

RESEARCH PAPER**OPEN ACCESS****Effects of dried faecal sludge fortified with various rates of Burkina phosphate powder on the growth and yields of maize and cotton cropped in a rotation system in western Burkina Faso****M. Traore^{*1}, J. K. F. Sanon¹, A. S. Hema², I. Semde¹, S. Traore¹, B. Koulibaly³**¹Laboratory for Research on Soil Fertility and Production Systems (LERF/SP),
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Bobo-Dioulasso, Burkina Faso**Key words:** Dry faecal sludges, Burkina phosphate, Rotation, Soil fertility, Yields, Burkina Faso**Received:** 15 August, 2026 **Accepted:** 25 August, 2026 **Published:** 03 September, 2026**DOI:** <https://dx.doi.org/10.12692/jbes/29.3.1-12>**ABSTRACT**

Soil fertility decline is one of the major causes of low performance of farming systems in Burkina Faso. This investigation focused on valorisation of local substrates as fertilizer, by evaluating the effects of different formulation of dried faecal sludge and Burkina phosphate on maize and cotton grown in rotation. The study was conducted at Matourkou (11°4' et 11°6' N, 4°19' et 4°21' W). The experimental design was a fisher bloc with six (6) treatments and four (4) replicates. The treatments included T1 (400 kg/ha BP); T2 (2500 kg/ha BVS); T3 (160 kg/ha BP + 1500 kg/ha BVS); T4 (120 kg/ha BP + 1750 kg/ha BVS); T5 (80 kg/ha BP + 2000 kg/ha BVS); T6 (37,5 kg/ha BP + 1750 kg/ha BVS + 687,8 kg/ha Montmorillonite clay + 12,5 kg/ha Ca(OH)₂). Maize and cotton high, root collar diameter, and yields were used for the determination of the effects of these treatments. As for the results, it's only in the second year of the experiment that treatments T4 significantly improved yields of maize (60.33%) and cotton (and 109.1%) compared to the control (T1); it also improved dry biomass yield for both crops. These results indicate that the combination of dry faecal sludge and Burkina phosphate (T4) improved soil fertility and yields in a cotton-maize crop rotation system. This fertilization option can be considered for the sustainability of agricultural production systems while offering robust option for dry faecal sludge recycling.

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INTRODUCTION

In sub-Saharan Africa and particularly in Burkina Faso, the majority of the economy relies on farming activities (Banque mondiale, 2017). However, the farming systems remain fragile because of its high dependence on harsh climatic conditions, fragile ecosystems and accelerated soil degradation; as consequences, the farming system is underperforming despite its socio-economic way (Lompo *et al.*, 2021; Dugué *et al.*, 2024).

Tropical ferruginous soil are the most dominant ones under cotton-cereals production systems in the western cotton production area of Burkina Faso and, these soils are featured by low organic matter and carbon content (Tiendrébéogo *et al.*, 2020; Badoua, 2024). Practices such other farming with low return in terms of fertilisation and poor management of crop residues strengthen soil degradation trends in this area. As consequences, nutrients budget remains negative in the cotton maize rotation farming systems (Yemadje *et al.*, 2025). To address the issue, mineral fertilizers have been promoted. However, their economic and physical inaccessibility have quickly come as the limits of sustainable fertilization practices using mineral fertilizer (Bazie *et al.*, 2020; Nignan *et al.*, 2023).

As outline above, phosphorus deficient is an intrinsic limit of soil productivity in Burkina Faso, and therefore cropping systems performances (Bonzi *et al.*, 2011; Fukuda *et al.*, 2021). To address the issue, several approaches have been adopted to boost the use of Burkina phosphate as amendment. However, most of them failed because its low solubility (Traoré, 2024). Various methods such as partial chemical acidulation, phospho-composting (Toundou, 2016; Traoré, 2024) have been tested for the solubilization of Burkina phosphate.

Currently, with the need for ecological intensification, research interests have been focused on alternative fertilizers based on affordable, natural and local products (Traoré *et al.*, 2013; Hema, 2024). In such context, dry faecal sludge is an alternative substrate due to its physicochemical properties and its high nutrients content (Siddo *et al.*, 2023; Hema, 2024). A

large quantity of dry sludges are released from the waste treatment stations without large-scale recycling approach, even though they could be used as basic substrate for the formulation of organo-mineral amendments. The dry faecal sludges were found to be acidic (Hema *et al.*, 2022) and this could be an interesting factor for addressing the solubility issues of Burkina phosphate outline above while fortifying the organo-mineral fertiliser resulting from the combination of the two substrates (Lompo, 1993; Hema, 2024).

Using organo-mineral substrates for soil fertility management is a common practice. Thus, previous studies showed that interactions between organic and mineral amendments significantly improved crop yields. However, the effectiveness of the resulting organo-mineral amendment is mainly due to a proper balance between the proportions of organic and the mineral substrates. In the same frame, it was shown that interactions between organic and mineral amendments significantly improve crop yields (Ayamba *et al.*, 2023; Youssouf *et al.*, 2023). To optimize performance of the organo-mineral fertilizer, local substrates such as montmorillonite clay were added as supplement in order to stabilize nutrients and reduce leaching, particularly in sandy soils with low buffering capacity (Kome *et al.*, 2019; Héma, 2024). The study reported herein aimed at evaluating the effects of various formulations of dry faecal sludge based organo-mineral amendments on the growth and the yield of maize and cotton farmed in rotation.

