

Morphological Characters of the Cultivated Rice Grains of Fiji (V)

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Introduction

In the 1982 academic year, the Kagoshima University Research Center for the South Pacific carried out the second-year's research in Fiji and Solomon Islands. This project examined the ecological, ethnological and bio-productive features of the natural environment, as well as the resources in Fiji and Solomon Islands. The present author was participated in the Project as a Leader for researching the agricultural sciences, *i.e.*, agricultural productivity, cultural pattern, pathological and physiological condition, land-use practices in tropical areas.

As a part of the project, 20 strains of cultivated rice, *Oryza sativa* L., using in Fiji were collected. Most of them were delivered him through the kindness of Dr. S. A. HAQUE, and some of those were directly collected in the fields by the members of the party. The grains of these strains were used for the morphological studies. The main purposes are to clarify the varietal variations and the phylogenetic relationships of the cultivated rice-strains used in the south Pacific areas.

Rice cultivation in Fiji had been started in Navua area in the late 19th century by Indo-Fijians, who migrated here as the contract workers of sugarcane plantation. Cultivation area was increased from year to year mainly by Indo-Fijians. Rice cultivation area was counted to be about 700 and 9,400 ha in 1951 and 1980, respectively. Cultivation area in Fiji increased yearly²⁾. The shares of rainfed fields in the total areas were 88% in area and 81% in production, respectively³⁾. However, the original place and migration route of the varieties used at the present was not clear. For example, No. 15 used in the present experimental series is called "Japanese" in the local appellation. However, it was detected to be an *indica* type belonging to the traditional one⁴⁾.

Since 1969, breeding works have been being pushed forward in viewpoints of aromatic¹⁾, short growing period¹⁰⁾ varieties, etc., in the several Asian countries. Sarma *et al.* (1990)¹¹⁾ reported that 43 traditional varieties in Assam showed grain length as 5.66–9.94 mm, breadth as 1.80–2.96 mm, L/B ratio as 2.44–4.33. Paramasivan *et al.* (1990)¹⁰⁾ reported that the TM6012 variety in Tamil Nadu showed "long slender" as recommended grain shape. Abassi *et al.* (1991)¹⁾ reported of a stability for the yield of medium-long-grain rice varieties and the advanced line in Pakistan. No report is recently recorded in South Pacific. In the present experimental series has been made to search the varietal variations, taking historical and racial improvements into considerations.

In the previous papers, the records of morphological characters of the unhusked and the husked grains, variation ranges in 12 characters⁴⁾, comparisons of the unhusked and the husked grains in 12 characters and the variation ranges in 12 characters⁶⁾, 12 correlation coefficients

between the practical values of the unhusked and the husked grains and linear regressions between the two⁸⁾, the remaining 15 mutual relations among 24 characters in view of practical values⁹⁾, were reported, in order to confirm the morphological characters of grains which were to make the strain's specificities clear.

In the present paper, mutual relations in the view of practical values, standard deviations and variation ranges were mainly described as the final report of the present experimental series, in order to confirm the morphological characters of grains as well as to make clear the geographical and ecotypic differentiations of the grains.

Materials and Methods

Twenty strains of rice cultivars, *Oryza sativa* L., collected in Fiji, between 15°S and 22°S, between 174°E and 174°W, south Pacific, during the trip were used in this experimental series. These are listed up in the Table 1 of the previous paper⁶⁾. In this table, strain number, ordinary sowing and harvesting times in the respective collection-sites and remarks are mentioned.

To make clear the relationships between practical values, standard deviations and variation ranges in the strain level, 6 relations were calculated, *i.e.*, practical value and other practical value, standard deviations and other standard deviations, variation range and other variation range (Table 1), practical value and its standard deviations, practical value and its variation range, standard deviations and its variation range (Table 2). Finally, comparisons of the 4 relation-groups were made, using mainly the data shown in Table 1 (Table 3) and those in Table 2 (Table 4).

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), s.d. (standard deviations), UHG (unhusked grain), HG (husked grain), c.c. (correlation coefficient), l.r. (linear regression), d.f. (degree of freedom).

