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Agromorphological Characterization and Agronomic Assessment of *Corchorus aestuans* L.: A Traditional Leafy Vegetable from Burkina Faso

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Authors' contributions

This work was carried out in collaboration among all authors. Author SZ designed the study, wrote the sample collection, and conducted the trial and collected the data, performed the statistical analyses, and drafted the manuscript. Author KM conceived the theme of the study and read the first draft of the manuscript. Authors ND and SB contributed to the interpretation of the data. Author BKP read and validated the study protocol. All authors read and approved the final manuscript.

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Abstract

This study presents an agromorphological characterisation of 20 accessions of *Corchorus aestuans* L. from four provinces in Burkina Faso. The objective was to contribute to a better understanding of the agromorphological diversity of *Corchorus aestuans* L. in Burkina Faso. To this end, 26 traits, including 14

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qualitative and 12 quantitative ones, were evaluated. The study was conducted over two rainy growing seasons (2021 and 2022) at the IRD experimental station in Gampéla using randomized complete block design with three replications. The results showed high agromorphological variability, leading to the identification of two morphotypes, purplish-red and purple. The best performances for the traits studied (petiole length, leaf length and width, peduncle length, fruit length and diameter, plant height, stem diameter, and number of branches) were obtained in 2022. Strong accession x year interactions were observed for all traits studied. Hierarchical Ascending Classification (HAC) using Ward's aggregation method and Euclidean distance allowed the accessions to be grouped into three clusters based on the agronomic traits. Group I consisted of accessions with the shortest growth cycle (54.61 days), the lowest number of branches (10.95), and the lowest leaf mass production (87.59 g fresh mass and 29.81 g dry mass). Group II consisted of large-sized accessions (50.90 cm), highly branched (13.94) with robust stems (1.10 cm) and the highest leaf mass (106.41 g fresh mass and 35.09 g dry mass). Finally, Group III was characterised by accessions with a long growth cycle (61.10 days).

Keywords: Corchorus aestuans; accession-environment interaction; morphotype; agronomic performance; Burkina Faso.

1. Introduction

Species of the genus *Corchorus* are found in the wild throughout the world's warm regions, particularly in Africa, Asia, Australia, and North and South America (Choudhary *et al*., 2017; Maity *et al.,* 2012). In Africa, these species are used as leafy vegetables and hold significant socio-economic importance for the local population (Benor *et al*., 2011). Due to their high content of β-carotene, minerals, protein, and vitamins, they serve as a good dietary supplement (Dansi *et al*., 2008; Choudhary *et al*., 2013; Ta-Bi *et al*., 2021). In Burkina Faso, four species of *Corchorus* (*C. olitorius, C. tridens, C. aestuans*, and *C. fascicularis*) are known and play a very important socioeconomic role for local communities (Thiombiano *et al*., 2012; Sawadogo *et al*., 2023a). The species *Corchorus aestuans*, well-adapted to local soil and climatic conditions, is used in the treatment of several conditions such as constipation, gangrene, anaemia, kwashiorkor, and dysentery (Nacoulma-Ouédraogo, 1996; Sawadogo *et al*., 2023a). Furthermore, it is a rich source of calcium, magnesium, and iron (Ta-Bi *et al.,* 2021; Sawadogo *et al*., 2023b). The leaves of this species are generally harvested from the wild for various uses. However, due to climate change and the excessive use of herbicides in agriculture, this species is becoming increasingly rare in the wild. Consequently, strategies for sustainable conservation and genetic improvement must be implemented. Characterising this species will therefore allow for the assessment of intraspecific diversity for future breeding research. The objective of this study is to contribute to a better understanding of the agromorphological diversity of *Corchorus aestuans* in Burkina Faso. Specifically, the study aims to (i) identify the traits that distinguish accessions and (ii) determine the relationships between the quantitative traits studied.

2. Materials and Methods

2.1 Materials

2.1.1 Plant Material

The plant material consists of 20 accessions of *Corchorus aestuans* collected in 2021 from four provinces in Burkina Faso (Sanguié, Kadiogo, Nahouri, and Houet). The distribution of accessions by province and code is shown in Table 1.

2.1.2 Description of the Experimental Site

The study was conducted at the experimental station of the Institute of Rural Development (IRD) in Gampéla, located in Kadiogo Province (12°15' N, 1°12' W). The area features a Sudano-Sahelian climate, characterised by significant inter-monthly rainfall variations (Thiombiano & Kampmann, 2010). The soil is characterised by physicochemical fertility, a predominantly silty-sandy texture, and a pH ranging from 5.26 to 5.64 (Joseph KI-ZERBO University, Burkina Faso, unpublished results). Two trials were carried out in 2021 and 2022. In 2021, total rainfall reached 978 mm over 45 rainy days, with August being the wettest month (378 mm); monthly temperature ranged from 20.7 °C to 36.6 °C (Fig. 1A). In contrast, during 2022 recorded a higher rainfall of 1,074.9 mm was recorded over 52 rainy days, with August again being 410 mm. During this period, the temperature fluctuated between 21.30 °C and 35.30 °C (Fig. 1B).

