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Agronomic and Nutritional Performance of African Eggplant (*Solanum aethiopicum*) Cultivars from the Sudanian-Sahelian Zone of Burkina Faso

Dramane KABORE [a++*], Pingawindé SAWADOGO [b#] and Renan Ernest TRAORE [a†]

[a] Laboratoire Biosciences, Équipe Génétique et Amélioration des Plantes, Université Joseph KI-ZERBO, Unité de Formation et de Recherche en Sciences de la Vie et de la Terre, 03 BP 7021 Ouagadougou 03, Burkina Faso.
[b] Centre Universitaire Polytechnique de Tenkodogo (CUP/T), Université Thomas SANKARA, Tenkodogo, Burkina Faso.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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[++] PhD in Plant Genetics and Breeding;
[#] Assistant Professor in Genetics and Plant Breeding (PhD);
[†] Full Professor in Genetics and Plant Breeding;
**Corresponding author: E-mail: dramanekabore61@gmail.com;*

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ABSTRACT

African eggplant (*Solanum aethiopicum*), which possesses high genetic potential, may adapt better to climate change and offer high fruit yield capacity. In several parts of sub-Saharan Africa, local populations report that the consumption of wild African eggplant can alleviate various ailments. This study was conducted in the Central Plateau of Burkina Faso, under the Sudanian-Sahelian climate. The study aimed to assess the nutritional and food potential of African eggplant cultivars while evaluating their agronomic performance under the influence of an optimal compost dose. The study was conducted starting in June 2024 on an agricultural plot located in Dapelgo. This area is characterised by annual rainfall ranging from 600 to 900 mm and temperatures varying between 18°C and 40°C. The soil at the experimental site was subjected to physicochemical analysis by the National Soil Bureau of Burkina Faso (BUNASOL). The experiment was carried out using a Fisher's randomised block design with three replications. Three morphotypes were studied: dark green-fruited, white-fruited, and purple-fruited morphotypes. Data analysis was performed using RStudio version 4.4.3. A two-factor analysis of variance (ANOVA) was conducted to assess the effects of cultivar and compost dose on morphological and chemical traits. Analysis of variance at the 5% significance level revealed significant differences among the three morphotypes. During and at the end of the experiment, the white-fruited morphotype showed the greatest plant height, as well as the highest number and weight of fruits. The compost dose of 5 t/ha was found to be the most suitable for optimal yield. In terms of biochemical performance, significant differences were also observed among the morphotypes. The dark green-fruited morphotype exhibited the highest contents of iron, sodium, potassium, and phosphorus. Regarding nutritional compounds such as alkaloids and flavonoids, the best results were recorded for the white-fruited morphotype. In contrast, the dark green-fruited morphotype showed higher levels of saponins and phenols. Overall, the 5 t/ha compost dose provided the best outcomes. Amongst the white, green, and purple, the green-fruited morphotype would be more beneficial to consumers due to its chemical and nutritional potential.

Keywords: Central Plateau; Sudanian-Sahelian zone; analysis of variance; morphotype; compost dose; nutritional compound.

1. INTRODUCTION

Climate change is increasingly having detrimental effects on many plant species worldwide. It poses significant challenges to global agriculture, with rising temperatures, altered precipitation patterns, and increased frequency of extreme weather events threatening crop yields (Terán et al.,2024). In this context, exotic plant species appear to be particularly vulnerable in Africa. In Burkina Faso, several exotic species are at risk of extinction. This concern related to climate change is compounded by a second major issue: rapid population growth. As a result, the country is facing mounting challenges in food security, pushing rural and agricultural communities further into poverty and increasing the prevalence of nutrition- and food-related diseases.

However, some indigenous crops, such as the African eggplant (*Solanum aethiopicum*), which possesses high genetic potential, may adapt better to climate change and offer high fruit yield capacity. *Solanum aethiopicum* is a very important vegetable for both rural and urban communities in Africa. The crop is rich in both macro- and micronutrients compared with other vegetables and is suitable for ensuring food and nutritional security (Han et al., 2021; Choi & Choi, 2024).

The African wild eggplant populations are particularly interesting because sub-Saharan Africa is a hotspot of wild relatives of all domesticated eggplants, including brinjal eggplant (Omondi et al., 2024). In several parts of sub-Saharan Africa, local populations report that the consumption of wild African eggplant can alleviate various ailments (Opabode & Owojori, 2018) (Ellong et al., 2015). Typically, its cultivation is managed by small-scale farmers in both rural and urban areas (Lassina Fondio et al., 2016).

Despite its importance, few studies have been conducted to improve cultivation practices for this crop in Burkina Faso. Most farmers grow it without a structured cropping system and without prior knowledge of the optimal compost dosage. Yet, identifying the compost requirements of African eggplant could help farmers increase their income, while consumers would benefit from improved nutritional intake through this native food source.

2. MATERIALS AND METHODS

2.1 Plant Material

Three (03) cultivars of African eggplant (*Solanum aethiopicum*) were used in this study. These cultivars were collected from three different administrative regions of Burkina Faso. The purple-fruited cultivar was sourced from the Central Plateau region, the green-fruited cultivar from the Centre-West region, and the white-fruited cultivar from the Central region. All three cultivars were obtained directly from local farmers (Fig. 1).

