Diallel Cross Experiment among Sikkimese Varieties, Indica and Japonica Testers of Rice, *Oryza sativa* L.

VI. Comparison of Unhusked with Husked Grains

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Introduction

Many reports have been published on the classification of rice varieties into geographical races. However, the idea of dividing rice varieties seems to be swiftly losing its significance in accordance with further performance of intensive works[1].

In order to confirm the classification of varieties, especially Sikkimese rice, and to clarify the relationships between its strains and those belonging to the types of typical *indica* and *japonica*, diallel crosses were carried out, using 16 strains, *i.e.*, 14 strains belonging to Sikkimese rice, 1 belonging to the type of *indica* and another to the type of *japonica*. The consideration using diallel crosses is superior to those using single cross for looking into combining ability, heterosis and cytoplasmic inheritance. Moreover, the system of genes controlling agronomically significant quantitative traits, such as plant height, was studied through the diallel analysis method[2]. So, diallel cross was employed here. In the previous papers in this series, crossability, pollen and seed fertilities[3], heading dates[4], some morphological characters of plant[5], morphological characters of unhusked and husked grains[6,7], and some relations among them were reported. In the present report, comparative studies of data reported on the unhusked and husked grains, and some relations among them were mainly described. Other characters, including conclusive survey of evolution and strain differentiations, are going to be published in the papers following hereafter.

Materials and Methods

Fourteen strains of Sikkimese rice varieties were picked out from 68 strains collected at Sikkim in 1959[8], and used in this experiment. In addition, one strain of *indica* and another one strain of *japonica* were used as the tester. They are listed up and classified in Table 1. Procedures of the cross and cultivation of the parental and hybrid plants were minutely mentioned in the previous paper[3].

For ascertaining the practical values of unhusked and husked grains[6,7], the whole data referring to the six characters were illustrated by the average values in the whole seeds used in the respective strain and the hybrid combinations. In the present paper, comparative data on six morphological characters of unhusked and husked grains were illustrated by the ratios of value on husked to that in unhusked ones in six characters, *i.e.*, length, width, thickness, ratio of length to width, ratio of length to thickness and ratio of width to thickness. To make clear the reciprocal relations, the correlation co-

efficient and linear regression of the respective two characters of female parent upon male parent were calculated. Basing on the data obtained in the calculation, t-test was made from analyses of the variance for reciprocal cross combinations. Further, to make clear the relationships between the respective characters, correlation coefficient and linear regression of these two characters were calculated.

Lastly, correlations between the practical values of unhusked and husked grains and linear regressions between these were calculated, too, in view of the six characters.

Results

PART I. Respective character in quotient of husked and unhusked grains

I. Length

Parent; In Table 1, the comparative values on the whole characters of parental plants used were shown. In this table, length, width and thickness, ratios of length to width,

Table 1. Comparative values on morphological characters of unhusked and husked grains of the pure strains; illustrated by the ratios of value in husked to value in unhusked grains in the respective character

Code No.	Strain No.	Origin	Variety	Length	Width	Thick-ness	L/W	L/T	W/T
1	108	Formosa	*Indica*	0.76	0.82	0.84	0.85	0.91	0.98
2	563	Japan	*Japonica*	0.69	0.78	0.86	0.89	0.80	0.90
3	C7707	Sikkim	Addey	0.72	0.85	0.85	0.85	0.85	1.00
4	C7716	Sikkim	Lama	0.73	0.81	0.88	0.85	0.83	0.97
5	C7717	Sikkim	Lama	0.72	0.83	0.85	0.86	0.85	0.99
6	C7718	Sikkim	Tokmor Zo	0.72	0.82	0.89	0.87	0.81	0.92
7	C7719	Sikkim	Tokmor Zo	0.69	0.84	0.89	0.83	0.78	0.94
8	C7722	Sikkim	Addey	0.71	0.82	0.86	0.87	0.83	0.95
9	C7725	Sikkim	Addey	0.72	0.82	0.82	0.88	0.88	1.00
10	C7727	Sikkim	Addey	0.75	0.90	0.85	0.86	0.88	1.06
11	C7729	Sikkim	Addey	0.70	0.84	0.91	0.84	0.77	0.92
12	C7732	Sikkim	Tapachini	0.72	0.85	0.86	0.84	0.84	1.00
13	C7734	Sikkim	Fudangay	0.71	0.85	0.87	0.84	0.82	0.97
14	C7735	Sikkim	Fudangay	0.74	0.85	0.88	0.84	0.82	0.97
15	C7754	Sikkim	Champasari	0.72	0.81	0.84	0.89	0.86	0.97
16	C7757	Sikkim	Addey	0.74	0.82	0.85	0.90	0.87	0.97

of length to thickness and of width to thickness were shown. The calculations were made using the average values of the respective character; illustrating by the ratios of value in husked grains to the value in unhusked ones.

The largest (0.76) was obtained in No.1, followed by No.10 (0.75). The smallest (0.69) was noted in Nos.2 and 7, followed by No.11 (0.70). Average and its standard deviations in the whole strains were found to be 0.72 ± 0.02.

Hybrid; The values among diallel crosses are shown in Table 2. A wide range was observed. The value of individual seed level ranged from 0.81 to 0.62 and the mean value ranged from 0.70 to 0.64. In combination level, the largest (0.79) was obtained in the com-

Table 2. Comparative values on length of unhusked and husked grains of F_1 hybrids

♀ \ ♂	Code No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Code No.	1		0.68	0.70	0.71	0.72	0.70	0.72	0.70	0.72	0.71	0.69	0.70	0.72	0.72	0.70	0.71
	2	0.73		0.69	0.69	0.71	0.69	0.71	0.70	0.73	0.69	0.73	0.71	0.72	0.72	0.68	0.73
	3	0.72	0.71		0.74	0.71	0.73	0.72	0.71	0.73	0.72	0.73	0.74	0.72	0.71	0.72	0.73
	4	0.71	0.77	0.74		0.72	0.74	0.74	0.77	0.76	0.76	0.76	0.76	0.75	0.76	0.74	0.74
	5	0.72	0.77	0.73	0.75		0.73	0.76	0.76	0.73	0.71	0.75	0.76	0.75	0.72	0.76	0.74
	6	0.74	0.70	0.71	0.74	0.71		0.72	0.74	0.73	0.73	0.75	0.75	0.71	0.74	0.73	0.74
	7	0.70	0.70	0.70	0.74	0.74	0.72		0.70	0.71	0.72	0.70	0.71	0.69	0.68	0.71	0.72
	8	0.72	0.73	0.70	0.76	0.75	0.75	0.72		0.71	0.71	0.72	0.72	0.79	0.73	0.69	0.70
	9	0.70	0.71	0.73	0.74	0.71	0.71	0.70	0.74		0.71	0.70	0.73	0.72	0.75	0.73	0.73
	10	0.73	0.74	0.74	0.74	0.75	0.74	0.71	0.73	0.76		0.73	0.73	0.74	0.73	0.73	0.74
	11	0.71	0.70	0.70	0.73	0.72	0.67	0.73	0.72	0.69	0.73		0.70	0.71	0.73	0.74	0.73
	12	0.71	0.70	0.73	0.73	0.74	0.70	0.74	0.73	0.72	0.71	0.71		0.71	0.74	0.72	0.72
	13	0.73	0.73	0.73	0.73	0.72	0.73	0.72	0.76	0.71	0.72	0.71	0.72		0.72	0.73	0.72
	14	0.71	0.69	0.72	0.74	0.72	0.72	0.71	0.72	0.72	0.73	0.70	0.72	0.71		0.72	0.72
	15	0.73	0.71	0.74	0.74	0.72	0.71	0.74	0.71	0.69	0.72	0.70	0.72	0.69	0.70		0.72
	16	0.73	0.70	0.72	0.75	0.72	0.72	0.71	0.72	0.73	0.73	0.71	0.73	0.71	0.71	0.76	

bination, No.8 (♀) × No.13 (♂), followed by No.4 × No.2, No.4 × No.8 and No.5 × No.2 (0.77). The smallest (0.67) was noted in the combination, No.11 × No.6, followed by No.1 × No.2, No.2 × No.15 and No.7 × No.14 (0.68). The differences in the value were confirmed to be very large in accordance with the varieties in the respective combination-set.

Table 3. Averages and their standard deviations of three characters in female and male parental levels; length, width and thickness

Code No.	Length		Width		Thickness	
	Female	Male	Female	Male	Female	Male
1	0.71±0.01	0.72±0.01	0.83±0.02	0.83±0.04	0.86±0.04	0.86±0.05
2	0.71±0.01	0.72±0.02	0.83±0.03	0.83±0.03	0.87±0.03	0.86±0.06
3	0.72±0.02	0.72±0.02	0.84±0.04	0.84±0.03	0.87±0.03	0.86±0.05
4	0.75±0.02	0.74±0.02	0.84±0.02	0.85±0.03	0.87±0.02	0.88±0.03
5	0.74±0.02	0.72±0.01	0.85±0.02	0.83±0.03	0.86±0.02	0.86±0.04
6	0.73±0.02	0.72±0.02	0.81±0.04	0.84±0.03	0.80±0.05	0.87±0.04
7	0.71±0.02	0.72±0.01	0.79±0.01	0.84±0.04	0.80±0.04	0.86±0.04
8	0.73±0.02	0.73±0.02	0.81±0.04	0.83±0.04	0.80±0.07	0.86±0.05
9	0.72±0.01	0.72±0.02	0.81±0.04	0.84±0.03	0.81±0.05	0.86±0.06
10	0.74±0.01	0.72±0.01	0.86±0.01	0.83±0.03	0.88±0.02	0.84±0.04
11	0.71±0.02	0.72±0.02	0.84±0.01	0.83±0.03	0.89±0.02	0.85±0.06
12	0.72±0.01	0.73±0.02	0.86±0.01	0.83±0.03	0.88±0.02	0.85±0.05
13	0.73±0.01	0.72±0.02	0.86±0.02	0.84±0.03	0.89±0.01	0.87±0.04
14	0.72±0.01	0.72±0.02	0.85±0.02	0.84±0.03	0.88±0.01	0.86±0.05
15	0.72±0.01	0.72±0.02	0.82±0.03	0.81±0.03	0.87±0.04	0.84±0.04
16	0.72±0.01	0.73±0.01	0.86±0.02	0.84±0.03	0.90±0.01	0.86±0.04
Whole	0.72±0.02		0.83±0.03		0.86±0.05	

In Table 3, the average value and the standard deviations in length in the whole combinations are shown. Each figure used in the table shows average and standard deviations in each parent when the strain was used as female and male parents, including 15 combinations each. In other words, the data ranked in the female row in Table 3 were horizontally calculated at the figures shown in Table 2, and the data ranked in the male row in Table 3 were longitudinally calculated at the figures shown in Table 2, respectively. In view of the female parent, the highest value in the parental average (0.75) was obtained in No.4, followed by Nos.5 and 10 (0.74). The lowest value in the parental average (0.71) was noted in Nos.1, 2, 7 and 11. The differences of the value in the parental level were ascertained to be large in accordance with each parent. The relation between the values of average and standard deviations was not recognized clearly. In view of the male parent, the highest value in the parental average (0.74) was also obtained in No.4, followed by Nos.8, 12 and 16 (0.73). The lowest value in the parental average (0.72) was noted in the remaining 12 strains. The relation between values of average and standard deviations was not recognized clearly, either. The average value and its standard deviations in the whole combinations were 0.72±0.02.

