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MILLET (*Pennisetum Glaucum* (L.) R. Br.) PRODUCTIVITY UNDER FERTILIZATION WITH POULTRY DROPPINGS IN BURKINA FASO

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ABSTRACT

Laying hen droppings are rich in nutrients and would be a good fertilizer for millet production. The objective of this study was to evaluate the effect of laying hen droppings on the agronomic potential of millet. A trial was conducted in Gampela during the 2021-2022 rainy season using a Fisher block design. D0 (control), D2 (2.5 t/ha), D3 (5 t/ha), D4 (7.5 t/ha) doses of laying hen droppings were applied before sowings. D2F (2.5 t/ha), D3F (5 t/ha), D4F (7.5 t/ha) of droppings were split in two, the first half was applied before sowing and the second half 35 days after sowing. D1 (100 kg/ha NPK, 50 kg/ha urea) was applied to the plants. The results showed a significant increase in chlorophyll content, canopy cover, leaf area, plant height, number of tillers, grain and straw yield of the plants amended with the doses of laying hen droppings and NPK combined with urea. The plants amended with laying hen droppings showed the best agronomic performance compared to the plants amended with NPK plus urea. D3, D3F, D4, D4F gave the best grain yields. Based on these results, D3 could be recommended for millet cultivation in the Sudano-Sahelian zone of Burkina Faso.

Keywords: Laying Hen Droppings, Chlorophyll, Canopy Cover Rate, Leaf Area .

1. INTRODUCTION

Millet (*Pennisetum glaucum*) is a plant, much more cultivated in the Sahelian and Sudano-Sahelian zone of Burkina Faso. In terms of cereal production in Burkina Faso, millet ranks third behind maize and sorghum with an estimated production of 970 176 t in 2019 (MAAH, 2020). Indeed, it is cultivated for its grains for human consumption but also for its above-ground biomass used as fodder for livestock (Newman *et al*, 2010; Dakheel et al, 2009). The stems of *P. glaucum* are used to make works of art in the construction of granaries, houses, doors or traditional beds but also directly as fuel (Hamadou et al, 2017). However, millet yields remain low nationally, below 1 t/ha. In order to improve millet yield, the use of chemical fertilizers such as NPK and urea at the dose of 100 kg of NPK and 50 kg of Urea per hectare have been recommended by the ministry in charge of agriculture. However, the majority of poor farmers are still confronted with the high cost of these commercial fertilizers and their periodic shortages on the market. Moreover, the use of these chemical fertilizers is not without consequences on the soil. Thus, chemical fertilizers are responsible for massive soil degradation, but are especially the major cause of groundwater pollution (Delphine Bossy, 2014). In view of these problems, it would be wise to propose fertilizers that are less costly but also protective of the environment, which could improve soil fertility and boost millet production.

In recent decades, there has been a proliferation of poultry farms in Burkina Faso. These poultry farms produce huge quantities of droppings that are unfortunately not used by farmers. Studies conducted by the Institut des Techniques de l'Aviculture in 2001 have shown that the droppings of laying hens are very rich in nutrients, and therefore necessary for the good development of plants. As a result, laying hen droppings are a source of fertilizer that can help solve soil fertility problems. In Burkina Faso, research work has been conducted on the physico-chemical properties of hen droppings and the effect of droppings on the growth and yield of maize (Alain *et al*, 2019) and rice (Aboubacar, 2017). However, no study has been done on the effect of droppings on millet production. The overall objective of the present study is to evaluate the effect of laying hen droppings on the agronomic potential of millet.

Specifically, it is about:

- to determine the effect of doses of laying hen droppings on the growth and development of millet;
- Identify the dose or doses of laying hen droppings that will optimize millet yield.

2.MATERIALS AND METHODS

2.1 Plant Materials

The plant material consists of a hybrid millet variety called «Nafagnon» provided by INERA/Kamboinsé (Institut National de l'Environnement et de Recherche Agricole). The choice of this variety is justified on the one hand by its high yield (4 t/ha) and the precocity of its cycle (80 to 85 days) but also and above all by its resistance to mildew (incidence < 10 %) and its tolerance to ergot and smut.

2.2 Study site

The study was conducted at the experimental station of the «Institut de Développement Rurale» (IDR) located in Gampela, about 20 kilometers east of the city of Ouagadougou. Geographically, the Gampela station is located at 12°22 West longitude and 12°25 North latitude.

The soils of the area are a tropical ferruginous type, more or less leached, representative of the soils of the central plateau (BUNASOL, 1998). The surface horizon of these soils is poor in organic matter.

The Sudan-Sahelian climate is characterized by the alternation of a rainy season from June to October and a dry season from November to May (Guinko, 1984). The average annual rainfall varies between 600 and 900 mm.