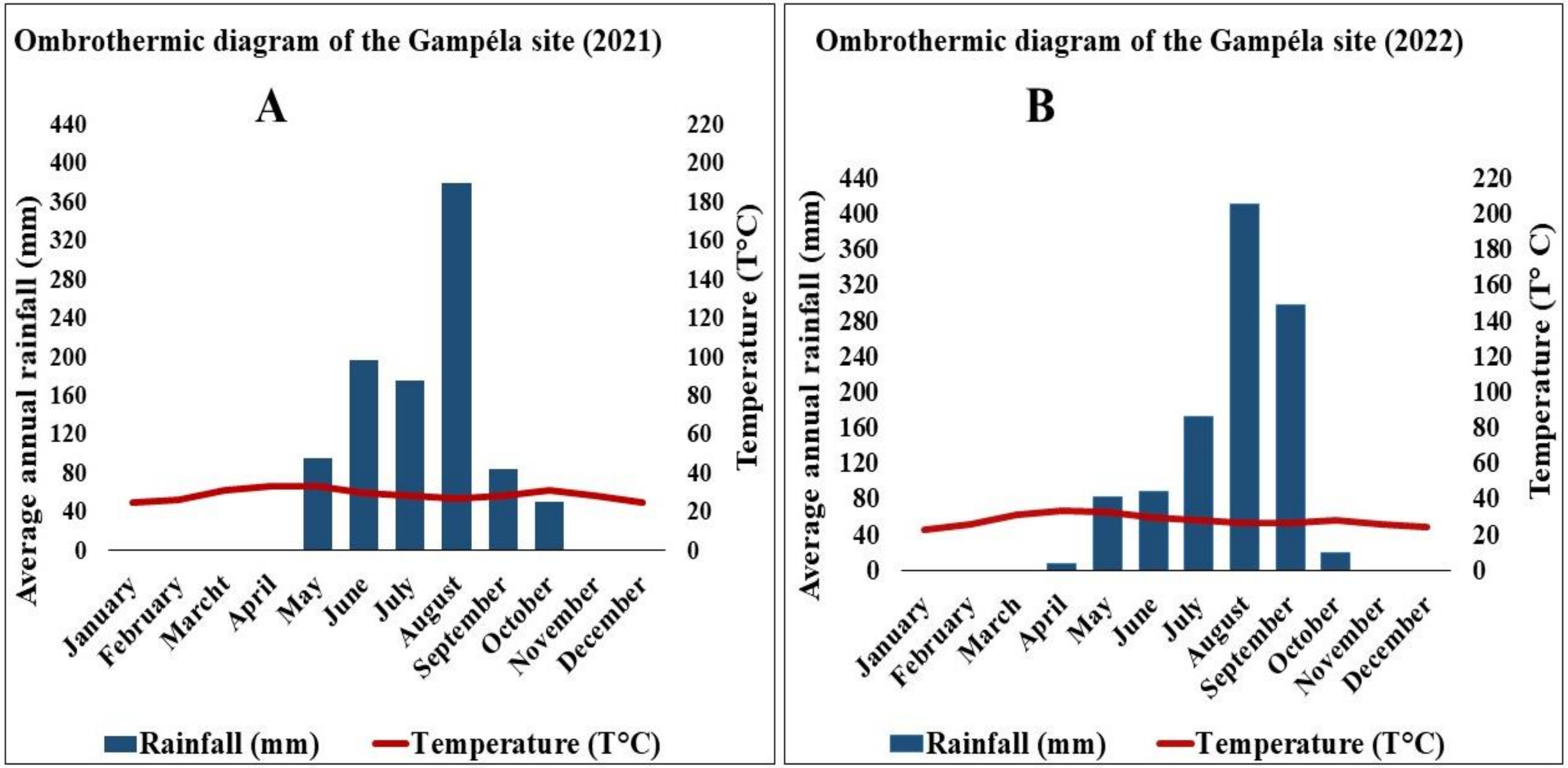

Fig. 1. Ombrothermic diagrams of the Gampéla experimental site for 2021 and 2022

Table 1. *Corchorus aestuans* accessions and collection sites

N°	Accessions (code)	Origin (provinces)	N°	Accessions (code)	Origin (provinces)
1	AEKOA1		11	AEREO	Sanguié
2	AEKOA2	Kadiogo	12	AEPO1	
3	AEKOA3		13	AEPO2	Nahouri
4	AEKOA5		14	AEPO4	
5	AEKOA6		15	AEPO5	
6	AEKOA7		16	AEPO6	
7	AEKOA8		17	AEBOB1	
8	AEKOA9		18	AEBOB2	
9	AEKOA10		19	AEBOB3	Houet
10	AEKOA11		20	AEBOB5	

