THE INFLUENCE OF SOME NPK MINERAL FERTILIZERS DOSES ON FIELD PEAS

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Abstract: *The influence of mineral fertilization on the field pea crop was analyzed based on some elements of productivity and biological yield. Fertilizers with nitrogen (0, 25, 75 kg a.s. /ha; a.s. active substance), phosphorus (0, 80 kg a.s. /ha) and potassium (0, 40, 80, 120 kg a.s. /ha) were applied to the field peas crop Boxer cultivar. The number of pods (Pp_N) varied between 88.00 - 202.00 /m^2. The weight of the pods (Pp_W) varied between 50.20 – 174.40±10.77 g/m^2. The weight of the peas grains (Pg_W) varied between 35.10 – 144.10±9.26 g/m^2. The weight of pea pods shells (Pps_W) varied between 15.00 – 37.00±1.64 g/m^2. Biological yield (BY) varied between 0.23 - 0.38±0.01 kg/m^2. The ratio between PgW/Pp_W was calculated and values between 0.680 – 0.830±0.011 were recorded. The Pps_W/Pp_W ratio was calculated and values between 0.170 - 0.320±0.011 were recorded. Different levels of correlation were recorded between determined parameters. Mathematical models were obtained that described the variation of the parameters considered, in relation to NPK fertilizers.*

Key words*: biological yield, fertilizers, field peas, grain production, leguminous crops*

INTRODUCTION

Legumes are important for humans and occupy the second place, after grasses [9]. The authors analyzed the importance of leguminous plants in different soil conditions, in natural and agricultural environments, and highlighted the direct importance through the productions achieved, as well as the importance for the soil and subsequent crops. It was recorded the high importance that leguminous crops present for sustainable agricultural systems through the ecosystem and socioeconomic services they provide [16].

The leguminous crops were analyzed in terms of the benefits they bring to human and animal nutrition (production of proteins, fibers, fodder, etc.) as well as based on the benefits in agricultural crop rotations through nitrogen fixation [12]. Legumes have been studied under conditions of intercropping, for the favorable "eco-agricultural" effects they have, beneficial to successive crops and the soil [4].

In the perspective of the growing demand for food resources, legumes represent an alternative source of protein, in the context of sustainable agricultural systems [8]. The authors of the study analyzed the influence of some environmental factors on the physiological processes of leguminous plants, and highlighted the importance of breeding programs for productive genotypes.

The importance of legumes in crop rotation has been highlighted for the purpose of sustainable agricultural systems [6]. The authors of the study referred to the simple rotations that prevail in many agricultural systems, and marked the need to reconsider legumes in the crop structure and agricultural rotations. At the same time, the authors mentioned some aspects that led to the restriction of the areas cultivated with legumes.

The influence of fertilizers (especially those with nitrogen) was analyzed in relation to the symbiotic fixation of molecular nitrogen through symbiosis in leguminous plants [1]. The authors presented the effects of intensive fertilization with synthetic fertilizers and recommended the need to reconsider biofertilizers for ensuring nitrogen (in a certain amount) in the agricultural environment.

Associated with the low fertility of soils in different parts of the world, leguminous

crops offer ecosystem and socio-economic benefits, by capitalizing on the respective areas, protein and biomass production, by fixing nitrogen and beneficial effects for successive crops [13]. Restoring soil fertility has been studied by cultivating leguminous species, with favorable effects by fixing nitrogen on successive crops, e.g. wheat [14]. In the study conditions, the authors communicated the replacement of a nitrogen rate between 18 - 46 kg/ha by using legumes in the rotation with the wheat crop.

The cultivated productive genotypes (varieties or hybrid firms) have led farmers to adopt fertilization systems with increasingly high rates of fertilizers, especially chemical fertilizers [17]. The authors highlighted the increasing dependence on inputs, and the low durability of these agricultural systems. In this context, the authors have analyzed alternatives at the farm level for sustaining productivity based on organic fertilizers, of leguminous crops, in conditions of environmental balance and farm sustainability. Studies in different locations (12 locations) with varied compositions of grasses and legumes, in relation to inorganic fertilizers with N, showed the important role of legumes for improving the quality and production of fodder [15].

