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

IV. Unhusked Grains

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Introduction

Many reports were already published on classification of rice varieties (Kato *et al.* [5] and others). However, the idea of dividing rice varieties into geographical races is of much complexities [3].

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, that is, 14 strains belonging to Sikkimese rice, 1 belonging to the type of *indica* and another to the type of *japonica*. In the previous papers [3, 4], crossability, pollen and seed fertilities, some morphological characters of plant and some relations among them were reported. In the present report, morphological characters of unhusked grains, and some relations among them were mainly described. Other characters, including morphological characters of husked grains, comparative studies of unhusked and husked grains, were measured and going to be published in the papers following hereafter.

Material and Method

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

The plants were subjected to natural day length during the experiment. The whole data referring to the seven characters were illustrated by the average values in the whole seeds used in the respective strain and the hybrid combinations. Measurements were done for length, width and thickness of unhusked grains and awn length. Twenty grains were used for the measurement for each strain or combination. The measurements were done at the largest position of the respective character. Calculation, moreover, were done for the ratios of length to width, of length to thickness and of width to thickness. To make clear the reciprocal relations, the correlation coefficient and linear

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

Results

PART I. Respective character

I. Length

Parent; Length of parental plants is shown in Table 1. The longest (10.16*mm*) was obtained in No. 15, followed by No. 5 (8.33*mm*) and No. 11 (8.03*mm*). The shortest (6.67*mm*) was noted in No. 16, followed by No. 14 (6.69*mm*) and No. 2 (6.78*mm*). Average and standard deviations in the whole strains were found to be 7.55±0.72.

Table 1. Materials used in the diallel cross experiment, variety name, origin, seven characters of unhusked grain.

Code No.	Strain	Origin	Variety	Length (*mm*)	Width (*mm*)	Thickness (*mm*)	L/W	L/T	W/T	Awn (*mm*)
1	108	Formosa	*Indica*	7.48	3.11	2.02	2.40	3.70	1.54	—
2	563	Japan	*Japonica*	6.78	3.42	1.91	1.98	3.55	1.79	47.8
3	C7707	Sikkim	Addey	7.10	3.20	2.06	2.22	3.45	1.55	—
4	C7716	〃	Lama	7.95	3.17	1.96	2.51	4.06	1.62	—
5	C7717	〃	Lama	8.33	3.19	2.15	2.61	3.87	1.48	—
6	C7718	〃	Tokmor Zo	7.94	3.32	1.96	2.39	4.05	1.69	—
7	C7719	〃	Tokmor Zo	6.88	3.28	2.17	2.10	3.17	1.51	10.9
8	C7722	〃	Addey	7.93	2.91	1.89	2.73	4.20	1.54	18.8
9	C7725	〃	Addey	7.18	3.43	2.15	2.09	3.34	1.60	—
10	C7727	〃	Addey	7.09	3.22	2.07	2.20	3.43	1.56	—
11	C7729	〃	Addey	8.03	2.91	1.83	2.76	4.39	1.59	24.7
12	C7732	〃	Tapachini	7.63	3.08	2.10	2.47	3.63	1.47	—
13	C7734	〃	Fudangay	6.97	3.35	2.21	2.08	3.15	1.52	8.4
14	C7735	〃	Fudangay	6.69	3.33	2.13	2.01	3.14	1.56	19.8
15	C7754	〃	Champasari	10.16	2.89	2.09	3.51	4.86	1.38	8.5
16	C7757	〃	Addey	6.67	3.11	2.03	2.15	3.29	1.53	—

Hybrid; The values of length among diallel crosses are shown in Table 2. A wide range was observed. Length for individual seed level ranged from 11.0*mm* to 6.0*mm* and mean length ranged from 9*mm* to 7*mm*. In the combination level, the longest (10.20*mm*) was obtained in the combination, No. 15 (♀)×No. 6 (♂), followed by No. 15 ×No. 14 (10.15*mm*) and No. 15×No. 9 (10.03*mm*). The shortest (6.53*mm*) was noted in the combination, No. 14×No. 16, followed by No. 3×No. 14 and No. 9×No. 14 (6.57 *mm*). The differences in length were confirmed to be very large in accordance with each set of combination.

Table 2. Length of unhusked grains of F_1 hybrids in *mm*.

♀ \ ♂	Code No.															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1		7.57	7.32	7.69	7.67	8.00	6.98	7.72	7.15	7.33	7.96	7.38	7.09	6.98	8.59	7.09
2	7.10		7.25	8.04	7.78	7.88	7.14	7.88	6.85	7.36	7.95	7.29	6.87	7.03	8.21	6.98
3	7.21	7.02		6.85	7.49	7.54	6.66	7.79	7.23	7.16	7.19	7.12	6.76	6.57	8.43	6.93
4	8.03	7.04	7.72		7.85	7.88	7.29	7.89	7.34	7.66	8.10	7.63	7.27	6.83	8.83	7.45
5	8.25	7.57	7.52	7.77		7.87	7.31	8.08	7.31	8.03	8.21	7.52	7.45	7.42	8.35	7.28
6	7.60	7.97	7.96	8.03	7.79		7.52	8.14	7.76	7.90	8.30	7.84	7.62	7.08	9.01	7.39
7	7.14	7.02	6.91	7.42	7.43	7.18		7.79	6.90	6.71	7.59	7.37	6.93	6.97	7.94	6.69
8	7.76	7.36	7.99	7.64	7.13	7.58	7.86		8.04	7.87	8.24	7.89	6.88	7.37	8.92	7.86
9	7.54	7.21	6.91	7.54	7.79	7.83	7.00	7.27		7.25	8.12	7.17	6.80	6.57	7.74	6.88
10	7.17	6.90	6.88	7.72	7.41	7.72	6.76	7.64	7.19		6.77	7.30	6.78	6.73	8.00	6.77
11	7.86	7.71	7.97	8.26	8.08	8.05	7.66	8.24	8.01	7.72		8.03	7.68	7.64	8.34	7.55
12	7.61	7.36	7.23	7.82	8.34	8.04	7.17	7.67	7.42	7.60	8.14		7.67	7.34	8.62	7.41
13	6.81	6.93	6.72	7.32	7.03	7.51	6.85	7.55	7.03	6.93	7.57	7.34		6.69	7.98	6.78
14	6.98	7.02	6.60	7.06	7.14	7.40	6.65	7.63	6.80	6.61	7.54	7.11	6.73		7.93	6.53
15	8.13	8.34	8.07	8.74	9.51	10.20	7.72	8.60	10.03	9.79	9.22	8.51	9.75	10.15		8.29
16	6.95	7.23	6.87	7.34	8.03	7.49	6.74	7.63	6.81	6.95	7.29	7.02	6.73	6.70	7.77	

