

Research Article



Diversity and Agronomic Performance of 20 Local Cowpea Cultivars (*Vigna unguiculata* (L.) Walp.) in Burkina Faso

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ABSTRACT

Vigna unguiculata is one of the main legumes consumed in Burkina Faso. Its genetic improvement requires a good understanding of the diversity of local cultivars. However, very little information exists on these local cultivars. This study aims to contribute to a better understanding of the diversity and agronomic performance of cowpea cultivars in Burkina Faso. The plant material studied consists of 20 cowpea cultivars, 17 of which are from the National Commission for Plant Genetic Resources Management (SP-CONAGREP) and three from the Institute of Environment and Agricultural Research (INERA). The experimental design was a randomized block with three replications. The experiment was conducted over two farming seasons in 2022 and 2023. The quantitative variables measured are related to phenology and yield. The results revealed cultivars with white flowers and violet flowers. For yield-related performance, the results showed that the Sanga and CSI01 cultivars were the most productive in terms of number of seeds per pod in 2022. Performance varies by cultivar and year and is influenced by climatic and environmental conditions. The DANPLA cultivar achieved the highest 100-seed weight in 2022 and 2023, at 17.03 g and 19.43 g, respectively. The structuring of the 20 cultivars in the collection resulted in four groups based on agronomic performance. Group I consists of early-cycle cultivars and is characterized by large seeds. These important traits can be exploited in breeding programs.



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1. Introduction

The cowpea is one of the world's main food and fodder legumes (Ilboudo *et al.* 2020). Cowpea is of crucial to the livelihoods of millions of relatively poor people in less-developed countries (Abebe and Alemayehu 2022). It has a food, economic, and medicinal role for these populations. Native to Africa, it adapts well to semi-arid and arid climates. It also improves soils thanks to the symbiotic association between its roots and Rhizobium bacteria (Dianda 2016; Namatsheve *et al.* 2020). This crop, which is less demanding on soil (fertility) and drought-tolerant, is consumed for its nutritional qualities

and is a plant with multiple uses. Very rich in protein and carbohydrates (Mekonnen *et al.* 2022; Chapron *et al.* 2025), cowpea helps reduce protein deficiency in the diets of populations, especially in rural areas (Affrifah *et al.* 2022). Indeed, its seeds, leaves, pods, and the entire plant can be used for human or animal consumption. Cowpea is a food source rich in proteins, vitamins, and fibers (Ntswane *et al.* 2024; Dabiré 2025), thus contributing to food and nutritional security. The area devoted to cowpea production worldwide in 2021 was 14,911,307 ha, with a production of 8,986,191 tonnes. Most of the land used for cowpea production is in West Africa, with a production of 7,678,565 tonnes on an area of 13,106,130 hectares (FAOSTAT 2022). In Burkina Faso, cowpea production was 829,204 tonnes in 2023 on an area of 483,413 ha (INSD 2025). Cowpea production

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is hampered by biotic and abiotic constraints that limit its productivity (Horn and Shimelis 2020; Seleiman *et al.* 2021). This low productivity could be explained in part by the limited dissemination of improved varieties and low valuation of local potential (Nadjiam *et al.* 2015). Indeed, local cowpea cultivars constitute a valuable gene pool for genetic improvement (Ghalmi 2011).

The collection and characterization of local cultivars held by producers are essential activities in the biodiversity conservation strategy (Ouedraogo *et al.* 2010). The exploitation and promotion of this local potential could contribute to improving cowpea productivity and also to the creation of new varieties. Knowledge of the diversity of traditional varieties and the assessment of their agronomic performance are necessary (Doumbia *et al.* 2013). Furthermore, the preservation of local cultivars is of paramount importance for Sahelian countries such as Burkina Faso, given the decline in genetic diversity within these cultivars and the impacts of climate change. Gbaguidi *et al.* (2013) reported a loss of genetic diversity in cowpea at a rate of 28 to 60% in southern Benin. The disappearance of plant species poses a potential threat to agricultural production (FAO 2008). Added to this is the introduction of improved varieties, which have been threatening their survival for several years (Nadjiam *et al.* 2015). Thus, the collection of local cowpea cultivars has become necessary due to losses suffered by existing gene banks in the country. These

losses are mainly due to poor storage conditions and a lack of suitable equipment. In addition, climate change, particularly the shortening of rainy seasons, has led to the abandonment of several local varieties with long cycles. This abandonment has been followed by the loss of these cultivars, thus creating genetic erosion within the species (Ouédraogo *et al.* 2010). Genetic material is a promising resource for breeding programs aimed at improving yield and productivity, thereby contributing to greater food and nutritional security (Chaudhary *et al.* 2025). Hence, the relevance of this study which aims to contribute to a better understanding of the diversity and agronomic performance of local cowpea varieties in Burkina Faso.

2. Materials and Methods

2.1. Study Site

The study was conducted at the experimental station of the Institute of Environment and Agricultural Research (INERA) in Kamboinsé, Burkina Faso. The experiments were carried out during the rainy agricultural seasons of 2022 and 2023, between July and October. In 2022 and 2023, the annual rainfall recorded was 1,097.7 mm and 698 mm at the CREAM/Kamboinsé meteorological service. This experimental station is located 12 km North of Ouagadougou, with geographical coordinates 12°27 North, 1°32 West (Figure 1). This area has a

