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Response of Selected Cowpea Varieties (*Vigna unguiculata* L. Walp.) to Organo-mineral Fertilization

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Abstract

Soil nutrient depletion is a major constraint limiting agricultural productivity in Burkina Faso. This study aims to evaluate the response of two cowpea varieties (*Vigna unguiculata* L. Walp.) to various organo-mineral fertilization levels. A randomized complete block design (RCBD) with three replications was used to compare two varieties (Komcallé and Niizwè) under four fertilization treatments: a control with no input (F0), NPK at 100 kg/ha (F1), jatropha compost at 2,500 kg/ha (F2), and a combination of NPK (50 kg/ha) + jatropha compost (2,500 kg/ha) (F3). Ten agromorphological traits were evaluated. The results indicate that fertilization, when considered alone, did not significantly influence the measured variables. In contrast, a significant varietal effect ($P < 0.05$) was observed across all parameters. Furthermore, the variety × fertilization interaction revealed significant differences ($P < 0.05$) for all studied traits. The Komcallé variety achieved its best grain yield (1,833.07 ± 45.31 kg/ha) under the combined F3 treatment (NPK + jatropha compost). For the Niizwè variety, the highest yields were recorded in the F0 control (1,125.97 ± 17.50 kg/ha), followed by the F2 treatment with jatropha compost alone (1,073.81 ± 20.09 kg/ha). Combining NPK fertilizer and jatropha compost with high-potential genetic varieties appears to be a promising pathway for improving cowpea performance over the medium to long term. Adopting such organo-mineral amendments could contribute to the sustainable intensification of cowpea production within smallholder farming systems.

Keywords: cowpea, agromorphological traits, organo-mineral fertilization, jatropha compost, soil fertility

1. Introduction

Cowpea (*Vigna unguiculata* (L.) Walp.) is one of the most vital annual food and fodder legumes cultivated throughout the arid and semi-arid regions of Sub-Saharan Africa (Boukar *et al.,* 2019). The African continent accounts for 95% of global production, with 80% originating from West Africa, led by Nigeria, followed by Niger and Burkina Faso (FAOSTAT, 2022). Cowpea seeds are a primary source of plant protein (23%), carbohydrates (64%), vitamins, and essential minerals (Hama-Ba *et al.,* 2017), significantly improving the nutritional status of local populations. In Burkina Faso, cowpea is the second-largest protein source after cereals, providing a higher daily protein intake than animal products (Hama-Ba *et al.,* 2017). Beyond food security, cowpea cultivation generates substantial income for producers and female processors (Remond and Walrand, 2017). Additionally, its protein-rich and highly digestible haulms are widely used for livestock feed (Tarawali *et al.,* 1997). As an essential driver for food security, cowpea is also central to agroecological transition dynamics (Magrini *et al.,* 2023). Through symbiotic nitrogen fixation, this legume can provide between 20 and 100 kg of nitrogen per hectare, enhancing soil fertility for intercropped or subsequent crops (Carsky *et al.,* 2002; Gbaguidi *et al.,* 2015). Consequently, in African farming systems, cowpea is frequently grown in rotation or intercropped with cereals like maize, millet, and sorghum to promote sustainable soil fertility management (N'Gbesso *et al.,* 2013).

Despite Africa having the largest land area dedicated to cowpea cultivation, the continent records the world's lowest yields. This gap exists because the genetic potential of cowpea varieties is severely limited by various biotic and abiotic stresses, hindering optimal productivity. Among abiotic factors, soil infertility is a primary constraint for resource-poor farmers in developing countries (Ju *et al.,* 2018). While this legume fixes atmospheric nitrogen, several studies emphasize that supplementary "starter" fertilization is essential to stimulate early growth and enhance yields (Dugie *et al.,* 2009; N'Gbesso *et al.,* 2013; Somé *et al.,* 2014). Indeed, Bado (2002) demonstrated that even with nitrogen fixation, cowpea requires initial nutrient inputs to boost development. Sustainable soil fertility management, therefore, relies on recycling organic resources and applying mineral inputs to correct nutritional imbalances and soil acidity (Magulu & Kabambé, 2015; Lal, 2011). However, the high cost and environmental impact of synthetic fertilizers have intensified interest in organic alternatives (Somé *et al.,* 2014). Compost, crop residues, and industrial by-products now serve as vital organic sources to supplement or replace chemical inputs (Maria *et al.,* 2017).

