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Morphological Characters of the Cultivated Rice Grains Delivered from Rice Research Station, Chinsurah, West Bengal, 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 and cultivated rices under the project, designated "The Distribution of Wild Rice and the Ecotypic Differentiation of Cultivated Rice in Burma and Assam", supported by a Grant from the Ministry of Education, Science and Culture of the Japanese Government. In this opportunity, 100 strains of cultivated rice stocked in Rice Research Station, Chinsurah, West Bengal, India, were delivered to the present author through the kindness of Dr. S. Biswas of the station. The grains of these strains were used for the morphological studies.

In the station, many strains of cultivated rice, *Oryza sativa* L., were collected and studied in view of the breeding program. While these were not used for fixing the morphological characters. Before fulfilment genetic and breeding purposes, however, varietal variations and methodology of these should be ascertained as promptly as possible.

Since 1969, high yielding varieties have been recommended by the governments of a lot of countries in south and southeast Asia. In India, breeding works are pushed forward in viewpoints of aromatic[3], early maturity[11] and medium-duration[14] varieties. Further, in brief, the following publications might be picked up as an outline of breeding or selection varieties in recent time in India. Roy (1977)[9] reported of rice germ plasm in Orissa. In this report, farmers of the irrigated zones prefer to grow only a few improved varieties in "kharif" season, but they grow mostly high yielding varieties in "rabi" season. In nonirrigated tracts, the genetic diversity was considerable. Sharma *et al.* (1978)[10] reported a new, stable, high yielding rice for hilly areas of Himachal Pradesh. Sinha *et al.* (1985)[12] reported of performance of some new 11 rices in Chinsurah, focusing growing duration, high yielding, cold resistance. Sivasubramanian *et al.* (1987)[14] reported also of performance of new varieties in Tamil Nadu, focusing medium-duration character. Sinha *et al.* (1988)[13] reported of screening rice varieties for cold tolerance at the seedling and the reproductive stages.

On the other hand, it is said that local and domestic varieties have been on the way of disappearance in these processes[1,2]. However, because of several problems in modern agronomical practices using the high yielding varieties, local varieties have been consciously kept in the respective localities. Recently, analyses of the primitive varieties have been put into limelight in these fields.

Taking these factors into account, the author tried to accomplish the work, the aim of which was to make a classification of the varietal variation and of the phylogenetic relationships of cultivated-rice-strains (=cultivars), using the relatively primitive and un-advanced ones in India, in the previous experimental series. The present experimental series was made to search the varietal variations, using the relatively advanced cultivars in India, taking these facts into

consideration.

In the previous papers[4-8], the records of morphological characters of the unhusked and husked grains[4], comparative values, area- and volume-columns and 6 characters of the ranges[5], 12 variation ranges[6], other 6 variation ranges and their summed-up data[7], and 12 mutual relations[8] were reported.

In the present paper, the remaining 15 mutual relations among 24 characters in 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

One hundred strains of rice cultivars were used in this experiment. They are listed up in Table 1 of the previous paper[4]. In this table, collection number, local name, original place are mentioned. They have different meanings in view of physiological characters, *i.e.*, *aman* and *aus*, and should be considered separately also in morphological studies. Accordingly, they are divided into two groups in the present experiment, *i.e.*, Group A --- *aman* varieties (=strain Nos.1~50), Group B --- *aus* varieties (=strain Nos.51~100).

To make clear the relations between the respective 2 characters of the unhusked and 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 husked grains (Tables 3 and 4), and area- and volume-columns (Table 5).

Some techniques, in which relatively large or small strains were selected and put into grouping, were adopted for the comparative studies of the whole strains used.

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. 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, 2 and 47 strains showed significances at 1% and 5% levels and no significance even at 5% level, respectively. In the whole strains (=50), c.c. was +0.2337 to the degree of freedom of 48, showing no significance even at 5% level.

Group B: One, 1 and 48 strains showed significances at 1% and 5% levels and no significance even at 5% level, respectively. In the whole strains (=50), c.c. was +0.0310 to the degree of freedom of 48, showing no significance even at 5% level.

Whole: Two, 3 and 95 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 (=100), c.c. was +0.2316 to the degree of freedom of 98, which is significant at 5% level. Generally speaking, the larger is the comparative value of L, the larger is the comparative value of W. L.r. of L on W was calculated as follows; $Y=0.415X+0.556$, where Y and X indicate the comparative values of L and W, respectively. This formula indicates that the comparative value of L becomes 0.415 larger, when the comparative

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	0.1543	—	−0.1047	—	0.0272	—
2	0.3002	—	0.5131**	Y = 0.544 X + 0.537	0.3450	—
3	−0.2092	—	0.2074	—	−0.0622	—
4	−0.0173	—	0.2027	—	−0.0128	—
5	0.0583	—	−0.1095	—	0.0087	—
6	0.2280	—	0.1224	—	0.2112	—
7	0.1669	—	0.2182	—	0.1245	—
8	0.2096	—	−0.1350	—	−0.1254	—
9	0.2121	—	−0.1726	—	0.2117	—
10	0.4741**	Y = 0.779 X + 0.310	−0.1456	—	0.1106	—
11	−0.1676	—	−0.1342	—	0.2190	—
12	0.2853	—	−0.0675	—	−0.0580	—
13	0.0984	—	0.3040	—	−0.3653*	Y = −0.278 X + 1.148
14	−0.0766	—	0.4979**	Y = 0.751 X + 0.384	0.0120	—
15	−0.1340	—	−0.0691	—	−0.1373	—
16	0.0972	—	0.1083	—	0.2989	—
17	0.0880	—	0.2675	—	0.0351	—
18	0.1556	—	0.1342	—	0.3212	—
19	−0.0039	—	0.1774	—	0.1101	—
20	0.1960	—	0.2750	—	−0.0818	—
21	0.2633	—	−0.1147	—	0.1370	—
22	0.3760*	Y = 0.736 X + 0.313	−0.1088	—	−0.1127	—
23	0.0739	—	−0.1380	—	0.3477	—
24	0.3296	—	−0.3730*	Y = −0.348 X + 1.157	−0.2692	—
25	0.0704	—	0.2949	—	0.1488	—
26	0.1691	—	0.3590	—	−0.0224	—
27	0.1425	—	−0.0352	—	−0.2358	—
28	0.2959	—	−0.0288	—	0.2732	—
29	0.3660*	Y = 0.643 X + 0.468	−0.1788	—	0.1152	—
30	−0.1707	—	0.4694**	Y = 0.974 X + 0.194	−0.2075	—
31	0.2165	—	−0.1317	—	0.0578	—
32	−0.2193	—	0.3755*	Y = 0.566 X + 0.502	−0.0297	—
33	−0.1544	—	0.0860	—	0.1747	—
34	−0.1226	—	0.3746*	Y = 0.724 X + 0.387	−0.1087	—
35	0.1828	—	0.0894	—	0.3063	—
36	−0.1602	—	−0.0852	—	0.1016	—
37	−0.0468	—	−0.0264	—	−0.0909	—
38	0.0538	—	0.0281	—	0.1481	—
39	0.1308	—	0.1788	—	−0.2135	—
40	0.2414	—	0.1908	—	0.0999	—

(Continued)

Table 1. (Continued)

Strain No.	Length and Width		Length and Thickness		Width and Thickness	
	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression
41	0.1196	—	−0.1363	—	−0.0289	—
42	−0.2158	—	0.1281	—	−0.2597	—
43	0.1545	—	0.4118*	Y = 0.866 X + 0.307	0.0069	—
44	0.3164	—	0.0052	—	0.1688	—
45	0.1296	—	−0.0620	—	0.1509	—
46	0.1989	—	−0.2438	—	−0.0531	—
47	−0.0034	—	−0.1835	—	0.1557	—
48	−0.0010	—	0.2175	—	−0.3466	—
49	0.1902	—	−0.3199	—	0.0912	—
50	0.1398	—	0.3224	—	0.1632	—
51	0.0376	—	0.0657	—	−0.0857	—
52	−0.1178	—	0.6395***	Y = 1.017 X + 0.179	−0.0599	—
53	0.1461	—	0.0299	—	−0.0043	—
54	0.0703	—	0.0988	—	0.1777	—
55	−0.1491	—	−0.3085	—	0.0771	—
56	0.1430	—	0.0949	—	0.2415	—
57	0.4758**	Y = 0.618 X + 0.401	−0.0308	—	−0.0857	—
58	0.1172	—	0.2976	—	0.1073	—
59	−0.0644	—	−0.1305	—	0.0326	—
60	−0.1493	—	−0.2276	—	−0.2335	—
61	−0.1783	—	0.0736	—	0.0490	—
62	−0.0472	—	−0.0616	—	0.0083	—
63	−0.0264	—	−0.0339	—	−0.3112	—
64	−0.0947	—	−0.0052	—	−0.2252	—
65	−0.1823	—	−0.1982	—	0.1727	—
66	0.1755	—	0.2943	—	−0.1050	—
67	0.3285	—	−0.1460	—	0.1947	—
68	0.0927	—	0.0980	—	−0.1386	—
69	0.0762	—	−0.1589	—	−0.0118	—
70	0.1108	—	0.0640	—	−0.0829	—
71	0.0829	—	0.1423	—	0.4221*	Y = 0.509 X + 0.451
72	0.2232	—	−0.1093	—	0.0203	—
73	0.1157	—	0.2226	—	−0.2927	—
74	0.1845	—	−0.2193	—	−0.0382	—
75	0.2289	—	−0.2492	—	0.1415	—
76	0.1210	—	0.2349	—	0.0232	—
77	−0.2347	—	0.3322	—	−0.3239	—
78	0.3665*	Y = 0.568 X + 0.466	0.2200	—	−0.2529	—
79	−0.2822	—	−0.2315	—	0.2526	—
80	0.2381	—	0.1054	—	0.2694	—
81	0.1462	—	−0.0836	—	−0.1303	—
82	−0.0147	—	0.2684	—	−0.4362*	Y = −0.285 X + 1.134

(Continued)

Table 1. (Continued)

Strain No.	Length and Width		Length and Thickness		Width and Thickness	
	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression
83	−0.1509	−	−0.2139	−	0.0166	−
84	0.1532	−	0.4315*	Y = 0.926 X + 2.389	0.0854	−
85	−0.3031	−	−0.1507	−	0.0371	−
86	0.1528	−	0.1012	−	0.2001	−
87	−0.1265	−	0.1547	−	−0.0293	−
88	−0.0756	−	0.2473	−	0.0040	−
89	−0.0812	−	0.1596	−	0.0270	−
90	0.1752	−	−0.2437	−	0.2916	−
91	0.0311	−	0.0978	−	−0.0305	−
92	0.0939	−	0.2026	−	−0.1109	−
93	−0.2125	−	0.1815	−	−0.2571	−
94	0.2644	−	0.0180	−	0.1892	−
95	−0.0256	−	0.2121	−	0.0453	−
96	−0.0178	−	−0.4589*	Y = −0.953 X + 1.594	−0.1801	−
97	0.3050	−	0.1045	−	−0.0156	−
98	0.1431	−	0.0012	−	0.0354	−
99	−0.0066	−	0.0843	−	0.2151	−
100	0.2038	−	−0.2091	−	0.1193	−

d.f. = 28

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

value of W becomes larger by 1 degree.

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. Three, 4 and 43 strains showed significances at 1% and 5% levels and no significance even at 5% level, respectively. In the whole strains, c.c. was −0.0909 to the degree of freedom on 48, showing no significance even at 5% level.

Group B: One, 2 and 47 strains showed significances at 0.1% and 5% levels and no significance even at 5% level, respectively. In the whole strains, c.c. was +0.2569 to the degree of freedom of 48, showing no significance even at 5% level.

