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Morphological Characterization of Jute Mallow (*Corchorius olitorius* L.) Accessions in Minna, Niger State, Nigeria

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Abstract

In sub-Saharan Africa, including Nigeria, jute mallow (*Corchorus olitorius*) is a major leafy vegetable. Unfortunately, the sub-region has a scarcity of reported improved varieties. Data on the morphological and yield characteristics of locally available accessions would be essential for breeding purposes. This study investigated the height and leaf production diversity of 26 *Corchorus olitorius* accessions during the cropping seasons of 2020 and 2021. The experiment was conducted in Minna, in Nigeria's Northern Guinea Savanna ecological zone. A randomized complete block design with three replicates was used. Plant height and number of leaves per plant were assessed at 2, 4, and 6 weeks after transplanting (WAT). The data were subjected to analysis of variance, and means were separated using Student-Newman-Keuls at a 5% probability level. Plant height and number of leaves per plant showed a wide range of genetic diversity. It was observed that the accessions NGB 00190 (73.7cm tall; 162 leaves/plant) and NGB 00197 (70.0cm tall; 220 leaves/plant) combined tallness with leaf abundance. Further genetic improvement of these promising accessions would contribute to nutrition and healthy living in the country.

Keywords: *Corchorus olitorius*, plant height, number of leaves, accessions, diversity

Introduction

Jute mallow (*Corchorus olitorius* L.), a member of the family Malvaceae, is a fibre crop of global importance and an essential vegetable in sub-Saharan Africa (Ngomuo *et al*., 2017). When cooked, the leaf, like okra, produces a slimy substance that can be processed into a sauce that can be eaten with cassava, millet and yam balls. During the dry season, its dried leaves and immature fruits can be ground into powder and used to make this sauce (Moyib *et al*., 2015).

The crop has enormous potential as a vegetable for low-income farmers. Increased consumption of vegetables such as *C. olitorius* has been regarded as one method of reducing household food

insecurity, particularly among low-income populations. Previous reports on the species' nutritional analysis indicate that *C. olitorius* has high nutritional qualities by being abundant in crude protein, iron, calcium, and magnesium (Isuosuo *et al*., 2018). As a result, it is necessary to promote its consumption. This could encourage a sustained increase in wild harvesting for genetic improvement. Plant breeding uses variability as a tool. Plant breeding also allows for the identification and selection of superior cultivars, and the improvement of such traits (Julia *et al*., 2016). Unfortunately, research on the evaluation of the morphological characterization of *C. olitorius* in Nigeria is limited.

This study reports the growth and yield characteristics of some *C. olitorius* accessions in Minna, Niger State, Nigeria.

Materials and Methods

Experimental site

The experiment was conducted at the Teaching and Research Farm of Niger State College of Education, Minna, situated within the Northern Guinea Savanna ecological zone of Nigeria (Latitude 9.56°N; Longitude 6.57°E; 233 metres above sea level). The experimental site had an average temperature of 24°C. The maximum temperature was 24°C while the minimum temperature was 23°C. The average annual rainfall of this area was 117 mm.

Source of seeds, and field layout

Seeds of *Corchorus olitorius* accessions were obtained from farmers in Minna, Kuta, Bida and the National Centre for Genetic Resources and Biotechnology (NACGRAB), Ibadan, Nigeria.

The experimental field measured 60m × 60m. The experiment was laid out using a randomized complete block design with three replicates. The treatments were 26 *Corchorus olitorus* accessions, as shown in Table 1.

Crop establishment and management

The experiment was carried out in two seasons: 1st August 2020 to 31st December 2020 for Season 1, and 1st August 2021 to 31st December 2021 for Season 2.

Corchorus olitorius accessions were grown into seedlings in a nursery on 1m × 1m beds. The seedlings were hardened-off a week before transplanting, and the most vigorous ones were chosen four weeks later. It was done at a rate of one plant per stand, with an intra-row spacing of 10 cm. Weeds were manually controlled with a hoe at 2, 5, and 8 weeks after transplanting. One hundred and twenty kilogram (20kg) of farmyard manure was obtained from the Livestock Unit of the Niger State College of Education's Teaching and Research Farm and incorporated into the soil using a plough, harrow, and ridger to improve soil fertility.

Data collection and analysis

Plant height and the number of leaves were recorded at 2, 4 and 6 weeks after planting (WAT). The data were subjected to analysis of variance (ANOVA) using the Statistical Analytical System (SAS, 2008). Means which showed significant differences were separated using Student-Newman-Keuls (SNK) at a 5 % level of probability.