Legumes are a vegetable source of protein for human nutrition and animal feed, with benefits for human health and for the environment [18]. The authors of the study highlighted the benefits of legumes in human nutrition, as well as the benefits for the environment through the eco-functional role they play in natural and cultivated (agricultural) ecosystems.

The present study analyzed the influence of mineral fertilization with NPK fertilizers on the field pea crop, based on some relevant productivity elements.

MATERIALS AND METHODS

The study analyzed the variation of some productivity elements in field peas, in relation to mineral fertilization, agricultural year 2022-2023. The study took place in ARDS Lovrin, Romania. The field experiment was located on a chernozem type soil with medium fertility. The biological material, the variety 'Boxer', was cultivated in a non-irrigated system. Sowing was done in March, the optimal time.

Mineral fertilization was provided by fertilizers with nitrogen (ammonium nitrate), phosphorus (superphosphate) and potassium (potassium sulfate). Fertilizers with phosphorus (0, and 80 kg a.s./ha) and potassium (0, 40, 80, and 120 kg a.s./ha) were applied in autumn and incorporated with the plowing work. Nitrogen fertilizers (0, 25, and 75 kg a.s./ha) were applied in spring.

At physiological maturity, determinations were made on the experimental variants regarding biological yield (BY, kg/m^2), pea pods number (Pp_N, m^2), pea pods weight (Pp_W, g/m^2), pea grains weight (Pg_W, g/m^2), pea pod shells weight (Pps_W, g/m^2). Based on the recorded values, the ratio Pg_W / Pp_W, and the ratio Pps_W / Pp_W were calculated.

The experimental data were analyzed under the aspect of statistical safety, the distribution of the data series, the interdependence relationships between the parameters and the relationship between the parameters and the applied fertilizers. The calculation module from EXCEL and the Past application [10] were used.

RESEARCH RESULTS

The analysis of the parameters considered representative for the field pea crop, in relation to mineral fertilization, led to the values presented in table 1. Thus, the determined parameters presented variation values (min, max) as follows: BY = 0.23 – 0.38±0.01 kg/m^2; Pp_N = 88.00 – 202.00±8.00 pea pods/m^2; Pp_W = 50.20 – 174.40±10.77 g/m^2; Pg_W = 35.10 – 144.10±9.26 g/m^2; Pps_W = 15.00 – 37.00±1.64 g/m^2. In the case of the

calculated ratios, they presented sub-unit values, as follows: Pg_W/Pp_W = 0.68 – 0.83±0.01, and Pps_W/Pp_W = 0.17 – 0.32±0.01.

Table 1.

The statistical values of the analyzed parameters for field peas, 'Boxer' cultivar in relation to mineral fertilization

	BY	Pp_N	Pp_W	Pg_W	Pps_W	Pg_W/Pp_W	Pps_W/Pp_W
N	16	16	16	16	16	16	16
Min	0.23	88.00	50.20	35.10	15.00	0.68	0.17
Max	0.38	202.00	174.40	144.10	37.00	0.83	0.32
Mean	0.30	144.50	105.01	80.98	24.03	0.76	0.24
Std. error	0.01	8.00	10.77	9.26	1.64	0.01	0.01
Variance	0.002	1024.000	1855.689	1371.932	42.886	0.002	0.002
Stand. dev	0.044	32.000	43.078	37.040	6.549	0.046	0.046
Median	0.31	144.00	95.65	71.35	23.60	0.76	0.24
25 prcntil	0.26	116.25	65.35	46.55	18.43	0.72	0.20
75 prcntil	0.34	172.00	150.73	118.95	28.78	0.80	0.28
Skewness	-0.1686	0.0468	0.4096	0.4266	0.4529	-0.0659	0.0659
Kurtosis	-0.9525	-0.6864	-1.2622	-1.2909	-0.3996	-1.1230	-1.1230
Geom. mean	0.299	141.062	96.796	73.098	23.199	0.756	0.239
Coeff. var	14.710	22.145	41.024	45.738	27.258	6.040	18.802

The representation of the distribution of the values of the parameters determined for peas, the 'Boxer' cultivar, is presented in figure 1. A normal distribution was observed (r = 0.965 to r = 0.996.

