cultivated area of about 1.50 million hectares [24], but it is a species that integrates perfectly in a sustainable agricultural system, being a natural source of nitrogen, which allows reducing the cost of cultivation and the environmental impact of nitrogen-based fertilizers.

Grass pea grows and develops very well under adverse agricultural conditions, performs well in a broad spectrum of soil types and its cultivation requires low or zero agricultural inputs [22] thereby, it can be successfully incorporated in crop rotation systems [4]. Grass pea is able to fix nitrogen very efficiently through symbiosis with *Rhizobium leguminosarum* bv. *viciae* [9] and in the presence of a specific protein called leghemoglobin, add about 124 kg/ha N in a single growing season [26].

It is also necessary for the rehabilitation of physical structure of the soil [30], and offers an efficient alternative in areas with land overexploited by cereal cultivation, which is why interest in this species has been renewed in Europe, and its cultivation has now extended to include marginal lands of the Mediterranean basin (France, Spain, Lebanon, Egypt, Syria, Libya, Morocco, Algeria), [8].

Since world food production is largely sustained by major crop plants (wheat, maize, etc.), as well as major nutrients and micronutrients that impact crop nutrition and productivity [29], [28], less emphasis has been accorded to minor crops [5], such as grass pea.

Sowing seeds at optimal row spacing allows efficient use of soil resources and fertilizer management is a key aspect which affects crop growth, development and productivity. Very limited studies regarding the judicious use of fertilizer on grass pea has been laid out worldwide, especially in Europe and Romania.

Therefore, the present study was undertaken to study the effect of row spacing and different levels of NPK fertilizer on seed yield and quality, and to indentify the optimum row spacing and the optimum level of NPK fertilizers for obtaining maximum yield of *Lathyrus sativus* L.

2. Materials and Methods

Experimental design

The bifactorial experiment was set up in the research field of Phytotechny at the Didactic Station, Ezăreni Farm, of the University of Life Sciences "Ion Ionescu de la Brad", Iaşi, to study the effect of row spacing and fertilization levels on yield of grass pea (*Lathyrus sativus* L.).

The study consisted of four row spacing (12,5 cm, 25 cm, 37,5 cm, 50 cm) with four different levels of NPK ($N_0P_0K_0$, $N_{36}P_{36}K_{16}$, $N_{60}P_{60}K_0$, $N_{92}P_{92}K_{32}$) using a randomized block design with three replications. The required quantities of fertilizer in the form of NPK (20% N, 20% P_2O_5 and 16% K_2O) as per treatment were applied one day before sowing the crop in each plot independently and was mixed properly with the soil. The plot size kept for each treatment measured 3x3 m^2. Sowing of crop was done on 26th April, 2021 and harvested at its full maturity on 24th August, 2021.

The crop of grass pea was grown in rainfed conditions without using irrigation and the other management practices were in accordance with the recommended practices for the crop.

The 1000-seed weight (g), hectolitre mass (kg), seed yield (kg ha) were calculated and additionally the seeds were analyzed for their protein composition. The crude protein in seeds was determined by the Kjeldahl method described by Nelson and Sommers (1980). The principle of method consists in the determination of total nitrogen content and its conversion into crude protein by multiplying by the factor 6.25. The crude protein content is given by the relation:

$$PB = Ntx6,25$$

The meteorological data (average air temperature and rainfall) of the five months in which the research was carried out are given in table (1) taken from Ezăreni meteorological station.

Statistical analyses

For all mentioned descriptors the experimental results were calculated using the analysis of variation method [10] to determine the significance of the difference between variants (fertilization, row spacing), calculating the limiting differences for the 5%, 1% and 0.1% probability of transgression.

Year/Month	April	May	June	July	August	Average
Temperature (℃)						
Average℃	7.8	14.9	19.8	22.2	20.9	17.1
2021	10.1	16.1	19.4	21.3	20.6	17.5
Deviation	-2.3	-1.2	0.4	0.9	0.3	0.38
Rainfall (mm)						
Σmm	56.4	86	107.4	80.3	155.6	97.14
2021	40.3	52.5	75.1	69.2	57.6	58.94
Deviation	16.1	33.5	32.3	11.1	98	38.2

Table 1. Temperature and precipitation during the growing season.

3. Results and Discussions

1000-seeds weight (g). In this study, the highest value of 1000-seed weight was 160.53 g, obtained at 25 cm row spacing with a difference from the control of 1.17 g, and the lowest value was 150.53 g at 50 cm row spacing. This is explained by better optimization of the nutrition space at row spacings of 25 cm and 37.5 cm, respectively.