Code No.

Table 3. Averages and standard deviations of three characters in female and male parental levels; length (*mm*), width (*mm*), thickness (*mm*) of unhusked grain.

Code No.	Length (*mm*)		Width (*mm*)		Thickness (*mm*)	
	Female	Male	Female	Male	Female	Male
1	7.50±0.44	7.48±0.45	3.27±0.11	3.25±0.14	2.08±0.08	2.12±0.15
2	7.44±0.45	7.35±0.40	3.37±0.09	3.40±0.16	2.16±0.10	2.21±0.15
3	7.20±0.46	7.33±0.49	3.22±0.11	3.27±0.18	2.14±0.09	2.16±0.16
4	7.65±0.47	7.68±0.46	3.21±0.06	3.22±0.12	2.02±0.07	2.05±0.12
5	7.73±0.36	7.77±0.93	3.21±0.09	3.22±0.21	2.08±0.06	2.08±0.15
6	7.86±0.43	7.88±0.67	3.46±0.15	3.25±0.21	2.23±0.15	2.06±0.14
7	7.20±0.37	7.15±0.39	3.45±0.08	3.23±0.16	2.32±0.11	2.12±0.15
8	7.76±0.47	7.83±0.31	3.26±0.18	3.17±0.14	2.21±0.18	2.07±0.14
9	7.31±0.43	7.46±0.79	3.45±0.17	3.29±0.18	2.35±0.17	2.16±0.13
10	7.18±0.41	7.53±0.74	3.21±0.11	3.30±0.17	2.08±0.11	2.16±0.11
11	7.92±0.24	7.88±0.56	3.07±0.07	3.20±0.15	1.97±0.06	2.07±0.16
12	7.63±0.38	7.50±0.40	3.18±0.11	3.28±0.14	2.05±0.07	2.12±0.15
13	7.14±0.37	7.27±0.75	3.23±0.11	3.25±0.18	2.06±0.08	2.14±0.14
14	7.05±0.41	7.07±0.87	3.27±0.10	3.31±0.16	2.08±0.13	2.17±0.15
15	9.00±0.82	8.31±0.40	3.00±0.13	3.20±0.12	2.02±0.09	2.13±0.12
16	7.17±0.40	7.19±0.46	3.13±0.08	3.16±0.11	2.04±0.06	2.09±0.14
Whole	7.55±0.68		3.25±0.17		2.12±0.15	

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 in Table 2, respectively. In view of the female parent, the highest value in the parental average (9.00 *mm*) was obtained in No. 15, followed by No. 11 (7.92 *mm*) and No. 6 (7.86 *mm*). The lowest value in the parental average (7.05 *mm*) was noted in No. 14, followed by No. 13 (7.14 *mm*) and No. 16 (7.17 *mm*). The differences of length in the parental level were ascertained to be very large in accordance with each parent. In standard deviation, the highest value (0.82) was obtained in No. 15, the value of which was peculiarly large. The lowest value (0.24) was noted in No. 11, followed by No. 5 (0.36). 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 (8.31 *mm*) was also obtained in No. 15, followed by also Nos. 6 and 11 (7.88 *mm*). The lowest value in the parental average (7.07 *mm*) was also noted in No. 14, followed by No. 7 (7.15 *mm*). In standard deviation, the highest value (0.93) was obtained in No. 5, followed by No. 14 (0.87). The lowest value (0.31) was noted in No. 8. The relation between values of average and standard deviations was not recognized clearly, either. The average length and its standard deviations in the whole combinations were 7.55±0.68.

In view of the variety specificity, the following facts were ascertained. In case of the female and male parents, Lama, half of Tokmor Zo, one third of Addey and Champasari varieties showed the values larger than that of the average in the whole combinations (= 7.55 *mm*). On the other hand, *indica*, *japonica*, two thirds of Addey, half of Tokmor Zo and Fudangay varieties showed the values smaller than that of the average in the whole combinations. Tapachini variety showed the values larger than that of the average in the whole combinations in case of the female parent, but smaller than that in case of the male parent. Generally speaking, the larger is the length noted at the time when strain was used as female parent, the larger is it noted at the time when strain was used as male parent.