To make clear the value in view of reciprocal combinations, correlation coefficient

and linear regression of the value of female parent on male parent in the same strain were calculated, and are shown in Table 4. Basing on the data obtained in this calculation, t-test was made from analyses of variance for reciprocal cross comparisons. From this table, the following items were ascertained. One and 1 strain showed significances at 0.1%, 5% levels, but 14 strains showed no significance even at 5% level, respectively. In the whole strains, correlation coefficient was +0.1647 to the degree of freedom of 118, showing no significance even at 5% level. It was concluded that the reciprocal differences in this study suggested no considerable cytoplasmic influence on the value.

Table 4. Correlation coefficient and linear regression of three characters of female parent (Y) on male parent (X); length, width and thickness. O points, 0.73 and 0.81 in length and width, respectively, in both female and male parents

Code No.	Length			Width			Thickness	
	Correlation coefficient	d.f.	Linear regression	Correlation coefficient	d.f.	Linear regression	Correlation coefficient	d.f.
1	-0.3470	13	-	-0.2764	13	-	0.3054	13
2	-0.3366	13	-	-0.0677	13	-	-0.3212	13
3	0.2773	13	-	-0.1708	13	-	0.1257	13
4	-0.2066	13	-	0.3619	13	-	0.3792	13
5	-0.3052	13	-	-0.0946	13	-	-0.0748	13
6	-0.1955	13	-	-0.2286	13	-	-0.1238	13
7	0.2748	13	-	-0.4116	13	-	-0.2350	13
8	0.8442***	13	Y=1.387X-0.760	0.1052	13	-	-0.2550	13
9	0.1955	13	-	-0.3835	13	-	0.1313	13
10	-0.2845	13	-	-0.1131	13	-	-0.1247	13
11	-0.0635	13	-	-0.0595	13	-	-0.0949	13
12	0.2901	13	-	-0.2571	13	-	-0.1366	13
13	0.5221*	13	Y=0.791X+0.353	0.0729	13	-	0.1271	13
14	0.4912	13	-	0.5413*	13	Y=0.583X+1.434	0.1821	13
15	-0.0647	13	-	-0.1353	13	-	-0.2121	13
16	0.1451	13	-	-0.3978	13	-	-0.2967	13
Whole	0.1647	118	-	0.0091	118	-	0.0618	118

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

The differences between the maximum and the minimum values of length for each parent, in view of the female parent, were as follows in the order from No.1 to No.16; 0.04, 0.05, 0.03, 0.06, 0.06, 0.05, 0.06, 0.10, 0.05, 0.05, 0.07, 0.04, 0.05, 0.05, 0.05 and 0.06, respectively. It may be noted that the value was peculiarly large in No.8. The average and its standard deviations were 0.05 ± 0.01. The strain showing large value in this respect had a remarkable difference in length, which were found in the combinations with 15 alien parents, at the time when it was used as female parent and alien strains were used as male parents, respectively. In an extreme case, the values were 0.79 and 0.69 in No.8 × No.13 and No.8 × No.15, respectively. The former was the largest in the whole combinations (=240). In other words, No.8 showed affinities remarkably different from each

strain, at the time when No.8 was used as female parent. The strain showing small value in this respect had a few differences in length, which were found in the combinations with 15 alien parents, at the time when the strain was used as female parent and alien strains were used as male parents. In an extreme case, the values were 0.74 and 0.71 in No.3×No.4 and No.3×No.5, respectively. In other words, No.3 showed affinities nearly similar to each strain, at the time when No.3 was used as female parent. Those in view of the male parent were as follows in the same order; 0.04, 0.09, 0.05, 0.07, 0.04, 0.08, 0.06, 0.07, 0.07, 0.07, 0.07, 0.06, 0.10, 0.08, 0.08 and 0.04, respectively. Those average and its standard deviations were 0.07 ± 0.02. The strain showing large value in this respect had a remarkable difference in length, which were found in the combinations with 15 alien parents, at the time when the strain was used as male parent and alien strains were used as female parents, respectively. In an extreme case, the values were 0.79 and 0.69 in No.8× No.13 and No.15×No.13, respectively. The former value was the largest and the latter was nearly the smallest in the whole combinations (=240). In other words, No.13 showed affinities remarkably different from each strain, at the time when it was used as male parent. The strain showing small value in this respect had a few differences in length, which were found in the combinations with 15 alien parents, at the time when the strain was used as male parent and alien strains were used as female parents. In an extreme case, the values were 0.74 and 0.70 in No.6×No.1 and No.7×No.1, respectively. In other words, No.1 showed affinities relatively similar to each strain, at the time when it was used as male parent. In reciprocal views, correlation coefficient between these was −0.0197, showing no significance even at 5% level.

To make clear the relations between Sikkimese rice and two testers, the differences in the value at the time when two testers were crossed with Sikkimese rice, and the reciprocals were calculated. In view of the female parent, the differences in the value for *indica* (No.1) and *japonica* (No.2) were as follows in the order from No.3 to No.16, provided that the calculation was made only by the absolute value; 0.01, 0.06, 0.05, 0.04, 0.00, 0.01, 0.01, 0.01, 0.01, 0.01, 0.00, 0.02, 0.02 and 0.03, respectively. The strain showing large value in this respect had a remarkable difference in length, which were found in the combinations with two testers, at the time when the strain was used as female parent and the testers were used as male parents. In an extreme case, the values were 0.71 and 0.77 in No.4×No.1 and No.4×No.2, respectively. In other words, No.4 showed affinities remarkably different from each tester, at the time when No.4 was used as female parent. The strain showing small value in this respect had a few differences in length, which were found in the combinations with two testers, at the time when the strain was used as female parent and the testers were used as male parents. In an extreme case, the values were 0.70 in both No.7×No.1 and No.7×No.2. In other words, No.7 showed affinities quite similar to each tester, at the time when No.7 was used as female parent. Average and its standard deviations in the whole Sikkimese rice were 0.02 ± 0.02. In view of the male parent, the differences in the value for *indica* and *japonica* were as follows in the same order; 0.01, 0.02, 0.01, 0.01, 0.01, 0.00, 0.01, 0.02, 0.04, 0.01, 0.00, 0.00, 0.02 and 0.02, respectively. The strain showing large value in this respect had a remarkable difference in length, which were found in the combinations with two testers, at the time when the strain was used as male parent and the testers were used as female parents. In an extreme case, the values were 0.69 and 0.73 in No.1×No.11 and No.2× No.11, respectively. In other words, No.11 showed affinities remarkably different from

Table 5. Comparative values on width of unhusked and husked grains of F_1 hybrids

♀ \ ♂	Code No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Code No.	1		0.82	0.84	0.83	0.83	0.81	0.83	0.83	0.85	0.86	0.83	0.82	0.81	0.85	0.81	0.82
	2	0.85		0.84	0.81	0.81	0.81	0.81	0.78	0.90	0.83	0.83	0.82	0.83	0.84	0.79	0.82
	3	0.73	0.83		0.86	0.82	0.87	0.88	0.84	0.81	0.81	0.88	0.88	0.87	0.86	0.82	0.85
	4	0.81	0.85	0.83		0.85	0.86	0.86	0.85	0.83	0.85	0.83	0.83	0.86	0.87	0.82	0.85
	5	0.80	0.85	0.83	0.88		0.84	0.87	0.84	0.85	0.84	0.84	0.85	0.84	0.85	0.83	0.86
	6	0.85	0.79	0.79	0.88	0.77		0.80	0.76	0.81	0.80	0.77	0.85	0.79	0.81	0.75	0.85
	7	0.79	0.78	0.79	0.81	0.79	0.81		0.78	0.80	0.79	0.77	0.77	0.80	0.79	0.77	0.81
	8	0.80	0.78	0.77	0.86	0.88	0.87	0.78		0.79	0.78	0.78	0.76	0.88	0.80	0.77	0.79
	9	0.80	0.78	0.88	0.80	0.79	0.77	0.80	0.80		0.79	0.81	0.78	0.81	0.88	0.84	0.88
	10	0.88	0.84	0.86	0.87	0.88	0.88	0.89	0.88	0.85		0.85	0.85	0.86	0.86	0.84	0.85
	11	0.84	0.85	0.84	0.87	0.83	0.85	0.86	0.83	0.85	0.86		0.84	0.84	0.85	0.81	0.84
	12	0.87	0.84	0.87	0.85	0.85	0.84	0.87	0.87	0.86	0.86	0.84		0.84	0.88	0.84	0.86
	13	0.88	0.84	0.86	0.88	0.86	0.87	0.86	0.86	0.87	0.88	0.82	0.86		0.84	0.85	0.87
	14	0.85	0.86	0.86	0.84	0.86	0.83	0.81	0.85	0.84	0.88	0.85	0.86	0.86		0.82	0.88
	15	0.85	0.84	0.88	0.82	0.82	0.82	0.81	0.82	0.82	0.80	0.82	0.83	0.79	0.77		0.83
	16	0.87	0.86	0.86	0.86	0.84	0.84	0.89	0.85	0.85	0.85	0.85	0.86	0.87	0.87	0.82	

each tester. The strain showing small value in this respect had a few differences in length, which were found in the combinations with two testers, at the time when the strain was used as male parent and the testers were used as female parents. In an extreme case, the values were 0.70 in both No.1 × No.8 and No.2 × No.8. In other words, No.8 showed affinities similar to each tester. Average and its standard deviations in the whole Sikkimese rice were 0.01 ± 0.01. In reciprocal views, correlation coefficient between these was -0.3257, showing no significance even at 5% level.

II. Width

Parent; Comparative values of the parental plants on the width are shown in Table 1. The largest (0.90) was obtained in No.10, followed by Nos.3, 12, 13 and 14 (0.85). The smallest (0.78) was noted in No.2, followed by Nos.4 and 15 (0.81). Average and its standard deviations in the whole strains were found to be 0.83 ± 0.03.