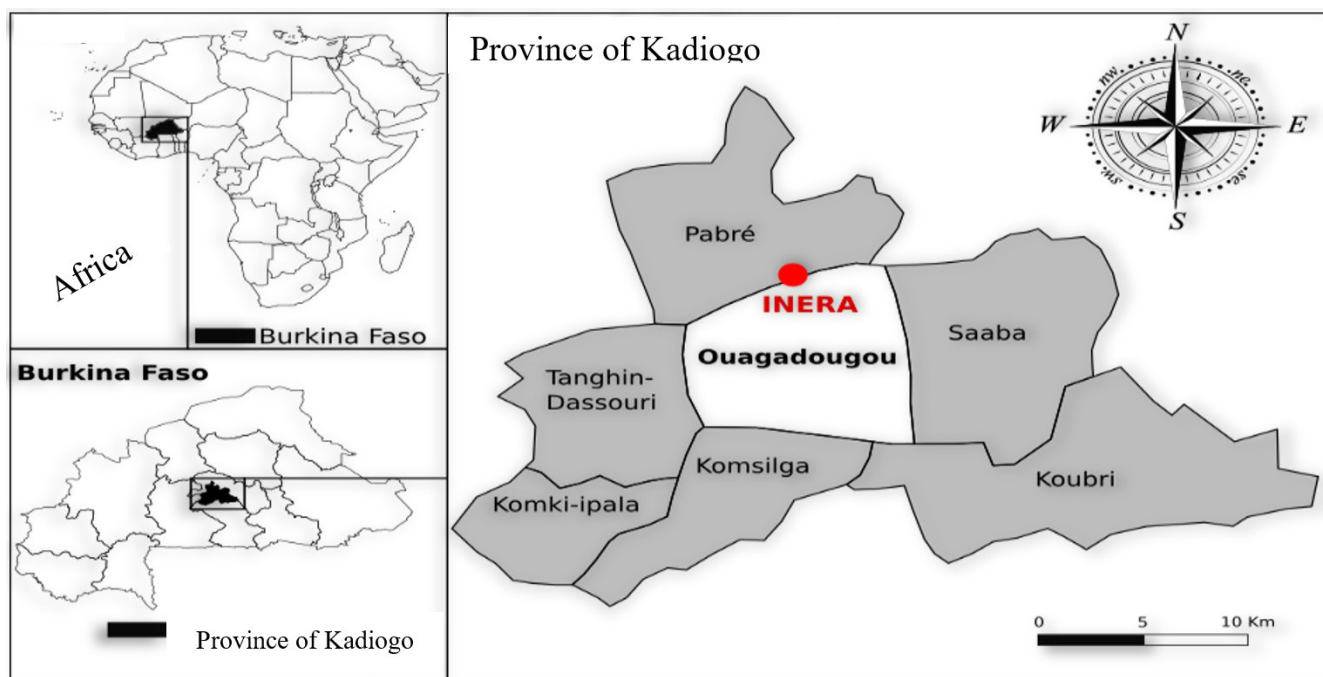


Figure 1. Map of the study site

Sudano-sahelian climate characterized by two unevenly distributed seasons (De Longueville *et al.* 2016). A rainy season from May to September and a dry season from October to April. The soil of the experimental site has a texture ranging from loamy to sandy loam or loamy clay from the surface layers to greater depths (Thiombiano 2023; Coulibaly *et al.* 2024). The pH values (H₂O) are slightly acidic (around 6) but satisfactory for agricultural production (Coulibaly 2024).

2.2. Plant Material

The plant material studied consists of 20 local cowpea cultivars, 17 of which come from a collection of the National Commission for Plant Genetic Resources Management (SP-CONAGREP) and three from the INERA cowpea germplasm based at Kamboinsé (Table 1).

2.3. Experimental Test Setup

The experimental design used was a randomized block design with three replicates. The spacing between replicates was 1.5 m. Each replicate was subdivided into two blocks 1 m apart, each comprising 10 elementary plots. The elementary plots comprised four rows, each 4 m long. The spacing was 0.75 m between rows and 0.4 m between plots. The spacing between the elementary plots was 1.2 m. With a length of 36 m and a width of 30 m, the total area of the trial was 1,080 m².

Table 1. List and origin of local cowpea cultivars tested

Cultivars	Origin
CSI01	Cascade
Sanga	INERA
CTA04	Cascade
CKI07	Cascade
CNK04	Centre-Nord
CNK05	Centre-Nord
CNK03	Centre-Nord
Pobe	INERA
CKI08	Cascade
Koakin	INERA
CNK06	Cascade
HKO01	Cascade
CNK08	Centre-Nord
CTA03	Cascade
CNK02	Centre-Nord
CNK07	Centre-Nord
CKI05	Cascade
CNK09	Centre-Nord
DANPLA	Cascade
CNK01	Centre-Nord

2.4. Conducting the Trial

The soil preparation for the trial consisted of plowing followed by harrowing. These operations allowed the removal of weeds, breaking up clods of soil, aerating the soil, preparing a seedbed, and facilitating water infiltration. Sowing was carried out on 21 July 2022 and 23 July 2023. It was performed manually, with two seeds per hill. The first weeding was done 15 days after sowing, and the second 30 days after sowing. NPK fertilizer (14-23-14) was applied to all plots at the first weeding at a rate of 100 kg/ha. Two phytosanitary treatments were applied. The first was carried out at the beginning of flowering with Pacha at a dose of 40 ml per 20 liters of water. The second was performed at the time of pod formation with a mixture of Pacha and K-optimal at 40 ml per 20 liters of water.

2.5. Data Collection

2.5.1. Qualitative Variables

Eight qualitative variables were collected. These include the color of the flower observed after the first flowers opened, the shape of the terminal leaflet, and the type of growth habit observed at the 50% flowering stage. The color and shape of the pods were noted when most pods had reached maturity. The seed color, seed texture, and seed eye color were also noted.

2.5.2. Quantitative Variables

Fourteen quantitative variables were measured. These include plant height on the 45th (PH45) and 60th (PH60) days after sowing, measured with a graduated ruler. The peduncle length (PL) was measured when the floral peduncles appeared using a graduated ruler. The date of first flower appearance (DFlo) was determined by counting the number of days between sowing and the date of first flowering. The 50% flowering date (Flo50) corresponds to the number of days elapsed from sowing until the day when 50% of the plants had flowered in a base plot. The 95% maturity days (Mat95) were determined for each elementary plot by counting the number of days required for 95% of the pods to reach maturity. Pod length (POL) was measured with a graduated ruler and corresponds to the average size of 10 randomly selected pods in each elementary plot. The number of pods per plant (NPP) was calculated by taking the average number of pods from five randomly selected plants in each plot. The number of seeds per pod

(NSP) is the average number of seeds in 10 randomly selected pods per elementary plot. The weight of one hundred seeds (HSW) is expressed in grams, determined by randomly selecting 100 seeds from each cultivar and weighing them with a precision electronic balance of 0.01 g. The seed length (SL) was expressed in centimeters and determined using a caliper by averaging the length of 10 randomly selected seeds per elementary plot. The seed width (SW) was determined by averaging the width of 10 randomly selected seeds per elementary plot. It was measured with calipers and is expressed in centimeters. Leaf yield (LYield), expressed in kg/ha, was calculated by determining the leaf production of each cultivar per hectare using the formula: $LYield = (\text{weight of leaves} \times 10,000)/\text{area}$. Seed yield (SYield), expressed in kg/ha, was determined by calculating the grain production of each cultivar per hectare using the formula: $SYield = (\text{weight of seeds} \times 10,000)/\text{area}$.

2.6. Data Processing and Analysis

The data were entered using Excel 2016. Qualitative variables were used to calculate variable frequencies and produce charts. For quantitative variables, an analysis of variance (ANOVA) was conducted to identify variables showing significant differences among cultivars. The Student-Newman-Keuls mean separation test was performed to better compare agronomic performance among cultivars. Multivariate analyses were carried out to highlight associations between quantitative variables and structure the accessions. The relationships between variables were assessed using Pearson's correlation matrix at the 5% significance level. The diversity of cultivars was assessed using Principal Component Analysis and Ascending Hierarchical Classification. Descriptive analysis, correlation test, principal component analysis, and hierarchical cluster analysis were used to combine the means of data from the two years of experimentation. All analyses were carried out using RStudio version 4.3.1.