Results

1. Relations between the practical values of the two respective characters

Correlation coefficient (abbreviated as c.c.) and linear regression (abbreviated as l.r.) of the practical value on another practical value among 27 character-combinations were calculated, and are shown in the left column of Table 1. Sixteen, 1 and 10 character-combinations showed significances at 0.1% and 5% levels and no significance even at 5% level, respectively. For example, c.c. of length (UHG) on thickness (UHG) through the whole strains (=20) was +0.6533 to the degree of freedom of 18, which is obviously significant at 0.1% level. Generally speaking, the longer is the length (UHG), the thicker is the thickness (UHG). L.r. of length (UHG) on thickness (UHG) was calculated as follows; $Y=0.341X+1.111$, where Y and X indicate length (UHG) and thickness (UHG), respectively. This formula indicates that the length (UHG) becomes 0.341 mm longer, when the thickness (UHG) becomes thicker by 1 degree.

2. Relations between the standard deviations of the two respective characters

C.c. and l.r. of s.d. on another s.d. among 27 character-combinations were calculated, and are shown in the central column of Table 1. Seven, 5, 9 and 6 character-combinations showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. For

Table 1. Correlation coefficient and linear regression of the former character (Y) on the latter character (X) for 27 combinations; practical value (left), s. d. (center) and range (right)

Combination	Practical value		S. d.		Range	
	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression
1·2	0.2254	—	-0.0292	—	-0.2487	—
1·3	0.6533***	Y=0.341X+1.111	0.2225	—	0.1022	—
2·3	0.4969*	Y=0.084X+1.386	0.4977*	Y=0.356X+0.034	0.0790	—
4·5	0.8697***	Y=0.824X+1.715	0.6820***	Y=0.519X+0.097	0.5514*	Y=0.358X+0.477
4·6	-0.7394***	Y=-0.202X+2.009	0.5386*	Y=0.223X+0.038	0.4856*	Y=0.169X+0.194
5·6	-0.3224	—	0.5524*	Y=0.300X+0.017	0.3117	—
11·12	0.2709	—	-0.0111	—	-0.0857	—
11·13	0.3241	—	0.4952*	Y=0.196X+0.035	0.3318	—
12·13	0.8685***	Y=0.451X+0.781	0.3462	—	0.4537*	Y=0.393X+0.151
14·15	0.8753***	Y=0.913X+0.961	0.7625***	Y=0.961X+0.041	0.3284	—
14·16	-0.6127***	Y=-0.163X+1.715	0.5114*	Y=0.262X+0.038	0.2780	—
15·16	-0.1606	—	0.7582***	Y=0.346X+0.018	0.3334	—
21·22	-0.1002	—	0.4376	—	-0.0045	—
21·23	-0.3895	—	0.7600***	Y=1.228X+0.002	0.0079	—
22·23	0.8061***	Y=0.510X+0.471	0.4551*	Y=0.667X+0.006	-0.0634	—
24·25	0.1114	—	0.6291**	Y=0.873X+0.003	0.0554	—
24·26	-0.0698	—	0.6739**	Y=0.873X+0.007	0.4664*	Y=0.690X+0.051
25·26	-0.0244	—	0.6766**	Y=0.632X+0.014	0.4431	—
1·11	0.9586***	Y=0.671X+0.315	0.7878***	Y=0.529X+0.037	0.5024*	Y=0.307X+0.404
2·12	0.8457***	Y=0.804X+0.064	0.2678	—	0.3040	—
3·13	0.9159***	Y=1.084X-0.397	0.6489**	Y=0.678X+0.022	0.0819	—
4·14	0.7369***	Y=0.673X+0.549	0.8718***	Y=0.687X+0.014	0.6005**	Y=0.344X+0.264
5·15	0.8280***	Y=0.833X-0.176	0.4947*	Y=0.575X+0.040	0.4528*	Y=0.408X+0.288
6·16	0.8059***	Y=0.715X+0.292	0.6195**	Y=0.585X+0.025	0.4347	—
31·33	0.9346***	Y=0.542X+1.234	0.4879*	Y=0.326X+0.295	0.4747*	Y=0.499X+0.515
32·34	0.9542***	Y=0.521X+0.451	0.5220*	Y=0.302X+0.763	0.8863***	Y=0.600X-1.244
35·36	0.9379***	Y=1.082X-0.109	0.8833***	Y=1.215X-0.004	0.2667	—