2.2 Experimental Site

The study was conducted starting in June 2024 on an agricultural plot located in Dapelgo. This site is situated approximately 35 km from Ouagadougou along the Ouaga-Kongoussi road. It lies within the northern Sudanian zone of Burkina Faso. This area is characterised by annual rainfall ranging from 600 to 900 mm and temperatures varying between 18°C and 40°C (Thiombiano & Kampmann, 2010).

2.3 Physicochemical Characteristics of Soil and Compost

The soil at the experimental site was subjected to physicochemical analysis by the National Soil Bureau of Burkina Faso (BUNASOL). Similarly, the compost used in the study was also analysed by the same institution (Table 1).

2.4 Experimental Design

The experimental design used was a Fisher randomised block design with three replications. Each replication was separated by a 1-meter pathway. Within each replication, each cultivar was sown in 4-meter rows, alternating with rows occupied by other cultivars. For each cultivar, 11 planting holes (hills) were sown, with four to five seeds per hole. The spacing between rows and between successive holes was 0.70 m and 0.40 m, respectively. Thinning to one plant per hole was carried out 21 days after sowing.

Fig. 1. Three African eggplant cultivars grown in Burkina Faso

Table 1. Physico-chemical analysis of the study soil and the compost used

Physico-chemical characteristics	Soil	Compost
Clay (< 2µ) (%)	9.55 - 12.58	-
Total silt (%)	28.52 - 29.25	-
Sand (50-200 µ) (%)	56.52 - 61.56	-
Total organic matter (%)	0.854 - 1.895	37.83
Total nitrogen (%)	0.035 - 0.059	2.15
Available potassium (ppm K)	67.14 - 87.73	03.67
Available phosphorus (ppm P)	7.34 - 9.87	04.81

Immediately after ploughing, five compost application rates were tested: 0 t/ha (control), 1 t/ha, 3 t/ha, 5 t/ha, and 9 t/ha.

2.5 Measured Variables

2.5.1 Agronomic parameters

The agronomic parameters measured included:

- Days to emergence, defined as the number of days between sowing and the emergence of 50% of the planting holes in a row;
- Days to 50% flowering, defined as the number of days from sowing to when 50% of the plants in a row had flowered;
- Plant height, measured from the soil surface to the uppermost leaf;
- Fuit weight per plant;
- Number of fruits per plant, based on observations from four representative plants per row.

2.6 Chemical Parameters

The mineral content of the fruits was evaluated by the National Soil Bureau of Burkina Faso (BUNASOL). For micronutrients, copper (Cu), iron (Fe), manganese (Mn), and zinc (Zn) were analysed using atomic absorption spectrophotometry. Other chemical elements such as nitrogen (N), total potassium (K), total phosphorus (P), and magnesium (Mg) were also analysed. Mineralisation was performed using a mixed solution of sulfuric acid, selenium, and salicylic acid. Following mineralisation, total phosphorus and nitrogen were determined from the digest using a SKALAR auto-analyser, with ammonium molybdate and ascorbic acid used as indicators for phosphorus, and Nessler's reagent used for nitrogen. Potassium was quantified using a flame photometer, and magnesium was measured by atomic absorption at 285.2 nm.

2.7 Statistical Analyses

Data analysis was performed using R studio version 4.4.3. A two-factor analysis of variance (ANOVA) was conducted to assess the effects of cultivar and compost dose on morphological and chemical traits. The figures and tables were generated by the same software.

3. RESULTS

3.1 Agronomic Performance of Cultivars under the Influence of Compost Doses

Following nursery sowing, a wide range of variation was observed in seedling emergence time, indicating clear differences among the three cultivars. Analysis of variance (ANOVA) revealed a significant effect of both the cultivar and compost dose on the number of days to emergence (*p*-value < 0.05; Table 2). Early and late emergences were recorded across treatments. The cultivar producing white fruits exhibited the earliest emergence, followed by the purple-fruited cultivar. In contrast, the dark green-fruited cultivar showed the latest emergence (Fig. 2).

Table 2. Emergence performance of the three cultivars

Source of variation	Df	SMG	SME	F statistic	P value
Dose of compost	4	9582.872	2395.718	45.4	<0.001
Morphotype	2	1854.458	927.229	12.5	<0.001
Dose*compost	8	8654.214	1081.77675	26.4	<0.001
Résidu	16	7812.524	488.28275		
Total	30	27904.068			

Legend: df: degree of freedom, SMG: means squared of genotype, SME: means squared of the residual

Table 3. Number of days to 50% flowering of the cultivars

Source of variation	Df	SMG	SME	F statistic	P value
Dose of compost	4	54123.412	13530.853	51.12	<0.001
Morphotype	2	24587.254	12293.627	47.45	<0.001
Dose*compost	8	37788.458	4723.55725	17.54	<0.001
Résidu	16	34587.547	2161.72169		
Total	30	151086.671			

Legend: df: degree of freedom, SMG: means squared of genotype, SME: means squared of the residual

With regard to the number of days from sowing to 50% flowering, the significant variation was attributed to compost dose rather than cultivar (Table 3). Cultivars receiving 1 t/ha of compost flowered later, while those treated with 3 t/ha and 5 t/ha flowered earlier. Overall, regardless of the compost dose, the purple-fruited cultivar was the earliest to flower, while the white-fruited cultivar was the latest (Fig. 3).

