

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

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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 rice and cultivated rice. In this opportunity, the cultivated rice practically planted not only in Assam but also in West Bengal States were directly collected in the cultivating fields and studied in view of morphological characters found in the grains.

Northeastern part of the India has been noted as one of the differentiation centers of rice (*Oryza sativa* L.), owing to the several genetic and cytogenetic investigations. However, some questions in these considerations were found and left remained. Sharma *et al.*<sup>7)</sup> carried out a systematic collection of the current and the primitive cultivars in the northeastern part of India in view of breeding program. For phylogenetic studies, both the investigation to clear and to confirm the varietal variations and the methodology applicable for these purposes must be promoted as possible.

Recently, high yielding varieties have been recommended by the governments of a lot of countries in south and southeast Asia, with the gradual disappearance of local varieties in these processes<sup>1)</sup>.

Taking these items into account, the present experimental series was made to give a finishing on to the works which are going to clarify the varietal variations and the phylogenetic relationships of the cultivated rice in India. In the previous papers, the records on morphological characters of the unhusked and husked grains and some mutual relations<sup>2,6)</sup>, comparative values<sup>3)</sup>, variation ranges in 24 characters<sup>3,4,5)</sup> were reported.

In the present paper, mutual relations in the views 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 those grains.

### Materials and Methods

Twenty-one strains of rice collected in India were used in this experimental series. They are listed up in Table I of the previous paper<sup>2)</sup>. 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 separate 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 relationships between practical value, standard deviations and variation ranges in the strain level, 6 relations were calculated, *i. e.*, practical value and other practical value (Table 1), standard deviations and other standard deviations (Table 2), variation range and other variation range (Table 3), practical value and its standard deviations (Table 4), practical value and its variation range (Table 5), standard deviations and its variation range (Table 6). Finally, comparisons of 4 relation-groups were made, mainly using the data shown in Tables 1, 2 and 3 (Table 7), and those in Tables 4, 5 and 6 (Table 8).

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

## Results

### 1. Relationships between the practical values in the two respective characters

*Group A:* C. c. and l. r. of the practical value on any other practical value among 27 character-combinations were calculated, and are shown in Table 1. Ten, 6 and 11 combinations showed significances at 0.1 % and 5 % levels and no significance even at 5 % level, respectively. For example, c. c. of W (HG) on T (HG) through the whole strains was +0.9598 to the degree of freedom of 7, which is obviously significant at 0.1 % level. Generally speaking, the wider is the W (HG), the thicker is the T (HG). L. r. of W on T was calculated as follows ;  $Y=0.800X-0.174$ , where Y and X indicate W and T, respectively. This formula indicates that W becomes 0.800 mm wider, when T becomes thicker by 1 degree.

*Group B:* Fifteen, 1, 3 and 8 combinations showed significances at 0.1 %, 1 % and 5 % levels and no significance even at 5 % level, respectively. For example, c. c. of W (UHG) on T (UHG) through the whole strains was +0.9583 to the degree of freedom of 10, which is obviously significant at 0.1 % level. Generally speaking, the wider is the W (UHG), the thicker is the T (UHG). L. r. of W on T was calculated as follows ;  $Y=0.429X+0.959$ , where Y and X indicate W and T, respectively. This formula indicates that W becomes 0.429 mm wider, when T becomes thicker by 1 degree.

*Whole :* Sixteen, 1, 1 and 9 combinations showed significances at 0.1 %, 1 % and 5 % levels and no significance even at 5 % level, respectively. For example, c. c. of W (UHG) on T (UHG) through the whole strains was +0.7569 to the degree of freedom of 19, which is obviously significant at 0.1 % level. Generally speaking, the wider is the W (UHG), the thicker is the T (UHG). L. r. of W on T was calculated as follows ;  $Y=0.377X+1.040$ , where Y and X indicate W and T, respectively. This formula indicates that the W becomes 0.377 mm wider, when the T becomes thicker by 1 degree.

### 2. Relationships between the s. d. of the two respective characters

*Group A:* C. c. and l. r. of s. d. on another s. d. among 27 character-combinations

Table 1. Correlation coefficient and linear regression of the practical value (the former character, Y) on another practical value (the latter character, X) for 27 combinations

Combination	Group A		Group B		Whole	
	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression
1. 2	-0.5843	—	-0.1269	—	-0.3785	—
1. 3	-0.3266	—	-0.0255	—	-0.0812	—
2. 3	0.7437*	Y=0.573X+0.344	0.9583***	Y=0.429X+0.959	0.7569***	Y=0.377X+1.040
4. 5	0.7688*	Y=1.201X+0.712	0.9421***	Y=0.828X+1.474	0.8383***	Y=0.783X+1.714
4. 6	-0.2281	—	-0.8823***	Y=-0.144X+1.770	-0.7248***	Y=-0.174X+1.900
5. 6	0.4462	—	-0.6800*	Y=-0.126X+1.824	-0.2397	—
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11.12	-0.3146	—	-0.1408	—	-0.2625	—
11.13	-0.1522	—	0.0580	—	0.0238	—
12.13	0.9598***	Y=0.800X-0.174	0.9372***	Y=0.472X+0.830	0.8388***	Y=0.547X+0.578
14.15	0.9526***	Y=1.739X-0.836	0.9567***	Y=0.833X+0.987	0.8287***	Y=1.030X+0.612
14.16	0.4630	—	-0.8768***	Y=-1.539X+1.632	-0.4471*	Y=-0.109X+1.563
15.16	0.7094*	Y=0.081X+1.116	-0.7034*	Y=-0.142X+1.674	0.1268	—
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21.22	0.6166	—	-0.4093	—	0.0072	—
21.23	0.6597	—	-0.2539	—	0.0679	—
22.23	0.9483***	Y=0.884X+0.148	0.4127	—	0.9120***	Y=0.825X+0.201
24.25	0.9534***	Y=0.991X-0.039	0.8054**	Y=0.498X+0.363	0.9292***	Y=0.905X+0.032
24.26	-0.6601	—	-0.6378*	Y=-0.425X+1.289	-0.5848**	Y=-0.262X+1.161
25.26	-0.4060	—	-0.1694	—	-0.2945	—
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1.11	0.9770***	Y=0.628X+0.708	0.9768***	Y=0.751X-0.493	0.9694***	Y=0.679X+0.213
2.12	0.7818*	Y=0.999X-0.547	0.9883***	Y=0.773X+0.201	0.8977***	Y=0.799X+0.106
3.13	0.9728***	Y=1.346X-0.986	0.9937***	Y=0.876X+0.056	0.9551***	Y=1.114X-0.472
4.14	0.7500*	Y=0.919X-0.097	0.9609***	Y=0.756X+0.220	0.8887***	Y=0.728X+0.354
5.15	0.9440***	Y=1.351X-0.203	0.9735***	Y=0.758X+0.058	0.8806***	Y=0.961X-0.676
6.16	0.9401***	Y=0.667X+0.397	0.9562***	Y=0.809X+0.168	0.9650***	Y=0.801X+0.187
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31.33	0.6928*	Y=0.720X-3.330	0.9918***	Y=0.566X+0.586	0.8938***	Y=0.587X+0.080
32.34	0.9241***	Y=0.761X-12.679	0.9925***	Y=0.512X+1.033	0.9429***	Y=0.579X-2.653
35.36	0.9936***	Y=1.396X-0.298	0.9052***	Y=0.947X-0.027	0.8712***	Y=1.183X-0.164