Whole: One, 3, 6 and 90 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 +0.1955 to the degree of freedom of 98, 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 49 strains showed significance at 5% level and no significance even at 5% level, respectively. In the whole strains, c.c. was +0.2810 to the degree of freedom of 48, which is significant at 5% 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; $Y = 1.343X + 0.795$, where Y and X indicate the comparative values of W and T, respectively. This formula indicates that the comparative value of W becomes 1.343 larger, when the comparative value of T becomes larger by 1 degree.

Group B: Two and 48 strains showed significances at 5% level and no significance even at 5% level, respectively. In the whole strains, c.c. was +0.2614 to the degree of freedom of 48, showing no significance even at 5% level.

Whole: Three and 97 strains showed significances at 5% level and no significance even at 5% level, respectively. In the whole strains of both of the groups, c.c. was +0.3894 to the degree of freedom of 98, which is 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; $Y=0.162X+0.769$, where Y and X indicate the comparative values of W and T, respectively. This formula indicates that the comparative value of W becomes 0.162 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, 5, 10 and 34 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 +0.5723 to the degree of freedom of 48, which is 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; $Y=0.461X+0.403$, where Y and X indicate the comparative value of L/W and L/T, respectively. This formula indicates that the comparative value of L/W becomes 0.461 larger, when the comparative value of L/T becomes larger by 1 degree.

Group B: Two, 5, 13 and 30 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 +0.5645 to the degree of freedom of 48, which is 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; $Y=0.275X+0.551$, 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 0.275 larger, when the comparative value of L/T becomes larger by 1 degree.

Whole: Three, 10, 23 and 64 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 +0.5119 to the degree of freedom of 98, which is 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; $Y=0.300X+0.533$, 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 0.300 larger, when the comparative 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. Thirty-six, 8, 2 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 −0.5515 to the degree of freedom of 48, which is significant at 0.1% 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; $Y=-0.567X+1.418$, 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 0.567 larger, when the comparative value of W/T becomes smaller by 1 degree.

Group B: Thirty-three, 12, 4 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 −0.8385 to the degree of freedom of 48, which is significant at 0.1% level. Generally speaking, the larger is the

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	0.1201	—	−0.6933***	Y = −0.982 X + 1.774	0.5773***	Y = 0.913 X + 0.213
2	0.1924	—	−0.6652***	Y = −0.710 X + 1.510	0.2159	—
3	0.5596**	Y = 0.336 X + 0.517	−0.9016***	Y = −0.985 X + 1.786	−0.2296	—
4	0.2757	—	−0.7410***	Y = −0.847 X + 1.667	0.3997*	Y = 0.787 X + 0.304
5	0.2176	—	−0.6301***	Y = −0.871 X + 1.678	0.6107***	Y = 0.899 X + 0.244
6	0.3424	—	−0.5367**	Y = −0.661 X + 1.518	0.4945**	Y = 0.697 X + 0.394
7	0.5368**	Y = 0.346 X + 0.498	−0.1452	—	0.5235**	Y = 0.950 X + 0.206
8	0.1610	—	−0.6886***	Y = −0.904 X + 1.692	0.5488**	Y = 1.058 X + 0.127
9	0.4182*	Y = 0.359 X + 0.484	−0.6493***	Y = −0.854 X + 1.648	0.3974*	Y = 0.609 X + 0.492
10	0.0964	—	−0.4700**	Y = −0.768 X + 1.591	0.7098***	Y = 0.843 X + 0.292
11	0.4102*	Y = 0.224 X + 0.583	−0.8044***	Y = −0.818 X + 1.602	0.1327	—
12	0.2113	—	−0.5560**	Y = −0.819 X + 1.607	0.6768***	Y = 1.085 X + 0.116
13	−0.1755	—	−0.7868***	Y = −1.303 X + 2.051	0.6584***	Y = 1.473 X − 0.221
14	0.2366	—	−0.8393***	Y = −0.960 X + 1.725	0.1677	—
15	0.2495	—	−0.7316***	Y = −0.893 X + 1.700	0.4555*	Y = 0.819 X + 0.323
16	0.5211**	Y = 0.658 X + 0.260	0.1429	—	0.7416***	Y = 0.820 X + 0.331
17	0.2328	—	−0.8046***	Y = −1.034 X + 1.821	0.3252	—
18	0.4185*	Y = 0.399 X + 0.454	−0.5961***	Y = −0.728 X + 1.552	0.4761**	Y = 0.636 X + 0.442
19	0.2933	—	−0.6467***	Y = −0.836 X + 1.617	0.5194**	Y = 0.834 X + 0.300
20	0.1730	—	−0.7604***	Y = −0.923 X + 1.695	0.4874**	Y = 0.793 X + 0.320
21	0.2420	—	−0.5619**	Y = −0.738 X + 1.517	0.6467***	Y = 0.925 X + 0.196
22	0.1594	—	−0.6609***	Y = −0.918 X + 1.724	0.6222***	Y = 0.909 X + 0.213
23	0.6165***	Y = 0.521 X + 0.344	−0.6006***	Y = −0.605 X + 1.439	0.2372	—
24	0.4327*	Y = 0.486 X + 0.369	−0.2901	—	0.7076***	Y = 0.829 X + 0.307
25	0.4340*	Y = 0.343 X + 0.498	−0.7173***	Y = −0.769 X + 1.583	0.2997	—
26	−0.0368	—	−0.7557***	Y = −1.141 X + 1.895	0.6612***	Y = 1.192 X + 0.010
27	0.0929	—	−0.7039***	Y = −1.033 X + 1.785	0.6145***	Y = 0.990 X + 0.194
28	0.3135	—	−0.5262**	Y = −0.736 X + 1.581	0.6071***	Y = 0.827 X + 0.299
29	0.3787*	Y = 0.541 X + 0.355	−0.3086	—	0.7430***	Y = 0.912 X + 0.304
30	−0.0151	—	−0.8072***	Y = −1.028 X + 1.827	0.5174**	Y = 1.390 X − 0.178
31	0.1858	—	−0.8073***	Y = −0.800 X + 1.631	0.3874*	Y = 0.781 X + 0.313
32	0.1267	—	−0.3946*	Y = −0.329 X + 1.211	0.2237	—
33	0.4469*	Y = 0.221 X + 0.599	−0.8188***	Y = −0.915 X + 1.702	0.0233	—
34	0.0919	—	−0.8140***	Y = −1.084 X + 1.859	0.3972*	Y = 0.824 X + 0.309
35	0.4144*	Y = 0.471 X + 0.379	−0.4842**	Y = −0.605 X + 1.430	0.2311	—
36	0.5425**	Y = 0.563 X + 0.312	−0.4334*	Y = −0.429 X + 1.295	0.4177*	Y = 0.398 X + 0.613
37	0.1916	—	−0.8038***	Y = −1.030 X + 1.813	0.4138*	Y = 0.825 X + 2.771
38	0.3985*	Y = 0.454 X + 0.426	−0.4765**	Y = −0.675 X + 1.531	0.5976***	Y = 0.742 X + 0.352
39	0.1646	—	−0.7877***	Y = −1.039 X + 1.802	0.4489*	Y = 0.979 X + 0.198

(Continued)

Table 2. (Continued)

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
40	0.1160	—	−0.6273***	Y = −0.834 X + 1.641	0.6011***	Y = 0.978 X + 0.200
41	0.3025	—	−0.7002***	Y = −0.812 X + 1.622	0.4447*	Y = 0.713 X + 0.352
42	0.2839	—	−0.7776***	Y = −0.882 X + 1.689	0.3483	—
43	−0.0376	—	−0.8192***	Y = −1.050 X + 1.803	0.5763***	Y = 1.123 X + 0.057
44	0.2540	—	−0.6464***	Y = −0.869 X + 1.655	0.5456**	Y = 0.881 X + 0.246
45	0.2724	—	−0.6680***	Y = −0.898 X + 1.700	0.5079**	Y = 0.732 X + 0.384
46	0.1522	—	−0.7002***	Y = −0.975 X + 1.778	0.5138**	Y = 0.905 X + 0.226
47	0.2505	—	−0.6806***	Y = −0.828 X + 1.637	0.4797**	Y = 0.590 X + 0.507
48	−0.0487	—	−0.8100***	Y = −1.273 X + 1.999	0.5812***	Y = 1.088 X + 0.110
49	0.4438*	Y = 0.371 X + 0.486	−0.6176***	Y = −0.643 X + 1.488	0.3895*	Y = 0.485 X + 0.569
50	0.5628**	Y = 0.347 X + 0.491	−0.5318**	Y = −0.463 X + 1.325	0.2146	—
51	0.0654	—	−0.7082***	Y = −1.036 X + 1.795	0.5496**	Y = 0.947 X + 0.222
52	0.1652	—	−0.9160***	Y = −1.076 X + 1.844	0.2204	—
53	0.2017	—	−0.7039***	Y = −0.961 X + 1.725	0.5078**	Y = 0.955 X + 0.201
54	0.5220**	Y = 0.403 X + 0.435	−0.6173***	Y = −0.645 X + 1.464	0.3070	—
55	0.4463*	Y = 0.425 X + 0.429	−0.5270**	Y = −0.618 X + 1.457	0.4975**	Y = 0.613 X + 0.480
56	0.6002***	Y = 0.534 X + 0.343	−0.4651**	Y = −0.470 X + 1.339	0.4068*	Y = 0.462 X + 0.585
57	0.2824	—	−0.5094**	Y = −0.710 X + 1.524	0.6417***	Y = 0.745 X + 0.348
58	0.1187	—	−0.9036***	Y = −1.078 X + 1.831	0.2916	—
59	0.1905	—	−0.6682***	Y = −0.835 X + 1.636	0.4813**	Y = 0.744 X + 0.357
60	0.4589*	Y = 0.395 X + 0.447	−0.5727***	Y = −0.782 X + 1.583	0.1955	—
61	0.3429	—	−0.8439***	Y = −0.893 X + 1.710	0.1705	—
62	0.4576*	Y = 0.266 X + 0.551	−0.7640***	Y = −0.774 X + 1.574	0.1987	—
63	0.0938	—	−0.5908***	Y = −0.428 X + 1.292	0.4771**	Y = 0.611 X + 0.462
64	0.1396	—	−0.7083***	Y = −0.985 X + 1.734	0.5610**	Y = 1.130 X + 0.060
65	0.3987*	Y = 0.418 X + 0.429	−0.2705	—	0.3234	—
66	−0.0147	—	−0.7691***	Y = −0.984 X + 1.762	0.6192***	Y = 1.097 X + 0.071
67	0.2602	—	−0.7050***	Y = −0.961 X + 1.748	0.2856	—
68	0.1796	—	−0.7398***	Y = −0.886 X + 1.669	0.2780	—
69	0.2285	—	−0.5136**	Y = −0.872 X + 1.646	0.7015***	Y = 1.024 X + 1.404
70	0.0787	—	−0.7378***	Y = −1.053 X + 1.813	0.5914***	Y = 1.044 X + 0.112
71	0.2189	—	−0.3984*	Y = −0.389 X + 1.299	0.4980**	Y = 0.347 X + 0.701
72	0.3580	—	−0.5656**	Y = −0.744 X + 1.559	0.3531	—
73	0.4414*	Y = 0.335 X + 0.490	−0.6415***	Y = −0.793 X + 1.583	0.3751*	Y = 0.612 X + 0.485
74	0.3832*	Y = 0.358 X + 0.463	−0.4856**	Y = −0.542 X + 1.361	0.5844***	Y = 0.698 X + 0.332
75	0.4051*	Y = 0.816 X + 0.129	−0.4252*	Y = −0.633 X + 1.478	0.4832**	Y = 0.357 X + 0.703
76	0.4972**	Y = 0.418 X + 0.432	−0.6041***	Y = −0.675 X + 1.499	0.3597	—
77	0.4611*	Y = 0.309 X + 0.532	−0.6306***	Y = −0.636 X + 1.476	0.3291	—
78	0.0028	—	−0.6270***	Y = −1.176 X + 1.925	0.7269***	Y = 1.190 X + 0.030
79	0.4545*	Y = 0.199 X + 0.609	−0.8817***	Y = −0.727 X + 1.531	−0.0084	—
80	0.2714	—	−0.8252***	Y = −0.680 X + 1.484	0.3069	—
81	0.1607	—	−0.7056***	Y = −0.865 X + 1.667	0.5015**	Y = 0.811 X + 0.253