Character numbers; 1, 11, 21-length, 2, 12, 22-width, 3, 13, 23-thickness, 4, 14, 24-L/W, 5, 15, 25-L/T, 6, 16, 26-W/T, 1~6-unhusked grains, 11~16-husked grains, 21~26-comparative values (=husked/unhusked), 31-area (UHG), 32-volume (UHG), 33-area (HG), 34-volume (HG), 35-quotient of area (=33/31), 36-quotient of volume (=34/32)

***, **, *; significant at 0.1%, 1% and 5% levels, respectively

d. f. = 18

example, c.c. of s.d. of width (UHG) on s.d. of thickness (UHG) through the whole strains was +0.4977 to the degree of freedom of 18, which is significant at 5% level. Generally speaking, the larger is the s.d. of width (UHG), the larger is the s.d. of thickness (UHG). L.r. of the s.d. of width (UHG) on the s.d. of thickness (UHG) was calculated as follows; $Y=0.356X+0.034$, where Y and X indicate s.d. of width (UHG) and s.d. of thickness (UHG), respectively. This formula indicates that the s.d. of width (UHG) becomes 0.356 larger, when the s.d. of thickness (UHG) becomes larger by 1 degree.

3. Relations between the variation ranges of the two respective characters

C.c. and l.r. of variation range on another variation range among 27 character-combinations were calculated, and are shown in the right column of Table 1. One, 1, 7 and 18 character-combinations showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. For example, c.c. of the variation range of L/W (UHG) on variation range of L/T (UHG) through the whole strains was +0.5514 to the degree of freedom of 18, which is significant at 5% level. Generally speaking, the larger is the variation range of L/W (UHG), the larger is the variation range of L/T (UHG). L.r. of variation range of L/W (UHG) on variation

Table 2. Correlation coefficient and linear regression of the former character (Y) on latter character (X) for 24 characters; practical value on its s. d. (left), practical value on its range (center) and s. d. on its range (right)

Character	Practical value on S. d.		Practical value on Range		S. d. on Range	
	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression
1	0.6455**	Y=0.056X-0.235	0.5017*	Y=0.162X-0.382	0.8611***	Y=3.201X+0.219
2	0.3418	—	-0.2559	—	0.6860***	Y=2.356X+0.139
3	0.6285**	Y=0.083X-0.105	0.3541	—	0.7035***	Y=3.017X+0.088
4	0.6660**	Y=0.808X-0.117	0.6606**	Y=0.319X-0.391	0.8075***	Y=3.213X+0.158
5	0.4575*	Y=0.045X-0.025	0.3056	—	0.7781***	Y=2.638X+0.252
6	-0.1158	—	-0.0264	—	0.5625**	Y=1.879X+0.164
11	0.6986***	Y=0.058X-0.187	0.5842**	Y=0.165X-0.294	0.4465*	Y=1.930X+0.345
12	0.5155*	Y=0.042X-0.018	0.2694	—	0.7104***	Y=2.594X+0.105
13	0.6055**	Y=0.070X-0.064	0.2734	—	0.5469*	Y=2.353X+0.118
14	0.3143	—	0.4556*	Y=0.138X+0.103	0.6376**	Y=1.846X+0.272
15	0.3104	—	-0.1208	—	0.5591*	Y=1.469X+0.369
16	0.4492*	Y=0.091X-0.055	0.1496	—	0.8368***	Y=3.909X+0.024
21	0.3338	—	0.1311	—	0.5105*	Y=1.050X+0.038
22	-0.4417	—	0.2414	—	0.4810*	Y=1.460X+0.055
23	-0.5471*	Y=-0.326X+0.313	-0.2513	—	0.3774	—
24	-0.4406	—	-0.1308	—	0.2598	—
25	0.5611*	Y=0.248X-0.168	0.1700	—	0.2682	—
26	0.0321	—	0.4200	—	0.4714*	Y=1.547X+0.077
31	0.1112	—	0.3100	—	0.5216*	Y=1.560X+2.836
32	0.4065	—	0.6742**	Y=0.223X+2.298	0.6125**	Y=2.566X+5.839
33	0.6501**	Y=0.045X+0.004	0.5780**	Y=0.187X-0.003	0.7800***	Y=3.667X+0.337
34	0.7848***	Y=0.066X-0.125	0.7286***	Y=0.299X-1.217	0.8560***	Y=4.202X-0.006
35	-0.4276	—	0.4715*	Y=0.334X-0.118	0.2559	—
36	-0.5202*	Y=-0.170X+0.112	0.1512	—	0.2918	—