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. = Group A - 7, Group B - 10, Whole - 19.

were calculated, and are shown in Table 2. Four, 5, 5 and 13 combinations 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 W (HG) on T (HG) through the whole strains was +0.6821 to the

Table 2. Correlation coefficient and linear regression of the s. d. (the former character, Y) on another s. d. (the latter character, X) for 27 combinations

Combi- nation	Group A		Group B		Whole	
	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression
1·2	0.2015	—	0.4926	—	0.4067	—
1·3	0.4471	—	0.1903	—	0.3126	—
2·3	0.8744**	Y=0.434X+0.029	0.4385	—	0.5612**	Y=0.316X+0.053
4·5	0.6919*	Y=0.786X+0.089	0.5359	—	0.6504**	Y=0.466X+0.137
4·6	0.3100	—	0.3564	—	0.2535	—
5·6	0.3722	—	0.1689	—	0.2270	—
11·12	0.1416	—	0.4070	—	0.2963	—
11·13	0.4880	—	0.3529	—	0.4357*	Y=0.090X+0.073
12·13	0.6821*	Y=0.325X+0.045	0.6215*	Y=0.378X+0.054	0.5876**	Y=0.350X+0.051
14·15	0.4266	—	0.8496***	Y=0.814X+0.050	0.7615***	Y=0.744X+0.070
14·16	0.1163	—	0.0725	—	0.0840	—
15·16	-0.3937	—	0.3021	—	0.1252	—
21·22	0.4585	—	0.8717***	Y=0.735X+0.168	0.4392*	Y=0.722X+0.020
21·23	0.4581	—	0.0602	—	0.2281	—
22·23	0.8311**	Y=0.545X+0.004	0.1000	—	0.5729**	Y=0.444X+0.009
24·25	0.8225**	Y=0.727X+0.003	0.8528***	Y=0.750X+0.000	0.8303***	Y=0.728X+0.002
24·26	0.8919**	Y=1.273X-0.003	0.3124	—	0.6285**	Y=0.889X+0.011
25·26	0.8574**	Y=1.384X+0.003	0.3997	—	0.6419**	Y=1.035X+0.014
1·11	0.9621***	Y=0.575X+0.031	0.9276***	Y=0.838X-0.026	0.9302***	Y=0.816X-0.027
2·12	0.9002***	Y=0.750X+0.026	0.7757**	Y=0.658X+0.031	0.8119***	Y=0.685X+0.031
3·13	0.9104***	Y=0.728X+0.023	0.8470***	Y=0.777X+0.021	0.8728***	Y=0.778X+0.020
4·14	0.4117	—	0.7833**	Y=0.690X+0.037	0.7862***	Y=0.638X+0.048
5·15	-0.5412	—	0.7212**	Y=0.916X-0.022	0.5324*	Y=0.589X+0.060
6·16	0.7434*	Y=0.500X+0.040	0.7293**	Y=1.040X-0.002	0.6868***	Y=0.702X+0.025
31·33	0.7217*	Y=0.484X+0.244	0.8958***	Y=0.598X+0.022	0.8784***	Y=0.575X+0.080
32·34	0.9917***	Y=0.944X-1.286	0.9615***	Y=0.524X+0.231	0.9268***	Y=0.543X+0.277
35·36	0.7268*	Y=0.750X+0.010	0.8972***	Y=0.805X+0.010	0.7822***	Y=0.773X+0.010

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. = Group A - 7, Group B - 10, Whole - 19.

degree of freedom of 7, which is significant at 5 % level. Generally speaking, the larger is the s. d. of W (HG), the larger is the s. d. of T (HG). L. r. of s. d. of W on s. d. of T was calculated as follows;  $Y=0.325X+0.045$ , where Y and X indicate the s. d. of W and the

s. d. of T, respectively. This formula indicates that the s. d. of W becomes 0.325 larger, when the s. d. of T becomes larger by 1 degree.

*Group B*: Eight, 4, 1 and 14 combinations 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 W (HG) on T (HG) through the whole strains was +0.6215 to the degree of freedom of 10, which is significant at 5 % level. Generally speaking, the larger is the s. d. of W (HG), the larger is the s. d. of T (HG). L. r. of s. d. of W on s. d. of T was calculated as follows ;  $Y=0.378X+0.054$ , where Y and X indicate the s. d. of W and the s. d. of T, respectively. This formula indicates that the s. d. of W becomes 0.378 larger, when the s. d. of T becomes larger by 1 degree.

*Whole*: Ten, 6, 3 and 8 combinations 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 W (HG) on T (HG) through the whole strains was +0.5876 to the degree of freedom of 19, which is significant at 1 % level. Generally speaking, the larger is the s. d. of W (HG), the larger is the s. d. of T (HG). L. r. of s. d. of W on s. d. of T was calculated as follows ;  $Y=0.350X+0.051$ , where Y and X indicate the s. d. of W and the s. d. of T, respectively. This formula indicates that the s. d. of W becomes 0.350 larger, when the s. d. of T becomes larger by 1 degree.

### 3. Relationships between the variation ranges of the two respective characters

*Group A*: C. c. and l. r. of variation range on another variation range among 27 character-combinations were calculated, and are shown in Table 3. One, 4, 1 and 21 combinations showed significances at 0.1 %, 1 % and 5 % levels and no significance even at 5 % level, respectively. For example, c. c. of variation range of W (UHG) on range of T (UHG) through the whole strains was +0.7237 to the degree of freedom of 7, which is significant at 5 % level. Generally speaking, the larger is the range of W (UHG), the larger is the range of T (UHG). L. r. of range of W on range of T was calculated as follows ;  $Y=0.249X+0.227$ , where Y and X indicate variation range of W and range of T, respectively. This formula indicates that the range of W becomes 0.249 larger, when the range of T becomes larger by 1 degree.