2.3 Experimental design

The experimental design used was a Fisher block consisting of 8 treatments repeated four (04) times with each treatment constituting an elementary plot, i.e. a total of 32 elementary plots (1 elementary plot x 8 treatments x 4 repetitions). The factor studied was the fertilization at eight levels which are : four non-fractioned doses of laying hen droppings D0 (absolute control without laying hen droppings application), D2 (2.5 t/ha), D3 (5 t/ha), D4 (7.5 t/ha) applied before sowing; three split doses of laying hen droppings D2F (1.25 t/ha of laying hen droppings applied before sowing and 1.25 t/ha of laying hen droppings applied 35th days after sowing (DAS) i.e. 2.5 t/ha), D3F (2.5 t/ha of laying hen droppings applied before sowing and 2,5 t/ha applied 35th DAS or 5 t / ha), D4F (3.75 t/ha of laying hen droppings applied before sowing and 3.75 t/ha applied 35th DAS or 7.5 t / ha) and a D1 dose (100 kg/ha of NPK applied on 14th DAS and 50 kg/ha of urea applied 35th DAS)

2.4 Conduct of the trial

Before ploughing, soil samples were taken from the study site in the 0 - 20 cm depth horizon. A physico-chemical analysis of these samples carried out at the CID (Cabinet d'ingénierie pour le développement) laboratory showed that the study soil is acidic (pH = 5.39) with a sandy-silty texture containing 5.63% organic matter, 3.26% total carbon, 4.89 ppm assimilable phosphorus, 32.96 ppm available potassium, 11% total nitrogen, 1.13 g/kg magnesium, 4.67 g/kg calcium and 948.66 mg/kg sodium (Table I).

As for the laying hen droppings used as fertilizer, the physicochemical analysis revealed that they have a relatively neutral pH (7.19), and contain a high content of organic matter (83.74%) and dry matter (96.28%). They contain 6.75% total nitrogen, 2.29% total phosphorus, 2.82% total potassium, 1.13 g/kg magnesium, 5.97% calcium and 834.02 mg/kg sodium (Table II).

The study plot was ploughed and waterworks were dug to separate the individual plots to limit contamination of the plots. The sowing was done following the spacing of 80 cm between the line and 40 cm between the poquets. At 14th days after sowing (DAS), a weeding followed by the reduction of the plants to two plants per poquet was done. Single doses D2, D3 and D4 of laying hen droppings were applied before sowing. The doses D2F, D3F and D4F of laying hen droppings were split into two parts, one half applied before sowing and the second half applied on 35th DAS. NPK was applied on 14th DAS and urea on 35th DAS. A phytosanitary treatment was applied on 26th DAS with the insecticide "lambda" following attacks of phytophagous insects. A ridging was done on 35th DAS corresponding to the stage of beginning of swelling to limit lodging.

Table I: Physic-chemical properties of the cultivation soil

Parameters	**Clay (%)**	**Silt (%)**	**Sand (%)**	**Mg^{2+} (meq/100g)**	**K^{+} (meq/100g)**	**Na^{+} (meq/100g)**	**C/N**	**P.Ass (ppm)**	**K. Av (ppm)**	**Ca^{2+} (meq/100g)**
Proportions / Quantities	9,8	9,81	80,39	1,86	0,64	0,28	11	4,89	32,96	2,5
Parameters	**MO (%)**	**TC (%)**	**TN (%)**	**SEB (meq/100g)**	**CEC (meq/100g)**	**SR (%)**	**MgT (g/kg)**	**Ca. T (g/kg)**	**Na. T (mg/kg)**	**pH**
Proportions / Quantities	5,63	3,26	0,29	5,28	8,25	64	2,74	4,67	948,66	5,39

Legend: TC = total carbon, TN = total nitrogen, CEC = Cation Exchange Capacity, SR = Saturation Rate, P. Ass = Assimilable Phosphorus, K Av = available potassium, SEB = Sum of Exchangeable Bases, Mg. T = total magnesium, Ca. T = total calcium, Na. T = total sodium

Table II: Chemical characteristics of laying hen droppings

Parameters	TN (%)	OM (%)	C(%)	C/N	DM (%)	TP (%)	KT (%)	MgT (g/kg)	CaT (g/kg)	NaT (mg/kg)	pH	MC (%)
Proportions/ Quantities	6,75	83,74	48,57	7	96,28	2,29	2,82	1,13	5,97	834,02	7,19	3,72

Legend: TN = total nitrogen, MC = moisture content, C = carbon, DM = dry matter, OM = organic matter, TP = total phosphorus, KT = total potassium.

2.5 Data collection

From 14th day after sowing (DAS) to flowering stage, the growth parameters were measured weekly. Indeed, the height of the plants was measured with a decameter starting from the collar to the top of the stem, the leaf area was determined with the software ImageJ 1.53e. The canopy cover rate was determined with the canopeo 1.1.7 software. The number of tillers was determined by counting. The chlorophyll content was determined with Spad on the 4th leaf from the top following the method used by Kotchi (2004).

At maturity, the length and diameter of the spike were measured respectively with a decameter and a caliper. After harvesting, drying, weighing of grains and straw, grain and straw yields were determined.

2.6. Data analysis

The collected data were processed on the EXCEL spreadsheet version 2013. Following the data processing, an analysis of variance (ANOVA) was performed with Xlstat software version 2016 in order to study the variability of the studied treatments. The comparison of treatments was done according to the Newman-Keuls test at the 5% threshold.

3. RESULTS

3.1 Chlorophyll content of leaves

Leaf chlorophyll content increased significantly with increasing doses of laying hen droppings and NPK dose combined with urea (Figure 1). The highest leaf chlorophyll content was recorded in plants amended with D4 (41.61) dose of chicken droppings. Analysis of variance showed that leaf chlorophyll content was significantly improved by fertilization with laying hen droppings (P = 0.001) and NPK fertilizer combined with urea (P = 0.019) compared to the control. However, there was no significant difference between the leaf chlorophyll content of plants amended with fractional and non-fractional doses of laying hen droppings (P = 0.51). In addition, no significant difference was observed between the chlorophyll content of plants amended with D1 (NPK combined with urea) and the different doses of laying hen droppings (P = 0.059).