Results

Plant height

In Season 1, plant height varied significantly ($p<0.05$) from 26.3cm in Bakin_ayoyo to 67.7cm in NGB_00190 at 2 WAT (Table 1). Next to NGB_00190 were the NGB_00197, Ayoyon_zazzau, and NGB_00199 with a mean height of 64, 62.7, and 60.8 cm, respectively. However, Lalo and NGB_00195 exhibited the same height (55.7 cm). Similarly, there was no difference between the height of NGB_00192 (53.7 cm) and NGB_00203 (53.7 cm). Moreover, the height difference between Farin_ayoyo (52.3 cm) and NGB_00230 (52 cm) was not significant ($p>0.05$). The height of NGB_00201 (47 cm) was similar to NGB_00201 (47 cm) but not statistically different from the average height of (46.7 cm) observed in NGB_00221. The trend of plant heights observed at 4 WAT in the accessions was similar to the data obtained at 2 WAT: Bakin_ayoyo and NGB_00190 still produced the shortest and tallest plants, respectively but values ranged between 29.3 and 70.8 cm, respectively (Table 1). There was no significant height difference between Lalo (58.8 cm) and NGB_00195 (58.7 cm), while NGB_00192 and NGB_00203 exhibited a similar height (56.7 cm). Furthermore, the height difference between Farin_ayoyo (55.3 cm) and NGB_00230 (55 cm) was not significant.

Table 1: Plant height in some accessions of jute mallow under field evaluation in Minna, Nigeria

	Season 1			Season 2		
Accession	2 WAT (cm)	4 WAT (cm)	6 WAT (cm)	2 WAT (cm)	4 WAT (cm)	6 WAT (cm)
Ayoyon_zazzau	62.7c	66.0c	69.0c	63.0c	66.0c	69.0c
Bakin_ayoyo	26.3t	29.3t	32.7t	27.0t	30.0u	33.0t
Farin_ayoyo	52.3k	55.3k	58.7j	53.0j	56.0k	59.0j
Kpatagi	31.0s	34.0s	37.0s	31.0s	34.0t	37.0s
Lalo	55.7h	58.8h	61.7g	56.0g	59.0h	62.0g
NGB_00187	57.0g	60.0g	63.0f	57.0f	60.0g	63.0f
NGB_00188	54.3i	57.3i	60.7h	55.0h	58.0i	61.0h
NGB_00190	67.7a	70.8a	73.7a	68.0a	71.0a	74.0a
NGB_00191	57.7ef	60.7f	63.0f	58.0e	61.0f	63.0f
NGB_00192	53.7j	56.7j	69.7b	54.0i	57.0j	70.0b
NGB_00193	49.7m	52.7m	56.0m	50.0m	53.0n	56.0m
NGB_00195	55.7h	58.7h	62.0g	56.0g	59.0h	62.0g
NGB_00196	50.7l	54.0l	56.7l	51.0l	54.0m	57.0l
NGB_00197	64.0b	67.0b	70.0b	64.0b	67.0b	70.0b
NGB_00198	45.0o	48.0o	51.0o	45.0o	48.0p	51.0o
NGB_00199	60.8d	63.8d	66.8d	61.0d	64.0d	67.0d
NGB_00200	44.0p	47.0p	50.0p	44.0p	47.0q	50.0p
NGB_00201	47.0n	50.0n	53.0n	47.0n	50.0o	53.0n
NGB_00202	47.0n	50.0n	53.0n	47.0n	50.0o	53.0n
NGB_00203	53.7j	56.7j	59.7i	54.0i	57.0j	60.0i
NGB_00221	46.7n	49.7n	52.7n	47.0n	50.0o	53.0n
NGB_00224	57.3fg	60.3fg	64.0e	58.0e	61.0f	64.0e
NGB_00225	58.0e	61.3e	64.0e	58.0e	62.0e	64.0e
NGB_00230	52.0k	55.0k	58.0k	52.0k	55.0l	58.0k
NGB_00235	35.3q	38.8q	41.8q	36.0q	39.0r	42.0q
Tungunuwa	31.7r	34.8r	37.8r	32.0r	35.0s	38.0r
SEM	0.2	0.2	0.2	0	0	0

Means followed by similar alphabet letter (s) within the column do not differ significantly at $p<0.05$ by Student-Newman-Keuls; WAT = weeks after transplanting.

As observed at 2 WAT, NGB_00201 and NGB_00202 produced plants of similar heights (50 cm) which were statistically at par with the height of NGB_00221 (49.7 cm). At 6 WAT, plant heights varied significantly from 32.7 cm (Bakin_ayoyo) to 73.7 cm (NGB_00190). The mean height of 70 cm observed in NGB_00197 was not significantly different from the 69.7 cm recorded in NGB_00192 (Table 1). A similar mean height of 64 cm was observed in NGB_00224 and NGB_00225. In the same vein, NGB_00187 and NGB_00191 had a uniform mean height of 63 cm. A mean height of 62 cm was observed in NGB_00195, which was statistically at par with the height (61.7 cm) of the Lalo accession. In addition, the heights of NGB_00201 and NGB_00202 accessions were similar (53 cm) but not significantly different from NGB_00221 which exhibited a mean height of 52.7 cm (Table 1).

