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Geographical Characteristics of Cultivated Rice in Africa

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Introduction

During the periods from October to November in 1984, from August to November in 1985, and from May to August in 1988, the writer travelled through 8 countries of Africa, *i.e.*, Madagascar, Tanzania, Kenya, Nigeria, Ivory Coast, Liberia, Senegal and Gambia, for the project entitled "Studies on the Distribution and Ecotypic Differentiation of Wild and Cultivated Rice Species in Africa", supported by a Grant from the Ministry of Education, Science and Culture of the Japanese Government. Making use of these opportunities, the cultivated rices distributed and under cultivation in African countries were studied, following the previous studies on differentiation of rice in the world[1,2,3].

In the present paper, the materials collected in the first trip (1984) and the second trip (1985) were briefly reported, but the materials collected in the third trip (1988) were omitted, in which 105 strains of *O. sativa* and 1 of *O. glaberrima* were collected[15,16].

Portères (1956) postulated the origin and diversity of *Oryza glaberrima*[14]. Recently, indigenous rice-collections in African countries were done by several scientists[17,18], and considerations on the distribution of cultivated rice[4,6] and the cultivation status[5] in Africa were made by the present author. It was said that *O. glaberrima* showed recently decreasing in cultivated area. The decrement had been done centering around strains of small grains, and selection pressure for large grains was strongly made in Africa, surpassing that in Asia[7].

Based on the present materials, abstracts of geographical distribution and grain type of both the species in Africa were already reported in the previous papers[8-12]. In the following paper, summarized data of these were reported[13]. The present paper was located as the final one in these studies.

Materials and Methods

Geographical situation and Accession Nos. of the collected materials were illustrated in Fig. 1 of the previous paper[6]. The strains collected in Gambia were included in the group of Senegal.

During the first (1984) and the second (1985) tours, 120 strains of *O. sativa* L. and 81 strains of *O. glaberrima* STEUD. were collected, and they were used for morphological investigations of unhusked grains[8-12]. In these papers, however, grains of 20 strains of the whole were wholly immatured and inadequate to be used for measurement. *i.e.*, 15 of *O. sativa* (8 strains of Madagascar, Collection Nos.20, 25, 29, 30, 48, 57, 58 and 59; 5 of Kenya, Nos.66, 67, 68, 69 and 80; 1 of Ivory Coast, No.1; 1 of Senegal, No.201), and 5 of *O. glaberrima* (1 of Nigeria, No.113; 3 of Ivory Coast, Nos.2, 3 and 4; 1 of Senegal, No.157). By propagation, 13 strains of them had

revived, *i.e.*, 5 of *O. sativa* (2 of Madagascar, Nos.20 and 58; 1 of Kenya, No.66; 1 of Ivory Coast, No.1; 1 of Senegal, No.201), and 3 of *O. glaberrima* (3 of Ivory Coast, Nos.2, 3 and 4). During the propagation, 5 strains showed intra-strains segregations, *i.e.*, Nos.32-3, 34-4, 44-3, 47-3 and 47-4 (Madagascar). So, 13 strains in the total were used here. Six characters of the unhusked grains were shown in Table 1. The results obtained here were supplemented and supplied in the respective Tables of the previous papers[8-12]. So, 120 strains of *O. sativa* and 81 of *O. glaberrima* were used for the present analysis.

Table 1. Six morphological characters of unhusked grains measured in 13 strains, which were not reported in the previous papers and remained for measurement. Accession No.1001 --- *O. sativa* in Ivory Coast, Nos.1002, 1003, 1004 --- *O. glaberrima* in Ivory Coast, Nos.1020-1058 --- *O. sativa* in Madagascar, No.1066 --- *O. sativa* in Kenya, No.1201 --- *O. sativa* in Senegal

Collection No.	Accession No.	Length (mm)	Width (mm)	Thickness (mm)	L/W	L/T	W/T
1	1001	9.81±0.49	2.73±0.09	1.87±0.04	3.60±0.24	5.24±0.24	1.46±0.06
2	1002	8.95±0.23	3.25±0.11	1.84±0.08	2.75±0.11	4.87±0.21	1.77±0.10
3	1003	8.63±0.30	3.22±0.13	1.97±0.05	2.68±0.10	4.39±0.18	1.64±0.07
4	1004	9.11±0.22	3.33±0.10	2.01±0.07	2.74±0.11	4.53±0.17	1.66±0.07
20	1020	8.15±0.28	3.06±0.16	1.91±0.06	2.67±0.12	4.27±0.16	1.60±0.07
32-3	1032-3	10.38±0.23	2.46±0.09	2.00±0.03	4.22±0.18	5.19±0.15	1.23±0.05
34-4	1034-4	10.45±0.28	2.49±0.09	2.02±0.04	4.21±0.20	5.18±0.16	1.23±0.05
44-3	1044-3	9.24±0.19	3.27±0.12	2.14±0.06	2.83±0.13	4.32±0.13	1.53±0.08
47-3	1047-3	9.29±0.33	3.14±0.08	2.04±0.09	2.96±0.10	4.55±0.20	1.54±0.08
47-4	1047-4	9.54±0.30	3.10±0.10	2.10±0.08	3.08±0.12	4.56±0.22	1.48±0.08
58	1058	8.72±0.29	2.90±0.09	1.86±0.06	3.01±0.11	4.68±0.15	1.56±0.07
66	1066	9.41±0.20	2.80±0.09	1.97±0.05	3.37±0.14	4.78±0.11	1.42±0.06
201	1201	10.76±0.21	2.87±0.09	2.07±0.06	3.76±0.14	5.20±0.14	1.39±0.07

