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RESEARCH ARTICLE

THE VARIABILITY OF THE ELEMENTS OF THE STRUCTURE ON THE PEA PRODUCTION (*PISUMSATIVUM L.S.*) ACCORDING TO THE FERTILIZER DOSES IN THE PEDOCLIMATIC CONDITIONS OF BRAZZAVILLE

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ABSTRACT

Objective: The effect of the 4 fertilizer doses was evaluated on the variability of the elements of the structure of local pea production (Pisumsativum L.S) in the Brazzaville area of the Republic of Congo. ***Methodology and results:*** In the field, the production parameters were observed during the development phase with different doses of fertilizer. variants with introduction of a minimum of fertilizer doses ($N_{12,5}$ P_{15} K_{15}) and nitrogen fertilizers (N_{25}) against the background of the average soil phosphorus and potassium supply, as well as when using the The effect of an organomineral fertilization system (NPK and manure post-effect) was the increase in the number of pods per plant compared to the control (control) variant of 26.5%, 21.2% and 23%, respectively., 0%. The maximum of this indicator is in the variant with the introduction of an average dose of mineral fertilizer (N_{25} P_{30} K_{30}) is 4.93 pods per plant. ***Conclusion and application of results:*** The increase in fertilizer doses contributes to the direct growth of the following indicators: seed weight per plant, straw weight and seed of unit area, seed yield by plant; these indicators will help to improve farming practices in the countryside for better productivity.

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INTRODUCTION

Pea (Pisumsativum LS) is a food legume whose leaves and seeds are very rich in protein. It is the staple food of millions of people in tropical and subtropical Africa with more than 25% protein and a lot of lysine and tryptophan (Singh *et al.,* 1997) .This helps to balance cereal and tuber based diets that are generally low in protein and high in carbohydrates (Singh *et al.,* 1997, Dudje *et al.,* 2009). In the Congo, peas, recently introduced, are increasingly appreciated by Congolese who become consumers of its seeds. However, its cultivation is still marginal at the expense of groundnuts, beans and soya appear alone in the national program of agricultural development included in the agricultural policy plan (Anonymous, 2008). Pea is grown in traditional cropping systems only to help diversify the family diet (kinzila, 2009). In addition, in these traditional cropping systems, soils are often poor, with poor mineral reserves and erosion (Agri Congo, 1994). Pea adapts well to abiotic constraints (drought, phosphorus and nitrogen deficiencies, soil acidity) and biotic (diseases and enemies) (Bressani, 1997), making it a culture available throughout the year, when others become rare. Most of the cultivated area is in West Africa (Quin, 1997) and covers 60% of cultivated land with Central Africa (Abdou, 1987). To develop agricultural production in the Bouenza region and, in particular, to increase animal production (Borget, 1989), legumes play an important role. The increase in gross legume royalties is only possible through the development of new cultivation techniques and the increase in the area of their crops. The most widespread cereal crop in the Bouenza region is peas. The broad pea expansion is due to high protein content, balanced amino acid composition, good digestibility and high yield in all natural and climatic zones (Borget 1989). Modern production requires pea (local) varieties with high productivity potential, stable yield and good technicality. In this regard, it is necessary to study agrotechnical techniques that affect the change in quantitative indicators that determine the overall productivity of the plant. This question was devoted to our study, the present study proposes to focus on cultural practices. Thus, it aims to evaluate the effects of the variability of the elements of the

structure of the (local) variety pea harvest as a function of the fertilizer doses in the pedoclimatic conditions of Brazzaville. The best harvest would maximize good productivity and yield in terms of leaves, pods and seeds, depending on the different doses of the fertilizers studied.

MATERIALS AND METHODS

Plant Material the local pea variety used in this study came from the National Institute for Agricultural Research (IRA), located in the southern part of the country, in the department of Bouenza. This variety is also distinguished from other varieties by a higher protein content. This one was bought at the Total market in Brazzaville in the Republic of Congo. The seeds are ovoid and brown in color.

Experimental site: The experiment was conducted from 2016-2018 at the Agricultural Techniques Extension Center. This locality is located in East-South (0 ° and 2 ° of South latitude and 15 ° and 16 ° of East longitude), to 17 kilometers of Brazzaville (Congo). The climate of the study area is of low tropical humid Congolese type, with 4 rainy and dry seasons (Anonymous, 1989). The average annual temperature is 25.5 ° C. Average minima are 19.9 ° C in July and mean maxima 31.9 ° C in March. The average annual rainfall is of the order of 1200 to 1400 mm unequally distributed. Precipitation is almost permanent, with December and April being the wettest months of the year in the study area. The maximum rainfall in April. There are two dry periods; a large one is observed in June-July-August-September and a small one in January-February, marked by the decrease of precipitations. The average annual relative humidity is still high (98%). The soils encountered have a predominantly sandy clay, highly desaturated, poor in bases and very permeable.