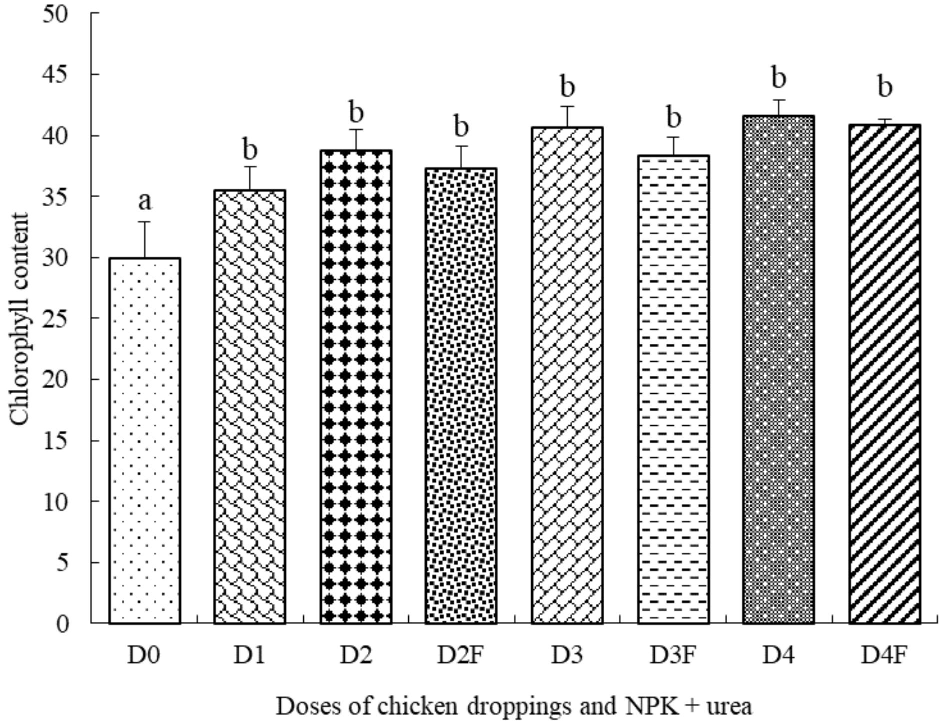

Figure 1: Effect of fertilizer on leaf chlorophyll content.
Legend: Histogram bars followed by the same letter are not significantly different at the 5% level

- **D2 =** 2.5 t/ha of laying hen droppings applied before sowing,
- **D2F =** 1.25 t/ha of laying hen droppings applied before sowing and 1.25 t/ha applied on 35th DAS (2.5 t/ha),
- **D3 =** 5 t/ha of laying hen droppings applied before sowing,
- **D3F =** 2.5 t/ha of laying hen droppings applied before sowing and 2.5 t/ha applied on 35th DAS (5 t/ha),
- **D4 =** 7.5 t/ha of laying hen droppings applied before sowing,
- **D4F =** 3.75 t/ha of laying hen droppings applied before sowing and 3.75 t/ha applied on 35th DAS (7.5 t/ha),
- **D1 =** 100 kg NPK/ha +50 kg urea/ha

3.2 Leaf area and canopy cover rate

Leaf area was significantly increased following the application of laying hen droppings (P = 0.000) and NPK plus urea (P = 0.008) compared to the control (Figure 2 A). The largest leaf area was measured in plants amended with D4 (381.80 cm^2) of laying hen droppings. The analysis revealed that the leaf area of plants amended with D3, D3F, D4 and D4F of laying hen droppings was significantly higher than that of plants amended with D1 (NPK + Urea) (P = 0.000). There was no significant difference between the leaf area of plants amended with split and unsplit doses of laying hen droppings (P = 0.68).

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The canopy cover rate of plants amended with D1 (NPK + Urea) and D2, D2F, D3, D3F, D4, D4F of laying hen droppings increased by 23.79%, 13.48%, 14%, 35.62%, 30.72%, 43.36%, and 30.85%, respectively, compared to the cover of D0 control plants (Figure 2 B). The canopy cover rate of plants amended with D4 laying hen droppings is higher than that of plants amended with NPK combined with urea (D1). The best canopy cover rate was measured in plants amended with D4 dose (74.90%) of laying hen droppings. The analysis of variance revealed a significant positive effect of laying hen droppings (P = 0.000) and NPK plus urea (P = 0.001) on the canopy cover rate compared to the control plants. In addition, a significant difference was observed between the D1 dose (NPK + urea) and the laying hen droppings doses (P = 0.002). However, the analysis did not reveal a significant difference between the canopy cover rate of the plants amended with the split and unsplit doses of laying hen droppings (P = 0.41).