To make clear the length in view of reciprocal combinations, correlation coefficient and linear regression of length of female parent on male parent in the same strain were calculated and is shown in Table 4. Basing on the data obtained in this calculation, t-test was made from analysis of variance for reciprocal cross comparisons. From this table, the following facts were ascertained. Four, 5, 4 and 3 strains showed significances at 0.1%, 1%, 5% levels and no significance even at 5% level, respectively. In the whole strains, value meant high significance at 0.1% level. Length of hybrids, at the time when each strain was used as female parent, is shown in Table 5 in relation to the length of hybrids at the time when respective strain was used as male parent. There is a strong positive correlation between them. Correlation coefficient is +0.6578 to the degree of freedom of 118, which is obviously significant at 0.1% level. Generally speaking, the longer is the length noted at the time when strain was used as female parent, the longer is it noted at the time when strain was used as male parent. It was concluded that reciprocal differences in this study suggested no considerable cytoplasmic influence on the length.

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; 1.61, 1.36, 1.86, 2.00, 1.07, 1.93, 1.25, 2.04, 1.55, 1.24, 0.79, 1.45, 1.29, 1.40, 2.48 and 1.33, respectively. The average and its standard deviations were 1.54±0.41. The strain showing large value in this respect had a remarkable difference in length, which was found in the combinations with 15 alien parent, at the time when the strain was used as female parent and alien strains were used as male parents. In an extreme case, the lengths were 10.20 *mm* and 7.72 *mm* in No. 15×No. 6 and No. 15×No. 7, respectively. The former was the largest in the whole combinations (= 240). In other words, No. 15 showed affinities remarkably different from each strain, at the time when No. 15 was used as female parent. The strain showing small value in this respect had a few differences in length, which was 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 lengths were 8.34 *mm* and 7.55 *mm* in No. 11×No. 15 and No. 11×No. 16, respectively. In other words, No. 11 showed affinities nearly similar to each strain, at the time when No. 11 was used as female parent. Those in view of the male parent were as follows in the same order; 1.44, 1.44, 1.41, 1.89, 2.48, 3.02, 1.21, 1.33, 3.23, 3.18, 2.45, 1.49, 3.02, 3.58, 1.27 and 1.76, respectively. It may be noted that the value was peculiarly large in No. 14. Those average and its standard deviations were 2.14±0.81. The strain showing large value in this respect had a remarkable difference in length, which was found in the combinations with 15

Table 4. Correlation coefficient and linear regression of three characters of female parent (Y) on male parent (X); length, width, thickness of unhusked grain. O points; 8.30 *mm*, 3.23 *mm* and 2.18 *mm* in length, width and thickness, 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.	Linear regression
1	0.7529**	13	Y = 0.697X−1.319	0.5211*	13	Y = 0.427X+0.629	0.1938	13	—
2	0.6753**	13	Y = 0.817X−0.157	−0.2600	13	—	0.1278	13	—
3	0.7372**	13	Y = 0.711X−1.911	0.4886	13	—	0.5701*	13	Y = 0.358X−0.385
4	0.5473*	13	Y = 0.622X−1.309	0.3969	13	—	0.5062	13	—
5	0.3506	13	—	0.1216	13	—	−0.0324	13	—
6	0.8418***	13	Y = 0.565X−1.024	−0.0732	13	—	0.1122	13	—
7	0.8791***	13	Y = 0.843X−0.956	−0.2688	13	—	0.0052	13	—
8	0.3375	13	—	0.1084	13	—	−0.1822	13	—
9	0.5367*	13	Y = 0.309X−3.964	0.1566	13	—	−0.1242	13	—
10	0.6112*	13	Y = 0.421X−3.130	0.4546	13	—	0.4692	13	—
11	0.5756*	13	Y = 0.576X−1.373	−0.2750	13	—	−0.2180	13	—
12	0.7209**	13	Y = 0.682X−1.327	0.2668	13	—	0.3136	13	—
13	0.7544**	13	Y = 0.494X−3.131	0.5854*	13	Y = 0.726X+0.811	0.1142	13	—
14	0.8415***	13	Y = 0.485X−3.583	0.5646*	13	Y = 0.603X+1.351	0.2190	13	—
15	−0.2340	13	—	−0.0842	13	—	−0.0680	13	—
16	0.7862***	13	Y = 0.652X−2.166	0.2445	13	—	0.3969	13	—
Whole	0.6578***	118	Y = 0.514X−2.151	0.2967***	118	Y = 0.275X+1.049	0.2013*	118	Y = 0.133X−0.432

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

Table 5. Length of unhusked grain of all the F_1 hybrids in relation to the reciprocal combinations. Figure used in the table shows the number of combinations.

Female parent (*mm*)	Male parent (*mm*)																			Total
	10.20 ∫ 10.01	10.00 ∫ 9.81	9.80 ∫ 9.61	9.60 ∫ 9.41	9.40 ∫ 9.21	9.20 ∫ 9.01	9.00 ∫ 8.81	8.80 ∫ 8.61	8.60 ∫ 8.41	8.40 ∫ 8.21	8.20 ∫ 8.01	8.00 ∫ 7.81	7.80 ∫ 7.61	7.60 ∫ 7.41	7.40 ∫ 7.21	7.20 ∫ 7.01	7.00 ∫ 6.81	6.80 ∫ 6.61	6.60 ∫ 6.41	
9.20～9.01	1																			1
9.00～8.81								1	1											2
8.80～8.61									1											1
8.60～8.41											2									2
8.40～8.21				1	1					2	2		1							7
8.20～8.01										1	2			2	1	2				8
8.00～7.81	1		2					1			2	2	8	1	1					18
7.80～7.61	1									1	1	4	2	4	1					14
7.60～7.41										1		1	1	1	2	5				11
7.40～7.21											1		3	5	3	5	2			19
7.20～7.01												1		2	2	2	3			10
7.00～6.81													1	1	2	2	6	2		14
6.80～6.61													1			1	3	5		10
6.60～6.41																		2	1	3
Total	3	0	2	1	1	0	0	2	2	5	10	8	17	16	12	17	14	9	1	120

$\gamma = +0.6578^{***}$ (d. f. = 118), significant at the 0.1% level.