Character numbers; 1, 11, 21-length, 2, 12, 22-width, 3, 13, 23-thickness, 4, 14, 24-L/W, 5, 15, 25-L/T, 6, 16, 26-W/T, 1~6-unhusked grains, 11~16-husked grains, 21~26-comparative values (=husked/unhusked), 31-area (UHG), 32-volume (UHG), 33-area (HG), 34-volume (HG), 35-quotient of area (=33/31), 36-quotient of volume (=34/32)

** , ** , *; significant at 0.1% , 1% and 5% levels, respectively

d. f. = 18

range of L/T (UHG) was calculated as follows; $Y=0.358X+0.477$, where Y and X indicate the variation range of L/W (UHG) and the variation range of L/T (UHG), respectively. This formula indicates that the variation range of L/W (UHG) becomes 0.358 larger, when the variation range of L/T (UHG) becomes larger by 1 degree.

4. Relations between the practical values and their standard deviations

C.c. and l.r. of practical value on its s.d. among 24 characters were calculated, and are shown in the left column of Table 2. Two, 5, 6 and 11 characters showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. For example, c.c. of practical value of length (UHG) on s.d. of length (UHG) through the whole strains (=20) was +0.6455 to the degree of freedom of 18, which is significant at 1% level. Generally speaking, the longer is the practical value of length (UHG), the larger is the s.d. of length (UHG). L.r. of practical value of length (UHG) on s.d. of length (UHG) was calculated as follows; $Y=0.056X-0.235$, where Y and X indicate practical value and s.d. of length (UHG), respectively. This formula indicates that the practical value of length (UHG) becomes 0.056 mm longer, when the s.d. of length (UHG) becomes larger by 1 degree.

5. Relations between the practical values and their variation ranges

C.c. and l.r. of practical value on its variation range among 24 characters were calculated, and are shown in the central column of Table 2. One, 4, 3 and 16 characters showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. For example, c.c. of practical value of length (UHG) on variation range of length (UHG) through the whole strains was +0.5017 to the degree of freedom of 18, which is significant at 5% level. Generally speaking, the longer is the practical value of length (UHG), the larger is the variation range of length (UHG). L.r. of practical value of length (UHG) on variation range of length (UHG) was calculated as follows; $Y=0.162X-0.382$, where Y and X indicate the practical value and variation range of length (UHG), respectively. This formula indicates that the practical value of length (UHG) becomes 0.162 mm longer, when the variation range of length (UHG) becomes larger by 1 degree.

6. Relations between the standard deviations and their variation ranges

C.c. and l.r. of s.d. on its variation range among 24 characters were calculated, and are shown in the right column of Table 2. Nine, 3, 7 and 5 characters showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. For example, c.c. of s.d. of length (UHG) on variation range of length (UHG) through the whole strains was +0.8611 to the degree of freedom of 18, which is obviously significant at 0.1% level. Generally speaking, the larger is the s.d. of length (UHG), the larger is the variation range of length (UHG). L.r. of s.d. of length (UHG) on variation range of length (UHG) was calculated as follows; $Y=3.201X+0.219$, where Y and X indicate s.d. and variation range of length (UHG), respectively. This formula indicates that the s.d. of length (UHG) becomes 3.201 larger, when the variation range (UHG) becomes larger by 1 degree.

7. The four relation-groups under comparison

From the data obtained in Table 1 of the present experiment, relations between the two respective characters were compared, and are shown in Table 3. In this table, the 3 relation-

Table 3. Comparisons of 4 relation-groups; relations between the respective character-combinations in view of practical values (A), standard deviations (B), variation ranges (C) and summing-up of A, B and C packs (D). Figures used in column of D showed the number of significant relations in the respective combinations in disregarding of the grade of significances.