Thirty grains were used for the measurement of each strain. Measurements were done in length, width and thickness of grains and done at the most eminent section of the respective characters. Calculations were done for the ratios of length to width, of length to thickness, and of width to thickness. The whole data referring to the six characters were illustrated by the average value in the whole strains. The tripartite classification was developed for *O. sativa*, but it was adopted here for *O. glaberrima* in considerations of the fact that the meanings of the trial was made on to this species for the first time.

For summing-up the data, the results mentioned above were used, in accordance with the respective country-groups. The results were given in Table 2 (*O. sativa*) and in Table 4 (*O. glaberrima*). The results obtained in accordance with the tripartite classification were given in Table 3 (*O. sativa*) and in Table 5 (*O. glaberrima*).

In the present paper, the following abbreviations were used, *i.e.*, L (length), W (width), T (thickness), L/W (ratio of length to width), L/T (ratio of length to thickness), W/T (ratio of width to thickness), MD (Madagascar), KE (Kenya), NI (Nigeria), IV (Ivory Coast), LI (Liberia), SE (Senegal), GA (Gambia).

Results and Discussion

1. *O. sativa* L. (120 strains)

(1) In the lengths for the strain level, the longest (12.40 mm) was obtained in Accession No.1036 (Collection No.36 in 1985), followed by No.1038 (11.71 mm) and No.1083 (10.84 mm). It was noticeable that No.1036 showed quite a long length. The shortest (6.30 mm) was noted in No.1182, followed by No.1033 (7.22 mm) and No.1034-2 (7.32 mm). It was also noticeable that value of No.1182 was very small. In the country level, (upper column of Table 2), the longest (9.81 mm) was obtained in IV, followed by KE (9.70 mm). The shortest (8.45 mm) was noted in SE, followed by NI (9.11 mm). It was noted that the value of SE was peculiarly small. Average and its standard deviations through the whole strains (=120) were found to be 9.30 ±0.94.

In the standard deviations of each strain, *i.e.*, those showing intra-population's variations, the largest (0.65) was obtained in No.38, followed by Nos.1005 and 1065 (0.50). The smallest (0.13) was noted in No.1044, followed by No.1141 (0.16), and Nos.1101, 1111 and 1173 (0.17). In the country level, the largest (1.28) was obtained in SE, followed by MD (1.04). The smallest (0.48) was noted in NI, followed by LI (0.58). (IV was omitted in this category, because IV had only one strain).

Standard deviations illustrated by average values of the respective countries were shown in the lower column of Table 2. The largest (0.49) was obtained in IV, followed by KE (0.32). The smallest (0.24) was noted in SE, followed by LI (0.27). Average and its standard deviations in the whole strains were found to be 0.29±0.08.

Table 2. Six morphological characters of unhusked grains collected in the six countries of Africa in 1984 and 1985, illustrated by average values of the respective countries in case of *O. sativa*. Upper column; practical values, lower column; standard deviations

Country	No. of strains	Length (mm)	Width (mm)	Thickness (mm)	L/W	L/T	W/T
Madagascar	47	9.32±1.04	3.03±0.32	2.06±0.11	3.11±0.56	4.54±0.50	1.47±0.14
Kenya	28	9.70±0.69	3.03±0.35	2.08±0.13	3.26±0.48	4.70±0.43	1.46±0.13
Nigeria	20	9.11±0.48	3.32±0.34	2.17±0.14	2.78±0.39	4.23±0.40	1.53±0.09
Ivory Coast	1	9.81±0.00	2.73±0.00	1.87±0.00	3.60±0.00	5.24±0.00	1.46±0.00
Liberia	11	9.31±0.58	3.43±0.14	2.28±0.11	2.72±0.12	4.08±0.12	1.51±0.05
Senegal	13	8.45±1.28	2.96±0.39	2.08±0.16	2.99±0.66	4.17±0.62	1.42±0.11
Madagascar	47	0.31±0.09	0.10±0.03	0.06±0.02	0.14±0.06	0.19±0.06	0.07±0.04
Kenya	28	0.32±0.08	0.10±0.04	0.07±0.02	0.13±0.03	0.18±0.05	0.06±0.02
Nigeria	20	0.26±0.07	0.09±0.02	0.07±0.02	0.11±0.05	0.16±0.04	0.07±0.01
Ivory Coast	1	0.49 -	0.09 -	0.04 -	0.24 -	0.24 -	0.06 -
Liberia	11	0.27±0.05	0.08±0.01	0.06±0.02	0.10±0.02	0.14±0.04	0.06±0.01
Senegal	13	0.24±0.04	0.10±0.02	0.07±0.02	0.13±0.04	0.16±0.07	0.07±0.02

