Vol. 20(10), pp. 855-860, October 2024
DOI: 10.5897/AJAR2024.16769
Article Number: 325678072640
ISSN: 1991-637X

http://www.academicjournals.org/AJAR

ACADEMIC JOURNALS
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African Journal of Agricultural Research

Full Length Research Paper

Performances of eight morphotypes of lettuce (*Lactuca sativa* L.) cultivated in Zinder region using quantative traits in rainy season

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Received 3 June, 2024; Accepted 25 July, 2024.

Lettuce (*Lactuca sativa* L.) is cultivated as a cash crop by small-scale farmers in Niger. This study assessed eight lettuce morphotypes from the Zinder region in Niger Republic for their agronomic performance traits. The experiment followed a randomized complete block design with three replications. Significant differences were observed between the morphotypes for various agro-morphological traits. Principal component analysis of the eleven measured traits indicated that the first two components accounted for 80.18% of the total variation. Furthermore, the study identified that four out of the eleven traits studied were the most significant in distinguishing among the eight morphotypes.

Key word: Agronomic performance, lettuce, *Lactuca sativa L.,* multivariate analysis, Niger Republic.

INTRODUCTION

Lettuce (*Lactuca sativa* L.) plays a crucial role as a cash crop for small farmers in developing countries. Globally, it is cultivated extensively, with an annual production exceeding 21 million tonnes (Ramirez, 2015; Fekadu et al., 2021). Lettuce boasts a wide range of varieties and enjoys significant popularity worldwide due to its economic importance (Elattir et al., 2003, Korichi, 2020). Its succulent leaves, widely used in salads, are rich in water, calcium, and proteins, contributing to its health benefits. Lettuce is also a good source of vitamins A, B (folic acid), C, E, and minerals such as calcium and iron (Fekadu et al., 2021; Dyląg et al., 2023).

In Niger, lettuce holds a prominent position among market gardeners, covering approximately 7,485.68 hectares with a national production of around 170,016.75 tonnes (MAE, 2018). However, the development of

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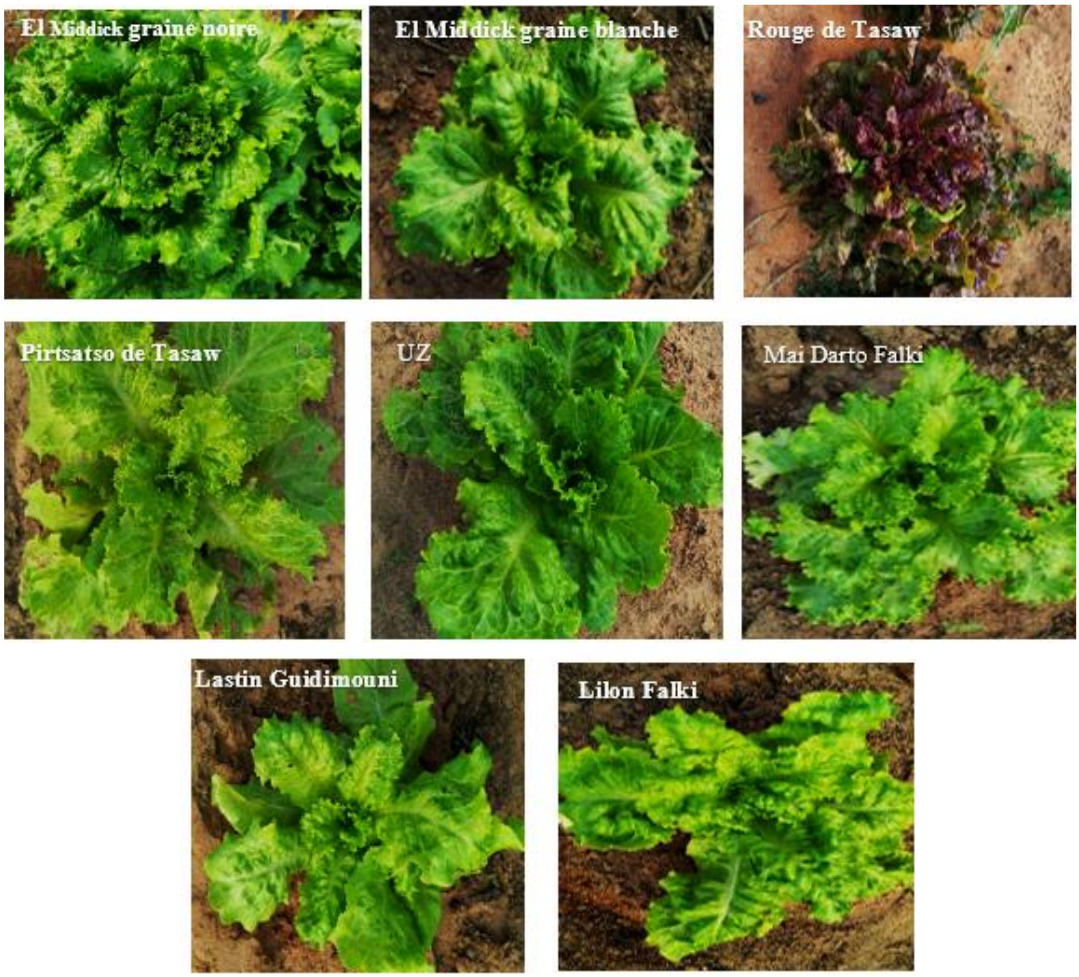