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 lengths were 10.15 *mm* and 6.57 *mm* in No. 15×No. 14 and No. 3×No. 14, respectively. The former value was the nearly largest and the latter was the nearly smallest in the whole combinations (= 240). In other words, No. 14 showed affinities remarkably different from each strain, at the time when No. 14 was used as male parent. The strain showing small value in this respect had a few differences in length, which was 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 lengths were 7.86 *mm* and 6.65 *mm* in No. 8×No. 7 and No. 14×No. 7, respectively. In other words, No. 7 showed affinities relatively similar to each strain, at the time when No. 7 was used as male parent. In reciprocal view, correlation coefficient between them was +0.3600, showing no significance even at 5% level.

In view of the variety specificity, the following facts were ascertained. In case of the female parent, *indica*, half of Addey, half of Lama, half of Tokmor Zo and Champasari varieties showed the values larger than that of the average in the whole strains (= 1.54). *Japonica*, half of Addey, half of Lama, half of Tokmor Zo, Tapachini and Fudangay varieties showed the values smaller than that of the average in the whole strains. In case of the male parent, half of Lama, half of Tokmor Zo, half of Addey and Fudangay varieties showed the values larger than that of the average in the whole strains (=2.14). *Indica*, *japonica*, half of Lama, half of Tokmor Zo, half of Addey, Tapachini and Champasari varieties showed the values smaller than that of the average in the whole strains. These findings propose a quite interesting problem concerning the strain or variety differentiations.

To make clear the relations between Sikkimese rice and two testers, the differences in length at the time when two testers crossed with Sikkimese rice and reciprocals were calculated. In view of the female parent, the differences in length 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; 0.19, 0.99, 0.68, 0.37, 0.12, 0.40, 0.33, 0.27, 0.15, 0.25, 0.12, 0.04, 0.21 and 0.28, respectively. The strain showing large value in this respect had a remarkable difference in length, which was 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 lengths were 8.03 *mm* and 7.04 *mm* 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 was 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 lengths were 6.98 *mm* and 7.02 *mm* in No. 14×No. 1 and No. 14×No. 2, respectively. In other words, No. 14 showed affinities quite similar to each tester, at the time when No. 14 was used as female parent. Average and its standard deviations in the whole Sikkimese rice were 0.31±0.24. In view of the male parent, the differences of length for *indica* and *japonica* were as follows in the same order; 0.07, 0.35, 0.11, 0.12, 0.16, 0.16, 0.30, 0.03, 0.01, 0.09, 0.22, 0.05, 0.38 and 0.11, respectively. The strain showing large value in this respect had a remarkable difference in length, which was 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 lengths were 8.59 *mm* and 8.21 *mm* in No. 1×No. 15 and No. 2× No. 15, respectively. In other words, No. 15 showed affinities remarkably different from each tester. The strain showing small value in this respect had a few differences in length, which was 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 lengths were 7.96 *mm* and 7.95 *mm* in No. 1×No. 11 and No. 2×No. 11, respectively. In other words, No. 11 showed the affinities similar to each tester. Average and its standard deviations in the whole Sikkimese rice were 0.15±0.11.

It was noticeable that Nos. 4 and 5 showed large values in the difference against each tester at the time when they were used as female parent, but showed small values, when used as male parent. No. 15 showed the reversed result. Nos. 3, 7, 11 and 13 showed relatively small values in the differences for each tester when they were used as both female and male parents. In reciprocal view, correlation coefficient between them was −0.6924, showing significance at 1% level. It means that the larger is the differences at the time when the strains were used as female parent, the smaller is it at the time when they were used as male parent.

In view of the variety specificity, the following facts were ascertained. In case of the female parent, Lama, half of Tokmor Zo and one third of Addey varieties showed the values larger than that of the average in the whole strains (= 0.31). Half of Tokmor Zo, two thirds of Addey, Tapachini, Fudangay and Champasari varieties showed the values smaller than that of the average in the whole strains. In case of the male parent, half of Lama, half of Tokmor Zo, one third of Addey and Champasari varieties showed the values larger than that of the average in the whole strains (= 0.15). Half of Lama, half of Tokmor Zo, two thirds of Addey, Tapachini and Fudangay varieties showed the values smaller than that of the average in the whole strains.

II. Width

Parent; Width of parental plants is shown in Table 1. The widest (3.43 *mm*) was obtained in No. 9, followed by No. 2 (3.42 *mm*) and No. 13 (3.35 *mm*). The narrowest (2.89 *mm*) was noted in No. 15, followed by Nos. 8 and 11 (2.91 *mm*). Average and standard deviations in the whole strains were found to be 3.18±0.53.

Hybrid; The values of width among diallel crosses are shown in Table 6. The considerable range was observed. Width for individual seed level ranged from 4.0 *mm* to 2.3 *mm* and mean width ranged from 3.4 *mm* to 2.5 *mm*. In the combination level, the widest (3.71 *mm*) was observed in the combination, No. 9×No. 2, followed by No. 9 ×No. 5 (3.64 *mm*) and No. 9×No. 6 (3.70 *mm*). The narrowest (2.79 *mm*) was noted in the combination, No. 15×No. 6, followed by No. 15×No. 9 (2.81 *mm*) and No. 15×No. 10 (2.87 *mm*). The differences in width were confirmed to be large in accordance with each set of combination.

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 (3.46 *mm*) was obtained in No. 6, followed by Nos. 7 and 9 (3.45 *mm*). The lowest value in the parental average (3.00 *mm*) was noted in No. 15, followed by No. 11 (3.07 *mm*) and No. 16 (3.13 *mm*). The differences of width in the parental level were ascertained to be large in accordance with each parent. In standard deviation, the

Table 6. Width of unhusked grains of F_1 hybrids in *mm*.