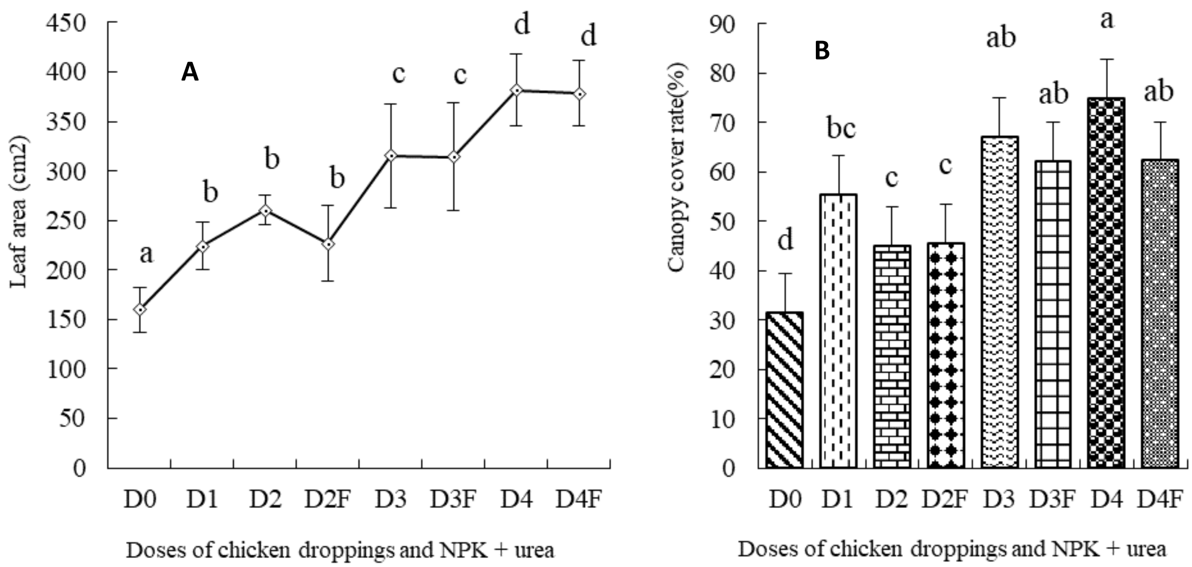

Figure 2: Effect of laying hen droppings and NPK combined with urea on leaf area (A) and canopy cover rate (B).

Legend: Histogram bars followed by the same letter are not significantly different at the 5% level

- **D2** = 2.5 t/ha of laying hen droppings applied before sowing,
- **D2F** = 1.25 t/ha of laying hen droppings applied before sowing and 1.25 t/ha applied on 35th DAS (2.5 t/ha),
- **D3** = 5 t/ha of laying hen droppings applied before sowing,
- **D3F** = 2.5 t/ha of laying hen droppings applied before sowing and 2.5 t/ha applied on 35th DAS (5 t/ha),
- **D4** = 7.5 t/ha of laying hen droppings applied before sowing,
- **D4F** = 3.75 t/ha of laying hen droppings applied before sowing and 3.75 t/ha applied on 35th DAS (7.5 t/ha),
- **D1** = 100 kg NPK/ha +50 kg urea/ha

3.3 Plant height at flowering

D1 (NPK + urea) and D2, D2F, D3, D3F, D4 and D4F amendments of laying hen droppings improved plant height growth compared to the control D0 (Figure 3). The height of the plants at flowering under the D3, D3F and D4 doses of laying hen droppings was higher than that of the plants amended with NPK combined with urea (D1). The tallest plants were observed under the D4 (243.84 cm) laying hen droppings amendments. The analysis of variance showed a significant effect of the doses of laying hen droppings (P = 0.000) and the dose of NPK combined with urea (P = 0.005) on plant height compared to the control dose D0. A significant difference was observed between the NPK plus urea dose (D1) and the laying hen droppings doses (P = 0.002). However, the analysis did not reveal any significant difference between the height of plants amended with split and unsplit doses of laying hen droppings (P = 0.53).

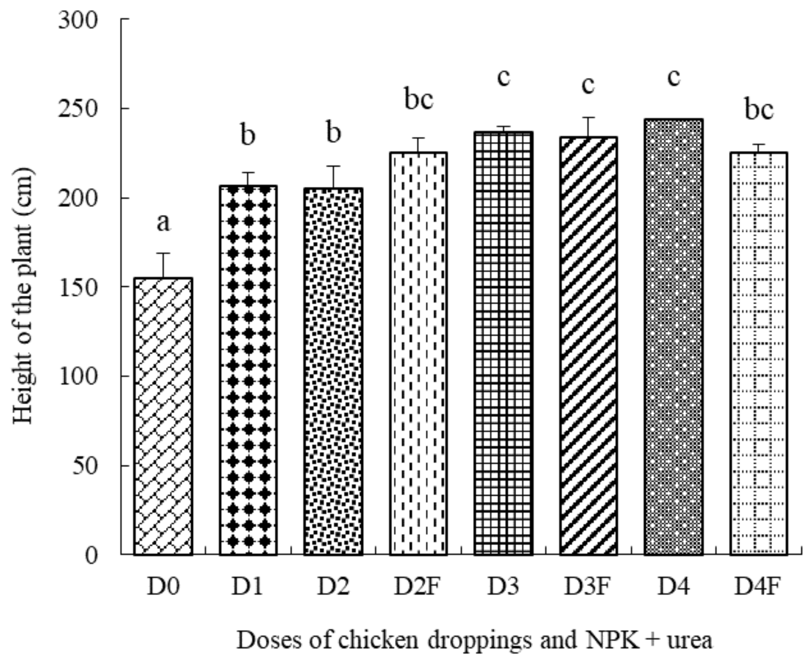

Figure 3: Effect of laying hen droppings and NPK plus urea on plant height at flowering stage