Grass pea crop showed a consecutive improvement in 1000-seed weight with each increase in NPK doses. Thus, in the control without fertilization, the weight of 1000 seeds was 156.13 g. The applying of $N_{93}P_{92}K_{32}$, with a very significant positive difference from the control, resulted in the highest value of 1000 seeds, which was 158.97 g. Also, the increasing level from $N_{36}P_{36}K_{16}$ to $N_{60}P_{60}K_{0}$ determined an increase in the weight of 1000 seeds, the differences from the control find very significant, positive (Figure 1).

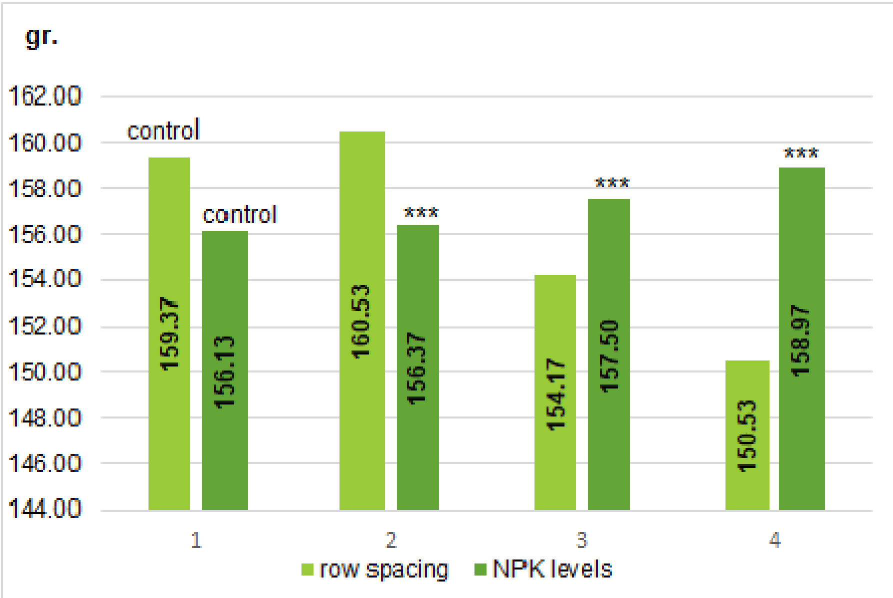

Figure 1. Effects of row spacing and levels of NPK on 1000 seeds weight.

The results from this study on the weight of 1000 seeds were lower than those of Karadag Y. [12], and higher than those of Seydosoglu Y. [25] and Kaminkyi V. [11].

Hectolitre weight. In *Figure 2*, it can be observed that the row spacing of 37.5 cm produced the highest value of hectrolitre weight, which was 80.0 kg/hl, with a difference compared to the control of 1.31 kg/hl. The applied NPK fertilizer did not have a positive influence on the hectolitre weight, the highest value obtained being 79.0 kg/hl for the control. Although the hectolitre weight has not been evaluated in many studies, the results are almost in agreement line with the findings of Campbell C. [7], which reported a hectolitre weight between 61.22 kg/hl and 82.88 kg/hl.

Yield. The highest seeds yield was obtained at 25 cm row spacing (2444 kg/ha), which was significantly higher than the yield obtained at the others row spacings applied. In figure 3 it can be observed that at 25 cm row spacing the difference is distinctly significant, with a difference of 514 kg compared to the control, and at 37.5 cm row spacing the difference is significant, with 340 kg higher than the control. In the case of row spacing of 50 cm, the difference to the control is significant, but negative. It