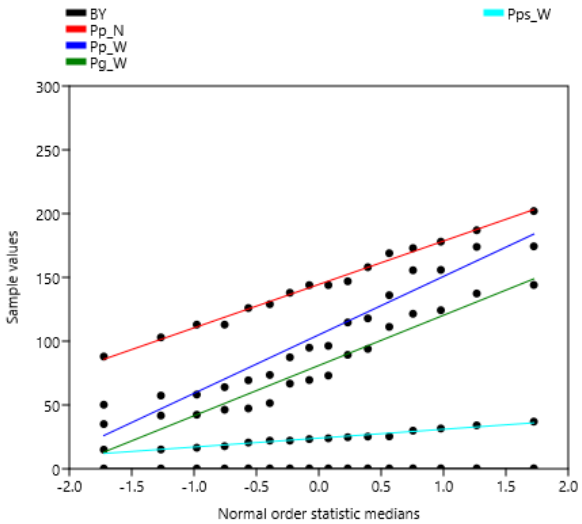

Figure 1. Probability plot for determined parameters

Parameters determined in field peas, the 'Boxer' cultivar, showed different variability. Based on the coefficient of variation (CV), high variability was appreciated at the level of the Pp_W parameters (CV=41.024) and the Pg_W parameter (CV=45.738). Moderate variability was recorded in the case of the pp_N parameter (CV=22.145) and the Pps_W parameter (CV=27.258). Low variability was recorded in the case of the BY parameter (CV=14.710) and the ratios PgW/Pp_W (CV=6.040), respectively Pps_W/Pp_W (CV=18.802).

The correlation analysis identified variable levels of correlation, represented graphically in figure 2. Very strong, positive correlation was recorded between Pg_W and Pp_W (r=0.998), between Pps_W and Pp_W (r=0.933), and between Pps_W and Pg_W (r=0.909). Very strong negative correlation was recorded between Pps_W/Pp_W and PgW/Pp_W (r=-0.999).

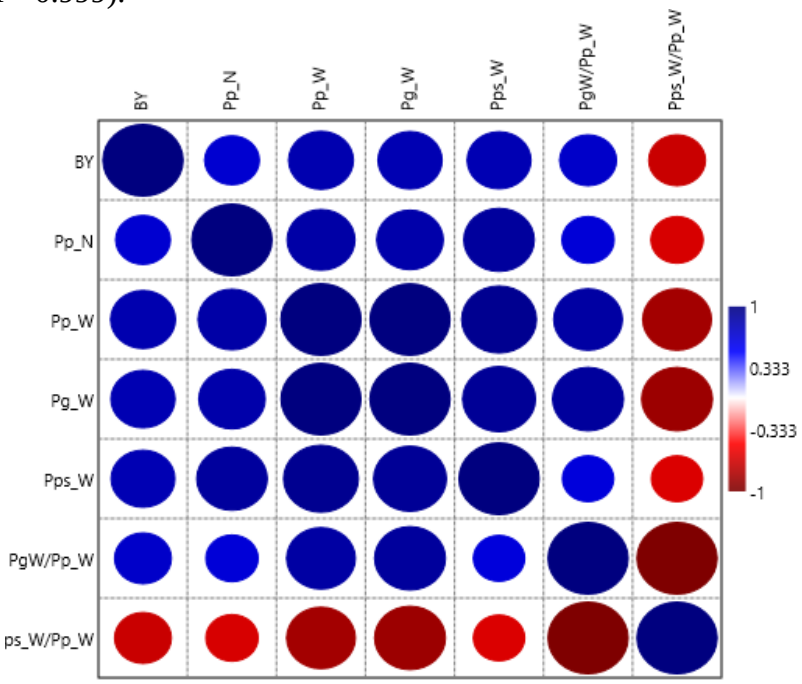

Figure 2. Correlation matrix diagram in the case of the parameters analyzed in the field pea crop, Boxer variety