♀ \ ♂	Code No.															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1		3.51	3.36	3.24	3.20	3.36	3.36	3.10	3.35	3.31	3.14	3.11	3.34	3.28	3.12	3.25
2	3.32		3.46	3.42	3.34	3.42	3.40	3.29	3.12	3.41	3.28	3.42	3.42	3.46	3.36	3.36
3	3.25	3.45		3.19	3.34	3.31	3.16	3.17	3.31	3.22	3.04	3.16	3.08	3.31	3.16	3.11
4	3.24	3.29	3.28		3.16	3.17	3.14	3.14	3.31	3.25	3.26	3.22	3.19	3.22	3.15	3.11
5	3.37	3.16	3.26	3.09		3.18	3.14	3.20	3.28	3.27	3.25	3.28	3.25	3.28	3.16	2.99
6	3.20	3.52	3.59	3.16	3.46		3.55	3.45	3.52	3.59	3.54	3.29	3.58	3.62	3.52	3.28
7	3.48	3.60	3.49	3.36	3.56	3.43		3.36	3.50	3.50	3.32	3.55	3.42	3.45	3.37	3.34
8	3.25	3.50	3.44	3.05	2.94	3.00	3.33		3.45	3.48	3.19	3.43	3.07	3.29	3.21	3.25
9	3.51	3.71	3.18	3.49	3.64	3.70	3.52	3.37		3.42	3.44	3.53	3.55	3.38	3.20	3.15
10	3.20	3.34	3.08	3.22	3.17	3.22	3.22	3.11	3.36		3.01	3.26	3.23	3.43	3.15	3.10
11	3.07	3.14	2.91	3.08	3.06	2.99	3.02	3.07	3.03	3.20		3.13	3.16	3.08	3.07	3.01
12	3.05	3.41	3.26	3.21	3.07	3.25	3.14	2.99	3.30	3.22	3.14		3.15	3.31	3.06	3.18
13	3.37	3.49	3.23	3.12	3.23	3.27	3.20	3.04	3.33	3.25	3.16	3.24		3.30	3.12	3.14
14	3.31	3.40	3.33	3.31	3.20	3.42	3.15	3.18	3.45	3.31	3.16	3.32	3.24		3.17	3.12
15	3.04	3.25	3.05	3.18	2.92	2.79	3.14	3.05	2.81	2.87	2.96	3.07	2.91	2.91		3.07
16	3.13	3.28	3.09	3.15	3.01	3.21	2.99	3.02	3.15	3.16	3.06	3.14	3.22	3.25	3.10	

Code No.

highest value (0. 18) was obtained in No. 8, followed by No. 9 (0. 17). The lowest value (0. 06) was noted in No. 4. 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 (3. 40 *mm*) was obtained in No. 2, followed by No. 14 (3. 31 *mm*) and No. 10 (3. 30 *mm*). The lowest in the parental average (3. 16 *mm*) was noted in No. 16, followed by No. 8 (3. 17 *mm*). In standard deviation, the highest value (0. 21) was obtained in Nos. 5 and 6. The lowest value (0. 11) was noted in No. 16, followed by No. 15 (0. 12). The relation between values of average and standard deviations was not recognized clearly, either. The average width and its standard deviations in the whole combinations were 3. 25±0. 17.

In view of the variety specificity, the following facts were ascertained. In case of the female parent, *indica*, *japonica*, Tokmor Zo, one third of Addey and half of Fudangay varieties showed the values larger than that of the average in the whole combinations (= 3. 25). Lama, two thirds of Addey, Tapachini, half of Fudangay and Champasari varieties showed the values smaller than that of the average in the whole combinations. In case of the male parent, *japonica*, half of Addey, Tapachini and half of Fudangay varieties showed the values larger than that of the average in the whole combinations. Lama, half of Tokmor Zo, half of Addey and Champasari varieties showed the values smaller than that of the average in the whole combinations. *Indica*, half of Tokmor Zo and half of Fudangay varieties showed the values the same as that of the average in the whole combinations. Generally speaking, the larger is the width noted at the time when strain was used as female parent, the larger is it noted at the time when strain was used as male parent.

To make clear the width in view of reciprocal combinations, correlation coefficient and linear regression of width of female parent on male parent in the same strain were calculated and is shown in Table 4. Three and 13 strains showed significances at 5% level and no significance even at 5% level, respectively. In the whole strains, correlation coefficient is +0. 2967 to the degree of freedom of 118, which is significant at 0. 1% level. Generally speaking, the wider is the width noted at the time when strain was used as female parent, the wider is it noted at the time when strain was used as male parent. It was concluded that reciprocal differences in this study suggested no considerable cytoplasmic influence on the width.

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. 41, 0. 34, 0. 41, 0. 20, 0. 38, 0. 46, 0. 28, 0. 56, 0. 56, 0. 42, 0. 25, 0. 42, 0. 45, 0. 33, 0. 46 and 0. 29, respectively. It may be noted that the values were peculiarly large in Nos. 8 and 9. The average and its standard deviations were 0. 39±0. 10. Those in view of the male parent were as follows in the same order; 0. 47, 0. 57, 0. 68, 0. 44, 0. 72, 0. 91, 0. 56, 0. 46, 0. 71, 0. 72, 0. 58, 0. 48, 0. 67, 0. 71, 0. 46 and 0. 37, respectively. It may be noted that the value was peculiarly large in No. 6. Those average and its standard deviations were 0. 59±0. 14. In reciprocal view, correlation coefficient between them was +0. 2074, showing no significance even at 5% level.