(2) In the widths for the strain level, the widest (3.89 mm) was obtained in No.1051, followed by No.1070 (3.88 mm) and No.1106 (3.77 mm). The narrowest (2.21 mm) was noted in No.1160, followed by No.1182 (2.44 mm) and No.1032-3 (2.46 mm). In the country level, the widest (3.43 mm) was obtained in LI, followed by NI (3.32 mm). The narrowest (2.73 mm) was

noted in IV, followed by SE (2.96 mm). Average and its standard deviations through the whole strains were found to be 3.09±0.37.

In the standard deviations of each strain, the largest (0.18) was obtained in No.1070, followed by Nos.1052 and 1078 (0.17). The smallest (0.05) was noted in Nos.1008, 1061 and 1081. In the country level, the largest (0.39) was obtained in SE, which was the same as in case of the length, followed by KE (0.35). The smallest (0.14) was noted in LI, followed by MD (0.32).

In the standard deviations of each country, the difference between the largest (0.10) and the smallest (0.08) was fixed to be very small (0.02). Average and its standard deviations in the whole strains were found to be 0.10±0.03.

(3) In the thicknesses for the strain level, the thickest (2.48 mm) was obtained in No.1106, followed by No.1070 (2.45 mm) and No.1110 (2.41 mm), in which the former was the same as in case of the width. The thinnest (1.73 mm) was noted in No.1182, which was the same as in case of the length, followed by No.1078 (1.75 mm) and No.1160 (1.83 mm). In the country level, the thickest (2.28 mm) was obtained in LI, followed by NI (2.17 mm). These orders of countries (LI > NI) were found to be the same as in case of the width. The thinnest (1.87 mm) was noted in IV, which was the same as in case of the width and was noted to be quite a small value, followed by MD (2.06 mm). Average and its standard deviations through the whole strains were found to be 2.10±0.15.

In the standard deviations of each strain, the largest (0.13) was obtained in No.1183, followed by No.1005 (0.12), and Nos.1070 and 1078 (0.11), in which No.1005, and Nos.1070 and 1078 were the same as in cases of the length and the width, respectively. The smallest (0.03) was noted in Nos.1032-3 and 1035, followed by 14 strains (0.04). In the country level, the largest (0.16) was obtained in SE, which was the same as in cases of the length and the width, followed by NI (0.14). The smallest (0.11) was noted in MD and LI.

In the standard deviations of each country, the difference between the largest (0.07) and the smallest (0.04) was fixed to be very small (0.03). Average and its standard deviations in the whole strains were found to be 0.07±0.02.

(4) In the ratios of length to width (L/W) for the strain level, the largest (4.22) was obtained in No.1032-3, followed by No.1034-4 (4.21), and Nos.1031-2 and 1190 (4.09). The smallest (2.02) was noted in No.1033, followed by Nos.1049 and 1051 (2.12). In the country level, the largest (3.60) was obtained in IV, which was the same as in case of the length and was noted to be of quite a large value, followed by KE (3.26). These orders of countries (IV > KE) were found to be the same as in case of the length. The smallest (2.72) was noted in LI, followed by NI (2.78), which was the same as in case of the length. Average and its standard deviations through the whole strains were found to be 3.05±0.54.

In the standard deviations of each strain, the largest (0.28) was obtained in No.1005, followed by Nos.1001 and 1040 (0.24). The smallest (0.06) was noted in Nos.1097 and 1138, followed by Nos.1093, 1173 and 1200 (0.07), in which No.1173 was the same as in case of the length. In the country level, the largest (0.66) was obtained in SE, which was the same as in cases of the length, width and thickness, followed by MD (0.56). The orders of countries (SE > MD) were found to be the same as in case of the length. The smallest (0.12) was noted in LI, which was the same as in cases of the width and thickness, followed by NI (0.39). These combinations of countries (NI and LI) were found to be the same as in case of the length.

In the standard deviations of each country, the difference between the largest (0.24) and

the smallest (0.10) was fixed to be very small (0.14). Average and its standard deviations in the whole strains were found to be 0.13 ± 0.15.

(5) In the ratios of length to thickness (L/T) for the strain level, the largest (5.61) was obtained in No.1036, which was the same as in case of the length, followed by No.1073 (5.38) and No.1083 (5.31), in which the latter was also the same as in case of the length. The smallest (3.25) was noted in No.1033, which was the same as in case of the L/W, followed by No.1070 (3.44) and No.1049 (3.45), in which the latter was also the same as in case of the L/W. In the country level, the largest (5.24) was obtained in IV, which was the same as in cases of the length and L/W, followed by KE (4.70). These orders of countries (IV > KE) were found to be the same as in cases of the length and L/W. The smallest (4.08) was noted in LI, which was the same as in case of the L/W, followed by SE (4.17), which was the same as in case of the width. Average and its standard deviations through the whole strains were found to be 4.45 ± 0.51.