Legend: Histogram bars followed by the same letter are not significantly different at the 5% level

- **D2** = 2.5 t/ha of laying hen droppings applied before sowing,
- **D2F =** 1.25 t/ha of laying hen droppings applied before sowing and 1.25 t/ha applied on 35th DAS (2.5 t/ha),
- **D3 =** 5 t/ha of laying hen droppings applied before sowing,
- **D3F =** 2.5 t/ha of laying hen droppings applied before sowing and 2.5 t/ha applied on 35th DAS (5 t/ha),
- **D4 =** 7.5 t/ha of laying hen droppings applied before sowing,
- **D4F =** 3.75 t/ha of laying hen droppings applied before sowing and 3.75 t/ha applied on 35th DAS (7.5 t/ha),
- **D1 =** 100 kg NPK/ha +50 kg urea/ha

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3.4 Number of tillers per plant at vegetative stage

Increasing doses of laying hen droppings induced an increase in the number of tillers compared to the D0 control dose (Figure 4). The number of tillers per plant at the vegetative stage of plants amended with D4 and D4F doses of laying hen droppings was higher than the number of tillers per plant of D1 (NPK + Urea). Plants amended with D4 dose of laying hen droppings had the highest number of tillers. The analysis of variance revealed a significant effect of laying hen droppings doses on plant tillering (P = 0.001) compared to the control D0. There was also a significant difference between NPK plus urea (D1) dose and laying hen droppings doses (P = 0.000). However, the D1 dose (NPK + urea) had no significant effect on the number of tillers (P = 0.91). There was no significant difference between the number of tillers of the plants amended with fragmented and unfragmented doses of laying hen droppings (P = 0.57).

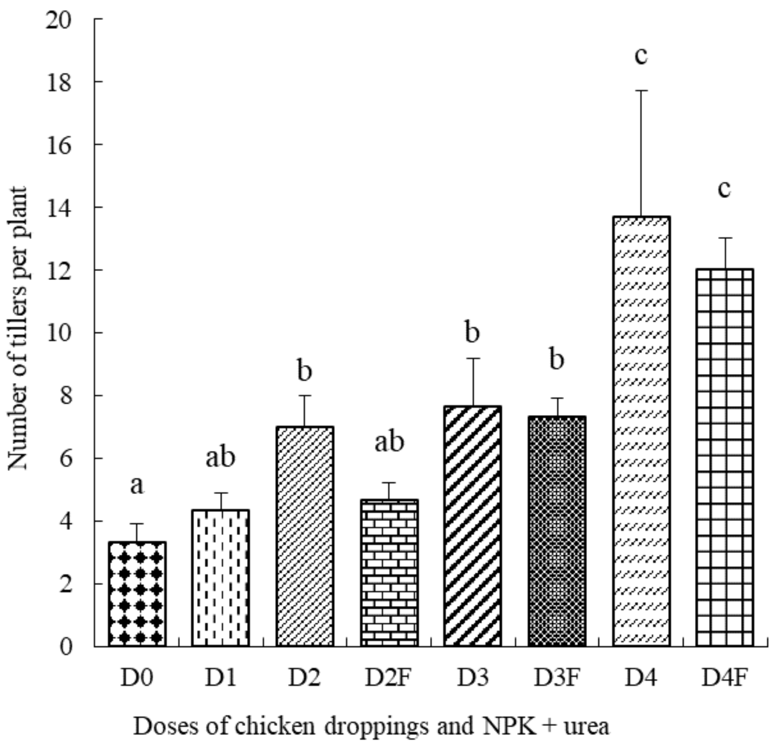

Figure 4: Effect of laying hen droppings and NPK combined with urea on the number of tillers per plant at vegetative stage.

Legend: Histogram bars followed by the same letter are not significantly different at the 5% level

- **D2 =** 2.5 t/ha of laying hen droppings applied before sowing,
- **D2F =** 1.25 t/ha of laying hen droppings applied before sowing and 1.25 t/ha applied on 35th DAS (2.5 t/ha),
- **D3 =** 5 t/ha of laying hen droppings applied before sowing,
- **D3F =** 2.5 t/ha of laying hen droppings applied before sowing and 2.5 t/ha applied on 35th DAS (5 t/ha),
- **D4 =** 7.5 t/ha of laying hen droppings applied before sowing,

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- **D4F =** 3.75 t/ha of laying hen droppings applied before sowing and 3.75 t/ha applied on 35th DAS (7.5 t/ha),
- **D1 =** 100 kg NPK/ha +50 kg urea/ha

3.5 Yield parameters

Increasing doses of laying hen droppings resulted in an increase in spike length compared to the control dose D0 (Table III). The spike length of plants amended with the laying hen droppings doses was greater than that of plants amended with NPK plus urea dose. The longest spikes were measured in plants amended with D4F (44 cm) dose of laying hen droppings. The analysis of variance showed a positive and significant effect of laying hen droppings on spike length (P = 0.000); a significant difference was also observed between the doses of laying hen droppings and NPK plus urea (P = 0.000). NPK plus urea (D1) dose had no significant effect on spike length (P = 0.057); the analysis did not reveal any significant difference between split and unsplit doses of laying hen droppings on spike length (P = 0.26).