*Group B*: Three, 2, 5 and 17 combinations showed significances at 0.1 %, 1 % and 5 % levels and no significance even at 5 % level, respectively. For example, c. c. of variation range of L (UHG) on range of W (UHG) through the whole strains was +0.7017 to the degree of freedom of 10, which is significant at 5 % level. Generally speaking, the larger is the range of L (UHG), the larger is the range of W (UHG). L. r. of range of L on range of W was calculated as follows ;  $Y=0.279X+0.187$ , where Y and X indicate variation range of L and range of W, respectively. This formula indicates that the range of L becomes 0.279 larger, when the range of W becomes larger by 1 degree.

*Whole*: Seven, 4, 7 and 9 combinations showed significances at 0.1 %, 1 % and 5 % levels and no significance even at 5 % level, respectively. For example, c. c. of variation range of L (UHG) on range of W (UHG) through the whole strains was +0.4543 to the degree of freedom of 19, which is significant at 5 % level. Generally speaking, the larger is the range of L (UHG), the larger is the range of W (UHG). L. r. of range of L on range of W was calculated as follows ;  $Y=0.229X+0.255$ , where Y and X indicate variation range

Table 3. Correlation coefficient and linear regression of the range (the former character, Y) on another range (the latter character, X) for 27 combinations

Combi- nation	Group A		Group B		Whole	
	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression
1·2	0.0291	—	0.7017*	$Y=0.279X+0.187$	0.4543*	$Y=0.229X+0.255$
1·3	-0.0035	—	0.0772	—	0.1746	—
2·3	0.7237*	$Y=0.249X+0.227$	0.4026	—	0.5078*	$Y=0.285X+0.263$
4·5	0.5296	—	0.4754	—	0.6359**	$Y=0.508X+0.595$
4·6	0.5223	—	0.3055	—	0.3771	—
5·6	0.4712	—	0.4595	—	0.4515*	$Y=0.194X+0.169$
11·12	-0.0499	—	0.4309	—	0.2998	—
11·13	0.3882	—	0.2197	—	0.3432	—
12·13	0.4503	—	0.0948	—	0.1637	—
14·15	0.6018	—	0.5471	—	0.5885**	$Y=0.684X+0.380$
14·16	0.2910	—	0.1861	—	0.2549	—
15·16	-0.3296	—	0.5625	—	0.4722*	$Y=0.222X+0.169$
21·22	0.0467	—	0.4703	—	0.2766	—
21·23	-0.1246	—	0.4226	—	0.4610*	$Y=0.627X+0.050$
22·23	0.5156	—	0.2850	—	0.3561	—
24·25	-0.1149	—	0.6469*	$Y=0.464X+0.042$	0.4227	—
24·26	0.6216	—	0.4632	—	0.5194*	$Y=0.751X+0.073$
25·26	0.4385	—	0.6055*	$Y=1.090X+0.066$	0.6073**	$Y=1.070X+0.061$
1·11	0.9798***	$Y=0.658X+0.044$	0.9552***	$Y=1.132X-0.371$	0.9390***	$Y=1.083X-0.366$
2·12	0.8118**	$Y=0.480X+0.313$	0.5587	—	0.6366**	$Y=0.490X+0.285$
3·13	0.8450**	$Y=0.893X+0.033$	0.7258**	$Y=0.880X+0.036$	0.7847***	$Y=0.880X+0.036$
4·14	0.4838	—	0.6681*	$Y=0.672X+0.149$	0.6781***	$Y=0.598X+0.222$
5·15	-0.4037	—	0.6925*	$Y=1.094X-0.299$	0.4903*	$Y=0.629X+0.225$
6·16	0.8276**	$Y=0.542X+0.129$	0.7969**	$Y=1.320X-0.103$	0.7560***	$Y=1.060X-0.024$
31·33	0.3185	—	0.5585	—	0.8057***	$Y=0.545X+0.627$
32·34	0.8510**	$Y=0.929X-4.240$	0.9383***	$Y=0.557X+0.998$	0.7618***	$Y=0.433X+4.446$
35·36	0.6361	—	0.8250***	$Y=0.809X+0.050$	0.6698***	$Y=0.998X+0.028$

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.=Group A - 7, Group B - 10, Whole - 19.

of L and range of W, respectively. This formula indicates that the range of L becomes 0.229 larger, when the range of W becomes larger by 1 degree.

#### 4. Relationships between the practical values and their s. d.

*Group A:* C. c. and l. r. of practical value on their s. d. among 24 characters were calculated, and are shown in Table 4. Five, 4 and 15 characters showed significances at 1 % and 5 % levels and no significance even at 5 % level, respectively. For example, c. c. of practical value of W (UHG) on s. d. of W (UHG) through the whole strains was +0.8747 to the degree of freedom of 7, which is significant at 1 % level. Generally speaking, the

Table 4. Correlation coefficient and linear regression of the practical value (Y) on its s. d. (X) for 24 characters

Char- acter No.	Group A		Group B		Whole	
	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression
1	-0.3739	—	0.8242***	Y=0.139X-0.883	0.6590**	Y=0.103X-0.559
2	0.8747**	Y=0.124X-0.251	0.1998	—	0.3390	—
3	0.7818*	Y=0.072X-0.065	0.5499	—	0.6080**	Y=0.077X-0.069
4	-0.5926	—	0.5336	—	0.5162*	Y=0.066X-0.028
5	-0.7944*	Y=-0.060X+0.426	0.4262	—	0.0741	—
6	0.2151	—	0.5276	—	0.2622	—
11	-0.3060	—	0.7462**	Y=0.147X-0.645	0.6809***	Y=0.133X-0.566
12	0.5679	—	0.4609	—	0.4902*	Y=0.052X-0.002
13	0.8191**	Y=0.043X+0.005	0.4523	—	0.5490*	Y=0.053X-0.007
14	0.0026	—	0.5120	—	0.4709*	Y=0.060X+0.005
15	0.6764*	Y=0.038X+0.051	0.4215	—	0.4680*	Y=0.047X+0.035
16	-0.4166	—	0.6575*	Y=0.232X-0.199	0.1534	—
21	0.4159	—	0.4433	—	-0.0868	—
22	-0.7393**	Y=-0.146X+1.549	-0.3862	—	-0.6957***	Y=-0.143X+0.152
23	-0.6475	—	-0.7746**	Y=-0.682X+0.641	-0.5058*	Y=-0.089X+0.103
24	0.8109**	Y=0.123X-0.073	0.3576	—	0.5383*	Y=0.091X-0.041
25	0.7872*	Y=0.102X-0.056	0.3925	—	0.5755**	Y=0.087X-0.042
26	-0.1447	—	-0.4443	—	-0.2755	—
31	0.4543	—	0.3278	—	0.3077	—
32	0.4110	—	0.4631	—	0.4173	—
33	-0.0004	—	0.3803	—	0.2702	—
34	0.1394	—	0.4696	—	0.3242	—
35	-0.8251**	Y=-0.215X+0.156	-0.2799	—	-0.6725***	Y=-0.211X+0.156
36	-0.5051	—	-0.1356	—	-0.4138	—

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. = Group A - 7, Group B - 10, Whole - 19.

wider is the practical value of W (UHG), the larger is the s. d. of W (UHG). L. r. of practical value of W on s. d. of W was calculated as follows ;  $Y=0.124X-0.251$ , where Y and X indicate practical value of W and s. d. of W, respectively. This formula indicates that the practical value of W becomes 0.124 mm wider, when the s. d. of W becomes larger by 1 degree.