MATERIALS AND METHODS

Site description

The investigations were conducted at the experimental site of the Agronomic school Matourkou, in the Guiriko region Guiriko (11°4' et 11°6' N, 4°19' et 4°21' W), district of Bobo Dioulasso in western Burkina Faso (Fig. 1). The site has a South-Sudanese climate, with annual rainfall ranging from 1,000 to 1,200 mm (Fontes and Guinko, 1995). As for soil, the most dominant type is leached tropical ferruginous soils with a sandy-loam texture, acidic and low organic matter content (Bunassols, 2003).

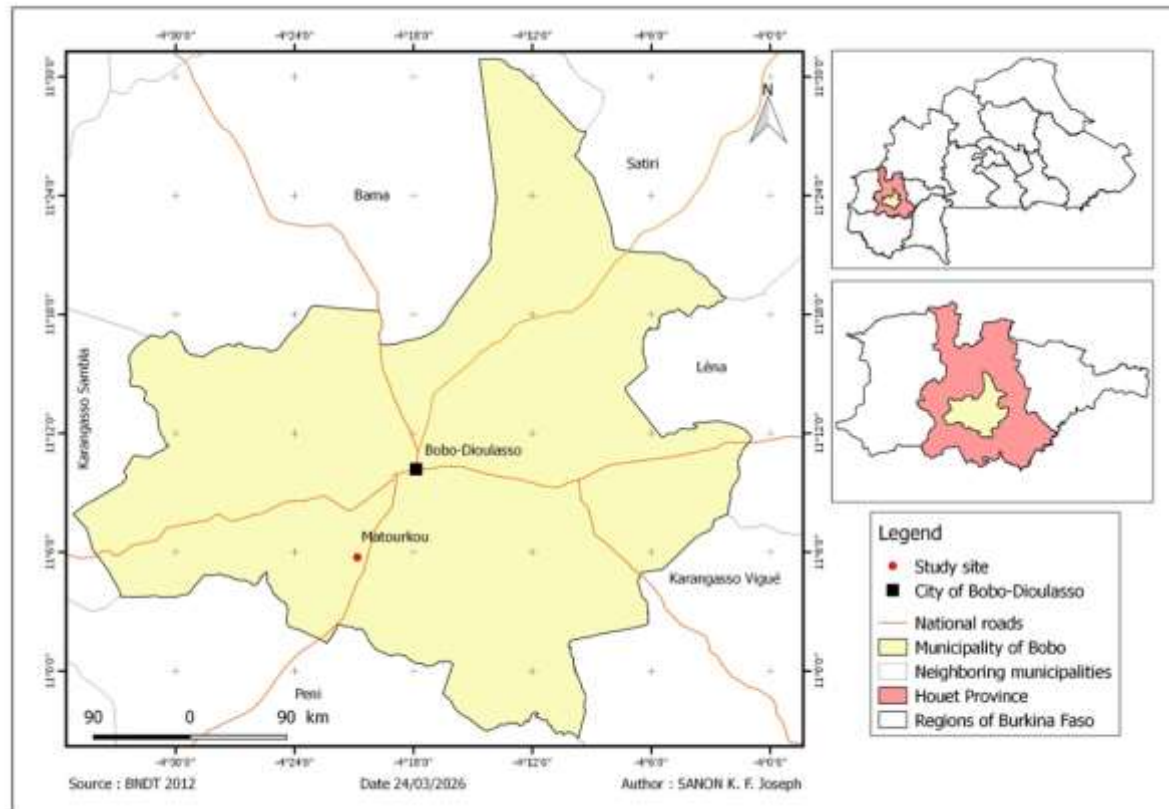


Fig. 1. Location of the experimental site of Matourkou

Table 1. Physico-chemical characteristics of dried faecal sludge

Parameters	pH	OM (%)	N (%)	P (g. kg ⁻¹)	K (g. kg ⁻¹)
DFS	4.71	30.52	1.70	8.6	8.6

Source: Hema (2024), Note: OM: organic matter; N: Nitrogen; P: phosphorus; K: potassium

Material

The vegetal material for the trials was “Kamboinsé Extra Précoce Jaune (K.E.J)” and FK64 varieties respectively for maize and cotton. The maize K.E.J is an early maturing maize variety with 75 days cycle and a potential grain yield of 3.2 t/ha (Hema, 2000). As for FK64, the cycle is 150 days with a potential seed cotton yield of 2.8t/ha (Koulibaly, 2018).

For soil fertilisation, various substrates were used as basic amendments and these substrates were different formulation of dry faecal sludge fortified with Burkina phosphate powder, of quicklime and montmorillonite clay. Mineral fertilizers used were urea (46% N) and NPK (15-15-15) for maize, and urea (46% N) and NPK (14-18-18+6S+1B) for cotton. The dry faecal sludge were collected from the wastewater and excreta treatment plant of the National Water

and Sanitation Office (ONEA) at Dogona/Bobo Dioulasso. Table 1 gives the physicochemical properties of the dry faecal sludge. As for the Burkina Phosphate (BP), mineral fertilizers, lime and Montmorillonite clay they were collected locally.

