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Research Article

Influence of Two Doses of Hen Droppings on Emergence and Growth of Five Provenances of *Sesamum indicum* L. Grown on the Sands of Brazzaville, Congo

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Abstract

The aim of the present study was to evaluate the influence of hen droppings on the emergence and growth of local sesame. A 5 x 3 complete bi-factorial combination, represented by the factors "provenance" and "dose", was inserted into a complete randomised block design. Three replicates were used. Here, the treatment was defined as the combination of five variants of the provenance factor with the three variants of the dose factor. A total of fifteen treatments, repeated 3 times, were studied. Five variables were monitored in the field: field emergence percentage, plant height (cm), crown diameter (mm), number of primary branches and number of leaves emitted on the main stem. The results showed that the curves for percentage emergence over 9 weeks showed almost similar behaviour for the last observation at week 9. In such cases, some statistics revealed significant differences not only between blocks but also between treatments. This suggested that the visual similarity in factor behaviour, for such variables, may be real or fake. For variables that did not discriminate between blocks, the idea of dividing the experimental site into blocks was not justified. Provenances P1 and P5 appeared to be insensitive to organic fertiliser inputs, whereas P2, P3 and P4 were it. This could be explained by whether or not they were sensitive to competition effects. For diameter at collar, treatments P2D1 and P5D1 combining Mouyondzi (P2) and Ngoko (P5) provenances as well as P4D1 and P4D2 combining Boundji (P4) provenance could be recommended to farmers located in the southern part of Brazzaville department. Nevetheless, their insensitivity could temper such recommendation. Concerning plant height, treatments P5D1 and P5D2 could be recommended to farmers located in the southern part of the Brazzaville region. Nevertheless, its supposed insensitivity at doses of hence droppings tempers our recommendations. For the number of leaves emitted and number of primary branches, treatments P5D0 and P5D1 as well as P5D1 and P5D2 combining provenance P5 could be recommended to farmers located in the southern part of the Brazzaville région at condition that its supposed insensitivity is not confirmed during confirmation trial.

Keywords

Organic Manure of Hen Droppings, Performance, Sesame, Variables of Morphological Development

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1. Introduction

Sesame (*Sesamum indicum* L.) is an ancient and important oilseed crop. It is grown mainly in tropical and subtropical regions of Asia, Africa and South America. It belongs to the Pedaliaceae family and to the Sesamum genus [1, 2]. At present, only *Sesamum indicum* and its many varieties are of commercial and economic value internationally, thanks to the nutritional and medicinal value of its seeds. According to the FAO [3] global sesame seed production exceeded 5.5 million tons in 2017, of which 57% was produced in Africa and 40% in Asia. The incomes generated by the sale of production was estimated at over 6.5 billion dollars in 2018 [4]. However, Congolese national production remains insignificant overall: over eight decades, it has risen from 50 tons in 1961 to 269.35 tons in 2021, compared with world production of 419,988 to 6,354,477 tons over the same period [5]. The seeds, along with their products and by-products, are an important source of quality protein and oil, making them one of the most sought-after protein crops for food, cosmetics and pharmacopoeia. The total protein content is 20% [6], and the oil from its seeds contains high levels of tocopherol (176 mg/kg fat), total sterols (543 mg/kg fat) and 14% aliphatic and terpene alcohols [7].

Although less well known, sesame leaves are an important source of polyphenols and iridized compounds, with the highest content of actenoside, a polyphenol with a broad medicinal use that has until now only been synthesised biosynthetically.

Faced with the growing need for good quality food in sufficient quantities, it is vital to increase agricultural and livestock production, including sesame. One of the levers for optimising agricultural production is the use of organic manure, a less expensive fertiliser that is rich in nutrients. Food security in the Congo is heavily dependent on national agricultural, animal and fish production, which remains low and insufficient to adequately cover the needs of the population. Between 1998 and 2005, the number of undernourished people in the Congo was estimated at around 32% of the total population [8]. Sesame was introduced to the Congo with the arrival of colonial explorers, who probably brought it back from West Africa. Its cultivation was motivated by the extraction of oil for soap-making and oilcake for chicken feed, but it was soon abandoned in favour of groundnuts. It was soon relegated to the status of a secondary or emergency food in Congolese village and rural communities. As a result, sesame is little known to the Congolese public. The agro-morphological performance of local sesame varieties is also poorly known. It is therefore crucial to know how these provenances respond to manure inputs. With a view to developing and promoting sesame as an alternative food that is both rich in nutrients and can be produced at low cost, we set out to assess the growth performance of five Congolese sesame varieties.

2. Materials and Methods

2.1. Experimental Site et Plant Material

The trial was set up and conducted over the period from 10 December 2020 to 10 April 2021, in the test garden of the Marien N'GOUABI University, located behind the Teachers Polytechnic College (ENSP). This enclosure is located in arrondissement N °1, Makélékélé in Brazzaville at 15 °14'23.6" East and 4 °16'42.4" South, overlooking a plateau 321 m high. The "transitional equatorial climate" prevails here, belonging to the lower-Congo type [9, 10] with average monthly temperatures ranging from around 21 °C to 27 °C. Annual temperature variations are small and do not exceed 5 °C. The site benefits from tropical climatic conditions, creating favourable conditions for peasant farming. According to the study of [11], this lower-Congo climate is characterised by two seasons, in particular a rainy season from October to May, The Brazzaville soil is made up of layers of fine sand with a sandy-clay texture, with a pH ranging from 4 to 5.5. The organic matter content and the degree of saturation of the absorbent complex are low [12, 13].

The plant material consisted of five provenances of local sesame whose seeds were used in the two cropping cycles. They were characterised mainly by their place of cultivation. These seeds have a varied integumentary coloration. They were obtained from farmers in five administrative districts of the Congo, including the districts of Mbama, Boundji and Ngoko in the western cuvette department and the districts of Mfouati and Mouyondzi in the Bouenza department. Once received, the seeds were sorted and separated according to their origin, and stored in clean, dry jars for sowing.

