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Multi-local evaluations of agromorphological performances of *Cleome gynandra* L. in Burkina Faso

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ABSTRACT: *Cleome gynandra* L., known as *kenebdo* in Burkina Faso is an important traditional leafy vegetable for nutritional supplement meant to populations in Burkina Faso where many people, especially children, are suffering from chronic malnutrition. Indeed, due to its high nutritional value, it is a good food supplement in providing nutritional and medicinal needs. This study aims at identifying varieties of interest according to climatic zones of Burkina Faso for varietal improvement of species through multi-local evaluations of a collection of *C. gynandra*. 36 accessions were basically collected in 12 provinces of Burkina Faso and used as plant material. Experiments were conducted in three sites located in the three climatic zones of Burkina Faso. They were conducted during rainy season using a Fischer block design with three replications. Measurements and observations were made on 16 variables, such as 4 qualitative and 12 quantitative variables. The study revealed great agromorphological variability within the accessions with significant different performances according to the three climatic zones. It also showed significant interaction between accessions and experimental sites for most of the variables. In general, the best agronomic performances were observed in Bobo Dioulasso followed by Ouagadougou while the low performances were recorded in Dori. For each climatic zone, a set of 10 accessions were identified as genotypes of interest that could be used for varietal improvement of *C. gynandra* in Burkina Faso.

KEYWORDS: Multi-local evaluations, performances, *Cleome gynandra*, Burkina Faso.

1 INTRODUCTION

In Burkina Faso, there is a large diversity of neglected food plants, either wild or in protoculture, with great nutritional potential. Unfortunately, many of them are not known well [1]. However, they enormously contribute to food supplementation and to the resilience of rural populations, especially in hunger times [1,2]. Among these neglected plants but potentially rich nutrients, there is *Cleome gynandra* L., known as African cabbage and spider plant in English, *wignin wignin* in Dioula or *kenebdo* in Moore. It has been identified as having high food, medicinal and economic potential in several countries [3,4] and has several advantages, including its production in an easy way, its rapid growth, and its quick adaptation to different agroecological conditions. Thanks to its high nutritional value [5,6], it is a good nutritional supplement for populations in developing countries where many people, especially children, are suffering from chronic malnutrition [7]. Rich in iron and vitamin A, this vegetable consumption is an advantageous in fighting recurrent problems of anemia mainly caused by malaria, dengue fever and blood loss during childbirth [8]. In addition, *C. gynandra* has a cultural value in Burkina Faso, as it is used for preparation of local meals considered as national speciality in terms of value in Burkina Faso [9]. In Burkina Faso, the interest in *C. gynandra* is growing. Its consumption and marketing are increasing, leading to larger areas of production and attracting many producers [4]. However, low agronomic performances, unavailability and poor quality of seeds are major obstacles to the promotion of its production. Thus, varietal improvement researches, including characterizations and agromorphological evaluations, have been undertaken in Burkina Faso for development of quality seeds. However, these characterizations and evaluations were carried out in a single experimental site located in the Sudano-Sahelian zone [10, 11, 12] and have not taken into account the environmental variability of Burkina Faso. As morphological markers are influenced by the interaction between environments and genotypes, it is essential to evaluate the agromorphological performances in several climatic zones of the country. This will allow to analyze its performances according to the climatic zones and identify a set of genotypes that can be used to develop varieties adapted to each zone. The present study therefore aims at: (i) describing some accessions of *Cleome gynandra* L. collected in Burkina Faso using qualitative variables, (ii) evaluating the agromorphological performances of the collection in the three climatic zones of Burkina Faso, (iii) determining the level of interaction between genotypes and experimental sites and (iv) identifying a set of accessions of interest that can be used for development of varieties adapted to the climatic zones

2 MATERIAL AND METHODS

2.1 MATERIALS

2.1.1 EXPERIMENTAL SITES

Experiments were conducted on three sites, Bobo Dioulasso, Ouagadougou and Dori, located in the three climatic zones of Burkina Faso (Fig. 1). Bobo Dioulasso and Ouagadougou are the two largest cities in Burkina Faso and *Cleome gynandra* is widely consumed in these cities. Dori is the main city in the Sahelian climate zone.

- **Experimental site 1** is located in the Sudanian zone, in the peri-urban area of Bobo Dioulasso at 11°12'0" North latitude and 4°18'0" West longitude. The Sudanian zone is the rainiest one of the country and is characterized by an annual rainfall more than 1100 mm, 5 to 6 months for the rainy season and temperatures ranging from 20 to 25 °C [13]. The average rainfall recorded in 2019 in Bobo Dioulasso was 1371 mm (Fig. 2 A).
- **Experimental site 2** is located in the Sudano-Sahelian zone, in the peri-urban area of Ouagadougou at 12°15' North latitude and 1°12' West longitude. The Sudano-Sahelian zone is the largest climatic zone in Burkina Faso. It is characterized by annual rainfall ranging from 600 to 900 mm, 4 to 5 months for the rainy season and temperatures ranging from 20 to 30°C [13]. The average rainfall recorded in 2019 in Ouagadougou was 852.7 mm (Fig. 2 B).
- **Experimental site 3** is located in the Sahelian zone, in the peri-urban area of Dori. The Sahelian zone is the dryest climatic zone; characterized by an annual rainfull less than 600 mm, high evapotranspiration, high temperatures, a short rainy season of 2 to 3 months and temperatures ranging from 30 to 40 °C [13]. The average rainfall recorded in 2019 at Dori was 509.7 mm (Fig.2 C).