In Burkina Faso, farmers primarily rely on organic waste, such as crop residues, to enhance agricultural production (Sombié *et al*., 2019). However, the availability of these resources is severely limited, particularly in the Sahelian zone, where biomass production is low and competition for animal feed is high (Kouyaté *et al.,* 2014; Ehlers & Hall, 1997). Under these conditions, increasing food crop yields in semi-arid West Africa depends heavily on sustainable soil fertility management. It is therefore crucial to address these constraints by proposing affordable alternatives for smallholder farmers. In this context, Integrated Soil Fertility Management (ISFM), which combines organic and mineral fertilizers, is essential. The use of alternative resources such as *Jatropha curcas* L., whose by-products can serve as organic fertilizer, offers promising prospects for sustainably improving cowpea production (Primandari *et al.,* 2018). Consequently, Jatropha is gaining interest as a bioenergy resource (Sama *et al.,* 2018), as its leaves, stems, fruits, husks, and seed cakes are all potential fertilizers (Primandari *et al.,* 2018). In this regard, this study was conducted in West-Central Burkina Faso to evaluate the response of two cowpea varieties to organo-mineral fertilization. The objective was to analyze the effects of this fertilization on the agromorphological traits, phenology, and yield of the selected varieties.

2. Material and Methods

2.1 Plant Material

The plant material used in this study consists of two improved cowpea varieties, Komcallé and Niizwè. Both varieties are officially registered in the National Catalog of Agricultural Species and Varieties of Burkina Faso. Their specific agromorphological characteristics are detailed in Table 1.

Table 1. Characteristics of the Cowpea Varieties Used in the Study

Variety code	Variety	Breeder	50% maturity (days)	100-seed weight (g)	Potential yield (T/ha)	Seed color
SCHV 435	KVX442-3-25SH (Komcallé)	INERA (Burkina Faso)	60	20.80	1.50-2.00	white
SCHV 447	Niizwé	IITA (Nigéria)	60	15.10	0.70-1.20	white

2.2 Fertilizer Materials and Application Rates

The soils of the study site are classified as leached tropical ferruginous soils (Lixisols), derived from granitic parent rock (Sedogo, 1981). They are characterized by nitrogen and phosphorus deficiencies and low organic matter (OM) content, resulting in a low cation exchange capacity (CEC) and slight acidity (Traoré, 2012). The chemical characteristics of the study site's soil are presented in Table 2.

Table 2. Chemical properties of the study site soil

Type de sol	C t %	Nt %	C/N	Pt (PPM)	K mg/100g	PH eau	PH KCL
Sol ferrugineux	0.38	0.36	10.50	146	0.05	5.30	4.50

Legend: *TC = Total Carbon; TN = Total Nitrogen; C/N = Carbon-to-Nitrogen ratio; TP = Total Phosphorus; K = Potassium*

Two types of fertilizers were used: a mineral NPK fertilizer (14-23-14) and an organic fertilizer derived from Jatropha curcas seed cakes (jatropha compost). The compost consisted of 92.83% organic matter (53.74% total carbon), 3.8% N, 2.1% P_2O_5, and 1.7% K_2O. The fertilizer application rates were as follows.

- F0: Absolute control (0 kg NPK + 0 kg Jatropha compost);

- F1: 100 kg.ha^{-1} NPK (72g per plot) + 0 kg Jatropha compost;

- F2: 250 kg.ha^{-1} Jatropha compost (180g per plot) + 0 kg NPK;

- F3: 50 kg.ha^{-1} NPK + 250 kg.ha^{-1} Jatropha compost.

Fertilizers were applied two weeks after sowing (WAS) according to the specified treatments (F0, F1, F2, and F3). The doses were pre-measured using an electronic scale and placed at the corresponding labeled plots. Each measured dose was then evenly distributed at the base of the emerged plants and covered with soil to minimize nutrient loss.