(Continued)

Table 2. (Continued)

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
82	0.0633	—	−0.8266***	Y = −0.966 X + 1.742	0.4817**	Y = 1.153 X + 0.031
83	0.1552	—	−0.5338**	Y = −0.482 X + 1.360	0.5125**	Y = 0.401 X + 0.650
84	0.2239	—	−0.7461***	Y = −0.763 X + 1.584	0.3915*	Y = 0.769 X + 0.310
85	0.6376***	Y = 0.388 X + 0.451	−0.7127***	Y = −0.554 X + 1.390	0.0537	—
86	0.3018	—	−0.6985***	Y = −0.872 X + 1.679	0.4544*	Y = 0.719 X + 0.358
87	0.3456	—	−0.5749***	Y = −0.526 X + 1.351	0.3770*	Y = 0.476 X + 0.544
88	0.3845*	Y = 0.407 X + 0.425	−0.7811***	Y = −0.814 X + 1.592	−0.1112	—
89	0.3838*	Y = 0.288 X + 0.553	−0.6549***	Y = −0.723 X + 1.553	0.4137*	Y = 0.609 X + 0.433
90	0.3671*	Y = 0.343 X + 0.516	−0.5387**	Y = −0.583 X + 1.441	0.3624*	Y = 0.408 X + 0.611
91	0.2346	—	−0.7171***	Y = −0.961 X + 1.754	0.4921**	Y = 0.792 X + 0.332
92	0.1326	—	−0.6908***	Y = −1.017 X + 1.796	0.6075***	Y = 0.971 X + 0.165
93	0.1615	—	−0.5544**	Y = −0.639 X + 1.457	0.4859**	Y = 0.658 X + 0.425
94	0.3178	—	−0.5517**	Y = −0.374 X + 1.253	0.1333	—
95	0.4948**	Y = 0.400 X + 0.463	−0.5373**	Y = −0.552 X + 1.413	0.4290*	Y = 0.546 X + 0.513
96	0.2909	—	−0.3700*	Y = −0.555 X + 1.409	0.6947***	Y = 0.814 X + 0.291
97	0.0502	—	−0.7559***	Y = −1.077 X + 1.869	0.5829***	Y = 1.074 X + 0.070
98	0.5365**	Y = 0.535 X + 0.324	−0.4444*	Y = −0.374 X + 1.235	0.2531	—
99	0.5559**	Y = 0.424 X + 0.412	−0.5902***	Y = −0.584 X + 1.409	0.3161	—
100	0.3840*	Y = 0.377 X + 0.456	−0.5682**	Y = −0.713 X + 1.521	0.4793**	Y = 0.613 X + 0.439

d.f. = 28

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

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; $Y = -0.726X + 1.543$, where Y and X indicate comparative values of L/W and W/T, respectively. This formula indicates that the comparative value of L/W becomes 0.726 larger, when the comparative value of W/T becomes smaller by 1 degree.

Whole: Sixty-nine, 20, 6 and 5 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 −0.6680 to the degree of freedom of 98, which is significant at 0.1% 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; $Y = -0.700X + 1.524$, 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 0.700 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 rigtht column of Table 2. Seventeen, 11, 10 and 12 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 +0.3139 to the degree of freedom of 48, which is significant at 5% level. Generally speaking, the larger is the comparative value of L/T, the larger is the comparative value of W/T. L.r. of L/T on W/T was calculated as follows; $Y = 0.401X + 0.631$, where Y and X indicate the comparative values of L/T and W/T, respectively. This formula indicates that the comparative value of L/T becomes 0.401 larger, when the comparative value of W/T becomes larger by 1 degree.

Group B: Nine, 14, 8 and 19 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 −0.0764 to the degree of freedom of 48, showing no significance even at 5% level.

Whole: Twenty-six, 25, 18 and 31 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 +0.1244 to the degree of freedom of 98, 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. Forty-six, 2 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 +0.9852 to the degree of freedom of 48, 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; $Y=0.750X-0.333$, where Y and X indicate L of UHG and L of HG, respectively. This formula indicates that the L of UHG becomes 0.750 mm longer, when the L of HG becomes longer by 1 degree.

Group B: Forty-nine and 1 strains showed significances at 0.1% and 1% levels, respectively. In other words, the whole strains (=50) showed significances. In the whole strains, c.c. was +0.9625 to the degree of freedom of 48, 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; $Y=0.671X+0.280$, where Y and X indicate L of UHG and L of HG, respectively. This formula indicates that the L of UHG becomes 0.671 mm longer, when the L of HG becomes longer by 1 degree.

Whole: Ninety-five, 3 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 group, c.c. was +0.9774 to the degree of freedom of 98, 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; $Y=0.737X-0.256$, where Y and X indicate the L of UHG and L of HG, respectively. This formula indicates that the L of UHG becomes 0.737 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. Twenty-eight, 6, 9 and 7 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 +0.9846 to the degree of freedom of 48, 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; $Y=0.746X+0.291$, where Y and X indicate W of UHG and W of HG, respectively. This formula indicates that the W of UHG becomes 0.746 mm wider, when the W of HG becomes wider by 1 degree.

Group B: Thirty-eight, 6, 5 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 +0.9563 to the degree of freedom of 48, 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; $Y=0.731X+0.343$, where Y and X indicate W of UHG and W of HG, respectively. This formula indicates that the W of UHG becomes 0.731 mm wider, when the W of HG becomes wider by 1 degree.

Whole: Sixty-six, 12, 14 and 8 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

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	0.8650***	Y=0.571X+1.334	0.7895***	Y=0.671X+0.471	0.5467**	Y=0.422X+1.020
2	−0.1917	−	0.7573***	Y=0.654X+0.561	0.8460***	Y=0.822X+0.207
3	0.7819***	Y=0.540X+1.821	0.3096	−	0.7609***	Y=0.747X+0.334
4	0.6985***	Y=0.540X+1.693	0.6160***	Y=0.550X+0.754	0.8198***	Y=1.023X−0.247
5	0.5672**	Y=0.347X+3.107	0.5670**	Y=0.487X+0.853	0.2318	−
6	0.6401***	Y=0.816X−1.019	0.6498***	Y=0.359X+1.154	0.9383***	Y=1.032X−0.279
7	0.6943***	Y=0.428X+2.574	0.7626***	Y=0.768X+0.249	0.7021***	Y=0.675X+0.470
8	0.9106***	Y=0.567X+1.388	0.4368*	Y=0.315X+1.482	0.9074***	Y=0.885X+0.039
9	0.7214***	Y=0.544X+1.441	0.6787***	Y=0.581X+0.744	0.7831***	Y=0.857X+0.102
10	0.8510***	Y=0.442X+2.717	0.4163*	Y=0.317X+1.490	0.6888***	Y=0.697X+0.427
11	0.8025***	Y=0.516X+1.547	0.5757***	Y=0.042X+2.109	0.8842***	Y=0.820X+0.151
12	0.7560***	Y=0.460X+2.195	0.6314***	Y=0.517X+0.917	0.7862***	Y=0.745X+0.346
13	0.8679***	Y=0.509X+2.135	0.6904***	Y=0.693X+0.489	0.6309***	Y=0.624X+0.587
14	0.8023***	Y=0.459X+2.207	0.3672*	Y=0.432X+1.144	0.6609***	Y=0.770X+0.288
15	0.7915***	Y=0.353X+3.086	0.6318***	Y=0.561X+0.790	0.8887***	Y=0.923X−0.055
16	0.8597***	Y=0.496X+2.002	0.7259***	Y=0.662X+0.526	0.5337**	Y=0.490X+0.824
17	0.8234***	Y=0.611X+0.915	0.4753**	Y=0.273X+1.394	0.8786***	Y=0.930X−0.063
18	0.8468***	Y=0.654X+0.437	0.2361	−	0.7631***	Y=0.860X+0.080
19	0.7197***	Y=0.460X+2.036	0.4636**	Y=0.496X+1.003	0.5798***	Y=0.705X+0.434
20	0.7827***	Y=0.399X+2.296	0.5060**	Y=0.417X+1.211	0.7972***	Y=0.706X+0.377
21	0.7606***	Y=0.407X+2.595	0.6736***	Y=0.507X+1.070	0.6444***	Y=0.850X+0.178
22	0.6154***	Y=0.525X+1.438	0.4288*	Y=0.382X+1.419	0.7500***	Y=0.822X+0.154
23	0.7505***	Y=0.416X+2.433	0.3804*	Y=0.057X+2.285	0.8213***	Y=0.895X+0.008
24	0.6332***	Y=0.468X+2.099	0.6067***	Y=0.708X+0.419	0.7994***	Y=0.679X+0.507
25	0.7381***	Y=0.666X+0.567	0.6077***	Y=0.596X+0.645	0.7756***	Y=0.813X+0.215
26	0.5824***	Y=0.543X+1.390	0.3977*	Y=0.605X+0.697	0.9056***	Y=1.090X−0.375
27	0.7264***	Y=0.500X+1.658	0.5965***	Y=0.489X+1.093	0.8380***	Y=0.782X+0.284
28	0.6593***	Y=0.419X+3.117	0.1610	−	0.5198**	Y=0.494X+0.835
29	0.8509***	Y=0.627X+0.477	0.6629***	Y=0.464X+0.888	0.4614*	Y=0.558X+0.636
30	0.8639***	Y=0.553X+1.481	0.3918*	Y=0.393X+1.144	0.7194***	Y=0.630X+0.537
31	0.7605***	Y=0.680X+0.421	0.3418	−	0.7312***	Y=0.732X+0.350
32	0.8155***	Y=0.717X−0.094	0.8052***	Y=0.576X+0.732	0.7699***	Y=0.796X+0.210
33	0.8763***	Y=0.684X+0.270	0.2896	−	0.6205***	Y=0.502X+0.822
34	0.8590***	Y=0.624X+0.836	0.2036	−	0.4063*	Y=0.450X+0.923
35	0.7082***	Y=0.447X+2.579	0.6994***	Y=0.654X+0.478	0.7969***	Y=0.902X+0.003
36	0.4804**	Y=0.299X+4.115	0.8346***	Y=0.563X+0.732	0.5439**	Y=0.673X+0.477
37	0.6979***	Y=0.488X+2.049	0.3518	−	0.7728***	Y=0.767X+0.295
38	0.8511***	Y=0.767X−0.294	0.7092***	Y=0.709X+0.414	0.7623***	Y=0.760X+0.309
39	0.3546	−	0.6231***	Y=0.521X+0.858	0.6276***	Y=0.716X+0.397
40	0.7065***	Y=0.516X+1.637	0.5186**	Y=0.596X+0.605	0.4484*	Y=0.412X+0.943
41	0.7527***	Y=0.609X+1.038	0.5327**	Y=0.348X+1.283	0.7055***	Y=0.658X+0.521

(Continued)

Table 3. (Continued)