2.2. Experimental Design, Crop Management and Data Collection

A 5 x 3 bifactorial scheme, represented by 'provenance' and 'dose', was inserted into a randomised complete block design with replicates. Three replicates were used. For the "origin" factor, five variants (P1, P2, P3, P4 and P5) were included in the said design. Similarly, three variants of the 'dose' factor (D0, D1 and D3) were combined. Here, the treatment is defined as the combination of two variants of each of the "origin" and "dose" factors. A total of fifteen treatments, repeated 3 times, were studied. Each block consisted of 45 elementary plots. Each plot consisted of 3 rows, each bearing 4 bunches with a spacing of 0.4 m between rows and 0.7 m between bunches on the row. This corresponds to a density of 35 714 plants/ha. The dimensions of an elementary plot were 3 m long and 1.2 m wide, giving a usable area of 3.6 m^2 per elementary plot. The system comprised a total of 105 elementary plots measuring 45 m in length and 15 m in width, giving a surface area of 675 m^2.

The crop was sown on 26 December 2020, followed by immediate watering. It was sown manually in flat patches on sowing lines. Two plants were pruned in each seed hole18 days after emergence, i.e. 21 days after sowing, followed by pricking out the pruned plants in the missing or poorly emerged poquets. This fertiliser was applied in staggered doses noted D1 for 150g and D2 for 300g, and D0 was designated for the control plot not fertilised by poquet three (3) weeks before sowing.

With regard to data collection, on an elementary plot, 4 plants from the median line per treatment were selected for measurements of growth variables. In each plot, emerged seeds were counted for 10 days after sowing. A seed is considered to have emerged when an autotrophic seedling is visible to the naked eye. The percentage of emergence was calculated using the following formula:

$$P = \frac{Number\ of\ emerged\ seeds}{Total\ of\ seeds} \times 100$$

During the vegetative growth period, the diameter at the collar was measured every week using an electronic caliper, the height of the plant using a tape measure, the number of leaves emitted from the main stem and the number of primary branches per plant were counted. The number of leaves emitted from the main stem was counted after each week. The number of leaves emitted from the main stem was counted after each week. The measurements and observations were carried out over two and a half months.

2.3. Analysis of the Data Collected

The raw data collected were analysed statistically using SPSS 26.0 software. Non-parametric methods were used, in particular the k-samples median test. The eponymous test was used to separate the medians two by two at the 5% significance level.

3. Results

3.1. Evolution of the Emergence Percentage of Treatments in the Field and Assessment of "Block" and "Treatment" Effects

The evolution of the percentage of field emergence of sesame seeds from five provenances subjected to two doses of hen droppings as a function of days after sowing (DAS) is shown in Figure 1. The first two days after sowing were marked by the non-emergence of cotyledonary leaves for all treatments. Seedling emergence began on the third day after sowing with an emergence percentage of 40% for all treatments. A significant increase in this percentage was observed on the 4th day after sowing, reaching a maximum of 76 and 80% for provenance 1 associated with a dose of 150 g and provenance 2 associated with a dose of 300 g of hen droppings. For the other origins, the maximum was reached on the 6th DAS with maxima of 55% and 62% for treatments P3D2 and P4D2 respectively. On the other hand, a maximum value of 78% emergence was reached on the 7th DAS for provenance 5 associated with the 300g dose of hen droppings (Figure 1).

To assess the differences reported during the last week of cultivation, median comparisons were made between the blocks on the one hand and the treatments on the other for each of the five variables measured, i.e. 1) the percentage of emergence in the field, 2) the diameter at the crown, 3) the height of the plant, 4) the number of leaves emitted from the main stem and 5) the number of branches borne by the main stem.

The variation in the percentage of emergence according to the blocks and treatments of the five sesame provenances is shown in Table 1. For the block factor, no significant differences were recorded between them. For the treatment factor, those combining provenances P1 and P5 at the two doses tested showed no statistical difference. Conversely, significant differences were observed between treatments combining provenances P2, P3 and P4. Thus, for the treatments combining the P2 provenance, three groups were recorded. The first, consisting of treatment P2D0, was characterised by a low median percentage emergence. The second, consisting of treatment P2D1, was marked by an average median percentage emergence. The third, P2D2, combining P2 source with D2 dose, was characterised by a high median percentage emergence.

Three groups were also observed for treatments combining P3 provenance. The first, consisting of treatment P3D0, stood out for its low median percentage emergence. The second, consisting of treatment P3D1, was distinguished by an average median percentage of emergence. The third, P3D2, which combined P3 with D2, had a high median percentage emergence.

When we consider the treatments combining P4 provenance, two classes of medians were noted. Firstly, treatment P4D1, with a low median percentage emergence. Secondly, treatments P4D0 and P4D2, characterised by a high median percentage emergence (Table 1).