*Group B*: One, 2, 1 and 20 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 L (UHG) on s. d. of L (UHG) through the whole strains was +0.8242 to the degree of freedom of 10, which is obviously significant at 0.1 % level. Generally speaking, the longer is the practical value of L (UHG), the larger is the s. d. of L (UHG). L. r. of practical value of L on s. d. of L was calculated as follows ;  $Y=0.139X-0.883$ , where Y and X indicate practical value of L and s. d. of L, respectively. This formula indicates that the practical value of L becomes 0.139 mm longer, when the s. d. of L becomes larger by 1 degree.

*Whole*: Three, 3, 7 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 L (UHG) on s. d. of L (UHG) through the whole strains was +0.6590 to the degree of freedom of 19, which is significant at 1 % level. Generally speaking, the longer is the practical value of L (UHG), the larger is the s. d. of L (UHG). L. r. of practical value of L on s. d. of L was calculated as follows ;  $Y=0.103X-0.559$ , where Y and X indicate practical value of L and s. d. of L, respectively. This formula indicates that the practical value of L becomes 0.103 mm longer, when the s. d. of L becomes larger by 1 degree.

## 5. Relationships between the practical values and their variation ranges

*Group A*: C. c. and l. r. of practical value on their variation range among 24 characters were calculated, and are shown in Table 5. One, 6 and 17 characters showed significances at 0.1 % and 5 % levels and no significance even at 5 % level, respectively. For example, c. c. of practical value of W (UHG) on variation range of W (UHG) through the whole strains was +0.7932 to the degree of freedom of 7, which is significant at 5 % level. Generally speaking, the wider is the practical value of W (UHG), the larger is the variation range of W (UHG). L. r. of practical value of W on variation range of W was calculated as follows ;  $Y=0.689X-1.630$ , where Y and X indicate practical value of W and variation range of W, respectively. This formula indicates that the practical value of W becomes 0.689 mm wider, when the variation range becomes larger by 1 degree.

*Group B*: One, 4 and 19 characters showed significances at 1 % and 5 % levels and no significance even at 5 % level, respectively. For example, c. c. of practical value of L (UHG) on variation range of L (UHG) through the whole strains was +0.7615 to the degree of freedom of 10, which is significant at 1 % level. Generally speaking, the longer is the practical value of L (UHG), the larger is the variation range of L (UHG). L. r. of practical value of L on variation range of L was calculated as follows ;  $Y=0.446X-2.603$ , where Y and X indicate practical value of L and variation range of L, respectively. This formula indicates that the practical value of L becomes 0.446 mm longer, when the variation range becomes larger by 1 degree.

*Whole* : Two, 7 and 15 characters showed significances at 1 % and 5 % levels and no

Table 5. Correlation coefficient and linear regression of the practical value (Y) on its range (X) for 24 characters

Char- acter No.	Group A		Group B		Whole	
	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression
1	-0.4410	—	0.7615**	$Y=0.446X-2.603$	0.5807**	$Y=0.316X-1.433$
2	0.7932*	$Y=0.689X-1.630$	0.1684	—	0.2911	—
3	0.6109	—	0.4499	—	0.4547*	$Y=0.281X-0.180$
4	-0.6022	—	0.5561	—	0.4980*	$Y=0.260X-0.053$
5	-0.7449*	$Y=-0.211X+1.632$	0.4256	—	0.1634	—
6	0.3391	—	0.4715	—	0.2215	—
11	-0.3915	—	0.6826*	$Y=0.616X-2.635$	0.6329**	$Y=0.568X-2.410$
12	0.5177	—	0.4810	—	0.4705*	$Y=0.223X+0.013$
13	0.3745	—	0.0415	—	0.1881	—
14	0.0313	—	0.5200	—	0.4503*	$Y=0.253X+0.013$
15	0.7884*	$Y=0.205X+0.075$	0.3831	—	0.4624*	$Y=0.243X+0.041$
16	-0.3116	—	0.5176	—	0.0347	—
21	0.7291*	$Y=1.162X-0.783$	0.1128	—	-0.1293	—
22	-0.5644	—	-0.3719	—	-0.4102	—
23	0.0011	—	-0.5765*	$Y=-3.028X+2.838$	-0.0026	—
24	-0.2688	—	0.4650	—	-0.0013	—
25	0.6967*	$Y=0.270X-0.121$	0.6497*	$Y=1.187X-0.802$	0.4417*	$Y=0.231X-0.078$
26	0.2191	—	-0.6686*	$Y=-1.600X+1.688$	-0.2441	—
31	0.4242	—	0.3928	—	0.3556	—
32	0.9034***	$Y=0.436X-7.149$	0.4464	—	0.5020*	$Y=0.331X+1.476$
33	0.1816	—	0.2544	—	0.2042	—
34	0.6773*	$Y=0.430X-1.201$	0.3443	—	0.4178	—
35	-0.1709	—	-0.0394	—	-0.0813	—
36	0.1234	—	-0.0648	—	0.1007	—

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. = Group A - 7, Group B - 10, Whole - 19.

significance even at 5 % level, respectively. For example, c. c. of practical value of L (UHG) on variation range of L (UHG) through the whole strains was +0.5807 to the degree of freedom of 19, which is significant at 1 % level. Generally speaking, the longer is the practical value of L (UHG), the larger is the variation range of L (UHG). L. r. of practical value of L on variation range of L was calculated as follows;  $Y=0.316X-1.433$ , where Y and X indicate practical value of L and variation range of L, respectively. This formula

indicates that the practical value of L becomes 0.316 mm longer, when the variation range becomes larger by 1 degree.