2.3 Experimental Design and Trial Conduct

The study was conducted at the Saria Research Station of the Institute for Environment and Agricultural Research (INERA), located at 12.267° N, 2.150° W, at an altitude of 300 m. The station is situated 80 km west of Ouagadougou in the North-Sudanian zone, with annual rainfall ranging between 700 and 900 mm. The experimental design was a Randomized Complete Block Design (RCBD) featuring a factorial arrangement of two factors with three replications. The first factor was the cowpea variety (Komcallé and Niizwè), and the second factor was the fertilization level (F0, F1, F2, and F3). The combination of these factors resulted in eight treatments, totaling 24 elementary plots.

Each elementary plot covered 7.2 m^2 (3 m × 2.4 m) and consisted of four rows spaced 80 cm apart. Sowing was performed at a rate of two seeds per hill, with a within-row spacing of 40 cm. Replications were separated by a 2 m alley, and a 1.6 m gap was maintained between elementary plots. The total experimental area was 394.24 m^2 (35.2 m × 11.2 m).

Crop management included two mechanical weedings at 14 and 29 days after sowing (DAS), followed by manual weeding at 45 DAS to control weed pressure. Fertilization was applied at 15 DAS according to the specific rates for each treatment (F0 to F3). To mitigate pest and disease damage, two phytosanitary treatments were performed: the first at flowering (33 DAS) using K-OPTIMAL (Acetamiprid 20 g/l + Lambda-cyhalothrin 15 g/l), and the second during pod formation (49 DAS) with Deltacal (Lambda-cyhalothrin 15 g/l + Acetamiprid 10 g/l).

2.4 Data Collection

The following agromorphological traits were measured on the central rows of each elementary plot:

- **Emergence**: The number of emerged plants was counted 14 days after sowing (DAS).

- **Days to 50% flowering**: The number of days from sowing until 50% of the plants in each plot were in bloom.

- **Plant height**: Measured from the root collar to the apical tip of the main stem at 48 DAS.

- **Canopy spread**: Measured as the distance between the tips of the longest leaves on opposite sides of the main stem at 48 DAS.

- **Days to 95% maturity**: The number of days from sowing until 95% of the plants reached physiological maturity.

- **Number of pods per plant**: Determined by counting pods from a sample of four randomly selected plants per plot.

- **Number of seeds per pod**: Calculated by counting the seeds from pods harvested from a sample of four plants per plot.

- **Pod weight**: Obtained by weighing the pods from each plot after five days of sun-drying.

- **Seed weight**: Determined by weighing the total seeds harvested from each elementary plot.

- **100-seed weight**: Determined by weighing 100 randomly selected seeds per plot.

- **Grain yield (kg/ha)**: Calculated based on the seed weight per plot and adjusted to a per-hectare basis, considering the planting density (80 cm × 40 cm):

$$\frac{\text{Grain weight per plot (kg)}}{\textit{Plot size } (m^2)} \times 10\,000$$

2.5 Data Analysis

The collected data were recorded in Microsoft Excel 2007. Analysis of variance (ANOVA) was performed using R software (version 3.6.1), with variety and fertilization as the main factors. Mean comparisons were conducted using the Student-Newman-Keuls (SNK) test at a 5% significance level.

3. Results

3.1 Variation in Phenology and Growth-Related Traits Based on Variety, Fertilization, and Treatments

The analysis of variance (ANOVA) results (Table 3) revealed a highly significant varietal effect ($P \leq 0.001$) for days to 50% flowering, days to 95% maturity, and plant height. In contrast, canopy spread was not significantly influenced by the variety. The Niizwè variety was earlier than Komcallé, exhibiting shorter cycles from sowing to flowering (36.7 vs. 42.1 days) and sowing to maturity (60.1 vs. 61.9 days). Furthermore, Niizwè recorded a greater average plant height (43.52 cm) compared to Komcallé (35.33 cm). However, fertilization had no significant effect on any of these vegetative and phenological traits.