Figure 1. The eight (8) lettuce morphotypes.

lettuce faces several challenges in Niger, notably the lack of productive and resilient varieties that can withstand the various climatic and biotic pressures during the rainy seasons. These challenges often force producers to halt production activities during adverse weather conditions, leading to reduced lettuce output in hot and humid periods and creating supply deficits.

This study aims to identify lettuce varieties adapted to Niger's rainy season conditions, thereby providing producers with a selection of productive varieties suitable for cultivation in the southern regions of Niger during the rainy season.

METHODOLOGY

Study site

The study was conducted in the experimental field of the Faculty of Science and Technology (FST) of Andre Salifou University (UAS) in Zinder during the rainy season 2022.The soil of the experimentation site is mainly classified as sandy clay and the climate is of sub-Sahelian type (Mamadou, 2015).

Plant material

The plant material used in this study consists of the lots of seeds of eight (8) morphotypes of lettuce which are: *Lastin Guidimouni; Mai Darto Falki; Lilon Falki; Tasaw Pirterso; El Middick Graine noire (GN)* and *blanche (GB)*; *Rouge of Tasaw* and a morphotype selected at the University of Zinder (*UZ,* Figure 1).

Experimental design

The experimental design adopted was a randomized complete block design with three repetitions, using eight varieties of lettuce per block, with each variety planted in its own plot. Plots were separated by 0.5 m alleys. The experimental area measured 48 m² (8 m × 6 m), divided into three blocks. Each plot contained 30 plants spaced 20 cm apart. Planting took place four weeks after sowing, with each variety transplanted when they reached 4-5 leaves. Plots were manually weeded every 14 days. Manure was applied one week before planting at a rate of 10 g (equivalent to 100 kg/ha) for mineral fertilizers and 2.4 g (equivalent to 24 kg/ha) for organic fertilizers. No chemical or phytosanitary treatments were

Table 1. Result of ANOVA according to lettuce morphotypes.