3. Results

3.1. Variation in Qualitative Variables

The cultivars exhibited substantial qualitative variation, characterized by high phenotypic diversity across vegetative and reproductive traits. Leaf morphology spans four distinct types: rounded, semi-rounded, sub-hastate, and the predominant hastate form (Figures 2 and 3); supported by upright, semi-upright, or prostrate growth habits (Figure 4). Floral diversity was marked by the prevalence of white flowers

(68.33%) over purple variants (Figures 5 and 6). While pod architecture was generally straight or slightly curved, cultivar CTA03 was uniquely distinguished by its curved pods (Figures 7 and 8), with yellow emerging as the most frequent of the five identified pod colors (Figures 9 and 10). Seed characteristics further underscored this variability; wrinkled white seeds (65%) were significantly more common than smooth

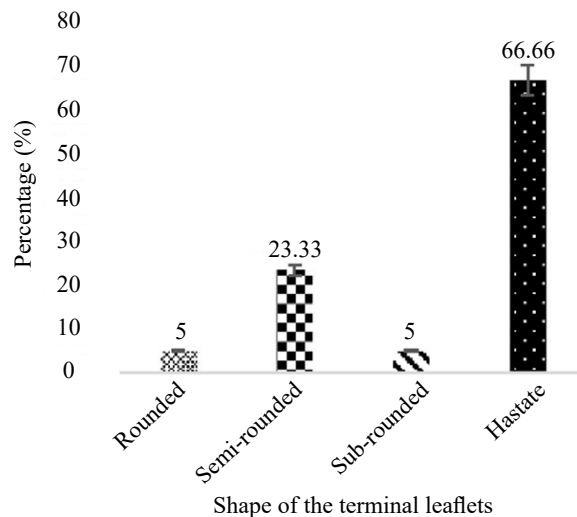


Figure 2. Frequency of terminal leaflet shape

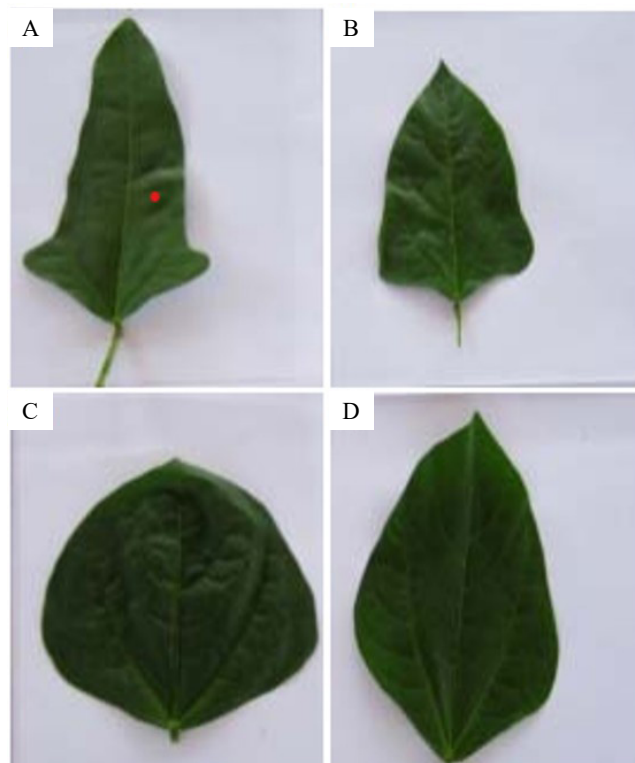


Figure 3. Shape of terminal leaflets (A) hastate, (B) sub-hastate, (C) rounded, (D) semi-rounded