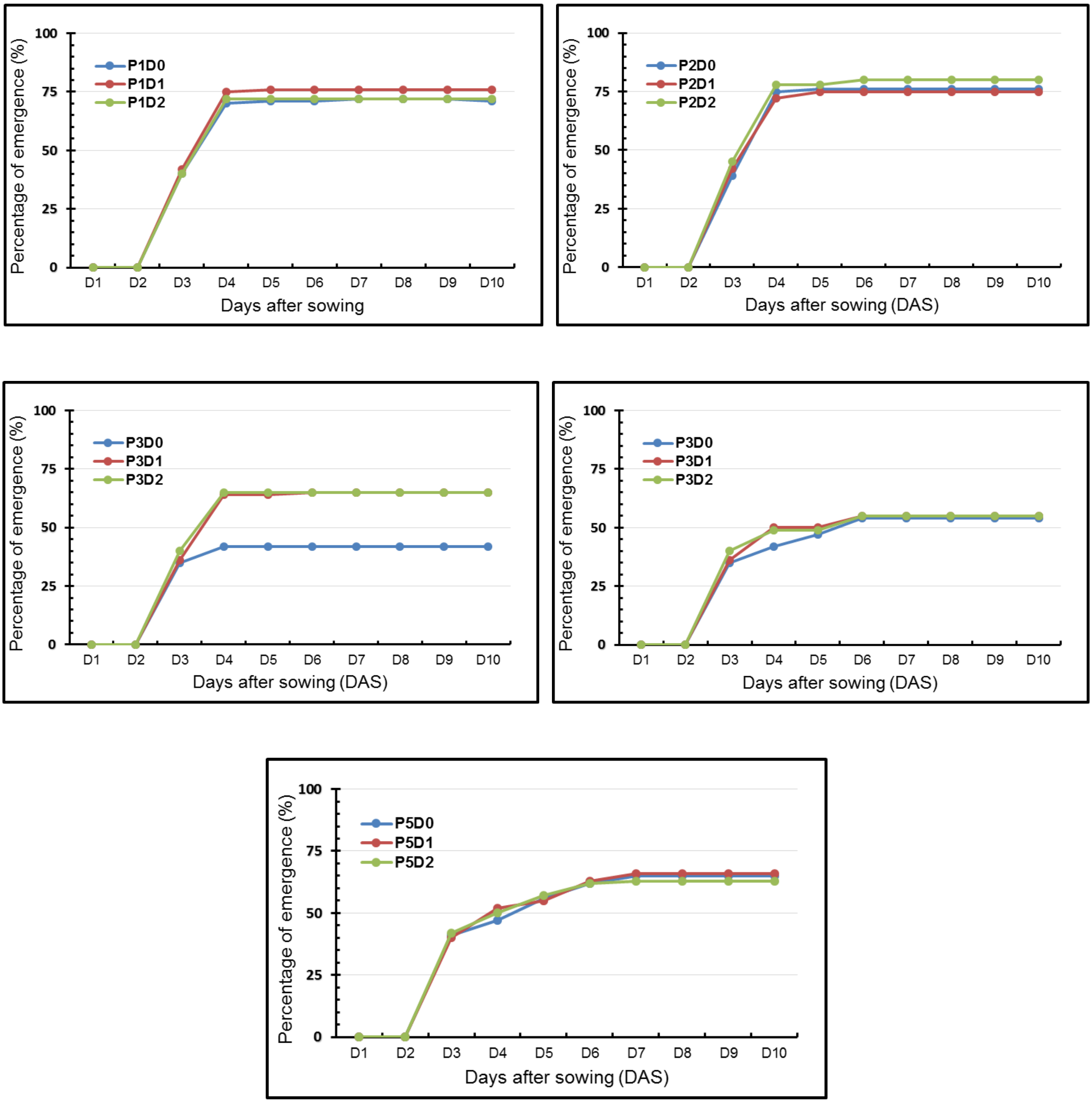


Figure 1. *Evolution of field emergence expressed as a percentage of treated and untreated plants of five provenances of local sesame in days after sowing (das).*

Table 1. *Influence of block and treatment and classification of medians of percentage emergence within the two above-mentioned factors for the five sesame provenances according to the Anova equivalent of the median test and the eponymous test for pairwise comparison of medians.*

Dependant variable *	Source Median[1*]	Statistics of test	df*	p-value	Factor	Median[2*]
PLEV	66	0.720	2	0.698	Block	
					Block2	65a
					Block1	65a

Dependant variable *	Source Median[1*]	Statistics of test	df*	p-value	Factor	Median[2*]
					Block3	68a
					Treatment	
					P1D0	80a
	80	3.000	2	0.223	P1D1	78a
					P1D2	82a
					P2D0	75a
	76	9.000	2	0.011	P2D1	76b
					P2D2	78c
					P3D0	54a
	56	9.000	2	0.011	P3D2	56b
					P3D1	57c
					P4D1	52a
	55	6.300	2	0.043	P4D0	55b
					P4D2	56b
					P5D2	63a
	66	1.286	2	0.526	P5D0	65a
					P5D2	66a

Legend: Dependent variable*: Variable measured, PLEV: Percentage of lift. Median[1*]: Median generated by the Anova equivalent of the median test. Statistics of test: Calculated parameters. df: Degree of freedom. p-value: Calculated probability value. Median[2*]: Parameter of the central tendency dividing the statistical series, in this case, the lift percentage, into two equal parts. It was used to separate the medians two by two according to the eponymous test of the median.

3.2. Evolution of the Growth Variables as a Function of Week and Assessment of "Block" and "Treatment" Effects

Changes in the diameter at the crown of sesame seedlings from the five provenances subjected to two doses of hen droppings as a function of the weeks after sowing are shown in Figure 1. The curves were analysed for the extreme (S1 and S9) and intermediate (S5) weeks, The largest diameter at the collar was obtained with provenance P2 associated with a dose of 300 g of hen droppings, while the smallest diameter at the collar was observed with provenance 4 associated with a dose of 0 g of hen droppings. At week 1, overall, the diameter values at the collar were all less than 10 mm, the largest being 8.3 mm, In week 5, the largest value of 15 mm was measured in provenance P1 associated with a dose of 300 g of hen droppings, while the smallest was 8 mm in provenance P3 associated with a dose of 0 g of hen droppings, In the final week, week 9, provenance 2 associated with dose 2 had the highest average diameter at the crown of 21 mm, while provenance P4 had the lowest average diameter at the crown of 11.75 mm. However, if we consider each provenance separately, the diameter at the crown varied very little between the control and treated plants, which is reflected in the curves by the small differences between them (Figure 2).