Strong correlation was recorded between Pp_W and BY (r=0.809), between Pg_W and BY (r=0.800), between Pp_W and Pp_N (r=0.847), between Pg_W and Pp_N (r=0.830), between Pps_W and Pp_N (r=0.880), between PgW/Pp_W and Pp_W (r=0.857) and respectively between PgW/Pp_W and Pg_W (r=0.884). Strong negative correlation was recorded between Pps_W/Pp_W and Pp_W (r=-0.857) and between Pps_W/Pp_W and Pg_W (r=-0.884). Moderate and weak correlations were also recorded at the level of the other parameters.

It was analyzed how the NPK fertilizers, in the applied doses, determined the variation of the main parameters (BY, Pp_N, Pp_W, and Pg_W). The BY variation was described in relation to NPK by equation (1), under conditions Multiple R=0.432. The Pp_N variation was described by equation (2) in relation to NPK, under conditions of Multiple R=0.503. The variation of Pp_W in relation to NPK was described by equation (3) under conditions of Multiple R=0.409. The variation of Pg_W in relation to NPK was described by equation (4) under conditions of Multiple R=0.399.

$$BY = 0.2727 - 0.00014 \cdot N + 0.00022 \cdot P + 0.00038 \cdot K \quad (1)$$

$$Pp\_N = 139.6 - 0.112 \cdot N - 0.1912 \cdot P + 0.2675 \cdot K \quad (2)$$

$$Pp\_W = 107.398 - 0.102 \cdot N - 0.3014 \cdot P + 0.2142 \cdot K \quad (3)$$

$$Pg\_W = 84.951 - 0.101 \cdot N - 0.2594 \cdot P + 0.1593 \cdot K \quad (4)$$

where: N – nitrogen fertilizer, kg a.s./ha; P – phorphorus fertilizer, kg a.s./ha; K – potassium fertilizer, kg a.s./ha; a.s. – active substance

From the analysis of equations (1) - (4), based on the values of the nitrogen coefficients, it was found the negative influence of nitrogen for the formation of the values of the analyzed parameters, under the study conditions. Phosphorus had a positive

influence on the formation of BY, and a negative influence on the formation of the other parameters. Potassium (K) showed a positive influence, for each parameter, in the study conditions. The results show the practical importance regarding fertilization recommendations in similar field pea culture conditions.

The response of crops to fertilization has been intensively studied, for reasons of optimizing fertilization, yields, production quality and the impact on the environment [2,5,7]. In leguminous crops, fertilization has certain peculiarities, especially through the application of nitrogen, as a result of the symbiotic fixation of this element by the plants. Abd-Alla et al. (2023) [1] communicated the influence of intensive nitrogen fertilization on legumes and recommended the need to reconsider organic fertilizers. Janusauskaite (2023) [11] reported a variable response recorded in three pea varieties with variable fertilization rates. Bijarniya et al. (2023) [3] reported the influence of mineral fertilization with NPK in the field pea crop on the crop and soil properties

Through the presented and analyzed results, the present study completes the published database regarding the influence of mineral fertilization in the category of leguminous crops, with data recorded for field peas.

CONCLUSIONS

NPK mineral fertilization through the doses applied in the study conditions generated variable response in terms of productivity parameters and yield in field pea crop, Boxer variety.

The recorded results showed a normal distribution, under statistical safety conditions. The parameters Pp_W (CV=41.024) and Pg_W (CV=45.738) showed high variability.

Various levels of correlation were recorded between parameters determined in the pea crop, in response to the applied mineral fertilization.

Mathematical models described the variation of each parameter in relation to the doses of NPK applied. The variable contribution of each fertilizing element to the formation of productivity parameter values was established.