### 6. Relationships between the s. d. and their variation ranges

*Group A*: C. c. and l. r. of s. d. on their variation range among 24 characters were calculated, are shown in Table 6. Seven, 6, 8 and 3 characters showed significances at

Table 6. Correlation coefficient and linear regression of the s. d. (Y) on its range (X) for 24 characters

Char- acter No.	Group A		Group B		Whole	
	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression
1	0.8916**	$Y = 3.378X + 0.206$	0.8957***	$Y = 3.121X + 0.277$	0.9030***	$Y = 3.160X + 0.265$
2	0.9358***	$Y = 5.726X - 0.260$	0.9196***	$Y = 3.717X + 0.063$	0.9036***	$Y = 4.411X - 0.054$
3	0.8566**	$Y = 3.624X + 0.037$	0.9039***	$Y = 4.195X + 0.041$	0.8896***	$Y = 4.327X + 0.005$
4	0.9664***	$Y = 4.859X - 0.072$	0.9534***	$Y = 3.684X + 0.115$	0.9636***	$Y = 3.918X + 0.006$
5	0.7640*	$Y = 2.856X + 0.262$	0.8412***	$Y = 3.621X + 0.234$	0.8515***	$Y = 3.867X + 0.130$
6	0.9042***	$Y = 2.976X + 0.102$	0.9037***	$Y = 5.080X - 0.036$	0.8645***	$Y = 3.761X + 0.056$
11	0.8548**	$Y = 3.640X + 1.034$	0.9666***	$Y = 4.419X - 0.003$	0.9632***	$Y = 4.433X - 0.026$
12	0.8669**	$Y = 3.763X + 0.080$	0.8932***	$Y = 4.040X + 0.056$	0.8843***	$Y = 3.942X + 0.063$
13	0.7826*	$Y = 4.375X - 0.029$	0.8354***	$Y = 5.129X - 0.067$	0.8408***	$Y = 5.145X - 0.080$
14	0.9580***	$Y = 5.586X - 0.164$	0.9424***	$Y = 4.157X - 0.011$	0.9444***	$Y = 4.172X + 0.001$
15	0.9515***	$Y = 4.397X - 0.028$	0.9095***	$Y = 4.870X - 0.057$	0.9183***	$Y = 4.831X - 0.072$
16	0.8625**	$Y = 2.763X + 0.092$	0.9628***	$Y = 6.285X - 0.128$	0.8984***	$Y = 5.366X - 0.080$
21	0.3588	—	0.8051**	$Y = 3.325X + 0.016$	0.7491***	$Y = 3.208X + 0.012$
22	0.7530*	$Y = 1.995X + 0.048$	0.7591**	$Y = 4.288X - 0.013$	0.6959***	$Y = 2.336X + 0.043$
23	0.6944*	$Y = 2.070X + 0.035$	0.8000**	$Y = 4.771X - 0.015$	0.7165***	$Y = 3.280X + 0.015$
24	0.2916	—	0.6716*	$Y = 3.188X + 0.026$	0.5134*	$Y = 1.889X + 0.068$
25	0.9249***	$Y = 2.767X + 0.025$	0.7670**	$Y = 2.970X + 0.027$	0.8294***	$Y = 2.856X + 0.027$
26	0.8502**	$Y = 2.567X + 0.056$	0.9382***	$Y = 4.108X + 0.003$	0.8811***	$Y = 3.315X + 0.032$
31	0.7415*	$Y = 4.557X - 1.159$	0.9677***	$Y = 3.925X + 0.016$	0.9276***	$Y = 4.036X - 0.258$
32	0.5437	—	0.9797***	$Y = 4.237X - 1.524$	0.8359***	$Y = 2.840X + 6.223$
33	0.9252***	$Y = 3.646X + 0.229$	0.9489***	$Y = 4.278X - 0.227$	0.9466***	$Y = 4.251X - 0.271$
34	0.7549*	$Y = 4.261X - 0.940$	0.9754***	$Y = 4.588X - 1.136$	0.8871***	$Y = 4.061X + 0.317$
35	0.6734*	$Y = 1.417X + 0.062$	0.8783***	$Y = 4.256X - 0.017$	0.7258***	$Y = 2.471X + 0.036$
36	0.7374*	$Y = 3.730X + 0.013$	0.9439***	$Y = 5.000X - 0.028$	0.8034***	$Y = 4.120X + 0.002$

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. = Group A - 7, Group B - 10, Whole - 19.

0.1 %, 1 % and 5 % levels and no significance even at 5 % level, respectively. For example, c. c. of s. d. of L (UHG) on variation range of L (UHG) through the whole strains was +0.8916 to the degree of freedom of 7, which is significant at 1 % level. Generally speaking, s. d. of L on variation range of L was calculated as follows;  $Y=3.378X+0.206$ , where Y and X indicate s. d. of L and variation range of L, respectively. This formula indicates that the s. d. of L becomes 3.378 larger, when the variation range becomes larger by 1 degree.

*Group B*: Nineteen, 4 and 1 characters showed significances at 0.1%, 1% and 5% levels, respectively. In other words, the whole characters showed significant relations. For example, c. c. of s. d. of L (UHG) on variation range of L (UHG) through the whole strains was +0.8957 to the degree of freedom of 10, which is obviously significant at 0.1% level. Generally speaking, the larger is the s. d. of L (UHG), the larger is the variation range of L (UHG). L. r. of s. d. of L on variation range of L was calculated as follows;  $Y=3.121X+0.277$ , where Y and X indicate s. d. of L and variation range of L, respectively. This formula indicates that the s. d. of L becomes 3.121 larger, when the variation range becomes larger by 1 degree.

*Whole*: Twenty-three and 1 characters showed significances at 0.1% and 5% levels, respectively. In other words, the whole characters showed significant relations. For example, c. c. of s. d. of L (UHG) on variation range of L (UHG) through the whole strains was +0.9030 to the degree of freedom of 19, which is obviously significant at 0.1% level. Generally speaking, the larger is the s. d. of L (UHG), the larger is the variation range of L (UHG). L. r. of s. d. of L on variation range of L was calculated as follows;  $Y=3.160X+0.265$ , where Y and X indicate s. d. of L and variation range of L, respectively. This formula indicates that the s. d. of L becomes 3.160 larger, when the variation range becomes larger by 1 degree.

### 7. The four relation-groups under comparison

From the data obtained in the Tables 1, 2 and 3 of the present experiment, relations between the two respective characters were compared, and are shown in Table 7. In this table, 3 relation-groups, *i. e.*, relation between the two respective practical values (A column in Table 7), relation between the two respective s. d. (B column) and relation between the two respective variation ranges (C column), were analysed. In addition to these, summed-up data from columns A, B and C were regulated, are shown in D column in the table, under the condition that the calculation was to be made by means of the significances in disregard of significant levels.

In Group A, significant combinations were counted as 16 (59.3%), 14 (51.9%), 6 (22.2%) and 36 (44.4%) in A, B, C and D columns, respectively. In Group B, those were counted as 19 (70.4%), 13 (48.2%), 10 (37.0%) and 42 (51.9%) in the same order, respectively. In the whole, these were counted as 18 (66.7%), 19 (70.4%), 18 (66.7%) and 55 (67.9%) in the same order, respectively.