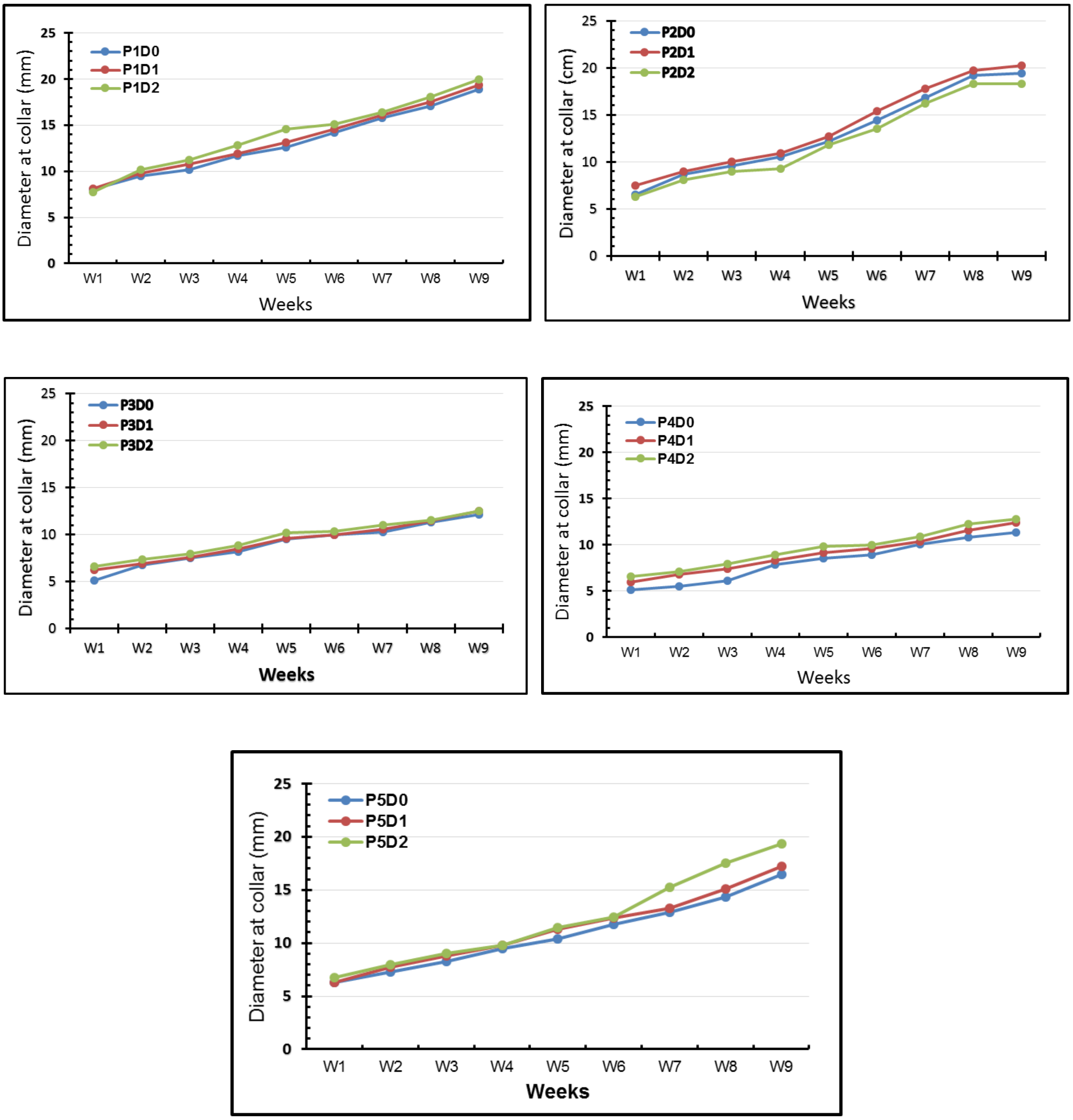


Figure 2. *Changes in collar diameter as a function of time in weeks of treated and untreated plants of five local sesame varieties.*

To examine the differences reported during the last week of cultivation, median comparisons were made between the blocks on the one hand and the treatments on the other. With regard to the block factor, two groups were noted: the first, made up of block 1, was characterised by a low median neck diameter, while the second, made up of blocks 2 and 3, was marked by a high median neck diameter (Table 2).

For the treatment factor, no statistical difference was recorded between the treatments of provenances P1 and P3. On the contrary, significant differences were observed between treatments combining provenances P2, P4 and P5. Two groups were recorded, the first consisting of treatments P2D2 and P2D0 combining provenance P2, P5D0 and P5D2 combining provenance P5, characterised by low medians, the second consisting of treatments P2D1 and P5D1 combining provenance P2 and P5 respectively, marked by high medians, Concerning the treatments combining provenance P4, two classes were also observed. The first, made up of treatment P4D0, was characterised by a low median, while the second, made up of treatments P4D1 and P4D2, showed high medians for diameter at the crown (Table 2).

Table 2. *Influence of block and treatment and classification of medians of neck diameter within the two above-mentioned factors for the five sesame provenances according to the Anova equivalent of the median test and the eponymous test for pairwise comparison of medians.*

Dependent variable *	Source Median[1*]	Statistics of test	df*	p-value	Factor	Median[2*]
DC					Block	
					Block3	16.32a
	16.000	1.561	2	0.458	Block2	17.84a
					Block1	15.5a
					Treatment	
					P1D0	18.07a
	19.225	1.426	2	0.490	P1D2	19.35a
					P1D1	19.85a
					P2D2	18.34a
	19.250	8.989	2	0.011	P2D0	19.20ab
					P2D1	20.38b
					P3D0	12.16a
	12.320	1.187[a]	2	0.552	P3D2	12.32a
					P3D1	12.50a
					P4D0	11.35a
	11.850	6.322	2	0.042	P4D1	12ab
					P4D2	12.5b
					P5D0	15.81a
	17.846	18.290	2	0.000	P5D2	17.11a
					P5D1	19.52b

Legend: It is as reported under table 1.

When we look at the height of sesame plants from different provenances subjected to two doses of hen droppings as a function of the weeks after sowing is presented in Figure 3, this height increases relatively and progressively in all provenances for control and treated plants, The highest numerical score of 160 cm was recorded for treatment P2D2, while the lowest was recorded for treatment P4D0. At week 1, plant height values were below 40 cm, with the highest numerical score of 39 cm recorded for treatment P2D2, while the lowest numerical score of 19 cm was recorded for treatment P4D0, During week 5, it was still the P2D0 treatment that showed a numerically greater height of 103 cm while the least numerically greater of 60 cm was recorded by the P4D0 treatment, The last week shows a numerically greater height of 155.70 cm recorded by treatment P2D2 while treatment P4D0 showed a lesser height of 99.871 cm during the same week, Considering each source separately, the value of plant height varies very little between control and untreated plants, which is reflected by these curves almost merged over more than 6 weeks (Figure 3).

When we examine block factor, two classes were noted. It about class 1, composed of block 1, is marked by a small median plant height, while class 2, constituted of block 2, is distinguished by a large median plant height.

With regard to the treatment factor, only the effect of the two doses combined with the P5 source revealed significant differences (p-values = 0.001). Two homogeneous groups were observed, the first consisting of the P5D0 treatment, with a low median plant height. The second, formed by treatments P5D1 and P5D2, is characterised by a high median (Table 3).