In view of the variety specificity, the following facts were ascertained. In case of the female parent, *indica*, two thirds of Addey, half of Tokmor Zo, Tapachini, half of Fudangay and Champasari varieties showed the values larger than that of the average in the whole strains (= 0. 39). *Japonica*, Lama, half of Tokmor Zo, one third of Addey

and half of Fudangay varieties showed the values smaller than that of the average in the whole strains. In case of the male parent, half of Addey, half of Lama, half of Tokmor Zo and Fudangay varieties showed the values larger than that of the average in the whole strains (= 0.59). *Indica*, *japonica*, half of Addey, half of Lama, half of Tokmor Zo, Tapachini and Champasari varieties showed the values smaller than that of the average in the whole strains. These findings propose a quite interesting problem concerning the strain or variety differentiations.

To make clear the relations between Sikkimese rice and two testers, the differences in width at the time when two testers crossed with Sikkimese rice and reciprocals were calculated. In view of the female parent, the differences in width 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; 0.20, 0.05, 0.21, 0.32, 0.12, 0.25, 0.20, 0.14, 0.07, 0.36, 0.12, 0.09, 0.21 and 0.15, respectively. Average and its standard deviations in the whole Sikkimese rice were 0.18 ± 0.09. In view of the male parent, the differences of width for *indica* and *japonica* were as follows in the same order; 0.10, 0.18, 0.14, 0.06, 0.04, 0.19, 0.23, 0.10, 0.14, 0.31, 0.18, 0.18, 0.24 and 0.11, respectively. Average and its standard deviations in the whole Sikkimese rice were 0.16 ± 0.07.

It was noticeable that No. 12 showed relatively large value in differences for each tester when it was used as both female and male parents. Nos. 7, 10 and 11 showed the reversed results. No. 6 showed large values in the differences to each tester at the time when it was used as female parent, but showed small values, when used as male parent. In reciprocal view, correlation coefficient between them was +0.0836, showing no significance even at 5% level.

In view of the variety specificity, the following facts were ascertained. In case of the female parent, half of Addey, half of Lama, half of Tokmor Zo, Tapachini and Champasari varieties showed the values larger than that of the average in the whole strains (= 0.18). Half of Addey, half of Lama, half of Tokmor Zo and Fudangay varieties showed the values smaller than that of the average in the whole strains. In case of the male parent, half of Lama, one third of Addey, Tapachini, Fudangay and Champasari varieties showed the values larger than that of the average in the whole strains (= 0.16). Half of Lama, two thirds of Addey and Tokmor Zo varieties showed the values smaller than that of the average in the whole strains.

III. Thickness

Parent; Thickness of parental plants is shown in Table 1. The thickest (2.21 *mm*) was obtained in No. 13, followed by No. 7 (2.17 *mm*) and No. 9 (2.15 *mm*). The thinnest (1.83 *mm*) was noted in No. 11, followed by No. 8 (1.89 *mm*). Average and standard deviations in the whole strains were found to be 2.05 ± 0.11.

Hybrid; The values of thickness among diallel crosses are shown in Table 7. The considerable range was observed. Thickness for individual seed level ranged from 3.6 *mm* to 1.2 *mm* and mean thickness ranged from 3.0 *mm* to 1.9 *mm*. In the combination level, the thickest (2.61 *mm*) was observed in the combination, No. 9×No. 2, which was the same as the width, followed by No. 9×No. 1, No. 9×No. 7, No. 9×No. 13 and No. 7×No. 9 (2.47 *mm*). The thinnest (1.79 *mm*) was noted in the combination, No. 14×No. 7, followed by No. 11×No. 3 (1.81 *mm*) and No. 10×No. 11 (1.82 *mm*). The differences in

Table 7. Thickness of unhusked grains of F_1 hybrids in *mm*.

♀ \ ♂	Code No.															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1		2.15	2.16	2.11	2.02	2.06	2.12	1.98	2.09	2.19	1.94	1.95	2.16	2.19	2.02	2.12
2	2.09		2.34	2.04	2.01	2.12	2.07	2.07	2.19	2.23	2.07	2.20	2.21	2.20	2.17	2.32
3	2.16	2.27		2.16	2.21	2.19	2.21	2.09	2.17	2.12	1.98	2.03	2.08	2.26	2.11	2.01
4	2.01	2.12	2.08		2.00	2.02	2.03	1.96	2.15	2.07	1.94	1.96	2.05	1.94	2.05	1.89
5	2.12	2.03	2.06	2.06		2.02	2.13	2.07	2.07	2.10	1.99	2.02	2.13	2.17	2.16	2.03
6	1.95	2.24	2.39	2.02	2.34		2.32	2.28	2.35	2.31	2.18	2.04	2.30	2.41	2.33	1.95
7	2.35	2.27	2.43	2.00	2.28	2.31		2.27	2.47	2.31	2.26	2.39	2.36	2.28	2.36	2.39
8	2.28	2.46	2.30	1.93	1.91	1.86	2.26		2.29	2.27	2.21	2.40	2.06	2.32	2.38	2.28
9	2.47	2.61	2.08	2.44	2.37	2.41	2.47	2.42		2.32	2.40	2.38	2.47	2.33	2.06	2.01
10	2.06	2.23	2.08	2.06	2.14	2.04	2.16	2.02	2.15		1.82	2.08	2.04	2.32	2.02	1.97
11	2.01	2.06	1.81	1.97	1.97	1.92	2.00	1.88	1.94	2.04		2.03	1.98	1.94	2.03	1.97
12	2.00	2.17	2.14	1.96	1.94	2.01	2.12	2.01	2.04	2.11	1.98		2.03	2.14	2.08	2.06
13	2.26	2.13	2.07	1.93	2.07	1.99	2.08	1.97	2.12	2.07	1.96	2.06		2.02	2.09	2.06
14	2.09	2.19	2.26	2.00	1.97	2.01	1.79	1.94	2.24	2.20	2.00	2.19	2.05		2.10	2.20
15	1.93	2.02	2.04	2.02	1.93	1.97	2.02	2.07	2.01	2.04	2.31	1.99	2.00	1.91		2.07
16	1.99	2.18	2.10	1.99	2.00	1.98	2.05	1.96	2.06	2.01	1.97	2.01	2.11	2.14	2.03	

Code No.

thickness were confirmed to be very large in accordance with each set of combination.