In season 2, the patterns of plant height were as observed in season 1. At 2 WAT, plant height varied significantly (p<0.05) between 27 cm in Bakin_ayoyo and 68 cm in NGB_00190 (Table 1). However, there were four groups of accession which exhibited comparable plant heights. These were NGB_00191, NGB_00224 and NGB_00225 were 58 cm tall; Lalo and NGB_00195 attained 56 cm height; NGB_00192 and NGB_00203 were 54 cm tall; and NGB_00201, NGB_00202, and NGB_00221 attained 47 cm height. At 4 WAT, plant height ranged significantly between 30 cm in Bakin_ayoyo and 71 cm in NGB_00190. In NGB_00191 and NGB_00224, an average height of 61 cm was observed; Lalo and NGB_00195 were 59 cm tall; NGB_00192 and NGB_00203 were 61 cm in height; whereas NGB_00201, NGB_00202 and NGB_00221 attained 50 cm height.

At 6 WAT, the heights of plants varied from 33 cm (Bakin_ayoyo) to 74 cm (NGB_00190). There was a slight deviation from the trends observed at 2 and 4 WAT. There was no difference between the mean height of NGB_00192 (70 cm) and NGB_00197 (70 cm). In the same vein, NGB_00224 and NGB_00225 were 64 cm tall; NGB_00187 and NGB_00191 attained 63 cm height; Lalo and NGB_00195 exhibited 62 cm height while NGB_00201, NGB_00202 and NGB_00221 were 53 cm tall (Table 1).

Number of leaves per plant

In Season 1, the number of leaves at 2 WAT varied significantly between 55 per plant in NGB_00202 and 199 in NGB_00197 (Table 2). The other accessions with a high number of leaves were NGB_00190 and Ayoyon-zazzau with 160 and 140 leaves per plant, respectively.

However, the difference in the number of leaves between NGB_00191 (137 per plant) and NGB_00199 (136 per plant) was not significant. A uniform mean of 125 per plant was observed in NGB_00198, NGB_00201 and NGB_00225. Although the accession NGB_00192 produced more leaves (118 per plant) than Lalo (117 per plant), the difference was not significant. Similarly, the difference in the number of leaves between NGB_00203 (107 per plant) and NGB_00193 (106 per plant) was not significant. In NGB_00221, the higher (85 per plant) number of leaves obtained was statistically similar to the value observed in NGB_00230 (84 per plant). Conversely, the plants of NGB_00235 and Tungunuwa produced a mean of 71 leaves per plant (Table 2).

At 4 WAT, the lowest and highest number of leaves increased to 70 and 214 per plant in NGB_00202 and NGB_00197, respectively (Table 2). The accession NGB_00191 produced a higher (152 per plant) number of leaves than NGB_00199 (151 per plant) but the difference was not significant. Similarly, NGB_00225 produced more leaves (141 per plant) than NGB_00198 and NGB_00201 (140 per plant) but the difference was not significant. Although NGB_00192 had a higher number of leaves (133 per plant) than Lalo (132 per plant), both values were statistically

at par. On the other hand, NGB_00193 and NGB_00203 produced a mean of 121 leaves per plant (Table 2).

Table 2: Number of leaves per plant in some accessions of jute mallow under field evaluation in Minna, Nigeria

	Season 1			Season 2		
Accession	2 WAT	4 WAT	6 WAT	2 WAT	4 WAT	6 WAT
Ayoyon-zazzau	140c	156c	163c	142c	157c	163c
Bakin_ayoyo	115g	129g	136g	115i	130h	136h
Farin_ayoyo	90n	104n	112o	90q	105p	112q
Kpatagi	76q	90r	97r	76u	91t	97t
Lalo	117f	132f	139f	118h	133g	139g
NGB_00187	102l	117l	122l	102o	117n	123n
NGB_00188	104k	119k	126k	105n	120m	126m
NGB_00190	160b	175b	181b	161b	176b	182b
NGB_00191	137d	152d	158d	137e	152d	158d
NGB_00192	118f	133f	138f	118h	133g	139g
NGB_00193	106j	121j	127jk	106m	121l	127l
NGB_00195	108i	123i	129i	108k	123j	129j
NGB_00196	99m	114m	119m	99p	114o	120o
NGB_00197	199a	214a	220a	199a	214a	220a
NGB_00198	125e	140e	146e	125g	140f	146f
NGB_00199	136d	151d	157d	138d	152d	158d
NGB_00200	81p	96q	102q	81t	96s	102s
NGB_00201	125e	140e	146e	125g	140f	146f
NGB_00202	55s	70u	76u	55x	70w	76w
NGB_00203	107j	121j	127j	107l	122k	128k
NGB_00221	85o	100o	116n	85r	100q	116p
NGB_00224	110h	124h	131h	110j	125i	131i
NGB_00225	125e	141e	147e	126f	141e	147e
NGB_00230	84o	99p	105p	84s	99r	105r
NGB_00235	71r	86s	92s	71v	86u	92u
Tungunuwa	71r	84t	91t	70w	85v	91v
SEM	0.7	0.2	0.2	0.1	0.2	0.0