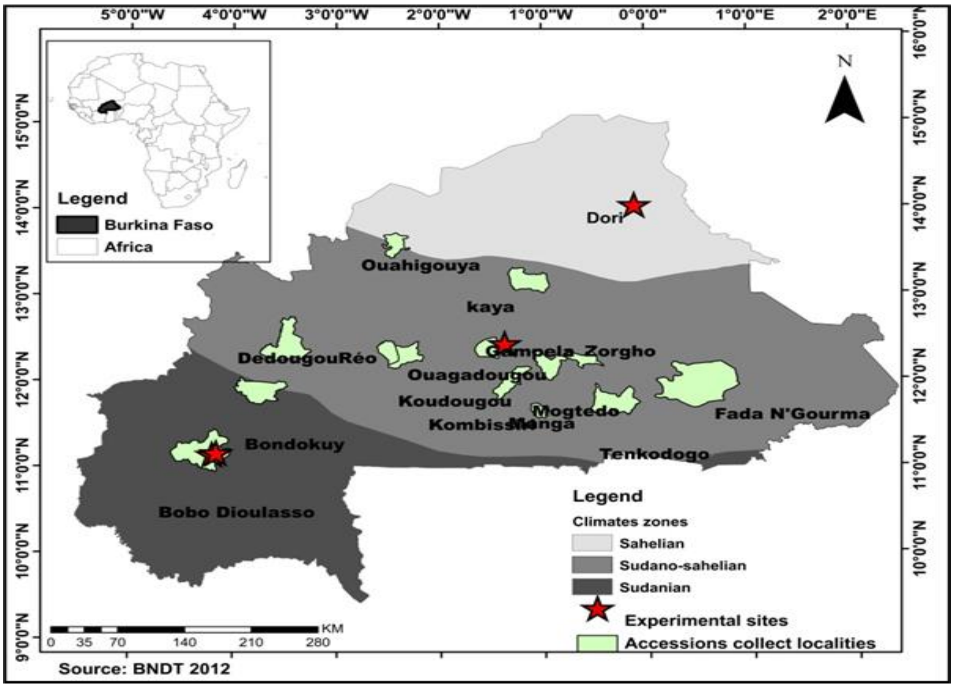

Fig. 1. Location of the three experimental sites

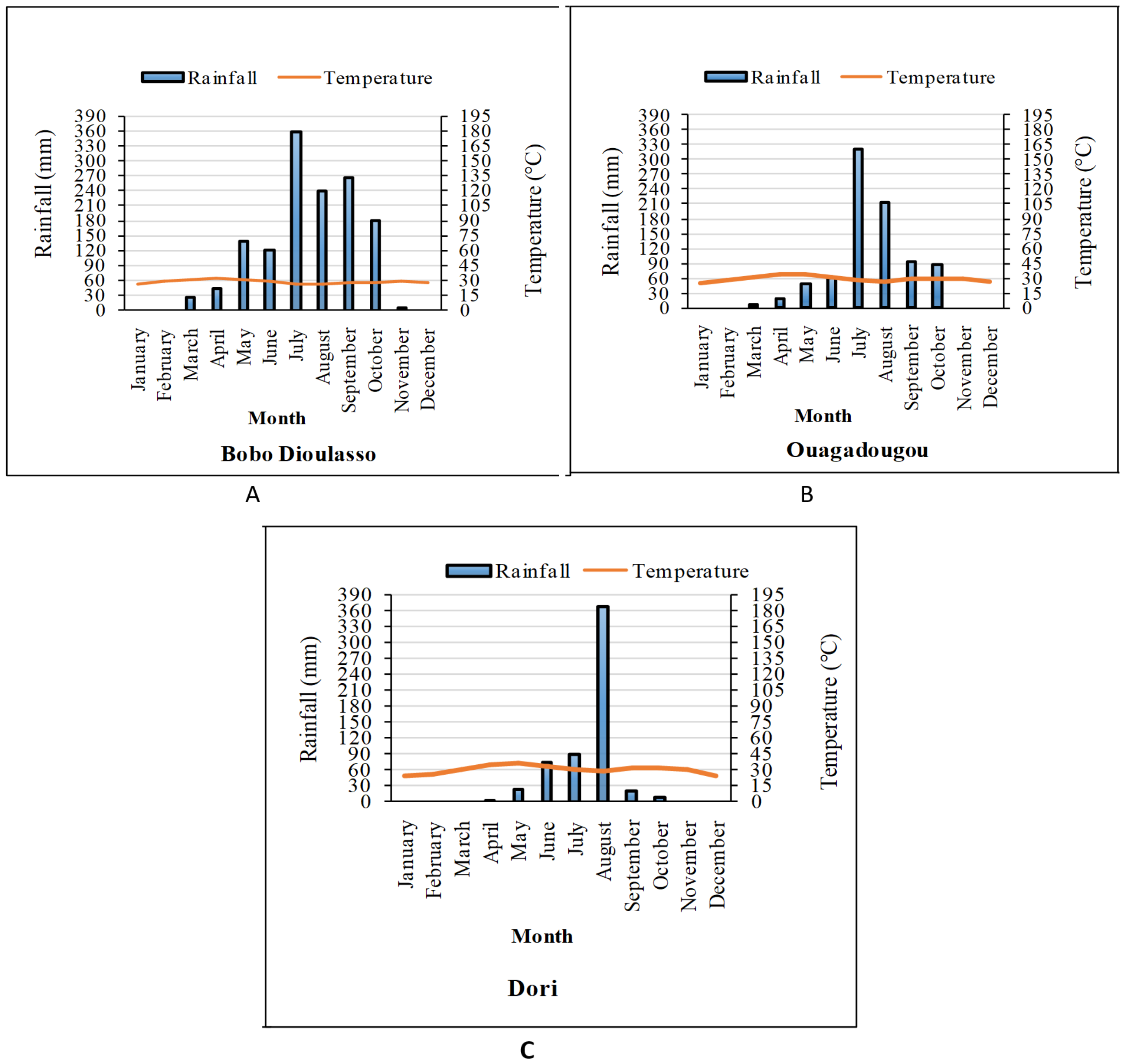

Fig. 2. Comparative umbra-thermal diagrams of the three experimental sites in 2019

2.1.2 Plant Material

The plant material consists of 36 accessions of *Cleome gynandra* L. from germplasm of Genetics and plant breeding Team of University Joseph KI-ZERBO. The accessions were collected in 12 provinces located in the three climatic zones of Burkina Faso.

2.2 Methods

2.2.1 Experimental Design

For each site, the experimental design was randomized complete block design with three replications. Replications were separated by 1 m. Each accession was represented by a row of 3 m on which 7 seedpots were sown. Accessions were randomly assigned to rows. The row spacing and spacing between plants were 0.5 m, respectively. Before the implementation of the experiments, the sites were ploughed and organic amendment (10 tons per hectare) was carried out. Sowing were carried out on

August 09, 2019 on the site of Bobo Dioulasso, on August 12, 2019 on the site of Ouagadougou and on August 15, 2019 on the site of Dori. A total of three weeding operations were carried out in each site.

2.2.2 DATA COLLECTING

A total of 16 variables, 12 quantitative and 4 qualitative, were included in the study. Except the number of days to 50% emergence and the number of days to 50 % flowering, measured on the whole row, the other quantitative variables were measured on 4 plants per row, 45 days after sowing. For the 4 qualitative variables, the observations were carried out during the entire development cycle of plants.

QUANTITATIVE VARIABLES