Table 3. ANOVA results for phenological and growth traits across varieties and fertilization levels

Facteurs		**DF50% (JAS)**	**MAT95% (JAS)**	**HP (cm)**	**EVG (cm)**
Variétés	**Komcallé**	42.17±0.16^{a}	61.92±0.19^{a}	35.33±0.61^{b}	57.25±1.09^{a}
	Niizwè	36.75±0.18^{b}	60.17±0.44^{b}	43.52±1.01^{a}	55.29±1.12^{a}
	Probabilité (P)	< 0.0001	0.000	< 0.0001	0.251
	Significativité	***	***	***	NS
Fertilisations	**F0**	37.50±1.35^{a}	61.33±0.55^{a}	40.08±1.90^{a}	56.10±0.25^{a}
	F1	36.50±1.20^{a}	61.00±0.36^{a}	39.25±2.33^{a}	55.10±1.13^{a}
	F2	37.00±1.20^{a}	61.00±0.57^{a}	39.13±1.74^{a}	56.79±0.46^{a}
	F3	37.00±1.60^{a}	60.83±0.54^{a}	39.25±1.41^{a}	56.38±1.13^{a}
	Probabilité (P)	0.988	0.919	0.982	0.535
	Significativité	NS	NS	NS	NS

*Légende: DF50%: Days to 50% flowering ; EVG: Plant spread; HP: Plant height; MAT95% : Days to 95% maturity; F0: Unfertilized control; F1: 100 kg.ha^{-1} NPK; F2: 250 kg.ha^{-1} Jatropha compost; F3: 50 kg.ha^{-1} NPK+ 250 kg.ha^{-1} Jatropha compost; NS: Non-significant ; ***: Very Highly Significante.*

Note: For the same factor and within the same column, means followed by the same letter are not significantly different at the 5% level (SNK test).

Phenological and growth parameter data across the different treatments are presented in Table 4. Statistical analysis revealed a significant treatment effect ($P < 0.01$) on all measured traits. Regarding phenology, the Ni–F0 treatment exhibited the earliest 50% flowering, with an average of 36.33 ± 0.33 DAS. For 95% maturity, the Ni–F3 treatment showed the shortest cycle, reaching maturity at 59.67 ± 0.33 DAS.

In terms of morphological parameters, the maximum plant height was achieved with the Ni–F1 treatment (44.42 ± 0.44 cm), while the greatest canopy spread was observed in the Ko–F3 treatment (58.75 ± 0.75 cm).

Table 4. ANOVA results for phenology and growth traits as a function of interaction

Traitements	**DF50% (JAS)**	**MAT95% (JAS)**	**HP (cm)**	**EVG (cm)**
Ko-F0	42.33±0.33^{a}	62.33±0.33^{a}	35.83±0.30^{cd}	56.58±0.30^{b}
Ko-F1	42.00±0.00^{ab}	61.33±0.33^{ab}	34.08±0.50^{d}	57.67±0.50^{ab}
Ko-F2	42.00±0.00^{ab}	62.00±0.57^{ab}	35.25±0.25^{cd}	56.00±0.52^{b}
Ko-F3	42.33±0.66^{a}	62.00±0.00^{ab}	36.17±0.22^{c}	58.75±0.75^{a}
Ni-F0	36.33±0.33^{c}	60.33±0.67^{b}	44.33±0.22^{a}	56.83±0.46^{b}
Ni-F1	36.67±0.33^{bc}	60.67±0.67^{b}	44.42±0.44^{a}	52.75±0.43^{c}
Ni-F2	36.67±0.33^{bc}	60.00±0.57^{b}	43.00±0.25^{ab}	57.58±0.41^{ab}
Ni-F3	37.33±0.33^{b}	59.67±0.33^{b}	42.33±0.65^{b}	54.00±0.43^{c}
Probabilité (P)	**< 0.0001**	**0.016**	**< 0.0001**	**< 0.0001**
Significativité	***	**	***	***

*Légende: DF50%: Days to 50% flowering; EVG: Plant spread; HP: Plant height ; MAT95%: Days to 95% maturity; NS: Non-significant;**: Highly Significant;***: Very Highly Significant; Ko: Komcallé; Ni: Niizwè; F0: Unfertilized control; F1: 100 kg.ha^{-1} NPK; F2: 250 kg.ha^{-1} Jatropha compost; F3: 50 kg.ha^{-1} NPK+ 250 kg.ha^{-1} Jatropha compost;*

Note: For the same factor and within the same column, means followed by the same letter are not significantly different at the 5% level (SNK test).