Strain No.	Length		Width		Thickness	
	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression
42	0.8347***	Y=0.601X+1.174	0.4621*	Y=0.432X+1.086	0.7873***	Y=0.764X+0.302
43	0.7947***	Y=0.571X+1.164	0.5737***	Y=0.592X+0.736	0.7089***	Y=0.780X+0.300
44	0.8033***	Y=0.672X+0.347	0.4017*	Y=0.367X+1.341	0.6495***	Y=0.486X+0.907
45	0.9062***	Y=0.682X+0.329	0.7480***	Y=0.471X+0.958	0.5386**	Y=0.651X+0.525
46	0.8631***	Y=0.547X+1.652	0.6275***	Y=0.324X+1.301	0.5511**	Y=0.584X+0.660
47	0.8576***	Y=0.587X+1.139	0.6422***	Y=0.519X+0.869	0.7682***	Y=0.705X+0.420
48	0.8324***	Y=0.535X+1.550	0.8437***	Y=1.036X−0.491	0.8799***	Y=1.097X−0.393
49	0.9236***	Y=0.548X+1.607	0.6699***	Y=0.576X+0.721	0.9008***	Y=1.189X−0.572
50	0.6519***	Y=0.350X+2.746	0.6281***	Y=0.491X+1.021	0.0931	−
51	0.9004***	Y=0.566X+1.071	0.5389**	Y=0.447X+1.469	0.6424***	Y=0.661X+0.559
52	0.8261***	Y=0.451X+2.127	0.2888	−	0.6703***	Y=0.574X+0.741
53	0.8498***	Y=0.496X+2.043	0.4246*	Y=0.409X+1.424	0.7679***	Y=0.626X+0.631
54	0.8229***	Y=0.441X+2.293	0.5347**	Y=0.566X+0.863	0.3267	−
55	0.7370***	Y=0.652X+0.385	0.7684***	Y=0.535X+1.173	0.6797***	Y=0.728X+0.425
56	0.7287***	Y=0.761X−0.393	0.6102***	Y=0.589X+0.910	0.7236***	Y=0.603X+0.695
57	0.8401***	Y=0.453X+2.233	0.8118***	Y=0.578X+0.807	0.8301***	Y=0.716X+0.408
58	0.8075***	Y=0.497X+1.709	0.7566***	Y=1.456X−2.239	0.7773***	Y=0.719X+0.436
59	0.8747***	Y=0.466X+2.124	0.6624***	Y=0.604X+0.828	0.7085***	Y=0.588X+0.717
60	0.7271***	Y=0.375X+2.756	0.8936***	Y=0.869X−0.123	0.8096***	Y=0.571X+0.742
61	0.8446***	Y=0.634X+0.937	0.6845***	Y=0.732X+0.347	0.8362***	Y=0.576X+0.729
62	0.7727***	Y=0.410X+2.516	0.7806***	Y=0.913X−0.180	0.9302***	Y=0.786X+0.264
63	0.8355***	Y=0.467X+2.017	0.9458***	Y=1.030X−0.571	0.9449***	Y=1.022X−0.250
64	0.9282***	Y=0.624X+0.634	0.7532***	Y=0.554X+1.012	0.8298***	Y=0.871X+0.110
65	0.9279***	Y=0.643X+0.604	0.8673***	Y=0.744X+0.327	0.7543***	Y=0.676X+0.533
66	0.9162***	Y=0.585X+1.115	0.6369***	Y=0.361X+1.321	0.6448***	Y=0.611X+0.589
67	0.8673***	Y=0.629X+0.683	0.3991*	Y=0.248X+2.063	0.8221***	Y=0.759X+0.326
68	0.8314***	Y=0.563X+1.242	0.7970***	Y=0.834X+0.036	0.9023***	Y=0.989X−0.167
69	0.8439***	Y=0.552X+1.189	0.6835***	Y=0.468X+1.369	0.8598***	Y=0.683X+0.513
70	0.9097***	Y=0.605X+0.806	0.3640*	Y=0.182X+1.927	0.8411***	Y=0.646X+0.529
71	0.7596***	Y=0.505X+1.874	0.6654***	Y=0.539X+0.928	0.6593***	Y=0.602X+0.604
72	0.8046***	Y=0.397X+2.596	0.6883***	Y=0.461X+1.138	0.8726***	Y=1.008X−0.231
73	0.6475***	Y=0.365X+2.927	0.7012***	Y=0.552X+1.014	0.8404***	Y=0.845X+0.136
74	0.7612***	Y=0.868X−1.286	0.8388***	Y=0.909X−0.421	0.8998***	Y=0.635X+0.625
75	0.8719***	Y=0.519X+1.523	0.8867***	Y=1.114X−0.654	0.8343***	Y=0.564X+0.747
76	0.6551***	Y=0.395X+2.742	0.8549***	Y=0.696X+0.533	0.7638***	Y=0.741X+0.381
77	0.6545***	Y=0.448X+2.185	0.8985***	Y=0.636X+0.599	0.8780***	Y=0.924X−0.041
78	0.7390***	Y=0.722X−0.129	0.5565**	Y=0.422X+1.344	0.8382***	Y=0.897X+0.008
79	0.9187***	Y=0.567X+1.165	0.6464***	Y=0.736X+0.220	0.9607***	Y=0.878X+0.068
80	0.7474***	Y=0.534X+1.513	0.3701*	Y=0.668X+0.238	0.8356***	Y=0.866X+0.056
81	0.8781***	Y=0.594X+0.966	0.8472***	Y=0.921X−0.397	0.8744***	Y=0.793X+0.246
82	0.7411***	Y=0.335X+3.223	0.4448*	Y=0.519X+1.011	0.6949***	Y=0.710X+0.404
83	0.7628***	Y=0.472X+1.934	0.7928***	Y=0.648X+0.698	0.9264***	Y=1.000X−0.215

(Continued)

Table 3. (Continued)

Strain No.	Length		Width		Thickness	
	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression
84	−0.9262***	Y=0.643X+0.579	0.8197***	Y=0.857X−0.101	0.8986***	Y=0.855X+0.111
85	0.7912***	Y=0.578X+1.194	0.8004***	Y=0.716X+0.360	0.8473***	Y=0.787X+0.259
86	0.8937***	Y=0.672X+0.373	0.6545***	Y=0.536X+0.829	0.8526***	Y=1.112X−0.403
87	0.7893***	Y=0.328X+2.685	0.7712***	Y=0.639X+0.579	0.8134***	Y=0.946X−0.074
88	0.8954***	Y=0.554X+1.108	0.7242***	Y=0.731X+0.278	0.8162***	Y=0.902X+0.007
89	0.9280***	Y=0.600X+1.190	0.8481***	Y=0.614X+0.606	0.7293***	Y=0.844X+0.128
90	0.8230***	Y=0.577X+1.029	0.4800**	Y=0.598X+0.818	0.8062***	Y=0.757X+0.259
91	0.9111***	Y=0.571X+0.992	0.5334**	Y=0.300X+1.904	0.7822***	Y=0.737X+0.334
92	0.9295***	Y=0.564X+1.360	0.8048***	Y=0.700X+0.441	0.6127***	Y=0.495X+0.931
93	0.8361***	Y=0.408X+2.622	0.9062***	Y=0.897X−0.160	0.8812***	Y=0.754X+0.320
94	0.9056***	Y=0.598X+0.767	0.7999***	Y=0.779X+0.232	0.7290***	Y=0.709X+0.410
95	0.7502***	Y=0.568X+1.255	0.8171***	Y=0.798X+0.152	0.8206***	Y=0.862X+0.079
96	0.8596***	Y=0.595X+1.007	0.8906***	Y=0.778X+0.199	0.8362***	Y=0.963X−0.120
97	0.9177***	Y=0.588X+1.277	0.5696**	Y=0.373X+1.298	0.8315***	Y=0.761X+0.270
98	0.4917**	Y=0.251X+3.862	0.8206***	Y=0.704X+0.483	0.9104***	Y=0.866X+0.085
99	0.8304***	Y=0.471X+1.923	0.7814***	Y=0.770X+0.221	0.7467***	Y=0.544X+0.848
100	0.8735***	Y=0.547X+1.409	0.7630***	Y=0.710X+0.355	0.8906***	Y=0.808X+0.188

d.f. = 28

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

+0.9849 to the degree of freedom of 98, 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; $Y=0.745X+0.297$, where Y and X indicate W of UHG and W of HG, respectively. This formula indicates that the W of UHG becomes 0.745 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. Thirty-nine, 6, 3 and 2 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 +0.9813 to the degree of freedom of 48, 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; $Y=0.970X-0.126$, where Y and X indicate T of UHG and T of HG, respectively. This formula indicates that the T of UHG becomes 0.970 mm thicker, when the T of HG becomes thicker by 1 degree.

Group B: Forty-nine and 1 strains showed significances at 0.1% level and no significance even at 5% level, respectively. In the whole strains, c.c. was +0.9859 to the degree of freedom of 48, 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; $Y=0.846X+0.123$, where Y and X indicate T of UHG and T of HG, respectively. This formula indicates that the T of UHG becomes 0.846 mm thicker, when the T of HG becomes thicker by 1 degree.

Whole: Eighty-eight, 6, 3 and 3 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

+0.9880 to the degree of freedom of 98, 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; $Y=0.860X+0.096$, where Y and X indicate T of UHG and T of HG, respectively. This formula indicates that the T of UHG becomes 0.860 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. Thirty-two, 4, 8 and 6 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 +0.9838 to the degree of freedom of 48, 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; $Y=0.839X-0.033$, 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 0.839 larger, when the L/W of HG becomes larger by 1 degree.

Group B: Forty, 8 and 2 strains showed significances at 0.1%, 1% and 5% levels, respectively. In other words, the whole strains (=50) showed significances. In the whole strains, c.c. was +0.9618 to the degree of freedom of 48, 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; $Y=0.808X+0.088$, 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 0.808 larger, when the L/W of HG becomes larger by 1 degree.

Whole: Seventy-two, 12, 10 and 6 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 +0.9875 to the degree of freedom of 98, 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; $Y=0.809X+0.078$, 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 0.809 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 column of Table 4. Forty-two, 1, 4 and 3 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 +0.9836 to the degree of freedom of 48, 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; $Y=0.853X-0.297$, 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 0.853 larger, when the L/T of HG becomes larger by 1 degree.

Group B: Forty-six, 2 and 2 strains showed significances at 0.1%, 1% and 5% levels, respectively. In other words, the whole strains (=50) showed significances. In the whole strains, c.c. was +0.9756 to the degree of freedom of 48, 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; $Y=0.805X-0.090$, 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 0.805 larger, when the L/T of HG becomes larger by 1 degree.