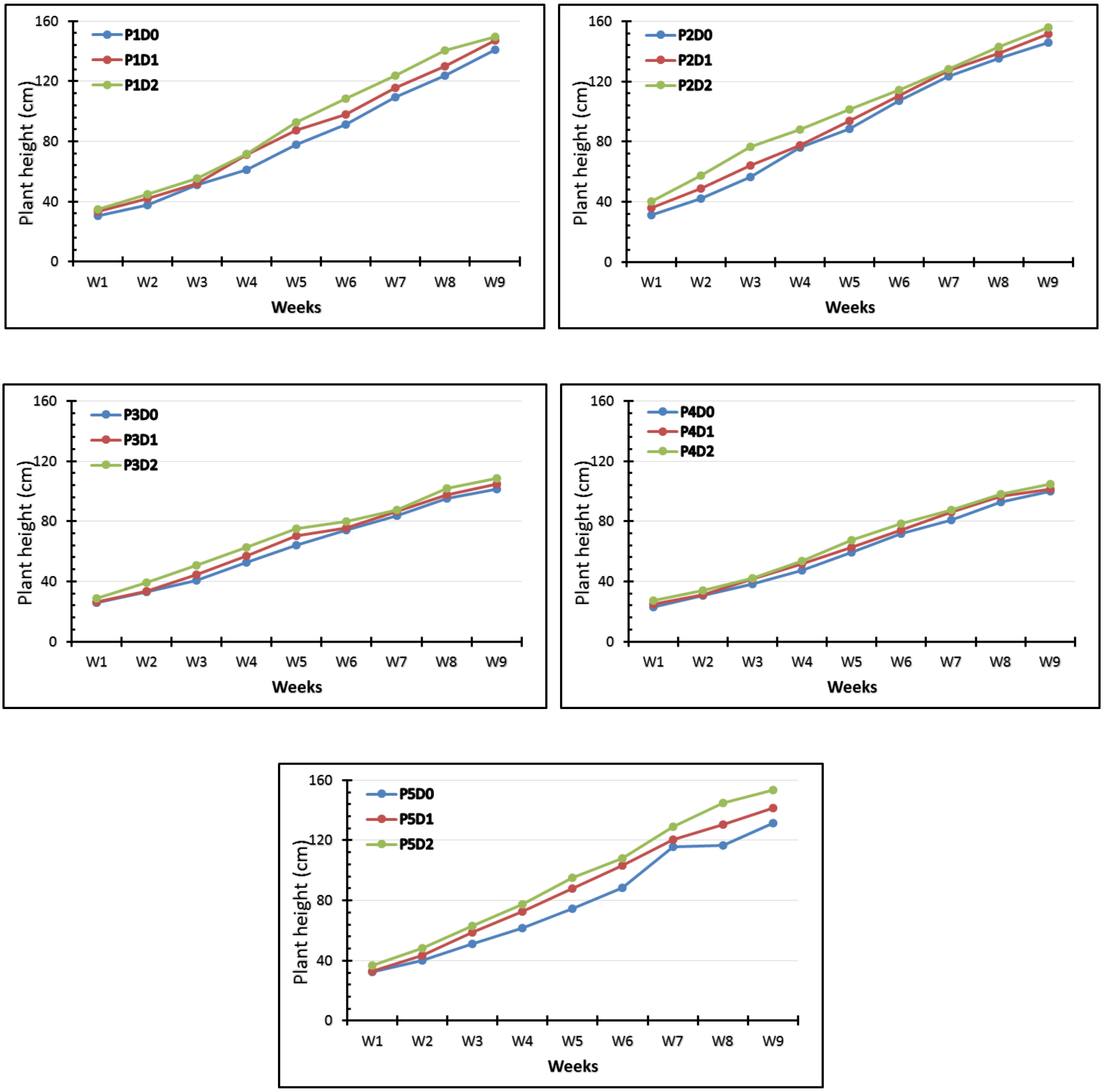


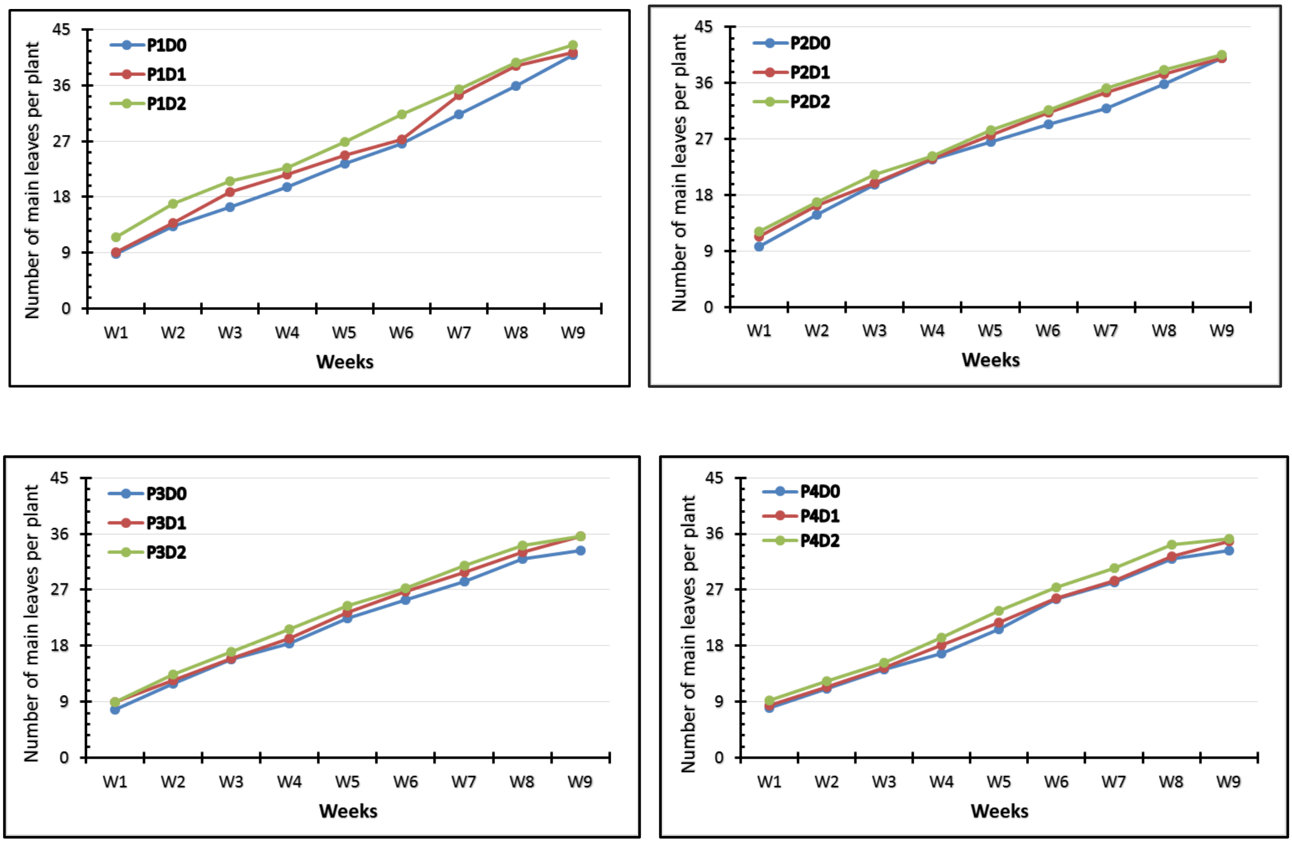
Figure 3. Evolution of plant height as a function of time in weeks for treated and untreated plants of five local sesame provenances.