Experimental design

The trial was conducted during the rainy seasons of 2024 and 2025. It consisted of two (2) sub-blocks of 24 elementary plots each. The elementary plot sized 16 m² (4m*4m) and disposed perpendicular to the slope. One sub-block planted with maize (sub-block A) and the other with cotton (sub-block B) for the first season in 2024. For 2025, cropping season 2025, crops rotation were done between the two sub-blocks; then sub-block A was occupied by cotton and B by maize. As for the details of the treatments in the sub-blocks, each sub-block included six (6) treatments

and four (4) replicates giving twenty-four (24) elementary outlined above; and plots were randomly disseminated according in a Fisher bloc design within each sub-block. As for the disposal of the elementary plots and the replicates; Replicates were separated by 2 m wide path, while 1 m paths separated the individual plots within the replicates. Except the control plot (T₁) amended only with Burkina phosphate, seedbed preparation for the other treatments included, in addition to soil tillage, the application of various rates and/or formulations of dried faecal sludge based organo-mineral fertilizer (Burkina phosphate, lime, or montmorillonite clay). As for crops fertilisation, mineral fertilizers were applied using the micro-dosing technique and at the rate of 62.5 kg/ha of NPK (14-18-18+6S+1B) and 41 kg/ha of urea (46% N) for cotton; the same rates were applied on maize and the NPK formulation applied was 15-15-15. The details of the six (6) treatments tested are:

T₁: 400 kg/ha Burkina phosphate + 62.5 kg/ha NPK + 41 kg/ha Urea;

T₂: 2500 kg/h dry faecal sludge + 62.5 kg/ha NPK + 41 kg/ha Urea;

T₃: 160 kg/ha Burkina phosphate + 1500 kg/ha dry faecal sludge + 62.5 kg/ha NPK + 41 kg/ha Urea;

T₄: 120 kg/ha Burkina phosphate + 1750 kg/ha dry faecal sludge + 62.5 kg/ha NPK + 41 kg/ha Urea;

T₅: 80 kg/ha Burkina phosphate + 2000 kg/ha dry faecal sludge + 62.5 kg/ha NPK + 41 kg/ha Urea;

T₆: 37.5 kg/ha Burkina phosphate + 1750 kg/ha dry faecal sludge + 687.8 kg/ha Montmorillonite + 12.5 kg/ha Ca (OH)₂ + 62.5 kg/ha NPK + 41 kg/ha Urea

Farm operations

The soil was ploughed to a depth of 30 cm and then amended two days before sowing. Each treatment received fertilizer and amendments as described in the experimental design. Maize and cotton were sown with a spacing of 0.80 m x 0.40 m. fifteen (15) days after sowing, Thinning operations were conducted in order to have a seedling density of two (2) plants per seedling hole corresponding to 62,500 plants/ha. Mineral fertilizers were applied to both crops at 15 and 30 days after sowing (DAS) for NPK and urea,

respectively. Agro-morphological parameters, specifically plant height and stalk base diameter were measured twice weekly over the vegetation period of each crop from 14 to 56 days after sowing (DAS) for maize and from 14 to 84 DAS for cotton. The measurements were done on five plants of the central seedling lines selected on the random base. At harvest, stalk biomass, maize grain, and seed cotton were weighed after drying. Yields were then determined on the sampling area of each plot and extrapolated to tonnes per hectare (t/ha). The yield is calculated using formula [I]:

$$[I] \text{ Average yield (kg/ha)} = (\text{Average harvest weight} \times 10,000) / (\text{Usable area})$$

With 10,000 the conversion coefficient from m² to ha

Data processing

Data were recorded using Microsoft Office Excel 2016 software. As for the the R software (version 4.4.1), it was used for assessing the effects of the different treatments on crop agro-morphologic parameters and yields. And, analysis of variance (ANOVA) was subsequently conducted for the discrimination of the means values, followed by the Newman-Keuls test at the 5% level for ranking them; the significance of the test was determined by comparing the probability (p) associated with the test statistic to the theoretical value of $\alpha = 0.05$.

RESULTS

Stalk base diameter of maize plants

Maize stalk base diameter increased from the 14th to the 56th day after sowing for all treatments across the two years of the experiment (Fig. 2a and b). In 2024, the lowest stem base diameters were observed in the control (T₁) while the highest mean diameter was recorded for treatment T₄ (21.73% increase compared to the control). T₄ was followed by treatments T₆ (15.25%) and T₅ (14.04%). Finally, treatments T₂ and T₃ showed variation rates of 10.26% and 9.65%, respectively, compared to T₁. At 84 days after sowing, although trends showed increases in mean diameter compared to the control (T₁), no significant difference was observed ($p = 0.9$).