2.2 Methods

2.2.1 Experimental Design and Cultivation Practices

The study was conducted using a randomised complete block design with three replicates. Replicates were separated by a 1.5-meter alleyway. Within each replicate, each accession was planted in 3.5-meter rows, with an inter-row spacing of 0.6 meters and an intra-row spacing of 0.5 meters. To overcome seed coat dormancy, seeds were pre-treated according to the method described by Mavengahama and Lewu (2012). Specifically, seeds were wrapped in cotton cloth and immersed in boiling water (100 °C) for 10 seconds. The seeds were then sown in a nursery using germination trays filled with potting soil. Seedlings were transplanted 30 days later. Two weeks before transplanting, poultry manure was applied at a rate of 6 tons/ha, followed by soil levelling and furrow preparation. Weeding was performed manually as required.

2.2.2 Data Collection

For each year of the experiment, 26 traits, including 14 qualitative and 12 quantitative traits, are assessed.

2.2.2.1 Qualitative Traits

Qualitative data were recorded during 50% flowering stage. Except for seed-related traits, which were assessed in the laboratory using a magnifying glass, all parameters were observed directly in the field. To avoid variances due to growth, qualitative trait evaluations were done on the same day. The following traits were recorded: branching habit, stem, leaf, stipule, fresh fruit, dry fruit and dry seed color, stem pubescence, leaf pubescence, leaf shape, leaf margin, fruit apex shape, fruit, and seed shape. The assessed traits and their corresponding are listed in Table 2.

Table 2. Qualitative traits and code for *Corchorus aestuans* L. observed during the study

N°	Trait	Code	N°	Trait	Code
1	Branching habit	BH	8	Fruit apex shape	FAS
2	Stem color	SC	9	Stem pubescence	SP
3	Leaf color	LC	10	Leaf pubescence	LP
4	Stipule color	SPC	11	Leaf shape	LS
5	Fresh fruit color	FFC	12	Leaf margin	LM
6	Dry fruit color	DFC	13	Fruit shape	FS
7	Dry seed color	DSC	14	Seed shape	SS

2.2.2.2 Quantitative Traits

The twelve quantitative traits were measured on three plants per row, except for the number of days to 50% flowering, which was assessed by counting across the entire elementary plot. The quantitative traits evaluated focused on the stem (plant height, stem diameter, and number of branches), the leaves (petiole length, leaf length and width), the fruits (peduncle length, fruit length, and fruit diameter), and the life cycle (Table 3). Traits relating to leaves and fruits were evaluated using three leaves and three fruits from each of the three selected plants.

Table 3. Quantitative traits descriptors used for characterization of *Corchorus aestuans* L. accessions in the study

N°	Traits	Code	Descriptors
1	Day to 50% flowering	DF	Number of days from seed germination to 50% flowering
2	Plant height	PH	Plant height at maturity measured from the base of the plant to the tip of the main stem using a meter ruler (cm)
3	Stem diameter	SD	Diameter of the plant base at soil level (cm)
4	Number of branches	NB	Total number of branches per plant
5	Petiole length	PL	Length from the insertion point on the stem to the base of the leaf blade (cm)
6	Leaf width	LW	Length of matured leaf at widest point (cm)
7	Leaf length	LL	Length of a matured lamina from the proximal end of the mid-vein to the distal end, excluding the petiole (cm)
8	Leaf fresh mass	LFM	Total fresh mass for three plants (g)
9	Leaf dry mass	LDS	Total dry mass for three plants (g)
10	Peduncle length	PEL	Length from the node of the branch to the point of attachment of the fruit (cm)
11	Fruit length	FL	Length from the point of attachment of the peduncle to the apex (cm)
12	Fruit diameter	FD	Diameter of the mature fruit at its widest point using a caliper (cm)

2.2.3 Statistical Analysis

Data collected from each year were subjected to analysis of variance (ANOVA) to identify discriminatory variables. Mean comparisons were performed using the Student-Newman-Keuls test to evaluate the performance of accessions across years and morphotypes. A two-way ANOVA (year × accession) was conducted to identify traits distinguishing the accessions and morphotypes, as well as to assess the significance of accession × years and morphotype × years interactions. Subsequently, multivariate analyses, including Agglomerative Hierarchical Clustering (AHC) and Discriminant Factorial Analysis (DFA) were performed to further characterise the data structure.