Variety	PlHe (cm)	LeLe (cm)	NuLe	LeAr (cm2)	CoDi (cm)	RoHe (cm)	StLe (cm)	LeWi (cm)	LeWe (cm)	PlWe (g)	RoWe
El Middick GN	30.13^{a}	11.26^{a}	25.33^{a}	70.15^{a}	1.12^{c}	9.92	26.31^{a}	8.197^{a}	56.89^{ab}	92.7^{ab}	35.99^{bc}
Lilon Falki	18.43^{bcd}	10.78^{a}	21.73^{abc}	63.12^{ab}	11.25^{b}	9.073	3.18^{d}	7.689^{ab}	75.99^{a}	121.71^{a}	45.65^{ab}
U.Z	24.61^{ab}	11.32^{a}	23.13^{ab}	62.92^{ab}	21.43^{a}	15.04	0.98^{d}	7.36^{abc}	64.57^{ab}	114.97^{a}	50.26^{a}
Pirtsatso de Tasaw	18.43^{bcd}	10.71^{a}	21.73^{abc}	62.58^{ab}	1.01^{c}	9.07	13.42^{b}	7.681^{ab}	75.99^{a}	121.71^{a}	45.72^{ab}
Lastin Guidimouni	23.20^{abc}	10.365^{ab}	17.27^{bc}	48.32^{bc}	0.88^{c}	8.08	11.35^{bc}	6.15^{c}	34.54^{c}	57.71^{c}	24.43
Mai Darto Falki	16.87^{cd}	8.95^{bc}	14.80^{cd}	42.69^{cd}	0.82^{c}	7.52	5.77^{cd}	6.284^{bc}	46.27^{bc}	75.72^{bc}	30.11^{c}
Rouge de Tasaw	13.73^{d}	7.92^{c}	9.60^{d}	29.97^{de}	0.41^{c}	7.34	6.60^{bcd}	4.603^{d}	12.36^{d}	18.42^{d}	6.06^{d}
El Middick GB	13.67^{d}	5.97^{d}	8.60^{d}	20.45^{e}	0.46^{c}	5.20	5.17^{cd}	4.237^{d}	7.66^{d}	11.16^{d}	3.493^{d}

PlHe: Plant height, NuLe: Number of leaves, LeAr: Leaves area, CoDi: Collar diameter, RoHe: Root height, StLe: Stem length, StWe: Stem weight, LeWe: Leaves weight, PlWe: Plant weight, UZ: Zinder University, LeLe: Leaves length, LeWi: Leaves width. Values with different letters within a column differ significantly.

applied during the experiment.

Data collection

Plant Height (cm), Number of Leaves, Leaves Area (cm^2), Collar Diameter (cm), Root Height (cm), Stem Lenght (cm), leaves Lenght (cm), Leaves Weight (cm), Plant Weight (g), leaves width (cm) and Root Weight (g) were measured. A total of eleven agro-morphological from the descriptors of the lettuce of the International Union for the Protection of Vegetable Obtentions characters (UPOV, 2017). A variance analysis was performed to test the differences between the variables with Minitab 18. A principal component analysis was performed on the agro morphological traits measured using R.

RESULTS

Analysis of the performance of lettuce morphotypes

The tallest plant height was recorded for El Middick GN (30.13 cm), while the shortest was observed for El Middick GB (13.67 cm, Table 1). El Middick GN also exhibited the highest number of leaves (22.6), as well as the widest (8.19 cm) and longest (11.26 cm) leaves (Table 1). Conversely, El Middick GB had the lowest means for number of leaves, leaf width, and leaf length, with values of 8.60, 4.23, and 5.97 cm, respectively (Table 1). Lilon Falki had the highest plant weight, followed by UZ, with 121.71 and 114.97 g, respectively (Table 1). In contrast, El Middick GB recorded the lowest mean plant weight (11.16 g) among all morphotypes in the collection (Table 1). El Middick GN, Lilon Falki, U.Z, and Pirtsatso de Tasaw exhibited leaves with weights exceeding 50 g (Table 1). UZ and Lilon Falki had the largest collar diameters, with 21.43 cm and 11.25 cm, respectively, while the smallest diameters were observed in Rouge de Tasaw (0.46 cm) and El Middick GB (0.41 cm, Table 1). The results from various variables, except root height, indicate significant differences among the different morphotypes (Table 2). The mean characteristics of morphotypes exhibit varied patterns across quantitative variables. The largest variations were observed in plant weight, leaves weight, and root weight, with standard deviations of 94.94, 30.60, and 20.34, respectively (Table 2). Moderate standard deviations were observed for number of leaves (8.52), root height (8.09), and plant height (8.06, Table 2). Other variables showed relatively lower standard deviations. The average plant weight was highest at 76.77 g, while the smallest diameter was observed in collar diameter (4.67 cm). The number of leaves ranged from 3 to 38, with a standard deviation of 8.52 (Table 2). Plant weight ranged from 1 to 187 g (Table 1).