In the standard deviations of each strain, the largest (0.39) was obtained in No.1078, followed by Nos.1028 and 1041 (0.37). The smallest (0.08) was noted in No.1190, followed by No.1135 (0.09), and Nos.1092, 1102, 1139 and 1173 (0.10), in which No.1092 was the same as in case of the L/W. In the country level, the largest (0.62) was obtained in SE, which was the same as in cases of the length, width, thickness and L/W, followed by MD (0.50). These orders of countries (SE > MD) were found to be the same as in cases of the length and L/W. The smallest (0.12) was noted in LI, which was the same as in cases of the width, thickness and L/W, followed by NI (0.40). These orders of countries (LI < NI) were found to be the same as in case of the L/W. Moreover, these combinations of countries (NI and LI) were found to be the same as in case of the length.

In the standard deviations of each country, the difference between the largest (0.24) and the smallest (0.14) was fixed to be very small (0.10). Average and its standard deviations in the whole strains were found to be 0.16 ± 0.06.

(6) In the ratios of width to thickness (W/T) for the strain level, the largest (1.86) was obtained in No.1051, which was the same as in case of the width, followed by No.1050 (1.75) and No.1092 (1.73). The smallest (1.21) was noted in No.1160, which was the same as in case of the width, followed by Nos.1032-3 and 1034-4 (1.23). In the country level, the largest (1.53) was obtained in NI, followed by LI (1.51). These combinations of countries (NI and LI) were found to be the same as in cases of the width and thickness. The smallest (1.42) was noted in SE, which was the same as in case of the length, followed by KE and IV (1.46). These combinations of countries (IV and SE) were found to be the same as in case of the width. Average and its standard deviations through the whole strains were found to be 1.47 ± 0.12.

In the standard deviations of each strain, the largest (0.31) was obtained in No.1028, which was noted to be of quite a large value, followed by Nos.1040 and 1077 (0.11), in which the former was the same as in case of the L/W. The smallest (0.02) was noted in No.1081, which was the same as in case of the width, followed by No.1065 (0.03) and 10 strains (0.04). In the country level, the largest (0.14) was obtained in MD, followed by SE (0.11). These combinations of countries (MD and SE) were found to be the same as in cases of the length, L/W and L/T. The smallest (0.05) was noted in LI, which was the same as in cases of the width, thickness, L/W and L/T, followed by NI (0.09). These orders of countries (LI < NI) were found to be the same as in cases of the L/W and L/T. Moreover, these combinations of countries (NI and LI) were found to be the same as in case of the length.

In the standard deviations of each country, the difference between the largest (0.07) and

the smallest (0.06) was fixed to be very small (0.01). Average and its standard deviations in the whole strains were found to be 0.07±0.03.

(7) In general, strains of IV and KE, and SE were fixed to be of longer and shorter grain types, respectively. Strains of LI and NI, and of IV were fixed to be of wider and narrower grain types, respectively. Strains of LI and IV were fixed to be of thicker and thinner grain types, respectively.

Table 3. Six morphological characters of unhusked grains belonging to the respective grain types of six countries of Africa, in accordance with tripartite classification in case of *O. sativa*. Upper column; practical values, lower column; standard deviations