ANOVA also revealed significant differences in plant height between cultivars, with these differences being more pronounced across compost doses than within cultivars under the same dose (Table 4). The white-fruited cultivar produced the tallest plants, followed by the dark green-fruited cultivar (Fig. 4).

Table 4. Height evaluation of the three cultivars

Source of variation	Df	SMG	SME	F statistic	P value
Dose of compost	4	894524.417	223631.104	24.21	<0.001
Morphotype	2	4584.145	2292.0725	4.46	<0.022
Dose*compost	8	487956.748	60994.5935	18.37	<0.001
Résidu	16	427854.785	26740.9241		
Total	30	1814920.1			

Legend: df: degree of freedom, SMG: mean squared genotype, SME: mean squared error of the residual

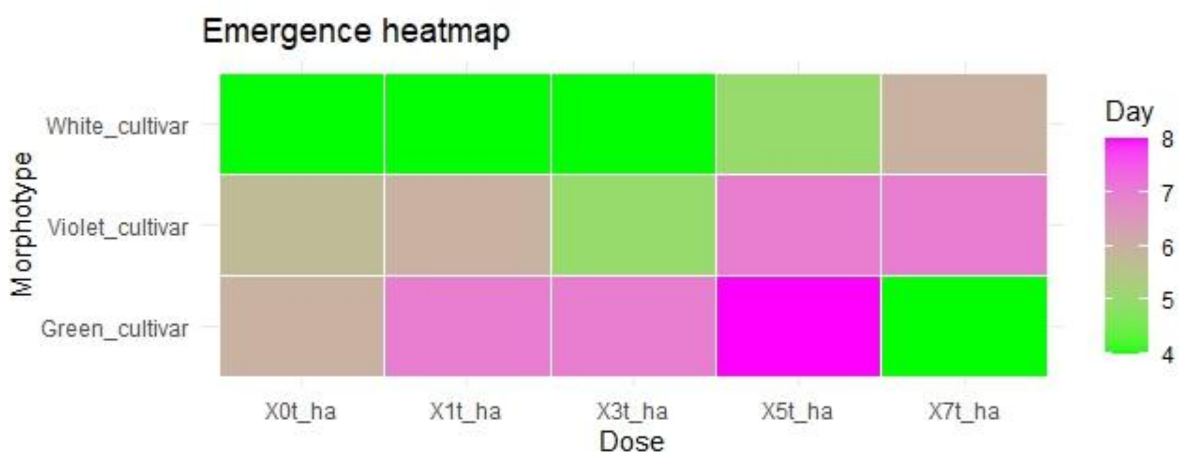


Fig. 2. Performance of the three cultivars in terms of seedling emergence duration under the effetct of compost doses

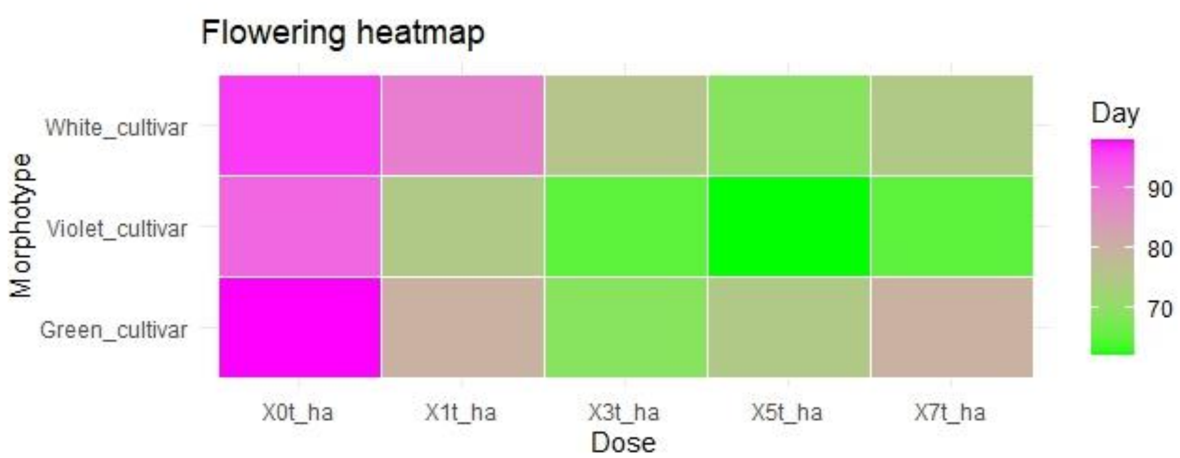


Fig. 3. Performance of the three cultivars in terms of flowering duration and maintence under the effetct of compost doses

Significant differences were also observed among cultivars for fruit weight (Table 5). The heaviest fruits were produced by the white-fruited cultivar, followed by the dark green-fruited one (Fig. 5).

In terms of fruit number, compost dose had a significant effect, both across and within compost treatments (Table 6). The white-fruited cultivar produced the highest number of fruits, followed by the purple-fruited cultivar (Fig. 6).

3.2 Biochemical Performance of Cultivars under Compost dose Treatments

Chemical analyses conducted on the fruit revealed cultivar-specific accumulation capacities that varied with compost dose. No significant differences ($p > 0.05$) were observed in the concentrations of manganese (Mn), zinc (Zn), and calcium (Ca), regardless of compost dose or cultivar.