Hybrid; The values among diallel crosses are shown in Table 5. The considerable range was observed. Values for individual seed level ranged from 0.92 to 0.70 and mean value ranged from 0.87 to 0.76. In combination level, the largest (0.90) was obtained in the combination, No.2 × No.9, followed by No.10 × No.7 and No.16 × No.7 (0.89). The smallest (0.73) was noted in the combination, No.3 × No.1, followed by No.6 × No.15 (0.75). The differences in the value were confirmed to be large in accordance with the varieties in the respective combination-set.

In Table 3, the average value and the standard deviations in width in the whole combinations are shown. In view of the female parent, the highest value in the parental average (0.86) was obtained in Nos.10, 12, 13 and 16. The lowest value in the parental average (0.79) was noted in No.7, followed by Nos. 6, 8 and 9 (0.81). The differences of the value in the parental level were ascertained to be large in accordance with each parent. The relation between the values of average and standard deviations was not recognized clearly. In view of the male parent, the highest value in the parental average (0.85) was obtained in No.4. The lowest value in the parental average (0.81) was noted in No.15. The relation between the values of average and standard deviations was not recognized clearly, either. The average and its standard deviations in the whole combinations were 0.83 ± 0.03.

To make clear the value in view of reciprocal combinations, correlation coefficient and linear regression of the value of female parent on male parent in the same strain were calculated, and are shown in Table 4. One strain showed significance at 5% level, but 15 strains showed no significance even at 5% level, respectively. In the whole strains, correlation coefficient was $+0.0091$ to the degree of freedom of 118, showing no significance even at 5% level. It was concluded that reciprocal differences in this study suggested no considerable cytoplasmic influence on the value.

The differences between the maximum and the minimum values of width for each parent in view of the female parent were as follows in the order from No.1 to No.16; 0.05, 0.11, 0.15, 0.06, 0.08, 0.13, 0.04, 0.12, 0.11, 0.05, 0.06, 0.04, 0.06, 0.07, 0.11 and 0.17, respectively. It may be noted that the values were peculiarly large in Nos.3 and 16. The average and its standard deviations were 0.09 ± 0.04. Those in view of the male parent were as follows in the same order; 0.15, 0.08, 0.11, 0.08, 0.11, 0.11, 0.11, 0.12, 0.11, 0.10, 0.11, 0.12, 0.09, 0.11, 0.10 and 0.09, respectively. Those average and its standard deviations were 0.11 ± 0.02. In reciprocal views, correlation coefficient between these was -0.2305, show-

ing no significance even at 5% level.

To make clear the relations between Sikkimese rice and two testers, the differences in the value at the time when two testers were crossed with Sikkimese rice, and reciprocals were calculated. In view of the female parent, the differences in the value for *indica* (No.1) and *japonica* (No.2) were as follows in the order from No.3 to No.16, provided that the calculation was made only by the absolute value; 0.10, 0.04, 0.05, 0.06, 0.01, 0.02, 0.02, 0.04, 0.01, 0.03, 0.04, 0.01, 0.01 and 0.01, respectively. Average and its standard deviations in the whole Sikkimese rice were 0.03 ± 0.03. In view of the male parent, the differences in the value for *indica* and *japonica* were as follows in the same order; 0.00, 0.02, 0.02, 0.00, 0.02, 0.05, 0.05, 0.03, 0.00, 0.00, 0.02, 0.01, 0.02 and 0.00, respectively. Average and its standard deviations in the whole Sikkimese rice were 0.02 ± 0.02. In reciprocal views, correlation coefficient between these was -0.0961, showing no significance even at 5% level.

III. Thickness

Parent; Comparative values of parental plants on the thickness are shown in Table 1. The largest (0.91) was obtained in No.11, followed by Nos.6 and 7 (0.89). The smallest (0.82) was obtained in No.9, followed by Nos.1 and 15 (0.84). Average and its standard deviations in the whole strains were found to be 0.86 ± 0.02.

Hybrid; The values among diallel crosses are shown in Table 6. The considerable range was observed. The values for individual seed level ranged from 0.96 to 0.68 and mean value ranged from 0.90 to 0.77. In the combination level, the largest (0.94) was obtained in the combination, No.16 × No.14, followed by No.3 × No.13, No.8 × No.6, No.9 × No.16 and No.15 × No.2 (0.93). The smallest (0.71) was noted in the combination, No.8 × No.2, followed by No.1 × No.9 (0.74). The differences in the value were confirmed to be large in accordance with the varieties in the respective combination-set.

In Table 3, the average value and the standard deviations in thickness in the whole combinations are shown. In view of the female parent, the highest value in the parental average (0.90) was obtained in No.16, followed by Nos.11 and 13 (0.89). The lowest value in the parental average (0.80) was noted in Nos.6, 7 and 8, followed by No.9 (0.81). The differences of the value in the parental level were ascertained to be large in accordance with each parent. The relation between the values of average and standard deviations was not recognized clearly. In view of the male parent, the highest value in the parental average (0.88) was obtained in No.4, which was the same as in cases of the length and width, followed by Nos.6 and 13 (0.87). The lowest value in the parental average (0.84) was noted in Nos.10 and 15. The relation between values of average and standard deviations was not recognized clearly, either. The average and its standard deviations in the whole combinations were 0.86 ± 0.05.

To make clear the value in view of reciprocal combinations, correlation coefficients of the value of female parent on male parent in the same strain were calculated, and are shown in Table 4. Whole strains showed no significance even at 5% level. In the whole strains, correlation coefficient was $+0.0618$ to the degree of freedom of 118, showing no significance even at 5% level. It was concluded that reciprocal differences in this study suggested no considerable cytoplasmic influence on the value.

The differences between the maximum and the minimum values of thickness for each parent in view of the female parent were as follows in the order from No.1 to No.

Table 6. Comparative values on thickness of unhusked and husked grains of F_1 hybrids

♀ \ ♂	Code No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Code No.	1		0.88	0.88	0.84	0.85	0.85	0.88	0.88	0.74	0.85	0.90	0.86	0.86	0.85	0.87	0.86
	2	0.92		0.86	0.88	0.85	0.86	0.88	0.87	0.91	0.88	0.86	0.86	0.87	0.85	0.82	0.84
	3	0.86	0.86		0.88	0.83	0.83	0.89	0.86	0.85	0.82	0.90	0.91	0.93	0.87	0.84	0.87
	4	0.87	0.89	0.86		0.84	0.89	0.86	0.89	0.87	0.87	0.90	0.85	0.87	0.89	0.84	0.89
	5	0.81	0.86	0.87	0.86		0.88	0.86	0.86	0.87	0.86	0.88	0.87	0.87	0.87	0.83	0.88
	6	0.87	0.79	0.76	0.88	0.78		0.79	0.76	0.79	0.78	0.79	0.88	0.78	0.77	0.76	0.88
	7	0.78	0.82	0.79	0.92	0.79	0.80		0.77	0.77	0.78	0.77	0.80	0.79	0.79	0.78	0.78
	8	0.75	0.71	0.76	0.90	0.89	0.93	0.77		0.78	0.79	0.78	0.75	0.90	0.79	0.75	0.79
	9	0.77	0.77	0.90	0.78	0.79	0.79	0.79	0.79		0.79	0.75	0.77	0.80	0.86	0.87	0.93
	10	0.89	0.90	0.86	0.87	0.86	0.91	0.91	0.87	0.85		0.89	0.86	0.89	0.87	0.88	0.86
	11	0.87	0.88	0.89	0.91	0.92	0.90	0.88	0.88	0.89	0.84		0.87	0.90	0.92	0.86	0.87
	12	0.88	0.86	0.86	0.87	0.90	0.90	0.89	0.89	0.89	0.85	0.88		0.88	0.92	0.84	0.86
	13	0.89	0.91	0.88	0.90	0.87	0.89	0.89	0.90	0.91	0.89	0.88	0.86		0.88	0.87	0.87
	14	0.88	0.89	0.86	0.89	0.89	0.87	0.86	0.91	0.90	0.86	0.89	0.88	0.87		0.87	0.88
	15	0.91	0.93	0.92	0.86	0.90	0.86	0.86	0.87	0.91	0.86	0.77	0.88	0.88	0.86		0.84
	16	0.92	0.90	0.90	0.91	0.89	0.90	0.88	0.92	0.89	0.90	0.89	0.90	0.92	0.94	0.88	

Table 7. Comparative values on ratio of length to width of unhusked and husked grains of F_1 hybrids

♂ \ ♀	Code No. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1		0.83	0.84	0.86	0.87	0.87	0.87	0.84	0.85	0.82	0.82	0.86	0.88	0.85	0.86	0.87
2	0.86		0.82	0.86	0.88	0.85	0.87	0.88	0.81	0.83	0.83	0.87	0.86	0.86	0.86	0.88
3	0.87	0.86		0.90	0.86	0.87	0.82	0.85	0.90	0.88	0.83	0.84	0.82	0.82	0.88	0.86
4	0.88	0.91	0.89		0.85	0.87	0.86	0.91	0.91	0.90	0.92	0.92	0.86	0.87	0.90	0.88
5	0.89	0.90	0.87	0.85		0.87	0.88	0.91	0.86	0.83	0.89	0.90	0.89	0.85	0.92	0.87
6	0.87	0.89	0.91	0.84	0.92		0.90	0.96	0.90	0.92	0.98	0.88	0.90	0.92	0.98	0.88
7	0.88	0.89	0.88	0.84	0.94	0.89		0.90	0.88	0.91	0.91	0.92	0.86	0.86	0.92	0.88
8	0.90	0.94	0.91	0.89	0.85	0.86	0.92		0.89	0.91	0.93	0.94	0.90	0.92	0.90	0.88
9	0.87	0.90	0.82	0.93	0.89	0.92	0.88	0.93		0.89	0.87	0.93	0.89	0.85	0.87	0.84
10	0.83	0.87	0.86	0.85	0.85	0.84	0.80	0.83	0.89		0.85	0.86	0.85	0.85	0.87	0.87
11	0.84	0.83	0.84	0.84	0.87	0.86	0.84	0.85	0.82	0.85		0.83	0.85	0.86	0.90	0.79
12	0.82	0.83	0.84	0.86	0.87	0.83	0.85	0.84	0.84	0.83	0.85		0.84	0.83	0.86	0.85
13	0.83	0.87	0.85	0.83	0.84	0.84	0.84	0.85	0.83	0.83	0.86	0.84		0.86	0.87	0.83
14	0.83	0.80	0.84	0.89	0.84	0.88	0.88	0.85	0.85	0.84	0.82	0.83	0.82		0.88	0.83
15	0.87	0.84	0.84	0.91	0.84	0.87	0.91	0.86	0.85	0.89	0.86	0.87	0.88	0.91		0.86
16	0.84	0.82	0.83	0.87	0.85	0.87	0.80	0.84	0.86	0.85	0.84	0.84	0.82	0.82	0.93	

Code No. (♂)

16; 0.16, 0.10, 0.11, 0.06, 0.07, 0.12, 0.15, 0.22, 0.18, 0.06, 0.08, 0.08, 0.05, 0.05, 0.09 and 0.06, respectively. It may be noted that the value was peculiarly large in No.8. The average and its standard deviations were 0.10 ± 0.05. Those in view of the male parent were as follows in the same order; 0.17, 0.22, 0.16, 0.14, 0.14, 0.14, 0.14, 0.16, 0.17, 0.12, 0.15, 0.16, 0.15, 0.17, 0.22 and 0.15, respectively. It may be noted that the values were peculiarly large in Nos.2 and 15. Those average and its standard deviations were 0.16 ± 0.03. In reciprocal views, correlation coefficient between these was $+0.1450$, showing no significance even at 5% level.