- **Variables related to plant cycle**: number of days to 50% emergence and number of days to 50 % flowering. The number of days to 50% emergence represents the number of days between sowing and the emergence of 50 % of plants per row while the number of days to 50 % flowering represents the number of days between sowing and the flowering of 50 % of plants per row.
- **Variables related to biomass production**: these are variables measured on stems and leave, such as plant height: measured from the ground to the last inflorescence of plant, stem diameter, number of primary branches; leaflet length: measured from the pulvinus to the apex of the central leaflet, leaflet width: measured at the middle part of the central leaflet, petiole length: measured from the sheath to the pulvinus, fresh biomass measured by weighing fresh biomass immediately after harvesting.
- **Variables related to fruit**: peduncle length, fruit length and fruit width were measured on the first three fruits per plant.

QUALITATIVE VARIABLES

Phenotypic observations were carried out on four traits which are stem color, leave color, degree of plant pubescence and plant type (erect or semi-erect). The phenotypic observations were carried out during the entire cycle of plants.

2.3 STATISTICAL ANALYSIS

Excel V.13 was used to carry out the graphs. GenStat v4.10.3 was used to carry out normality tests and three-way (α=5%) analysis of variance (accessions, experimental sites and morphotypes). The analysis of variance (ANOVA) was performed using quantitative variables to determine those that discriminate the accessions and the morphotypes. It was also performed to determine the effect of experimental sites on agronomic performances of accessions.