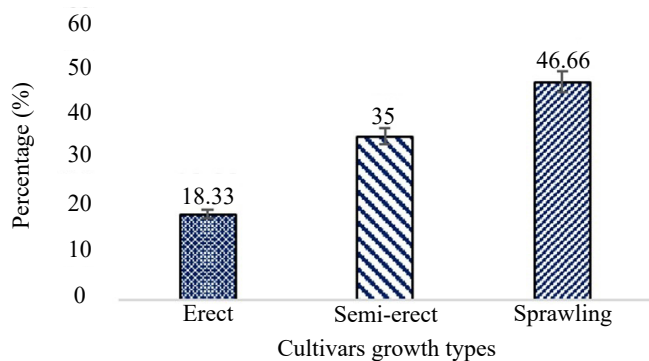


Figure 4. Type of growth habit of cultivars

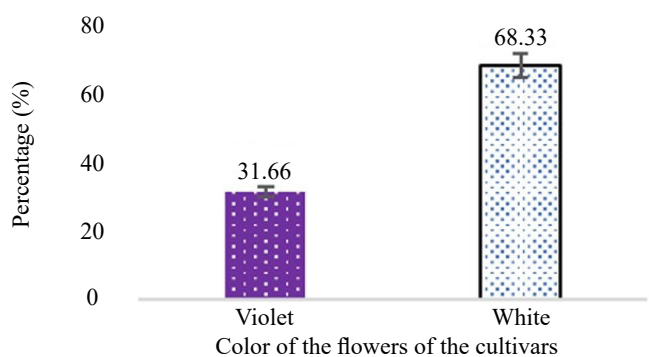


Figure 5. Frequency of flower colour

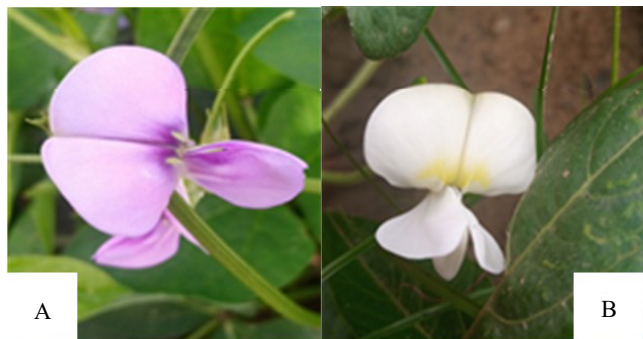


Figure 6. Colour of flowers (A) purple flower, (B) white flower

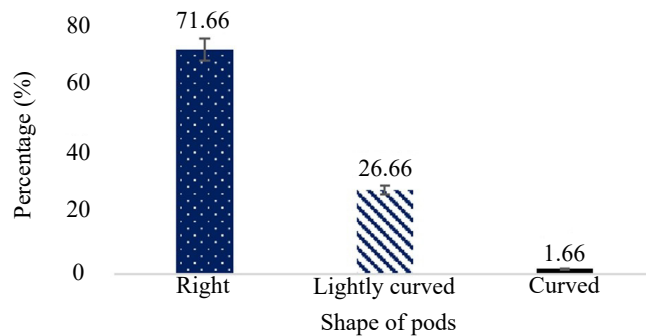


Figure 8. Frequency of pod shape of cultivars

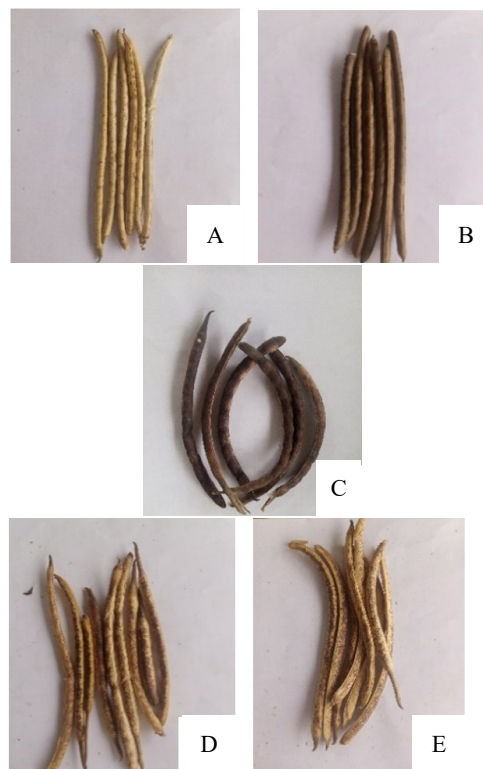


Figure 9. Pod color (A) yellow pods, (B) brown pods, (C) purple pods, (D) yellow pods with red spots, (E) yellow pods with purple spots



Figure 7. Shape of the cultivars' pods (A) straight pods, (B) slightly curved pods, (C) curved pods

variants (35%) across five distinct color categories (Figures 11, 12, and 13), with pigmentation at the seed eye limited to either brown or black (Figure 14).

3.2. Variation of Quantitative Variables for the Two Years of Experimentation

Significant differences were observed between the minimum and maximum values of most variables measured for the cultivars studied in 2022 and

2023. Indeed, variables such as peduncle length, 50% flowering date, and 95% maturity date showed considerable variation (Table 2). The results of the analysis of variance showed significant differences between the cultivars ($P < 0.05$) for the variables pod length, 50% flowering date, 95% maturity date, number of seeds per pod, and hundred-seed weight. The coefficient of determination (R^2) was low for forage yield and grain yield.

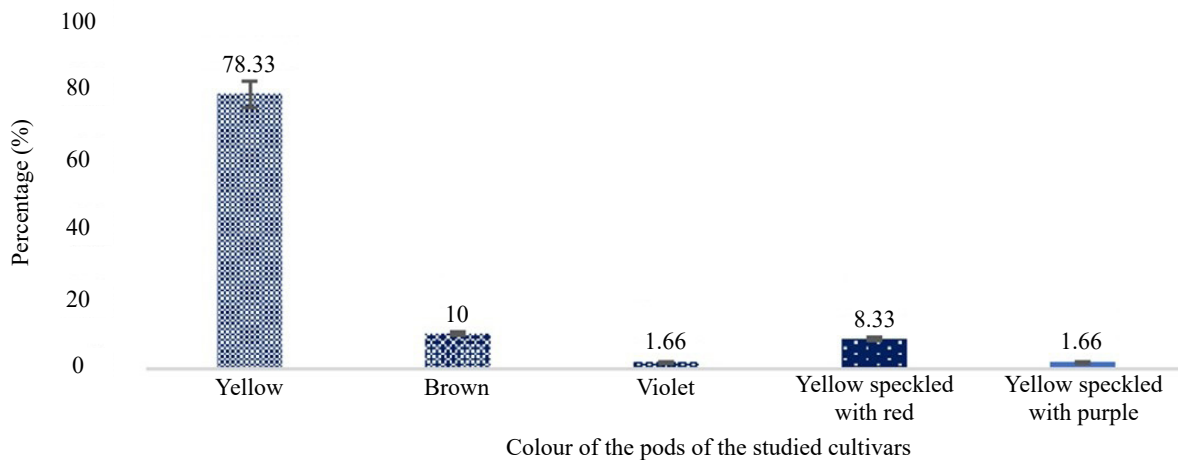


Figure 10. Types of colors observed on the pods

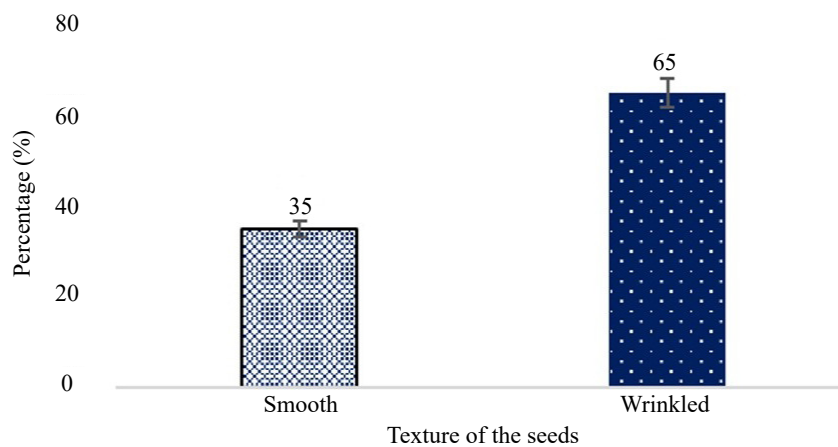


Figure 11. Types of seed texture



Figure 12. Seed color (A) red, (B) white, (C) brown, (D) red with black spots, (E) pale orange

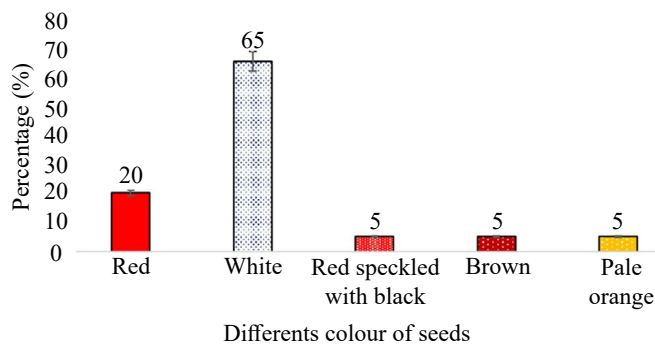


Figure 13. Frequency of seed color

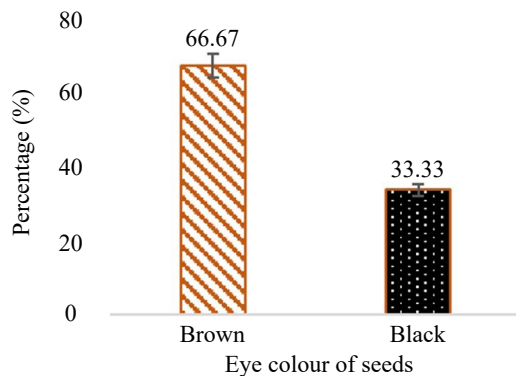


Figure 14. Frequency of seed eye color

3.3. Phenological Performance of Cowpea Cultivars in 2022 and 2023

The results of the mean comparison test, recorded in Table 3, show the performance of the cultivars with respect to the phenological parameters in 2022 and 2023. The results reveal variation in performance among the cultivars within the same season and from one year to the next. The five phenological variables allowed discrimination of cultivars for the 2022 and 2023 seasons. The CKI05 and CSI01 cultivars reached 50% flowering early in 2022 and 2023, respectively. In 2022, the CSI01 cultivar was the earliest, while in 2023, the CTA04 and HKO01 cultivars were the earliest.