Country	Grain type	No. of strains	Length (mm)	Width (mm)	Thickness (mm)	L/W	L/T	W/T
Madagascar	A	1	7.22±0.00	3.58±0.00	2.22±0.00	2.02±0.00	3.25±0.00	1.61±0.00
	B	20	9.70±0.99	3.25±0.24	2.12±0.11	3.02±0.46	4.60±0.46	1.54±0.12
	C	26	9.11±0.94	2.84±0.25	2.01±0.08	3.26±0.58	4.55±0.47	1.42±0.12
Kenya	B	19	9.77±0.77	3.19±0.32	2.12±0.12	3.12±0.51	4.63±0.49	1.51±0.12
	C	9	9.56±0.44	2.70±0.11	1.98±0.09	3.56±0.20	4.84±0.18	1.37±0.07
Nigeria	B	14	9.13±0.49	3.50±0.23	2.23±0.13	2.64±0.33	4.08±0.37	1.55±0.08
	C	6	9.09±0.45	2.89±0.10	2.03±0.05	3.13±0.28	4.57±0.20	1.47±0.10
Ivory Coast	C	1	9.81±0.00	2.73±0.00	1.87±0.00	3.60±0.00	5.24±0.00	1.46±0.00
Liberia	B	9	9.56±0.21	3.47±0.11	2.32±0.07	2.76±0.07	4.13±0.09	1.50±0.05
	C	2	8.15±0.14	3.25±0.06	2.10±0.01	2.52±0.09	3.89±0.08	1.52±0.01
Senegal	A	1	6.30±0.00	2.44±0.00	1.73±0.00	2.59±0.00	3.65±0.00	1.41±0.00
	B	4	9.72±1.00	3.10±0.30	2.17±0.09	3.20±0.60	4.51±0.65	1.43±0.09
	C	8	8.39±0.94	2.96±0.46	2.08±0.13	2.93±0.69	4.07±0.56	1.42±0.12
Madagascar	A	1	0.22 -	0.12 -	0.07 -	0.10 -	0.14 -	0.07 -
	B	20	0.32±0.11	0.11±0.03	0.07±0.02	0.15±0.08	0.21±0.07	0.09±0.06
	C	26	0.30±0.07	0.10±0.02	0.06±0.01	0.14±0.05	0.17±0.03	0.06±0.01
Kenya	B	19	0.32±0.08	0.10±0.03	0.07±0.02	0.12±0.03	0.17±0.03	0.06±0.02
	C	9	0.32±0.07	0.09±0.04	0.06±0.02	0.14±0.03	0.18±0.08	0.05±0.01
Nigeria	B	14	0.27±0.08	0.10±0.02	0.06±0.03	0.11±0.05	0.16±0.04	0.07±0.01
	C	6	0.24±0.03	0.08±0.02	0.06±0.01	0.12±0.02	0.15±0.03	0.06±0.02
Ivory Coast	C	1	0.49 -	0.09 -	0.04 -	0.24 -	0.24 -	0.06 -
Liberia	B	9	0.28±0.04	0.07±0.01	0.06±0.02	0.10±0.02	0.14±0.04	0.06±0.01
	C	2	0.20±0.04	0.10±0.01	0.05±0.01	0.08±0.00	0.12±0.02	0.06±0.02
Senegal	A	1	0.29 -	0.09 -	0.09 -	0.11 -	0.21 -	0.08 -
	B	4	0.22±0.03	0.10±0.02	0.06±0.01	0.12±0.03	0.14±0.04	0.05±0.02
	C	8	0.25±0.04	0.10±0.02	0.07±0.03	0.13±0.05	0.17±0.08	0.07±0.02

(8) Tripartite classification:

Based on the data obtained concerning the grain-length (L) and grain-width (W) of unhusked grains, the whole strains of *O. sativa* were classified into three grain types, *i.e.*, A (short) type, B (large) type and C (slender) type, according to the tripartite classification. Two strains of them belonged to the A type (1.7% of the whole strains=120), 66 strains to the B type (55.0%) and 52 strains to the C type (43.3%), respectively (Table 3). Two strains of A type were found in No.1033, variety name as Japonè, collected in Ambolajanakomby, Madagascar, and in No.1182, variety name as Mano nding wouling, collected in Biaro, Kolda,

Senegal. Average values and their standard deviations of six characters found in the respective types and in the respective countries were shown in the upper column of Table 3.

Average values and their standard deviations of the length in the whole strains were found to be 6.76 mm±0.46 (A type, 2 strains), 9.55 mm±0.82 (B type, 66 strains) and 9.07 mm±0.89 (C type, 52 strains), respectively. Average values and their standard deviations of the width in the whole strains were found to be 3.01 mm±0.57 (A type), 3.30 mm±0.29 (B type) and 2.84 mm±0.27 (C type), respectively. Average values and their standard deviations of the thickness in the whole strains were found to be 1.98 mm±0.25 (A type), 2.17 mm±0.13 (B type) and 2.02 mm±0.10 (C type), respectively.

Average values and their standard deviations of L/W in the whole strains were found to be 2.31±0.29 (A type), 2.94±0.47 (B type) and 3.22±0.56 (C type), respectively. Average values and their standard deviations of L/T in the whole strains were found to be 3.45±0.20 (A type), 4.43±0.50 (B type) and 4.51±0.50 (C type), respectively. Average values and their standard deviations of W/T in the whole strains were found to be 1.51±0.10 (A type), 1.52±0.11 (B type) and 1.42±0.11 (C type), respectively.

In B type, strains of KE and NI were fixed to be of longer and shorter types, respectively. On the contrary, in C type, strains of IV and LI were fixed to be of longer and shorter types, respectively. It was noted that the range was peculiarly large. In B type, strains of NI and LI, and SE were fixed to be of wider and narrower types, respectively. In C type, strains of LI, and IV and KE were fixed to be of wider and narrower types, respectively.

In B type, LI, and KE and MD were fixed to be of thicker and thinner types, respectively. In C type, LI and IV were fixed to be of thicker and thinner types, respectively.

Standard deviations illustrated by the average values of the respective countries and of the respective grain types were shown in the lower column of Table 3. It was noticed that the values were fixed to be relatively small excepting in the case of length.