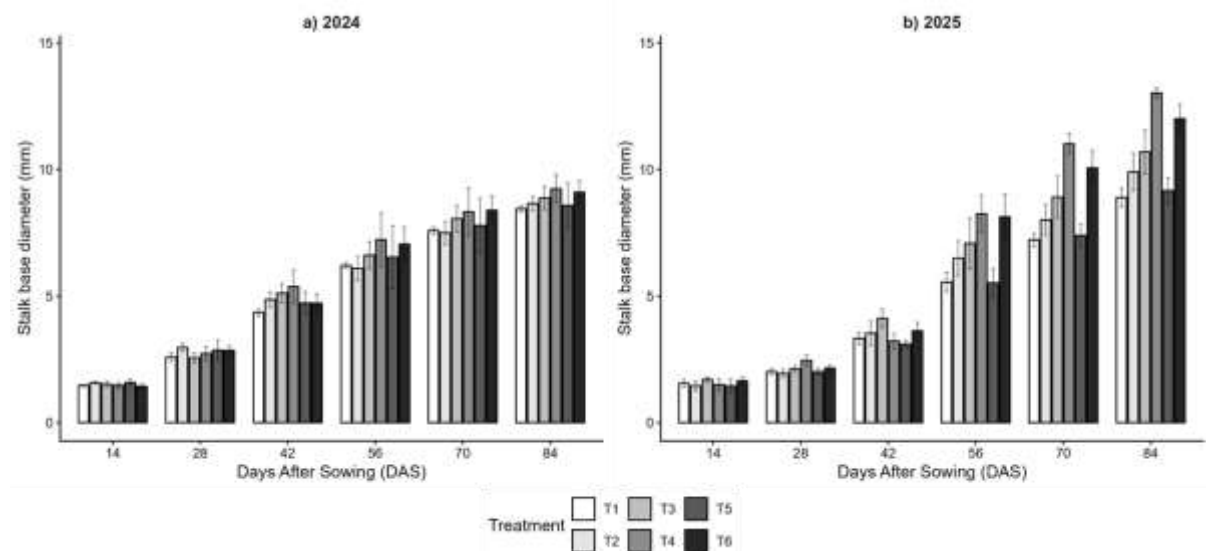


Fig. 2. Variation in maize plant stalk base diameter according to treatments in cropping campaigns 2024 (a) and 2025 (b)

Note : T1 : 400 kg/ha BP + 62,5 kg/ha NPK + 41 kg/ha urea ; T2 : 2500 kg/h BVS + 62,5 kg/ha NPK + 41 kg/ha urea ; T3 : 160 kg/ha BP + 1500 kg/ha BVS + 62,5 kg/ha NPK + 41 kg/ha urea ; T4 : 120 kg/ha BP + 1750 kg/ha BVS + 62,5 kg/ha NPK + 41 kg/ha urea ; T5 : 80 kg/ha BP + 2000 kg/ha BVS + 62,5 kg/ha NPK + 41 kg/ha urea ; T6 : 37,5 kg/ha BP + 1750 kg/ha BVS + 687,8 kg/ha Montmorillonite + 12,5 kg/ha Ca (OH)₂ + 62,5 kg/ha NPK + 41 kg/ha urea)

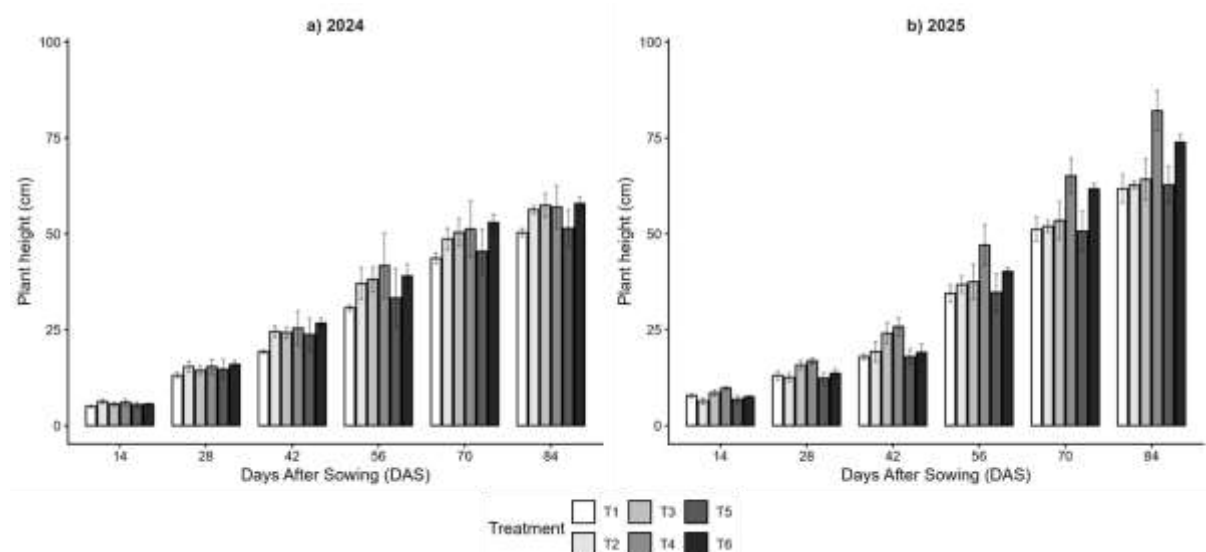


Fig. 3. Variation of maize plant high according to the treatments

Note : T1 : 400 kg/ha BP + 62,5 kg/ha NPK + 41 kg/ha urea ; T2 : 2500 kg/h BVS + 62,5 kg/ha NPK + 41 kg/ha urea ; T3 : 160 kg/ha BP + 1500 kg/ha BVS + 62,5 kg/ha NPK + 41 kg/ha urea ; T4 : 120 kg/ha BP + 1750 kg/ha BVS + 62,5 kg/ha NPK + 41 kg/ha urea ; T5 : 80 kg/ha BP + 2000 kg/ha BVS + 62,5 kg/ha NPK + 41 kg/ha urea ; T6 : 37,5 kg/ha BP + 1750 kg/ha BVS + 687,8 kg/ha Montmorillonite + 12,5 kg/ha Ca (OH)₂ + 62,5 kg/ha NPK + 41 kg/ha urea

As for the cropping campaign 2025, T4 recorded the highest final mean diameter, followed by T6 and T5. Compared to the control (T₁), the diameters in these

treatments were respectively 22%, 15%, and 14% higher. For treatments T2 and T3, the increase compare to the control was 10% for each.

Maize plant height variation

As for maize plant height, the results did not show clear trends across the two cropping seasons (Fig. 3a and b). In the first year of the experiment (2024), different fertilizers did not induce significant effects on maize plant height at harvest ($p = 0.56$). In contrast, during the second cropping year (2025), treatment T4 induced significantly higher maize height at harvest compared to the control (T1). The other treatments led to increases ranging from 5% to 9%. However, despite these positive trends, no significant difference was observed between the treatments.