3.2 Variation of Cowpea Yield Components as a Function of Variety and Fertilizer Treatments

The analysis of variance results (Tables 5 and 6) revealed significant ($P = 0.004$) to highly significant ($P \leq 0.001$) varietal effects across all evaluated yield parameters. These included the number of harvested plants, pods per plant, pod weight, seeds per pod, 100-seed weight, seed weight per plant, and grain yield. The Komcallé variety recorded the highest mean values for several traits: number of harvested plants (23.67 ± 0.58), pods per plant (36.83 ± 0.86), pod weight (960.00 ± 19.72 g), 100-seed weight (18.58 ± 0.08 g), seed weight (658.80 ± 23.32 g), and grain yield (1,736.00 ± 34.27 kg/ha). In contrast, the Niizwè variety achieved a significantly higher mean value only for the number of seeds per pod (13.58 ± 0.22).

Table 5. ANOVA results for harvested plants, seeds per pod, and pod weight as a function of variety and fertilization

Variables **Facteurs**		**NPR**	**NGs/Pl**	**NGrG**	**PGs (g)**
Variétés	**Komcallé**	23.67±0.58^{a}	36.83±0.86^{a}	12.42±0.28^{b}	960.00±19.72^{a}
	Niizwè	20.92±0.22^{b}	29.42±0.71^{b}	13.58±0.22^{a}	640.83±20.75^{b}
	Probabilité (P)	**< 0.0001**	**< 0.0001**	**0.004**	**< 0.0001**
	Significativité	***	***	**	***
Fertilisations	**F0**	21.17±0.30^{a}	32.83±0.30^{a}	13.33±0.33^{a}	723.33±59.63^{a}
	F1	22.50±0.42^{a}	33.83±2.77^{a}	13.00±0.36^{a}	760.00±90.93^{a}
	F2	21.67±0.66^{a}	32.67±2.10^{a}	13.00±0.36^{a}	850.00±59.64^{a}
	F3	23.83±1.30^{a}	33.17±2.03^{a}	12.67±0.66^{a}	868.33±75.28^{a}
	Probabilité (P)	**0.114**	**0.978**	**0.782**	**0.446**
	Significativité	**NS**	**NS**	**NS**	**NS**

Table 6. ANOVA results for 100-seed weight, total seed weight, and grain yield as a function of variety and fertilization

Facteurs	**Variables**	**P100 (g)**	**PGr (g)**	**RDT (kg/ha)**
Variétés	**Komcallé**	18.58±0.08^{a}	658.80±23.32^{a}	1736.00±34.27^{a}
	Niizwè	14.32±0.16^{b}	317.18±20.06^{b}	953.10±65.26^{b}
	Probabilité (P)	**< 0.0001**	**< 0.0001**	**< 0.0001**
	Significativité	***	***	***
Fertilisations	**F0**	16.32±0.93^{a}	456.20±37.59^{a}	1342.59±97.82^{a}
	F1	16.45±0.97^{a}	433.85±103.05^{a}	1183.52±267.01^{a}
	F2	16.37±1.02^{a}	511.43±72.58^{a}	1453.44±171.21^{a}
	F3	16.67±0.93^{a}	550.47±92.33^{a}	1400.11±168.43^{a}
	Probabilité (P)	**0.994**	**0.731**	**0.731**
	Significativité	**NS**	**NS**	**NS**

*Legend: NPR: Number of harvested plants; NGs/pl: Number of pods per plant; NGrG: Number of seeds per pod; PGs : Pod weight; PGr: Seed weight; P100: 100-seed weight; RDT : Seed yield; F0: Unfertilized control; F1: 100 kg.ha^{-1} NPK ; F2: 250 kg.ha^{-1} Jatropha compost; F3: 50 kg.ha^{-1} NPK+ 250 kg.ha^{-1} Jatropha compost; NS: Non-significant; **: Highly Significant";***: Very Highly Significant*

Note: For the same factor and within the same column, means followed by the same letter are not significantly different at the 5% level (SNK test)

The analysis of variance revealed a highly significant ($P \leq 0.001$) interaction effect (variety × fertilization) across all measured parameters (Table 7).