Whole: Eighty-eight, 3, 6 and 3 strains showed significances at 0.1%, 1% and 5% levels and no

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	−0.8470***	Y=0.748X+0.343	0.6845***	Y=0.497X+1.266	0.7364***	Y=0.598X+0.423
2	0.7743***	Y=0.694X+0.413	0.7814***	Y=0.568X+0.825	0.8368***	Y=0.715X+0.278
3	0.4656**	Y=0.443X+1.419	0.7961***	Y=0.560X+1.118	0.6412***	Y=0.705X+0.317
4	0.6255***	Y=0.496X+1.299	0.5821***	Y=0.613X+0.882	0.7446***	Y=0.718X+0.282
5	0.4951**	Y=0.366X+1.719	0.0241	—	0.4020*	Y=0.413X+0.651
6	0.5708***	Y=0.342X+2.256	0.8550***	Y=0.828X−0.090	0.8914***	Y=0.844X+0.139
7	0.7980***	Y=0.757X+0.229	0.7047***	Y=0.574X+0.939	0.7600***	Y=0.831X+0.158
8	0.7729***	Y=0.581X+0.878	0.7714***	Y=0.581X+0.990	0.8656***	Y=0.788X+0.219
9	0.7249***	Y=0.552X+0.907	0.6572***	Y=0.577X+0.883	0.7920***	Y=0.859X+0.129
10	0.8124***	Y=0.674X+0.560	0.6563***	Y=0.428X+1.769	0.6896***	Y=0.673X+0.376
11	0.3378	—	0.8213***	Y=0.632X+0.631	0.7290***	Y=0.824X+0.133
12	0.6576***	Y=0.528X+0.978	0.6736***	Y=0.440X+1.473	0.6675***	Y=0.632X+0.409
13	0.7805***	Y=0.695X+0.504	0.6254***	Y=0.515X+1.350	0.6365***	Y=0.778X+0.243
14	0.2945	—	0.8564***	Y=0.683X+0.386	0.4268*	Y=0.503X+0.564
15	0.6103***	Y=0.384X+1.454	0.7876***	Y=0.739X+0.225	0.8207***	Y=0.723X+0.326
16	0.8379***	Y=0.608X+0.783	0.6870***	Y=0.648X+0.658	0.7807***	Y=0.912X+0.080
17	0.4307*	Y=0.329X+1.887	0.9027***	Y=0.896X−0.467	0.6358***	Y=0.601X+0.438
18	0.5806***	Y=0.574X+0.770	0.7715***	Y=0.881X−0.386	0.7312***	Y=0.710X+0.319
19	0.2540	—	0.5997***	Y=0.556X+0.848	0.6062***	Y=0.689X+0.327
20	0.6023***	Y=0.409X+1.135	0.8021***	Y=0.746X+0.097	0.6663***	Y=0.458X+0.696
21	0.7542***	Y=0.499X+0.922	0.6479***	Y=0.570X+0.725	0.7776***	Y=0.706X+0.277
22	0.7034***	Y=0.696X+0.386	0.4243*	Y=0.386X+1.500	0.5183**	Y=0.483X+0.677
23	0.5054**	Y=0.356X+1.403	0.7400***	Y=0.505X+1.145	0.6894***	Y=0.653X+0.396
24	0.7536***	Y=0.733X+0.256	0.2364	—	0.6912***	Y=0.677X+0.339
25	0.6330***	Y=0.575X+1.080	0.7220***	Y=0.527X+1.259	0.7427***	Y=0.716X+0.260
26	0.3160	—	0.9414***	Y=1.006X−0.879	0.9047***	Y=1.289X−0.456
27	0.6634***	Y=0.512X+0.846	0.6746***	Y=0.482X+1.114	0.7371***	Y=0.708X+0.331
28	0.4337*	Y=0.415X+1.818	0.6053***	Y=0.415X+1.932	0.5198**	Y=0.612X+0.404
29	0.7831***	Y=0.569X+0.621	0.6087***	Y=0.480X+1.004	0.5227**	Y=0.635X+0.406
30	0.4302*	Y=0.375X+1.620	0.8108***	Y=0.661X+0.623	0.4909**	Y=0.512X+0.545
31	0.3597	—	0.6874***	Y=0.669X+0.584	0.3885*	Y=0.424X+0.682
32	0.6786***	Y=0.704X+0.372	0.7128***	Y=0.839X−0.213	0.8176***	Y=0.743X+0.265
33	0.4563*	Y=0.302X+1.990	0.7231***	Y=0.695X+0.386	0.5049**	Y=0.401X+0.639
34	0.3429	—	0.6168***	Y=0.600X+0.810	−0.0032	—
35	0.7547***	Y=0.628X+0.824	0.4609*	Y=0.485X+1.519	0.7848***	Y=0.776X+0.196
36	0.7765***	Y=0.392X+1.716	0.2419	—	0.7939***	Y=0.642X+0.369
37	0.3672*	Y=0.285X+1.860	0.6581***	Y=0.541X+1.071	0.5658**	Y=0.480X+0.584
38	0.8347***	Y=0.915X−0.244	0.6243***	Y=0.543X+1.271	0.8336***	Y=0.929X+0.033
39	0.7148***	Y=0.536X+1.017	0.7296***	Y=0.619X+0.701	0.5252**	Y=0.493X+0.559
40	0.5872***	Y=0.601X+0.820	0.3727*	Y=0.286X+2.192	0.4341*	Y=0.516X+0.507

(Continued)

Table 4. (Continued)

Strain No.	Length/Width		Length/Thickness		Width/Thickness	
	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression
41	0.4740**	Y=0.391X+1.643	0.4323*	Y=0.352X+1.952	0.5141**	Y=0.421X+0.632
42	0.6577***	Y=0.576X+1.011	0.7365***	Y=0.482X+1.462	0.4429*	Y=0.452X+0.606
43	0.6491***	Y=0.604X+0.683	0.7651***	Y=0.663X+0.426	0.7011***	Y=0.784X+0.187
44	0.4529*	Y=0.330X+1.536	0.5007**	Y=0.374X+1.606	0.5619**	Y=0.407X+0.688
45	0.7812***	Y=0.581X+0.931	0.6864***	Y=0.536X+1.147	0.6008***	Y=0.496X+0.548
46	0.4013*	Y=0.261X+2.225	0.6129***	Y=0.458X+1.546	0.4864**	Y=0.306X+0.763
47	0.7063***	Y=0.475X+1.262	0.6476***	Y=0.523X+1.165	0.7576***	Y=0.701X+0.316
48	0.8241***	Y=0.839X−0.063	0.8650***	Y=0.769X+0.041	0.8613***	Y=1.230X−0.384
49	0.7923***	Y=0.620X+0.790	0.7420***	Y=0.637X+0.716	0.8650***	Y=1.000X−0.056
50	0.4334*	Y=0.272X+1.550	0.7218***	Y=0.527X+0.921	0.8065***	Y=0.743X+0.272
51	0.7637***	Y=0.662X+0.353	0.4332*	Y=0.507X+0.986	0.6037***	Y=0.496X+0.688
52	0.3891*	Y=0.429X+1.002	0.8907***	Y=0.717X+0.256	0.3672*	Y=0.504X+0.649
53	0.5299**	Y=0.478X+0.952	0.7722***	Y=0.474X+1.178	0.4255*	Y=0.338X+0.865
54	0.5096**	Y=0.496X+0.948	0.7342***	Y=0.480X+1.173	0.5306**	Y=0.519X+0.584
55	0.5892***	Y=0.478X+0.818	0.6814***	Y=0.700X+0.265	0.8005***	Y=0.775X+0.261
56	0.4930**	Y=0.626X+0.447	0.6599***	Y=0.586X+0.648	0.7128***	Y=0.638X+0.458
57	0.8555***	Y=0.593X+0.706	0.8197***	Y=0.547X+0.945	0.8303***	Y=0.679X+0.352
58	0.7681***	Y=1.101X+0.633	0.7202***	Y=0.455X+1.131	0.6667***	Y=0.916X+0.015
59	0.6388***	Y=0.633X+0.518	0.7601***	Y=0.497X+1.109	0.7391***	Y=0.575X+0.548
60	0.7281***	Y=0.784X+0.086	0.8094***	Y=0.396X+1.433	0.7382***	Y=0.866X+0.116
61	0.5562**	Y=0.543X+0.965	0.8147***	Y=0.562X+1.014	0.7441***	Y=0.714X+0.300
62	0.6624***	Y=0.681X+0.379	0.8818***	Y=0.546X+0.896	0.7564***	Y=0.847X+0.138
63	0.7001***	Y=0.698X+0.348	0.8409***	Y=0.647X+0.501	0.9382***	Y=1.072X−0.198
64	0.7221***	Y=0.501X+0.804	0.8570***	Y=0.615X+0.562	0.7655***	Y=0.701X+0.344
65	0.9140***	Y=0.822X+0.051	0.7513***	Y=0.516X+1.021	0.6728***	Y=0.605X+0.446
66	0.7950***	Y=0.541X+0.942	0.6999***	Y=0.553X+1.003	0.6188***	Y=0.458X+0.654
67	0.5340**	Y=0.477X+0.898	0.7368***	Y=0.844X−0.177	0.6162***	Y=0.684X+0.346
68	0.7772***	Y=0.708X+0.355	0.8848***	Y=0.730X+0.174	0.8668***	Y=1.003X−0.110
69	0.7410***	Y=0.564X+0.614	0.5860***	Y=0.418X+1.283	0.7127***	Y=0.544X+0.603
70	0.8198***	Y=0.538X+0.838	0.8829***	Y=0.613X+0.659	0.6125***	Y=0.439X+0.700
71	0.4810**	Y=0.386X+1.401	0.4445*	Y=0.389X+1.766	0.8477***	Y=0.810X+0.224
72	0.6689***	Y=0.440X+1.121	0.7193***	Y=0.605X+0.725	0.8215***	Y=0.784X+0.222
73	0.7378***	Y=0.555X+0.672	0.5187**	Y=0.446X+1.264	0.7209***	Y=0.712X+0.347
74	0.8177***	Y=1.131X−0.526	0.7145***	Y=0.522X+0.898	0.7940***	Y=0.678X+0.315
75	0.9243***	Y=0.927X−0.418	0.6468***	Y=0.300X+1.843	0.8952***	Y=0.956X+0.028
76	0.7790***	Y=0.658X+0.440	0.7642***	Y=0.508X+1.054	0.7772***	Y=0.694X+0.365
77	0.6722***	Y=0.507X+0.981	0.8581***	Y=0.657X+0.556	0.8505***	Y=0.744X+0.278
78	0.7785***	Y=0.719X+0.273	0.6466***	Y=0.508X+1.139	0.7409***	Y=0.640X+0.476
79	0.4132*	Y=0.496X+0.900	0.6573***	Y=0.861X−0.218	0.8056***	Y=0.783X+0.147
80	0.5984***	Y=0.943X+0.060	0.6857***	Y=0.574X+0.850	0.6118***	Y=0.803X+0.036
81	0.8836***	Y=0.869X+0.041	0.8626***	Y=0.652X+0.494	0.8393***	Y=0.978X−0.122
82	0.5202**	Y=0.587X+0.697	0.5865***	Y=0.379X+1.647	0.3402	−

(Continued)

Table 4. (Continued)

Strain No.	Length/Width		Length/Thickness		Width/Thickness	
	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression
83	0.7438***	Y=0.557X+0.666	0.7789***	Y=0.847X−0.239	0.9260***	Y=0.997X−0.051
84	0.8516***	Y=0.884X−0.035	0.8867***	Y=0.639X+0.522	0.8773***	Y=0.888X+0.047
85	0.6470***	Y=0.483X−1.035	0.7205***	Y=0.603X+0.741	0.7569***	Y=0.787X+0.187
86	0.5900***	Y=0.543X+0.892	0.7841***	Y=0.731X+0.259	0.7718***	Y=0.738X+0.267
87	0.4676**	Y=0.371X+1.121	0.8062***	Y=0.549X+0.754	0.8177***	Y=0.943X−0.055
88	0.7128***	Y=0.626X+0.565	0.6867***	Y=0.573X+0.782	0.8024***	Y=0.880X+0.040
89	0.7996***	Y=0.738X+0.459	0.8783***	Y=0.745X+0.257	0.8327***	Y=0.815X+0.138
90	0.7023***	Y=0.947X−0.204	0.7965***	Y=0.746X+0.218	0.7416***	Y=0.758X+0.293
91	0.5939***	Y=0.447X+0.857	0.8006***	Y=0.778X+0.044	0.6534***	Y=0.644X+0.475
92	0.7477***	Y=0.541X+0.889	0.8124***	Y=0.589X+0.830	0.6835***	Y=0.585X+0.497
93	0.6544***	Y=0.803X+0.086	0.7200***	Y=0.604X+0.699	0.7184***	Y=0.805X+0.170
94	0.7621***	Y=0.824X+0.008	0.7963***	Y=0.636X+0.497	0.8231***	Y=0.875X+0.101
95	0.8225***	Y=0.903X−0.192	0.7451***	Y=0.614X+0.757	0.8340***	Y=0.865X+0.112
96	0.8845***	Y=0.766X+0.231	0.5619**	Y=0.587X+0.816	0.8731***	Y=1.050X−0.158
97	0.8307***	Y=0.504X+1.202	0.8580***	Y=0.638X+0.797	0.7878***	Y=0.538X+0.551
98	0.6848***	Y=0.482X+0.823	0.6614***	Y=0.530X+0.883	0.8771***	Y=0.902X+0.042
99	0.6720***	Y=0.597X+0.565	0.7395***	Y=0.501X+0.980	0.7462***	Y=0.772X+0.234
100	0.6415***	Y=0.665X+0.537	0.8184***	Y=0.684X+0.407	0.8387***	Y=0.853X+0.092

d.f. = 28

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

significance even at 5% level, respectively. In the whole strains of both of the groups, c.c. was +0.9868 to the degree of freedom of 98, 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=0.828X−0.183, 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 0.828 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. Thirty-four, 10, 5 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 +0.9657 to the degree of freedom of 48, 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=0.777X+0.217, 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 0.777 larger, when the W/T of HG becomes larger by 1 degree.