To make clear the relations between Sikkimese rice and two testers, the differences in the value at the time when two testers were crossed with Sikkimese rice, and reciprocals were calculated. In view of the female parent, the differences in the value for *indica* (No.1) and *japonica* (No.2) were as follows in the order from No.3 to No.16, provided that the calculation was made only by the absolute value; 0.00, 0.02, 0.05, 0.08, 0.04, 0.04, 0.00, 0.01, 0.01, 0.02, 0.02, 0.01, 0.02 and 0.02, respectively. Average and its standard deviations in the whole Sikkimese rice were 0.02 ± 0.02. In view of the male parent, the differences in the value for *indica* and *japonica* were as follows in the same order; 0.02, 0.04, 0.00, 0.01, 0.00, 0.01, 0.17, 0.03, 0.04, 0.00, 0.01, 0.00, 0.05 and 0.02, respectively. It may be noted that the value was peculiarly large in No.9. Average and its standard deviations in the whole Sikkimese rice were 0.03 ± 0.04. In reciprocal views, correlation coefficient between these was -0.0337, showing no significance even at 5% level.

IV. Ratio of length to width

Parent; Comparative values of parental plants on ratio of length to width are shown in Table 1. The largest (0.90) was obtained in No.16, followed by Nos.2 and 15 (0.89). The smallest (0.83) was noted in No.7. Average and its standard deviations in the whole strains were found to be 0.86 ± 0.02.

Hybrid; The values among diallel crosses are shown in Table 7. A considerable range was observed. Values for individual seed level ranged from 1.01 to 0.76 and mean value ranged from 0.95 to 0.84. In combination level, the largest (0.98) was obtained in the combinations, No.6 × No.11 and No.6 × No.15, followed by No.6 × No.8 (0.96). The smallest (0.79) was noted in the combination, No.11 × No.16, followed by No.10 × No.7, No.14 × No.2 and No.16 × No.7 (0.80). The differences in the value were confirmed to be large in accordance with the varieties in the respective combination-set.

In Table 8, the average value and the standard deviations in the ratio in the whole combinations are shown. In view of the female parent, the highest value in the parental average (0.91) was obtained in No.6, followed by No.8 (0.90). The lowest value in the parental average (0.84) was noted in No.12. The differences of the value were ascertained to be large in accordance with each parent. The relation between values of average and standard deviations was not recognized clearly. In view of the male parent, the highest value in the parental average (0.89) was obtained in No.15, followed by No.12 (0.88). The lowest value in the parental average (0.86) was noted in 7 strains. The relation between values of average and standard deviations was not recognized clearly, either. The average and its standard deviations in the whole combinations were 0.87 ± 0.04.

To make clear the value in view of reciprocal combinations, correlation coefficient and linear regression of the ratio of female parent on male parent in the same strain were calculated, and are shown in Table 9. One strain showed significance at 5% level,

Table 8. Averages and their standard deviations of three characters in female and male parental levels; ratios of length to width, of length to thickness and of width to thickness

Code No.	Length/Width		Length/Thickness		Width/Thickness	
	Female	Male	Female	Male	Female	Male
1	0.85±0.02	0.86±0.02	0.83±0.05	0.84±0.05	0.97±0.05	0.98±0.05
2	0.86±0.02	0.87±0.04	0.82±0.02	0.84±0.07	0.95±0.03	0.97±0.04
3	0.86±0.03	0.86±0.03	0.84±0.02	0.84±0.04	0.97±0.04	0.98±0.02
4	0.89±0.02	0.87±0.03	0.86±0.02	0.84±0.04	0.97±0.02	0.97±0.04
5	0.88±0.02	0.87±0.03	0.86±0.03	0.85±0.04	0.98±0.02	0.97±0.04
6	0.91±0.04	0.87±0.02	0.91±0.04	0.83±0.04	1.01±0.03	0.96±0.03
7	0.89±0.02	0.86±0.04	0.89±0.03	0.84±0.05	1.00±0.04	0.99±0.03
8	0.90±0.02	0.87±0.04	0.91±0.05	0.85±0.06	1.01±0.04	0.96±0.04
9	0.89±0.03	0.86±0.04	0.89±0.05	0.85±0.06	1.01±0.03	0.99±0.06
10	0.85±0.02	0.87±0.04	0.84±0.03	0.86±0.04	0.99±0.03	0.99±0.03
11	0.85±0.02	0.87±0.05	0.81±0.04	0.85±0.08	0.95±0.03	0.98±0.04
12	0.84±0.01	0.88±0.04	0.82±0.02	0.85±0.05	0.98±0.03	0.98±0.02
13	0.85±0.01	0.86±0.03	0.82±0.01	0.84±0.05	0.97±0.02	0.97±0.04
14	0.85±0.03	0.86±0.03	0.81±0.03	0.84±0.05	0.97±0.03	0.98±0.04
15	0.87±0.02	0.89±0.03	0.82±0.04	0.87±0.04	0.95±0.04	0.97±0.03
16	0.85±0.03	0.86±0.02	0.80±0.02	0.85±0.03	0.95±0.02	0.98±0.01
Whole	0.87±0.04		0.85±0.05		0.98±0.04	

but 15 strains showed no significance even at 5% level, respectively. In the whole strains, correlation coefficient was +0.0659 to the degree of freedom of 118, showing no significance even at 5% level. It was concluded that reciprocal differences in this study suggested no considerable cytoplasmic influence on the ratio.

The differences between the maximum and the minimum values of the ratio for each parent in view of the female parent were as follows in the order from No.1 to No.16; 0.06, 0.07, 0.08, 0.07, 0.09, 0.14, 0.10, 0.09, 0.11, 0.09, 0.11, 0.05, 0.04, 0.09, 0.07 and 0.13, respectively. The average and its standard deviations were 0.09±0.02. Those in view of the male parent were as follows in the same order; 0.08, 0.14, 0.09, 0.10, 0.10, 0.09, 0.11, 0.13, 0.10, 0.10, 0.16, 0.11, 0.08, 0.10, 0.12 and 0.09, respectively. Those average and its standard deviations were 0.11±0.02. In reciprocal views, correlation coefficient between these was +0.0755, showing no significance even at 5% level.

To make clear the relations between Sikkimese rice and two testers, the differences in the value at the time when two testers were crossed with Sikkimese rice, and reciprocals were calculated. In view of the female parent, the differences in the value for *indica* (No.1) and *japonica* (No.2) were as follows in the order from No.3 to No.16, provided that the calculation was made only by the absolute value; 0.01, 0.03, 0.01, 0.02, 0.01, 0.04, 0.03, 0.04, 0.01, 0.01, 0.04, 0.03, 0.03 and 0.02, respectively. Average and its standard deviations in the whole Sikkimese rice were 0.02±0.01. In view of the male parent, the differences in the value for *indica* and *japonica* were as follows in the same order; 0.02, 0.00, 0.01, 0.02, 0.00, 0.04, 0.04, 0.01, 0.01, 0.01, 0.02, 0.01, 0.00 and 0.01, respectively. Average

Table 9. Correlation coefficient and linear regression of three characters of female parent (Y) on male parent (X); the ratios of length to width, of length to thickness and of width to thickness. O points, 0.88, 0.88 and 0.99 in the 1st, 2nd and 3rd ratios, respectively, in both female and male parents

Code No.	Length/Width			Length/Thickness			Width/Thickness		
	Correlation coefficient	d.f.	Linear regression	Correlation coefficient	d.f.	Linear regression	Correlation coefficient	d.f.	Linear regression
1	0.1277	13	—	0.3455	13	—	0.3656	13	—
2	0.0557	13	—	−0.3660	13	—	−0.3575	13	—
3	0.0427	13	—	0.1469	13	—	0.3989	13	—
4	0.2121	13	—	0.0901	13	—	0.0516	13	—
5	−0.0389	13	—	−0.0055	13	—	0.1154	13	—
6	−0.2331	13	—	−0.3588	13	—	0.0000	13	—
7	−0.0428	13	—	−0.1391	13	—	0.1152	13	—
8	−0.5282*	13	Y = −0.452X + 1.892	−0.6779**	13	Y = −0.481X + 0.771	−0.5755*	13	Y = −0.436X + 0.000
9	0.0049	13	—	0.0563	13	—	0.3180	13	—
10	−0.1353	13	—	−0.2545	13	—	0.1235	13	—
11	0.3449	13	—	−0.1123	13	—	−0.0623	13	—
12	0.2668	13	—	−0.0310	13	—	−0.2429	13	—
13	0.0470	13	—	−0.2814	13	—	−0.0305	13	—
14	0.4667	13	—	0.2513	13	—	−0.2625	13	—
15	−0.0297	13	—	0.3310	13	—	−0.1011	13	—
16	0.1048	13	—	0.0130	13	—	0.3789	13	—
Whole	0.0659	118	—	−0.0189	118	—	0.0648	118	—

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

Table 10. Comparative values on ratio of length to thickness of unhusked and husked grains of F_1 hybrids