3. Results

3.1 Morphological characteristics of *Corchorus aestuans* L.

Qualitative analysis shows that the accessions possess pubescent, green leaves with ovate blades and serrate margins (Fig. 2). The pubescent, cylindrical stems are purple (Fig. 3A) or purplish-red (Fig. 3B), with branches arranged in a ladder-like pattern. The fruits, grouped in threes (Fig. 4A) or pairs (Fig. 4B), feature hexagonal cross-sections and three-pointed triangular apices. When ripe, the fruits are light green with red slits and red or green peduncles.

Fig. 2. Green, oval-shaped leaves of *Corchorus aestuans* L

Fig. 3. Stem coloration observed in *Corchorus aestuans* L.

A): purple stem; B): purplish-red stem

Fig. 4. Stems of *C. aestuans* L. bearing fruits with peduncles of varying colors at the nodes

A): three fruits with green peduncles; B): two fruits with red peduncles

When dry, the accessions produce brown, shrivelled fruits (Fig. 5A). Two seed morphotypes were identified, accessions with polyhedral seeds (Fig. 5B), and those with trapezoidal seeds featuring longitudinal (Fig. 5C). Each type accounts for 50% of the studies' accessions.

Fig. 5. Fruit color and seed shape in *Corchorus aestuans* L.

A): brown fruit; B): brown, polyhedral seeds; C): brown, trapezoidal seeds with white speckles and longitudinal ridges

Based on the morphological characteristics of various organs, two morphotypes were identified,

- The purple morphotype, characterised by a purple stem and fruits clustered in threes (Fig. 6A). Accessions of this morphotype produce fruits with green peduncles at maturity and polyhedral seeds. This morphotype accounts for 50% of the accessions.
- The purplish-red morphotype, characterised by a purplish-red stem and fruits clustered in pairs (Fig. 6B). Accessions of this morphotype bear fruits with red peduncles at maturity and trapezoidal seeds. It also accounts for 50% of the accessions.

3.2 Average Performance of *Corchorus aestuans* L. Accessions over Two Growing Seasons

Analysis of variance (ANOVA) for the studied traits is summarised in Table 4. Except for peduncle length, which showed no significant difference in 2021, all other traits exhibited significant differences among accessions at the 1% probability level ($p < 0.01$) across both years. Calculated minimum and maximum values revealed substantial phenotypic variation. For instance, days to 50% flowering ranged from 44 to 65 days in 2021 and from 43 to 70 days in 2022. Plant height varied from 18 to 67.08 cm in 2021 and from 30 to 80 cm in 2022. The number of branches ranged between 5 – 16 (2021) and 7 – 22 (2022). Leaf fresh mass ranged from 47 to 157 g in 2021, increasing to a range of 48.83 to 356.30 g in 2022. Conversely, leaf dry mass ranged from 20 to 60 g in 2021 and 14.17 to 106 g in 2022. At maturity, fruit length ranged from 1.47– 5.22 cm (2021) and 1.50 – 4.90 cm (2022), while fruit diameter varied between 0.29 – 0.76 cm (2021) and 0.34 – 0.76 cm (2022).

Fig. 6. Stems of the morphotypes identified within the *Corchorus aestuans* L. accessions
A) purple morphotype; B) purplish-red morphotype

Comparative analysis across years showed highly significant differences ($p < 0.01$) for all traits, except leaf fresh mass and days to 50% flowering. Furthermore, highly significant accession x year interactions were observed for all traits. The highest mean performance for petiole length, leaf dimensions, peduncle length, fruit characteristics, plant height, stem diameter, and number of branches was recorded in 2022. In contrast, the highest leaf dry mass was observed in 2021.

High coefficients of determination ($R^2 > 50$ %) were observed for leaf length and width and fruit diameter in 2021; for peduncle length in 2022, and for both days to 50% flowering and fruit length across both years. For all other traits, R^2 values remained below 50%.

3.3 Average Performance of *Corchorus aestuans* L. Morphotypes

Analysis of variance (ANOVA) for morphotype traits (Table 5) revealed highly significant differences ($p < 0.01$) between the accessions of the two studied morphotypes. The only exceptions were leaf fresh mass and days to 50% flowering in 2021, and petiole length, leaf width, and peduncle length in 2022. Regarding morphotype-year interactions, only peduncle length failed to differentiate the morphotypes. The purplish-red morphotype exhibited the highest values for petiole length, fruit length, and leaf dimensions across both years. Conversely, the purple morphotype showed the highest values for stem diameter and plant height. Coefficients of determination (R^2) remained generally low ($R^2 < 50\%$), except for leaf length ($R^2 = 50.90$), fruit length ($R^2 = 72.88$), and fruit diameter ($R^2 = 67.01$) in 2021.