Like spike length, the NPK plus urea dose and laying hen droppings doses induced an increase in spike diameter compared to the control doses D0 (Table III). The spike diameter of the plants amended with D3, D3F, D4 and D4F of laying hen droppings was higher than that of the plants amended with NPK plus urea dose (D1). The largest spike was measured in plants amended with D4F (30.12 mm) of laying hen droppings dose. The analysis of variance showed that the doses of laying hen droppings (P = 0.0001) and NPK combined with urea (P = 0.003) significantly improved spike diameter compared to the control dose D0. A significant difference was observed between the spike diameter of the plants amended with laying hen droppings and those amended with NPK plus urea (P = 0.001). However, there was no significant difference between the spike diameter of plants amended with fractional and non-fractional doses of laying hen droppings (P = 0.3).

The straw yield of plants amended with D3, D3F, D4 and D4 doses of laying hen droppings increased by 2 539.87 kg, 2 096.80 kg, 3 090.32 kg and 2 810.55 kg, respectively, compared to the yield of D0 control plants (Table III). The straw yield of plants amended with D4 dose of laying hen droppings was higher than that of plants amended with NPK combined with urea (D1). The D4 (5 691.05 kg/ha) dose of laying hen droppings resulted in the highest straw yield. The laying hen droppings doses significantly improved the straw yield (P = 0.0001) compared to the control dose. A significant difference was observed between the straw yield of plants amended with of laying hen droppings and those amended with NPK plus urea (P = 0.0001). However, NPK plus urea did not have a significant effect on straw yield (P = 0.29). No significant difference was observed between the straw yield of split and unsplit doses of laying hen droppings (P = 0.5).

The doses of laying hen droppings and NPK plus urea improved grain yield. The grain yield of the plants amended with the doses of laying hen droppings was higher than that of the plants amended with the dose of NPK combined with urea. The D4F (3 958.42 kg/ha) dose of laying hen droppings gave the highest grain yield. The results of analysis of variance revealed a significant effect of laying hen droppings ($P < 0.0001$) and NPK plus urea (P = 0.001) on grain yield compared to the control. A significant difference was observed between the laying hen droppings and NPK plus urea dose (P = 0.000). However, the analysis did not reveal any significant difference between the grain yield of the plants amended with the split and unsplit doses of laying hen droppings (P = 0.43).

Table III: Yield and its components

Treatments \ Parameters		Spike length (cm)	Diameter of the spike (mm)	Straw yield (kg/ha)	Grain yield (Kg/ha)
Control	**D0**	31,37 ± 2,05^{A}	24,07 ± 0,62^{D}	2 526.13 ± 595.06^{D}	647.14 ± 108.09^{C}
NPK+Urée	**D1**	34,62 ± 1,89^{AB}	26,40 ± 1,33^{C}	3 542.39 ± 704.08^{BCD}	2 469.01 ± 274.42^{B}
Laying hen droppings	**D2**	38,00 ± 1,78^{BC}	27,30 ± 2,00^{BC}	3 336.23 ± 519.44^{CD}	1 768.50 ± 217.00^{B}
	D2F	40,25 ± 2,53^{C}	26,08 ± 0,48^{C}	2 717.77 ± 512.08^{D}	2 141.54 ± 166.70^{B}
	D3	39,62 ± 1,70^{C}	29,55 ± 0,46^{AB}	4 921.60 ± 833.99^{AB}	3 922.71 ± 665.65^{A}
	D3F	38,13 ± 0,95^{BC}	28,88 ± 0,58^{AB}	4 587.68 ± 725.31^{ABC}	3 504.45 ± 517.53^{A}
	D4	40,87 ± 1,80^{C}	28,74 ± 1,99^{AB}	5 691.05 ± 1609.33^{A}	3 867.71 ± 564.28^{A}
	D4F	44,00 ± 3,74^{C}	30,12 ± 1,10^{A}	5 357.14 ± 657.65^{AB}	3 958.42 ± 661.89^{A}
Laying hen droppings * D0		**0.000 s**	**0.0001 s**	**0.0001 s**	**< 0.0001 s**
(NPK+Urée) * D0		0.057 ns	**0.003 s**	0.29 ns	**0.001 s**
Laying hen droppings * (NPK+Urée)		**0.000 s**	**0.001 s**	**0.0001 s**	**0.0000 s**

Legend: Means followed by the same letter are not significantly different at the 5% level

- **s** = significant difference
- **ns** = non significant difference
- **D2 =** 2.5 t/ha of laying hen droppings applied before sowing,
- **D2F =** 1.25 t/ha of laying hen droppings applied before sowing and 1.25 t/ha applied on 35th DAS (2.5 t/ha),
- **D3 =** 5 t/ha of laying hen droppings applied before sowing,
- **D3F =** 2.5 t/ha of laying hen droppings applied before sowing and 2.5 t/ha applied on 35th DAS (5 t/ha),
- **D4 =** 7.5 t/ha of laying hen droppings applied before sowing,
- **D4F =** 3.75 t/ha of laying hen droppings applied before sowing and 3.75 t/ha applied on 35th DAS (7.5 t/ha),
- **D1 =** 100 kg NPK/ha +50 kg urea/ha