2. *O. glaberrima* STEUD. (81 strains)

(1) In the lengths for the strain level, the longest (9.84 mm) was obtained in Accession No.1114 (Collection No.114 in 1985), followed by Nos.1105 and 1129 (9.77 mm). The shortest (7.47 mm) was noted in No.1194, followed by No.1177 (7.64 mm) and No.1198 (7.75 mm). In the country level (upper colomn of Table 4), the longest (9.29 mm) was obtained in NI. It was

Table 4. Six morphological characters of unhusked grains collected in the four countries of Africa in 1984 and 1985, illustrated by average values of the respective countries in case of *O. glaberrima*. Upper column; practical values, lower column; standard deviations

Country	No. of strains	Length (mm)	Width (mm)	Thickness (mm)	L/W	L/T	W/T
Nigeria	25	9.29±0.33	3.50±0.16	2.12±0.08	2.67±0.15	4.40±0.32	1.66±0.08
Liberia	12	8.76±0.47	3.05±0.19	1.92±0.14	2.88±0.23	4.60±0.41	1.60±0.06
Ivory Coast	3	8.90±0.20	3.27±0.05	1.94±0.07	2.72±0.03	4.60±0.20	1.69±0.06
Senegal	41	8.45±0.41	3.30±0.25	2.03±0.08	2.57±0.15	4.18±0.23	1.63±0.05
Nigeria	25	0.24±0.05	0.11±0.03	0.07±0.02	0.10±0.03	0.14±0.04	0.08±0.02
Liberia	12	0.20±0.06	0.08±0.02	0.06±0.01	0.09±0.03	0.15±0.05	0.06±0.02
Ivory Coast	3	0.22±0.04	0.11±0.01	0.07±0.01	0.11±0.00	0.19±0.02	0.08±0.01
Senegal	41	0.19±0.05	0.09±0.02	0.06±0.01	0.09±0.03	0.15±0.04	0.07±0.02

noted that the value was particularly large. The smallest (8.45 mm) was noted in SE. Average and its standard deviations through the whole strains (=81) were found to be 8.77±0.53.

In the standard deviations of each strain, *i.e.*, in those showing intra-population's variations, the largest (0.39) was obtained in No.1015, followed by No.1179 (0.37) and No.1129 (0.33). The smallest (0.09) was noted in No.1155, followed by No.1133 (0.10) and No.1144 (0.12). In the country level, the largest (0.47) was obtained in LI. The smallest (0.20) was noted in IV.

Standard deviations illustrated by average values of the respective countries were shown in the lower column of Table 4. The largest (0.24) was obtained in NI. The smallest (0.19) was noted in SE. Average and its standard deviations in the whole strains were found to be 0.21 ±0.06.

(2) In the widths for the strain level, the widest (3.83 mm) was obtained in No.1105, followed by No.1158 (3.75 mm) and No.1094 (3.73 mm). The narrowest (2.70 mm) was noted in No.1129-2, followed by No.1145 (2.78 mm) and No.1129 (2.87 mm). In the country level, the widest (3.50 mm) was obtained in NI, which was the same as in case of the length. The narrowest (3.05 mm) was noted in LI. Average and its standard deviations through the whole strains were found to be 3.32±0.22.

In the standard deviations of each strain, the largest (0.16) was obtained in No.1014, followed by Nos.1015, 1016 and 1112 (0.15). The smallest (0.06) was noted in 7 strains, *i.e.*, Nos.1096, 1098, 1133, 1137, 1146, 1153 and 1105. In the country level, the largest (0.25) was obtained in SE. The smallest (0.05) was noted in IV, which was the same as in case of the length.

In the standard deviations of each country, the difference between the largest (0.11) and the smallest (0.08) was fixed to be very small (0.03). Average and its standard deviations in the whole strains were found to be 0.10±0.02.

(3) In the thicknesses for the strain level, the thickest (2.26 mm) was obtained in No.1105, which was the same as in case of width, followed by No.1098 (2.24 mm) and No.1015 (2.22 mm). The thinnest (1.60 mm) was noted in No.1129-2, which was also the same as in case of the width, followed by No.1145 (1.72 mm) and No.1129 (1.75 mm). These orders of strains (1129-2 < 1145 < 1129) were found to be the same as in case of the width. In the country level, the thickest (2.12 mm) was obtained in NI, which was the same as in cases of the length and width. The thinnest (1.92 mm) was noted in LI, which was also the same as in case of the width. Average and its standard deviations through the whole strains were found to be 2.04 ±0.12.

In the standard deviations of each strain, the largest (0.13) was obtained in No.1015, which was the same as in case of the length, followed by Nos.1117, 1129-2, 1170 and 1199 (0.09). The smallest (0.04) was noted in Nos.1010, 1123, 1137, 1150, 1164 and 1175. In the country level, the largest (0.14) was obtained in LI, which was the same as in case of the length. The smallest (0.07) was noted in IV, which was the same as in cases of the length and width.

In the standard deviations of each country, the difference between the largest (0.07) and the smallest (0.06) was fixed to be very small (0.01). Average and its standard deviations in the whole strains were fixed to be 0.06±0.01.