In Group A, 6, 6, 6 and 9 combinations showed significances at 3, 2, 1 and 0 chances, respectively. Average and its s. d. through the whole combinations were found to be  $1.33 \pm 1.16$ . In Group B, 8, 4, 10 and 5 combinations showed significances at 3, 2, 1 and 0 chances, respectively. Average and its s. d. through the whole combinations were found to be  $1.55 \pm 1.10$ . In the whole, 13, 4, 8 and 2 combinations showed significances at 3, 2, 1 and 0 chances, respectively. Average and its s. d. through the whole combinations were found to be  $2.04 \pm$

Table 7. 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 columns of Total and D showed the number of significant relations in the respective combinations in disregard of the grade of significances

Combi- nation	Group A				Group B				Whole				Total			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
1. 2				0				* 1				* 1	0	0	2	2
1. 3				0				0					0	0	0	0
2. 3	*	**	*	3	***			1	***	**	*	1	3	2	2	7
4. 5	*	*		2	***			1	***	**	**	3	3	2	1	6
4. 6				0	***			1	***			1	2	0	0	2
5. 6				0	*			1			*	1	1	0	1	2
-----																
11.12				0				0					0	0	0	0
11.13				0				0			*		1	0	1	1
12.13	***	*		2	***	*		2	***	**			2	3	3	6
14.15	***			1	***	***		2	***	***	**		3	3	2	6
14.16				0	***			1	*				1	2	0	2
15.16	*			1	*			1			*		1	2	1	3
-----																
21.22				0		***		1		*			1	0	2	2
21.23				0				0				*	1	0	1	1
22.23	***	**		2				0	***	**			2	2	2	4
24.25	***	**		2	**	***		3	***	***			2	3	3	7
24.26		**		1	*			1	**	**	*		3	2	2	5
25.26		**		1				* 1		**	**		2	0	2	4
-----																
1.11	***	***	***	3	***	***	***	3	***	***	***	***	3	3	3	9
2.12	*	***	**	3	***	**		2	***	***	**	***	3	3	2	8
3.13	***	***	**	3	***	***	**	3	***	***	***	***	3	3	3	9
4.14	*			1	***	**	*	3	***	***	***	***	3	3	2	7
5.15	***			1	***	**	*	3	***	*	*	***	3	3	2	7
6.16	***	*	**	3	***	**	**	3	***	***	***	***	3	3	3	9
-----																
31.33	*	*		2	***	***		2	***	***	***	***	3	3	1	7
32.34	***	***	**	3	***	***	***	3	***	***	***	***	3	3	3	9
35.36	***	*		2	***	***	***	3	***	***	***	***	3	3	2	8

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.: Group A - 7, Group B - 10, Whole - 19.

1.04.

In the total of these three groups, significant combinations were counted as 53 (65.4 %), 46 (56.8 %), 34 (42.0 %) and 133 (54.7 %) in A, B, C and D columns, respectively. In column A, 14, 5, 1 and 7 combinations showed significances at 3, 2, 1 and 0 chances, respectively. Average and its s. d. through the whole combinations were found to be  $1.96 \pm 1.26$ . In column B, 9, 9, 1 and 8 combinations showed significances at 3, 2, 1 and 0 chances, respectively. Average and its s. d. through the whole combinations were found to be  $1.70 \pm 1.21$ . In column C, 4, 7, 8 and 8 combinations showed significances at 3, 2, 1 and 0 chances, respectively. Average and its s. d. through the whole combinations were found to be  $1.26 \pm 1.04$ . In column D, 4, 2, 5, 3, 1, 2, 1, 5, 2 and 2 combinations showed significances at 9, 8, 7, 6, 5, 4, 3, 2, 1 and 0 chances, respectively. Average and its s. d. through the whole combinations were found to be  $4.93 \pm 2.97$ .

Through the whole groups and columns, 27 combinations might be divided into 2 categories, *i. e.*, the one with higher frequency and other with lower frequency. Fourteen combinations, *i. e.*, 2·3, 4·5, 12·13, 14·15, 24·25, 1·11, 2·12, 3·13, 4·14, 5·15, 6·16, 31·33, 32·34 and 35·36, belonged to the former one. The remaining 13 combinations belonged to the latter one.

#### 8. The other four relation-groups under comparison

From the data obtained in Tables 4, 5 and 6 of the present experiment, relations between the two respective characters were compared, and are shown in Table 8. In this table, 3 relation-groups, *i. e.*, relation between practical values and their s. d. (E column of Table 8), practical values and their variation ranges (F column) and s. d. and their variation ranges (G column), were analysed. In addition to these, summed-up data from columns E, F and G were regulated, and are shown in H column in the table, under the condition that the calculation was made by means of the significances in disregard of significant levels.

In Group A, significant characters were counted as 9 (37.5 %), 7 (29.2 %), 21 (87.5 %) and 37 (51.4 %) in E, F, G and H columns, respectively. In Group B, those were counted as 4 (16.7 %), 5 (20.8 %), 24 (100.0 %) and 33 (45.8 %) in the same order, respectively. In the whole, those were counted as 13 (54.2 %), 9 (37.9 %), 24 (100.0 %) and 46 (63.9 %) in the same order, respectively.

In Group A, 4, 5 and 15 characters showed significances at 3, 2 and 1 chances, respectively. Average and its s. d. through the whole characters were found to be  $1.54 \pm 0.76$ . In Group B, 3, 3 and 18 characters showed significances at 3, 2 and 1 chances, respectively. Average and its s. d. through the whole characters were found to be  $1.38 \pm 0.70$ . In the whole, 8, 6 and 10 characters showed significances at 3, 2 and 1 chances, respectively. Average and its s. d. through the whole characters were found to be  $1.92 \pm 0.86$ . It was noticeable that all of the characters through the whole groups showed significances.