♀ \ ♂	Code No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Code No.	1		0.77	0.80	0.85	0.85	0.82	0.82	0.79	0.98	0.84	0.76	0.82	0.84	0.85	0.80	0.83
	2	0.79		0.80	0.79	0.83	0.80	0.80	0.80	0.81	0.78	0.84	0.83	0.82	0.84	0.83	0.87
	3	0.84	0.83		0.85	0.85	0.88	0.81	0.81	0.86	0.87	0.81	0.82	0.78	0.82	0.85	0.84
	4	0.82	0.87	0.86		0.85	0.83	0.86	0.87	0.88	0.88	0.85	0.90	0.86	0.86	0.88	0.84
	5	0.89	0.90	0.83	0.87		0.84	0.88	0.89	0.84	0.82	0.84	0.88	0.87	0.83	0.91	0.85
	6	0.85	0.89	0.94	0.84	0.91		0.91	0.97	0.92	0.94	0.95	0.85	0.91	0.96	0.97	0.85
	7	0.89	0.86	0.89	0.81	0.93	0.90		0.92	0.92	0.93	0.92	0.88	0.87	0.86	0.91	0.92
	8	0.96	1.04	0.92	0.85	0.84	0.81	0.94		0.91	0.90	0.92	0.95	0.87	0.93	0.92	0.89
	9	0.91	0.92	0.81	0.94	0.89	0.89	0.90	0.94		0.89	0.93	0.95	0.91	0.87	0.83	0.80
	10	0.83	0.82	0.86	0.85	0.87	0.81	0.77	0.84	0.90		0.82	0.84	0.83	0.84	0.83	0.86
	11	0.82	0.79	0.79	0.80	0.78	0.74	0.83	0.82	0.77	0.87		0.80	0.79	0.80	0.87	0.84
	12	0.81	0.81	0.85	0.84	0.82	0.78	0.83	0.82	0.81	0.84	0.80		0.81	0.81	0.86	0.84
	13	0.83	0.81	0.83	0.81	0.83	0.82	0.81	0.84	0.78	0.81	0.81	0.83		0.82	0.84	0.83
	14	0.81	0.77	0.84	0.84	0.81	0.83	0.82	0.79	0.80	0.85	0.75	0.81	0.81		0.83	0.82
	15	0.81	0.76	0.80	0.86	0.81	0.83	0.86	0.81	0.77	0.83	0.92	0.82	0.79	0.81		0.85
	16	0.79	0.77	0.81	0.82	0.80	0.80	0.81	0.78	0.82	0.82	0.80	0.81	0.77	0.76	0.86	

and its standard deviations in the whole Sikkimese rice were 0.01 ± 0.01. In reciprocal views, correlation coefficient between these was -0.0921, showing no significance even at 5% level.

V. Ratio of length to thickness

Parent; Comparative values of parental plants on ratio of length to thickness are shown in Table 1. The largest (0.91) was obtained in No.1, followed by Nos.9 and 10 (0.88). The smallest (0.77) was noted in No.11, followed by No.7 (0.78). Average and its standard deviations in the whole strains were found to be 0.84 ± 0.04.

Hybrid; The values among diallel crosses are shown in Table 10. A wide range was observed. The value for individual seed level ranged from 1.06 to 0.72 and mean value ranged from 0.94 to 0.82. In combination level, the largest (1.04) was observed in the combination, No.8 × No.2, followed by No.1 × No.9 (0.98). The smallest (0.74) was noted in the combination, No.11 × No.6, followed by No.14 × No.11 (0.75). The differences in the value were confirmed to be large in accordance with the varieties in the respective combination-set.

In Table 8, the average value and the standard deviations in the ratio in the whole combinations are shown. In view of the female parent, the highest value in the parental average (0.91) was obtained in Nos.6 and 8, followed by No.9 (0.89). The lowest value in the parental average (0.80) was noted in No.16. The differences of the value were ascertained to be large in accordance with each parent. The relation between the values of average and standard deviations was not recognized clearly. In view of the male parent, the highest value in the parental average (0.87) was obtained in No.15, followed by No.10 (0.86). The lowest value in the parental average (0.83) was noted in No.6. The relation between values of average and standard deviations was not recognized clearly, either. The average and its standard deviations in the whole combinations were 0.85 ± 0.05.

To make clear the value in view of reciprocal combinations, correlation coefficient and linear regression of the ratio of female parent on male parent in the same strain were calculated, and are shown in Table 9. One strain showed significance at 1% level, but 15 strains showed no significance even at 5% level, respectively. In the whole strains, correlation coefficient was -0.0189 to the degree of freedom of 118, showing no significance even at 5% level. It was concluded that reciprocal differences in this study suggested no considerable cytoplasmic influence on the ratio.

The differences between the maximum and the minimum values of the ratio for each parent in view of the female parent were as follows in the order from No.1 to No. 16; 0.22, 0.09, 0.10, 0.08, 0.09, 0.13, 0.12, 0.23, 0.15, 0.13, 0.13, 0.08, 0.06, 0.10, 0.16 and 0.10, respectively. It may be noted that the values were peculiarly large in Nos.1 and 8. The average and its standard deviations were 0.12 ± 0.05. Those in view of the male parent were as follows in the same order; 0.17, 0.28, 0.15, 0.15, 0.15, 0.16, 0.17, 0.19, 0.21, 0.15, 0.20, 0.15, 0.14, 0.20, 0.17 and 0.12, respectively. It may be noted that the value was peculiarly large in No.2. Those average and its standard deviations were 0.17 ± 0.04. In reciprocal views, correlation coefficient between these was $+0.1760$, showing no significance even at 5% level.

To make clear the relations between Sikkimese rice and two testers, the differences in the value at the time when two testers were crossed with Sikkimese rice, and reciprocals were calculated. In view of the female parent, the differences in the

ratio for *indica* (No.1) and *japonica* (No.2) were as follows in the order from No.3 to No. 16, provided that the calculation was made only by the absolute value; 0.01, 0.05, 0.01, 0.04, 0.03, 0.08, 0.01, 0.01, 0.03, 0.00, 0.02, 0.04, 0.05 and 0.02, respectively. Average and its standard deviations in the whole Sikkimese rice were 0.03 ± 0.02. In view of the male parent, the differences in the value for *indica* and *japonica* were as follows in the same order; 0.00, 0.06, 0.02, 0.02, 0.02, 0.01, 0.17, 0.06, 0.08, 0.01, 0.02, 0.01, 0.03 and 0.04, respectively. It may be noted that the value was peculiarly large in No.9. Average and its standard deviations in the whole Sikkimese rice were 0.04 ± 0.04. In reciprocal views, correlation coefficient between these was -0.3200, showing no significance even at 5% level.

VI. Ratio of width to thickness

Parent; Comparative values of parental plants on ratio of width to thickness are shown in Table 1. The largest (1.06) was obtained in No.10, followed by Nos.3, 9 and 12 (1.00). The smallest (0.90) was noted in No.2, followed by Nos.6 and 11 (0.92). Average and its standard deviations in the whole strains were 0.97 ± 0.04.

Hybrid; The values among diallel crosses are shown in Table 11. A wide range was observed. The values for individual seed level ranged from 1.18 to 0.81 and the mean value ranged from 1.04 and 0.90. In combination level, the largest (1.15) was obtained in the combination, No.1 × No.9, which was the same as in case of the husked grain, followed by No.8 × No.2 (1.10) and No.6 × No.4 (1.08). The smallest (0.85) was noted in the combination, No.3 × No.1, followed by No.2 × No.3 and No.7 × No.4 (0.89). The differences in the value were confirmed to be large in accordance with the varieties in the respective combination-set.

In Table 8, the average value and the standard deviations in the ratio in the whole combinations are shown. In view of the female parent, the highest value in the parental average (1.01) was obtained in Nos.6, 8 and 9. The lowest value in the parental average (0.95) was noted in Nos.2, 11, 15 and 16. The differences of the value were ascertained to be large in accordance with each parent. The relation between the values of average and standard deviations was not recognized clearly. In view of the male parent, the highest value in the parental average (0.99) was obtained in Nos.7, 9 and 10. The lowest value in the parental average (0.96) was noted in Nos.6 and 8. The relation between values of average and standard deviations was not recognized clearly, either. The average and its standard deviations in the whole combinations were 0.98 ± 0.04.

To make clear the value in view of reciprocal combinations, correlation coefficient and linear regression of the ratio of female parent on male parent in the same strain were calculated, and are shown in Table 9. One strain showed significance at 5% level, but 15 strains showed no significance even at 5% level, respectively. In the whole strains, correlation coefficient was $+0.0648$ to the degree of freedom of 118, showing no significance even at 5% level. It was concluded that reciprocal differences in this study suggested no considerable cytoplasmic influence on the ratio.

The differences between the maximum and the minimum values of the ratio for each parent in view of the female parent were as follows in the order from No.1 to No.16; 0.22, 0.11, 0.19, 0.08, 0.07, 0.12, 0.15, 0.16, 0.12, 0.09, 0.12, 0.10, 0.07, 0.09, 0.17 and 0.08, respectively. The average and its standard deviations were 0.12 ± 0.04. Those in view of the male parent were as follows in the same order; 0.22, 0.17, 0.10, 0.19, 0.13,

Table 11. Comparative values on ratio of width to thickness of unhusked and husked grains of F_1 hybrids

♂ \ ♀	Code No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Code No.	1		0.93	0.96	0.99	0.98	0.94	0.94	0.94	1.15	1.01	0.93	0.96	0.95	1.00	0.93	0.95
	2	0.93		0.98	0.92	0.95	0.94	0.92	0.89	1.00	0.94	0.96	0.96	0.95	0.98	0.96	0.99
	3	0.85	0.97		0.98	0.99	1.04	0.99	0.97	0.96	0.99	0.98	0.97	0.94	0.99	0.97	0.97
	4	0.94	0.96	0.97		0.01	0.96	0.99	0.95	0.96	0.98	0.93	0.98	0.99	0.98	0.98	0.96
	5	1.00	0.99	0.96	1.02		0.96	1.01	0.98	0.97	0.98	0.95	0.98	0.97	0.98	1.00	0.98
	6	0.98	1.00	1.04	1.08	0.99		1.02	1.01	1.03	1.02	0.97	0.97	1.02	1.05	0.99	0.96
	7	1.00	0.96	1.01	0.89	0.99	1.01		1.02	1.04	1.02	1.01	0.96	1.02	1.00	0.98	1.04
	8	1.07	1.10	1.01	0.96	0.99	0.94	1.02		1.02	0.99	0.99	1.02	0.97	1.01	1.03	1.00
	9	1.05	1.01	0.98	1.02	1.00	0.98	1.02	1.01		1.01	1.07	1.02	1.02	1.02	0.96	0.95
	10	1.00	0.94	1.00	1.00	1.03	0.97	0.97	1.01	1.01		0.96	0.98	0.97	0.99	0.96	0.99
	11	0.97	0.96	0.94	0.95	0.90	0.95	0.98	0.94	0.95	1.02		0.97	0.93	0.93	0.94	0.96
	12	0.99	0.98	1.01	0.98	0.95	0.94	1.04	0.98	0.97	1.02	0.95		0.96	0.96	1.00	0.99
	13	1.00	0.93	0.98	0.97	0.99	0.98	0.97	0.95	0.95	0.99	0.94	1.00		0.96	0.97	1.00
	14	0.97	0.97	0.99	0.95	0.96	0.95	0.94	0.93	0.93	1.02	0.96	0.98	0.99		0.94	1.00
	15	0.93	0.96	0.96	0.95	0.91	0.95	1.00	0.94	0.90	0.93	1.07	0.94	0.90	0.90		0.99
	16	0.95	0.95	0.97	0.95	0.94	0.93	1.00	0.92	0.95	0.95	0.95	0.96	0.94	0.93	0.93	

0.10, 0.12, 0.13, 0.25, 0.09, 0.14, 0.08, 0.12, 0.15, 0.10 and 0.09, respectively. Those average and its standard deviations were 0.14 ± 0.05. In reciprocal views, correlation coefficient between these was +0.1862, showing no significance even at 5% level.