(4) In the ratios of length to width (L/W) for the strain level, the largest (3.40) was obtained in No.1129, followed by No.1189 (3.19) and No.1016 (3.09). It was noticed that the value was peculiarly large in No.1129. The smallest (2.27) was noted in No.1158, followed by

No.1171 (2.39), and Nos.1159 and 1177 (2.41), in which the last one was the same as in case of the length. In the country level, the largest (2.88) was obtained in LI. The smallest (2.57) was noted in SE, which was the same as in case of the length. Average and its standard deviations through the whole strains were found to be 2.65 ± 0.20.

In the standard deviations of each strain, the largest (0.16) was obtained in Nos.1014, 1015 and 1114, in which the first and the second ones were the same as in cases of the width and the thickness, respectively. The smallest (0.06) was noted in Nos.1094, 1198, 1133, 1142, 1153 and 1195. These combinations of strains (Nos.1198, 1133 and 1153) were found to be the same as in case of the width. In the country level, the largest (0.23) was obtained in LI, which was the same as in the cases of the length and thickness. The smallest (0.03) was noted in IV, which was the same as in the cases of the length, width and thickness.

In the standard deviations of each country, the difference between the largest (0.11) and the smallest (0.09) was fixed to be very small (0.02). Average and its standard deviations in the whole strains were found to be 0.09 ± 0.03.

(5) In the ratios of length to thickness (L/T) for the strain level, the largest (5.59) was obtained in No.1129, which was the same as in case of the L/W, followed by No.1129-2 (5.02), and Nos.1016 and 1145 (4.95), in which the middle one was the same as in case of the L/W. It was noticed that the value was particularly large in No.1129, which was also the same in case of the L/W. The smallest (3.82) was noted in No.1177, followed by No.1198 (3.83) and No.1158 (3.89). In the country level, the largest (4.60) was obtained in LI and IV, in which the former one was the same as in case of the L/W. The smallest (4.18) was noted in SE, which was the same as in cases of the length and L/W. Average and its standard deviations through the whole strains were found to be 4.32 ± 0.30.

In the standard deviations of each strain, the largest (0.29) was obtained in No.1179, followed by No.1015 (0.28) and No.1129-2 (0.26). The smallest (0.08) was noted in No.1094, which was the same as in case of the L/W, followed by Nos.1013, 1123, 1148, 1150 and 1196 (0.09). In the country level, the largest (0.41) was obtained in LI, which was the same as in cases of the length, thickness and L/W. The smallest (0.20) was noted in IV, which was the same as in cases of the length, width, thickness and L/W. It was noticed that the values of IV were always the smallest in the respective five characters.

In the standard deviations of each country, the difference between the largest (0.19) and the smallest (0.14) was fixed to be very small (0.05). Average and its standard deviations in the whole strains were found to be 0.15 ± 0.05.

(6) In the ratios of width to thickness (W/T) for the strain level, the largest (1.77) was obtained in No.1002, followed by Nos.1117 and 1151 (1.74). The smallest (1.50) was noted in Nos.1015 and 1189, followed by No.1126 (1.54). In the country level, the largest (1.69) was obtained in IV, which was the same as in case of the L/T. The smallest (1.60) was noted in LI, which was the same as in cases of the width and thickness. Average and its standard deviations through the whole strains were found to be 1.64 ± 0.06.

In the standard deviations of each strain, the largest (0.12) was obtained in Nos.1014 and 1015, in which the former and the latter ones were the same as in the cases of the width and L/W, and the length, thickness and L/W, respectively, followed by Nos.1112, 1117 and 1151 (0.11), in which the former and the middle ones were the same as in cases of the width and the thickness, respectively. The smallest (0.04) was noted in Nos.1137, 1175 and 1196, in which the first and the second ones were the same as in cases of the width and thickness, respectively. In

the country level, the largest (0.08) was obtained in NI. The smallest (0.05) was noted in SE.

In the standard deviations of each country, the difference between the largest (0.08) and the smallest (0.06) was fixed to be very small (0.02). Average and its standard deviations in the whole strains were found to be 0.07±0.03.

(7) In general, strains of NI and SE were fixed to be of longer and shorter grain types, respectively. Strains of NI and LI were fixed to be of wider and narrower grain types, respectively. Strains of NI, and IV and LI were fixed to be of thicker and thinner grain types, respectively.

Table 5. Six morphological characters of unhusked grains belonging to the respective grain types of four countries of Africa, in accordance with tripartite classification in case of *O. glaberrima*. Upper column; practical values, lower column; standard deviations