Means followed by similar alphabet letter (s) within the column do not differ significantly at $p<0.05$ by Student-Newman-Keuls; WAT = weeks after transplanting

The observations made at 6 WAT showed that the number of leaves ranged between 76 (NGB_00202) and 220 (NGB_00197) per plant (Table 2). A high number of leaves was also observed in NGB_00190 and Ayoyon-zazzau which produced a mean of 181 and 163 per plant, respectively. In the plants of NGB_00191 and NGB_00199, a mean of 158 and 157 leaves were found per plant, respectively. The plants of NGB_00225 produced 147 leaves per plant, which was not significantly different from a uniform number of 146 observed in NGB_00198 and NGB_00201. Although there was no significant difference between the number of leaves in Lalo and NGB_00192, a higher value was observed in the former (139 per plant) than latter (138 per plant).

In season 2, the number of leaves at 2 WAT varied significantly ($p<0.05$) between 55 per plant in NGB_00202 and 199 per plant in NGB_00197 (Table 2). Other accessions with a high number of leaves were NGB_00190, Ayoyon-zazzau, NGB_00191, and NGB_00199 with a mean of 161, 142, 138, and 137 leaves per plant in that order. Nevertheless, NGB_00198 and NGB_00201 produced the same number of leaves (125 per plant). In the same vein, Lalo and NGB_00192 had

a uniform number of 118 per plant (Table 2). At 4 WAT, the accessions NGB_00202 and NGB_00197 produced the lowest and highest number of leaves with a mean of 70 and 214 per plant, respectively. The mean number of 152 leaves observed in NGB_00191 was the same as in NGB_00199 but significantly higher than the mean of 140 leaves found in NGB_00198 and NGB_00201. Furthermore, a uniform mean of 133 leaves was produced in Lalo and NGB_00192 (Table 2).

In the 6th WAT, the trend of leaf production was similar to that of 4th week after sowing. The lowest number of leaves was observed in NGB_00202 (76 leaves per plant) whereas NGB_00197 exhibited the highest (220 leaves per plant). However, there was a uniform mean of 158 leaves for NGB_00191 and NGB_00199, 146 leaves in NGB_00198 and NGB_00201, and 139 leaves for Lalo and NGB_00192 (Table 2).

Discussion

The significant differences in height and the number of leaves observed among the accessions of *Cochorus olitorius* might be attributed to genetic diversity among them. This is in agreement with the findings of Ngomuo *et al*. (2017) in a study involving some accessions of *C. olitorius*. The accession NGB_00190 which consistently exhibited the tallest plants irrespective of the time of evaluation revealed its uniqueness as a genetic resource for breeding for such a trait. The same remark can be attributed to NGB_00197, Ayoyon_zazzau, and NGB_00199 which consistently produced tall plants. The observation that the highest number of leaves came from NGB_00191 revealed its superiority for leaf production. Although plant height and the number of leaves are quantitative traits which are controlled by polygenic genes, the observation that NGB_00190 and NGB_00197 were among the top accessions for leaf production revealed a synergistic effect of the genes controlling both traits in those accessions. In other accessions, there was no positive relationship between plant height and the number of leaves, implying an antagonistic interaction. This corroborates the work of Jakobson and Jarosz (2019) which elucidated that polygenically inherited traits are complex due to the influence of several genes controlling trait expressions. The differences in plant height and the number of leaves per plant observed in this study corroborate the findings of Nwangburuka and Denton (2012) who reported significant morphological differences among fifteen genotypes of *C. olitorius*.

Conclusion

This study revealed a wide range of genetic diversity for vital breeding traits such as plant height and the number of leaves per plant. It was found that the accessions NGB_00190 and NGB_00197 combined tallness with leaf abundance. Plant breeders could take advantage of the genes for tallness and abundant leaf production in NGB_00190 and NGB_00197 to develop an all-inclusive variety of the crop.

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