Stalk base diameter of the cotton plants

Growth of cotton plant stalk base diameter over the two cropping seasons did not showed clear trends according to the treatments (Fig. 4a and b). In the first year, cotton plant stalk base diameter growth was not affected significantly by different treatments from 14 and 28 days after sowing (DAS). From 56 DAS, although trends showed increases in mean diameter

in treated plots compared to the control (T1), it did not result in to significant difference ($p = 0.9$).

Specifically, treatments T4 and T6 resulted in increases of 16% (7.22 ± 1.05 mm) and 14% (7.04 ± 0.68 mm), respectively, compared to T1 (6.2 ± 0.09 mm). Treatments T3 and T5 showed lower variations, 7% and 5%, respectively. As for T2, it showed no notable difference compared to the control. Conversely, during the 2025 season, the treatments induced significant variations in the final cotton plant stalk base mean diameter ($p = 0.001$). Its growth remained uniform until 28 days after sowing (DAS) before diverging by the final observation (84 DAS). Treatment T4 recorded the highest mean, with a diameter of 13.02 ± 0.2 mm. Compared to the control, a significant increase of was observed (46%), followed by T6 (35%). Treatments T3 and T2 induced increases of 20% and 11%. Finally, treatment T5 (9.16 ± 0.51) with a variation of only 3% did not induced significant variation compared to the control T1.

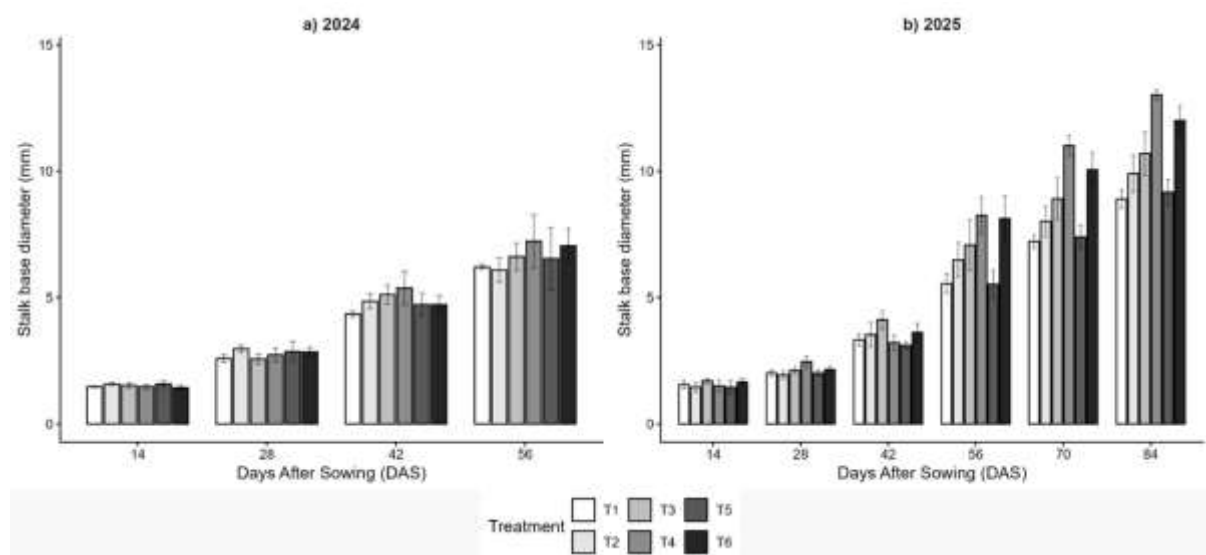


Fig. 4. Variation in cotton plant Stalk base diameter according to treatments in cropping campaigns 2024 (a) and 2025 (b)

Note : T1 : 400 kg/ha BP + 62,5 kg/ha NPK + 41 kg/ha urea ; T2 : 2500 kg/h BVS + 62,5 kg/ha NPK + 41 kg/ha urea ; T3 : 160 kg/ha BP + 1500 kg/ha BVS + 62,5 kg/ha NPK + 41 kg/ha urea ; T4 : 120 kg/ha BP + 1750 kg/ha BVS + 62,5 kg/ha NPK + 41 kg/ha urea ; T5 : 80 kg/ha BP + 2000 kg/ha BVS + 62,5 kg/ha NPK + 41 kg/ha urea ; T6 : 37,5 kg/ha BP + 1750 kg/ha BVS + 687,8 kg/ha Montmorillonite + 12,5 kg/ha Ca (OH)₂ + 62,5 kg/ha NPK + 41 kg/ha urea