Country	Grain type	No. of strains	Length (mm)	Width (mm)	Thickness (mm)	L/W	L/T	W/T
Nigeria	B	24	9.32±0.30	3.51±0.15	2.13±0.07	2.67±0.16	4.40±0.20	1.64±0.07
	C	1	8.54±0.00	3.23±0.00	1.92±0.00	2.65±0.00	4.46±0.00	1.69±0.00
Liberia	B	4	8.91±0.32	3.24±0.11	2.01±0.05	2.76±0.18	4.45±0.26	1.62±0.04
	C	8	8.68±0.51	2.95±0.15	1.87±0.14	2.95±0.22	4.68±0.44	1.59±0.06
Ivory Coast	B	1	9.11±0.00	3.33±0.00	2.01±0.00	2.74±0.00	4.53±0.00	1.66±0.00
	C	2	8.79±0.16	3.24±0.02	1.91±0.07	2.72±0.04	4.63±0.24	1.71±0.07
Senegal	B	22	8.60±0.18	3.40±0.11	2.08±0.07	2.56±0.11	4.19±0.21	1.64±0.05
	C	19	8.25±0.39	3.23±0.10	1.97±0.07	2.58±0.19	4.16±0.26	1.62±0.05
Nigeria	B	24	0.24±0.05	0.11±0.03	0.07±0.02	0.10±0.03	0.14±0.04	0.07±0.02
	C	1	0.26 -	0.13 -	0.07 -	0.12 -	0.21 -	0.09 -
Liberia	B	4	0.21±0.05	0.08±0.00	0.06±0.01	0.08±0.02	0.15±0.05	0.06±0.00
	C	8	0.19±0.07	0.08±0.02	0.05±0.01	0.09±0.03	0.15±0.06	0.06±0.02
Ivory Coast	B	1	0.22 -	0.10 -	0.07 -	0.11 -	0.17 -	0.07 -
	C	2	0.27±0.04	0.12±0.01	0.07±0.02	0.11±0.00	0.20±0.02	0.09±0.02
Senegal	B	22	0.21±0.06	0.10±0.02	0.06±0.01	0.09±0.03	0.14±0.05	0.07±0.04
	C	19	0.18±0.04	0.09±0.02	0.06±0.01	0.09±0.02	0.15±0.04	0.07±0.02

(8) Tripartite classification:

Though the tripartite classification was developed for the classification of *O. sativa*, it was temporarily used for *O. glaberrima* in the present paper.

Based on the data obtained concerning the grain-length (L) and grain-width (W) of unhusked grains, the whole strains of *O. glaberrima* were classified into two grain types, *i.e.*, B (large) type and C (slender) type, according to the tripartite classification. Zero strain of them belonged to A (short) type, 51 strains to the B type (63.0% of the whole strains=81) and 30 strains to the C type (37.0%), respectively (Table 5). Average values and their standard deviations of six characters found in the respective types and in the respective countries were shown in the upper column of Table 5.

Averages and their standard deviations of length in the whole strains were found to be 9.00 mm±0.41 (B type, 51 strains) and 8.38 mm±0.49 (C type, 30 strains), respectively. Averages and their standard deviations of width in the whole strains were found to be 3.44 mm ±0.15 (B type) and 3.13 mm±0.17 (C type), respectively. Averages and their standard deviations of thickness in the whole strains were found to be 2.09 mm±0.08 (B type) and 1.94 mm

±0.10 (C type), respectively.

Averages and their standard deviations of L/W in the whole strains were found to be 2.63±0.15 (B type) and 2.69±0.25 (C type), respectively. Averages and their standard deviations of L/T in the whole strains were found to be 4.31±0.23 (B type) and 4.34±0.39 (C type), respectively. Averages and their standard deviations of W/T in the whole strains were found to be 1.65±0.05 (B type) and 1.62±0.06 (C type), respectively.

In B type, strains of NI and SE were fixed to be of longer and shorter types, respectively. In C type, strains of IV and SE were fixed to be of longer and shorter types, respectively. In B type, strains of NI and LI were fixed to be of wider and narrower types, respectively. In C type, strains of IV, NI and SE were found to be nearly of the same width and fixed to be of wider type. Strains of LI were only found to be of narrower type.

In B type, strains of NI, and IV and LI were fixed to be of thicker and thinner types, respectively. In C type, strains of SE and LI were fixed to be of thicker and thinner types, respectively.

Standard deviations illustrated by the average values of the respective countries and of the respective grain types were shown in the lower column of Table 5. It was noted that the values were fixed to be relatively small excepting in the case of length.

Summary

The locality and species specificities of *Oryza sativa* L. (120 strains, *i.e.*, 47 of Madagascar, 28 of Kenya, 20 of Nigeria, 1 of Ivory Coast, 11 of Liberia and 13 of Senegal) and of *O. glaberrima* (81 strains, *i.e.*, 25 of Nigeria, 12 of Liberia, 3 of Ivory Coast and 41 of Senegal) collected in 1984 and 1985 in Africa were briefly reported in view of the unhusked grains.

In *O. sativa*, strains of IV (Ivory Coast) and KE (Kenya), and SE (Senegal) were fixed to be of longer and shorter grain types, respectively. Strains of LI and NI (Nigeria), and of IV were fixed to be of wider and narrower grain types, respectively. Strains of LI (Liberia) and IV were fixed to be of thicker and thinner grain types, respectively.

In *O. glaberrima*, strains of NI and SE were fixed to be of longer and shorter grain types, respectively. Strains of NI and LI were fixed to be of wider and narrower grain types, respectively. It was noticed that the standard deviations of IV were always the smallest in the respective five characters excepting the value of W/T.

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