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Some Morphological Characters of the Cultivated Rice Grains Collected in India (V)

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Introduction

During the period from December in 1978 to January in 1979, the writer was sent to India for collection of the wild and cultivated rices. In this opportunity, the cultivated rice practically planted not only in Assam but also in West Bengal States were directly collected in the fields and used for the studies in view of morphological characters found in grains.

Northeastern part of India has been seen as the one of the differentiation centers of rice (*Oryza sativa* L.), owing to the several genetical and cytogenetical investigations. However, some questions in these considerations were found and remained at the present. Sharma *et al.*[5] carried out the systematic collection of current and the primitive cultivars in the northeastern part of India in view of breeding program. For phylogenetical studies, investigation to clear and to confirm the varietal variations and the methodology for these purposes should be promoted as early as possible.

Taking into account these items, the present experimental series was made to accomplish the work which are going to clarify the varietal variations and the phylogenetical relationships of cultivated rice in India. In the previous papers, the records on morphological characters of the unhusked and the husked grains and some mutual relations[1], comparative values of them[2], variation ranges in 24 characters[2,3,4] were reported.

In the present paper, the remaining 15 mutual relations among 24 characters in the views of practical value were mainly described, in order to confirm the morphological characters of grains as well as to make clear the geographical and ecotypic differentiations of these grains.

Materials and Methods

Twenty-one strains of rice collected in India were used in this experimental series. They are listed up in Table 1 of the previous paper[1]. In this table, collection-number, -date and -place, the detailed informations of habitat are mentioned. States included in this paper are Meghalaya, Assam and West Bengal. The strains distributed in the respective localities have different meanings in view of morphological and physiological characters, and should be separately considered. So, they are divided into 2 groups, *i.e.*, Group A···strains collected in Meghalaya and Assam States (=9 strains), Group B···strains collected in West Bengal State (=12 strains).

To make clear the relations between the respective 2 characters of the unhusked and the husked grains in the grain level, correlation coefficient and linear regression between them were calculated through the whole characters, *i.e.*, comparative values (Tables 1 and 2), comparison of the unhusked with the husked grains (Tables 3 and 4), and area and volume columns (Table 5).

Some new techniques, in which relatively large or small strains were picked up and grouped, were adopted for the comparative studies of the whole strains collected.

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

Results

1. Comparative values of L and W

Group A: Correlation coefficient (abbreviated as c.c.) and linear regression (abbreviated as l.r.) of width (W) on length (L) in the same strains were calculated, and are shown in the left column of Table 1. One and 8 strains showed significance at 1% level and no significance even at 5% level, respectively. In the whole strains (=9), c.c. was +0.6166, showing no significance even at 5% level.

Group B: One and 11 strains showed significance at 5% level and no significance even at 5%

Table 1. Correlation coefficient and linear regression of the three components; comparative values of width (Y) on length (X), comparative values of thickness (Y) on length (X), comparative values of thickness (Y) on width (X)

Strain No.	Length and Width		Length and Thickness		Width and Thickness	
	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression
1	0.1669	—	−0.5000**	Y=−0.704X+1.433	−0.1101	—
2	0.3275	—	0.2808	—	0.1865	—
3	−0.0304	—	−0.5960***	Y=−1.500X+1.720	0.8207***	Y=0.376X+0.442
4	−0.1861	—	0.0446	—	0.0249	—
5	0.3097	—	−0.0808	—	0.0745	—
6	−0.4800**	Y=−0.397X+1.118	−0.0361	—	0.2102	—
7	0.0766	—	0.1843	—	0.0917	—
8	0.0298	—	0.2250	—	−0.2949	—
9	0.0767	—	0.0096	—	0.0995	—
10	0.2935	—	0.5246**	Y=0.835X+0.301	0.1463	—
11	−0.2582	—	−0.0524	—	−0.1120	—
12	0.1129	—	−0.0257	—	−0.0990	—
13	0.3680*	Y=0.500X+0.503	0.0013	—	−0.0556	—
14	−0.0128	—	0.5214**	Y=0.157X−0.200	−0.3103	—
15	−0.0399	—	0.1093	—	0.5068**	Y=0.248X+0.648
16	0.1405	—	0.0545	—	−0.0715	—
17	0.1257	—	0.5548**	Y=0.437X+0.599	0.1055	—
18	0.0398	—	0.2904	—	0.3202	—
19	0.3247	—	0.1704	—	0.0290	—
20	0.1286	—	−0.1064	—	0.0411	—
21	0.2212	—	0.2737	—	0.1132	—

***, **, *; significant at 0.1%, 1% and 5% levels, respectively. d.f.=28.

level, respectively. In the whole strains (=12), c.c. was −0.4093, showing no significance even at 5% level.

Whole: One, 1 and 19 strains showed significances at 1% and 5% levels and no significance even at 5% level, respectively. In the whole strains of both of the groups (=21), c.c. was +0.0072, showing no significance even at 5% level.

2. Comparative values of L and T

Group A: C.c. and l.r. of T on L in the same strains were calculated, and are shown in the central column of Table 1. One, 1 and 7 strains showed significances at 0.1% and 1% levels and no significance even at 5% level, respectively. In the whole strains, c.c. was +0.6597, showing no significance even at 5% level.

Group B: Three and 9 strains showed significances at 1% level and no significance even at 5% level, respectively. In the whole strains, c.c. was −0.2539, showing no significance even at 5% level.

Whole: One, 4 and 16 strains showed significances at 0.1% and 1% levels and no significance even at 5% level, respectively. In the whole strains of both of the groups, c.c. was +0.0679, showing no significance even at 5% level.

3. Comparative values of W and T

Group A: C.c. and l.r. of T on W in the same strains were calculated, and are shown in the right column of Table 1. One and 8 strains showed significance at 0.1% level and no significance even at 5% level, respectively. In the whole strains, c.c. was +0.9483 to the degree of freedom of 7, which is obviously significant at 0.1% level. Generally speaking, the larger is the comparative value of W, the larger is the comparative valus of T. L.r. of W on T was calculated as follows; $Y=0.884X+0.148$, where Y and X indicate the comparative values of W and T, respectively. This formula indicates that the comparative value of W becomes 0.884 larger, when the comparative value of T becomes larger by 1 degree.

Group B: One and 11 strains showed signficance at 1% level and no significance even at 5% level, respectively. In the whole strains, c.c. was +0.4127, showing no significance even at 5% level.

Whole: One, 1 and 19 strains showed significances at 0.1% and 1% levels and no significance even at 5% level, respectively. In the whole strains of both of the groups, c.c. was +0.9120 to the degree of freedom of 19, which is obviously significant at 0.1% level. Generally speaking, the larger is the comparative value of W, the larger is the comparative value of T. L.r. of W on T was calculated as follows; $Y=0.825X+0.201$, where Y and X indicate the comparative values of W and T, respectively. This formula indicates that the comparative value of W becomes 0.825 larger, when the comparative value of T becomes larger by 1 degree.