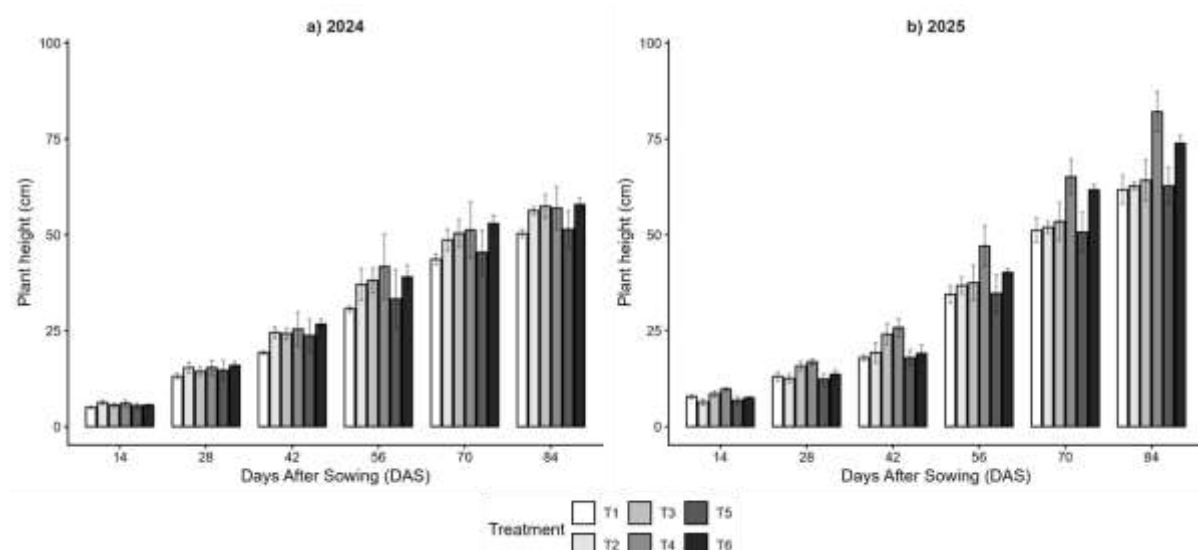


Fig. 5. Variation of cotton plant high according to the treatments

Note : T1 : 400 kg/ha BP + 62,5 kg/ha NPK + 41 kg/ha urea ; T2 : 2500 kg/h BVS + 62,5 kg/ha NPK + 41 kg/ha urea ; T3 : 160 kg/ha BP + 1500 kg/ha BVS + 62,5 kg/ha NPK + 41 kg/ha urea ; T4 : 120 kg/ha BP + 1750 kg/ha BVS + 62,5 kg/ha NPK + 41 kg/ha urea ; T5 : 80 kg/ha BP + 2000 kg/ha BVS + 62,5 kg/ha NPK + 41 kg/ha urea ; T6 : 37,5 kg/ha BP + 1750 kg/ha BVS + 687,8 kg/ha Montmorillonite + 12,5 kg/ha Ca (OH)₂ + 62,5 kg/ha NPK + 41 kg/ha urea

Table 2. Variation in grain maize and straw yields in 2024 and 2025

Treatments	Maize grain (kg/ha)		Dry biomass (maize stalk) kg/ha	
	2024	2025	2024	2025
T1	1428 ± 60	1316 ± 196 ^b	2174 ± 131	1685 ± 127 ^b
T2	1584 ± 102	1360 ± 195 ^b	2171 ± 110	1905 ± 43 ^b
T3	1899 ± 107	1503 ± 109 ^{ab}	2188 ± 205	1831 ± 66 ^b
T4	1744 ± 85	2110 ± 103 ^a	2235 ± 340	2651 ± 50 ^a
T5	1641 ± 293	1674 ± 130 ^{ab}	2170 ± 152	1894 ± 121 ^b
T6	1554 ± 84	1460 ± 85 ^b	2105 ± 147	1862 ± 116 ^b
p- value	0.32	0.01	0.999	0.00002

Note : T1 : 400 kg/ha BP + 62,5 kg/ha NPK + 41 kg/ha urea ; T2 : 2500 kg/h BVS + 62,5 kg/ha NPK + 41 kg/ha urea ; T3 : 160 kg/ha BP + 1500 kg/ha BVS + 62,5 kg/ha NPK + 41 kg/ha urea ; T4 : 120 kg/ha BP + 1750 kg/ha BVS + 62,5 kg/ha NPK + 41 kg/ha urea ; T5 : 80 kg/ha BP + 2000 kg/ha BVS + 62,5 kg/ha NPK + 41 kg/ha urea ; T6 : 37,5 kg/ha BP + 1750 kg/ha BVS + 687,8 kg/ha Montmorillonite + 12,5 kg/ha Ca (OH)₂ + 62,5 kg/ha NPK + 41 kg/ha urea

Cotton plant high variation

For the cropping campaign of 2024, treatments did not induce significant difference 84 days after sowing ($p = 0.567$) (Fig. 5a and b). However, amendments based on fortified dry faecal sludge with Burkina phosphate (T6, T3, T4, and T2) resulted in increases of 15% (57.88 ± 1.81 cm), 14.15% (57.45 ± 3 cm), 13.15% (56.95 ± 5.6 cm), and 11.92% (56.33 ± 1.05 cm), respectively, compared to the T1 control (50.33 ± 1.06 cm).

For second cropping campaign (2025), amendments based on fortified dry faecal sludge with Burkina

phosphate (T4, T6, T3, and T2) resulted in increases of 36%, 27%, 24%, and 21% respectively, compared to the T1 control. Treatment T5 showed only a slight variation of 8%. In contrast to the cropping campaign of 2025; treatments induced significant variations in final stem mean height 84 days after sowing ($p = 0.0108$) during the second cropping season. Thus, treatment T4 had significantly highest stem (82.05 ± 5.2 cm) corresponding to an increase of 33% compared to the control (T1); it was followed by treatment T6, 20% of increase. Conversely, other treatments showed no significant differences compared to the control.