In the total of these groups, significant characters were counted as 26 (36.1 %), 21 (29.2 %), 69 (95.8 %) and 116 (53.7 %) in E, F, G and H columns, respectively. In E column, 10, 6 and 8 characters showed significances at 2, 1 and 0 chances, respectively. Average and its s. d. through the whole characters were found to be  $1.08 \pm 0.86$ . In column F, 1, 4, 10 and 9 characters showed significances at 3, 2, 1 and 0 chances, respectively. Average and its s. d. through the whole characters were found to be  $0.88 \pm 0.83$ . In column G, 21 and 3

Table 8. Comparisons of 4 relation-groups; relations between practical values and their standard deviations (E), practical values and its variation ranges (F), standard deviations and their variation ranges (G) and summing-up of E, F and G packs (H). Figures used in columns of Total and H showed the number of significant relations in the respective characters in disregard of the grade of significances

Char- acter No.	Group A				Group B				Whole				Total			
	E	F	G	H	E	F	G	H	E	F	G	H	E	F	G	H
1			**	1	***	**	***	3	**	**	***	3	2	2	3	7
2	**	*	***	3			***	1			***	1	1	1	3	5
3	*		**	2			***	1	**	*	***	3	2	1	3	6
4			***	1			***	1	*	*	***	3	1	1	3	5
5	*	*	*	3			***	1			***	1	1	1	3	5
6			***	1			***	1			***	1	0	0	3	3
11			**	1	**	*	***	3	***	**	***	3	2	2	3	7
12			**	1			***	1	*	*	***	3	1	1	3	5
13	**		*	2			***	1	*		***	2	2	0	3	5
14			***	1			***	1	*	*	***	3	1	1	3	5
15	*	*	***	3			***	1	*	*	***	3	2	2	3	7
16			**	1	*		***	2			***	1	1	0	3	4
21		*		1			**	1			***	1	0	1	2	3
22	**		*	2			**	1	***		***	2	2	0	3	5
23			*	1	**	*	**	3	*		***	2	2	1	3	6
24	**			1			*	1	*		*	2	2	0	2	4
25	*	*	***	3		*	**	2	**	*	***	3	2	3	3	8
26			**	1		*	***	2			***	1	0	1	3	4
31			*	1			***	1			***	1	0	0	3	3
32		***		1			***	1		*	***	2	0	2	2	4
33			***	1			***	1			***	1	0	0	3	3
34		*	*	2			***	1			***	1	0	1	3	4
35	**		*	2			***	1	***		***	2	2	0	3	5
36			*	1			***	1			***	1	0	0	3	3

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.: Group A - 7, Group B - 10, Whole - 19.

characters showed significances at 3 and 2 chances, respectively. Average and its s. d. through the whole characters were found to be  $2.88 \pm 0.33$ . In column H, 1, 3, 2, 8, 5 and 5 characters showed significances at 8, 7, 6, 5, 4 and 3 chances, respectively. Average and its s. d. through the whole characters were found to be  $4.83 \pm 1.40$ .

Through the whole groups and columns, 24 characters may tentatively be divided into 2 categories, *i. e.*, the one with higher frequency and other with lower frequency. Six characters, *i. e.*, character Nos. 1, 3, 11, 15, 23 and 25, belonged to the former one. The remaining 18 characters belonged to the latter one.

### Discussion

Basing on the results obtained in the previous<sup>2,6)</sup> and the present experiments, the following problems are to be discussed here.

1. C. c. of the practical value on another practical values (Table 1 and pack A in Table 7) were decided to be significant in 16/27 cases (=59.3%), 19/27 cases (=70.4%) and 18/27 cases (=66.7%) in Group A, Group B and the whole, respectively. Through the 3 groups mentioned above, 14, 5, 1 and 7 character-combinations showed significant correlations in 3, 2, 1 and 0 chances, respectively. It was noticed that combination Nos. 15·16 (=L/T and W/T of HG) showed significances in Groups A and B, but showed no significance in the whole. It might be attributable to positive and negative status in Group A and in Group B, respectively. Average and its s. d. through the whole combinations and groups were found to be  $1.96 \pm 1.26$ .

C. c. of the intra-strain's variations (=s. d.) on other s. d. (Table 2 and pack B in Table 7) were decided to be positively significant in 14/27 (=51.9%), 13/27 (=48.2%) and 19/27 (70.4%) in Group A, Group B and the whole, respectively. Through the 3 groups, 9, 9, 1 and 8 character-combinations showed significant correlations at 3, 2, 1 and 0 chances, respectively. It was noticed that combination Nos. 11·13 (=L and T of HG) showed no significances in Groups A and B, but showed significance in the whole. Average and its s. d. through the whole combinations and groups were found to be  $1.70 \pm 1.21$ .

C. c. of the variation range on another variation range (Table 3 and pack C in Table 7) were decided to be positively significant in 6/27 cases (=22.2%), 10/27 cases (=37.0%) and 18/27 cases (=66.7%) in Group A, Group B and the whole, respectively. Through the 3 groups, 4, 7, 8 and 8 character-combinations showed significant correlations in 3, 2, 1 and 0 chances, respectively. It was noticed that 7 combinations, *i. e.*, 4·5 (=L/W and L/T of UHG), 5·6 (=L/T and W/T of UHG), 14·15 (=L/W and L/T of HG), 15·16 (=L/T and W/T of HG), 21·23 (=comparative values of L and T), 24·26 (=comparative values of L/W and W/T) and 31·33 (=areas of UHG and HG), showed no significance in Group A and Group B, but showed significances in the whole. Average and its s. d. through the whole combinations and groups were found to be  $1.26 \pm 1.04$ .

C. c. of the 3 columns mentioned above (pack D in Table 7) were decided to be significant in 53/81 cases (=65.4%), 46/81 cases (=56.8%), 34/81 cases (=42.0%) and 133/243 cases (=54.7%) in pack A, pack B, pack C and pack D, respectively. It was noticed that 4 combinations, *i. e.*, 1·11 (=L of UHG and HG), 3·13 (=T of UHG and HG), 6·16 (=W/T of UHG and HG) and 32·34 (=volumes of UHG and HG), showed significant correlations through the whole cases. On the other hand, 2 combinations, *i. e.*, 1·3 (=L and T of UHG) and 11·12 (=L and W of HG), showed no significant relations through the whole cases at all.

2. C. c. of the practical value on their s. d. of the respective characters (Table 4 and pack E in Table 8) were decided to be significant in 9/24 cases (=37.5%), 4/24 cases (=16.7%)

and 13/24 cases (=54.2 %) in Group A, Group B and the whole, respectively. Through the 3 groups, 10, 6 and 8 characters showed significant correlations in 2, 1 and 0 cases, respectively. It was noticed that 3 characters, *i. e.*, 4 (=L/W of UHG), 12 (=W of HG) and 14 (=L/W of HG), showed no significance in Groups A and B, but showed significances in the whole. Area and volume characters showed, in general, a few significances. It was quite the reversed results of the previous chapter. Average and its s. d. through the whole characters were found to be  $1.08 \pm 0.86$ .

C. c. of the practical value on their variation ranges of the respective characters (Table 5 and pack F in Table 8) were decided to be significant in 7/24 cases (=29.2 %), 5/24 cases (=20.8 %) and 9/24 cases (=37.5 %) in Group A, Group B and the whole, respectively. Through the 3 groups, 1, 4, 10 and 9 characters showed significant correlations at 3, 2, 1 and 0 chances, respectively. It was noticed that 4 characters, *i. e.*, 3 (=T of UHG), 4 (=L/W of UHG), 12 (=W of HG) and 14 (=L/W of HG), showed no significance in Groups A and B, but showed significances in the whole. Average and its s. d. through the whole characters were found to be  $0.88 \pm 0.83$ .