4. Comparative values of L/W and L/T

Group A: C.c. and l.r. of L/T on L/W in the same strains were calculated, and are shown in the left column of Table 2. One, 2 and 6 strains showed significances at 0.1% and 5% levels and no significance even at 5% level, respectively. In the whole strains, c.c. was +0.9534 to the degree of freedom of 7, which is obviously significant at 0.1% level. Generally speaking, the larger is the comparative value of L/W, the larger is the comparative value of L/T. L.r. of L/W on L/T was calculated as follows; $Y=0.991X-0.039$, where Y and X indicate the comparative values of L/W

Table 2. Correlation coefficient and linear regression of the three components; comparative values of ratio of length to thickness (Y) on ratio of length to width (X), comparative values of ratio of width to thickness (Y) on ratio of length to width (X), comparative values of ratio of width to thickness (Y) on ratio of length to thickness (X)

Strain No.	L/W and L/T		L/W and W/T		L/T and W/T	
	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression
1	0.2845	—	−0.5807***	Y=−0.748X+1.577	0.6032***	Y=0.873X+0.249
2	0.1945	—	−0.6070***	Y=−0.929X+1.746	0.6280***	Y=0.920X+0.237
3	0.8394***	Y=0.359X+0.628	−0.8647***	Y=−0.445X+1.424	−0.4528*	Y=−0.545X+1.472
4	0.4047*	Y=0.271X+0.501	−0.7950***	Y=−0.947X+1.745	0.1786	—
5	0.1334	—	−0.7030***	Y=−0.941X+1.727	0.5972***	Y=1.015X+0.143
6	0.4535*	Y=0.371X+0.473	−0.5590**	Y=−0.321X+1.200	−0.0173	—
7	0.2919	—	−0.7976***	Y=−0.868X+1.681	0.3188	—
8	0.1713	—	−0.9132***	Y=−0.890X+1.678	0.2233	—
9	0.2487	—	−0.7665***	Y=−0.912X+1.723	0.4139*	Y=0.735X+0.373
10	0.1562	—	−0.7034***	Y=−0.965X+1.759	0.5754***	Y=0.947X+0.180
11	0.1489	—	−0.5562**	Y=−0.690X+1.536	0.5320**	Y=0.904X+0.282
12	0.2961	—	−0.7762***	Y=−0.855X+1.616	0.3274	—
13	0.3945*	Y=0.382X+0.456	−0.5123**	Y=−0.679X+1.501	0.5779***	Y=0.790X+0.333
14	0.4069*	Y=0.446X+0.398	−0.7219***	Y=−1.593X+2.264	−0.4152*	Y=−0.836X+1.579
15	0.7342***	Y=0.510X+0.355	−0.6591***	Y=−0.471X+1.336	−0.0116	—
16	0.4024*	Y=0.274X+0.564	−0.5682**	Y=−0.561X+1.411	0.4356*	Y=0.633X+0.405
17	0.5290**	Y=0.285X+0.530	−0.7689***	Y=−0.769X+1.564	0.1063	—
18	0.4919**	Y=0.277X+0.545	−0.8048***	Y=−0.816X+1.611	0.0306	—
19	0.3993*	Y=0.352X+0.495	−0.6075***	Y=−0.676X+1.510	0.4688**	Y=0.592X+0.450
20	0.4456*	Y=0.397X+0.434	−0.3908*	Y=−0.414X+1.271	0.3753*	Y=0.446X+0.574
21	0.3024	—	−0.1627	—	0.2580	—

***, **, *; significant at 0.1%, 1% and 5% levels, respectively. d.f.=28.

and L/T, respectively. This formula indicates that the comparative value of L/W becomes 0.991 larger, when the comparative value of L/T becomes larger by 1 degree.

Group B: One, 2, 5 and 4 strains showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. In the whole strains, c.c. was +0.8054 to the degree of freedom of 10, which is significant at 1% level. Generally speaking, the larger is the comparative value of L/W, the larger is the comparative value of L/T. L.r. of L/W on L/T was calculated as follows; Y=0.498X+0.363, where Y and X indicate the comparative values of L/W and L/T, respectively. This formula indicates that the comparative value of L/W becomes 0.498 larger, when the comparative value of L/T becomes larger by 1 degree.

Whole: Two, 2, 7 and 10 strains showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. In the whole strains of both of the groups, c.c. was +0.9292 to the degree of freedom of 19, which is obviously significant at 0.1% level. Generally speaking, the larger is the comparative value of L/W, the larger is the comparative value of L/T. L.r. of L/W on L/T was calculated as follows; Y=0.905X+0.032, where Y and X indicate the comparative values of L/W and L/T, respectively. This formula indicates that the comparative

value of L/W becomes 0.905 larger, when the comprative value of L/T becomes larger by 1 degree.

5. Comparative values of L/W and W/T

Group A: C.c. and l.r. of W/T on L/W in the same strains were calculated, and are shown in the central column of Table 2. Eight and 1 strains showed significances at 0.1% and 1% levels, respectively. In other words, the whole strains showed significances. In the whole strains, however, c.c. was −0.6601, showing no significance even at 5% level.

Group B: Seven, 3, 1 and 1 strains showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. In the whole strains, c.c. was −0.6378 to the degree of freedom of 10, which is significant at 5% level. Generally speaking, the larger is the comparative value of L/W, the smaller is the comparative value of W/T. L.r. of L/W on W/T was calculated as follows; $Y=-0.425X+1.289$, where Y and X indicate the comparative values of L/W and W/T, respectively. This formula indicates that the comparative value of L/W becomes 0.425 larger, when the comparative value of W/T becomes smaller by 1 degree.

Whole: Fifteen, 4, 1 and 1 strains showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. In the whole strains of both of the groups, c.c. was −0.5848 to the degree of freedom of 19, which is significant at 1% level. Generally speaking, the larger is the comparative value of L/W, the smaller is the comparative value of W/T. L.r. of L/W on W/T was calculated as follows; $Y=-0.262X+1.161$, where Y and X indicate the comparative values of L/W and W/T, respectively. This formula indicates that the comparative value of L/W becomes 0.262 larger, when the comparative value of W/T becomes smaller by 1 degree.

6. Comparative values of L/T and W/T

Group A: C.c. and l.r. of W/T on L/T in the same strains were calculated, and are shown in the right column of Table 2. Three, 2 and 4 strains showed significances at 0.1% and 5% levels and no significance even at 5% level, respectively. In the whole strains, c.c. was −0.4060, showing no significance even at 5% level.

Group B: Two, 2, 3 and 5 strains showed significances at 0.1%, 1 and 5% levels and no significance even at 5% level, respectively. In the whole strains, c.c. was −0.1694, showing no significance even at 5% level.

Whole: Five, 2, 5 and 9 strains showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. In the whole strains of both of the groups, c.c. was −0.2945, showing no significance even at 5% level.

7. Lengths of UHG and HG

Group A: C.c. and l.r. of L of HG on L of UHG in the same strains were calculated, and are shown in the left column of Table 3. The whole strains (=9) showed significances at 0.1% level. In the whole strains, c.c. was +0.9777 to the degree of freedom of 7, which is obviously significant at 0.1% level. Generally speaking, the longer is the L of UHG, the longer is the L of HG. L.r. of L of UHG on L of HG was calculated as follows; $Y=0.628X+0.708$, where Y and X indicate L of UHG and L of HG, respectively. This formula indicates that the L of UHG becomes 0.628 mm longer, when the L of HG becomes longer by 1 degree.