However, ANOVA at the 5% significance level revealed significant differences in iron (Fe), sodium (Na), potassium (K), and phosphorus (P) contents. These differences were notable both across compost doses and between cultivars (Table 7).

Among the three cultivars, the dark green-fruited cultivar showed the highest capacity for nutrient accumulation, followed by the white-fruited cultivar. The purple-fruited cultivar consistently showed the lowest concentrations of Fe, Na, K, and P (Fig. 7).

Table 5. Weight evaluation of the three cultivars

Source of variation	Df	SMG	SME	F statistic	P value
Dose of compost	*4*	879.258	219.8145	5.25	<0.001
Morphotype	*2*	458.457	229.2285	4.45	<0.001
*Dose*compost*	*8*	698.213	87.276625	4.67	<0.001
Résidu	*16*	315.258	19.703625		
Total	*30*	2351.186			

Legend: df: degree of freedom, SMG: mean squared genotype, SME: mean squared error of the residual

Table 6. Evaluation of the number of fruits per plant of the three cultivars

Source of variation	df	SMG	SME	F statistic	P value
Dose of compost	4	9854.415	2463.60375	45.21	<0.001
Morphotype	2	2145.548	1072.774	12.54	<0.001
Dose*compost	8	8745.127	1093.14088	24.41	<0.001
Résidu	16	8045.478	502.842375		
Total	30	28790.568			

Legend: df: degree of freedom, SMG: means squared of genotype, SME: means squared of the residual

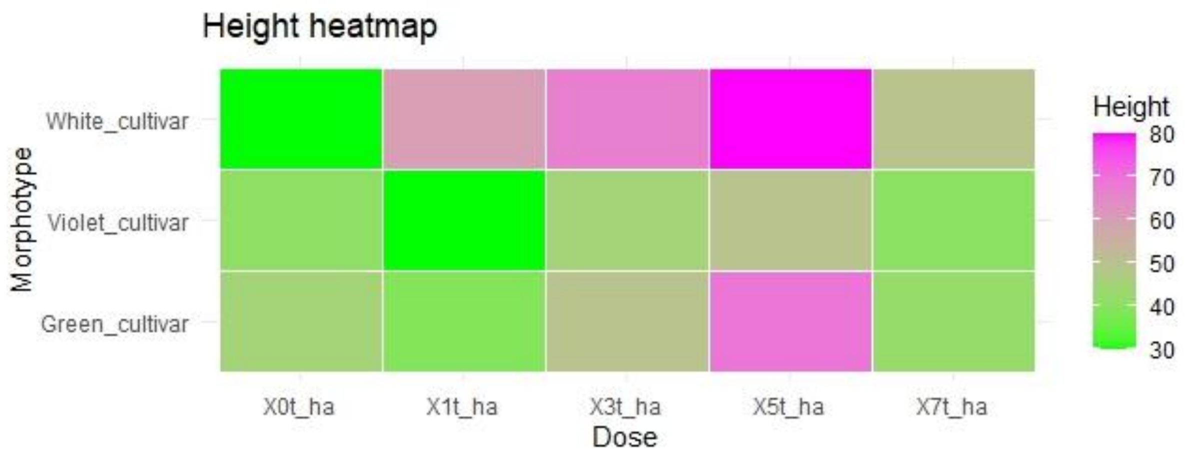


Fig. 4. Performance of the three cultivars in terms of fruit height under the effetct of compost doses

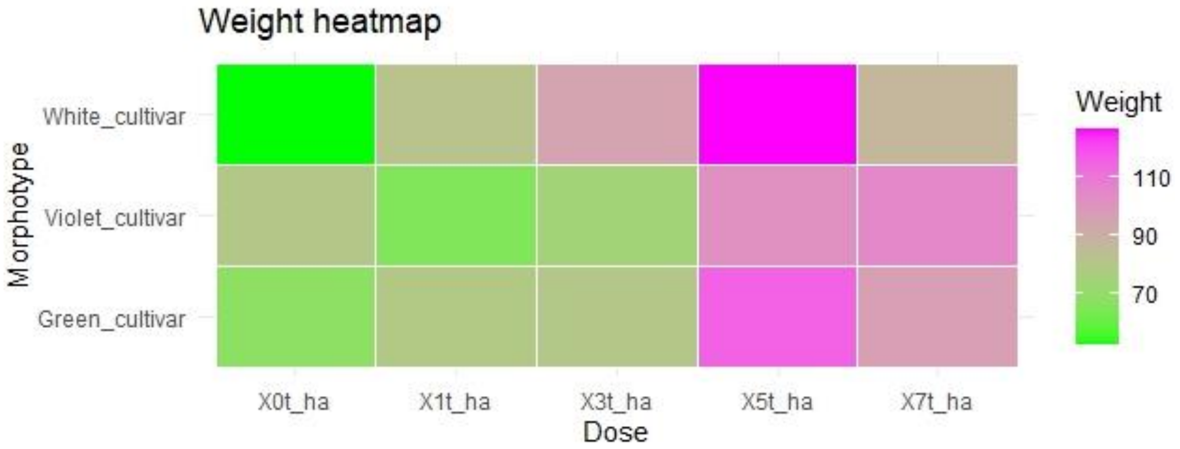


Fig. 5. Performance of the three cultivars in terms of fruit weight under the effetct of compost doses