3 RESULTS

3.1 DESCRIPTION OF THE ACCESSIONS

Regardless of the experimental site, two types of plant, erect and semi-erect (Fig. 3) were observed. The erect type constitutes the major part of the collection (80%). The erect plants were characterized by an erect main stem from which secondary branches spread out. The semi-erect accessions, which represent 20% of the collection, were characterized by branches that spread out on the ground.

A B

Fig. 3. Type of plant: erect (A) and semi-erect (B)

In relation to stem color, three morphotypes were observed whatever the experimental site. The majority of the collection were green morphotype (39% of accessions). Up to 28% of accessions were violet morphotype and 33 % of accessions were slightly violet morphotype (Fig. 4). The green morphotype is characterized by green stems, petioles and leaves. The violet morphotype is characterized by violet stems and petioles and dark green leaves. The slightly violet morphotype, is characterized by slightly violet stems and petioles and dark green leave.

A B C

Fig. 4. The three observed morphotypes: green (A), Violet (B) and slightly violet (C)

At the adult stage, three degrees of plant pubescence were observed, such as low, medium and high pubescence accessions with a predominance of low pubescence accessions, about 61% of the collection (Table 1).

Table 1. Frequency of the different modalities of the qualitative variables studied

Variables	Modality	Frequency (%)
Stem color	Green Violet Slightly violet	38.89 27.78 33.33
Leave color	Green Dark green	36.11 63.89
Type of plant	Erect Semi-erect	80.56 19.44
Degree of pubescence	Low Medium High	61.11 25.00 13.89

3.2 Comparative Performances Of Accessions According To The Three Experimental Sites

The results of the analysis of variance showed highly significant differences ($p < 0.05$) between the performances of the accessions on the one hand and between the three experimental sites on the other hand for all the quantitative variables studied. They also showed a significant site effect, resulting in a significant interaction between accessions and experimental sites for most of the variables studied.

Cycle-related variables

The plants emerged in 3 days on average (Table 2) after sowing both at the sites located in Bobo Dioulasso and Ouagadougou but 4 days after sowing at the site located in Dori. Significant differences were observed between the emergence of the accessions ($p <0.001$). The site did not significantly influence this emergence ($p=0.478$) but a significant interaction between accessions and sites was observed ($p < 0.001$).

As for the number of days to 50% flowering (Table 2), it varied significantly from one site to another ($p < 0.001$) and according to accessions ($p < 0.001$) with a highly significant interaction between accessions and sites ($p < 0.001$). The plant cycles were approximately equal in Ouagadougou and Bobo Dioulasso, ranging from 21 to 34 days after sowing in Bobo Dioulasso, and from 23 to 33 days after sowing in Ouagadougou. Plant cycles were slightly shorter in Dori than those of the other sites, ranging from 19 to 31 days after sowing.

Table 2. Plant cycles in the three sites and results of analysis of variance

Variables	Bobo	Ouaga	Dori	P value (Accessions)	P value (Sites)	P value (Accessions*sites)
50% Emergence	3.60	3.61	4.12	P < 0.001	P = 0.478	P < 0.001
50% Flowering	26.91	26.16	24.42	P < 0.001	P < 0.001	P < 0.001

Ouaga: Ouagadougou; Bobo: Bobo Dioulasso

Variables related to biomass production

At 45 days after sowing, plant height ranged from 48 to 135 cm in Bobo Dioulasso with an average of 88 cm, from 35 to 134 cm in Ouagadougou with an average of 83 cm and from 32 to 72 cm in Dori with an average of 50 cm. Thus, the best performances were observed in Bobo Dioulasso followed by Ouagadougou while the lowest were observed in Dori (Table 3). High significant differences were observed between biomass of accessions ($p <0.001$) and between the three experimental sites ($p <0.001$). Significant interactions between accessions and experimental sites ($p <0.001$) were also observed.

For the number of primary branches, highly significant differences between accessions ($p < 0.001$) and between the three sites ($p < 0.001$) were observed with a significant interaction between accessions and experimental sites ($p = 0.002$). The number of primary branches varied from 3 to 13 with an average of 6 branches in Bobo Dioulasso, from 3 to 11 branches with an average of 5 in Ouagadougou, from 3 to 10 branches with an average of 4 in Dori. Thus, the greatest number of branches was observed in Bobo Dioulasso followed by Ouagadougou and Dori.

As for stem diameter, significant differences were observed between accessions (p <0.001) and between sites (p <0.001) with a significant interaction between accessions and sites (p <0.001). At the Bobo Dioulasso and Ouagadougou sites, plants recorded a mean diameter of 1.35 cm respectively. The average diameter was low in Dori, at 1.02 cm. In fact, they ranged from 0.55 to 2.47 cm in Bobo Dioulasso, from 0.50 to 2.70 cm in Ouagadougou and from 0.639 to 1.53 cm in Dori.