Group B: Ten, 1 and 1 strains showed significances at 0.1%, 1% and 5% levels, respectively. In other words, the whole strains showed significances. In the whole strains, c.c. was +0.9768 to the degree of freedom of 10, which is obviously significant at 0.1% level. Generally speaking, the

Table 3. Correlation coefficient and linear regression of the three characters of unhusked (Y) on husked (X) grains; length, width and thickness

Strain No.	Length		Width		Thickness	
	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression
1	0.8799***	Y=0.656X+0.573	0.7287***	Y=0.609X+0.887	0.9058***	Y=0.786X+0.311
2	0.8934***	Y=0.623X+0.730	0.5591**	Y=0.471X+1.352	0.6860***	Y=0.699X+0.442
3	0.9078***	Y=0.714X−0.131	0.1555	—	0.9843***	Y=1.036X−0.591
4	0.9572***	Y=0.626X+0.711	0.7958***	Y=0.629X+0.641	0.9653***	Y=0.999X−0.201
5	0.7782***	Y=0.636X+0.621	0.6406***	Y=0.569X+0.949	0.8394***	Y=0.864X+0.090
6	0.8086***	Y=0.480X+1.993	0.9871***	Y=1.002X−0.501	0.9409***	Y=0.927X−0.052
7	0.9065***	Y=0.601X+0.963	0.6101***	Y=0.684X+0.552	0.8774***	Y=0.808X+0.229
8	0.8330***	Y=0.594X+0.905	0.7604***	Y=0.678X+0.398	0.9722***	Y=1.024X−0.264
9	0.7638***	Y=0.526X+1.705	−0.0722	—	0.6311***	Y=0.744X+0.312
10	0.8989***	Y=0.727X−0.118	0.7898***	Y=0.684X+0.458	0.8211***	Y=0.928X−0.067
11	0.8623***	Y=0.688X+0.132	0.4745**	Y=0.739X+0.330	0.8183***	Y=0.798X+0.193
12	0.8559***	Y=0.739X−0.462	0.9777***	Y=1.184X−1.028	0.9948***	Y=0.982X−0.158
13	0.7925***	Y=0.568X+1.157	0.8853***	Y=0.809X+0.104	0.9178***	Y=0.823X+0.168
14	0.9425***	Y=0.763X−0.642	0.8958***	Y=0.612X+0.602	0.9769***	Y=1.289X−0.829
15	0.4270*	Y=0.180X−4.205	0.7884***	Y=0.443X+0.916	0.9154***	Y=0.793X+0.203
16	0.9352***	Y=0.841X+1.149	0.7317***	Y=0.525X+0.836	0.7721***	Y=0.846X+0.128
17	0.7467***	Y=0.696X−0.122	0.9127***	Y=0.636X+0.490	0.8943***	Y=0.863X+0.070
18	0.8365***	Y=0.548X+1.420	0.6330***	Y=0.562X+0.941	0.9634***	Y=0.963X−0.124
19	0.5366***	Y=0.456X+2.030	0.7092***	Y=0.886X−0.252	0.8792***	Y=0.705X+0.454
20	0.9111***	Y=0.909X−2.118	0.7567***	Y=0.594X+0.615	0.8396***	Y=0.747X+0.336
21	0.7952***	Y=0.394X+2.896	0.6858***	Y=0.537X+0.893	0.7553***	Y=0.726X+0.418

***, **, *; significant at 0.1%, 1% and 5% levels, respectively. d.f.=28.

longer is the L of UHG, the longer is the L of HG. L.r. of L of UHG on L of HG was calculated as follows; Y=0.751X−0.493, where Y and X indicate L of UHG and L of HG, respectively. This formula indicates that the L of UHG becomes 0.751 mm longer, when the L of HG becomes longer by 1 degree.

Whole: Nineteen, 1 and 1 strains showed significances at 0.1%, 1% and 5% levels, respectively. In other words, the whole strains showed significances. In the whole strains of both of the groups, c.c. was +0.9694 to the degree of freedom of 19, which is obviously significant at 0.1% level. Generally speaking, the longer is the L of UHG, the longer is the L of HG. L.r. of L of UHG on L of HG was calculated as follows; Y=0.679X+0.213, where Y and X indicate L of UHG and L of HG, respectively. This formula indicates that the L of UHG becomes 0.679 mm longer, when the L of HG becomes longer by 1 degree.

8. Widths of UHG and HG

Group A: C.c. and l.r. of W of HG on W of UHG in the same strains were calculated, and are shown in the central column of Table 3. Six, 1 and 2 strains showed significances at 0.1% and 1% levels and no significance even at 5% level, respectively. In the whole strains, c.c. was +0.7818 to the degree of freedom of 7, which is significant at 5% level. Generally speaking, the wider is the W

of UHG, the wider is the W of HG. L.r. of W of UHG on W of HG was calculated as follows; $Y = 0.999X - 0.547$, where Y and X indicate W of UHG and W of HG, respectively. This formula indicates that the W of UHG becomes 0.999 mm wider, when the W of HG becomes wider by 1 degree.

Group B: Eleven and 1 strains showed significances at 0.1% and 1% levels, respectively. In other words, the whole strains showed significances. In the whole strains, c.c. was +0.9883 to the degree of freedom of 10, which is obviously significant at 0.1% level. Generally speaking, the wider is the W of UHG, the wider is the W of HG. L.r. of W of UHG on W of HG was calculated as follows; $Y = 0.773X + 0.201$, where Y and X indicate W of UHG and W of HG, respectively. This formula indicates that the W of UHG becomes 0.773 mm wider, when the W of HG becomes wider by 1 degree.

Whole: Seventeen, 2 and 2 strains showed significances at 0.1% and 1% levels and no significance even at 5% level, respectively. In the whole strains of both of the groups, c.c. was +0.8977 to the degree of freedom of 19, which is obviously significant at 0.1% level. Generally speaking, the wider is the W of UHG, the wider is the W of HG. L.r. of W of UHG on W of HG was calculated as follows; $Y = 0.799X + 0.106$, where Y and X indicate W of UHG and W of HG, respectively. This formula indicates that the W of UHG becomes 0.799 mm wider, when the W of HG becomes wider by 1 degree.

9. Thicknesses of UHG and HG

Group A: C.c. and l.r. of T of HG on T of UHG in the same strains were calculated, and are shown in the right column of Table 3. The whole strains showed significances at 0.1% level. In the whole strains, c.c. was +0.9728 to the degree of freedom of 7, which is obviously significant at 0.1% level. Generally speaking, the thicker is the T of UHG, the thicker is the T of HG. L.r. of T of UHG on T of HG was calculated as follows; $Y = 1.346X - 0.986$, where Y and X indicate T of UHG and T of HG, respectively. This formula indicates that the T of UHG becomes 1.346 mm thicker, when the T of HG becomes thicker by 1 degree.

Group B: The whole strains showed significances at 0.1% level. In the whole strains, c.c. was +0.9937 to the degree of freedom of 10, which is obviously significant at 0.1% level. Generally speaking, the thicker is the T of UHG, the thicker is the T of HG. L.r. of T of UHG on T of HG was calculated as follows; $Y = 0.876X + 0.056$, where Y and X indicate T of UHG and T of HG, respectively. This formula indicates that the T of UHG becomes 0.876 mm thicker, when the T of HG becomes thicker by 1 degree.