Group B: Forty-six, 1, 2 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 +0.8510 to the degree of freedom of 48, which is 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=0.709X+0.324, 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 0.709 larger, when the W/T of HG becomes larger by 1

degree.

Whole: Eighty, 11, 7 and 2 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 +0.9620 to the degree of freedom of 98, 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; $Y=0.784X+0.211$, 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 0.784 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. Thirty-eight, 8, 2 and 2 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 +0.9737 to the degree of freedom of 48, which is 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; $Y=0.553X+1.364$, where Y and X indicate the area of UHG and area of HG, respectively. This formula indicates that the area of UHG becomes 0.553 mm^2 wider, when the area of HG becomes wider by 1 degree.

Group B: Forty-five, 3 and 2 strains showed significances at 0.1%, 1% and 5% levels, respectively. In other words, the whole strains (=50) showed significances. In the whole strains, c.c. was +0.9641 to the degree of freedom of 48, 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; $Y=0.502X+2.431$, where Y and X indicate the area of UHG and area of HG, respectively. This formula indicates that the area of UHG becomes 0.502 mm^2 wider, when the area of HG becomes wider by 1 degree.

Whole: Eighty-three, 11, 4 and 2 strains 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 +0.9755 to the degree of freedom of 98, 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; $Y=0.506X+2.375$, where Y and X indicate the area of UHG and area of HG, respectively. This formula indicates that the area of UHG becomes 0.506 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. Forty-six, 2, 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 +0.9801 to the degree of freedom of 48, 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; $Y=0.518X+1.722$, where Y and X indicate the volume of UHG and volume of HG, respectively. This formula indicates that the volume of UHG becomes 0.518 mm^3 larger, when the volume of HG becomes larger 1 degree.

Group B: The whole strains (=50) showed significances at 0.1% level. In the whole strains, c.c. was +0.9784 to the degree of freedom of 48, 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; $Y=0.464X+4.047$, where Y and X indicate the volume of UHG and volume of HG, respectively. This formula indicates that the volume of UHG becomes

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	−0.8012***	Y=0.448X+3.865	0.7746***	Y=0.420X+6.650	0.7954***	Y=0.793X+0.069
2	0.7611***	Y=0.407X+4.857	0.7608***	Y=0.398X+8.264	0.9388***	Y=1.053X−0.079
3	0.5263**	Y=0.265X+9.555	0.4666**	Y=0.213X+19.677	0.8832***	Y=0.932X−0.017
4	0.6475***	Y=0.465X+3.441	0.7074***	Y=0.560X−0.482	0.8676***	Y=0.967X−0.040
5	0.6072***	Y=0.385X+4.395	0.6542***	Y=0.321X+8.600	0.6994***	Y=0.794X+0.069
6	0.5871***	Y=0.316X+7.279	0.8013***	Y=0.571X−1.416	0.9048***	Y=1.009X−0.074
7	0.7245***	Y=0.479X+3.262	0.6811***	Y=0.398X+7.848	0.8785***	Y=1.083X−0.105
8	0.4823**	Y=0.251X+9.683	0.7775***	Y=0.439X+6.183	0.8581***	Y=0.811X+0.058
9	0.6484***	Y=0.416X+0.461	0.6837***	Y=0.408X+7.015	0.8769***	Y=0.966X−0.035
10	0.5471**	Y=0.214X+10.963	0.5789***	Y=0.263X+16.426	0.8481***	Y=0.877X+0.018
11	0.3563	−	0.6616***	Y=0.291X+10.343	0.9053***	Y=0.974X−0.043
12	0.5910***	Y=0.307X+7.235	0.6982***	Y=0.381X+8.515	0.9048***	Y=0.864X+0.032
13	0.6941***	Y=0.429X+5.487	0.7727***	Y=0.389X+10.367	0.8228***	Y=0.799X+0.068
14	0.6603***	Y=0.475X+2.908	0.6041***	Y=0.373X+8.768	0.9178***	Y=1.031X−0.072
15	0.7151***	Y=0.457X+3.491	0.8068***	Y=0.550X−0.141	0.8428***	Y=0.897X−0.002
16	0.7727***	Y=0.418X+4.593	0.6562***	Y=0.278X+12.256	0.7910***	Y=1.103X−0.124
17	0.6975***	Y=0.314X+6.421	0.7599***	Y=0.373X+7.576	0.8894***	Y=0.975X−0.048
18	0.5695**	Y=0.325X+6.818	0.6290***	Y=0.372X+8.691	0.8348***	Y=1.115X−0.130
19	0.6583***	Y=0.432X+3.830	0.5948***	Y=0.364X+8.987	0.8255***	Y=0.984X−0.046
20	0.6617***	Y=0.326X+5.714	0.7661***	Y=0.366X+6.842	0.8521***	Y=0.901X−0.001
21	0.6568***	Y=0.350X+6.789	0.4878**	Y=0.280X+17.145	0.8356***	Y=0.950X−0.012
22	0.1471	−	0.6291***	Y=0.407X+6.400	0.8723***	Y=0.860X+0.022
23	0.6170***	Y=0.437X+3.759	0.7234***	Y=0.541X−0.612	0.9082***	Y=1.075X−0.103
24	0.4138*	Y=0.269X+8.403	0.7244***	Y=0.441X+5.810	0.8901***	Y=0.736X+0.107
25	0.6373***	Y=0.459X+3.978	0.7541***	Y=0.579X−0.826	0.8810***	Y=1.031X−0.071
26	0.4994**	Y=0.509X+2.322	0.7056***	Y=0.568X−0.598	0.7982***	Y=0.906X−0.000
27	0.6165***	Y=0.339X+6.392	0.7762***	Y=0.417X+7.081	0.8350***	Y=0.839X+0.048
28	0.3719*	Y=0.222X+9.695	0.2982	−	0.8482***	Y=0.963X−0.037
29	0.7372***	Y=0.429X+2.633	0.6330***	Y=0.356X+5.058	0.7312***	Y=0.918X−0.001
30	0.6426***	Y=0.450X+3.558	0.6885***	Y=0.377X+7.558	0.8636***	Y=0.861X+0.027
31	0.4746**	Y=0.320X+7.092	0.5979***	Y=0.353X+9.988	0.9157***	Y=0.908X−0.002
32	0.7603***	Y=0.412X+4.293	0.6574***	Y=0.338X+9.287	0.8092***	Y=1.088X−0.110
33	0.6244***	Y=0.389X+4.763	0.3847*	Y=0.165X+16.427	0.6655***	Y=0.976X−0.041
34	0.7628***	Y=0.343X+5.690	0.7411***	Y=0.358X+8.626	0.7875***	Y=0.958X−0.031
35	0.6507***	Y=0.425X+4.301	0.6897***	Y=0.457X+3.797	0.8707***	Y=1.012X−0.063
36	0.7939***	Y=0.499X+2.699	0.7468***	Y=0.477X+3.676	0.7559***	Y=0.907X−0.000
37	0.5000**	Y=0.253X+8.452	0.6687***	Y=0.370X+9.065	0.8486***	Y=0.840X+0.043
38	0.7116***	Y=0.492X+3.775	0.7319***	Y=0.439X+7.604	0.7962***	Y=1.015X−0.068
39	0.6845***	Y=0.424X+4.253	0.7020***	Y=0.409X+6.882	0.8327***	Y=0.983X−0.044
40	0.5692**	Y=0.416X+3.754	0.5724***	Y=0.374X+6.655	0.8259***	Y=0.961X−0.030

(Continued)

Table 5. (Continued)

Strain No.	Area		Volume		Quotient	
	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression
41	−0.6701***	Y=0.337X+6.417	0.7538***	Y=0.364X+9.201	0.8805***	Y=0.910X−0.000
42	0.6871***	Y=0.436X+4.550	0.8333***	Y=0.520X+2.249	0.8186***	Y=0.808X+0.063
43	0.6341***	Y=0.453X+3.608	0.6204***	Y=0.383X+8.736	0.7780***	Y=1.004X−0.052
44	0.5936***	Y=0.444X+3.827	0.6497***	Y=0.435X+6.072	0.8687***	Y=0.954X−0.021
45	0.8055***	Y=0.375X+5.512	0.7447***	Y=0.382X+8.353	0.8192***	Y=0.940X−0.018
46	0.7877***	Y=0.333X+6.533	0.7746***	Y=0.347X+10.076	0.8349***	Y=0.865X+0.025
47	0.7618***	Y=0.485X+3.140	0.6352***	Y=0.367X+9.118	0.7769***	Y=0.846X+0.043
48	0.8176***	Y=0.626X−0.140	0.8039***	Y=0.549X+0.976	0.7569***	Y=0.848X+0.041
49	0.6067***	Y=0.341X+6.522	0.7594***	Y=0.458X+5.213	0.8683***	Y=0.918X−0.007
50	0.7001***	Y=0.346X+5.565	0.6437***	Y=0.328X+9.963	0.9305***	Y=1.119X−0.125
51	0.6618***	Y=0.296X+9.100	0.6010***	Y=0.336X+14.244	0.7691***	Y=0.871X+0.014
52	0.6138***	Y=0.301X+6.416	0.6152***	Y=0.282X+16.662	0.8447***	Y=0.922X−0.018
53	0.7028***	Y=0.364X+6.630	0.7630***	Y=0.385X+9.975	0.8751***	Y=0.917X−0.004
54	0.7377***	Y=0.392X+5.458	0.6233***	Y=0.277X+15.988	0.8862***	Y=0.999X−0.056
55	0.8327***	Y=0.442X+4.989	0.7190***	Y=0.347X+15.200	0.7190***	Y=0.784X+0.067
56	0.7071***	Y=0.516X+2.334	0.7022***	Y=0.449X+5.914	0.8700***	Y=0.992X−0.054
57	0.8040***	Y=0.378X+5.854	0.7370***	Y=0.303X+13.893	0.8740***	Y=0.881X+0.012
58	0.5464**	Y=0.467X+3.497	0.6270***	Y=0.433X+6.618	0.9387***	Y=0.952X−0.030
59	0.7891***	Y=0.400X+5.998	0.7530***	Y=0.431X+7.030	0.7932***	Y=0.852X+0.025
60	0.8881***	Y=0.484X+2.649	0.9020***	Y=0.449X+4.097	0.6336***	Y=0.586X+0.173
61	0.8163***	Y=0.641X−0.391	0.7859***	Y=0.510X+3.651	0.9039***	Y=0.956X−0.027
62	0.8145***	Y=0.532X+1.695	0.8722***	Y=0.508X+1.795	0.8922***	Y=0.829X+0.047
63	0.9030***	Y=0.610X−0.310	0.9353***	Y=0.590X−2.702	0.7553***	Y=0.713X+0.116
64	0.8650***	Y=0.482X+3.219	0.8729***	Y=0.503X+2.628	0.7566***	Y=0.763X+0.094
65	0.8875***	Y=0.491X+3.045	0.8574***	Y=0.508X+2.746	0.7544***	Y=1.059X−0.087
66	0.7860***	Y=0.370X+5.457	0.8088***	Y=0.389X+7.501	0.7967***	Y=0.879X+0.021
67	0.6708***	Y=0.351X+6.793	0.7282***	Y=0.342X+12.235	0.8953***	Y=0.934X−0.019
68	0.8248***	Y=0.573X+0.677	0.8131***	Y=0.504X+2.567	0.8562***	Y=0.854X+0.035
69	0.7737***	Y=0.375X+6.510	0.8689***	Y=0.387X+9.978	0.7741***	Y=0.880X+0.011
70	0.5799***	Y=0.302X+6.869	0.7575***	Y=0.326X+10.105	0.8161***	Y=0.809X+0.058
71	0.7575***	Y=0.422X+5.039	0.5847***	Y=0.290X+13.813	0.7993***	Y=1.129X−0.147
72	0.7714***	Y=0.336X+6.458	0.7987***	Y=0.406X+6.501	0.7931***	Y=0.861X+0.020
73	0.6297***	Y=0.304X+8.587	0.7822***	Y=0.357X+11.949	0.8864***	Y=0.921X−0.009
74	0.8198***	Y=0.610X−1.399	0.8684***	Y=0.498X+0.740	0.8212***	Y=0.832X+0.041
75	0.7206***	Y=0.456X+3.882	0.6916***	Y=0.296X+13.879	0.7571***	Y=0.810X+0.058
76	0.8037***	Y=0.418X+5.426	0.7903***	Y=0.405X+9.471	0.8936***	Y=0.910X+0.001
77	0.8942***	Y=0.461X+3.343	0.8560***	Y=0.463X+3.853	0.7409***	Y=0.850X+0.033
78	0.4640**	Y=0.302X+7.943	0.7882***	Y=0.639X−4.639	0.8069***	Y=0.862X+0.024
79	0.8235***	Y=0.569X+0.082	0.8726***	Y=0.545X−1.635	0.9235***	Y=0.954X−0.026
80	0.4121*	Y=0.354X+5.116	0.5774***	Y=0.401X+4.443	0.9636***	Y=0.958X−0.035
81	0.7972***	Y=0.564X+0.416	0.8525***	Y=0.494X+1.759	0.6720***	Y=0.698X+0.121
82	0.4545*	Y=0.251X+0.948	0.6841***	Y=0.333X+11.624	0.8530***	Y=0.797X+0.058