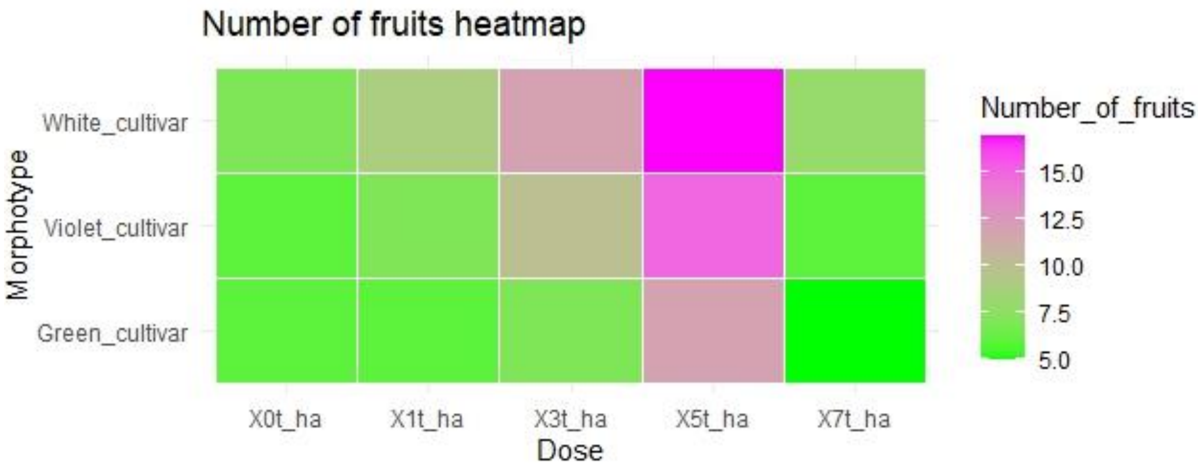


Fig. 6. Performance of the three cultivars in terms of fruit number under the effect of compost doses

Table 7. Evaluation of the chemical elements of the three studied cultivars

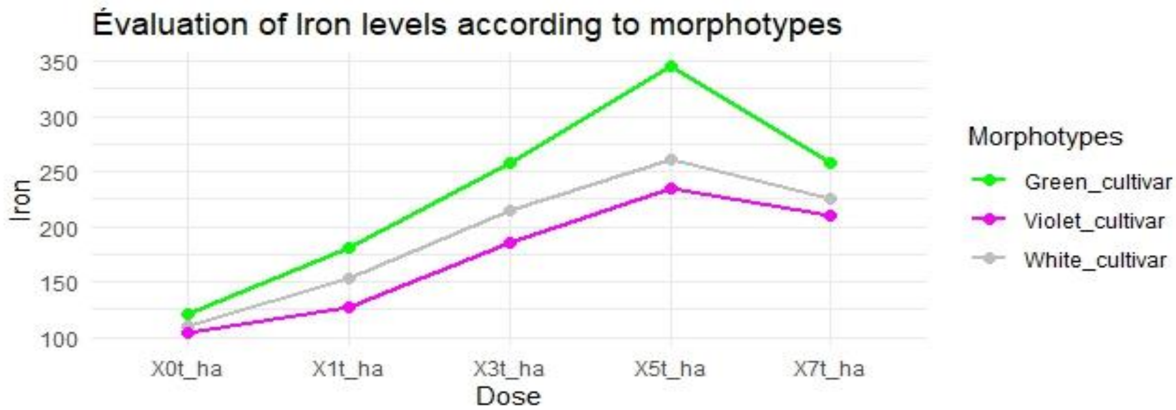
Parameters (mg/100 g)	Dart green cultivar	White cultivar	Violet cultivar	P-value
Zinc	4.45 ± 0.01	4.51 ± 0.01	4.39 ± 0.01	<0.141
Manganese	174.14 ± 0.05	170.84 ± 0.04	169.47 ± 0.06	<0.061
Calcium	18.51 ± 0.02	16.38 ± 0.03	17.57 ± 0.02	<0.095
Iron	360.25± 0.02	335.09 ± 0.02	290.73 ± 0.01	<0.001
Sodium	157.35 ± 0.01	132.78 ± 0.02	119.42 ± 0.01	<0.001
Potassium	258.54 ± 0.01	221.25 ± 0.01	205.46 ± 0.02	<0.001
Phosphorus	1158.54 ± 0.90	1092.58 ± 0.72	984.65 ± 0.70	<0.001