Establishment of the test and experimental setup: The experiment was conducted in the stationary crop rotation of the seeds. The structure of the cultivated land in the rotation is as follows: 50% of the cereals, 40% of the plowing, 10% of the beans. The pea was sown in a simple manner with 15 cm spacings and the density per hectare was 1.2 million seedlings. During all the years of study, the local variety of corn precursor pea was sown. The total area is 190.4 m² (5.6m x 34.0m), the area used is 108m² (3.6m x 30.0m) .Before sowing, the seeds were kept in a bag and regularly exposed to the sun to avoid insect attacks. The germination capacity of the seeds was evaluated at the Plant Physiology and Production Laboratory of the Faculty of Science and Technology of Marien Ngouabi University. After sowing, maintenance operations (weeding, hoeing) were carried out each time to avoid competition with weeds and to harbor insects.

The placement of the cup is systematic. The planned doses according to the plan of the experiment for the general treatment of the soil:

1. Control - without fertilizer;
2. Minimum dose of complete mineral fertilizers ($N_{12,5}$ P_{15} K_{15});
3. Average dose of complete mineral fertilizers (N_{25} P_{30} K_{30});
4. Organo-mineral fertilizer system (consequence NPK, manure and straw);
5. Fertilization of the pea in the germination phase at the N_{25} dose.

The experimental setup is a fisher block with four (4) repetitions. Each block is subdivided into five (5) parcels corresponding to five (5) treatments of which: T0 (control); T1 ($N_{12,5}$ P_{15} K_{15}); T2 (N_{25} P_{30} K_{30}); T3 (NPK residual effect, fertilizer); T4 (N_{25} fertilization)

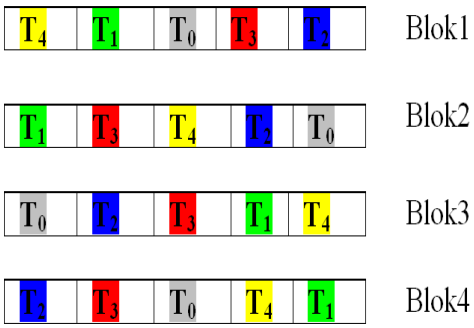

Figure 1. Schematic of the experimental device

Measured Variables and Data Analysis: Data on production parameters were observed during the development phase: number of seeds per pod per plant; this parameter is made by choosing 30 pods per treatment then count the number of seeds per pod to evaluate the average per treatment. For the number of pods, pods were counted per plant, and the number of pods contained was counted in each plot, which corresponded to a treatment. The number of fertile nodes was counted. The weight of 1000 seeds is determined with a precision balance. Seed yield per plant is calculated as a percentage. All data were statistically analyzed using XLSTAT software version 7.5.3. The evaluation of the effect of fertilizer doses on the variability of the elements of the pea production structure was made by comparing average plant levels. The comparison between the means of all the variables was made by the Student Newmann and Keuls test at the 5% threshold.

RESULTS

The analysis of the results of the study showed that, under the influence of the fertilizer doses studied, the most varied sign is the number of pea pods per plant. The three-year average rate of change is 14.8%, with an annual variation ranging from 12.2 to 24.9% (Table 1). On average, in three years, the value of this indicator for plants grown on land without fertilizer (control) is 3.23 pieces. Improved food conditions led to an increase in this indicator. On variants with introduction of a minimum of fertilizer ($N_{12,5}$ P_{15} K_{15}) and nitrogen fertilizer (N25) against the background of the average soil phosphorus and potassium supply, as well as during use the effect of an organomineral fertilizer system (NPK and manure post-effects) was the increase in the number of pods per plant compared to the (control) control variant of 26.5%, 21.2% and 23.0%. The maximum of this indicator is in the variant with the introduction of an average dose of mineral fertilizer (N_{25} $P_{30}K_{30}$) is 4.93 gousses per plant. The mathematical treatment of the data obtained showed a close relationship between the number of gousses per plant and the pea seed yield (+ 0.872 + 0.182). Table 2, shows the second indicator, which varies under the influence of fertilizer doses, is the number of fertile nodes (the average variation rate over three years is 12.7% with an annual variation of 5, 5% to 18.3%). Improving the diet of mineral nutrition of plants leads to an increase of this indicator from 12.3% to 29.2% with a value in the variant without fertilizer (control) is 1.21 pieces.