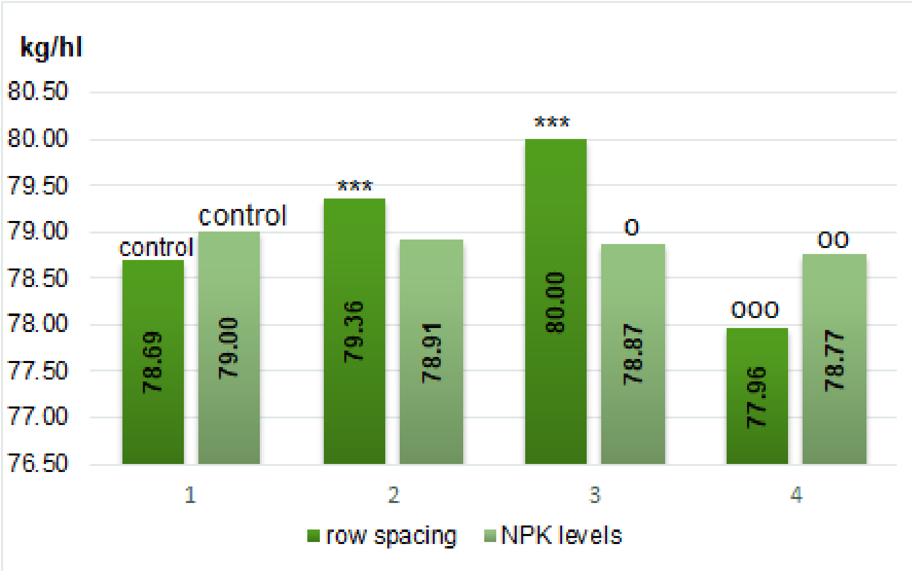

Figure 2. Effects of row spacing and different levels of NPK on hectolitre weight.

might due, to the lower number of plants per unit area as compared to the other spacings. Nandini Devi [18] and Luikham E. [13] reports similar results for *Lathyrus sativus* L.

In the case of fertilization, the application of complex fertilizers at the rate of $N_{36}P_{36}K_{16}$, recorded the highest yield value of 2276 kg/ha, but it should be noted that the application of $N_{60}P_{60}K_0$ and $N_{92}P_{92}K_{32}$ resulted in a decrease in yield, 1835 kg/ha and 1783 kg/ha respectively, the differences being very significant but negative (*Figure 3*). Kaminkyi V. [11] reported similar findings.

The effectiveness of lower fertilizer rates has been confirmed by several scientific studies. Thus, the application of potassium fertilizer had a significant effect on production parameters (pod/plant, seed/pod, MMB, biomass yield and seed yield), with the highest values obtained when applying a 20 kg/ha K_2O dose [1]. Mesfin S. [17] obtained the highest seed yields when $N_{20}P_{20}$ was applied, thus the use of nitrogen-phosphorus fertilizers had a positive effect on root system formation at early stages of plant development and on legumes productivity. Sahu B. [23] showed that the application of mineral fertilizers with nitrogen, phosphorus and potassium at the rate of 20.40.20 significantly increased crop yield.

Protein content (%) in *Lathyrus sativus* L. Analysing the influence of row spacing on the crude protein content of the grass pea seeds, it can be seen that the row spacing of 37.5 cm resulted in the highest protein content of 33.99%, the difference from the

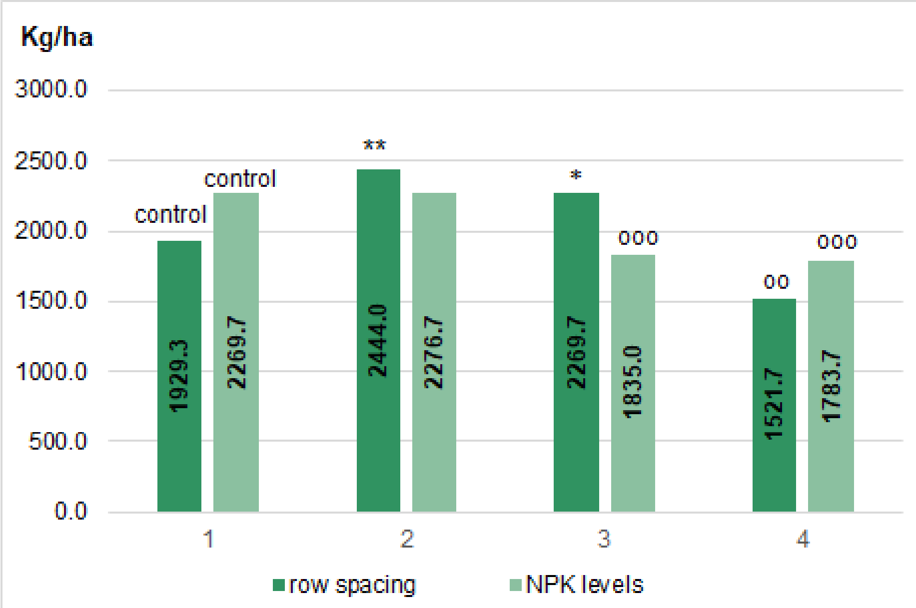

Figure 3. Effects of row spacing and levels of NPK on seeds yield.

control being very significant, positive. The lowest value was recorded at 50 cm row spacing, with a difference to the control very significant but negative. According to the results obtained in this study, the highest crude protein value of 31.6% was recorded when $N_{60}P_{60}K_0$ fertilizer was applied, followed by 30.4% when $N_{36}P_{36}K_{16}$ treatment was applied. The differences between the doses of NPK and control are highly significantly, positive (*Figure 4*). In this study, these findings regarding the protein content of grass pea seeds are similar with the results obtained by Banerjee P. *et al* [3].