For leave dimensions (Table 3), such as petiole length, width and length of the central leaflet, the highest performances were observed in Bobo Dioulasso followed by Ouagadougou. The lowest performances were observed in Dori. Differences were significant between accessions (p < 0.001) and between experimental sites (p < 0.001) for leave dimensions. The interaction between accessions and experimental sites was significant for petiole length (p < 0.001) and for central leaflet length (p < 0.001) but not significant for central leaflet width (p = 0.906).

Fresh biomass also varied significantly between accessions (p < 0.004) and sites (p < 0.001) with a highly significant interaction between accessions and sites (p < 0.001). Indeed, biomass varied from 1.20 to 178.50g in Ouagadougou and from 4 to 113g in Bobo Dioulasso. In Dori, the biomass varied from 61.67 to 7.5g. Thus, the highest biomass was observed in Ouagadougou with an average of 40.84 g, compared to an average of 30.41g in Bobo Dioulasso and 25.83 in Dori.

Table 3. Performances of variables related to biomass production according to experimental sites and results of analysis of variance

Variables	Bobo	Ouaga	Dori	P value (accessions)	P value (sites)	P value (accessions-sites)
Diameter	1.34	1.36	1. 02	P < 0.001	P < 0.001	P < 0.001
Plant height	87.27	82.98	50.00	P < 0.001	P < 0.001	P < 0.001
Primary branches number	6.38	5.40	5.20	P < 0.001	P < 0.001	p =0.002
Petiole length	10.672	8.71	8.44	P < 0.001	P<0.001	P < 0.001
Leaflet width	3.19	2.92	2.32	P < 0.001	P < 0.001	p = 0.906
Leaflet length	8.10	6.91	5.28	P < 0.001	P < 0.001	P < 0.001
Biomass	30.41g	40.84	25.83	P < 0.001	P < 0.001	P < 0.001

Ouaga: Ouagadougou; Bobo: Bobo Dioulasso

VARIABLES RELATED TO FRUIT

Fruit width and length were highly variable among accessions (p < 0.001) and according to experimental sites (p < 0.001) but interactions between sites and accessions were not significant (Table 4). Fruit width and length varied respectively from 0.3 to 1.2 cm and from 2.3 to 19.3 cm in Bobo Dioulasso, from 0.3 to 1.1 cm and from 6.5 to 20.3 cm in Ouagadougou and from 0.2 to 0.6 cm and from 7.05 to 14.1 cm in Dori. Peduncle length was highly variable among accessions (p < 0.001) but the experimental sites did not influence peduncle length.

Table 4. Average performances of variables related to fruit in the three sites and results of analysis of variance

Variables	Bobo	Ouaga	Dori	P value Accessions	P value Sites	P value accessions*sites
Pedoncle length	2.01	1.93	1.78	P < 0.001	P< 0.001	P = 0,121
Fruit length	12.84	12.32	10.62	P < 0.001	P< 0.006	p = 0,258
width	0.57	0.58	0.50	P < 0.001	P< 0,739	p = 0,906

Ouaga: Ouagadougou; Bobo: Bobo Dioulasso

3.3 COMPARATIVE PERFORMANCES OF THE MORPHOTYPES ACCORDING TO THE EXPERIMENTAL SITES

On the same site, very few significant differences were observed between morphotypes. Notable differences were observed between morphotypes for plant cycle, leave dimensions and fruits length. The plant cycle was, on average, 29 days for the green morphotype, 27 days for the violet morphotype and 28 days for the slightly violet. Leave length and width were respectively 7.47 cm and 3.10 cm for the green morphotype, 6.67 cm and 2.88 cm for the violet morphotype, and 6.85 cm and 2.89 cm for the slightly violet morphotype. In general, performances of the green morphotype were superior than those of the other morphotypes except in Dori where the cycle of the violet morphotype was longer than those of the others (Table 5, 6, 7).

Depending on the experimental sites, performances were highly variable for plant cycle, plant height, leave size, biomass and fruit length (Figure 5). At Bobo Dioulasso, the plant cycles were, on average, 27.69 days for the green morphotype, 27.18 days for the slightly violet morphotype and 26.26 days for the violet morphotype (Table 5) while at Ouagadougou, they were 27.47 days for the green morphotype, 26.48 days for the slightly violet and 26 days for violet (Table 6). At Dori, the green morphotype had a cycle of 24.12 days, the slightly violet had 24.67 days and the violet had 25.34 days (Table 7). For plant height, the morphotypes recorded approximatively the same performances in Bobo Dioulasso and Ouagadougou, ranging from 80.66 to 89.46 cm. But at Dori, they were very low, varying from 49.09 to 50.18 cm. At Bobo Dioulasso, leave biomass were 35.66 g for the green morphotype, 33.66 g for the slightly violet and 30.93 g for the violet one while at Ouagadougou, they were 43.35 g, 41.09 g and 38.05 g respectively. At Dori, green morphotype recorded a biomass of 20.35 g, up to 28.48 g for slightly violet and 22.44 g for the violet. Thus, except leave biomass, for which the best performances were observed at Ouagadougou, in general, the best performances were observed at Bobo Dioulasso followed by Ouagadougou; the lowest performances were observed at Dori.