Table 4. Mean performance of *Corchorus aestuans* L. accessions in 2021 and 2022, and summary accession x years interaction

	Year 2021					Year 2022					P value		
Traits	Min	Max	Mean	R² %	Pr > F	Min	Max	Mean	R²%	Pr > F	year	Accession	Acc x years
PL (cm)	1.20	4.57	2.19 b	47.33	< 0.0001	1.53	5.40	3.43 a	19.38	0.0098	< 0.0001	< 0.0001	< 0.0001
LL (cm)	4.17	11.73	7.34 b	70.39	< 0.0001	5.83	11.07	8.42 a	25.57	0.0001	< 0.0001	< 0.0001	< 0.0001
LW (cm)	2.23	6.40	4.23 b	60.81	< 0.0001	3.60	7.63	5.45 a	20.88	0.0039	< 0.0001	< 0.0001	< 0.0001
PEL (cm)	0.31	1.67	0.50 b	13.99	0.148 8 ns	0.40	0.90	0.58 a	56.60	< 0.0001	< 0.0001	< 0.0001	< 0.0001
FL (cm)	1.47	5.22	2.99 b	80.52	< 0.0001	1.50	4.90	3.32 a	80.21	< 0.0001	< 0.0001	< 0.0001	< 0.0001
FD (cm)	0.29	0.74	0.52 b	79.19	< 0.0001	0.34	0.76	0.54 a	45.01	< 0.0001	< 0.0001	< 0.0001	< 0.0001
LFM (g)	47.00	157.00	102.93 a	47.86	< 0.0001	48.83	356.30	104.83 a	48.04	< 0.0001	0.634 ns	< 0.0001	< 0.0001
LDS (g)	20.00	60.00	36.567 a	42.73	< 0.0001	14.17	106.00	31.291 b	48.52	< 0.0001	< 0.0001	< 0.0001	< 0.0001
PH (cm)	18.00	67.08	34.54 b	45.09	< 0.0001	30.00	80.00	57.07 a	29.22	< 0.0001	< 0.0001	< 0.0001	< 0.0001
SD (cm)	0.30	1.46	0.76 b	42.76	< 0.0001	0.50	2.34	1.07 a	45.75	< 0.0001	< 0.0001	< 0.0001	< 0.0001
NB	5.00	16.00	10.02 b	40.67	< 0.0001	7.00	22.00	14.29 a	46.77	< 0.0001	< 0.0001	< 0.0001	< 0.0001
DF	44.00	65.00	56.88 a	54.27	< 0.0001	43.00	70.00	57.27 a	51.75	< 0.0001	0.390 ns	< 0.0001	< 0.0001

Legend. Acc- accessions; Min-minimum; Max-maximum; PL-petiole length; LL-leaf length; LW- Leaf width; PEL- peduncle length; FL- Fruit length; FD-Fruit diameter; LFM-leaf fresh mass; LDS-leaf dry mass; PH-plant height; SD-Stem diameter; NB- Number of branches; DF-day to 50% flowering; R²- coefficients of determination; Pr>F-F of Fisher. Means with different letters within a column are significantly different at p < 0.01 according to the Newman-Keuls test

Table 5. Mean performance of *Corchorus aestuans* L. morphotypes in 2021 and 2022, and summary morphotype x year interactions

	Year 2021				Year 2022				Morphotype x year
Traits	Purple	purplish-red	R² %	Pr > F	Purple	Purplish-red	R² %	Pr > F	
PL (cm)	1.81 b	2.564 a	35.88	< 0.0001	3.50 a	3.37 a	0.91	0.203 ns	< 0.0001
LL (cm)	6.05 b	8.64 a	50.90	< 0.0001	8.19 b	8.65 a	4.84	0.003	< 0.0001
LW (cm)	3.58 b	4.99 a	32.66	< 0.0001	5.39 a	5.50 a	0.44	0.378 ns	< 0.0001
PEL (cm)	0.52 a	0.46 b	22.39	< 0.0001	0.59 a	0.57 a	1.03	0.176 ns	0.9506 ns
FL (cm)	2.14 b	3.85 a	72.88	< 0.0001	2.73 b	3.92 a	41.98	< 0.0001	0.0002
FD (cm)	0.60 a	0.42 b	67.01	< 0.0001	0.58 a	0.49 b	21.30	< 0.0001	< 0.0001
LFM (g)	102.60 a	103.27 a	0.01	0.887 ns	134.71 a	74.94 b	22.96	< 0.0001	< 0.0001
LDS (g)	34.87 b	38.27 a	2.67	0.028	40.38 a	22.20 b	23.69	< 0.0001	< 0.0001
PH (cm)	36.64 a	32.02 b	5.45	0.002	59.44 a	54.69 b	3.91	0.008	< 0.0001
SD (cm)	0.65 a	1.96 b	25.49	< 0.0001	1.21 a	0.91 b	23.57	< 0.0001	0.0243
NB	10.69 a	9.36 b	9.11	< 0.0001	15.92 a	12.66 b	33.60	< 0.0001	< 0.0001
DF	57.33 a	56.43 a	1.20	0.144 ns	60.37 a	54.17 b	19.29	< 0.0001	0.0057