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 (2.35 *mm*) was obtained in No. 9, followed by No. 7 (2.32 *mm*) and No. 6 (2.23 *mm*). The lowest value in the parental average (1.97 *mm*) was noted in No. 11, followed by Nos. 4 and 15 (2.02 *mm*). The differences of the parental level were ascertained to be very large in accordance with each parent. In standard deviation, the highest value (0.18) was obtained in No. 8, which was the same as the width in case of female parent, followed by No. 9 (0.17). The lowest value (0.06) was noted in Nos. 5, 11 and 16. 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 (2.21 *mm*) was obtained in No. 2, which was the same as the width in case of female parent, followed by No. 14 (2.17 *mm*). The lowest value in the parental average (2.05 *mm*) was noted in No. 4, followed by Nos. 8 and 11 (2.07 *mm*). In standard deviation, the highest value (0.16) was obtained in Nos. 3 and 11. The lowest value (0.11) was noted in No. 10, followed by Nos. 4 and 15 (0.12). The relation between values of average and standard deviations was not recognized clearly, either. The average thickness and its standard deviations in the whole combinations were 2.12 ± 0.15.

In view of the variety specificity, the following facts were ascertained. In case of the female parent, *japonica*, half of Addey and Tokmor Zo varieties showed the values larger than that of the average in the whole combinations (= 2.12). *Indica*, half of Addey, Lama, Tapachini, Fudangay and Champasari varieties showed the values smaller than that of the average in the whole combinations. In case of the male parent, *japonica*, half of Addey, Fudangay and Champasari varieties showed the values larger than that of the average in the whole combinations. Lama, half of Tokmor Zo and half of Addey varieties showed the values smaller than that of the average in the whole combinations. *Indica*, half of Tokmor Zo and Tapachini varieties showed the values the same as that of the average in the whole combinations. Reciprocal differences were not illustrated clearly in the variety level in view of thickness, so far as the considerations made with the use of the data shown in Table 3 were concerned.

To make clear the thickness in view of reciprocal combinations, correlation coefficient and linear regression of thickness of female parent on male parent in the same strain were calculated and is shown in Table 4. Only 1 strain showed significance at 5% level, and the remaining 15 strains showed no significance even at 5% level. In the whole strains, correlation coefficient is +0.2013 to the degree of freedom of 118, which is significant at 5% level. Generally speaking, the thicker is the thickness noted at the time when strain was used as female parent, the thicker is it noted at the time when strain was used as male parent. It was concluded that reciprocal differences in this study suggested no considerable cytoplasmic influence on the thickness.

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. 16; 0.25, 0.33, 0.29, 0.26, 0.18, 0.46, 0.47, 0.60, 0.60, 0.50, 0.25, 0.23, 0.33, 0.47, 0.40 and 0.22, respectively. It may be noted that the values were peculiarly large in Nos. 8 and 9. The average and its standard deviations were 0.37 ± 0.13. Those in view of the male parent were as follows in the same order; 0.54, 0.59, 0.62, 0.51, 0.46, 0.55, 0.68, 0.54, 0.53, 0.28, 0.58, 0.45, 0.49, 0.50, 0.36 and 0.50, respectively. It may

be noted that the value was peculiarly large in No. 7. Those average and its standard deviations were 0.51±0.09. In reciprocal view, correlation coefficient between them was −0.0163, showing no significance even at 5% level.

In view of the variety specificity, the following facts were ascertained. In case of the female parent, Tokmor Zo, half of Addey, half of Fudangay and Champasari varieties showed the values larger than that of the average in the whole strains (= 0.37). *Indica*, *japonica*, Lama, half of Addey, Tapachini and half of Fudangay varieties showed the values smaller than that of the average in the whole strains. In case of the male parent, *indica*, *japonica*, two thirds of Addey and Tokmor Zo varieties showed the values larger than that of the average in the whole strains (= 0.51). Half of Lama, one third of Addey, Tapachini, Fudangay and Champasari varieties showed the values smaller than that of the average in the whole strains. Half of Lama variety showed the value the same as that of the average in the whole strains. These findings propose a quite interesting problem concerning the strain or variety differentiations.

To make clear the relations between Sikkimese rice and two testers, the differences in thickness at the time when two testers crossed with Sikkimese rice and reciprocals were calculated. In view of the female parent, the differences in thickness 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; 0.11, 0.11, 0.09, 0.29, 0.08, 0.18, 0.14, 0.17, 0.05, 0.17, 0.13, 0.10, 0.09 and 0.19, respectively. It may be noted that the value was peculiarly large in No. 6. Average and its standard deviations in the whole Sikkimese rice were 0.14±0.06. In view of the male parent, the differences of thickness for *indica* and *japonica* were as follows in the same order; 0.18, 0.07, 0.01, 0.06, 0.05, 0.09, 0.10, 0.04, 0.13, 0.25, 0.05, 0.01, 0.15 and 0.20, respectively. It may be noted that the value was peculiarly large in No. 12. Average and its standard deviations in the whole Sikkimese rice were 0.10±0.07.