Table 3. Influence of block and treatment and classification of medians of neck diameter within the two above-mentioned factors for the five sesame provenances according to the Anova equivalent of the median test and the eponymous test for pairwise comparison of medians.

Dependent variable *	Source				Factor	Median[2*]
	Median[1*]	Statistics of test	df*	p-value		
					Bloc	
					Bloc1	117a
HT	128	13.512	2	0.001	Bloc2	134ab
					Bloc3	138b

Dependent variable *	Source Median[1*]	Statistics of test	df*	p-value	Factor	Median[2*]
					Traitement	
					P1D0	140a
	144.500	1.426	2	0.490	P1D2	148a
					P1D1	152a
					P2D0	148a
	150.000	0.000	2	1.000	P2D1	150a
					P2D2	150a
					P3D2	99a
	105.000	1.586	2	0.452	P3D0	105a
					P3D1	107.6a
					P4D0	95a
	100.000	5.700	2	0.058	P4D1	106a
					P4D2	104a
					P5D0	121a
	143.000	14.428	2	0.001	P5D1	143b
					P5D2	154b

Legend: It is as reported under table 1.



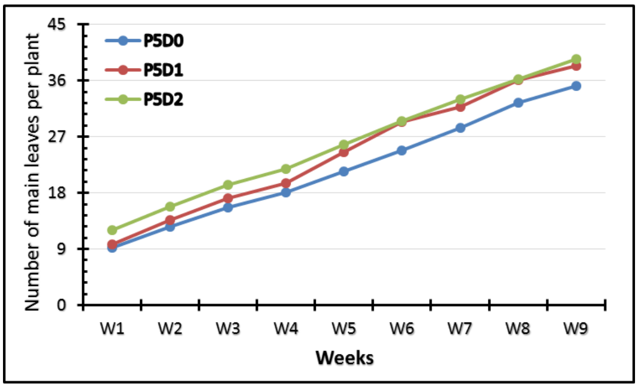


Figure 4. *Evolution of the number of main leaves emitted as a function of time in weeks for treated and untreated plants of five local sesame provenances.*

With regard to the number of emitted leaves borne on the main stem, changes over nine weeks of cultivation in the five provenances subjected to two doses of hen droppings showed a relative and progressive increase for control and treated plants. The highest numerical score was recorded for the P1D2 treatment, while the lowest was observed for the P4D0 treatment. At week 1, the averages for this variable were below 15 units, with the highest score of 13 units recorded for the P2D2 treatment and the lowest score of 7 units recorded for the P4D0 treatment. This number increases during week 5, with treatment P2D2 still having the highest number of units (28) and treatment P4D0 the lowest (22). The ninth week of measurements showed the highest number of leaves for all treatments from each source. Treatment P1D2 recorded the highest number of leaves with more than 42 units, compared with the lowest number of 34 units recorded by treatments P3D0 and P4D0. With regard to the provenances taken separately according to dose, the number of emitted leaves carried by the main stem varied little between control and treated plants. This is reflected in the merged or almost merged curves for more than 6 weeks, except for provenance P5 where the treated plants had a numerically greater number of leaves for 9 weeks (Figure 4).

Statistically, examination of the block effect reveals the existence of two classes. Class 1, represented by block 1, is marked by a small median for the number of leaves on the main stem (NFP). Class 2, consisting of blocks 2 and 3, is characterised by a large median for the number of leaves on the main stem.

With regard to the number of leaves on the main stem (NFP), there was no statistical difference between treatments combining provenances P1, P2, P3 and P4 (Table 4). However, significant differences were observed between treatments combining provenance P5. Two homogeneous classes were also recorded: the first, consisting of treatment P5D2, was characterised by a low median, while the second, consisting of treatments P5D0 and P5D1, was characterised by high medians (Table 4).

Table 4. *Influence of block and treatment and classification of medians of neck diameter using the two above-mentioned factors for the five sesame provenances according to the Anova equivalent of the median test and the eponymous test for pairwise comparison of medians.*

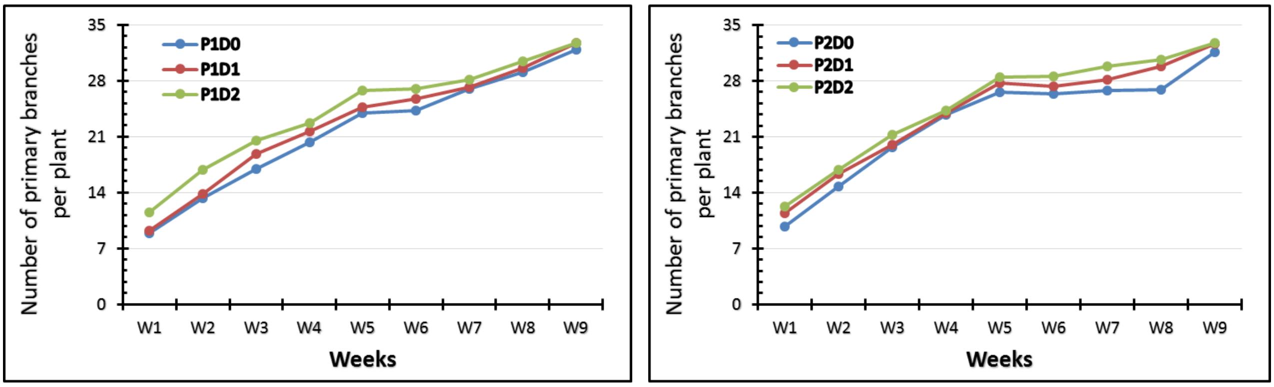
Dependent variable *	**Source**				**Factor**	**Median2***
	Median1*	**Statistics of test**	**df***	**p-value**		
					Bloc	
					Bloc1	36a
	38.000	13.481	2	0.001	Bloc2	38b
					Bloc3	38b
					Treatement	
NFP						
					P1D1	40a
	40.000	1.903	2	0.386	P1D2	40a
					P1D0	42a
	40.000	0.101	2	0.951	P2D0	40a