3.4. Comparison of Cultivars based on Yield Performance in 2022 and 2023

The results of the mean separation test of cultivars for yield-related variables revealed differences in performance among the cultivars during the 2022 and 2023 seasons (Table 4). The Sanga and CSI01 cultivars had the highest number of seeds per pod in 2022 and 2023, respectively. For seed length, the highest values were observed in the Pobe cultivar. The DANPLA cultivar had the highest 100-seed weight. For the 2023

Table 2. Average performance of cultivars for the two crop years

Variables	Minimum	Maximum	Mean	CV%	R ² %	F	P-value
PL	7.08	41.66	22.76	29.13	40.03	3.513	<0.0001
DFlo	37.00	57.00	44.78	10.61	46.01	4.485	<0.0001
Flo50	40.00	61.00	48.41	11.11	46.77	4.625	<0.0001
Mat95	59.00	84.00	69.18	9.27	31.15	2.381	0.003
NPP	15.40	98.60	37.97	43.63	18.04	1.159	0.308
POL	10.90	22.91	14.11	12.03	37.13	3.109	<0.0001
PH45	10.00	116.66	59.49	38.48	22.51	1.529	0.092
PH60	20.20	238.39	111.52	48.88	7.05	0.399	0.988
SL	5.55	9.94	7.62	14.40	72.89	14.150	<0.0001
SW	3.52	7.04	4.88	21.48	5.94	0.332	0.996
NSP	7.40	24.10	12.84	18.35	52.26	5.761	<0.0001
HSW	7.30	23.60	13.09	24.19	62.10	8.623	<0.0001
LYield	215.67	20000.00	3400.00	104.33	12.98	0.785	0.719
SYield	132.33	2873.00	1001.54	57.53	10.40	0.611	0.890

PL: Peduncle length, DFlo: Flowering day, Flo50: Number of days to 50% flowering, Mat95: Number of days to 95% maturity, PH45: Plant height on the 45th day, PH60: Plant height on the 60th day, NPP: Number of pods per plant, POL: Pod length, SL: Seed length, SW: Seed width, NSP: Number of seeds per pod, HSW: Hundred seed weight, LYield: Leaf yield, SYield: Seed yield, R²: Coefficient of determination, CV%: Coefficient of variation

Table 3. Comparison of cultivar performance for phenological parameters in 2022 and 2023

Variables	PH60		DFlo		Flo50		Mat95	
Year	2022	2023	2022	2023	2022	2023	2022	2023
CKI05	135.21 ^{cd}	72.06 ^{abcde}	40.00 ^h	40.00 ^{defg}	43.66 ^h	41.66 ^{efg}	67.00 ^{hi}	62.00 ^{def}
CKI07	150.94 ^{abcd}	44.06 ^{ef}	43.33 ^{fgh}	38.66 ^g	47.33 ^{fgh}	41.66 ^{efg}	69.66 ^{fghi}	61.66 ^{ef}
CKI08	143.33 ^{bcd}	64.73 ^{abcdef}	41.00 ^h	39.66 ^{efg}	44.66 ^h	42.66 ^{efg}	68.33 ^{ghi}	62.00 ^{def}
CNK01	168.33 ^{abcd}	79.26 ^{ab}	50.33 ^{abc}	43.33 ^{bcd}	55.33 ^{ab}	48.33 ^{abcd}	76.66 ^{bcd}	65.66 ^{bc}
CNK02	161.11 ^{abcd}	55.53 ^{bcdef}	49.66 ^{bcd}	45.00 ^{abc}	53.00 ^{bcd}	48.00 ^{abcd}	77.66 ^{abcd}	66.66 ^{ab}
CNK03	159.22 ^{abcd}	64.73 ^{abcdef}	53.00 ^{ab}	42.66 ^{bcdef}	57.66 ^a	45.66 ^{bcdef}	78.66 ^{abc}	66.33 ^{ab}
CNK04	152.55 ^{abcd}	77.03 ^{abc}	48.00 ^{cde}	42.00 ^{cdefg}	53.66 ^{abcd}	47.66 ^{abcd}	74.66 ^{bcdef}	69.66 ^a
CNK05	154.44 ^{abcd}	70.66 ^{abcde}	54.33 ^a	42.66 ^{bcdef}	57.66 ^a	46.00 ^{bode}	83.00 ^a	66.66 ^{ab}
CNK06	123.22 ^d	49.86 ^{cdef}	50.66 ^{abc}	43.66 ^{bcd}	54.66 ^{ab}	48.00 ^{abcd}	79.33 ^{ab}	66.66 ^{ab}
CNK07	177.99 ^{abc}	71.53 ^{abcde}	51.33 ^{abc}	45.66 ^{abc}	55.66 ^{ab}	51.00 ^a	78.66 ^{abc}	67.00 ^{ab}
CNK08	169.99 ^{abcd}	69.16 ^{abcde}	51.00 ^{abc}	46.33 ^{ab}	54.66 ^{ab}	51.00 ^a	78.00 ^{abc}	66.66 ^{ab}
CNK09	184.68 ^{ab}	73.80 ^{abcd}	48.66 ^{bcd}	43.66 ^{bcd}	52.66 ^{bcd}	45.33 ^{cdefg}	73.66 ^{cdefg}	64.33 ^{bcd}
CSI01	162.66 ^{abcd}	74.60 ^{abcd}	40.33 ^h	39.00 ^{fg}	44.33 ^h	40.66 ^g	65.33 ⁱ	61.66 ^{ef}
CTA03	185.88 ^{ab}	78.26 ^{abc}	49.66 ^{bcd}	44.66 ^{abc}	54.00 ^{abc}	49.66 ^{abc}	78.00 ^{abc}	67.66 ^{ab}
CTA04	133.25 ^{cd}	51.26 ^{bcdef}	45.66 ^{defg}	39.66 ^{efg}	49.33 ^{defg}	41.66 ^{efg}	70.66 ^{fghi}	60.00 ^f
DANPLA	179.22 ^{abc}	39.80 ^f	45.66 ^{defg}	40.66 ^{defg}	50.00 ^{cdefg}	43.66 ^{defg}	72.33 ^{defgh}	65.33 ^{bcd}
HKO01	195.77 ^a	91.13 ^a	41.66 ^{gh}	39.00 ^{fg}	45.66 ^{gh}	41.00 ^{fg}	68.00 ^{hi}	60.00 ^f
Koakin	134.88 ^{cd}	47.26 ^{def}	47.33 ^{cdef}	48.33 ^a	51.33 ^{bcd}	50.33 ^{ab}	74.00 ^{bcdef}	67.33 ^{ab}
Pobe	177.55 ^{abc}	43.53 ^{ef}	48.33 ^{cd}	43.66 ^{bcd}	52.00 ^{bode}	45.66 ^{bcdef}	71.33 ^{efgh}	62.66 ^{cdef}
Sanga	132.66 ^{cd}	59.66 ^{bcdef}	43.66 ^{efgh}	39.33 ^{fg}	48.00 ^{efgh}	41.33 ^{efg}	70.66 ^{fghi}	61.66 ^{ef}