To make clear the relations between Sikkimese rice and two testers, the differences in the value at the time when two testers were crossed with Sikkimese rice, and reciprocals were calculated. In view of the female parent, the differences in the value for *indica* (No.1) and *japonica* (No.2) were as follows in the order from No.3 to No.16, provided that the calculation was made only by the absolute value; 0.12, 0.02, 0.01, 0.02, 0.04, 0.03, 0.04, 0.06, 0.01, 0.01, 0.07, 0.00, 0.03 and 0.00, respectively. Average and its standard deviations in the whole Sikkimese rice were 0.03 ± 0.03. In view of the male parent, the differences in the value for *indica* and *japonica* were as follows in the same order; 0.02, 0.07, 0.03, 0.00, 0.02, 0.05, 0.15, 0.07, 0.03, 0.00, 0.00, 0.02, 0.03 and 0.04, respectively. It may be noted that the value was peculiarly large in No.9, which was the same as in case of the husked grain. Average and its standard deviations in the whole Sikkimese rice were 0.04 ± 0.04. In reciprocal views, correlation coefficient between these was +0.3485, showing no significance even at 5% level.

Part II. Relation between the respective two characters

I. Length and width

Parent; Correlation coefficient of comparative values of width on length in parental plants was +0.3300 to the degree of freedom of 14, showing no significance even at 5% level.

Hybrid; Correlation coefficients of comparative values of width on length in the same strain were calculated, and are shown in Table 12. One, 2 and 5 strains showed significances at 0.1%, 1% and 5% levels, respectively, but 8 strains showed no significance even at 5% level. In the whole combinations, correlation coefficient was +0.3471 to the degree of freedom of 238, which was significant at 0.1% level. Generally speaking, the larger is the comparative value of width, the larger is the comparative value of length, too.

II. Length and thickness

Parent; Correlation coefficient of comparative values of thickness on length in parental plants was −0.4071 to the degree of freedom of 14, showing no significance even at 5% level.

Hybrid; Correlation coefficients of comparative values of thickness on length in the same strain were calculated, and are shown in Table 12. Three strains showed significances at 5% level, but 13 strains showed no significance even at 5% level, respectively. In the whole combinations, correlation coefficient was +0.1994 to the degree of freedom of 238, which was significant at 1% level. Generally speaking, the larger is the comparative value of thickness, the larger is the comparative value of length, too.

III. Width and thickness

Parent; Correlation coefficient of comparative values of thickness on width in parental plants was +0.0358 to the degree of freedom of 14, showing no significance

Table 12. Correlation coefficient and linear regression of the three components; I-comparative values of width (Y, O point=0.81) on length (X, O point=0.73), II-comparative values of thickness (Y, O point=0.83) on length (X, O point=0.73), III-comparative values of thickness (Y, O point=0.83) on width (X, O point=0.81), respectively

Code No.	I			II			III		
	Correlation coefficient	d.f.	Linear regression	Correlation coefficient	d.f.	Linear regression	Correlation coefficient	d.f.	Linear regression
1	0.3388	28	—	0.1116	28	—	0.3888*	28	Y=0.292X+1.039
2	0.3005	28	—	0.0503	28	—	0.6872***	28	Y=0.559X+0.973
3	0.4373*	28	Y=1.122X+4.080	0.4247*	28	Y=0.608X+2.467	0.6870***	28	Y=0.384X+0.725
4	0.2024	28	—	0.1379	28	—	0.3746*	28	Y=0.219X+1.686
5	0.5069**	28	Y=0.722X+2.592	0.3182	28	—	0.5347**	28	Y=0.431X+0.479
6	0.2254	28	—	0.0239	28	—	0.8501***	28	Y=0.609X−0.090
7	0.3782*	28	Y=0.826X+1.362	0.4109*	28	Y=0.612X+0.969	0.7759***	28	Y=0.534X−0.170
8	0.6125***	28	Y=1.021X+1.073	0.4526*	28	Y=0.621X+0.486	0.8709***	28	Y=0.716X−0.249
9	0.3290	28	—	0.1316	28	—	0.7863***	28	Y=0.652X−0.832
10	0.5510**	28	Y=1.006X+4.134	0.2158	28	—	0.7268***	28	Y=0.423X+0.154
11	−0.0569	28	—	0.0865	28	—	0.7172***	28	Y=0.672X+0.498
12	0.2470	28	—	0.0958	28	—	0.8283***	28	Y=0.538X+0.307
13	0.4558*	28	Y=0.639X+4.174	0.2903	28	—	0.6409***	28	Y=0.404X+1.018
14	0.3680*	28	Y=0.613X+4.160	0.1673	28	—	0.5816***	28	Y=0.408X+0.812
15	0.4297*	28	Y=0.586X+1.319	0.1560	28	—	0.6258***	28	Y=0.508X+1.244
16	0.0000	28	—	0.1987	28	—	0.5564**	28	Y=0.447X+1.023
Whole	0.3471***	238	Y=0.569X+2.018	0.1994**	238	Y=0.244X+1.465	0.7427***	238	Y=0.554X+0.296

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

Table 13. Correlation coefficient and linear regression of the three components; IV–comparative values of ratio of length to thickness (Y, O point=0.88) on ratio of length to width (X, O point=0.88), V–comparative values of ratio of width to thickness (Y, O point=0.99) on ratio of length to width (X, O point=0.88), VI–comparative values of ratio of width to thickness (Y, O point=0.99) on ratio of length to thickness (X, O point=0.88), respectively

Code No.	IV			V			VI		
	Correlation coefficient	d.f.	Linear regression	Correlation coefficient	d.f.	Linear regression	Correlation coefficient	d.f.	Linear regression
1	0.5002**	28	Y=0.558X−0.575	0.0573	28	—	0.8204***	28	Y=0.894X+1.095
2	0.8036***	28	Y=0.692X−0.926	0.3235	28	—	0.7794***	28	Y=0.540X+0.193
3	0.7970***	28	Y=0.519X−0.622	0.1727	28	—	0.5082**	28	Y=0.478X+0.476
4	0.6693***	28	Y=0.351X−1.174	−0.0614	28	—	0.4537*	28	Y=0.561X+0.059
5	0.8213***	28	Y=0.570X−0.720	0.1389	28	—	0.6769***	28	Y=0.519X+0.119
6	0.8337***	28	Y=0.650X−0.615	0.3173	28	—	0.5911***	28	Y=0.377X+0.193
7	0.7837***	28	Y=0.527X−0.122	0.2313	28	—	0.6398***	28	Y=0.506X+0.602
8	0.8842***	28	Y=0.789X−0.498	0.5575**	28	Y=0.349X−0.279	0.8664***	28	Y=0.607X−0.041
9	0.6190***	28	Y=0.619X+0.204	0.2626	28	—	0.8542***	28	Y=0.701X+0.717
10	0.6956***	28	Y=0.413X−0.318	0.0856	28	—	0.6626***	28	Y=0.476X+0.818
11	0.6699***	28	Y=0.481X−1.326	0.0634	28	—	0.6627***	28	Y=0.443X−0.037
12	0.5724***	28	Y=0.362X−2.007	0.2069	28	—	0.7453***	28	Y=0.437X+0.763
13	0.8503***	28	Y=0.508X−0.895	0.0182	28	—	0.7827***	28	Y=0.845X+1.148
14	0.6805***	28	Y=0.478X−1.074	0.1130	28	—	0.6840***	28	Y=0.549X+0.548
15	0.6878***	28	Y=0.520X−1.604	0.1537	28	—	0.6577***	28	Y=0.533X−0.467
16	0.5838***	28	Y=0.371X−1.482	0.0014	28	—	0.7154***	28	Y=0.581X+0.439
Whole	0.7464***	238	Y=0.555X−0.713	0.1912**	238	Y=0.110X−0.281	0.7148***	238	Y=0.553X+0.378

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

even at 5% level.

Hybrid; Correlation coefficients of comparative values of thickness on width in the same strain were calculated, and are shown in Table 12. Twelve, 2, and 2 strains showed significances at 0.1%, 1% and 5% levels, respectively. In the whole combinations, correlation coefficient was +0.7427 to the degree of freedom of 238, which was obviously significant at 0.1% level. Generally speaking, the larger is the comparative value of thickness, the larger is the comparative value of width, too.

IV. Ratio of length to width and ratio of length to thickness

Parent; Correlation coefficient of comparative values of ratio of length to thickness (abbreviated as R · L/T) on comparative values of ratio of length to width (R · L/W) in the parental plants was +0.3556 to the degree of freedom of 14, showing no significance even at 5% level.

Hybrid; Correlation coefficients of comparative value of R · L/T on comparative value of R · L/W in the same strain were calculated, and are shown in Table 13. Fifteen and 1 strain showed significances at 0.1% and 1% levels, respectively. In the whole strains, correlation coefficient was +0.7464 to the degree of freedom of 238, which was obviously significant at 0.1% level. Generally speaking, the larger is the comparative value of R · L/W, the larger is the comparative value of R · L/T, too.

V. Ratio of length to width and ratio of width to thickness

Parent; Correlation coefficient of comparative values of ratio of width to thickness (R · W/T) on comparative values of R · L/W in parental plants was −0.1051 to the degree of freedom of 14, showing no significance even at 5% level.

Hybrid; Correlation coefficients of comparative value of R · W/T on comparative value of R · L/W in the same strain were calculated, and are shown in Table 13. One strain showed significance at 1% level, but 15 strains showed no significance even at 5% level, respectively. In the whole strains, correlation coefficient was +0.1912 to the degree of freedom of 238, which was significant at 1% level. Generally speaking, the larger is the comparative value of R · W/T, the larger is the comparative value of R · L/W, too.

VI. Ratio of length to thickness and ratio of width to thickness

Parent; Correlation coefficient of comparative values of R · W/T on comparative values of R · L/T in parental plants was +0.7038 to the degree of freedom of 14, which was significant at 1% level. Generally speaking, the larger is the comparative value of R · W/T, the larger is the comparative value of R · L/T, too. Linear regression of those of R · L/T on R · W/T was calculated as follows; $Y=0.720X-0.883$, where Y and X indicate comparative values of R · L/T and R · W/T, respectively. This formula indicates that the former becomes 0.720 larger, by becoming 1 degree larger the latter (O points, 0.98 in the former and 0.84 in the latter, respectively).