For the Komcallé variety, the Ko–F3 treatment (NPK + jatropha compost) showed the best performance for the number of harvested plants (26.67 ± 0.33), pod weight (1,036.67 ± 0.88 g), and seed weight (756.93 ± 0.53 g). The highest number of pods per plant was achieved with Ko–F1 (40.00 ± 0.57), while the Ko–F0 and Ko–F1 treatments recorded the maximum number of seeds per pod (13.00 ± 0.57).

Regarding the Niizwè variety, the Ni–F1 treatment recorded the highest number of harvested plants (21.67 ± 0.33). The maximum number of pods per plant (33.33 ± 0.33) and the highest seed weight (372.13 ± 0.40 g) were both observed under the Ni–F0 control treatment. Additionally, the Ni–F3 treatment yielded the highest number of seeds per pod (14.00 ± 0.57), while Ni–F2 resulted in the greatest pod weight (716.67 ± 3.33 g).

Table 7. ANOVA results for yield components as a function of the variety × fertilization interaction

Traitements	**NPR**	**NGs**	**NGrG**	**PGs (g)**	**P100 (g)**	**PGr (g)**
Ko-F0	21.67 ± 0.33^{c}	32.33 ± 0.33^{cd}	13.00 ± 0.57^{b}	856.67 ± 0.33^{bc}	18.40 ± 0.11^{a}	540.27 ± 0.18^{c}
Ko-F1	23.33 ± 0.33^{b}	40.00 ± 0.57^{a}	13.00 ± 0.57^{b}	963.33 ± 1.66^{b}	18.53 ± 0.28^{a}	664.27 ± 0.86^{b}
Ko-F2	23.00 ± 0.57^{b}	37.33 ± 0.33^{b}	12.33 ± 0.33^{bc}	983.33 ± 0.88^{b}	18.63 ± 0.18^{a}	673.73 ± 0.39^{ab}
Ko-F3	26.67 ± 0.33^{a}	37.67 ± 0.33^{b}	11.33 ± 0.33^{c}	1036.67 ± 0.88^{a}	18.73 ± 0.06^{a}	756.93 ± 0.53^{a}
Ni-F0	20.67 ± 0.33^{d}	33.33 ± 0.33^{c}	13.67 ± 0.57^{b}	590.00 ± 1.15^{d}	14.23 ± 0.14^{b}	372.13 ± 0.40^{d}
Ni-F1	21.67 ± 0.33^{c}	27.67 ± 0.33^{e}	13.00 ± 0.57^{b}	556.67 ± 1.66^{d}	14.37 ± 0.58^{b}	203.43 ± 2.33^{e}
Ni-F2	20.33 ± 0.33^{d}	28.00 ± 0.57^{d}	13.67 ± 0.33^{b}	716.67 ± 3.33^{c}	14.10 ± 0.28^{b}	349.13 ± 0.91^{d}
Ni-F3	21.00 ± 0.57^{cd}	28.67 ± 0.33^{d}	14.00 ± 0.57^{a}	700.00 ± 1.15^{c}	14.60 ± 0.32^{b}	344.00 ± 1.50^{d}
Probabilité (P)	**< 0.0001**	**< 0.0001**	**< 0.0001**	**< 0.0001**	**< 0.0001**	**< 0.0001**
Significativité	***	***	***	***	***	***

Legend: NPR: Number of harvested plants; NGs: Number of pods per plant; NGrG: Number of seeds per pod; PGs: Pod weight; PGr: Seed weight; P100: 100-seed weight; Ko: Komcallé; Ni: Niizwè; F0 : Unfertilized control; F1: 100 kg.ha^{-1} *NPK; F2: 250 kg.ha*$^{-1}$ *Jatropha compost; F3: 50 kg.ha*$^{-1}$ *NPK+ 250 kg.ha*$^{-1}$ *Jatropha compost; ***: Very Highly Significant*

Note: For the same factor and within the same column, means followed by the same letter are not significantly different at the 5% level (SNK test)

Figure 1 illustrates the grain yield variations resulting from the interaction between variety and fertilization level. The analysis of variance (ANOVA) revealed a highly significant interaction effect ($P \leq 0.001$) on grain yield. For the Komcallé variety, the highest yield was achieved under the F3 treatment (NPK + jatropha compost), reaching 1,833.07 ± 45.31 kg/ha. In contrast, for the Niizwè variety, the best performances were observed in the F0 control (1,125.97 ± 17.50 kg/ha), followed by the F2 treatment with jatropha compost alone (1,073.81 ± 20.09 kg/ha).