Table 5. Performances of the three morphotypes at Bobo Dioulasso

Variables	Green morphotype	Violet morphotype	Slightly violet morphotype	P value
50 % emergence (days)	3	3	3	P < 0.001
50% flowering (days)	27.69	27.18	26.26	P < 0.001
Diameter (cm)	1.40	1.3	1.29	P = 0.006
Height (cm)	89.46	83.66	88.04	P = 0.011
Primary branches number	6	6	6	P= 0.530
Petiole length (cm)	10.50	11.35	10.28	P= 0.009
Leaflet width (cm)	3.33	3.12	3.08	P < 0.001
Leaflet length (cm)	8.61	7.82	7.68	P < 0.001
Biomass (g)	35.66	30.93	33.66	P= 0.464

Table 6. Performances of the three morphotypes at Ouagadougou

Variables	Green morphotype	Violet morphotype	Slightly violet morphotype	P value
50 % emergence (days)	3	3	3	P= 0.004
50% flowering (days)	27.45	26	26.48	P= 0.208
Diameter (cm)	1.35	1.37	1.35	P= 0.964
Height (cm)	83.2	80.66	82.83	P=0.978
Primary branches number	6	6	6	P=0.686
Petiole length (cm)	8.13	9.33	8.92	P= 0.004
Leaflet width (cm)	2.99	2.86	2.89	P= 0.429
Leaflet length (cm)	7.12	6.72	6.82	P= 0.131
Biomass (g)	43.35	38.05	41.09	P= 0.515

Table 7. Performances of the three morphotypes at Dori

Variables	Green morphotype	Violet morphotype	Slightly violet morphotype	P value
50 % emergence (days)	4	4	4	P < 0.001
50% flowering (days)	24.12	25.34	24.67	P= 0.621
Diameter (cm)	1.03	1.02	0.96	P= 0.506
Height (cm)	49.78	50.18	49.09	P= 0.925
Primary branches number	5	5	5	P= 0.064
Petiole length (cm)	8.55	8	8.22	P= 0.556
Leaflet width (cm)	2.84	2.48	2.54	P= 0.050
Leaflet length (cm)	5.93	5.37	5.41	P= 0.045
Biomass (g)	20.53	22.44	28.48	P= 0.107