Whole: The whole strains showed significances at 0.1% level. In the whole strains of both of the groups, c.c. was +0.9551 to the degree of freedom of 19, which is obviously significant at 0.1% level. Generally speaking, the thicker is the T of UHG, the thicker is the T of HG. L.r. of T of UHG on T of HG was calculated as follows; $Y = 1.114X - 0.472$, where Y and X indicate T of UHG and T of HG, respectively. This formula indicates that the T of UHG becomes 1.114 mm thicker, when the T of HG becomes thicker by 1 degree.

10. L/W of UHG and HG

Group A: C.c. and l.r. of L/W of HG on L/W of UHG in the same strains were calculated, and are shown in the left column of Table 4. Eight and 1 strains showed significances at 0.1% level and no significance even at 5% level, respectively. In the whole strains, c.c. was +0.7500 to the degree of freedom of 7, which is significant at 5% level. Generally speaking, the larger is the L/W

Table 4. Correlation coefficient and linear regression of the three characters of unhusked (Y) on husked (X) grains; ratio of length to width, ratio of length to thickness and ratio of width to thickness

Strain No.	Length/Width		Length/Thickness		Width/Thickness	
	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression
1	0.5704***	Y=0.702X+0.354	0.8803***	Y=0.653X+0.468	0.8261***	Y=0.708X+0.341
2	0.7441***	Y=0.579X+0.576	0.5769***	Y=0.472X+1.117	0.5321***	Y=0.631X+0.504
3	−0.8404***	Y=−2.190X+9.679	0.9633***	Y=2.345X−6.697	0.3288	—
4	0.7618***	Y=0.711X+0.327	0.9313***	Y=0.838X−0.205	0.8787***	Y=0.913X+0.081
5	0.7811***	Y=0.718X+0.297	0.8242***	Y=0.684X+0.371	0.5560**	Y=0.528X+0.603
6	0.7798***	Y=0.754X+0.315	0.8918***	Y=0.625X+0.681	0.9839***	Y=1.009X−0.125
7	0.8287***	Y=0.785X+0.150	0.8784***	Y=0.687X+0.384	0.7761***	Y=0.677X+0.381
8	0.6825***	Y=0.725X+0.389	0.9385***	Y=0.762X+0.090	0.8661***	Y=0.825X+0.088
9	0.1683	—	0.3289	—	0.1469	—
10	0.9058***	Y=0.934X−0.248	0.8847***	Y=0.713X+0.363	0.9038***	Y=1.077X−0.199
11	0.6075***	Y=1.109X−1.179	0.8578***	Y=0.721X+0.265	0.7420***	Y=0.836X+0.178
12	0.9410***	Y=1.001X−0.494	0.9531***	Y=0.804X−0.204	0.9903***	Y=1.218X−0.383
13	0.8139***	Y=0.614X+0.764	0.7995***	Y=0.530X+1.058	0.6570***	Y=0.711X+0.274
14	0.9309***	Y=0.788X+0.152	0.9512***	Y=1.253X−0.202	0.8836***	Y=1.144X−0.279
15	0.6334***	Y=0.323X+1.798	0.8172***	Y=0.433X+1.462	0.8507***	Y=0.733X+0.286
16	0.8228***	Y=0.820X+0.233	0.8182***	Y=0.753X+0.239	0.6875***	Y=0.580X+0.427
17	0.7627***	Y=0.514X+1.141	0.6982***	Y=0.510X+1.144	0.7097***	Y=0.524X+0.492
18	0.7484***	Y=0.585X+0.681	0.9375***	Y=0.768X+0.018	0.8565***	Y=0.727X+0.293
19	0.7429***	Y=0.936X−0.157	0.7230***	Y=0.551X+0.786	0.6231***	Y=0.754X+0.235
20	0.8737***	Y=0.829X+0.088	0.8350***	Y=0.859X−0.393	0.7675***	Y=0.559X+0.438
21	0.7285***	Y=0.486X+1.120	0.8178***	Y=0.456X+1.314	0.6119***	Y=0.590X+0.437

***, **; significant at 0.1% and 1% levels, respectively. d.f.=28.

of UHG, the larger is the L/W of HG. L.r. of L/W of UHG on L/W of HG was calculated as follows; Y=0.919X−0.097, where Y and X indicate L/W of UHG and L/W of HG, respectively. This formula indicates that the L/W of UHG becomes 0.919 larger, when the L/W of HG becomes larger by 1 degree.

Group B: The whole strains showed significances at 0.1% level. In the whole strains, c.c. was +0.9609 to the degree of freedom of 10, which is obviously significant at 0.1% level. Generally speaking, the larger is the L/W of UHG, the larger is the L/W of HG. L.r. of L/W of UHG on L/W of HG was calculated as follows; Y=0.756X+0.220, where Y and X indicate L/W of UHG and L/W of HG, respectively. This formula indicates that the L/W of UHG becomes 0.756 larger, when the L/W of HG becomes larger by 1 degree.

Whole: Twenty and 1 strains showed significances at 0.1% level and no significance even at 5% level, respectively. In the whole strains of both of the groups, c.c. was +0.8887 to the degree of freedom of 19, which is obviously significant at 0.1% level. Generally speaking, the larger is the L/W of UHG, the larger is the L/W of HG. L.r. of L/W of UHG on L/W of HG was calculated as follows; Y=0.728X+0.354, where Y and X indicate L/W of UHG and L/W of HG, respectively. This formula indicates that the L/W of UHG becomes 0.728 larger, when the L/W of HG becomes

larger by 1 degree.

11. L/T of UHG and HG

Group A: C.c. and l.r. of L/T of HG on L/T of UHG in the same strains were calculated, and are shown in the central colum of Table 4. Eight and 1 strains showed significances at 0.1% and no significance even at 5% level, respectively. In the whole strains, c.c. was +0.9440 to the degree of freedom of 7, which is obviously significant at 0.1% level. Generally speaking, the larger is the L/T of UHG, the larger is the L/T of HG. L.r. of L/T of UHG on L/T of HG was calculated as follows; $Y=1.351X-0.203$, where Y and X indicate L/T of UHG and L/T of HG, respectively. This formula indicates that the L/T of UHG becomes 1.351 larger, when the L/T of HG becomes larger by 1 degree.

Group B: The whole strains showed significances at 0.1% level. In the whole strains, c.c. was +0.9735 to the degree of freedom of 10, which is obviously significant at 0.1% level. Generally speaking, the larger is the L/T of UHG, the larger is the L/T of HG. L.r. of L/T of UHG on L/T of HG was calculated as follows; $Y=0.758X+0.058$, where Y and X indicate L/T of UHG and L/T of HG, respectively. This formula indicates that the L/T of UHG becomes 0.758 larger, when the L/T of HG becomes larger by 1 degree.

Whole: Twenty and 1 strains showed significances at 0.1% and no significance even at 5% level, respectively. In the whole strains of both of the groups, c.c. was +0.8806 to the degree of freedom of 19, which is obviously significant at 0.1% level. Generally speaking, the larger is the L/T of UHG, the larger is the L/T of HG. L.r. of L/T of UHG on L/T of HG was calculated as follows; $Y=0.961X-0.676$, where Y and X indicate L/T of UHG and L/T of HG, respectively. This formula indicates that the L/T of UHG becomes 0.961 larger, when the L/T of HG becomes larger by 1 degree.