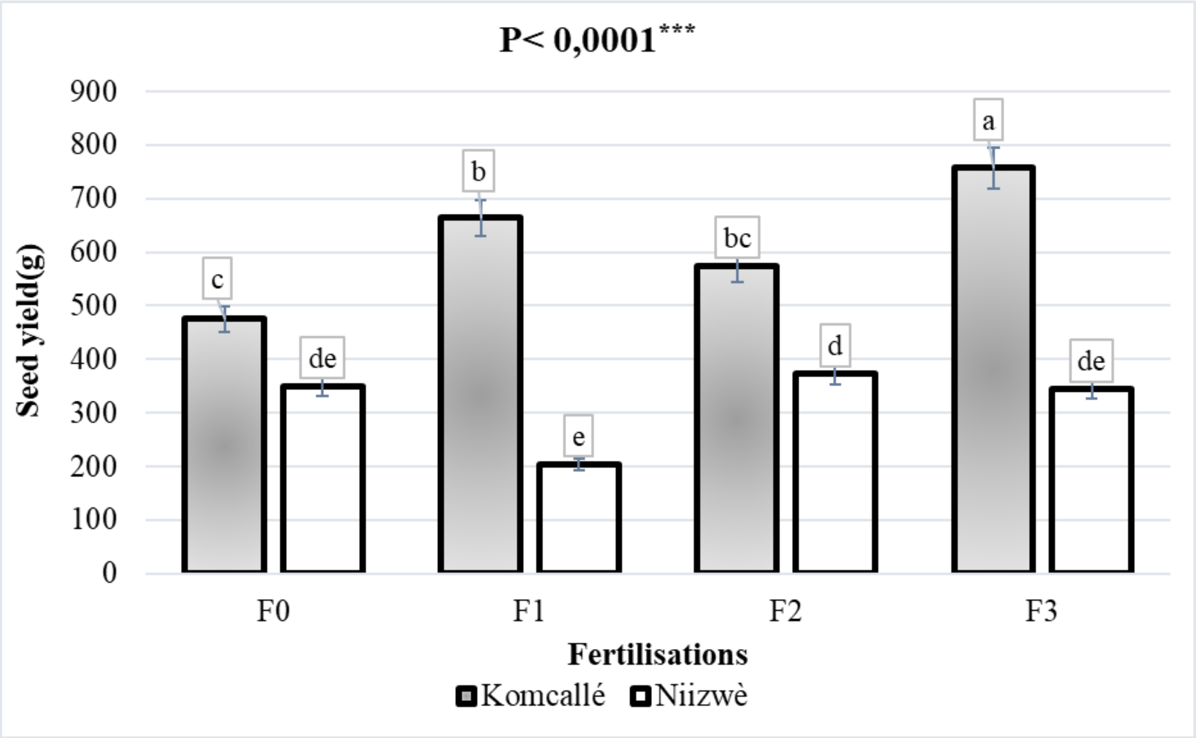

Figure 1. Mean grain yield of cowpea varieties under different fertilization levels

Legend: F0: Unfertilized control; F1: 100 kg.ha^{-1} *NPK; F2: 250 kg.ha*$^{-1}$ *Jatropha compost; F3: 50 kg.ha*$^{-1}$ *NPK+ 250 kg.ha*$^{-1}$ *Jatropha compost; ***: Very Highly Significant*

4. Discussion

Under various fertilization conditions, the Komcallé variety proved more productive in terms of pod and seed yield than Niizwè. However, Komcallé exhibited a longer maturity cycle, with sowing-to-flowering and sowing-to-maturity periods exceeding those of Niizwè. These differences can be attributed to distinct genetic potentials and the total biomass accumulated during the growth cycle. Indeed, under favorable conditions, long-cycle varieties benefit from an extended period for biomass accumulation, which translates into higher grain production. Conversely, the short-cycle Niizwè variety offers a strategic advantage in drought-prone environments; its ability to be sown late or harvested early reduces the risk of terminal drought stress, ensuring at least a minimum yield in unpredictable seasons.