Legend. Acc- accessions; Min-minimum; Max-maximum; PL-petiole length; LL-leaf length; LW- Leaf width; PEL- peduncle length; FL- Fruit length; FD-Fruit diameter; LFM-leaf fresh mass; LDS-leaf dry mass; PH-plant height; SD-Stem diameter; NB- Number of branches; DF-day to 50% flowering; R²- coefficients of determination; Pr>F-F of Fisher. Means with different letters within a column are significantly different at p < 0.01 according to the Newman-Keuls test

3.4 Correlation among Traits

Numerous significant correlations, both positive and negative, were observed among the studied variables (Table 6). Specifically, leaf fresh mass exhibited strong positive correlations with plant height (r = 0.68), stem diameter (r = 0.75), and the number of branches (r = 0.68). Similarly, plant height was highly correlated with stem diameter (r = 0.84) and the number of branches (r = 0.75). Regarding leaf morphology, leaf width showed a robust positive correlation with both leaf length (r = 0.86) and petiole length (r = 0.80).

Table 6. Correlation table for 12 quantitative traits of *Corchorus. aestuans* accessions

Traits	PL	LL	LW	POL	FL	FD	LFM	LDS	PH	SD	NB	DF
PL (cm)	1											
LL (cm)	**0.67**	1										
LW (cm)	**0.80**	**0.86**	1									
PEL (cm)	-0.23	-0.49	-0.51	1								
FL (cm)	0.53	0.88	0.74	**-0.48**	1							
FD (cm)	-0.47	-0.89	-0.73	**0.56**	**-0.93**	1						
LFM (g)	-0.35	**-0.58**	**-0.44**	0.47	-0.60	0.66	1					
LDS (g)	-0.22	**-0.48**	-0.38	0.40	-0.57	0.60	**0.95**	1				
PH (cm)	-0.27	-0.31	-0.33	0.32	-0.35	0.43	**0.68**	**0.63**	1			
SD (cm)	-0.42	-0.49	-0.50	0.43	-0.47	0.59	**0.75**	**0.75**	**0.84**	1		
NB	-0.45	-0.76	-0.66	0.61	-0.73	0.85	**0.68**	**0.61**	**0.75**	**0.82**	1	
DF	-0.46	**-0.62**	**-0.50**	0.38	**-0.69**	**0.57**	0.24	0.17	-0.23	-0.07	0.22	1

Legend. PL-petiole length; LL-leaf length; LW- Leaf width; PEL- peduncle length; FL- Fruit length; FD-Fruit diameter; LFM-leaf fresh mass; LDS-leaf dry mass; PH- plant height; SD-Stem diameter; NB- Number of branches; DF-day to 50% flowering

3.5 Structure of Variability in *Corchorus aestuans* L. Accessions

3.5.1 Diversity Patterns among the 20 *Corchorus aestuans* L. Accessions

The dendrogram (Fig. 7) indicates that the 20 accessions are clustered into three distinct groups. Group I comprise nine accessions, all originating from Kadiogo Province; these specimens exclusively exhibit the purple morphotype. Group II consists of five accessions from Nahouri and Kadiogo provinces, characterized by a reddish-purple morphotype. Finally, Group III includes six accessions from the provinces of Houet, Sanguié, and Nahouri, encompassing accessions of both morphotypes.