12. W/T of UHG and HG

Group A: C.c. and l.r. of W/T of HG on W/T of UHG in the same strains were calculated, and are shown in the right column of Table 4. Six, 1 and 2 strains showed significances at 0.1% and 1% levels and no significance even at 5% level, respectively. In the whole strains, c.c. was +0.9401 to the degree of freedom of 7, which is obviously significant at 0.1% level. Generally speaking, the larger is the W/T of UHG, the larger is the W/T of HG. L.r. of W/T of UHG on W/T of HG was calculated as follows; $Y=0.667X+0.397$, where Y and X indicates W/T of UHG and W/T of HG, respectively. This formula indicates that the W/T of UHG becomes 0.667 larger, when the W/T of HG becomes larger by 1 degree.

Group B: The whole strains showed significances at 0.1% level. In the whole strains, c.c. was +0.9562 to the degree of freedom of 10, which is obviously significant at 0.1% level. Generally speaking, the larger is the W/T of UHG, the large is the W/T of HG. L.r. of W/T of UHG on W/T of HG was calculated as follows; $Y=0.809X+0.168$, where Y and X indicate W/T of UHG and W/T of HG, respectively. This formula indicates that the W/T of UHG becomes 0.809 larger, when the W/T of HG becomes larger by 1 degree.

Whole: Eighteen, 1 and 2 strains showed significances at 0.1% and 1% levels and no significance even at 5% level, respectively. In the whole strains of both of the groups, c.c. was +0.9650 to the degree of freedom of 19, which is obviously significant at 0.1% level. Generally speaking, the larger is the W/T of UHG, the larger is the W/T of HG. L.r. of W/T of UHG on W/T of HG was calculated as follows; $Y=0.801\ X+0.187$, where Y and X indicates the W/T of

UHG and W/T of HG, respectively. This formala indicates that the W/T of UHG becomes 0.801 larger, when the W/T of HG becomes larger by 1 degree.

13. Areas of UHG and HG

Group A: C.c. and l.r. of area of HG on area of UHG in the same strains were calculated, and are shown in the left column of Table 5. Eight and 1 strains showed significances at 0.1% and 5% levels, respectively. In other words, the whole strains showed significances. In the whole strains, c.c. was +0.6928 to the degree of freedom of 7, which is significant at 5% level. Generally speaking, the wider is the area of UHG, the wider is the area of HG. L.r. of area of UHG on area of HG was calculated as follows; $Y=0.720X-3.330$, where Y and X indicates area of UHG and area of HG, respectively. This formula indicates that the area of UHG becomes 0.720 mm^2 wider, when the area of HG becomes wider by 1 degree.

Table 5. Correlation coefficient and linear regression of the three characters; area of husked grain (Y) on area of unhusked grain (X), volume of husked grain (Y) on volume of unhusked grain (X), and quotient of volume (Y) on quotient of area (X)

Strain No.	Area		Volume		Quotient	
	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression
1	0.7338***	Y=0.481X+4.025	0.8599***	Y=0.550X+1.920	0.8805***	Y=0.762X+0.099
2	0.7699***	Y=0.475X+3.922	0.5040**	Y=0.374X+11.854	0.5874***	Y=1.114X−1.325
3	0.9301***	Y=1.563X−27.593	0.9976***	Y=0.696X−16.002	0.9740***	Y=0.895X−0.093
4	0.9397***	Y=0.480X+3.114	0.9297***	Y=0.477X+3.421	0.8275***	Y=0.914X−0.009
5	0.5889***	Y=0.346X+7.346	0.7820***	Y=0.491X+3.506	0.9567***	Y=0.858X+0.026
6	0.9761***	Y=0.621X−0.509	0.5978***	Y=0.193X+18.007	−0.2123	—
7	0.5897***	Y=0.379X+5.801	0.7098***	Y=0.462X+5.667	0.9219***	Y=0.998X−0.052
8	0.8172***	Y=0.488X+2.036	0.8147***	Y=0.500X+0.679	0.8744***	Y=0.647X+1.479
9	0.4205*	Y=0.273X+8.605	0.6293***	Y=0.378X+8.969	0.8779***	Y=0.863X+0.017
10	0.7638***	Y=0.457X+3.933	0.7447***	Y=0.473X+3.815	0.8738***	Y=1.152X−0.153
11	0.6453***	Y=0.435X+3.386	0.7862***	Y=0.532X+1.105	0.6852***	Y=0.817X+0.052
12	0.9640***	Y=0.781X−4.592	0.9504***	Y=0.634X−5.356	0.9666***	Y=0.955X−0.024
13	0.8765***	Y=0.587X+0.174	0.9330***	Y=0.531X+0.381	0.9975***	Y=0.871X+0.022
14	0.8752***	Y=0.412X+4.066	0.9431***	Y=0.602X−4.736	0.4227*	Y=0.603X+1.635
15	0.7289***	Y=0.251X+6.057	0.7714***	Y=0.306X+7.352	0.9459***	Y=1.017X−0.066
16	0.8241***	Y=0.523X+2.183	0.8596***	Y=0.531X+0.775	0.8849***	Y=0.950X−0.028
17	0.9055***	Y=0.507X+1.454	0.9273***	Y=0.491X+1.075	0.9261***	Y=1.009X−0.063
18	0.3546	—	0.6496***	Y=0.358X+13.339	0.5817***	Y=0.895X+0.015
19	0.5883***	Y=0.462X+3.251	0.7412***	Y=0.422X+6.353	0.9189***	Y=0.908X−0.014
20	0.5827***	Y=0.374X+5.731	0.7400***	Y=0.382X+8.608	0.9536***	Y=0.947X−0.027
21	0.7456***	Y=0.351X+6.576	0.6405***	Y=0.317X+13.351	0.6499***	Y=0.837X+0.038

***, **, *; significant at 0.1%, 1% and 5% levels, respectively. d.f.=28.

Group B: Eleven and 1 strains showed significances at 0.1% and no significance even at 5% level, respectively. In the whole strains, c.c. was +0.9918 to the degree of freedom of 10, which is obviously significant at 0.1% level. Generally speaking, the wider is the area of UHG, the wider is

the area of HG. L.r. of area of UHG on area of HG was calculated as follows; $Y=0.566X+0.586$, where Y and X indicate the area of UHG and the area of HG, respectively. This formula indicates that the area of UHG becomes 0.566 mm^2 wider, when the area of HG becomes wider by 1 degree.

Whole: Nineteen, 1 and 1 strains showed significances at 0.1% and 5% levels and no significance even at 5% level, respectively. In the whole strains of both of the groups, c.c. was +0.8938 to the degree of freedom of 19, which obviously significant at 0.1% level. Generally speaking, the wider is the area of UHG, the wider is the area of HG. L.r. of area of UHG on area of HG was calculated as follows; $Y=0.587X+0.080$, where Y and X indicate the area of UHG and the area of HG, respectively. This formula indicates that the area of UHG becomes 0.587 mm^2 wider, when the area of HG becomes wider by 1 degree.