Table 3. Variation in grain seed cotton and stalk biomass yields in 2024 and 2025

Treatments	Seed cotton yield (kg/ha)		Dry weight of cotton stems (kg/ha)	
	2024	2025	2024	2025
T1	753 ± 245	791 ± 131 ^b	1647 ± 72	1358 ± 16 ^b
T2	810 ± 90	760 ± 96 ^b	2274 ± 474	1868 ± 303 ^b
T3	970 ± 95	1050 ± 103 ^{ab}	1997 ± 430	2059 ± 216 ^b
T4	1086 ± 317	1654 ± 120 ^a	1918 ± 82	3826 ± 817 ^a
T5	678 ± 28	987 ± 197 ^b	1695 ± 329	1789 ± 22 ^b
T6	749 ± 69	1017 ± 75 ^b	1875 ± 239	2156 ± 245 ^{ab}
p- value	0.573	0.005	0.798	0.00458

Note : T1 : 400 kg/ha BP + 62,5 kg/ha NPK + 41 kg/ha urea ; T2 : 2500 kg/h BVS + 62,5 kg/ha NPK + 41 kg/ha urea ; T3 : 160 kg/ha BP + 1500 kg/ha BVS + 62,5 kg/ha NPK + 41 kg/ha urea ; T4 : 120 kg/ha BP + 1750 kg/ha BVS + 62,5 kg/ha NPK + 41 kg/ha urea ; T5 : 80 kg/ha BP + 2000 kg/ha BVS + 62,5 kg/ha NPK + 41 kg/ha urea ; T6 : 37,5 kg/ha BP + 1750 kg/ha BVS + 687,8 kg/ha Montmorillonite + 12,5 kg/ha Ca (OH)2 + 62,5 kg/ha NPK + 41 kg/ha urea

Maize grain and dry biomass yields as effected by the treatments

Yields varied over years and treatments (Table 2). For the 2024 cropping season, treatments did not induce significant variation on grain yield ($p = 0.32$), ranging from 1,429 kg/ha (T1) to 1,899 kg/ha (T3). In 2025, the application of amendments with dry faecal sludge fortified with Burkina phosphate (T4) induced the highest yield with 2,110 kg/ha, while T1 with 1,316 kg/ha recorded the lowest yield. In general, the variations were significant with highest yield in T4 followed by T3 and T5, while the three (3) treatments T1(1,428 kg/ha), T2 (1,584 kg/ha), and T6 (1,460 kg/ha) showed lowest yields. Over the two-year trial period, yield of the control (T1) remains stable but low compared to other treatments. Yields in treatments T4 and T5 showed increasing trend from 2024 to 2025, whereas treatments T2, T3, and T6 recorded decreasing grain yield over the two cropping seasons. As for biomass yield, variations were recorded according to the treatments and the cropping years. For the 2024 season, dry biomass production of maize (stalks) was not significantly affected by treatments ($p = 0.99$); ranging from 2,105 kg/ha (T6) to 2,235 kg/ha (T4). During the 2025 season, however, treatment T4 (2,651 kg/ha) was significantly higher than the control $p = 0.00$. Yields for the other treatments ranged from 1,685 kg/ha (T1) to 1,905 kg/ha (T2). Yields were higher in 2024 compared to 2025.

Seed cotton and dry cotton stalk biomass yields as affected by the treatments

Over the two-year trial period (2024 and 2025), seed cotton yields were significantly influenced by the

treatments only in 2025 (Table 3). For the 2025 season, the application of dry faecal sludge fortified by Burkina phosphate (T4) produced the highest yield (1,654 kg/ha) while the T1 control with 791 kg/ha had the lowest yield. The other treatments showed average yields ranging from 760 kg/ha to 1,050 kg/ha (Table 3). Over the two years of experiment, an increase in yields was recorded for all treatments. Treatment T4 recorded the highest variation more than 50% from 2024 to 2025. Dry biomass yield from cotton stalks was not significantly influenced by treatments in 2024 ($p > 0.05$). In contrast, the 2025 cropping campaign T4 improved significantly dry biomass yields $p = 0.005$ (Table 3). Over the cropping campaigns, the quantity of dry biomass produced for treatment T4 nearly doubled, rising from 1,917 kg/ha in 2024 to 3,825 kg/ha in 2025. Meanwhile, treatment T2 recorded a decrease in stalk biomass, falling from 2,274 kg/ha to 1,868 kg/ha. Stalk biomass yields for treatments T3, T5, and T6 showed slight increases.

DISCUSSION

Maize and cotton plants agro-morphologic parameters as affected by the application of dry faecal sludge based amendments

Stalk base diameter is a key indicator of plants vigour, anchoring capacity and therefore its capacity of resistance to mechanical or climatic stress. The general data trend showed that dry faecal sludge based amendments induced positive variations in the stalk base diameter of maize and cotton at the second year of the trials. This variation was mostly noticed in treatments T4 (120 kg/ha Burkina phosphate + 1750

kg/ha dry faecal sludge). Indeed, this treatment significantly improved the stalk base diameters both for maize and cotton, indicating an improvement in plant mineral nutrition as the results nutrients released from the amendment applied. In general, soils in the investigation area are well-known for their poor nutrients content either because of their intrinsic property or, as the result of a process of degradation. And, these deficiencies limit plants development and consequently stalk base diameter growth when soils are not adequately amended. Therefore, positive variation of stalk base diameters of maize and cotton is due to nutrients released from the fortify dry faecal sludge with Burkina phosphate. Previous investigation conducted by Hema (2024) has shown that the application of dried faecal sludge promotes healthy root development and, consequently, improved nutrient uptake. The natural acidity of the sludge also appears to enhance the solubilization of Burkina Phosphate (Lompo, 1993), thereby increasing phosphorus availability for plants. Furthermore, Ayamba *et al.* (2023) reported that organo-mineral amendments improve plant physiology compared to the use of mineral fertilizers alone. Through the gradual release of their nutrient content, dry faecal sludge acts as a nutrient pool continuously release in soil solution for plant uptake; unlike mineral fertilizers, which are prone to significant leaching, particularly in sandy soils (Garcia-Randez *et al.*, 2025).