Table 1. Structure of pea production according to fertilizer doses, 2016-2018

Variant	Number of fertile nodes / plant (pièces)	Number of fertile pods / plant (pièces)	Number of seeds / pod (pièces)	Number of seeds / plant(pièces)	Number of seeds / plant(pièces)
1.Contrôle	1,21	3,23	3,73	12,0	251,4
2. $N_{12,5}P_{15}K_{15}$	1,44	4,40	3,63	16,0	260,5
3. $N_{25}P_{30}K_{30}$	1,71	4,93	3,50	17,3	257,5
4. NPK residual effect, fertilizer	1,38	4,20	3,73	15,7	249,2
5.N_{25}fertilisati-on	1,53	4,10	3,67	15,0	263,4
V,%	12,7	14,8	2,6	13,0	2,3

Table 2. Correlation of dependence between the characteristics of the indicators of the structure of the pea harvest according to the 2016-2018 fertilizer doses

Indicator of harvest structure	r±Sr
Number of fertile nodes / plant	0,767±0,170
Number of pods / plant	0,872±0,082
Number of seeds / pod	-0,507±0,096
Number of seeds / plant	0,921±0,023
Number of seeds / plant	0,260±0,158

Table 3. Productivity of pea plants by fertilizer doses, 2016-2018

Variant of experience	Weight of seeds / plant (g)	Weight of a plant (g)	Yield of seeds / plant (%)	Weight of straw (g / m^2)	Weight of seeds (g/m^2)
1.Contrôle	3,02	7,74	39,0	380,3	243,0
2. $N_{12,5}P_{15}K_{15}$	4,17	9,69	43,0	411,5	310,8
3. $N_{25}P_{30}K_{30}$	4,45	11,59	38,3	527,0	328,3
4. NPK residual effect, fertilizer	3,91	10,57	36,9	528,3	310,0
5.N_{25}fertilisati-on	3,95	10,69	36,9	499,4	292,3

The maximum number of fertile nodes (1.71) formed plants in the variant with an average dose of mineral fertilizer. Analysis of the results showed a close relationship between this indicator and the yield of pea seeds - 0.767 ± 0.170. It should also be noted that the increase in the number of fertile nodes per plant has a significant effect on the increase in the number of pods (the correlation coefficient between these characteristics is 0.907 ± 0.042). On average, over three years of study, there was a small effect of fertilizer doses studied on a mass of 1,000 seeds (V = 2.3%). The most notable effect on the increase of this indicator was observed in the variants with the introduction of a minimum dose of complete mineral fertilizer and a medium dose of nitrogen in the form of fertilization. Exceedances were 9.1 and 12.0 g, respectively, 3.6% and 4.7%. Analysis of the relationship between pea seed size and yield revealed a weak relationship between these indicators, r = 0.260 ± 0.158. Table 2 shows the correlation of dependence between the characteristics of the indicators of the structure of the pea harvest. Thus, the studied fertilizer rates help to increase seed yield by improving structural indicators such as the number of fertile nodes per plant, as well as the number of pods and seeds of a plant, and to a lesser extent, by increasing the size of the seeds.

The weak or inverse influence of the fertilizer doses tested had an impact on the pods, but the degree of this effect was due to the weather conditions that accumulate during the vegetation in the individual years. Table 3 shows the productivity of pea plants as a function of the fertilizer doses studied. The productivity of a plant, as a constituent component of yield, increased with increasing fertilizer doses (Table 3). Thus, on average, in three years of study, the application of a minimum fertilizer dose ($N_{12,5}$ P_{15} K_{15}) contributed to an increase in the weight of seeds of a plant of 38.0% compared to the variant without fertilizer (witness). The largest seed mass of the plant averaged over three years was observed in the variant with a medium dose (N_{25} P_{30} K_{30}) is 4.45 grams, which exceeded the control of 47.3%. The use of the organomineral system effect, as well as the introduction of nitrogen fertilization (N_{25}) in the context of the average soil phosphorus and potassium supply, increased this figure by 29.4% and 30%., 7%. A similar trend is observed with the mass of a plant each year and an average of three years. On the fertilized variants, the mass of the plant increased by 25.1-49.7% with a value on the control variant-7.74 grams. However, for an indicator such as the grain yield of a plant, its increase over control is only observed in the variant with the introduction of a minimum rate of fertilizer - 4.0% and 43.0%. Continuous improvement of mineral nutrition does not lead to an increase in the proportion of grains in the plant. In addition, compared to control, it decreased by 0.7-2.1%, which is due to an increased increase in mass above ground, as evidenced by the total mass of straw per unit area on these variants, which has reduced the yield of the grain of a plant. Thus, if the lowest dose ($N_{12,5}$ P_{15} K_{15}) increases the mass of the straw compared to a variant without fertilizer on average three years for a total of 8.2%, then it is necessary to increase the dose twice (N_{25} P_{30} K_{30}) and use the effect of the organomineral system and introduce nitrogen fertilizer (N_{25}) is 31.3 to 38.5% or 1.2 to 1.3 times. To characterize the ability of plants to rationally use organic matter to form an economically valuable part of the crop, use an indicator such as the ratio of seed to straw.