14. Volumes of UHG and HG

Group A: C.c. and l.r. of volume of HG on volume of UHG in the same strains were calculated, and are shown in the central column of Table 5. Eight and 1 strains showed significances at 0.1% and 1% levels, respectively. In other words, the whole strains showed significances. In the whole strains, c.c. was +0.9241 to the degree of freedom of 7, which is obviously significant at 0.1% level. Generally speaking, the larger is the volume of UHG, the larger is the volume of HG. L.r. of volume of UHG on volume of HG was calculated as follows; $Y=0.761X-12.679$, where Y and X indicate the volume of UHG and volume of HG, respectively. This formula indicates that the volume of UHG becomes 0.761 mm^3 larger, when the volume of HG becomes larger by 1 degree.

Group B: The whole strains showed significances at 0.1% level. In the whole strains, c.c. was +0.9925 to the degree of freedom of 10, which is obviously significant at 0.1% level. Generally speaking, the larger is the volume of UHG, the larger is the volume of HG. L.r. of volume of UHG on volume of HG was calculated as follows; $Y=0.512X+1.033$, where Y and X indicate the volume of UHG and the volume of HG, respectively. This formula indicates that the volume of UHG becomes 0.512 mm^3 larger, when the volume of HG becomes larger by 1 degree.

Whole: Twenty and 1 strains showed significances at 0.1% and 1% levels, respectively. In other words, the whole strains showed significances. In the whole strains of both of the groups, c.c. was +0.9429 to the degree of freedom of 19, which is obviously significant at 0.1% level. Generally speaking, the larger is the volume of UHG, the larger is the volume of HG. L.r. of volume of UHG on volume of HG was calculated as follows; $Y=0.579X-2.653$, where Y and X indicate the volume of UHG and the volume of HG, respectively. This formula indicates that the volume of UHG becomes 0.579 mm^3 larger, when the volume of HG becomes larger by 1 degree.

15. Quotients of area and volume

Group A: C.c. and l.r. of quotient of volume on quotient of area in the same strains were calculated, and are shown in the right column of Table 5. Eight and 1 strains showed significances at 0.1% level and no significance even at 5% level, respectively. In the whole strains, c.c. was +0.9936 to the degree of freedom of 7, which is obviously significant at 0.1% level. Generally speaking, the larger is the quotient of area, the larger is the quotient of volume. L.r. of quotient of area on quotient of volume was calculated as follows; $Y=1.396X-0.298$, where Y and X indicate the quotient of area and quotient of volume, respectively. This formula indicates that the quotient of area becomes 1.396 larger, when the quotient of volume becomes larger by 1 degree.

Group B: Eleven and 1 strains showed significances at 0.1% and 5% levels, respectively. In

other words, the whole strains showed significances. In the whole strains, c.c. was +0.9052 to the degree of freedom of 10, which is obviously significant at 0.1% level. Generally speaking, the larger is the quotient of area, the larger is the quotient of volume. L.r. of quotient of area on quotient of volume was calculated as follows; $Y=0.947X-0.027$, where Y and X indicate the quotient of area and the quotient of volume, respectively. This formula indicates that the quotient of area becomes 0.947 larger, when the quotient of volume becomes larger by 1 degree.

Whole: Nineteen, 1 and 1 strains showed significances at 0.1% and 5% levels and no significance even at 5% level, respectively. In the whole strains of both of the groups, c.c. was +0.8712 to the degree of freedom of 19, which is obviously significant at 0.1% level. Generally speaking, the larger is the quotient of area, the larger is the quotient of volume. L.r. of quotient of area on quotient of volume was calculated as follows; $Y=1.183X-0.164$, where Y and X indicate the quotient of area and the quotient of volume, respectively. This formula indicates that the quotient of area becomes 1.183 larger, when the quotient of volume becomes larger by 1 degree.

Discussion

Basing on the results obtained in the previous[1] and the present experiments, the following problems are to be discussed here.

1. C.c. of the respective character-combinations in the strain level were fixed to be significant in 154/243 cases (=63.7%), 217/324 cases (=67.0%) and 371/567 cases (=65.4%) in Group A, Group B and the whole of both of the groups, respectively. Those in the group-total were fixed to be significant in 14/27 (=51.9%), 18/27 (=66.7%) and 18/27 (=66.7%) in Group A, Group B and the whole of both of the groups, respectively. In detail, some characteristics were found. Significant correlations in the strain level were accounted as follows in the order of the combination numbers from 1 to 27; 7, 5, 7, 14, 17, 17, 8, 8, 7, 13, 19, 16, 2, 5, 2, 11, 20, 12, 21, 19, 21, 20, 20, 19, 20, 21 and 21 strains, respectively. It was noticeable that the values were particularly large in combination numbers from 19 to 27. Average values and their s.d. through the whole combinations were found to be 5.70 ± 2.75, 8.04 ± 3.83 and 13.74 ± 6.40 in Group A, Group B and the whole of both of the groups, respectively.

The whole combinations (=27) were divided into 2 packs, *i.e.*, pack I (combination Nos. 1~18) and pack II (Nos. 19~27). Significant correlations were accounted as 49.38% (80/162), 50.93% (110/216), 50.27% (190/378), 91.36% (74/81), 99.07% (107/108) and 95.77% (181/189) in pack I of Group A, Group B and the whole, pack II of Group A, Group B and the whole, respectively. Those averages and their s.d. through the whole combinations within the packs were found in the same order to be 4.44 ± 2.50, 6.11 ± 3.28, 10.56 ± 5.54, 8.22 ± 0.79, 11.89 ± 0.31 and 20.11 ± 0.74, respectively. From the data, it might be said that the pack II showed combinations by for more significant than those in the pack I . Moreover, the pack I was to be re-divided into 6 sub-packs as follows; sub–1 (combination Nos. 1~3), sub–2 (Nos. 4~6), sub–3 (Nos. 7~9), sub–4 (Nos. 10~12), sub–5 (Nos. 13~15), sub–6 (Nos. 16–18). Significant correlations were accounted as follows; sub–1 (9/27=33.33% in Group A, 10/36=27.78% in Group B and 19/63=30.16% in the whole), sub–2 (22/27=81.48%, 26/36=72.22% and 48/63=76.19% in the same order), sub–3 (9/27=33.33%, 14/36=38.89% and 23/63=36.51%), sub–4 (19/27=70.37%, 29/36=80.56% and 48/63=76.19%), sub–5 (4/27=14.82%, 5/36=13.89% and 9/63=14.29%), sub–6 (17/27=62.96%, 26/36=72.22% and 43/63=68.25%). It was ascertained that sub–2, –4 and –6, *i.e.*, ratio-columns,

showed the higher significances in comparison with those of sub–1, –3 and –5 in Group A, Group B and the whole strains of both of the groups.

In the pack II, no clear difference was found in sub-packs. These differences found in the packs and sub-packs might be seen as specificities of character or character-combinations.

2. The respective strains showed significant combinations as follows in the order fixed from strain No. 1 to No. 21; 19, 17, 21, 17, 19, 17, 16, 15, 13 in Group A, 18, 15, 14, 23, 20, 19, 17, 22, 16, 19, 18 and 16 in Group B, respectively. It was noticeable that the strain No. 13 showed significanses in 23/27 combinations (=85.19% in the whole), and strain No. 9 showed significances only in 13/27 combinations (=48.15% in the whole), respectively. Average values and their s.d. through the whole strains were found to be 17.11 ± 2.23, 18.08 ± 2.60 and 17.66 ± 2.49 in Group A, Group B and the whole strains of both of the groups, respectively.