Diversity structuring

The first two components of the Principal Component Analysis (PCA) collectively explain 80.18% of the total variation in the analysis. The first component, influenced primarily by leaf area and plant weight, accounts for 67.48% of the variability, while the second component, defined by stem length and collar diameter, contributes 12.70% to the total variation (Figure 2).

Leaf area and plant weight are most strongly represented on axis 1 and positively correlated with this axis, contributing 10.94 and 10.53%, respectively. Stem length and collar diameter better represent axis 2, positively correlating with this axis and contributing 47.64 and 35.71%, respectively (Table 3). The arrangement of

Table 2. Variance analysis table.

Variable	Minimum	Maximum	Moyenne	EcTyp	Pr>F	Significance
NuLe (g)	3.00	38.00	17.77	8.52	0.000	TH
LeLe (cm)	3.00	13.80	9.66	2.32	0.000	TH
LeWi (cm)	1.96	9.80	6.52	1.89	0.000	TH
PlWe (g)	1.40	187.00	76.77	49.94	0.000	TH
LeWe (g)	0.50	118.20	46.78	30.60	0.000	TH
RoWe (g)	0.30	102.00	30.21	20.34	0.000	TH
StLe (cm)	0.40	53.50	9.09	9.73	0.000	TH
CoDi (cm)	0.10	36.50	4.67	8.15	0.000	TH
RoHe (cm)	0.50	92.00	8.90	8.09	0.062	NS
PlHe (cm)	7.00	44.00	19.88	8.06	0.000	TH
LeAr (cm^2)	4.41	93.15	50.03	22.23	0.000	TH

PlHe: Plant height, NuLe: number of leaves, LeAr: leaves area, CoDi: collar diameter, RoHe: root height, StLe: stem lenght, StWe: stem weight, LeWe: leaves weight, PlWe: plant weight, UZ: Université de Zinder, LeLe: leaves length, LeWi: leaves width.

Table 3. Variable's contributions in total data variation.

Variable	F1	F2
	Contribution (%)	Contribution (%)
NuLe	9.62	0.01
LeLe	9.66	0.14
LeWi	10.33	0.14
PlWe	10.53	2.45
LeWe	10.32	1.84
RoWe	9.63	2.68
StLe	1.62	47.64
CoDi	2.61	35.71
RoHe	7.02	1.47
PlHe	6.78	7.67
LeAr	10.94	0.12
Variability (%)	67.48	12.70