Hybrid; Correlation coefficients of comparative value of R · W/T on comparative value of R · L/T in the same strain were calculated, and are shown in Table 13. Fourteen, 1 and 1 strain showed significances at 0.1%, 1% and 5% levels, respectively. In the whole strains, correlation coefficient was +0.7148 to the degree of freedom of 238, which was obviously significant at 0.1% level. Generally speaking, the

larger is the comparative value of R · W/T, the larger is the comparative value of R · L/T, too.

Part III. Comparison of the practical values of unhusked and husked grains

I. Length

Parent; Correlation coefficient of length of husked on unhusked grains in parental plants was +0.9779 to the degree of freedom of 14, which was obviously significant at 0.1% level. Generally speaking, the longer is the length of unhusked grain, the longer is the length of husked grain. Linear regression of length of husked on unhusked grains was calculated as follows; $Y=0.964X+0.484$, where Y and X indicate lengths of unhusked and husked grains, respectively. This formula indicates that the length of unhusked grain becomes 0.964 *mm* longer, by becoming 1 unit longer the length of husked grain.

Hybrid; Correlation coefficient and linear regression of length of husked grain on length of unhusked grain in the same strain were calculated, and are shown in Table 14. The whole strains showed significances at 0.1% level. In the whole combinations, correlation coefficient was +0.6167 to the degree of freedom of 238, which was significant at 0.1% level. Generally speaking, the longer is the length of unhusked grain, the longer is the length of husked grain, too.

II. Width

Parent; Correlation coefficient of width of husked on unhusked grains in parental plants was +0.8426 to the degree of freedom of 14, which was obviously significant at 0.1% level. Generally speaking, the wider is the width of unhusked grain, the wider is the width of husked grain. Linear regression of width of husked on unhusked grains was calculated as follows; $Y=0.784X+0.243$, where Y and X indicate widths of unhusked and husked grains, respectively. This formula indicates that the width of unhusked grain becomes 0.784 *mm* wider, by becoming 1 unit wider the width of husked grain.

Hybrid; Correlation coefficient and linear regression of width of husked grain on width of unhusked grain in the same strain were calculated, and are shown in Table 14. Twelve, 3 and 1 strain showed significances at 0.1%, 1% and 5% levels, respectively. In the whole combinations, correlation coefficient was +0.7365 to the degree of freedom of 238, which was significant at 0.1% level. Generally speaking, the wider is the width of unhusked grain, the wider is the width of husked grain, too.

III. Thickness

Parent; Correlation coefficient of thickness of husked on unhusked grains in parental plants was +0.8595 to the degree of freedom of 14, which was obviously significant at 0.1% level. Generally speaking, the thicker is the thickness of unhusked grain, the thicker is the thickness of husked grain, too. Linear regression of thickness of husked grain on unhusked grain was calculated as follows; $Y=0.703X-1.392$, where Y and X indicate thicknesses of unhusked and husked grains, respectively. This formula indicates

Table 14. Correlation coefficient and linear regression of three characters of unhusked (Y) on husked (X) grains; length, width and thickness. O points, 8.30 *mm*, 3.23 *mm* and 2.18 *mm* (unhusked), 5.88 *mm*, 2.58 *mm* and 1.77 *mm* (husked) in length, width and thickness, respectively

Code No.	Length			Width			Thickness		
	Correlation coefficient	d.f.	Linear regression	Correlation coefficient	d.f.	Linear regression	Correlation coefficient	d.f.	Linear regression
1	0.9392***	28	Y=0.898X−0.002	0.6563***	28	Y=0.613X+2.265	0.5288**	28	Y=0.616X+1.812
2	0.7847***	28	Y=0.722X−0.884	0.5418**	28	Y=0.354X+3.258	0.4192*	28	Y=0.466X+3.520
3	0.9417***	28	Y=0.883X+0.321	0.5949***	28	Y=0.472X+2.643	0.5779***	28	Y=0.656X+2.872
4	0.8985***	28	Y=0.857X+1.300	0.5535**	28	Y=0.319X+2.763	0.7382***	28	Y=0.762X+2.302
5	0.9068***	28	Y=0.947X+1.288	0.7396***	28	Y=0.452X+2.388	0.7130***	28	Y=0.547X+1.443
6	0.9229***	28	Y=0.880X+0.732	0.7260***	28	Y=0.442X+2.277	0.6575***	28	Y=0.354X+0.803
7	0.9211***	28	Y=1.023X+0.862	0.5613**	28	Y=0.308X+2.076	0.7735***	28	Y=0.678X+1.412
8	0.6589***	28	Y=0.488X−0.297	0.4106*	28	Y=0.179X+0.878	0.3895*	28	Y=0.185X+0.056
9	0.9475***	28	Y=0.790X−0.099	0.7086***	28	Y=0.465X+2.862	0.4991**	28	Y=0.381X+2.661
10	0.9633***	28	Y=0.939X+1.072	0.7451***	28	Y=0.649X+3.197	0.6145***	28	Y=0.764X+2.566
11	0.8765***	28	Y=0.864X+0.261	0.6732***	28	Y=0.475X+1.487	0.4173*	28	Y=0.258X−0.050
12	0.9018***	28	Y=0.880X+0.384	0.6604***	28	Y=0.454X+2.852	0.6297***	28	Y=0.611X+2.061
13	0.9425***	28	Y=0.875X+0.442	0.7720***	28	Y=0.661X+3.235	0.6429***	28	Y=0.656X+3.228
14	0.9574***	28	Y=0.879X+0.182	0.7834***	28	Y=1.038X+2.153	0.7971***	28	Y=1.002X+3.735
15	0.9296***	28	Y=0.799X+0.942	0.7372***	28	Y=0.606X+0.388	0.3784*	28	Y=0.242X+0.643
16	0.9116***	28	Y=0.881X+0.334	0.6878***	28	Y=0.633X+2.922	0.6745***	28	Y=0.831X+3.351
Whole	0.6167***	238	Y=0.370X−1.429	0.7365***	238	Y=0.567X+0.323	0.5930***	238	Y=0.555X+1.985

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

Table 15. Ratio of length to width of the parental plants in relation to unhusked and husked grains. Figure used in the table shows the number of strains.

Husked	Unhusked										Total
	3.60 ≀ 3.51	2.80 ≀ 2.71	2.70 ≀ 2.61	2.60 ≀ 2.51	2.50 ≀ 2.41	2.40 ≀ 2.31	2.30 ≀ 2.21	2.20 ≀ 2.11	2.10 ≀ 2.01	2.00 ≀ 1.91	
3.20～3.11	1										1
.											.
2.40～2.31		2									2
2.30～2.21			1								1
2.20～2.11				1							1
2.10～2.01					1	2					3
2.00～1.91								1			1
1.90～1.81							1	1	1		3
1.80～1.71									2	1	3
1.70～1.61									1		1
Total	1	2	1	1	1	2	1	2	4	1	16

$r = +0.9850^{***}$ (d.f. = 14), significant at 0.1% level.

that the thickness of unhusked grain becomes 0.703 *mm* thicker, by becoming 1 unit thicker the thickness of husked grain.

Hybrid; Correlation coefficient and linear regression of thickness of husked grain on thickness of unhusked grain in the same strain were calculated, and are shown in Table 14. Ten, 2 and 4 strains showed significances at 0.1%, 1% and 5% levels, respectively. In the whole combinations, correlation coefficient was +0.5930 to the degree of freedom of 238, which was significant at 0.1% level. Generally speaking, the thicker is the thickness of unhusked grain, the thicker is the thickness of husked grain, too.

IV. Ratio of length to width

Parent; Correlation coefficient of ratio of length to width (abbreviated as R·L/W) of husked on unhusked grains in the parental plants was +0.9850 to the degree of freedom of 14, which was obviously significant at 0.1% level (Table 15). Generally speaking, the larger is R·L/W of unhusked grain, the larger is R·L/W of husked grain, too. Linear regression of R·L/W of husked on unhusked grains was calculated as follows; $Y = 0.882X + 0.253$, where Y and X indicate R·L/W of unhusked and husked grains, respectively. This formula indicates that the R·L/W of unhusked grain becomes 0.882 larger, by becoming 1 unit larger R·L/W of husked grain.

Hybrid; Correlation coefficient and linear regression of R·L/W of husked grain on R·L/W of unhusked grain in the same strain were calculated, and are shown in Table 16. The whole strains showed significances at 0.1% level. In the whole combinations, correlation coefficient was +0.9197 to the degree of freedom of 238, which was obviously significant at 0.1% level (Table 17). Generally speaking, the larger is R·L/W of unhusked grain, the larger is R·L/W of husked grain.

Table 16. Correlation coefficient and linear regression of three characters of unhusked (Y) on husked (X) grains; ratio of length to width (R · L/W), ratio of length to thickness (R·L/T) and ratio of width to thickness (R·W/T). O points, 2.76, 3.88 and 1.53 (unhusked), 2.36, 3.26 and 1.54 (husked) in R·L/W, R·L/T and R·W/T, respectively

Code No.	Length/Width			Length/Thickness			Width/Thickness		
	Correlation coefficient	d.f.	Linear regression	Correlation coefficient	d.f.	Linear regression	Correlation coefficient	d.f.	Linear regression
1	0.9316***	28	Y=0.892X+0.176	0.8282***	28	Y=1.010X−0.377	0.3338	28	—
2	0.6481***	28	Y=0.476X−1.989	0.8196***	28	Y=0.969X−0.977	0.4282*	28	Y=0.809X−2.341
3	0.7576***	28	Y=0.602X−1.383	0.8865***	28	Y=1.091X−0.170	0.4700**	28	Y=0.625X−1.733
4	0.9035***	28	Y=0.952X+0.890	0.8965***	28	Y=1.042X+0.507	0.5904***	28	Y=0.451X−1.045
5	0.9427***	28	Y=0.727X+0.009	0.8973***	28	Y=0.951X+0.577	0.6273***	28	Y=0.668X−1.246
6	0.9492***	28	Y=0.805X+0.613	0.7673***	28	Y=0.801X+0.661	0.6302***	28	Y=0.554X−0.765
7	0.8581***	28	Y=0.784X+0.043	0 7935***	28	Y=0.948X−0.133	0.6668***	28	Y=0.393X−1.564
8	0.8184***	28	Y=0.607X−0.039	0.6584***	28	Y=0.562X+0.292	0.5599**	28	Y=0.378X−1.691
9	0.8547***	28	Y=0.831X+0.174	0.9334***	28	Y=0.884X−0.225	0.6544***	28	Y=0.766X−0.425
10	0.9591***	28	Y=0.921X+0.384	0.7405***	28	Y=0.924X−0.393	0.6872***	28	Y=0.921X−0.823
11	0.8401***	28	Y=0.770X−0.088	0.4840**	28	Y=0.610X−0.039	0.6627***	28	Y=0.467X−1.822
12	0.9029***	28	Y=0.809X−0.222	0.8740***	28	Y=1.008X−0.018	0.6882***	28	Y=0.607X−1.366
13	0.9676***	28	Y=0.922X+0.388	0.9685***	28	Y=1.082X−0.534	0.6634***	28	Y=0.748X−1.866
14	0.8477***	28	Y=0.738X−0.687	0.9204***	28	Y=1.054X−0.734	0.8028***	28	Y=0.645X−1.730
15	0.9549***	28	Y=0.802X+0.819	0.8838***	28	Y=0.895X+1.308	0.7061***	28	Y=0.540X−3.270
16	0.9165***	28	Y=0.931X+0.375	0.8668***	28	Y=1.184X−0.339	0.7344***	28	Y=0.600X−2.207
Whole	0.9197***	238	Y=0.865X+0.326	0.8511***	238	Y=1.013X+0.031	0.5669***	238	Y=0.518X−1.559

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

Table 17. Ratio of length to width of the F_1 hybrids in relation to unhusked and husked grains. Figure used in the table shows the number of combinations.