DISCUSSION

Organic matter in the form of semi-rotten manure plays many roles in improving or maintaining the physical qualities of the soil, in its ability to store water reserves, in the development of microbial life (Rouanet, 1986). For Dupriez *et al.* (1983) reviewed by Swift *et al.* (1987), organic manure, such as animal manure, provide nutrients to the soil while improving its structure. The combination of the residual effect, NPK fertilizer thus makes it possible to obtain the best results of the average daily increment of substance at the beginning of the vegetation (from germination to bud formation) on the plants (Geslin, 1997). The analysis of the bibliography has shown that multiple seeds in a pod are the least variable sign (Ostapenko *et al.,* 1985, Kriuchkova, 1988). In our study, the

amount of seeds in a pod under the influence of fertilizer varied to a lesser extent. The rate of change is 2.6% and, over one year, from 1.6% to 4.7%. The mathematical analysis shows the inverse relationship between the number of pods on the plant and their seed-forming capacity is r = -0.823 ± 0.127. A similar, but less narrow, relationship exists between the seed formation capacity in pods and the yield of pea seeds is r = -0.507 ± 0.096. However, the combined effect of the number of pods on the plant and their seed formation capacity on pea seed yield is close (r is the multiple correlation coefficient was 0.970 ± 0.017). Thus, according to the results of our study, the use of fertilizer provides an increase in the crop, which, depending on the experience options, is determined by the weather conditions of a given year. The highest average yield over three years and separately over the years, the options with a medium dose (N_{25} P_{30} K_{30}) and with the use of the organomineral system (NPK post-effect and manure) are distinguished. According to Pesola (1987), weather factors affect the quality of pea seeds more.

A similar trend has been observed in our experiments. Organic matter in the form of semi-rotten manure plays many roles in improving or maintaining the physical qualities of the soil, in its ability to store water reserves, in the development of microbial life (Rouanet, 1986). For Dupriez *et al.* (1983) reviewed by Swift *et al.* (1987), organic manure, such as animal manure, provide nutrients to the soil while improving its structure. The combination of the residual effect, NPK fertilizer thus makes it possible to obtain the best results of the average daily increment of substance at the beginning of the vegetation (from germination to bud formation) on the plants (Geslin, 1997). . The analysis of data on the number of seeds from a plant, as an indicator of productivity, shows that the fertilizer doses studied have a significant impact on this figure (V = 13.0%). The improvement of the mineral nutrition regime of pea plants helps to increase this indicator is from 20.0 to 30.6%. It was bigger in the variants with the introduction of a minimum of ($N_{12,5}$ P_{15} K_{15}) and average of (N_{25} P_{30} K_{30}) doses of mineral fertilizer and rises respectively of 16,0 pieces and 17,3 pieces It is necessary note also a significant effect of the number of seeds of a plant on the yield r = 0.921 ± 0.023. In our research on the variant without fertilizer, on average over three years, this figure was 0.71. The application of the minimum rate increased this ratio by 28.1%, which is certainly due to a higher increase in grain mass per unit area (27.9%) and to a smaller one - straw (8.2%). However, a further increase in fertilizer doses, although it contributed to an additional increase in grain mass per unit area averaging 20.2-35.1%, but reduced the ratio of seeds: straw, while increasing the mass of straw per unit area. The decrease of seed versus straw in these variants was 7.5-39.2% compared to a field without fertilizer.

Conclusion

For example, the fertilizer rates studied helped to increase seed yield by improving structural indicators such as the number of fertile nodes per plant, as well as the number of pods and seeds of a plant, and to a lesser extent. Measure, increasing the size of the seed. The fertilizer doses tested have had a weak or inverse influence on the impact of a pod, but the degree of this influence is due to the meteorological conditions that accumulate during the vegetation for a few years. The studies carried out showed a varied influence of the fertilizer doses used on the productivity of pea plants. The increase in fertilizer doses contributes to the direct growth of the following indicators: the weight of the seed of the plant, the weight of the straw and the seed of the unit of surface. However, because of the intensive development of the vegetative mass in the variants with a medium dose of mineral fertilizers, as well as in the variants using the continuation of the organomineral fertilizer system and the application of fertilization with nitrogen, there is has a decrease in indicators such as the release of seeds from the plant and the ratio of seed to straw. It should be noted that in the variant with a minimum rate of fertilizer ($N_{12,5}$ P_{15} K_{15}), the percentage increase in the mass of the seed is higher than the straw with a unit area, which leads to an increase of these indicators in relation not only to control, but also to other fertilized variants.

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