(Continued)

Table 5. (Continued)

Strain No.	Area		Volume		Quotient	
	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression
83	−0.8134***	Y=0.480X+3.482	0.8241***	Y=0.466X+4.671	0.8669***	Y=0.966X−0.043
84	0.7616***	Y=0.535X+1.655	0.7966***	Y=0.514X+1.415	0.9268***	Y=1.009X−0.063
85	0.6632***	Y=0.290X+9.099	0.9041***	Y=0.517X+0.593	0.8848***	Y=0.898X+0.003
86	0.7972***	Y=0.475X+2.759	0.8107***	Y=0.535X+0.577	0.8648***	Y=1.017X−0.067
87	0.8633***	Y=0.391X+4.123	0.7942***	Y=0.353X+7.902	0.7938***	Y=0.875X+0.020
88	0.8708***	Y=0.502X+1.629	0.8339***	Y=0.430X+4.226	0.8850***	Y=0.965X−0.034
89	0.9376***	Y=0.460X+3.786	0.8873***	Y=0.386X+0.904	0.7977***	Y=0.909X−0.004
90	0.4792**	Y=0.290X+8.939	0.6092***	Y=0.337X+11.770	0.8867***	Y=1.047X−0.102
91	0.8544***	Y=0.388X+5.523	0.8617***	Y=0.348X+10.870	0.7602***	Y=0.998X−0.067
92	0.8946***	Y=0.524X+2.026	0.8697***	Y=0.467X+4.368	0.7465***	Y=0.871X+0.014
93	0.9238***	Y=0.506X+2.094	0.9468***	Y=0.463X+3.767	0.8043***	Y=0.804X+0.062
94	0.8180***	Y=0.500X+2.272	0.8143***	Y=0.445X+4.635	0.9061***	Y=0.988X−0.052
95	0.7846***	Y=0.465X+3.355	0.8243***	Y=0.534X+0.840	0.8485***	Y=0.906X−0.002
96	0.8928***	Y=0.536X+1.694	0.9268***	Y=0.495X+2.707	0.5902***	Y=0.591X+0.191
97	0.7018***	Y=0.396X+5.534	0.7449***	Y=0.477X+3.627	0.8576***	Y=0.883X+0.007
98	0.6695***	Y=0.355X+7.050	0.7940***	Y=0.350X+12.566	0.9091***	Y=0.907X−0.003
99	0.8413***	Y=0.455X+3.695	0.8218***	Y=0.365X+11.358	0.8406***	Y=1.006X−0.061
100	0.8509***	Y=0.477X+2.845	0.8862***	Y=0.423X+5.789	0.8493***	Y=0.870X+0.014

d.f. = 28

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

0.464 mm^3 larger, when the volume of HG becomes larger by 1 degree.

Whole: Ninety-six, 2, 1 and 1 strains 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 +0.9843 to the degree of freedom of 98, 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=0.468X+4.009, where Y and X indicate the volume of UHG and volume of HG, respectively. This formula indicates that the volume of UHG becomes 0.468 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. The whole strains (=50) showed significances at 0.1% level. In the whole strains, c.c. was +0.9304 to the degree of freedom of 48, 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=0.956X−0.029, where Y and X indicate the quotient of area and quotient of volume, respectively. This formula indicates that the quotient of area becomes 0.956 larger, when the quotient of volume becomes larger by 1 degree.

Group B: The whole strains (=50) showed significances at 0.1% level. In the whole strains, c.c. was +0.9550 to the degree of freedom of 48, which is 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=0.909X−0.004, where Y and X indicate the quotient

of area and quotient of volume, respectively. This formula indicates that the quotient of area becomes 0.909 larger, when the quotient of volume becomes larger by 1 degree.

Whole: The whole strains (=100) showed significances at 0.1% level. In the whole strains of both of the groups, c.c. was +0.9574 to the degree of freedom of 98, 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; $Y=0.969X-0.038$, where Y and X indicate the quotient of area and quotient of volume, respectively. This formula indicates that the quotient of area becomes 0.969 larger, when the quotient of volume becomes larger by 1 degree.

Discussion

Basing on the results obtained in the previous[8] 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 804/1,350 cases (=59.6%), 827/1,350 cases (=61.3%) and 1,631/2,700 cases (=60.4%) in Group A, Group B and the whole of both of the groups, respectively. Those in the group-average were fixed to be significant in 20/27 (=74.1%), 19/27 (=70.4%) and 22/27 (=81.5%) 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 in Group A as follows, in the order of the combination numbers from 1 to 27; 7, 16, 6, 4, 49, 42, 8, 17, 4, 15, 48, 41, 3, 7, 1, 16, 46, 38, 48, 43, 48, 44, 47, 49, 48, 49 and 50 strains, respectively. Those in Group B were as follows in the same order; 19, 9, 6, 19, 45, 45, 10, 12, 3, 16, 47, 41, 2, 3, 2, 20, 49, 31, 50, 49, 49, 50, 50, 49, 50, 50 and 50 strains, respectively. Those in the whole of the both of the groups were as follows in the same order; 26, 25, 12, 33, 94, 87, 18, 29, 7, 31, 95, 82, 5, 10, 3, 36, 95, 69, 98, 92, 97, 94, 97, 98, 98, 99 and 100 strains, respectively. It was noticeable that the values were particularly larger in combination numbers from 19 to 27 in Group A, Group B and the whole. Average values and their s.d. through the whole combinations were found to be 29.78 ± 18.68, 31.93 ± 20.70 and 60.37 ± 37.72 in Group A, Group B and the whole of both of 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 378/900 (=42.0%), 379/900 (=42.1%), 751/1,800 (=42.1%), 426/450 (=94.75%), 447/450 (=99.3%) and 873/900 (=97.0%) in pack I of Group A, Group B and the whole, in 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 20.94 ± 16.94, 21.06 ± 16.81, 42.06 ± 33.54, 47.33 ± 2.21, 49.67 ± 0.47 and 97.00 ± 2.36, respectively. It was noted that s.d. of pack II were very small among the three groups. From the data, it might be said that the pack II showed combinations by far 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) and sub-6 (Nos.16-18). Significant correlations were accounted as follows; sub-1 (29/150=19.3% in Group A, 34/150=22.7% in Group B and 63/300=21.0% in the whole), sub-2 (105/150=70.0%, 109/150=72.7% and 214/300=71.3% in the same order), sub-3 (29/150=19.3%, 25/150=16.7% and 54/300=18.0%), sub-4 (104/150=69.3%, 104/150=69.3% and 208/300=69.3%), sub-5 (11/150=0.7%, 7/150=4.7% and 18/300=6.0%), sub-6 (100/150=66.7%, 100/150=66.7% and 200/300=66.7%). It was ascertained that sub-2, sub-4 and sub-6, *i.e.*, ratio-columns, showed the

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

In the pack II, no clear differences were 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 at those from strain No.1 to No.100; 15, 15, 15, 18, 13, 16, 15, 19, 17, 17, 14, 16, 17, 16, 21, 18, 15, 16, 16, 16, 16, 17, 19, 17, 16, 14, 16, 13, 19, 16, 14, 18, 15, 15, 17, 15, 14, 18, 14, 16, 18, 15, 16, 16, 15, 17, 15, 16, 17, 15 in Group A; 17, 16, 17, 16, 19, 18, 18, 15, 16, 17, 15, 16, 15, 16, 16, 16, 15, 14, 18, 16, 17, 15, 17, 17, 19, 16, 15, 18, 17, 15, 16, 16, 16, 15, 17, 18, 16, 16, 17, 17, 17, 18, 20, 15, 17, 18, 16, 15, 17, 18 in Group B, respectively. It was noticeable that the strain No.15 showed significances in 21/27 combinations (=77.8% in the whole), and strain Nos.5 and 28 showed significances only in 13/27 combinations (=48.2% in the whole), respectively. Average values and their s.d. through the whole strains were found to be 16.08±1.61, 16.54±1.25 and 16.17±2.11 in Group A, Group B and the whole strains of both of the groups, respectively.

3. Significant correlations were analysed in the positive or in the negative statuses as well as in the degree of their statuses. Significant correlations were accounted as follows in 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; 437 combinations in the whole significant combinations (=804) (54.4%), 116 (14.4%), 553 (68.8%); 112 (13.9%), 21 (2.6%), 133 (16.5%); 100 (12.4%), 18 (2.2%), 118 (14.7%). Those in Group B were accounted as follows in the same order; 491 combinations in the whole significant combinations (=827) (59.4%), 97 (11.7%), 588 (71.1%); 91 (11.0%), 32 (3.9%), 123 (14.9%); 93 (11.3%), 23 (2.8%), 116 (14.0%). Those in the whole strains of both of the groups were accounted as follows in the same order; 928 combinations in the whole significant combinations (=1,631) (56.9%), 213 (13.1%), 1,141 (70.0%); 203 (12.5%), 53 (3.2%), 256 (15.7%); 193 (11.8%), 41 (2.5%), 134 (8.2%). It might be a noticeable phenomenon that about 70% (68.8% in Group A, 71.1% in Group B and 70.0% in the whole) showed significant combinations at 0.1% level. It might mean those extreme biological actions, which were extremely called "all or northing", *i.e.*, going from one extreme to another. While 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 649 combinations (=80.7%) and 155 (=19.3%) in Group A, 675 (81.6%) and 152 (18.4%) in Group B, 1,324 (81.2%) and 307 (18.8%) in the whole of the both of the groups, respectively. No clear difference was found in these groups.

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*. Four cases were found, *i.e.*, strain Nos.29, 85 and 93 --- combination 2·3; strain No.15 --- combination 4·5 and 14·15; strain Nos.24 and 96 --- combination 21·23. 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.15. These phenomena may be attributed to the actions of the respective genes concerned in all the events.