PH60: Plant height on the 60th day, DFlo: Flowering day, Flo50: Number of days to 50% flowering, Mat95: Number of days to 95% maturity

Table 4. Performance of cultivars for yield-related variables in 2022 and 2023

Variables	NSP		SL		HSW		SYield	
ANNEE	2022	2023	2022	2023	2022	2023	2022	2023
CKI05	15.10 ^{abc}	14.80 ^{ab}	6.50 ^{ef}	6.59 ^{ef}	10.10 ^{efg}	9.83 ^{ef}	1811.44 ^a	553.54 ^{abc}
CKI07	15.23 ^{ab}	14.40 ^{abc}	6.27 ^f	6.55 ^{ef}	10.66 ^{defg}	9.57 ^{ef}	1091.11 ^{abc}	482.95 ^{abc}
CKI08	15.83 ^a	14.53 ^{ab}	6.32 ^{ef}	6.44 ^{ef}	10.53 ^{defg}	9.13 ^f	1535.11 ^{abc}	448.71 ^{bc}
CNK01	12.03 ^{de}	11.13 ^{def}	7.98 ^{abcd}	7.78 ^{cd}	13.36 ^{bode}	14.13 ^{bc}	1100.11 ^{abc}	742.09 ^{ab}
CNK02	11.70 ^{de}	9.80 ^{fg}	7.49 ^{cd}	8.753 ^{abc}	12.36 ^{bcdef}	13.73 ^c	874.55 ^{bc}	511.73 ^{abc}
CNK03	16.16 ^a	8.86 ^g	7.95 ^{abcd}	8.70 ^{abc}	13.76 ^{bcd}	16.43 ^{abc}	712.55 ^c	708.24 ^{ab}
CNK04	12.26 ^{cde}	11.60 ^{def}	8.17 ^{abc}	8.09 ^{bcd}	15.40 ^{ab}	13.86 ^c	1884.66 ^a	787.96 ^{ab}
CNK05	12.33 ^{bcd}	10.93 ^{defg}	7.92 ^{abcd}	8.43 ^{abc}	15.06 ^{ab}	15.80 ^{abc}	1105.77 ^{abc}	689.02 ^{ab}
CNK06	11.30 ^e	11.60 ^{def}	7.74 ^{bcd}	8.66 ^{abc}	12.36 ^{bcdef}	15.93 ^{abc}	1763.44 ^a	683.58 ^{ab}
CNK07	11.86 ^{de}	10.93 ^{defg}	7.50 ^{cd}	8.40 ^{abc}	11.63 ^{cdefg}	13.60 ^{cd}	1261.00 ^{abc}	594.35 ^{abc}
CNK08	12.06 ^{de}	11.46 ^{def}	8.04 ^{abc}	9.36 ^a	14.60 ^{abc}	17.76 ^{ab}	1604.22 ^{ab}	652.08 ^{abc}
CNK09	11.93 ^{de}	10.60 ^{efg}	7.62 ^{cd}	8.56 ^{abc}	12.93 ^{bcdef}	16.00 ^{abc}	1709.77 ^{ab}	649.75 ^{abc}
CSI01	15.66 ^a	16.00 ^a	6.15 ^f	6.22 ^{ef}	8.66 ^g	9.83 ^{ef}	1640.00 ^{ab}	423.49 ^{bc}
CTA03	11.83 ^{de}	11.46 ^{def}	8.53 ^{ab}	7.80 ^{cd}	14.83 ^{abc}	13.00 ^{cde}	1105.00 ^{abc}	596.12 ^{abc}
CTA04	15.80 ^a	13.10 ^{bcd}	6.44 ^{ef}	6.29 ^{ef}	10.33 ^{efg}	10.03 ^{def}	1423.33 ^{abc}	289.24 ^c
DANPLA	12.07 ^{de}	12.26 ^{cde}	8.16 ^{abc}	8.89 ^{ab}	17.30 ^a	19.43 ^a	1557.66 ^{abc}	636.28 ^{abc}
HKO01	14.36 ^{abcd}	12.93 ^{bcd}	7.16 ^{de}	7.18 ^{de}	12.83 ^{bcdef}	12.93 ^{cde}	1376.11 ^{abc}	416.45 ^{bc}
Koakin	11.70 ^{de}	12.00 ^{def}	7.83 ^{bcd}	8.35 ^{abc}	12.40 ^{bcdef}	13.90 ^c	1874.66 ^a	835.74 ^a
Pobe	11.70 ^{de}	11.66 ^{def}	8.70 ^a	9.326 ^a	15.03 ^{ab}	15.50 ^{bc}	1272.33 ^{abc}	824.76 ^a
Sanga	16.70 ^a	15.86 ^a	5.99 ^f	5.75 ^f	9.80 ^{fg}	9.00 ^f	1366.00 ^{abc}	466.54 ^{abc}

SL: Seed length, NSP: Number of seeds per pod, HSW: Weight of 100 seeds, SYield: Seed yield

growing year, the Koakin cultivar had the highest grain yield per hectare.

3.5. Correlation between Quantitative Variables

The results of the Pearson correlation test revealed several significant correlations (Table 5). A negative and significant correlation was observed between the number of seeds per pod and the seed length. The number of pods per plant is strong and positively correlated with seed yield. The weight of 100 seeds is positively and very significantly correlated with seed length.

3.6. Principal Component Analysis

The first two axes of the principal component analysis explain 71.36% of the total variance (Figure 15). Thus, axis 1 is positively correlated, among other things, with the number of pods per plant and seed yield. Axis 2 is positively associated, among other things, with the number of seeds per pod and pod length.