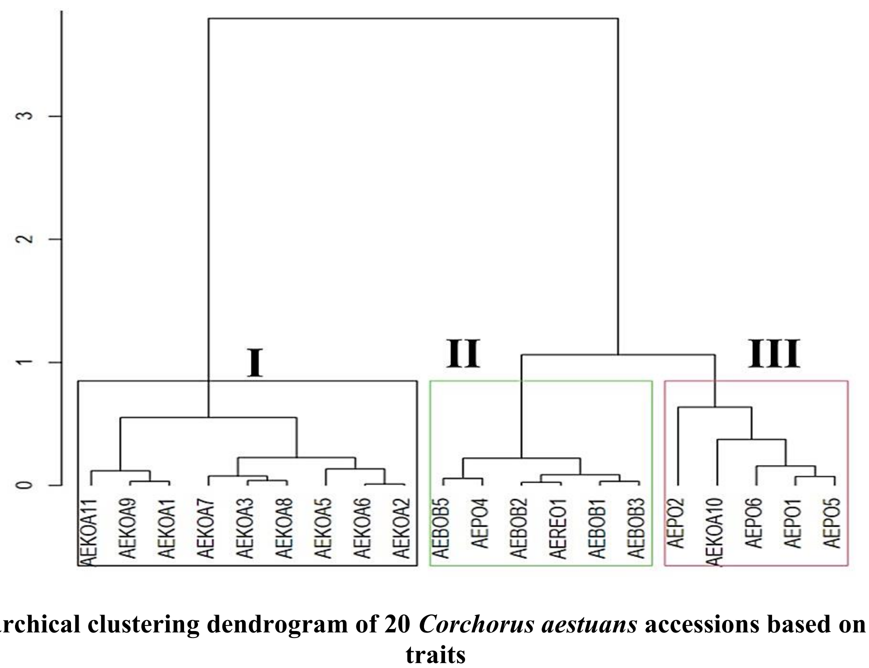

Fig. 7. Hierarchical clustering dendrogram of 20 *Corchorus aestuans* accessions based on quantitative traits

3.5.2 Characterisation of Groups Derived from CAH

The characterisation of the three groups derived from the AHC (Ascending Hierarchical Clustering) using discriminant factor analysis reveals highly significant differences between the groups (Fig. 8). Indeed, Wilks' Lambda test yielded an observed F-value of 41.41, significantly higher than the critical F-value of 2.18, with a p-value < 0.0001. Furthermore, the Mahalanobis (McLachlan, 1992) distances were 96.88 between Groups I and II, 94.23 between Groups I and III, and 134.94 between Groups II and III.

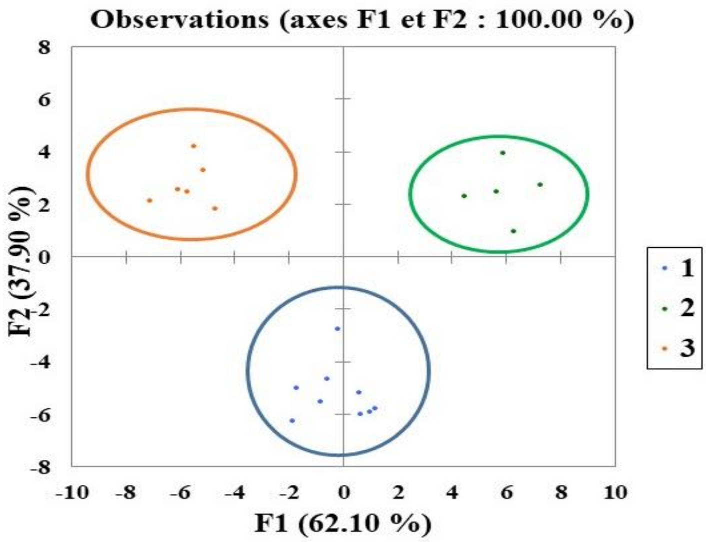

Fig. 8. Distribution of accessions groups from AHC on the first two axes (1/2) of the Discriminant Function Analysis (DFA)

Analysis of variance results, followed by the Newman-Keuls test for mean separation (Table 7), indicate that all variables significantly differentiate the three groups. Group I, consisting exclusively of purplish-red morphotype accessions, is early-maturing and exhibits the lowest number of branches and the lowest leaf mass yield. However, accessions in this group produce long fruits and leaves with long, broad blades and long petioles. Group II comprises large, highly branched accessions with sturdy stems and leaves on short petioles; this group achieved the highest leaf mass and the best overall agronomic performance. The six accessions in this group are AEBOB5, AEPO4, AEBOB2, AEREO1, AEBOB3, and AEBOB1. Finally, Group III (heterogeneous) is characterised by long-cycle accessions with average agronomic performance in terms of fresh and dry leaf mass.

Table 7. Average performance of the three clusters identified by agglomerative Hierarchical Clustering (AHC)

Traits	Group I	Group II	Group III	R²%	Pr>F
PL (cm)	2.95 a	2.60 c	2.81 b	2.63	0.0086
LL (cm)	8.71 a	6.96 c	7.48 b	24.14	< 0.0001
LW (cm)	5.26 a	4.38 b	4.64 b	11.61	< 0.0001
PEL (cm)	0.51 b	0.57 a	0.55 a	6 .12	< 0.0001
FL (cm)	3.93 a	2.56 b	2.47 b	52.01	< 0.0001
FD (cm)	0.45 b	0.59 a	0.58 a	43.79	< 0.0001
LFM (g)	87.59 c	126.20 a	106.41 b	11.13	< 0.0001
LDS (g)	29.81 c	39.14 a	35.09 b	6.84	< 0.0001
PH (cm)	43.94 b	50.90 a	43.04 b	4.60	0.0002
SD (cm)	0.83 b	1.10 a	0.85 b	14.53	< 0.0001
NB	10.95 c	13.94 a	12.18 b	14.72	< 0.0001
DF	54.61 c	57.42 b	61.10 a	20.40	< 0.0001