4.DISCUSSION

The application of laying hen droppings and NPK combined with urea had variable effects following the different parameters studied. Leaf chlorophyll content increased significantly following the application of laying hen droppings on the one hand, and NPK (100 kg/ha) combined with urea (50 kg/ha) on the other. From the D2 (2.5t/ha) dose of laying hen droppings, the plants have reached their maximum leaf chlorophyll content. This increase in chlorophyll content in the leaves is believed to be due to the availability of nutrients in the soil following amendment with laying hen droppings and NPK combined with urea. Among the macronutrients contained in laying hen droppings and mineral fertilizer, nitrogen is thought to promote chloroplast multiplication and increase chlorophyll content (Diehl, 1975; Yoshida, 1981). In addition, it represents the major part of the constituents of chlorophyll molecules. Also, magnesium and iron contained in laying hen droppings can participate directly in chlorophyll synthesis. Amujoyegbe *et al*, 2007 observed an increase in leaf chlorophyll content in sorghum and maize plants amended with NPK and laying hen droppings. Like chlorophyll content, the doses of laying hen droppings and the dose of NPK combined with urea induced a significant increase in plant height. The tallest plants were observed under the D3, D3F and D4 doses of laying hen droppings. This better growth in height could be explained by the increase in the growth speed of the stems generated by the fertilization with laying hen droppings and NPK combined with urea, which would have brought a sufficient quantity of nitrogen and phosphorus necessary for the growth of the plants. Phosphorus and nitrogen are essential macronutrients for plants and promote growth, especially at the juvenile stage (Harper, 1994; Stevenson, 1986; Gachon, 1968). Similar results have been observed on sunflower (Yerima *et al*, 2014), maize (Saleem *et al*, 2009). Similarly, the doses of laying hen droppings and the dose of NPK combined with urea also induced an increase in leaf area. The largest leaves were measured under the D4 and D4F doses of laying hen droppings. This better leaf development would be justified by the increase in leaf length and width favored by the phosphorus supplied by the laying hen droppings and the NPK. Phosphorus is a macronutrient that improves leaf elongation (Plenet *et al*, 2000). An increase in leaf area of yam plants (Agbede et *al.*, 2010) sorghum and maize (Amujoyegbe et *al.*, 2007) were observed following the application of chicken droppings. Like leaf area, laying hen droppings significantly improved the tillering of millet plants. Laying hen droppings are very rich in nitrogen (67.5 kg N/t). According to Vidal (1963), nitrogen improves plant tillering. Thus, the increase in the number of tillers produced by millet plants would be attributable to the contribution of hen droppings (7.5 t/ha), which would have supplied about 337.5 kg N/ha to the millet plants before sowing. This availability of nitrogen in sufficient quantities would have stimulated the tillering of millet plants. Availability of phosphorus and potassium improves plant tillering (Gros, 1979). An increase in the number of tillers was observed by Aboubacar, (2017) in rice amended with 7.5 t/ha of chicken droppings. As with tillering, canopy cover rate was significantly increased by the application of laying hen droppings and NPK combined with urea. This increase could be explained by better plant tillering, better leaf development, better leaf production by the plants induced by fertilizers.

The yield and its components were significantly improved by the amendment with laying hen droppings. Indeed, the application of 5 t/ha of laying hen droppings resulted in the best grain yield. This better grain yield could be explained on the one hand by a better filling of the spikes and on the other hand by the increase in the diameter, the length of the spikes and the number of flowering tillers following the amendment with layer hen droppings and NPK combined with urea. These amendments enriched the soil with macronutrients. These macronutrients play a major role in the yield. Indeed, potassium during the grain filling stage increases the size and weight of the grains by promoting the migration of reserves (photo-assimilas) from the different vegetative parts of the plant to the seeds. In addition to the phosphorus absorbed from the soil, the plant would have remobilized and redirected the phosphorus present in the vegetative parts towards the spikes to ensure good grain filling. Similar results have been observed on sunflower Yerima et *al*, 2014) sunflower, corn (Alain et *al*, 2019) amended with laying hen droppings. Moreover, the straw yield also increased significantly following the amendment with laying hen droppings. This improvement of the straw yield could be explained by a good vegetative development marked by a significant improvement of the plant height, the number of leaves, the leaf surface, the number of tillers induced by the fertilization with laying hen droppings. Similar results were observed in maize (Alain et *al*, 2019) and rice (Aboubacar, 2017) amended with chicken droppings.

When comparing the types of fertilizers, plant height, canopy cover rate, leaf area, number of tillers, grain and straw yields of plants amended with laying hen droppings were significantly higher than those of plants amended with NPK combined with urea. These results could be explained by the high macronutrient content of laying hen droppings (nitrogen, phosphorus and potassium), which are key to plant growth and yield. Indeed, the application of 5 t of laying hen droppings per hectare brought about 114.5 kg of phosphorus per hectare, 337.5 kg of nitrogen per hectare and 141 kg of potassium per hectare to the plants, which is largely superior to that provided by NPK combined with urea, which is 37 kg of nitrogen, 23 kg of phosphorus and 14 kg of potassium per hectare. On the other hand, this could be explained by the high losses of certain macronutrients such as nitrogen by leaching or volatilization from NPK fertilizers combined with urea, as these elements were directly available to the plant. On the other hand, in the case of chicken droppings, losses would be minimal because the droppings have gone through a mineralization stage to make the nutrients available. Therefore, this mineralization time would have limited the losses of mineral elements.