3.7. Structuring the diversity of cultivars

Hierarchical ascending classification (HAC) allowed the structuring of the cultivars into four groups (Figure 16). The truncation gives an interclass variance of 90.82% and an intraclass variance of 9.18%. Group

Table 5. Associations between agromorphological variables

Variables	DFlo	Flo50	Mat95	NPP	POL	SL	SW	NSP	HSW	LYield	SYield
DFlo	1										
Flo50	0.96***	1									
Mat95	0.84***	0.86***	1								
NPP	0.35***	0.38***	0.50***	1							
POL	-0.46***	-0.49***	-0.44***	-0.14	1						
SL	0.41***	0.38***	0.23*	-0.04	-0.26**	1					
SW	-0.37***	-0.40***	-0.58***	-0.55***	0.19*	0.41***	1				
NSP	-0.33***	-0.30**	-0.16	0.11	0.39***	-0.66***	-0.36***	1			
HSW	0.34***	0.30**	0.22*	-0.05	-0.24**	0.85***	0.41***	-0.59***	1		
LYield	0.35***	0.37***	0.55***	0.49***	-0.28**	-0.04	-0.56***	0.05	-0.09	1	
SYield	0.23*	0.28**	0.43***	0.70***	-0.11	-0.06	-0.59***	0.11	-0.07	0.65***	1

DFlo: Flowering Day, Flo50: Number of Days to 50% Flowering, Mat95: Number of Days to 95% Maturity, NPP: Number of Pods per Plant, POL: Pod length, SL: Seed length, SW: Seed width, NSP: Number of seeds per pod, HSW: Hundred seed weight, LYield: Leaf yield, SYield: Seed yield

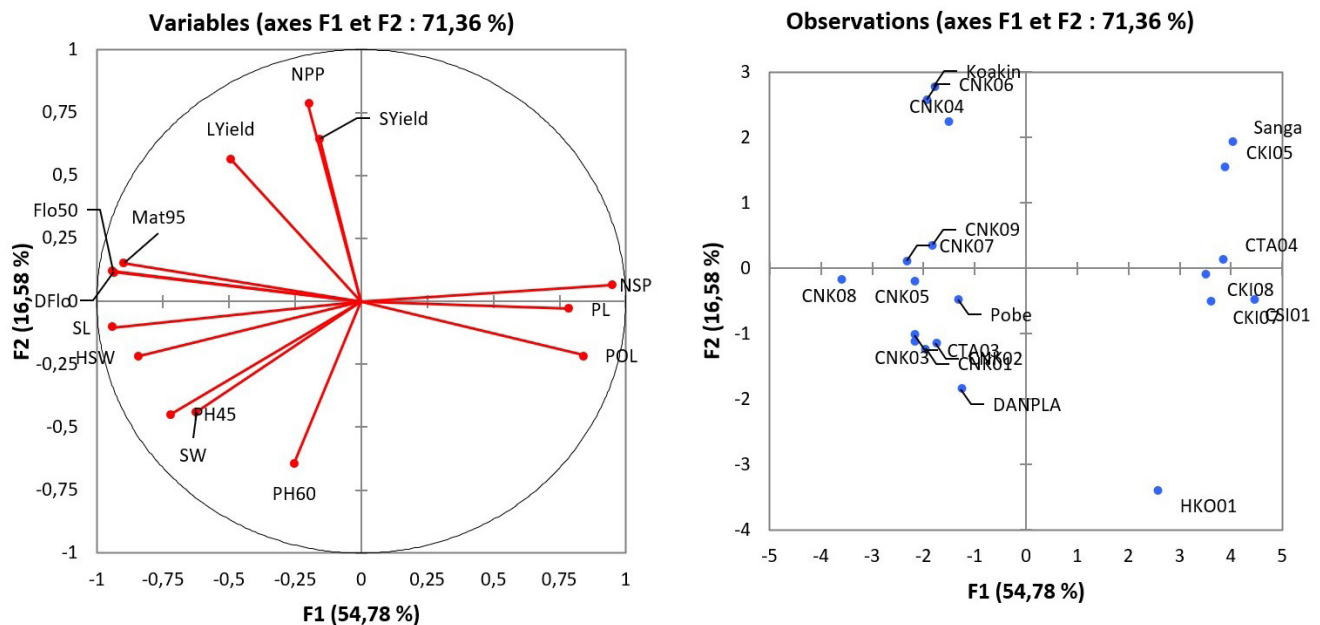


Figure 15. Results of the principal component analysis of quantitative variables

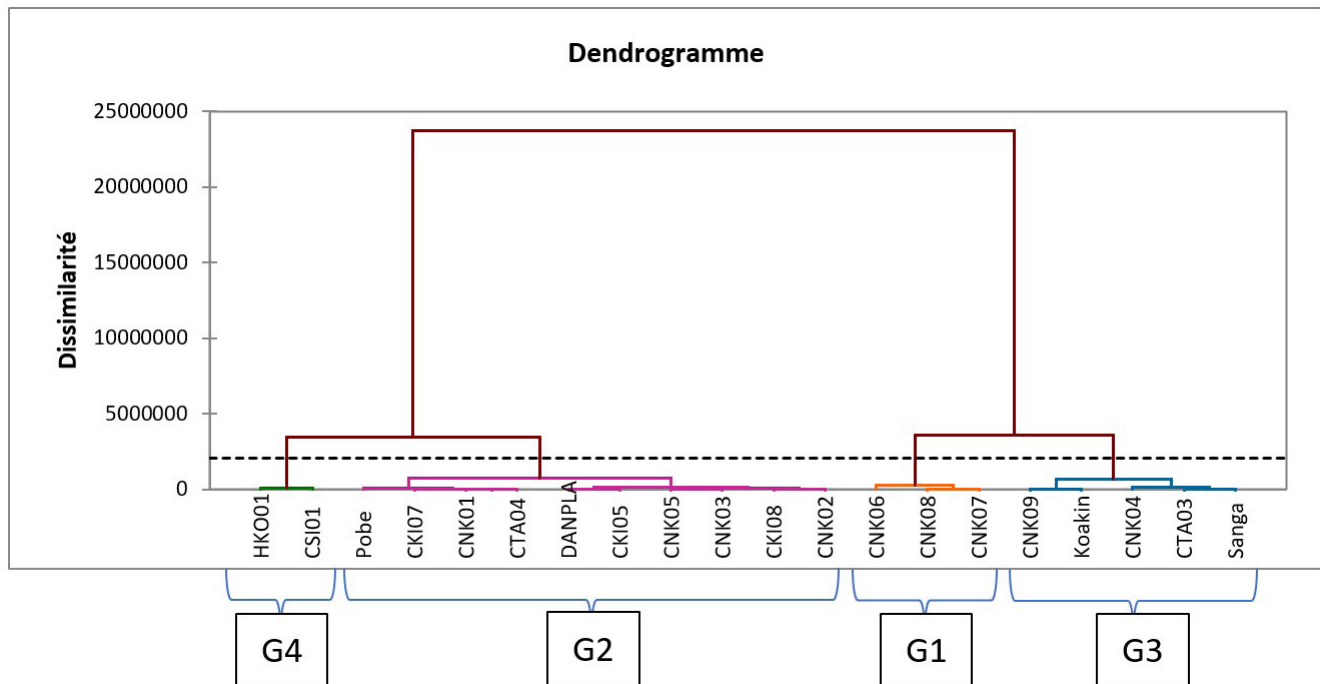


Figure 16. Dendrogram resulting from the hierarchical ascending classification of cultivars

1 consists of three cultivars, group 2 of ten cultivars, group 3 of five cultivars, and group 4 of two cultivars. Group 1 is characterized by early-cycle cultivars with large seeds (Table 6).