The various fertilization treatments had no statistically significant effect on the measured traits, ranging from vegetative and phenological parameters to grain yield. These results may be attributed to several factors governing nutrient use efficiency (NUE). According to Assa (1987) and Ladha *et al.* (1992), chemical composition, organic matter decomposition rates, application timing and methods, and the synchronization between nutrient release and crop uptake are critical factors for optimizing NUE. Although not statistically significant, the F3 treatment (NPK + jatropha compost) recorded the highest mean values for pod weight, 100-seed weight, and total seed weight. This suggests a synergistic compatibility between jatropha compost and mineral NPK. In this regard, Bationo and Mokwunye (1991) indicated that combining NPK with organic matter increases soil nutrient availability, thereby positively influencing productivity.

The lack of a significant response to compost in the short term is consistent with the findings of Chailane (2011), who noted that only 30% of nitrogen from compost is typically released in the first year, with the remainder becoming available in subsequent years (25% and 15% in years two and three, respectively). Studies by Somé *et al.* (2014) and Karikari et al. (2015) further confirm that the benefits of compost on grain yield are more pronounced in the long term. Moreover, Maltas *et al.* (2012) observed that the impact of organic fertilizers on yield is often contrasting unless nitrogen is a strictly limiting factor, in which case their residual effects are consistently positive. Despite the absence of immediate statistical significance, the potential for jatropha compost to improve N, P, and K uptake in cowpea genotypes (Sombié *et al.,* 2019) remains a promising pathway for sustainable soil fertility management.

Other researchers have reported findings consistent with the present study. Indeed, Gomgnimbou *et al.* (2017) and Houot *et al.* (2002) demonstrated that organo-mineral fertilization does not significantly impact pod weight, 100-seed weight, or grain yield during the first cropping year. Furthermore, Bado (2002) and Gbogodi and Echo (2012) noted that the benefits of organo-mineral inputs on crop productivity become more pronounced starting from the second year of application. This delayed response is likely due to the low and slow mineralization rates of compost during the initial stages of soil incorporation (Gomgnimbou *et al.,* 2017).

Regarding the interaction effect, the Komcallé variety achieved its best and most significant performance when treated with jatropha compost. These results align with Bado (2002), who reported that soil amendments such as phosphorus, dolomite, and manure significantly influence cowpea grain yields. However, these findings contrast with those of Houot *et al.* (2002), who observed no significant effects from organic treatments during the initial year of compost application.

5. Conclusion

This study highlights the influence of organo-mineral amendments on the agromorphological parameters and yield of two cowpea varieties under field conditions in Burkina Faso. Our results indicate that fertilizer application did not induce statistically significant differences in agromorphological traits, pod and seed production, or overall grain yield. However, it is noteworthy that the highest mean values for pod weight, 100-seed weight, total seed weight, and grain yield were consistently achieved with the F3 treatment (NPK + jatropha compost).

The superior performance of jatropha compost on the grain yield of the Komcallé variety justifies the use of this organic amendment in cowpea production. Conversely, the response of the Niizwè variety under zero-input conditions demonstrates its strong genetic potential and efficient nutrient utilization in the absence of fertilization. Ultimately, the combination of NPK fertilizer and jatropha compost, integrated with the appropriate genetic potential, offers a promising strategy for improving cowpea yields by supplying essential nutrients while simultaneously enhancing long-term soil fertility.

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Author contributions

Dr. SIDIBE Hamadou and Dr. BAZIE Hugues Roméo were responsible for study design and revising. M. OUEDRAOGO Daouda was responsible for data collection. Dr. SIDIBE Hamadou and M. OUEDRAOGO Daouda drafted the manuscript and Prof. SAWADOGO Mahamadou and Dr Batieno Benoît Joseph revised it. All authors read and approved the final manuscript.

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Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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