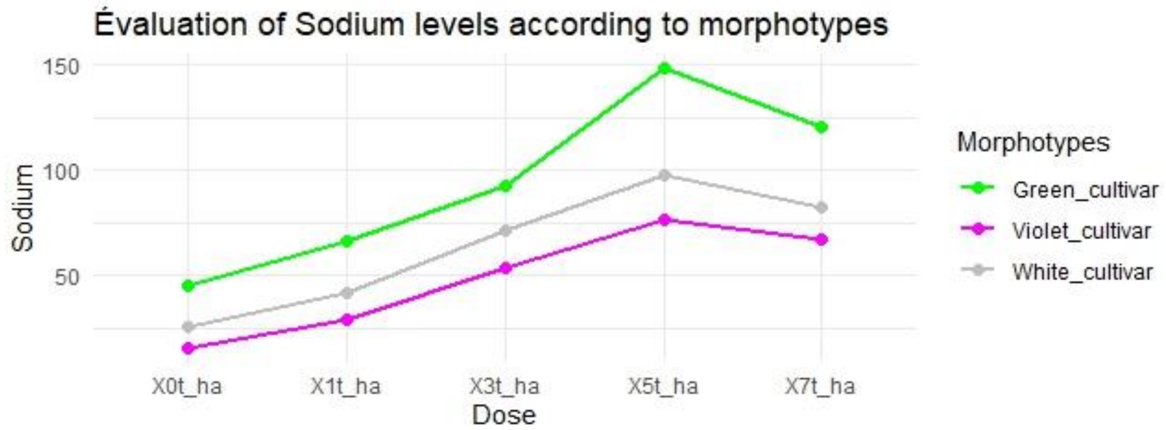
3.3 Nutrient Substance Performance of Cultivars under the Influence of Compost Doses

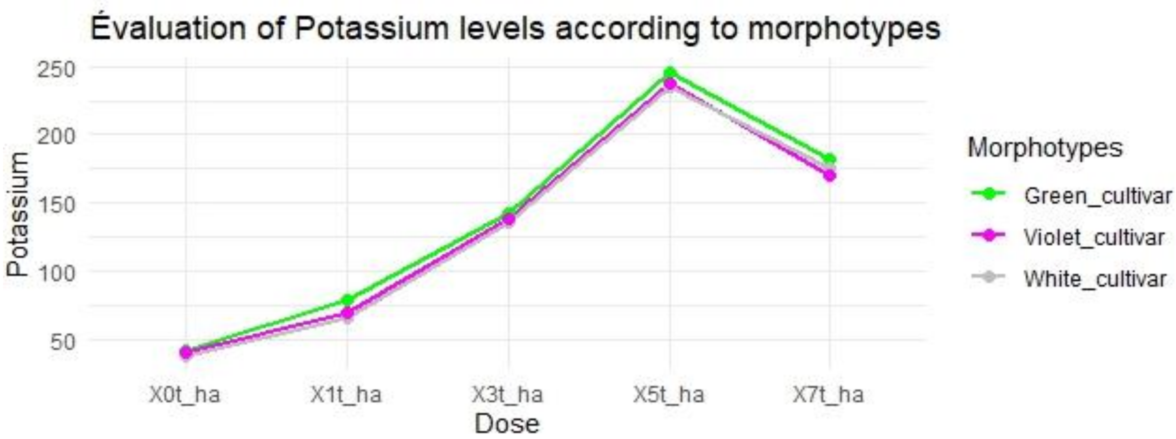
Variance analysis using the Newman-Keuls test revealed significant differences at the 5% level. Indeed, the alkaloid content of the cultivars varied with compost dose and even within the same compost dose. Additionally, there was a significant difference in flavonoid performance among the three cultivars. Similarly, the saponin levels differed between cultivars and across compost doses. The cultivars treated with a 5 t/ha compost dose exemplified the highest nutrient substance performance among the three cultivars (Table 8). The dark green-fruited cultivar exhibited the highest performance in alkaloids and flavonoids (Fig. 8). In contrast, the highest performances in saponins and phenols were achieved by the white-fruited cultivar (Fig. 9).

Table 8. Evaluation of the nutrients of the three cultivars studied

Parameters (mg/100 g)	Dart green cultivar	White cultivar	Violet cultivar	P-value
Alkaloid	8.87 ± 0.02	6.52 ± 0.01	5.36 ± 0.02	<0.001
Flavonoid	0.41 ± 0.01	0.32 ± 0.01	0.21 ± 0.01	<0.001
Saponin	15.55 ± 0.02	18.61 ± 0.02	13.25 ± 0.01	<0.001
Phenol	1.53 ± 0.03	2.23 ± 0.03	1.23 ± 0.03	<0.031