Legend. Acc- accessions; Min-minimum; Max-maximum; PL-petiole length; LL-leaf length; LW- Leaf width; PEL- peduncle length; FL- Fruit length; FD-Fruit diameter; LFM-leaf fresh mass; LDS-leaf dry mass; PH- plant height; SD-Stem diameter; NB- Number of branches; DF-day to 50% flowering; R^2- coefficients of determination; Pr>F-F of Fisher. Means with different letters within a column are significantly different at $p < 0.01$ according to the Newman-Keuls test

4. Discussion

Agromorphological characterization over two years reveals that several qualitative and quantitative traits distinguish the accessions studied. This indicates the existence of high phenotypic variability among these accessions. Begum and Kumar (2011), Nwangburuka and Denton (2012), and Soliman *et al*. (2014) also highlighted similar phenotypic variability in *Corchorus* accessions in India, Nigeria, and Egypt, respectively. Throughout the two-year study, qualitative traits did not vary between year, demonstrating that these traits are stable and likely to be minimally influenced by the environment. Indeed, qualitative traits are often controlled by a limited number of genes (monogenic or oligogenic) (Wasonga *et al*., 2015), and their expression is generally more stable under varying soil and climatic conditions compared to polygenic traits. Consequently, variability in the color and shape of different organs (stem, fruit, seeds) is likely driven primarily by the genotype and is, therefore, highly heritable. As a result, direct selection focused on these easily identifiable traits can lead to stable genotypes as early as the first stage. These results corroborate the findings of Dube *et al.* (2018), Kiébré *et al.* (2017), and Nwangburuka and Denton (2012).

Unlike qualitative traits, the variability and performance of the quantitative traits evaluated fluctuate from one year to another, indicating that these traits are strongly influenced by environmental conditions. Indeed, since phenotypic expression results from the combined action of genotype and environmental factors (G \times E), the observed variation in performance across years is likely due to environmental influences. Benor *et al.* (2012) also found that variations in fiber and leaf yield for the species *C. olitorius* and *C. capsularis* are significantly influenced by rainfall fluctuations and soil fertility. Thus, the strong agronomic performance achieved in 2022 indicates that climatic conditions were more favourable, allowing the plants to fully express their agronomic potential. Indeed, species of the genus *Corchorus* thrive when annual rainfall ranges between 1,000 and 2,000 mm with a temperature of 30 °C (Jansen *et al*., 2007; Maity *et al*., 2012; Dube, 2017). Consequently, in 2022, a cumulative rainfall of 1,074.9 mm distributed over 52 days, with monthly temperatures ranging from 21.30 °C to 35.30 °C, was more conducive to healthy plant development. In contrast, the lower rainfall in 2021 (978 mm), combined with its poor distribution over only 45 rainy days, prevented plants from achieving their full agronomic potential. Similarly, the highly significant interactions between accessions and year observed for most quantitative traits confirm that accessions respond differently to environmental factors. This differential response across years indicates that the accessions are genetically distinct, reflecting intraspecific diversity that could be leveraged in a breeding program for this species.

Since *C. aestuans* is primarily used as a leafy vegetable, leaf mass yield could serve as a key quantitative criterion for the selection and development of new varieties. However, as yield is strongly influenced by the environment, selection based solely on this trait is unlikely to be effective in a breeding program (Nwangburuka & Denton, 2012; Benor *et al.,* 2012). To achieve this, it is necessary to incorporate additional yield-related traits to facilitate the selection process. The strong, positive, and significant correlation observed between leaf mass yield and traits such as plant height, stem diameter, and the number of branches suggests that selection based on these parameters could be highly effective. To this end, accessions combining high leaf mass yield with these key yield-contributing traits can be identified as elite accessions. Consequently, breeding efforts should focus on these specific accessions to enhance overall species yield. According to Ozaz *et al*. (2024), selection based on yield components is an effective strategy; furthermore, the association of vegetative traits with yield provides precise data regarding the traits of interest for selective breeding. Based on this structural analysis, the accessions that exhibited the superior performance for leaf mass, plant height, stem diameter, and number of branches are: AEKOA9, AEKOA10, AEKOA11, AEBOB1, AERO1, AEKPO4, AEKPO6, and AEBOB5. These identified accessions serve as valuable genetic resources for future breeding research.

5. Conclusion

This study has enhanced the understanding of the agromorphological variability of *Corchorus aestuans* L. varieties consumed in Burkina Faso. The characterization of qualitative variables such as the color of the stem, fruits, and seeds, as well as seed shape enabled the identification of two distinct morphotypes among the accessions. The year factor significantly influenced most of the studied traits quantitative, with accessions showing superior performance in 2022.

Disclaimer (Artificial Intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

Competing Interests

Authors have declared that they have no known competing financial interests or non-financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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