There is a positive correlation between row spacing and production (kg/ha), with the quadratic regression having a value of 0.988%. Between 1000-seeds weight and production the regression factor is 0.933%. Between hectolitre weight and production the regression factor is 0.915%. A low interaction was found between protein and row spacing.

In the case of fertilization, a strong correlation was found between this factor and 1000-seeds weight, with the quadratic regression having a significant value of 0.989%.

A low interaction was found between fertilizer doses (NPK) and yield, hectolitre mass and protein content, the regression factors having the following values: 0.644%, 0.512%, 0.181%.

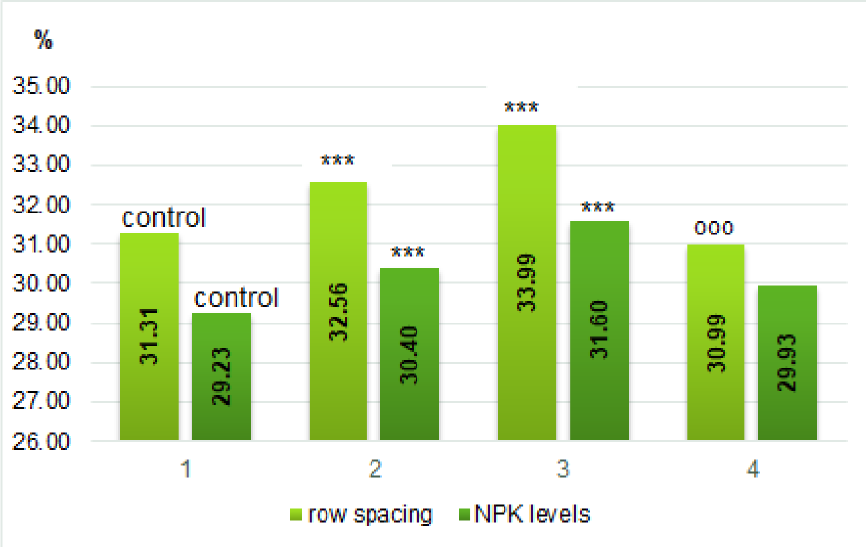

Figure 4. Effects of row spacing and levels of NPK on the protein content in grass pea.

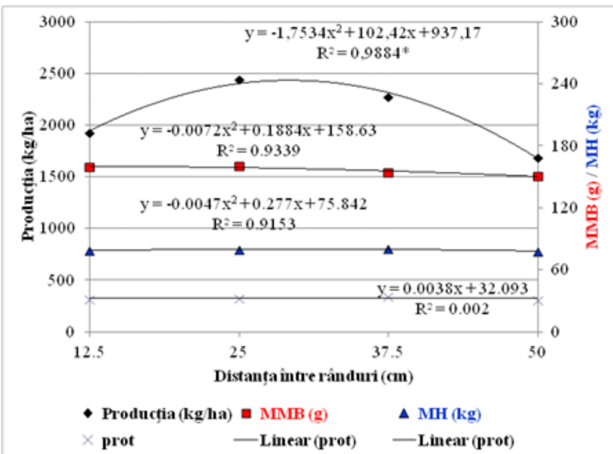

Figure 5. Correlation between row spacing and production elements.

4. Conclusions

The seeds of *Lathyrus sativus* L. have potential as an alternative source of protein, according to the experimental results, the protein content is rich, ranging from 29.23% to 33.99%.

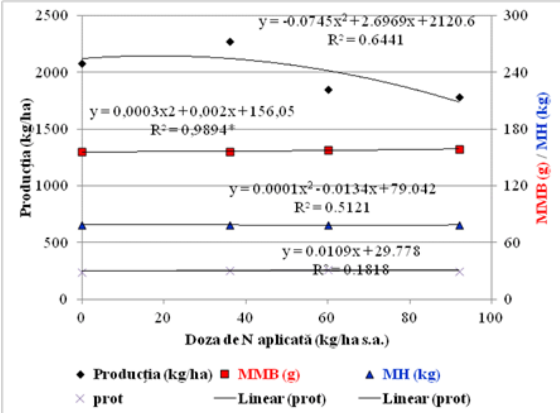

Figure 6. Correlation between levels of NPK and production elements.

It was found that one dose of $N_{60}P_{60}$ is sufficient for better grass pea production. Also, sowing grass pea at 50 cm row spacing for forage, green manure or cover crop production, and sowing at 25 cm row spacing is recommended when seed consumption is desired.

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