Husked	Unhusked																		Total
	3.70 ≀ 3.61	3.60 ≀ 3.51	3.50 ≀ 3.41	3.40 ≀ 3.31	3.30 ≀ 3.21	3.20 ≀ 3.11	3.10 ≀ 3.01	3.00 ≀ 2.91	2.90 ≀ 2.81	2.80 ≀ 2.71	2.70 ≀ 2.61	2.60 ≀ 2.51	2.50 ≀ 2.41	2.40 ≀ 2.31	2.30 ≀ 2.21	2.20 ≀ 2.11	2.10 ≀ 2.01	2.00 ≀ 1.91	
3.20～3.11	1		1																2
3.10～3.01		1	1																2
3.00～2.91				1															1
2.90～2.81			1																1
2.80～2.71																			0
2.70～2.61						1													1
2.60～2.51										3									3
2.50～2.41									2	1	1	1							5
2.40～2.31										4	4	1	1						10
2.30～2.21										1	4	4	3	2					14
2.20～2.11											1	12	11	8	1				33
2.10～2.01												1	14	21	10	1			47
2.00～1.91														9	15	9	2		35
1.90～1.81															13	20	6		39
1.80～1.71																13	14	9	36
1.70～1.61																	4	7	11
Total	1	1	3	1	0	1	0	0	2	9	10	19	29	40	39	43	26	16	240

$r = +0.9197^{***}$ (d.f. = 238), significant at 0.1% level.

V. Ratio of length to thickness

Parent; Correlation coefficient of ratio of length to thickness (abbreviated as R·L/T) of husked on unhusked grains in the parental plants was +0.9356 to the degree of freedom of 14, which was obviously significant at 0.1% level. Generally speaking, the larger is R·L/T of unhusked grain, the larger is R·L/T of husked grain. Linear regression of R·L/T of husked on unhusked grains was calculated as follows; $Y=0.804X+0.436$, where Y and X indicate R·L/T of unhusked and husked grains, respectively. This formula indicates that R·L/T of unhusked grain becomes 0.804 larger, by becoming 1 unit larger R·L/T of husked grain.

Hybrid; Correlation coefficient and linear regression of R·L/T of husked grain on R·L/T of unhusked grain in the same strain were calculated, and are shown in Table 16. Fifteen and 1 strain showed significances at 0.1% and 1% levels, respectively. In the whole combinations, correlation coefficient was +0.8511 to the degree of freedom of 238, which was obviously significant at 0.1% level. Generally speaking, the larger is R·L/T of unhusked grain, the larger is R·L/T of husked grain.

VI. Ratio of width to thickness

Parent; Correlation coefficient of ratio of width to thickness (abbreviated as R·W/T) of husked on unhusked grains in the parental plants was +0.7485 to the degree of freedom of 14, which was obviously significant at 0.1% level. Generally speaking, the larger is R·W/T of unhusked grain, the larger is R·W/T of husked grain. Linear regression of R·W/T of husked on unhusked grains was calculated as follows; $Y=0.631X+1.802$, where Y and X indicate R·W/T of unhusked and husked grains, respectively. This formula indicates that R·W/T of unhusked grain becomes 0.631 larger, by becoming 1 unit larger R·W/T of husked grain.

Hybrid; Correlation coefficient and linear regression of R·W/T of husked grain on R·W/T of unhusked grain in the same strain were calculated, and are shown in Table 16. Twelve, 2 and 1 strain showed significances at 0.1%, 1% and 5% levels, respectively, but 1 strain showed no significance even at 5% level. In the whole combinations, correlation coefficient was +0.5669 to the degree of freedom of 238, which was significant at 0.1% level. Generally speaking, the larger is R·W/T of unhusked grain, the larger is R·W/T of husked grain.

Discussion

Basing on the results obtained in this experiment, the following problems are to be discussed here.

i) The average value of hybrid in the parental level were sometimes larger than those of the respective parent for several characters (Tables 1, 3 and 8). On the other hand, in view of the standard deviations, it did not necessarily follow that the values of the parental level were larger than those of the respective parent. At this point, the considerations on hybrid vigor or heterosis may as well be borne in mind. Richharia *et al.*[12] found substantial heterosis in height and tillering of F_1 hybrids of rice by comparing them with mid-parental values. Typical varietal representatives of the two distantly related variety-groups of rice in combination are expected to show considerable hybrid vigor. Superiority of F_1 hybrids was estimated on the basis of heterosis,

which was illustrated by the mean increase of F_1 hybrids over the mid-parental value of parents[10]. The strains used in the present study may be included in this category. For example, in case of No.1 in view of thickness, the average values in parental level were indicated to be 0.84, 0.86 and 0.86 in pure line, averages for female and male parents, respectively (Tables 1 and 3). In combination level, the values were 0.84, 0.86, 0.88 and 0.92 in No.1, No.2, No.1 (♀)×No.2 (♂) and No.2 (♀)×No.1 (♂), respectively (Tables 1 and 6). These considerations were ascertained in the several characters calculated in the present experiment.

ii) From the data of reciprocal relations, it was clearly ascertained that some sets of combinations were always observed to have been constantly disordered from the standard pattern to be set in exceptional regions for several characters. These tendencies were found in several combinations, for example, No.8×No.2, No.8×No.13, and in others.

In reciprocal views, it may be noticeable that No.8 showed significances in 4 characters and Nos.13 and 14 showed significances in only 1 character each, respectively (Tables 4 and 9). These characters may be used for hetero- or homozygosis in each strain. In the whole combinations, any significant relations were not found at all. In spite of the negative correlations found in the reciprocal comparisons, no significant difference was shown through the whole combinations. So, it was concluded that the reciprocal differences suggested no considerable cytoplasmic inheritance reported in this experiment.

iii) Six relations among the respective characters were analyzed, basing on correlation coefficient. In view of parental plants, only one case showed significance. In view of the whole combinations, the whole cases showed significances. One, 2 5 and 8 strains showed significant correlations in 6, 5, 4 and 3 relations between the two characters, respectively (Tables 12 and 13). It was noticeable that 3 relations, *i.e.*, the ones between length and thickness, between ratio of length to thickness and ratio of length to width, between ratio of width to thickness and ratio of length to thickness, showed significances in the whole strains. It may be a peculiar phenomenon that No. 8, Addey variety, showed significant correlations through all cases both in the respective character and in the comparative character.

In comparing the parental pure line and parental average in hybrid combinations, at the time when some strain was crossed with alien strains, it was ascertained that correlation coefficients were sometimes different in the former and in the latter. In view of each set of combination, it was noticeable that some sets of combinations, *i.e.*, No. 6×No.15, No.9×No.2, were found to have been disordered from the standard pattern to be set in the exceptional regions for several characters. The strains, in which some sets of combinations showed such tendency, showed, in general, no significance in strain level. These findings propose an interesting problem for strain or variety specificities.

iv) In comparisons of the practical values of unhusked and husked grains for six characters, the parental plants for the whole cases and hybrid combinations for most cases showed significances. It means that strains used here are noted to show a synchrony to intra-plant variance with strain. Such tendency was denoted for ear-emergence[11].

v) Chou[2] held that China is one of the primary centres of the origin and that the differentiation of the *japonica* varieties took place in China. On the other hand, other

scientists held that Sikkim might be one of the differentiation centres of *O. sativa* into *japonica* and *indica*, judging from diallel crosses using several strains collected in Sikkim and other countries[4]. Since two countries mentioned above are closely located, further experiments should be practiced.

Summary

Succeeding to the previous papers, diallel cross experiments were made, using 14 strains of Sikkimese rice varieties and one type of *indica* and another type of *japonica*. In this report, the comparative values of unhusked and husked grains on six morphological characters, *i.e.*, length, width, thickness, ratio of length to width, ratio of length to thickness, and ratio of width to thickness, and the mutual relationships were described. The main results obtained during this study were summarized as follows:

1) The comparative values of length of parental plants and F_1 hybrids were both 0.72 in average. In view of the reciprocal combinations, 2 strains showed positive significances. The comparative values of width of parental plants and F_1 hybrids were both 0.83 in average. In view of reciprocal combinations, 1 strain showed positive significance. Thecomparative values of thickness of parental plants and F_1 hybrids were both 0.86 in average. In view of reciprocal combinations, the whole strains showed no significance. The comparative values of L/W of parental plants and F_1 hybrids were 0.86 and 0.87 in average, respectively. In view of reciprocal combinations, 1 strain showed negative significance. The comparative values of L/T of parental plants and F_1 hybrids were 0.84 and 0.85 in average, respectively. In view of reciprocal combinations, 1 strain showed negative significance. The comparative values of W/T of parental plants and F_1 hybrids were 0.97 and 0.98 in average, respectively. In view of reciprocal combinations, 1 strain showed negative significance.

2) The differences of the respective characters in the parental and combination levels were ascertained to get larger in accordance with the variety of each parent. In view of reciprocal comparisons in the whole characters, it was concluded that the reciprocal differences suggested no considerable cytoplasmic influence on the six characters measured here. Substantial heteroses in several cases of F_1 hybrids compared with mid-parental values were ascertained.

3) Six relations between the respective two characters were analyzed and showed the following results. In view of parental plants, only 1 case, *i.e.*, the relation between L/T and W/T, showed positive significance at 1% level. In view of the whole cross combinations, 4 and 2 cases showed positive significances at 0.1% and 1% levels, respectively.

4) In comparison of the practical values of unhusked and husked grains for six characters, the followings were denoted. In view of parental plants, the whole cases showed positive significances at 0.1% level. In view of the hybrid combinations, 15 strains and the whole combinations showed positive significances in case of the ratio of width to thickness. The all strains and the whole combinations showed positive significances in the remaining 5 characters, *i.e.*, length, width, thickness, ratio of length to width and ratio of length to thickness.

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