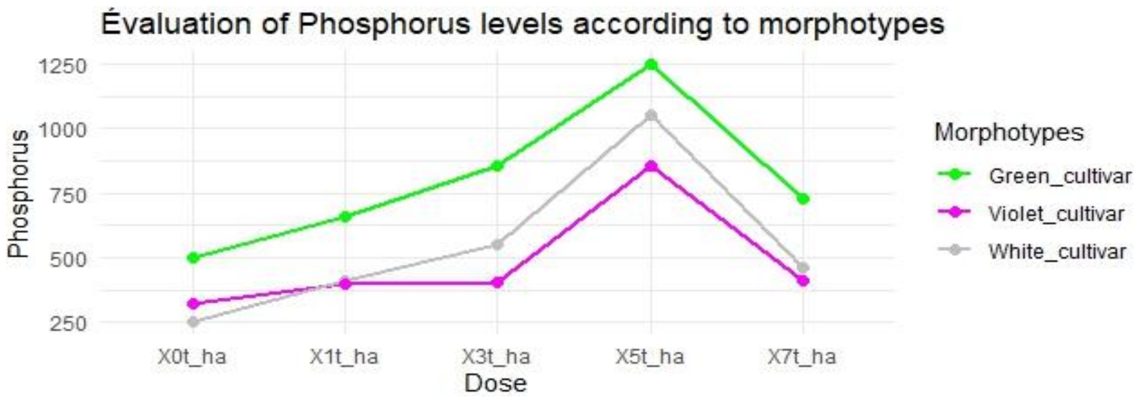
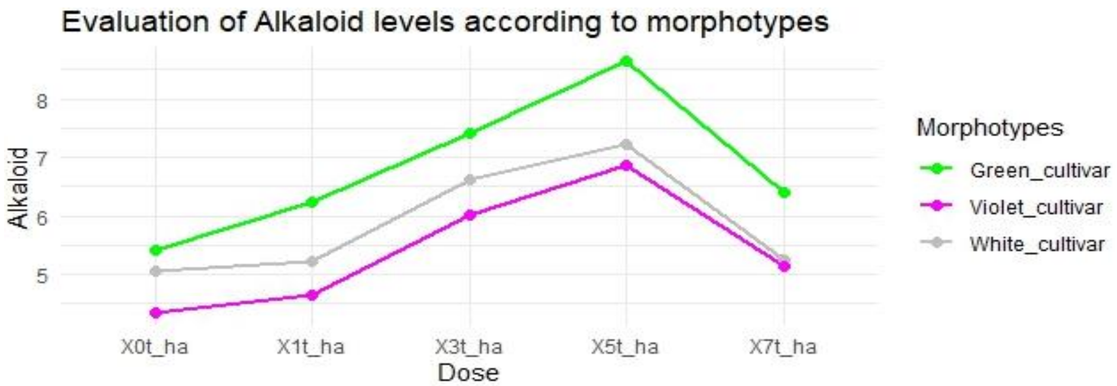


Fig. 7. Performance of the three cultivars in terms of chimical elements under the effetct of compost doses



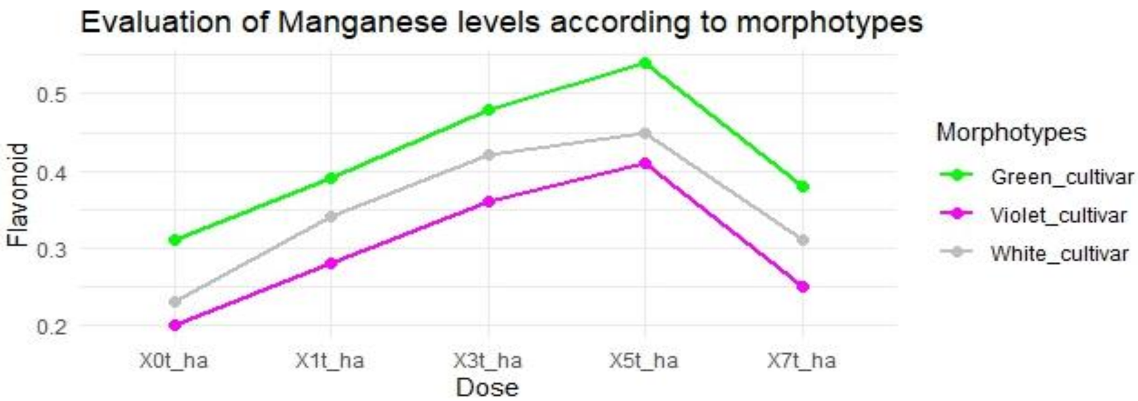
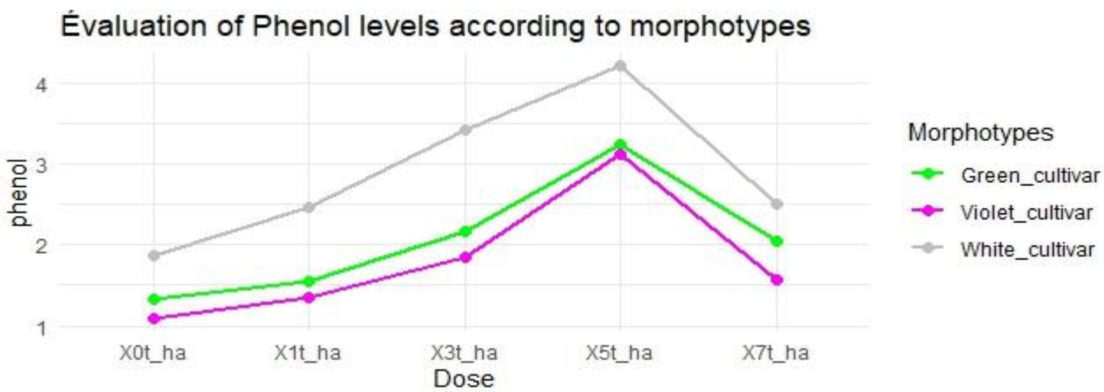