Combination	A	B	C	D	Combination	A	B	C	D
1·2				0	21·22				0
1·3	***			1	21·23		***		1
2·3	*	*		2	22·23	***	*		2
4·5	***	***	*	3	24·25		**		1
4·6	***	*	*	3	24·26		**	*	2
5·6		*		1	25·26		**		1
11·12				0	1·11	***	***	*	3
11·13		*		1	2·12	***			1
12·13	***		*	2	3·13	***	**		2
14·15	***	***		2	4·14	***	***	**	3
14·16	***	*		2	5·15	***	*	*	3
15·16		***		1	6·16	***	**		2
					31·33	***	*	*	3
					32·34	***	*	***	3
					35·36	***	***		2

Character numbers; 1, 11, 21-length, 2, 12, 22-width, 3, 13, 23-thickness, 4, 14, 24-L/W, 5, 15, 25-L/T, 6, 16, 26-W/T, 1~6-unhusked grains, 11~16-husked grains, 21~26-comparative values (=husked/unhusked), 31-area (UHG), 32-volume (UHG), 33-area (HG), 34-volume (HG), 35-quotient of area (=33/31), 36-quotient of volume (=34/32)

**, **, *; significant at 0.1%, 1% and 5% levels, respectively

d. f. = 18

groups, *i.e.*, relation between the two respective practical values (A column in Table 3), relation between the two respective s.ds. (B column in Table 3) and relation between the two respective variation ranges (C column in Table 3), were analysed. In addition to these, summed-up data in the columns of A, B and C were regulated, and are shown in D column of Table 3, under the condition that the calculation was to be made by means of the significances in disregard of significant levels.

Significant combinations were counted as 17/27 cases (=63.0%), 21/27 cases (=77.8%), 9/27 cases (=33.3%) and 47/81 cases (=58.0%) in columns A, B, C and D, respectively. In column A, 16, 1 and 10 character-combinations showed significances at 0.1% and 5% levels and no significance even at 5% level, respectively. In column B, 7, 5, 9 and 6 character-combinations showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. In column C, 1, 1, 7 and 18 character-combinations showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. In column D, 24, 6, 17 and 34 character-combinations showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. Moreover, 7, 9, 8 and 3 character-combinations showed significances at 3, 2, 1 and 0 columns, respectively. Average and its s.d. through the whole cases were found to be 1.74 ± 0.97 .

Through the whole columns, 27 character-combinations might be divided into 2 categories,

i.e., the one with higher frequency and the other with lower frequency. Seven character-combinations, *i.e.*, character-combination Nos. 4·5, 4·6, 1·11, 4·14, 5·15, 31·33, 32·34, belonged to the former one. The remaining 20 character-combinations belonged to the latter. It was noticed that the whole character-combinations of the husked grains and the comparative values belonged to the latter one.

8. The other four relation-groups under comparison

From the data obtained in Table 2 of the present experiment, relations between the two respective characters were compared, and are shown in Table 4. In this table, 3 relation-groups, *i.e.*, relation between practical values and their s.ds. (E column in Table 4), relation between practical values and their variation ranges (F column in Table 4) and relation between s.ds. and their variation ranges (G column in Table 4), were analysed. In addition to these, summed-up data from the columns of E, F and G were regulated, and are shown in H column of Table 4, under the condition that the calculation was made by means of the significances in disregard of significant levels.

Table 4. Comparisons of 4 relation-groups; relations between practical values and its standard deviations (E), practical values and its variation ranges (F), standard deviations and its variation ranges (G) and summing-up of E, F and G packs (H). Figures used in column of H showed the number of significant relations in the respective characters in disregarding of the grade of significances.

Character	E	F	G	H	Character	E	F	G	H
1	**	*	***	3	21			*	1
2			***	1	22			*	1
3	**		***	2	23	*			1
4	**	**	***	3	24				0
5	*		***	2	25	*			1
6			**	1	26			*	1
11	***	**	*	3	31			*	1
12	*		***	2	32		**	**	2
13	**		*	2	33	**	**	***	3
14		*	**	2	34	***	***	***	3
15			*	1	35		*		1
16	*		***	2	36	*			1

Character numbers; 1, 11, 21-length, 2, 12, 22-width, 3, 13, 23-thickness, 4, 14, 24-L/W, 5, 15, 25-L/T, 6, 16, 26-W/T, 1~6-unhusked grains, 11~16-husked grains, 21~26-comparative values (=husked/unhusked), 31-area (UHG), 32-volume (UHG), 33-area (HG), 34-volume (HG), 35-quotient of area (=33/31), 36-quotient of volume (=34/32)

** , ** , *; significant at 0.1%, 1% and 5% levels, respectively

d. f. = 18

Significant characters were counted as 13/24 cases (=54.2%), 8/24 cases (=33.3%), 19/24 cases (=79.2%) and 40/72 cases (=55.6%) in the columns of E, F, G and H, respectively. In column E, 2, 5, 6 and 11 characters showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. In column F, 1, 4, 3 and 16 characters showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. In

column G, 9, 3, 7 and 5 characters showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. In column H, 12, 12, 16 and 32 characters showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. Moreover, 5, 7, 11 and 1 characters showed significances at 3, 2, 1 and 0 columns, respectively. Average and its s.d. through the whole columns and characters were found to be 1.67 ± 1.13 .