Dependent variable *	Source				Factor	Median2*
	Median1*	Statistics of test	df*	p-value		
					P2D1	40a
					P2D2	41a
					P3D2	34a
	34.000	4.279	2	0.118	P3D0	36a
					P3D1	36a
					P4D0	34a
	34.000	3.073	2	0.215	P4D1	36a
					P4D2	36a
					P5D2	34a
	38.000	9.410	2	0.009	P5D0	38b
					P5D1	39b

During the first five weeks, the number of primary branches on the main stem increased sharply in all the provenances associated with the doses tested. Treatment P5D2 recorded the highest numerical value of 33 units, compared with the lowest of 10 in treatment P3D0. This number continued to increase at a more moderate rate thereafter for some treatments before reaching 32 units in week nine for treatments P2D1 and P2D2, 31 units for treatments P1D2, P1D1 and P1D0, and 30 and 19 units respectively for treatments P5D1 and P5D0. For treatments P3D0 and P4D0, this number did not increase after the fourth week and stagnated at 10.01 units. Treatments P3D2, P3D1 and P4D2 reached the maximum of this number in the fifth week, with values of 11, 11 and 11.10 units respectively. The maximums of 10.25 and 11 units were reached in the seventh week by treatments P4D0 and P4D1. Fertilised plants had a relatively high number of primary branches compared with unfertilised plants (Figure 5).

When we consider separately the provenances linked to the doses applied, the number of primary branches carried by the main stem varies little between the control plants and the treated plants of provenances P1, P2, P3 and P4. This is reflected by curves that are merged or almost merged for more than 6 weeks, except for provenance P5 where the treated plants record a numerically greater number during the nine weeks (Figure 5).

Examination of the block effect reveals that there are no groups (Table 5). With regard to the number of primary branches, the Anova equivalent of the median test for k samples did not reveal any statistical difference between the treatments combining provenances P1, P2, P3 and P4 and the two doses D1 and D2. On the other hand, significant differences were identified between treatments combining provenance 5 and the two doses. The treatments combined with provenance 5 can be divided into 2 classes: the first, consisting of treatment P5D0, has a low median, while the second, consisting of treatments P5D1 and P5D2, has a high median (Table 5).



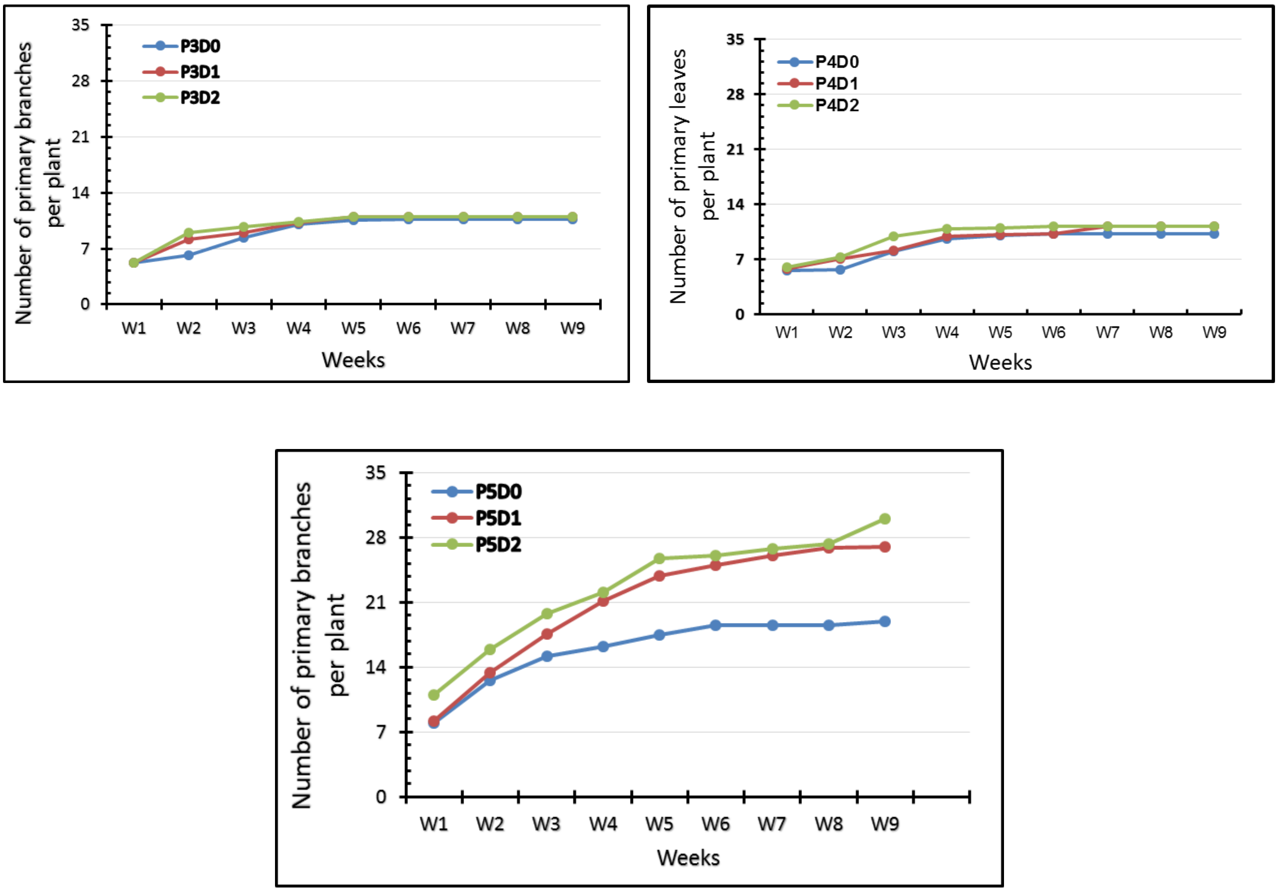


__Figure 5__. Changes in the number of primary branches as a function of time in weeks in treated and untreated seedlings of five local sesame provenances.

__Table 5__. Influence of block and treatment and classification of the number of primary branches using the two above-mentioned factors for the five sesame provenances according to the Anova equivalent of the median test for k independent samples and the eponymous test for pairwise comparison of medians.