3. Significant correlations were analysed in the positive or the negative status and in the degree of their status. Significant correlations were accounted as follows in the order of 0.1% levels (positive, negative and the whole), 1% levels (positive, negative and the whole) and 5% levels (positive, negative and the whole) in Group A; 98 combinations in the whole significant combinations (=154) (63.6%), 20 (13.0%), 118 (76.6%); 10 (6.5%), 6 (3.9%), 16 (10.4%); 14 (9.1%), 6 (3.9%), 20 (13.0%). Those in Group B were accounted as follows in the same order; 133 combinations in the whole significant combinations (=217) (61.3%), 20 (9.2%), 153 (70.5%); 23 (10.6%), 6 (2.8%), 29 (13.4%); 26 (12.0%), 9 (4.2%), 35 (16.1%). Those in the whole strains of both of the groups were accounted as follows in the same order; 231 combinations in the whole significant combinations (=371) (62.3%), 40 (10.8%), 271 (73.1%), 33 (8.9%), 12 (3.2%), 45 (12.1%); 40 (10.8%), 15 (4.0%), 55 (14.8%). It might be a noticeable phenomenon that about three fourths (76.6% in Group A, 70.5% in Group B and 73.1% in the whole) showed significant combinations at 0.1% level. It might have meant those biological actions, which were extremely called "all or nothing", *i.e.*, going from one extreme to another. In a stricter sense, those characters were looked upon as being in possesion of a stable state, and they were exhibited independently of the other characters. The positive and the negative combinations in the total were accounted as 122 combinations (79.2%) and 32 (20.8%) in Group A, 182 (83.9%) and 35 (16.1%) in Group B, 304 (81.9%) and 67 (18.1%) in the whole of the both of the groups, respectively.

Negative correlations were found in the strain level in some combinations, though positive correlations were found in the most strains in the same character-combinations, and *vice versa*. Six cases were found, *i.e.*, strain No. 1···combination 1·2; strain No. 3···combination 25·26; strain No. 8···combination 2·3; strain No. 14···combinations 11·12 and 25·26; strain No. 20···combination 1·2. Unfortunately those unnatural facts and discrepancies are not to be fully explained at the present time. It was, however, an interesting phenomenon concerning strain differentiations, especially in case of strain No. 14, which was collected at 11 km south from Diamond Harbour, Calcutta. These phenomena may be attributed in the actions of the respective genes concerning in the all the events.

4. The three strains showing the relatively large values were picked-up in the respective combinations (=27), regardless of the positive or the negative status. The respective strains showed the following numbers of the larger values in the order from strain Nos. 1 to 21; 5, 7, 19, 12, 7, 10, 4, 13 and 4 in Group A; 6, 3, 12, 11, 14, 2, 4, 15, 6, 3, 5 and 0 in Group B, respectively. Averages and their s.d. through the whole strains were found to be 9.00 ± 4.71 in Group A, 6.75 ± 4.78 in Group B and 7.71 ± 4.88 in the whole strains, respectively. Those in the whole strains

(=21) were shown in the same order as follows; 1, 3, 16, 3, 1, 7, 0, 5, 1, 3, 1, 9, 6, 9, 2, 2, 9, 2, 0, 1 and 0, respectively. Average and its s.d. through the whole strains of both of the groups were found to be 3.86±4.03.

In the larger set of combinations of L and T (UHG), the largest (+0.9820) was found in No. 3, followed by No. 9 (+0.6461) and No. 4 (+0.4050). In the larger set of combinations of L and T (HG), the largest (+0.6966) was found in No. 3, followed by No. 9 (+0.5255) and No. 4 (+0.2870). These orders of strains were finally illustrated in both of the cases as 3>9>4, and were fixed to be the same as in both character-combinations. These phenomena were found in the other 3 cases, *i.e.*, ② 3>8>4…No. 3 (+0.9918, +0.9843 and +0.9633), No. 8 (+0.7943, +0.9722 and +0.9385) and No. 4 (+0.7223, +0.9653 and +0.9313) in L/T and W/T (UHG), T (UHG and HG) and L/T (UHG and HG); ③ 6>4>8…No. 6 (+0.9871 and +0.9839), No. 4 (+0.7958 and +0.8787) and No. 8 (+0.7604 and +0.8661) in W (UHG and HG) and W/T (UHG and HG); ④ 12>14>18…No. 12 (+0.9948 and +0.9531), No. 14 (+0.9769 and +0.9512) and No. 18 (+0.9634 and +0.9375) in T (UHG and HG) and L/T (UHG and HG).

On the other hand, some sets of strains did not show the same orders, but showed the same combination numbers, which meant the strain numbers occurring regardless of the orders. Eight cases were ascertained, *i.e.*, ① 3·4·6…L/W and L/T of comparison (3>6>4) and areas of UHG and HG (6>4>3); ② 3·5·7…L/W of UHG and HG (3>7>5) and quotients of areas and volumes (3>5>7); ③ 13·17·20…L and W of UHG (17>20>13) and L/W and L/T of UHG (13>20>17); ④ 14·16·17…L and T of UHG (14>17>16) and L/W and W/T of UHG (17>14>16); ⑤ 13·14·17…L and W of HG (13>17>14) and L and T of HG (17>14>13); ⑥ 10·12·14…L/W of UHG and HG (12>14>10) and W/T of UHG and HG (12>10>14); ⑦ 3·14·17…L/T and W/T of UHG (3>17>14) and L and T of HG (17>3>14); ⑧ 3·12·14…T of UHG and HG (12>3>14) and volumes of UHG and HG (3>12>14).

5. The three strains showing the relatively small values were picked-up in the respective combinations (=27), regardless of the positive or the negative status. The respective strains showed the following numbers of the smaller values in the order from strain Nos. 1 to 21; 6, 11, 5, 9, 13, 10, 6, 8, 13 in Group A; 2, 11, 6, 5, 6, 5, 8, 5, 8, 6, 10 and 9 in Group B, respectively. Averages and their s.d. through the whole strains were found to be 9.00±2.83 in Group A, 6.75±2.42 in Group B and 7.71±2.83 in the whole strains, respectively. Those in the whole strains (=21) were shown in the same order as follows; 1, 6, 5, 4, 4, 6, 1, 5, 8, 2, 5, 3, 1, 5, 2, 3, 4, 5, 3, 6 and 2, respectively. Average and its s.d. through the whole strains of both of the groups were found to be 3.86±1.88.

In the smaller set of combinations of W (UHG and HG), the smallest (−0.0722) was noted in No. 9, followed by No. 3 (+0.1555) and No. 2 (+0.5591). In the smaller set of combinations of W/T (UHG and HG), the smallest (+0.1469) was noted in No. 9, followed by No. 3 (+0.3288) and No. 2 (+0.5321). These orders of strains were finally illustrated in both of the cases as 9<3<2, and were fixed to be the same as in both character-combinations. These phenomena were found in an other 1 case, *i.e.*, ② 9<2<5…No. 9 (+0.6311 and +0.1469), No. 2 (+0.6860 and +0.3288) and No. 5 (+0.8394 and +0.5560) in T (UHG and HG) and L/T (UHG and HG).