Through the whole columns, 24 characters may be divided into 2 categories, *i.e.*, the one with higher frequency and other with lower frequency. Five characters, *i.e.*, character Nos. 1, 4, 11, 33 and 34, belonged to the former one. The remaining 19 characters belonged to the latter one. It was noticed that the whole characters of the comparative values (character No. 21 to No. 26) belonged to the latter one. Moreover, 19/24 characters (=79.2%) belonged to the latter.

Discussion

Basing on the results obtained in the previous and the present experiments, the following problematic items are to be discussed here.

1. C.c. of the practical value on another practical values (the left column of Table 1 and column A of Table 3) were decided to be significant in 17/27 cases (=63.0%). Sixteen character-combinations, *i.e.*, 3 of UHG, 3 of HG, 1 of comparative values, 6 of comparison, 3 of area and volume, showed significances at 0.1% level. The whole of the character-combinations belonging to comparison, and area and volume showed significances at 0.1% level. These phenomena were found to be the same as in case of Madura Island, Indonesia⁷⁾.

One character-combination, *i.e.*, 1 of UHG, showed significance at 5% level. Ten character-combinations, *i.e.*, 2 of UHG, 3 of HG, 5 of comparative values, showed no significance even at 5% level. In general, UHG, comparisons and area and volume columns showed higher significances. Average significant level and its s.d. through the whole character-combinations were found to be 1.78 ± 1.42 .

C.c. of the intra-strain's variation (=s.d.) on another variation (=s.d.) (the central column of Table 1 and column B of Table 3) were decided to be positively significant in 21/27 cases (=77.8%). Seven character-combinations, *i.e.*, 1 of UHG, 2 of HG, 1 of comparative values, 2 of comparison, 1 of area and volume, showed significances at 0.1% level. Five character-combinations, *i.e.*, 3 of comparative values, 2 of area and volume, showed significances at 1% level. Nine character-combinations, *i.e.*, 3 of UHG, 2 of HG, 1 of comparative value, 1 of comparison, 2 of area and volume, showed significances at 5% level. Six character-combinations, *i.e.*, 2 of UHG, 2 of UH, 1 of comparative values, 1 of comparison, showed no significance even at 5% level. In general, UHG and HG showed a few significances. Average significant level and its s.d. through the whole character-combinations were found to be 1.48 ± 1.10 .

C.c. of the variation range on another variation range (the right column of Table 1 and column C of Table 3) were decided to be positively significant in 9/27 cases (=33.3%). It was noticed that the value (=33.3%) was very low in comparison with those of Madura Island, Indonesia, in which the value was ascertained as 55.6%⁷⁾. One character-combination, *i.e.*, 1 of area and volume, showed significance at 0.1% level. Another 1 character-combination, *i.e.*, 1 of comparison, showed significance at 1% level. Seven character-combinations, *i.e.*, 2 of UHG, 1 of HG, 1 of comparative values, 2 of comparison, 1 of area and volume, showed significances at 5% level. Eighteen character-combinations, *i.e.*, 4 of UHG, 5 of HG, 5 of comparative values, 3 of comparison, 1 of area and volume, showed no significance even at 5% level. In general, UHG,

HG and comparative values showed a few significances. Average significant level and its s.d. through the whole character-combinations were found to be 0.44 ± 0.74 . It was noticed that the value ($=0.44$) was particularly small.

C.c. of the three columns mentioned above (column D of Table 3) were decided to be significant in 47/81 cases ($=58.0\%$). Seven character-combinations, *i.e.*, 2 of UHG, 3 of comparison, 2 of area and volume, showed significances at 3 columns. Nine character-combinations, *i.e.*, 1 of UHG, 3 of HG, 2 of comparative values, 2 of comparison, 1 of area and volume, showed significances at 2 columns. Eight character-combinations, *i.e.*, 2 of UHG, 2 of HG, 3 of comparative values, 1 of comparison, showed significances at 1 column. Three character-combinations, *i.e.*, 1 of UHG, 1 of HG, 1 of comparative values, showed no significance at all. In general, HG and comparative values showed a few significances. Average and its s.d. through the whole character-combinations were found to be 1.24 ± 1.26 . In view of significant level, those were found to be 1.74 ± 0.97 .