4. The three strains showing the relatively larger values were picked-up in the respective combinations (=27), regardless of the positive or negative statuses. The respective strains showed the following numbers of the larger values in the order from the strain Nos.1 to 100; 2, 2, 2, 5, 0, 5, 0, 4, 0, 2, 0, 0, 3, 3, 5, 2, 1, 0, 3, 0, 0, 1, 3, 3, 0, 5, 0, 0, 4, 1, 0, 1, 0, 3, 0, 3, 0, 1, 0, 0, 0, 2, 2, 1, 3, 1, 0, 4, 2, 2 in Group A; 1, 4, 0, 0, 1, 2, 1, 4, 0, 0, 0, 1, 5, 1, 3, 0, 2, 1, 2, 2, 1, 1, 2, 0, 3, 0, 2, 4, 4, 1, 0, 2, 2, 4, 3, 1, 1, 0, 1, 0, 1,

0, 6, 1, 0, 6, 0, 0, 1, 2 in Group B, respectively. Averages and their s.d. through the whole strains were found to be 1.62±1.62 in Group A, 1.58±1.61 in Group B and 1.60±1.62 in the whole strains of both of the groups, respectively. Those through the whole strains (=100) were shown in the same order as follows; 0, 2, 1, 4, 0, 3, 0, 2, 0, 1, 0, 0, 2, 1, 3, 1, 1, 0, 1, 0, 0, 0, 1, 0, 0, 4, 0, 0, 2, 0, 0, 0, 0, 2, 0, 2, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0 in Group A; 1, 3, 0, 0, 0, 1, 1, 4, 0, 0, 0, 0, 5, 1, 2, 0, 1, 0, 1, 2, 1, 0, 1, 0, 1, 0, 1, 2, 1, 1, 0, 1, 1, 0, 1, 1, 0, 0, 1, 0, 0, 2, 6, 0, 0, 2, 0, 0, 0, 1 in Group B, respectively. Averages and their s.d. through the whole strains were found to be 0.70±1.08 in Group A, 0.92±1.28 in Group B and 0.81±1.19 in the whole strains of both of the groups, respectively. It was noticed that the average value of Group B was fixed to be twice in comparison with that of Group A.

In the larger set of combinations of L/T and W/T (UHG), the largest (+0.9440) was found in No.26, followed by No.6 (+0.8625) and No.15 (+0.8105). In the larger set of combinations of L/T and W/T (HG), the largest (+0.9390) was found in No.26, followed by No.6 (+0.9144) and No.15 (+0.8772). These orders of strains were finally illustrated in both of the cases as 26>6>15, and were fixed to be the same as in both character-combinations. These phenomena were found only once.

5. The three strains showing the relatively smaller values were picked-up in the respective combinations (=27), regardless of the positive or negative statuses. The respective strains showed the following numbers of the smaller values in the order from strain Nos.1 to 100; 2, 2, 2, 0, 5, 1, 2, 0, 0, 0, 2, 0, 2, 3, 0, 3, 1, 3, 3, 1, 1, 1, 2, 2, 0, 2, 0, 4, 2, 1, 1, 0, 3, 4, 0, 1, 3, 3, 2, 0, 0, 1, 3, 1, 3, 2, 2, 2, 2, 1 in Group A; 3, 4, 4, 2, 1, 0, 2, 1, 2, 2, 1, 2, 0, 2, 2, 1, 2, 0, 1, 3, 2, 1, 4, 1, 0, 0, 0, 2, 4, 3, 1, 4, 1, 0, 2, 0, 1, 2, 1, 1, 1, 1, 0, 3, 1, 3, 2, 2, 0, 0 in Group B, respectively. Averages and their s.d. through the whole strains were found to be 1.56±1.25 in Group A, 1.56±1.22 in Group B and 1.56±1.24 in the whole strains of both of the groups, respectively. Those through the whole strains (=100) were shown in the same order as follows; 2, 2, 2, 0, 2, 0, 1, 0, 0, 0, 1, 0, 1, 1, 0, 2, 1, 3, 3, 0, 0, 1, 0, 1, 0, 1, 0, 4, 0, 1, 0, 0, 3, 3, 0, 1, 2, 1, 2, 0, 0, 0, 2, 1, 0, 0, 1, 1, 2, 1 in Group A; 0, 1, 2, 1, 0, 0, 1, 1, 1, 1, 0, 1, 0, 1, 2, 1, 1, 0, 0, 1, 0, 0, 1, 1, 0, 0, 0, 1, 2, 0, 0, 1, 1, 0, 1, 0, 0, 1, 1, 0, 0, 0, 0, 1, 0, 1, 0, 1, 0, 0 in Group B, respectively. Averages and their s.d. through the whole strains were found to be 0.98±1.05 in Group A, 0.56±0.61 in Group B and 0.77±0.88 in the whole strains of both of the groups, respectively. It was noticed that the average value of Group B was fixed to be twice in comparison with that of Group A.

Grouping techniques in which the three strains showing relatively the smaller values in the correlation coefficients were picked-up in the respective character-combinations as shown in the previous chapter are not applicable in this chapter.

6. The strains showing the relatively larger and smaller values were summed-up in the respective combinations, regardless of the positive or the negative statuses.

The respective strains showed the following numbers in the order from strain Nos.1 to 100; 4, 4, 4, 5, 5, 6, 2, 4, 0, 2, 2, 0, 5, 6, 5, 5, 2, 3, 6, 1, 1, 2, 5, 5, 0, 7, 0, 4, 6, 2, 1, 1, 3, 7, 0, 4, 3, 4, 2, 0, 0, 3, 5, 2, 3, 3, 2, 6, 4, 3 in Group A; 4, 8, 4, 2, 2, 2, 3, 5, 2, 2, 1, 3, 5, 3, 5, 1, 4, 1, 3, 5, 3, 2, 6, 1, 3, 0, 2, 6, 8, 4, 1, 6, 3, 4, 5, 1, 2, 2, 2, 1, 2, 3, 6, 4, 1, 9, 2, 2, 1, 2 in Group B, respectively. Averages and their s.d. through the whole strains were found to be 3.18±2.02 in Group A, 3.16±2.04 in Group B and 3.17±2.03 in the whole strains of both of the groups, respectively.

Those through the whole strains (=100) were shown in the same order as follows; 2, 4, 3, 4, 2, 3, 1, 2, 0, 1, 1, 0, 3, 2, 3, 3, 2, 3, 4, 0, 0, 1, 1, 1, 0, 5, 0, 4, 2, 1, 0, 0, 3, 5, 0, 3, 2, 1, 2, 0, 0, 1, 2, 1, 1, 0, 1, 1, 2, 1 in Group A; 1, 4, 2, 1, 0, 1, 2, 5, 1, 1, 0, 1, 5, 2, 4, 1, 2, 0, 1, 3, 1, 0, 2, 1, 1, 0, 1, 3, 3, 1, 0, 2, 2, 0, 2, 1, 0, 1, 2, 0, 0, 2, 6, 1, 0, 3, 1, 1, 0, 1 in Group B, respectively. Averages and their s.d. through the whole strains were found to be 1.68±1.41 in Group A, 1.50±1.42 in Group B and 1.59±1.42 in the whole strains of both

of the groups, respectively.

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 −0.0331 to the degree of freedom of 48, 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 +0.7844 to the degree of freedom of 48, which is significant at 0.1% level. Generally speaking, the more is the numbers of strains showing the larger values, the more is the numbers of the total strains showing the larger and smaller values. L.r. of the number of strains showing larger values on the number of the total strains was calculated as follows; $Y=0.975X+1.601$, where Y and X indicate the number of strains showing larger values and the number of total strains, respectively. This formula indicates that the number of strains showing the larger values becomes 0.975 more, when the number of total strains becomes more by 1 degree. C.c. of the numbers of strains showing the smaller values and the numbers of total strains was +0.2338 to the degree of freedom of 48, showing no significance even at 5% level.

In Group B, c.c. of the numbers of strains showing the larger values and the smaller values was found to be +0.0191 to the degree of freedom of 48, showing no significance even at 5% level. C.c. of the numbers of strains showing the larger values and the total strains was +0.8044 to the degree of freedom of 48, 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; $Y=0.999X+1.522$, where Y and X indicate the numbers 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 0.999 more, when the number of total strains becomes more by 1 degree. C.c. of the numbers of strains showing the smaller values and the total strains was +0.6148 to the degree of freedom of 48, which is obviously significant at 0.1% 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; $Y=1.022X+1.586$, when 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 1.022 more, when the number of total strains becomes more by 1 degree.

In the whole strains of both of the groups (=100), c.c. of the number of strains showing the larger values and the smaller values was found to be +0.0457 to the degree of freedom of 98, 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 found to be +0.7861 to the degree of freedom of 98, which is 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; $Y=0.994X+1.560$, 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 0.994 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 +0.6042 to the degree of freedom of 98, which is significant at 0.1% 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 the strains showing the smaller values on the number of total strains was calculated as follows; $Y=0.989X+1.638$, 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 0.989 more, when the number of total strains becomes more by 1 degree.

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 −0.0400 [−0.1287 in a part of A and +0.0321 in a part of B] to the degree of freedom of 98, showing no significance even at 5% level. C.c. of the number of strains showing the larger values and the total strains was +0.7645 [+0.6223 in a part of A and +0.9021 in a part of B] to the degree of freedom of 98, which is significant at 0.1% level. Generally speaking, the more is the number of strains showing the larger values, the more is the number of strains showing the larger values, and 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; $Y=0.897X+0.837$, 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 0.897 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 +0.5466 [+0.6477 in a part of A and +0.4341 in a part of B] to the degree of freedom of 98, which is significant at 0.1% 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 the strains showing the smaller values on the number of total strains was calculated as follows; $Y=0.873X+0.928$, 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 0.873 more, when the number of total strains becomes more by 1 degree.

It was noticed that relations between the number of strains showing the larger values and the number of total strains showed significances at 0.1% level through the four columns. These techniques were newly adopted by the present author. Further analyses might be requested hereafter sincerely.

8. According to the tripartite classification, correlation coefficients of the respective characters in the strain level were fixed to be significant in 12/15 cases (=80.0%), 310/420 cases (=73.8%) and 769/1,065 cases (=72.2%) in type A, type B and type C, respectively. In these viewpoints, no remarkable difference was noted between these types.

Summary

Succeeding to the previous papers, some morphological studies on grain characters and considerations on ecotypic differentiations of 100 strains of cultivated rice species, *Oryza sativa* L., delivered from Rice Research Station, Chinsurah, West Bengal, India, were reported in the present paper. The results obtained here were summarized as follows:

Concerning correlation coefficients among 15 character-combinations, 537/750 cases (=71.6%) in Group A, 554/750 cases (=73.9%) in Group B and 1,091/1,500 cases (=72.7%) 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, 804/1,350 cases (=59.6%) in Group A, 827/1,350 cases (=61.3%) in Group B and 1,631/2,700 cases (=60.4) 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 29.78 ± 18.68, 31.93 ± 20.70 and 60.37 ± 37.72, respectively.

The whole character-combinations (=27) were divided 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 correlation were accounted as 42.0% (=378/900 cases), 42.1% (=379/900 cases), 42.1% (=757/1,800 cases), 94.7% (=426/450 cases), 99.3% (=447/450 cases) and 97.0% (=873/900 cases) in pack I 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 20.94 ±16.94, 21.06±16.81, 42.06±33.54, 47.33±2.21, 49.67±0.47 and 97.00±2.36, 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 of negative statuses. 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 techniques, by which correlation coefficients and linear regressions based on the respective character-combinations were re-calculated in view of correlation between them, were adopted for the first time in the experimental series by the present author. Although some findings were ascertained, several problems were left unascertained, and further experiments might be requested.

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