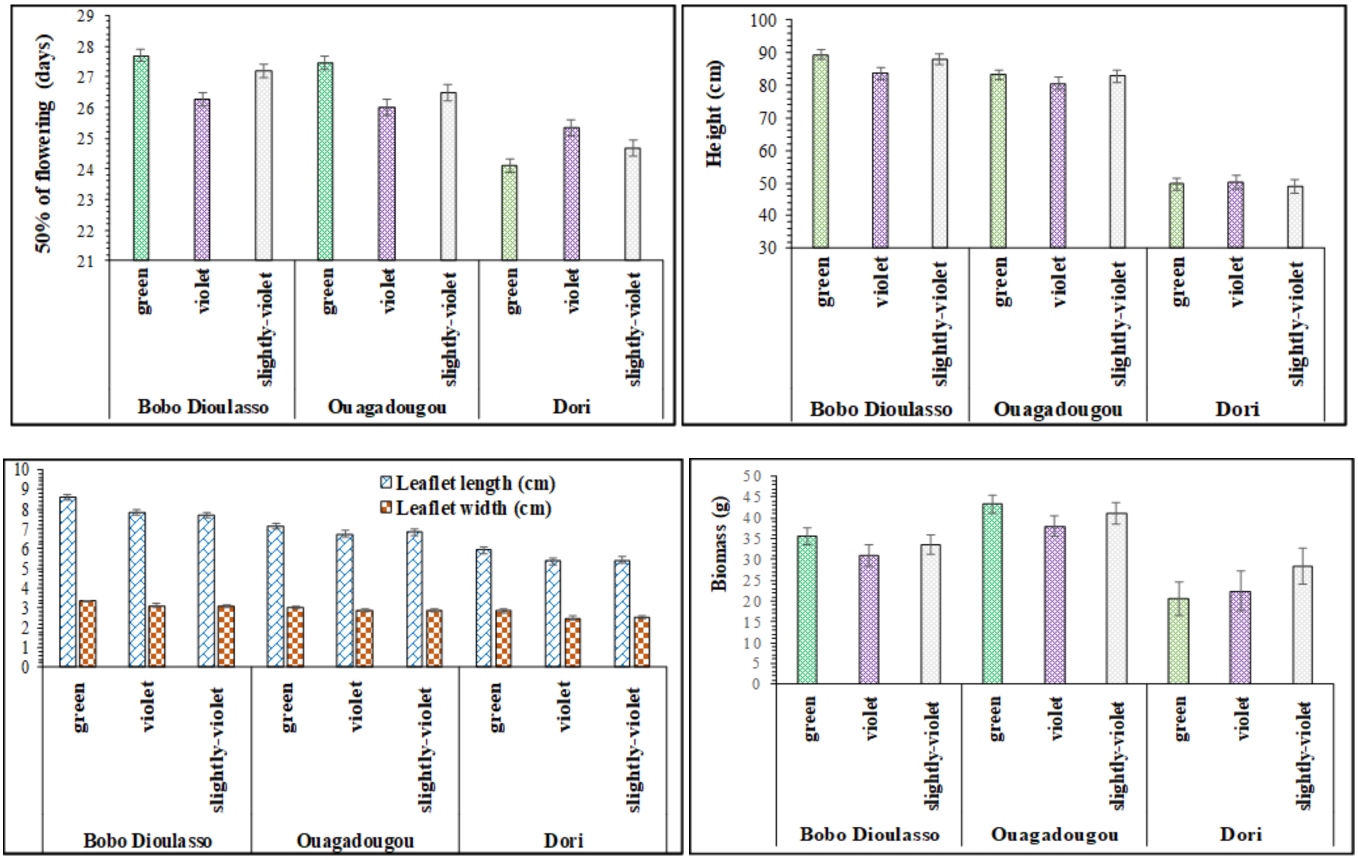

Fig. 5. Performances of some variables according to morphotypes and experimental sites

3.4 Identification Of Best Performing Accessions According To The Experimental Sites

Taking into account yield parameters including plant cycle, plant height, leave biomass and leave dimensions; the best performing accessions were Oua9, Oua10, Oua2, Oua3, Man, Kou, Ded2, Bob3, Kom2, Ded5 at Bobo Dioulasso (Table 8), Oua9, Oua10, Bob4, Man, Ded4, Kou, Reo1, Bond, Kom2, Bob3 at Ouagadougou (Table 9) and Oua10, Oua9, Ded4, Ded3, Bond, Kou, Kom2, Bob3, Man, Kay2 at Dori (Table 10). At Bobo Dioulasso, the ten best performing accessions included 5 green morphotypes, 3 violet morphotypes and 2 slightly violet morphotypes. At Ouagadougou, 4 accessions were green, 2 were violet and 4 slightly violet while at Dori, among the best performing accessions, 4 were green, 3 violet and 3 slightly violet. Thus, on all the sites, most of the best performing accessions were green morphotype.

Table 8. The ten best performing accessions at the experimental site of Bobo Dioulasso

Variables	MOR	50%FL	DIA	HEI	PBN	LW	LL	BIO
Oua9	Green	25.18	1.78	102.90	6.45	3.94	10.58	32.45
Oua10	Green	23.00	1.36	96.11	5.66	3.27	8.63	31.11
Oua2	Green	28.20	1.54	91. 00	6.80	3.79	**10.59**	32.30
Oua3	Green	25.71	1.37	91.85	7.28	3.65	9.21	33.00
Man	Slightly violet	30.33	1.54	99.83	7.91	3.52	9.10	33.33
Kou	Slightly violet	26.00	1.46	105.63	7.45	3.38	8.06	32.36
Ded2	Violet	29.33	1.45	94.44	6.00	3.41	8.68	36.00
Bob3	Green	25.66	1.53	89.66	6.22	3.42	9.21	30.22
Kom2	Violet	28.50	1.21	94.00	7.75	3.15	8.75	34.87
Ded5	Violet	26.28	1.68	91.00	6.14	3.17	7.98	35.85

***MOR**: Morphotype; **50%FL**: 50% of flowering; **DIA**: Diameter; **HEI**: Pant height; **PBN**: Primary branches number, **LW**: Leaflet width, **LL**: Leaflet lenght; **BIO**: Biomass*

Table 9. The ten best performing accessions at the experimental site of Ouagadougou

Variables	MOR	50%FL	DIA	HEI	PBN	LW	LL	BIO
Oua9	Green	25.10	1.76	111.50	6.30	3.86	9.09	60.73
Oua10	Green	25.66	1.61	87.91	5.11	2.81	6.85	49.18
Bob4	Slightly violet	25.00	1.55	92.83	6.00	3.22	7.35	51.58
Man	Slightly violet	26.66	1.48	102.00	6.33	3.50	8.48	43.20
Ded4	Violet	26.42	1.60	91.00	5.28	3.03	6.72	52.57
Kou	Green	27.60	1.52	89.80	5.90	3.12	6.97	54.98
Reo1	Slightly violet	26.50	1.70	96.62	6.62	3.37	7.58	76.21
Bond	Slightly violet	27.50	1.76	89.66	5.33	2.70	6.48	52.78
Kom2	Violet	27.11	1.55	84.44	5.88	2.94	6.75	71.38
Bob3	Green	26.00	1.55	88.25	4.91	3.18	8.03	38.40