2. C.c. of the practical values on their s.d. of the respective characters (the left column of Table 2 and column E of Table 4) were decided to be significant in 13/24 cases ($=54.2\%$). Two characters, *i.e.*, 1 of HG, 1 of area and volume, showed significances at 0.1% level. Five characters, *i.e.*, 3 of UHG, 1 of HG, 1 of area and volume, showed significances at 1% level. Six characters, *i.e.*, 1 of UHG, 2 of HG, 2 of comparative values, 1 of area and volume, showed significances at 5% level. Eleven characters, *i.e.*, 2 of UHG, 2 of HG, 4 of comparative values, 3 of area and volume, showed no significance even at 5% level. In general, comparative values showed a few significances. Average significant level and its s.d. through the whole characters were found to be 0.92 ± 1.00 .

C.c. of practical value on their variation ranges of the respective characters (the central column of Table 2 and column F of Table 4) were decided to be positively significant in 8/24 cases ($=33.3\%$). One character, *i.e.*, 1 of area and volume, showed significance at 0.1% level. Four characters, *i.e.*, 1 of UHG, 1 of HG, 2 of area and volume, showed significances at 1% level. Three characters, *i.e.*, 1 of UHG, 1 of HG, 1 of area and volume, showed significances at 5% level. Sixteen characters, *i.e.*, 4 of UHG, 4 of HG, the whole ($=6$) of comparative values, 2 of area and volume, showed no significance even at 5% level. It was noticed that the whole of characters belonging to comparative values showed no significance at all. Average significant level and its s.d. through the whole characters were found to be 0.58 ± 0.91 .

C.c. of s.d. on their variation ranges of the respective characters (the right column of Table 2 and column G of Table 4) were decided to be positively significant in 19/24 cases ($=79.2\%$). Nine characters, *i.e.*, 5 of UHG, 2 of HG, 2 of area and volume, showed significances at 0.1% level. Three characters, *i.e.*, 1 of UHG, 1 of UH, 1 of area and volume, showed significances at 1% level. Seven characters, *i.e.*, 3 of HG, 3 of comparative values, 1 of area and volume, showed significances at 5% level. Five characters, *i.e.*, 3 of comparative values, 2 of area and volume, showed no significance even at 5% level. In general, UHG and HG showed many significances and at higher levels. On the other hand, comparative values showed a few significances. Average significant level and its s.d. through the whole characters were found to be 1.67 ± 1.18 .

C.c. of the three columns mentioned above (column H of Table 4) were decided to be significant in 40/72 cases ($=55.6\%$). Five characters, *i.e.*, 2 of UHG, 1 of HG, 2 of area and volume, showed significances at 3 columns. Seven characters, *i.e.*, 2 of UHG, 4 of HG, 1 of area and volume, showed significances at 2 columns. Eleven characters, *i.e.*, 2 of UHG, 1 of HG, 5 of comparative values, 3 of area and volume, showed significances at 1 column. One character, *i.e.*,

1 of comparative values, showed no significance even at 5% level. In general, comparative values showed low significant level. Average and its s.d. through the whole characters were found to be 1.06 ± 1.13 . In view of significant level, those were found to be 1.67 ± 0.85 .

It was noticed that the values (33.3% in F column and 79.2% in G column) were very low in comparison with those of Madura Island, Indonesia, in which the values were 45.8% and 100.0% in the columns of F and G, respectively⁷⁾.

3. Two, 0 and 0 negative correlations at the significant levels were found in the relationships of the practical value on another practical value (column A), of s.d. on another s.d. (column B) and of the variation range on another variation range (column C), respectively. It was noticeable that the character-combinations of comparative values, comparison, and area and volume showed no negative correlation at all.

The relations between L/W and W/T, *i.e.*, character-combination Nos. 4-6 in UHG and 14-16 in HG, showed negative significances. Moreover, character-combination Nos. 24-26 in comparative values showed also negative relation even non-significant level (Table 1).