Fig. 8. Performance of the cultivars in alkaloid and flavonoid content



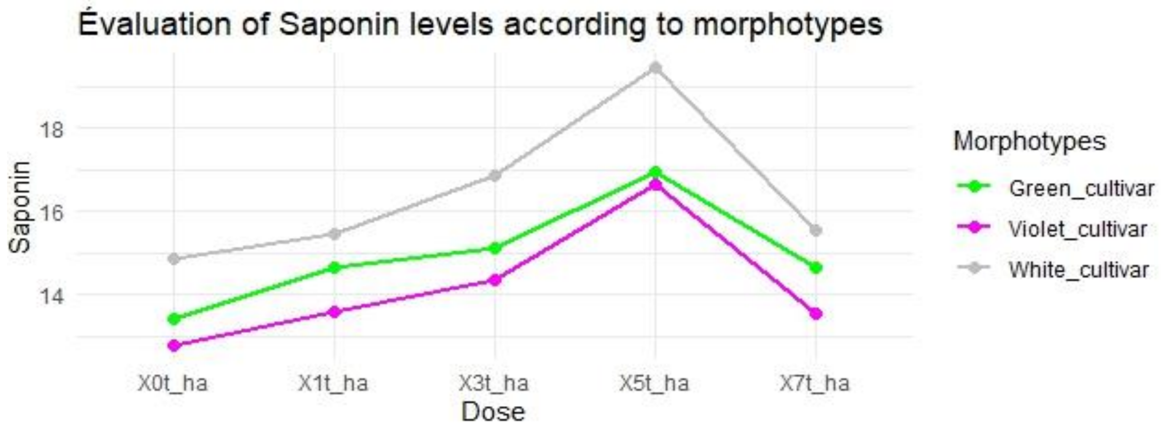


Fig. 9. Performance of the cultivars in saponin and phenol content

4. DISCUSSION

At the end of this experiment, several differences were observed regarding agronomical-morphological performance, chemical elements, and biochemical substances. Thus, cultivars producing purple-colored fruits performed less well compared to those with dark green and white fruits. However, other studies on edible leaves may show the opposite. Additionally, the compost model used, given its characteristics, could have an unfavourable effect on the benefits of the purple-fruited morphotype. On the other hand, the dark green and white-fruited morphotypes exhibited higher performance depending on the variation in compost doses. The white-fruited morphotype, in particular, holds the most promising qualities for generating higher monetary income for market gardeners. In fact, using this morphotype with a compost dose of 5 t/ha results in larger fruits and a higher yield of fruits compared to the other two morphotypes. This could be attributed to the genotype or the quality of the chosen compost. This agricultural practice could ensure the long-term conservation of several indigenous species, particularly the African eggplant (Gockowski et al., 2003). Regarding the chemical elements, significant differences were noted between morphotypes. Overall, due to the chemical value developed by the species, it would be beneficial to integrate the African eggplant into dietary habits (Ali & Tsou, 2000). Indeed, the morphotype producing dark green fruits could be exploited by market gardeners while applying a compost dose of 5 t/ha. This would be a benefit for consumers. For example, the significant amount of zinc in the dark green morphotype could be recommended for individuals living with HIV (Baum et al., 2003)(Traore et al., 2015). The species contains higher levels of calcium, magnesium, and zinc than species such as amaranth and vegetable purslane (Odhav et al., 2007). Regarding phosphorus, the high levels in dark green fruits would play a role in DNA and RNA synthesis. In fact, consuming these fruits could meet various hormonal needs and facilitate several biochemical reactions. Moreover, the high sodium content could help maintain nerve sensitivities and balance osmotic pressure (Fungo et al., 2015). The high iron content in this cultivar would be especially beneficial for pregnant women, breastfeeding women, and vulnerable children (García et al., 2010) ; (Ndlovu & Afolayan, 2008). Additionally, given the importance of iron in the body, consuming the dark green cultivar could be one of the most effective fruits for blood synthesis (Malakul et al., 2011). (Black et al., 2003) showed that iron deficiency in the diets of pregnant women leads to over 10% maternal mortality. Based on this study, the issue of maternal mortality could be mitigated for the well-being of families. The biochemical analysis reveals very high levels of alkaloids and flavonoids in the dark green-fruited morphotypes. Regarding tannins and saponins, the white-fruited morphotype is most prized due to its higher richness in these two substances. Both the dark green and white-fruited morphotypes would be highly beneficial for medicine due to the significant levels of substances they contain. Therefore, aqueous extractions would help meet the high demand for the compounds in this species (Nandy et al., 2020). These substances are considered to have anti-inflammatory, antimicrobial properties and could inhibit the activity of tumour agents (Malongane et al., 2018); (Asl & Hosseinzadeh, 2008).

5. CONCLUSION

The study highlighted the agronomic performance and nutritional values of the African eggplant from the Soudano-Sahelian climate zone of Burkina Faso. In this regard, it should be noted that the white-fruited morphotypes perform better in terms of yield and are very rich in phenolic compounds and saponins. Although the green-fruited morphotype does not have high yield potential, it possesses satisfactory nutritional value in terms of iron, sodium, potassium, phosphorus, flavonoids, and alkaloids. As for the purple morphotype, it closely follows the other two in terms of performance, including nutritional richness. The white-fruited morphotype is commercially useful, as its yield performance would bring higher financial gain to producers. From a health perspective, the green-fruited morphotype would be more beneficial to consumers due to its chemical and nutritional potential.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

The authors hereby declare that no generative AI technologies, such as Large Language Models (ChatGPT, GitHub Copilot) or text-to-image generators, were used in the writing or revision of the manuscript titled: False sesame (Ceratotheca sesamoides Endl.) and its traditional therapeutic wonders in the Sudanian and Sudano-Sahelian zones of Burkina Faso.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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