C. c. of s. d. on their variation ranges of the respective characters (Table 6 and pack G in Table 8) were expectedly decided to be significant in 21/24 cases (=87.5 %), 24/24 cases (=100.0 %) and 24/24 cases (=100.0 %) in Group A, Group B and the whole, respectively. Moreover, they were noted to have some high levelled relations. Those phenomena meant that the character-s. d. were reasonably assumed to be connected with the character-variation-ranges. Generally speaking, the larger is the s. d., the larger is the variation range. Through the 3 groups, 21 and 3 characters showed significant correlations in 3 and 2 cases, respectively. Average and its s. d. through the whole characters were found to be  $2.88 \pm 0.33$ .

C. c. of the 3 columns mentioned above (pack H in Table 8) were decided to be significant in 26/72 cases (=36.1 %), 21/72 cases (=29.2 %), 69/72 cases (=95.8 %) and 116/216 cases (=53.7 %) in pack E, pack F, pack G and pack H, respectively. It was noted that 1 character, *i. e.*, 25 (=comparative value of L/T) showed significances in 8/9 (=88.9 %) through the whole cases. On the other hand, 5 characters, *i. e.*, 6 (=W/T of UHG), 21 (=comparative value of L), 31 (=area of UHG), 33 (=area of HG) and 36 (=quotient of volumes), showed significances only in 3/9 cases (=33.3 %) through the whole cases.

3. Eight (=0 in Group A, 5 in Group B, 3 in the whole), 0 and 0 negative correlations at the significant levels were found in the relations of the practical value on another practical value (pack A), of s. d. on another s. d. (pack B), and of variation range on another variation range (pack C), respectively. Moreover, combination Nos. 4·6 (=L/W and W/T of UHG), 5·6 (=L/T and W/T of UHG), 14·16 (=L/W and W/T of HG), 15·16 (=L/T and W/T of HG) and 24·26 (=comparative values of L/W and W/T), showed negative correlations at significant levels as 2, 1, 2, 1 and 1 cases, respectively. It was noticed that character-combinations L/W and W/T showed many negative correlations.

Seven (=3 in Group A, 1 in Group B, 3 in the whole), 3 (=1 in Group A, 2 in Group B, 0 in the whole) and 0 negative correlations at the significant levels were found in the relations between the practical value and its s. d. (pack E), between the practical value and its variation range (pack F), and s. d. and its variation range (pack G), respectively. Moreover, character Nos. 5 (=L/T of UHG), 22 (=comparative value of W), 23 (=comparative value of T), 26 (=comparative value of W/T) and 35 (=quotient of areas) showed

negative correlations at significant levels as 2, 2, 3, 1 and 2 cases, respectively.

Basing on the data obtained in the packs A to H, it was concluded that those phenomena meant the character-specificities in these characters. In other words, these characters might genetically be fixed as those in possession of a flexibility and affectability to and by a few environmental conditions.

4. In summing-up, significant relations were found as 53 cases (=65.4 %), 46 cases (=56.8 %), 34 cases (=42.0 %), 133 cases (54.7 %), 26 cases (=36.1 %), 21 cases (=29.2 %), 69 cases (=95.8 %) and 116 cases (=53.7 %) in the order of packs A to H, respectively. Average and its s. d. through the whole packs were found to be  $54.21 \pm 19.25$ . It might be concluded that pack G (=s. d. and its variation range) was of the most stable character, and was intimately correlated with each other through the whole strains in disregard of the geographical conditions. However, some characters showed quite low correlations or no significant correlation at all even at 5% level.

Twenty-four characters and 27 mutual 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 may be affirmed that those characters or character-combinations are to be used for analysing the grain morphological constitutions in the future. Moreover, it might be confirmed that such indices of ideas may be used as a sort of handy index in the experiments.

5. Comparisons of morphological characters found in the materials, which had been collected in northeastern (Group A) and eastern (Group B) India, are looked upon as having quite important meanings in view of the origin and diversity of the wild and cultivated species. These considerations were carried out, aiming at getting better understandings of the phylogenetic status and of mutual relationships between them. Although several comparative data were mentioned in the present paper, an accumulation of complete comparison data endorsed by proper discussions of these aspects has been far from being perfect, and further studies are to be performed sincerely. Universal theory on ancestral species and original place of the cultivated rice species (*Oryza sativa* L.) will be accomplished only after consummation of these schemes.

### 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 :

1. In the data obtained from summing-up from 3 relation-groups, *i. e.*, practical value on the other practical values, s. d. on the other s. d., and variation range on the other variation ranges, 53 (16 in Group A, 19 in Group B and 18 in the whole), 46 (14 in Group A, 13 in Group B and 19 in the whole) and 34 (6 in Group A, 10 in Group B and 18 in the whole) character-combinations showed significances, respectively. Averages and their s. d. through the whole character-combinations were found to be in the same orders as  $1.96 \pm 1.26$ ,  $1.70 \pm 1.21$ ,  $1.26 \pm 1.04$  and  $4.93 \pm 2.97$ , respectively. In the total, 36, 42, 55 and 133 character-combinations showed significances in Group A, Group B, the whole and the grand

total, respectively. Averages and their s. d. through the whole character-combinations were found to be  $1.33 \pm 1.16$ ,  $1.55 \pm 1.10$ ,  $2.04 \pm 1.04$  and  $4.93 \pm 2.97$  in the same order, respectively.

2. Concerning correlations among the 3 components in the same characters, *i. e.*, between practical value and its s. d., practical value and its variation range, and s. d. and its variation range, 26 (9 in Group A, 4 in Group B and 13 in the whole), 21 (7 in Group A, 5 in Group B and 9 in the whole) and 69 (21 in Group A, 24 in Group B and 24 in the whole) characters showed significances, respectively. Averages and their s. d. through the whole characters were found to be in the same orders as  $1.08 \pm 0.86$ ,  $0.88 \pm 0.83$ ,  $2.88 \pm 0.33$  and  $4.83 \pm 1.40$ , respectively. In the total, 37, 33, 46 and 116 characters showed significances in Group A, Group B, the whole and the grand total, respectively. Averages and their s. d. through the whole characters were found to be  $1.54 \pm 0.76$ ,  $1.38 \pm 0.70$ ,  $1.92 \pm 0.86$  and  $4.83 \pm 1.40$  in the same order, respectively.

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 something useful, having some universal validities as indices in the examinations of variety- and strain-differentiations. Moreover, comparisons of data obtained in northeastern and eastern India were carried out to some extents, and several interesting informations were shown in view of the locality-specificities.

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