Two, 0 and 0 negative correlations at the significant levels were found in the relations between the practical value and its s.d. (column E), between the practical value and its variation range (column F) and between s.d. and its variation range (column G), respectively. It was noticeable that the characters of UHG and HG showed no negative correlation at all.

Basing on the data obtained in the columns A to H, it was concluded that those phenomena meant the character-specificities in those characters. In other words, those characters might genetically be fixed as those in possession of a flexibility and an affectability to any effects coming from environmental conditions.

4. In summing-up, significant relations were found as 63.0%, 77.8%, 33.3%, 58.0%, 54.2%, 33.3%, 79.2% and 55.6% in the order of the columns from A to H, respectively. Average and its s.d. through the whole columns were found to be 56.80 ± 16.18 . It might be concluded that column G (=relation between s.d. and its variation ranges) was of the most stable character, being intimately correlated with each other through the whole strains in disregard of the geographical conditions. Because, these tendencies has been noticed in the strains of Burma⁵⁾ and Madura Island, Indonesia⁷⁾. However, some characters showed quite low correlation or no significant correlation at all even at 5% level.

Twenty-four characters and 27 mutual character-combinations were used for analysing the variety- and strain-differentiations in the present experimental series. Some of them are yet of developing status. Although, it might be affirmed that those characters of character-combinations are to be used for analysing the grain morphological constitution in the future.

Moreover, it might be confirmed that such indices of ideas may be used as a sort of handy indices in the experiment.

5. It might be noticeable that significant relations were found as 87/153 cases (=56.9%) in the summed-up data. Moreover, in view of significant level, 36/87 cases (=41.4%), 18/87 cases (=20.7%) and 33/87 cases (=37.9%) showed significances at 0.1%, 1% and 5% levels, respectively. In view of the significant level, through the columns A, B and C, 24/47 cases (=51.1%), 6/47 cases (=12.8%) and 17/47 cases (=36.2%) showed significant relations at 0.1%, 1% and 5% levels, respectively. In those through the columns of E, F and G, 12/40 cases (=30.0%), 12/40 cases (=30.0%) and 16/40 cases (=40.0%) showed significant relations at 0.1%, 1% and 5% levels, respectively. No clear difference was found between these two groups A~C and E~G.

In addition to those facts, 36/153 cases (=23.5%), 18/153 cases (=11.8%), 33/153 cases (=21.6%) and 66/153 cases (=43.1%) showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively.

Hence the assumption that this might mean some biological functions, extremely called “all or nothing”, *i.e.*, a phenomenon going from one extreme to another. In a stricter sense, those characters were looked upon being in possession of stable state, and being exhibited independently of other characters.

Summary

Succeeding to the previous papers, some morphological studies on grain characters and considerations on ecotypic differentiations of 20 strains of cultivated rice species, *Oryza sativa* L., collected in Fiji, South Pacific, were reported. The results obtained here were summarized as follows:

1. In the data obtained summed-up from 3 relation-groups, *i.e.*, practical value on the other practical values, s.d. on the other s.d.s. and variation range on other variation ranges, 17/27 character-combinations (=63.0%), 21/27 character-combinations (=77.8%) and 9/27 character-combinations (=33.3%) showed significances, respectively. Average significant levels and their s.d.s. through the whole character-combinations were found to be 1.78 ± 1.42 , 1.48 ± 1.10 and 0.44 ± 0.74 , respectively, in the same order. Through the 3 columns, 47/81 cases (=58.0%) showed significances.

2. Concerning correlations among the 3 components in the same characters, *i.e.*, between practical value and its s.d., between practical value and its variation range, and between s.d. and its variation range, 13/24 characters (=54.2%), 8/24 characters (=33.3%) and 19/24 characters (=79.2%) showed significant relations, respectively. Average significant levels and their s.d.s. through the whole characters were found to be 0.92 ± 1.00 , 0.58 ± 0.91 and 1.67 ± 1.18 , respectively, in the same order. Through the 3 columns, 40/72 cases (=55.6%) showed significances.

3. Varietal and ecotypic differentiations were extensively discussed, basing on the data from the previous and the present experiments. Characters and character-combinations confirmed in the experiments were to be looked upon as of something useful, having some universal validities and indices in the examinations of variety- and strain-differentiations. Moreover, comparisons of data obtained here and at some other neighbouring regions were carried out to some extents, and several interesting informations were shown in view of the locality-specificities.

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