On the other hand, some sets of strains did not show the same strain orders, but showed the same combination numbers, which meant the strain numbers occurring regardless of the orders. Five cases were ascertained, *i.e.*, ① 5·6·8…L and T of UHG (8<6<5) and of HG (6<8<5); ② 4·6·8…L/W and L/T of UHG (4<6<8) and L/T and W/T of comparison (6<4<8); ③ 11·

12·14…L/W and L/T of UHG (14<12<11) and of HG (12<14<11); ④ 16·17·20…L/T and W/T of UHG (20<16<17) and of HG (16<20<17); ⑤ 16·17·20…through the whole strains of both of the groups same as in case of the ④.

6. The strains showing the relatively large and small values were summed-up in the respective combinations, regardless of the positive or the negative status. The respective strains showed the following numbers in the order from strain Nos. 1 to 21; 11, 18, 24, 21, 20, 20, 10, 21, 17 in Group A; 8, 14, 18, 16, 20, 7, 12, 20, 14, 9, 5, 9 in Group B, respectively. Averages and their s.d. through the whole strains were found to be 18.00 ± 4.42 in Group A, 13.50 ± 4.37 in Group B and 15.43 ± 4.92 in the whole strains, respectively. Those in the whole strains (=21) were shown in the same orders as follows; 2, 9, 21, 7, 5, 13, 1, 10, 9, 5, 6, 12, 7, 14, 4, 5, 13, 7, 3, 7 and 2, respectively. Average and its s.d. through the whole strains of both of the groups were found to be 7.71 ± 4.74.

7. From the data mentioned in the 3 chapters, c.c. and l.r. of the respective character-combinations were calculated, and the following facts were found. In Group A, c.c. of the numbers of strains showing the larger and the smaller values were found to be -0.4000, showing no significance even at 5% level. C.c. of the numbers of strains showing the larger values and the total strains (=larger +smaller) was $+0.8102$ to the degree of freedom of 7, which is significant at 1% level. Generally speaking, the more is the numbers of strains showing the larger values, the more is the numbers of total strains. L.r. of the number of strains showing the larger values on the number of total strains was calculated as follows; $Y=0.760X+11.160$, where Y and X indicate the number of strains showing larger values and number of total strains, respectively. This formula indicates that the number of strains showing the larger values becomes 0.760 more, when the number of total strains becomes more by 1 degree. C.c. of the number of strains showing smaller values and the number of total strains was found to be $+0.2132$, showing no significance even at 5% level.

In Group B, c.c. of the number of strains showing the larger values and the smaller values was found to be -0.4161, showing no significance even at 5% level. C.c. of the number of strains showing the larger values and the total strains was $+0.8639$ to the degree of freedom of 10, which is obviously significant at 0.1% level. Generally speaking, the more is the number of strains showing the larger values, the more is the number of total strains. L.r. of the number of strains showing the larger values on the number of total strains was calculated as follows; $Y=0.789X+8.171$, where Y and X indicate the number of strains showing the larger values and the number of total strains, respectively. This formula indicates that the number of strains showing the larger values becomes 0.789 more, when the number of total strains becomes more by 1 degree. C.c. of the number of strains showing the smaller values and number of the total strains was $+0.0986$, showing no significance even at 5% level.

In the whole strains of both of the groups (=21), c.c. of the number of strains showing the larger values and the smaller values was found to be -0.2747, showing no significance even at 5% level. C.c. of the number of strains showing the larger values and the number of total strains was $+0.8333$ to the degree of freedom of 19, which is obviously significant at 0.1% level. Generally speaking, the more is the number of strains showing the larger values, the more is the number of total strains. L.r. of the number of strains showing the larger values on the number of total strains was calculated as follows; $Y=0.841X+8.944$, where Y and X indicate the number of strains showing the larger values and the number of total strains, respectively. This formula indicates that the number of strains showing the larger values becomes 0.841 more, when the number of total strains becomes more by 1 degree. C.c. of the number of strains showing the smaller values and the number of total strains was found to be $+0.2905$, showing no significance even at 5% level.

In case of the strains through the whole strains, regardless of Group A and Group B, c.c. of the number of strains showing the larger and the smaller values was found to be +0.1793, showing no significance even at 5% level. C.c. of the numbers of strains showing the larger values and the total strains was +0.9204 to the degree of freedom of 19, which is obviously significant at 0.1% level. Generally speaking, the more is the number of strains showing the larger values, the more is the number of total strains. L.r. of the number of strains showing the larger values on the number of total strains was calculated as follows; $Y=1.084X+3.534$, where Y and X indicate the number of strains showing the larger values and the number of total strains, respectively. This formula indicates that the number of strains showing the larger values becomes 1.084 more, when the number of total strains becomes more by 1 degree. C.c. of the number of strains showing the smaller values and the number of total strains was +0.5496 to the degree of freedom of 19, which is significant at 1% level. Generally speaking, the more is the number of strains showing the smaller values, the more is the number of total strains. L.r. of the number of strains showing the smaller values on the number of total strains was calculated as follows; $Y=1.383X+2.379$, where Y and X indicate the number of strains showing the smaller values and the number of total strains, respectively. This formula indicates that the number of strains showing the smaller values becomes 1.383 more, when the number of total strains becomes more by 1 degree.

These techniques were adopted at the first time by the present author in the present paper. Further anaysis might be requested sincerely.

Summary

Succeeding to the previous papers, some morphological studies on grain characters and considerations on ecotypic differentiations of 21 strains of cultivated rice species, *Oryza sativa* L., collected in India, were reported in the present paper. The results obtained here were summarized as follows:

Concerning correlation coefficients among 15 character-combinations, 95/135 cases (=70.4%) in Group A, 138/180 cases (=76.7%) in Group B and 233/315 cases (=74.0%) in the whole, respectively, showed significant relations through the whole cases.

From the previous and the present experiments, concerning the correlation coefficients among 27 character-combinations, 154/243 cases (=63.4%) in Group A, 217/324 cases (=67.0%) and 371/567 cases (=65.4%) in the whole, respectively, showed significant relations through the whole cases. Those averages and their s.d. through the whole combinations were found to be in the same order as $5.70+2.75$, 8.04 ± 3.83 and 13.74 ± 6.40, respectively.

The whole character-combinations (=27) were divded into 2 groups in view of the correlation-occurrence-frequencies, *i.e.*, pack I (combination Nos. 1~18) and pack II (Nos. 19~27). Significant correlations were accounted as 49.38% (=80/162 cases), 50.93% (=110/216), 50.27% (=190/378), 91.36% (=74/81), 99.07% (=107/108) and 95.77% (=181/189) in pack I of Group A, Group B and the whole, pack II of Group A, Group B and the whole, respectively. Those averages and their s.d. through the whole combinations within the packs were found in the same orders to be 4.44 ± 2.50, 6.11 ± 3.28, 10.56 ± 5.54, 8.22 ± 0.79, 11.89 ± 0.31 and 20.11 ± 0.78, respectively.

The three strains showing relatively the larger and the smaller values in the correlation coefficients were picked-up in the respective character-combinations (=27), regardless of the positive or negative status. These characters and techniques confirmed in the experiments were to

be looked upon as something useful, having some universal validities as indices in the examinations of strain differentiations.

Moreover, some new techniques, by which correlation cofficients and linear regressions based on the respective characrer-combinations were re-calculated in view of correlation between them, and were adopted for the first time in this experiment by the present author. Although some findings were ascertained, several problems were remained, and further experiments might be requested.

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