Plant hight was not significantly affected by the treatments. However, the general trend showed increase of plant height with the application of the dry faecal sludge-based amendment. In 2025, treatment T4 (120 kg/ha Burkina phosphate + 1750 kg/ha Dry faecal sludge) induced the higher plant heights, with increases of 12% for maize and 33% for cotton compared to the T1 control (400 kg/ha of Burkina phosphate). The improvement of plant height observed from the second year is likely due to the residual effects of the organic amendments. Indeed, Koulibaly *et al.* (2009) note that organic amendments act as pool that gradually release nutrients in cotton-maize rotation systems strengthening the residual

effect of organic amendments. The vigorous stem growth could also be linked to improved phosphorus availability. Although Burkina Phosphate is rich in phosphorus, it has naturally low solubility; however, when combined with dry faecal sludge rich in organic acids, its solubility is enhanced (Lompo, 1993). Furthermore, Bonzi *et al.* (2011) indicated that rock phosphate yields better results in soils with good organic matter status.

Effectiveness of dry faecal fortified with Burkina phosphate on yields

The yields variation showed significant crops response to the application of dry faecal sludge-based amendments (combinations of dried faecal sludge and Burkina Phosphate). Specially during the second year of the experiment in 2025, soil amendment using treatment T4 induced significantly higher maize grain and seed cotton yields than control treatment (unamended plots).

In 2024 (first cropping campaign), no significant variations were observed between amended plots compared to the unamended ones. This contrasting trend between the two years (2024–2025) reflects the complex interaction between the proportions of organic and mineral substrates.

The applied amendments had no significant effects on yields in the first year of application; the phosphate-rock contained in organic amendments (fortified dry faecal sludge with Burkina phosphate) did not release enough phosphorus based nutrients for plants due to its dissolution kinetic, found to be low by several authors (Bonzi *et al.*, 2011; Traoré, 2024). Consequently, it limited the expression of its productive potential compared to the control (Hema, 2024; Musazura *et al.*, 2025). For the second cropping campaign (2025), treatment T4 (dry faecal sludge fortified with Burkina phosphate) gave the highest yields for both maize and cotton when compared to other treatments. As for other treatments including dry faecal sludge + Burkina phosphate (T3 and T5), the low plant high recorded in these plots compared T4 may be due to a high ratio of Burkina phosphate (T3) without

sufficient dry faecal sludge to induce a convenient mineralisation. It could have resulted in to a limited supplementation of phosphorus release, whereas a relatively higher quantity compared to Burkina phosphate (T5) may lead to a long-term nutritional imbalance (Ayamba *et al.*, 2023; Hema, 2024). Organic acids realized from sludge decomposition contribute to the solubilization of natural phosphate. Sharma *et al.* (2013) reported that phosphate solubilization by microorganisms contained in the sewage sludge occurs following the production of organic acids, notably through acidification and the chelation of phosphate-bound cations. Thus, soluble complexes form with the metal ions linked the natural phosphate (Ca^{2+} , Al^{3+} , $\text{Fe}^{2+}/\text{Fe}^{3+}$), go through a process that contributes to the dissolution of phosphate apatites and release of phosphorus. Treatment T6 performs relatively well, despite using only a very low dose of Burkina phosphate (37.5 kg/ha) and an amount of dry faecal sludge similar to that of treatment T4 (1750 kg/ha). This is evident in the height progression of the cotton plants in 2025, where the divergence of plant growth from 42 days after sowing (DAS) reflects a level of nutrient availability that the T1 control fails to provide. Indeed, montmorillonite is a clay with a high cation exchange capacity that retains essential nutrients that are gradually released to plants (Hasbullah *et al.*, 2018; Kome *et al.*, 2019). The addition of lime in this treatment would also help foster a suitable acidic environment, thereby stimulating the activity of phosphate-solubilizing bacteria (Kome *et al.*, 2019; Sagnon *et al.*, 2024). The residual effects observed over the two years demonstrates that the fortification of dry faecal sludge with Burkina phosphate creates a nutrient pool for plant nutrition while offering means for sustainable soil fertility improvement in a cotton-maize rotation system.

CONCLUSION

The objective of this investigation was to evaluate the effects of various formulations of dried faecal sludge and Burkina phosphate on the growth and yield of maize and cotton in a rotation system. The results showed that dried faecal sludge fortified with natural phosphate offers a sustainable alternative

for improving maize and cotton yields in the farming systems based on maize cotton rotation in western Burkina Faso. Amendments based on fortified dried faecal sludge with Burkina phosphate, particularly treatment T4 (120 kg/ha Burkina phosphate + 1750 kg/ha Dry faecal sludge) improved agro-morphological parameters and crop yields. Indeed, treatment T4 yielded better (2,110 kg/ha for grain maize) and (1,654 kg/ha for seed cotton) in 2025, corresponding to increases of 60% and 109%, respectively, compared to the control (T1).

The residual effect observed during the second cropping season on maize and cotton crops indicates that amendments based on fortified dried faecal sludge with Burkina phosphate enhanced plant nutrition, resulting in better grain and seed yields respectively for maize and cotton. As summary, the investigation shows that the agronomic valorisation of dried faecal sludge fortified with Burkina phosphate is a sustainable fertilization option for small scale farming systems in Burkina Faso.

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