5.CONCLUSION

The overall objective of this study was to evaluate the effect of laying hen droppings on millet productivity. It was found that the amendment with laying hen droppings had a significant effect on millet productivity. Indeed, it improved leaf chlorophyll content, leaf area, canopy cover rate, number of tillers, spike length and diameter, grain and straw yield. Compared to NPK fertilizer combined with urea, parameters such as canopy cover, leaf area, number of tillers, plant height, spike length and diameter, grain and straw yield of plants amended with laying hen droppings were higher than those of plants fertilized with NPK combined with urea. The dose of 5 t/ha of laying hen droppings gave the optimal yield, so this dose could be recommended as a single application before sowing for millet production the Sudano-Sahelian zone of Burkina Faso.

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REFERENCES

Aboubacar, B. C. Effects of poultry droppings on soil chemical properties and paddy yield of strick rainfed rice in the southern Sudanian zone of Burkina Faso. *Dissertation*, 2017; 68.

Agbede, T. M., Oladitan, T. O., Alagha, S. a., Ojomo, a. O., & Ale, M. O. Comparative Evaluation of Poultry Manure and NPK Fertilizer on Soil Physical and Chemical Properties, Leaf Nutrient Concentrations, Growth and Yield of Yam (*Dioscorea rotundata* Poir) in Southwestern Nigeria. *World Journal of Agricultural Science*, 2010; *6*(5), 540-546.

Alain P.K. Gomgnimbou, Alimata A. Bandaogo, Kalifa Coulibaly, Abdramane Sanon, S. O. and H. B. N. Short-term effects of poultry droppings application on maize (*Zea mays* L .) yield and chemical characteristics of a ferralitic soil in the South Sudanian zone of Burkina Faso Effects on short term application of poultry m. *International Journal of Biological and Chemical Sciences*, *13*(August), 2019; 2041-2052.

Amujoyegbe, B. J., Opabode, J. T., & Olayinka, A. Effect of organic and inorganic fertilizer on yield and chlorophyll content of maize (*Zea mays* L.) and sorghum Sorghum bicolour (L.) Moench. *African Journal of Biotechnology*. 2007; *6*(16), 1869-1873. https://doi.org/10.5897/ajb2007.000-2278

Bunasols. Pedological study of the Experimental Station of Gampèla. Rapport technique n059. Ministry of Agriculture and Livestock, Burkina Faso. 1988; 46 p.

Dakheel, A.J., G. Shabbir and A.Q. Al-Gailani. Yield stability of pspikel millet genotypes under irrigation with different salinity levels. Europ. J. Sci. Res. 2009; 37: 288-301

Delphine Bossy. Engrais, une pollution agricole dangereuse. 2014; 57pp.

Diehl J.A. General Agriculture. 1975; pp 205-211

Gachon, L. Phosphorus. 1968; *231*, 579-586.

Gros, A. Fertilizers: a practical guide to fertilization (7 ed) Maison Rustique, Paris. 1979; 542 p.

Guinko S. Végétation de la Haute Volta. Thesis of Doctorate of Eta, University of Bordeaux III. 1984 ; 318 p.

Hamadou, M., Idrissa, S., Mahamadou, C., & Valentin, K. Fodder potentialities of millet (*Pennisetum glaucum* (L .) R . Br) : A review of the literature. *Journal of Animal &Plant Sciences*. 2017; *34*(2), 5424-5447. http://www.m.elewa.org/JAPS; ISSN 2071-7024

Harper, J.E. Nitrogen metabolism in "Physiology and determination of crop yield". DOI:10.2134/1994.physiologyanddetermination. American Society of Agronomy, Inc. Crop Science Society of America, Inc. Soil Science Society of America, Inc. 1994; 285-302.

M. F. Saleem, W. Farhad, M. A. C. and H. M. H. Effect of poultry manure levels on the productivity of spring maize (*Zea mays* L.). *Journal of Animal and Plant Sciences*. 2009*; 19*(3), 122-125.

MAAH. Annuaire des statistiques agricoles du Burkina Faso. *Direction Générale Des Études et Des Statistiques Sectoriels, MASA, ParGs* (European Union). 2020; 227.

Newman Y., Jennings E., Vendramini, J. and Blount, A. Pspikel millet (*Pennisetum glaucum*): overview and management. University of FL. IFAS Extension, Publication # SS- AGR. 2010; 337

Plenet, D., S. Etchebest, A. Mollier, Pellerin, S. Growth analysis of maize yield field crops under phosphorus deficiency: 1. Leaf growth. Plant and Soil. 2000; 223: 117-130

Serge Olivier Kotchi, Détection du stress hydrique par thermographie infrarouge : application à la culture de la pomme de terre. 2004; DOI :10.13140/RG.2.1.4909.5280.

Stevenson J. F. Cycles of soil: carbon, nitrogen, phosphorus, sulfur, micronutrients. John Wiley & Sons, New York. 1986.

Vidal, P. Growth and mineral nutrition of millet grown in Senegal. *Thesis*. 1963; 150.

Yerima, B., Tiamgne, A., & Van Ranst, E. Response of two sunflower (Helianthus sp.) varieties to chicken droppings fertilization on a Hapli-Humic Ferralsol at Yongka Western Highlands Resspikech Garden Park (YWHRGP) Nkwen-Bamenda, Cameroon, Central Africa. Tropicultura. 2014; 32(4), 168-176.

Yoshida S. Fundamentals of rice crop science. International Rice Resspikech Institute (IRRI), Los Banos-Laguna, Philippines. 1981; 269 p.