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REFERENCES

[1]. ABD-ALLA M.H., AL-AMRI S.M., EL-ENANY A.-W.E., 2023, Enhancing rhizobium–legume symbiosis and reducing nitrogen fertilizer use are potential options for mitigating climate change, Agriculture, 13, 2092

[2]. AGEGNEHU G., AMEDE T., DESTA G., ERKOSSA T., LEGESSE G., GASHAW T., VAN ROYEN A., HARAWA R., DEGEFU T., MEKONNEN K. SCHULZ S., 2023, Improving fertilizer response of crop yield through liming and targeting to landscape positions in tropical agricultural soils, Heliyon, 9(6), e17421

[3]. BIJARNIYA A., THOMAS T., SWAROOP N., VINAY., 2023, Influence of different levels of NPK and biochar on physico-chemical properties of soil in field pea, International Journal of Environment and Climate Change, 13(8), 988-995

[4]. CHAMKHI I., CHETO S., GEISTLINGER J., ZEROUAL Y., KOUISNI L., BARGAZ A., GHOULAM C., 2022, Legume-based intercropping systems promote beneficial rhizobacterial community and crop yield under stressing conditions, Industrial Crops and Products, 183, 114958

[5]. DHAKAL C., LANGE K., 2021, Crop yield response functions in nutrient application: A review, Agronomy Journal, 113(6), 5222-5234
[6]. DITZLER L., VAN APELDOORN D.F., PELLEGRINI F., ANTICHI D., BÁRBERI P., ROSSING W.A.H., 2021, Current research on the ecosystem service potential of legume inclusive cropping systems in Europe. A review, Agronomy for Sustainable Development, 41, 26
[7]. DOBREI A., SALA F., GHITA A., MALAESCU M., 2009, Researches concerning the influence of different fertilization systems on the quantity and quality of the production at some table grapes cultivars, Journal of Horticulture, Forestry and Biotechnology, 13, 454-457
[8]. DUTTA A., TRIVEDI A., NATH C.P., GUPTA D.S., HAZRA K.K., 2022, A comprehensive review on grain legumes as climate-smart crops: Challenges and prospects, Environmental Challenges, 7, 100479
[9]. GRAHAM P.H., VANCE C.P., 2003, Legumes: Importance and constraints to greater use, Plant Physiology, 131(3), 872-877
[10]. HAMMER Ø., HARPER D.A.T., RYAN P.D., 2001, PAST: Paleontological Statistics software package for education and data analysis, Palaeontologia Electronica, 4(1), 1-9
[11]. JANUSAUSKAITE D., 2023, Productivity of three pea (*Pisum sativum* L.) varieties as influenced by nutrient supply and meteorological conditions in boreal environmental zone, Plants (Basel), 12(10), 1938
[12]. JIMENEZ-LOPEZ J.C., SINGH K.B., CLEMENTE A., NELSON M.N., OCHATT S., SMITH P.M.C., 2020, Editorial: Legumes for global food security, Frontiers in Plant Science, 11, 926
[13]. RAWAL N., KHATRI N., KHANKA D., PANERU P., 2023, Fertilizer management and incorporation of legumes on performance of maize (*Zea mays* L.) in western hills of Nepal, Journal of Agriculture and Food Research, 14, 100690
[14]. REGASSA H., ELIAS E., TEKALIGN M., LEGESE G., 2023, The nitrogen fertilizer replacement values of incorporated legumes residue to wheat on vertisols of the Ethiopian highlands, Heliyon, 9(11), e22119
[15]. ŠIDLAUSKAITĖ G., KADŽIULIENĖ Ž., 2023, The effect of inorganic nitrogen fertilizers on the quality of forage composed of various species of legumes in the Northern part of a Temperate Climate Zone, Plants (Basel), 12(21), 3676
[16]. STAGNARI F., MAGGIO A., GALIENI A., PISANTE M., 2017, Multiple benefits of legumes for agriculture sustainability: an overview, Chemical and Biological Technologies in Agriculture, 4, 2
[17]. ULLAH I., TARIQ M., SHARIF M., 2023, Comparative effect of organic and inorganic fertilizers on improving soil fertility and productivity of different legumes under alkaline calcareous soil, Gesunde Pflanzen, 75, 361-376
[18]. YANNI A.E., IAKOVIDI S., VASILIKOPOULOU E., KARATHANOS V.T., 2024, Legumes: A vehicle for transition to sustainability, Nutrients, 16, 98