4. Discussion

The collection of local cowpea varieties tested showed considerable agromorphological variability among the cultivars. The analysis of qualitative variables such as leaflet shape, flower color, pod, and seed characteristics revealed significant variability among the cultivars. This large variability could result from the expression of high genotypic heterogeneity. Differences in seed color, shape, and size of the seeds are the most important criteria for seed diversification and result from genetic differences among cowpea cultivars (Molosiwa *et al.* 2016; Assouman *et al.* 2021). The results obtained revealed that 68.33% of the cultivars have white flowers and 31.67% have purple flowers. The results of the present study differ from those of Doumbia *et al.* (2013), who reported high percentages of purple flowers. These results could be explained by the fact that the color of the flowers is generally associated with that of the seed coat (Egbadzor *et al.* 2012). Indeed, purple flowers produce colored seeds, and white flowers produce white seeds. The pigmentation of flowers and seeds is due to the effects of a single locus, although flower color can be influenced by epistatic genetic interactions

that have no effect on seed coat pigmentation (Padi 2003; Oladejo *et al.* 2021). Numerous genes with minor effects could be involved in the inheritance of seed coat color and color patterns in cowpea (Joshua and Namo 2023). Our results also showed that most white-seeded cultivars have a wrinkled texture. These traits are important for consumers and producers when choosing varieties. According to Egbadzor *et al.* (2012), consumer preferences, among other characteristics, are determined by the color and pattern of the eye. Varieties with large white seeds and a wrinkled texture are highly valued by producers and consumers (Zannou *et al.* 2013; Batiéno 2015). Indeed, the market value of cowpea varieties varies, among other factors, with the color and size of the seeds (Zannou *et al.* 2013).

Moreover, 46.67% of the varieties exhibited a creeping habit. The leaves of creeping varieties provide adequate ground cover while retaining moisture during hot periods. This type of habit limits weed proliferation (Nadjiam *et al.* 2015).

Significant variations were observed between cultivars in 2022 and 2023 for most of the variables measured. Indeed, the 95% maturity date varied from 59 to 84 days. These values indicate that the studied collection includes both early- and late-cycle cultivars. The variation in the maturation cycle would be due to the genotype of the cultivars or climatic conditions. Similar conclusions were reported by Doumbia *et al.* (2013).

Table 6. Characteristics of agromorphological groups

Classe	Flo50	Mat95	NPP	PH60	SL	SW	HSW	SYield
1	52.50	72.72	38.92	110.30	8.29	5.00	14.32	1093.11
2	47.78	68.72	35.05	107.41	7.58	4.91	13.11	918.53
3	49.40	70.17	44.83	112.67	7.67	4.76	13.11	1127.62
4	42.92	63.75	33.96	131.04	6.68	4.79	11.07	964.02

The results of the variance analysis revealed significant differences among the cultivars in yield-related performance, reflecting their variability. Yield differences could be explained by the time required for reserve accumulation and genetic variation among the cultivars. The climate adaptation factor could also justify these variations (Coulibaly *et al.* 2020).

The performance of the cultivars varied by cultivar and year. The low values of the coefficient of determination (R^2) below 20% for forage and grain yield would be explained by the dominant effect of environmental conditions. According to Oumarou *et al.* (2017), the determinants of yields include, among others, climatic conditions, production systems, and techniques. Indeed, temperatures between 28 and 30°C during the growing season allow cowpeas to perform optimally (Agossou *et al.* 2018). High temperatures during the cowpea's reproductive phase result in flower drop and poor pod and seed set (Biradar *et al.* 2025).

The highest weight of 100 seeds was recorded for the DANPLA cultivar in 2022 and 2023, at 17.03 g and 19.43 g, respectively. The variation in the weight of 100 seeds confirms the difference in seed size among cowpea varieties (Traore *et al.* 2022). Seed size is important for consumers, which is why breeders select varieties with good morphological traits and large seeds (Dolumbia *et al.* 2013). The correlation test revealed significant negative correlations between the date of first flower appearance and pod length, and between the number of seeds per pod and seed length. These strong negative correlations indicate that these variables move in opposite directions. The weight of 100 seeds is positively and very significantly correlated with seed length and width. Pod size, the number of pods per plant, and the weight of 100 seeds are among the very important factors for grain yield (Thiemele *et al.* 2025). These positive correlations indicate that the improvement of one trait automatically leads to the improvement of the other. The application of residual nitrogen and phosphorus to crops is a management practice that would contribute to the sustainability of the production system. Nitrogen and phosphorus would significantly increase, among other things, grain yield, 100-grain weight, and the number of pods in cowpea (Kyei-Boahen *et al.* 2017; Bawa 2020). Increasing uptake

of nitrogen and organic carbon is inversely associated with nodulation, growth parameters, and shoot biomass, while phosphorus uptake is directly correlated with seed yield (Aliyu *et al.* 2023).

The HAC enabled the structuring of the 20 cultivars in the collection into four groups based on agronomic performance. The truncation resulted in an interclass variance of 90.82%, reflecting a high dissimilarity between cultivars of different groups. Group 1 is characterized by late-maturing cultivars. The cultivars in this group are also characterized by large seeds. Indeed, consumers prefer cowpea varieties with large seeds. Large seeds have good food processing qualities (Dolumbia *et al.* 2013). Group 4 includes early-maturing cultivars and those with the highest number of seeds per pod, hence the longest pods compared to other cultivars. The earliness of cowpea varieties is an important agronomic trait that can help cope with the effects of climate change, particularly drought. These cultivars may be of interest to breeding programs seeking to improve their agronomic performance. Indeed, Characterization and evaluation of cowpea germplasm are essential for future breeding initiatives (Chaudhary *et al.* 2025). Farmers' expertise in preserving the biodiversity of local cultivars helps to reduce genetic erosion. To support the efforts of these farmers' efforts, it is necessary to continue improving and promoting these local resources. The results obtained in this study are based on phenotypic characterization and could be complemented by molecular descriptors to further characterize diversity.

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