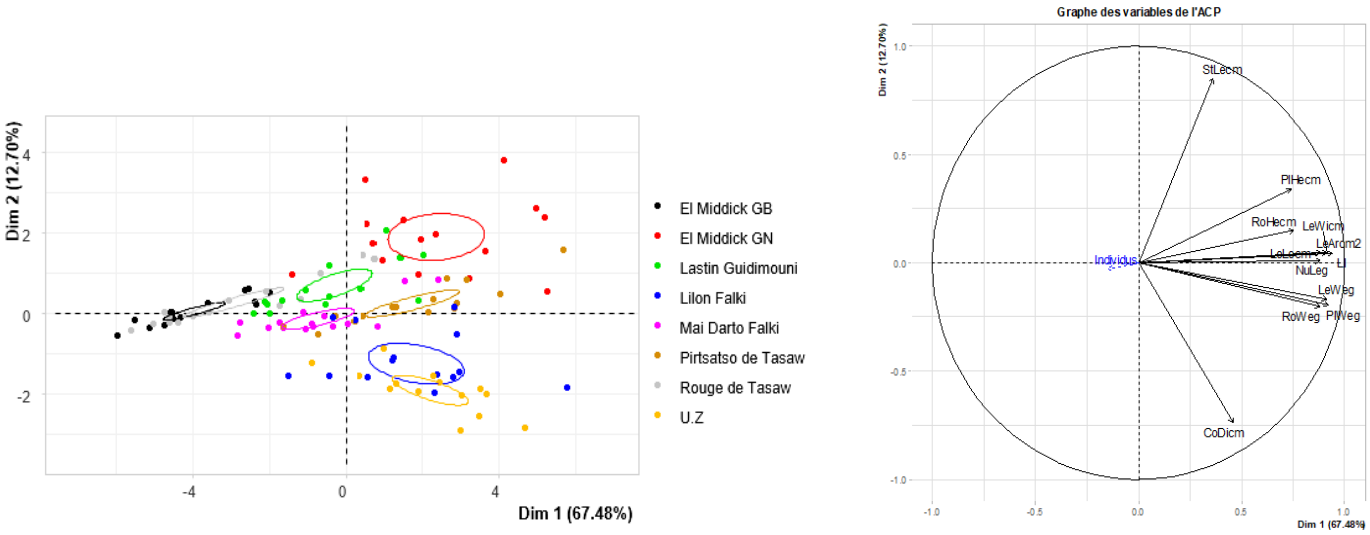

Figure 2. Structuring of lettuce morphotypes in the first plane of the ACP.

different varieties' individuals allowed grouping varieties together. Based on the variables defining the axes and the position of varieties relative to these axes, El Middick GN shows high values for leaf area and plant weight (Figure 2). Additionally, varieties like Pirtsatso de Tasaw, Mai Darto Falki, and Lastin Guidimouni, positioned closer to the center, appear to be influenced by all variables. In contrast, Lilon Falki and UZ exhibit high values for stem length and collar diameter, whereas El Middick GB and Rouge de Tasaw show contrasting characteristics (Figure 2).

The first component distinguishes El Middick GN, Pirtsatso de Tasaw, Lilon Falki, and UZ from El Middick GB (Figure 2). The second component contrasts El Middick GN with Lilon Falki and UZ, as well as El Middick GB with Lilon Falki and UZ (Figure 2). These findings allow for the identification of four distinct groups: El Middick GN (group 1), El Middick GB (group 2), Pirtsatso de Tasaw (group 3), and Lilon Falki and UZ (group 4, Figure 2).

DISCUSSION

The present study aimed to evaluate the agro-morphological characteristics of eight lettuce morphotypes collected from the Zinder region. Agro-morphological evaluation is a crucial step in the study of genetic diversity in cultivated plants (Polyzos et al., 2019; Sultan and Raina, 2020; Abdou et al., 2022), providing preliminary information useful for selection programs. Significant differences were found for all agro-morphological characteristics analyzed except root height, indicating substantial phenotypic variability within the studied collection. Similar findings were reported by Oliya et al. (2022) in their evaluation of 38 lettuce accessions collected from India, where all traits assessed showed significant differences, likely due to the larger number of accessions studied compared to the present research.

El Middick GN exhibited the highest number of leaves among all varieties in the collection, reflecting its strong genetic potential. In contrast, Lilon Falki and UZ morphotypes stood out for their greater plant weights compared to other morphotypes, likely due to a combination of genetic potential and favorable environmental conditions. Pereira et al. (2023) reported similar results. Statistical analysis of root height did not reveal significant differences between varieties, suggesting this trait may not be useful for differentiation in this study.

Significant differences were observed in leaf weight and plant weight among varieties, highlighting considerable variability within the collection. These findings align with results from lettuce cultivar studies in Algeria by Lallouche et al. (2020). El Middick GB exhibited lower performance across most parameters, possibly due to sensitivity to environmental conditions, particularly during the rainy season.

Principal Component Analysis (PCA) grouped the varieties into four distinct clusters based on leaf area, plant weight, stem length, and collar diameter. These characteristics allowed for differentiation between varieties with higher weight and those with greater height. Phenotypic selection by producers, focusing on observable traits such as leaf weight, plant weight, and size, likely contributed to structuring this variability. Producers typically choose seeds based on the heaviest and most visually appealing plants (Ben Madani and Belouadah, 2018).

Conclusion

The present results demonstrated a variation for all the characters. Thus, there was a significant difference for all parameters studied except root height. El Middick GN, UZ and Lilon Falki showed good performances under the study conditions. On the other hand, El Middick GB would adapt less in rainy conditions. The principal component analysis carried out structured the collection into four groups. Each group can be a source of interesting traits for improvement for lettuce production in the rainy season.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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