Dependent variable *	Source Median[1*]	Statistics of test	df*	p-value	Factor	Median[2*]
					Block	
					block1	24a
	26.000	3.602	2	0.165	block2	26a
					block3	28a
					Treatment	
					P1D0	31.5a
NRAMP	32.000	0.636	2	0.728	P1D1	32a
					P1D2	32a
					P2D0	30a
	32.000	0.793	2	0.673	P2D1	32a
					P2D2	32a
					P3D0	10a
	10.000	1.421	2	0.491	P3D1	10a

Dependent variable *	Source Median[1*]	Statistics of test	df*	p-value	Factor	Median[2*]
					P3D2	10a
					P4D0	10a
	10.000	0.752	2	0.687	P4D1	10a
					P4D2	10a
					P5D0	18a
	30.000	7.887	2	0.019	P5D1	30ab
					P5D2	33b

4. Discussion

The influence of hen droppings on the expression of emergence and growth was evaluated on five sesame provenances associated with two doses of said droppings. In general. the curves showing the evolution of the different emergence and growth variables over nine weeks of observations showed an increasing trend with small nuances between provenances. Some variables discriminated blocks and/or treatments, others not.

Regarding the percentage of emergence, at week 9, the observations were almost identical. This resulted in the same points on the emergence curves. This trend was confirmed statistically by the absence of differences not only between the blocks, but also between certain treatments. For the blocks, the absence of statistical differences between them suggests the homogeneity of the experimental site. Thus, for this variable, the idea to partition the experimental site into blocks was not justified. For treatments combining provenances P1 and P5, the absence of significant differences illustrates the absence of dose influence. These results corroborate those of [14], who showed no influence of nitrate or ammonium inputs and various combinations of the two minerals on sesame seedling emergence.

The existence of statistical differences for treatments combining provenances P2, P3 and P4 at the two doses D1 and D2 shows that treatments P2D2, P3D2 and P4D2 are the best. This allows us to offer them to Congolese farmers, particularly those in Brazzaville, the provenances of Mouyondzi (P2), Mbama (P3) and Boundji (P4). This could be explained by whether or not they are sensitive to competition effects.

For collar diameter, the evolution curves showed a visual separation of the points at the 9th week for the treatments combining provenances P1, P2 and P5 at the two doses D1 and D2. Nevertheless, significant differences were noted among the blocks and among the treatments, Concerning the blocks, blocks 2 and 3 revealed a high median for this variable. The existence of these differences illustrates the block effect, and therefore the heterogeneity of the experimental field. However, only treatments P2D1 and P5D1 combining provenances P2 and P5 and P4D1 and P4D2 combining provenance P4 recorded the highest medians. Thus, the visual observation that showed a difference in points at week 9 was not statistically confirmed. However, work carried out on Mbama sesame where the application of pig manure revealed no effect on the expression of diameter at the crown [15] contrasts with our own. Some authors recorded a lack of effects of cow manure in Brazil on crown diameter growth [16]. Therefore, for our work, treatments P2D1 and P5D1 combining Mouyondzi (P2) and Ngoko (P5) provenances as well as P4D1 and P4D2 combining Boundji (P4) provenance could be recommended to farmers located in the southern part of Brazzaville department.

When we consider plant height, the development curves revealed a macroscopic separation of the value of the observations during the 9th week for the objects linking provenances P1, P2, P3 and P5 to the two doses of fertiliser D1 and D2. However, statistical discrepancies were observed as well as between certain treatments. For example, block 2 recorded the highest median plant height. The experimental site was heterogeneous. The hypothesis of dividing the experimental area into blocks was not without meaning for this variable. For the treatments, provenance P5, in treatments P5D1 and P5D2, expressed the highest medians of plant height. Similarly, here, the trend showing visual differences over the last observations was not confirmed statistically. Provenances P1, P2 and P3 showed no differences at week nine for the treatments in which they were involved. This result is comparable to those on the cultivar BRS [14]. It also showed that nitrate or ammonium application and various combinations of the two did not affect the above variables. Authors revealed similar results [17, 18]. Consequently, for our work, treatments P5D1 and P5D2 could be recommended to farmers located in the southern part of the Brazzaville department. Nevertheless, its supposed unsensitivity at doses of hence droppings tempers our recommendations.

For the number of leaves emitted, the evolution graphs showed a visual separation of the observations at week 9 for provenance P5 associated with treatments P5D0 and P5D1. Nevertheless, statistical differences were recorded between the blocks and between the treatments. For the blocks, blocks 2 and 3 showed a large median for this variable. The observation of these differences shows the block effect. There is therefore a fertility gradient in the experimental field. The idea of separating the experimental site into blocks was justified. However, only treatments P2D1 and P5D1 combining provenances P2 and P5 as well as P4D1 and P4D2 combining provenance P4 recorded the highest medians. Thus, the visual observation that showed a difference in points at week 9 was confirmed statistically. Our results are similar to those of [19, 20] who showed that application of 300kg.ha-1 NPK improved leaf number and plant height in sesame. Similarly, mineral fertilisation improved sesame growth and production [21, 22]. In the same vein, other work reported that organic pig and chicken manure improved plant height and leaf number of *Sesamum radiatum* Schum [23]. Therefore, treatments P5D0 and P5D1 combining provenance P5 could be recommended to farmers located in the southern part of the Brazzaville department at condition that its supposed insentivity is not confirmed during confirmation test.

Considering the number of primary branches, the development curves revealed a macroscopic separation of the value of the observations during the 9th week for the objects associating provenances P3 and P4 with the two doses of fertiliser D1 and D2. Statistical differences were only observed with treatments P5D1 and P5D2 associating provenance P5, so there was no block effect. Concerning the treatments, provenance P5, in treatments P5D1 and P5D2, expressed the highest medians for plant height. Similarly, here, the trend showing visual differences over the last observations was not statistically confirmed for P3, but rather for P5. Our results are similar to those of [24]. Consequently, treatments P5D1 and P5D2 could be recommended to farmers working in the southern part of the Brazzaville department at condition that its supposed insentivity is not confirmed during confirmation test.

5. Conclusion

Treatments P4D1 and P4D2 combining provenance P4 recorded the highest medians of the number of leaves emitted. The leaves are one of the valuable parts of vegetative system of the plant. They could be recommended to farmers working in the southern part of the Brazzaville department provided that the confirmation trial confirms it.

Abbreviations

MESRSIT: Ministry of Higher Education, of Scientific Research and Technological Innovation

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Conflicts of Interest

The authors declare no conflicts of interest.

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