***MOR**: Morphotype; **50%FL**: 50% of flowering; **DIA**: Diameter; **HEI**: Pant height; **PBN**: Primary branches number, **LW**: Leaflet width, **LL**: Leaflet lenght; **BIO**: Biomass*

Table 10. The ten best performing accessions at the experimental site of Dori

Variables	MOR	50%FL	DIA	HEI	PBN	LW	LL	BIO
Oua10	Green	33.87	0.99	56.87	7.70	3.19	6.14	31.64
Man	Green	33.87	0.99	56.87	7.70	3.19	6.14	31.64
Kou	Green	33.87	1.44	40.25	5.99	3.20	6.50	31.64
Kom 1	Violet	30.27	1.42	72.75	6.74	3.50	7.98	59.99
Oua9	Green	28.22	1.38	60.61	9.68	2.56	6.63	84.88
Bond	Slightly violet	29.61	1.32	50.37	6.66	5.07	5.13	63.96
Déd 3	Violet	30.21	1.07	44.71	7.50	2.94	6.17	47.05
REO1	Slightly violet	30.30	0.98	57.06	8.50	2.96	6.30	30.54
Kom2	Violet	33.08	0.81	60.64	8.0	3.60	6.30	31.64
Bob 3	Green	32.43	0.95	54.24	9.51	2.53	5.62	28.71

***MOR**: Morphotype; **50%FL**: 50% of flowering; **DIA**: Diameter; **HEI**: Pant height; **PBN**: Primary branches number, **LW**: Leaflet width, **LL**: Leaflet lenght; **BIO**: Biomass*

4 DISCUSSION

The identification of three morphotypes, three degree of pubescence, erect and semi-erect type of plant, independently of the experimental site, indicates that the environment does not significantly influence these variables; offering possibilities for varietal selection. Thus, a simple selection can allow development of *Cleome gynandra* varieties according to morphotypes, erect and semi-erect type of plant and pubescence degree of plant.

The agronomic performances measured, especially plant cycle, plant height, number of primary branches, stem diameter and fresh biomass indicate that Bobo Dioulasso located in the Sudanian zone and Ouagadougou located in the Sudano-Sahelian zone are more suitable for *Cleome gynandra* L. cultivation than Dori located in the Sahelian zone. Indeed, the performances of these variables recorded at Bobo Dioulasso and Ouagadougou are equal or even higher than those reported in the previous studies [10, 11, 12]. The good performances observed in both Sudanian and Sudano-Sahelian zones indicate the great environmental plasticity of *Cleome gynandra*, probably due to its advantageous C4 cycle for photosynthesis. According to authors [14,15], these two climatic zones are part of a large tropical zone that is suitable for the development of *Cleome gynandra* L. The low yield of fresh biomass observed at Bobo Dioulasso, contrary to the other variables, would be due to an inappropriate harvesting date (50 JAS at Ouagadougou and 55 JAS at Bobo Dioulasso). This late harvesting in Bobo Dioulasso would have resulted in the fall of senescent leaves. At maturity, the plant goes into senescence, resulting in a decline in leave quality and yield [16]. Thus, the ideal date for harvesting could be reduced to 30 days after sowing [17], generally between 3 and 5 weeks after sowing.

The significant interactions observed between accessions and experimental sites suggest that the choice of genotype to be cultivated should take into account the climatic zone. But the interaction between the morphotypes and experimental sites were not significant for all the variables studied except the number of days to 50% flowering, indicating that morphotype is not a determining criterion in the choice of genotypes to be cultivated according to the climatic zones. Otherwise, the morphotype is not a reliable indicator of yield that can be used in the choice of the genotypes to be cultivated according to *Cleome gynandra* cultivation zone.

The best performing accessions identified at Bobo Dioulasso, Ouagadougou and Dori are mostly green morphotypes and can be explained by the preferential selection towards this morphotype. Of these ten top accessions identified for each site, six accessions, such as Oua10, Oua9, Man, Kom2, Kou, Bob3, performed well at all the three sites. Thus, these accessions have stable performances regardless of cultivation zone and can be used for the development of high-yielding varieties that can be vulgarized in the three climatic zones of Burkina Faso. Indeed, a major factor for the adoption of interesting varieties is superior agronomic performances [18]. This superiority constitutes an added value in terms of food supplementation, resilience and income for farmers.

5 CONCLUSION

The description of the collection showed that the color of morphotypes does not depend on sites; offering possibilities for varietal selection of *Cleome gynandra* varieties for vulgarization in the three climatic zones of Burkina Faso. A variation of agronomic performances according to the experimental sites and a significant interaction between accessions and experimental sites for the major part of the studied variables were observed. But variations according to the morphotypes are very low. The best performances were observed in Bobo Dioulasso and Ouagadougou respectively. The lowest performances were observed in Dori. The study allowed to determine, for each climatic zone, a set of accessions that could be used for the development of efficient varieties of *C. gynandra* in Burkina Faso.

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