It was noticeable that Nos. 12 and 16 showed relatively large values in the differences for each tester when they were used as both female and male parents. Nos. 7, 8, 10 and 13 showed the reversed results. No. 6 showed large value in the difference to each tester at the time when it was used as female parent, but showed small value, when used as male parent. No. 11 showed the reversed result. In reciprocal view, correlation coefficient between them was +0.4496, showing no significance even at 5% level.

In view of the variety specificity, the following facts were ascertained. In case of the female parent, half of Tokmor Zo, half of Addey and Tapachini varieties showed the values larger than that of the average in the whole strains (= 0.14). Lama, half of Tokmor Zo, Fudangay, Champasari and one third of Addey varieties showed the values smaller than that of the average in the whole strains. In case of the male parent, half of Addey, Tapachini and Champasari varieties showed the values larger than that of the average in the whole strains (= 0.10). One third of Addey, Lama, Tokmor Zo and Fudangay varieties showed the values smaller than that of the average in the whole strains. One sixth of Addey, No. 9, showed the values similar to that of the average in the whole strains in both female and male cases.

IV. Awn

Parent; Awn length of parental plants is shown in Table 1. Only 7 strains showed remarkable long awns. It may be noted that the awn was peculiarly long in No. 11,

Table 8. Awn of grains of F_1 hybrids in *mm*.

♀ \ ♂	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1		38.2	—	—	6.1	—	15.5	29.7	—	—	38.6	—	12.8	12.1	—	—
2	35.8		41.9	37.9	36.5	35.3	47.0	88.3	5.5	41.7	89.5	51.1	49.7	47.1	62.6	42.8
3	—	40.3		—	—	—	1.0	—	—	—	1.6	—	0.7	—	—	—
4	—	51.8	—		—	—	—	—	—	—	±	—	—	—	—	—
5	17.0	48.9	—	—		—	±	40.0	—	—	43.8	+	2.7	8.6	15.0	11.5
6	—	25.5	—	—	—		13.9	18.8	—	—	+	—	—	+	±	—
7	18.4	51.1	13.4	0.9	14.8	12.9		38.4	13.7	6.8	40.6	14.9	14.4	22.0	23.3	±
8	23.1	+	—	1.3	0.8	3.1	39.0		—	—	40.5	41.5	2.0	35.9	44.7	—
9	—	47.0	—	—	—	—	16.6	—		—	—	—	+	+	—	—
10	—	36.4	—	—	—	—	0.3	—	—		—	—	2.4	3.6	—	—
11	36.3	8.6	1.0	—	23.0	+	43.6	38.0	34.0	—		33.0	37.6	37.3	39.5	—
12	—	49.4	+	—	0.7	—	11.9	29.9	—	—	31.5		—	1.4	9.5	—
13	27.8	51.8	6.2	—	9.4	4.2	9.0	25.3	9.0	—	35.2	15.2		13.6	14.3	2.1
14	11.2	43.3	7.2	6.9	5.3	11.8	17.7	28.8	5.8	2.9	26.7	10.9	11.6		17.9	6.3
15	0.8	6.8	—	—	0.8	6.4	9.6	42.9	4.5	6.7	15.6	5.0	11.4	5.3		—
16	—	5.0	—	—	0.6	—	0.9	—	—	—	1.3	—	—	0.4	—	

Code No.

+ : more or less found a few awn. ± : awn was found or not found in the same combination.

Addey variety.

Hybrid; The values of awn length among diallel crosses are shown in Table 8. Mark "+" means that awn was found in a little grade. Mark "±" means that awn was found or not found seed by seed in the same combination. The wide range was found. Awn length for individual seed level ranged from 91.4 *mm* to 0.0 *mm* and mean awn length ranged from 50 *mm* to 15 *mm*. In combination level, the longest (89.5 *mm*) was observed in combination, No. 2×No. 11, followed by No. 2×No. 8 (88.3 *mm*), No. 4 ×No. 2 and No. 13×No. 2 (51.8 *mm*). Awns were found more or less in 143 cases from 240 combinations. The differences in awn length were confirmed to be very large in accordance with each set of combination.

Reciprocal differences were not illustrated clearly in the variety level in view of awn length, so far as the considerations made with the case of the data shown in Table 8 were concerned.

V. Ratio of length to width

Parent; Ratio of length to width of parental plants is shown in Table 1. The largest (3.51) was obtained in No. 15, followed by No. 11 (2.76) and No. 8 (2.73). The smallest (1.98) was noted in No. 2, followed by No. 14 (2.01) and No. 13 (2.08). It may be noted that the value was peculiarly large in No. 15. Average and standard deviations in the whole strains were found to be 2.39±0.38.

Hybrid; The values of ratio of length to width (abbreviated as "the ratio") among diallel crosses are shown in Table 9. The wide range was observed. The ratio for individual seed level ranged from 3.9 to 1.7 and mean ratio ranged from 2.8 to 2.0. In the combination level, the largest (3.65) was observed in the combination, No. 15× No. 6, followed by No. 15×No. 9 (3.57) and No. 15×No. 14 (3.48). The smallest (1.92) was noted in the combinations, No. 7×No. 10 and No. 9×No. 13, followed by No. 6× No. 14, No. 7×No. 2, No. 9×No. 2 and No. 9×No. 14 (1.95). The differences in the ratio were confirmed to be very large in accordance with each set of combination.

In Table 10, 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 (3.03) was obtained in No. 15, followed by No. 11 (2.59) and No. 12 (2.42). The lowest value in the parental average (2.10) was noted in No. 7, followed by No. 9 (2.12) and No. 14 (2.16). The differences of the ratio in the parental level were ascertained to be large in accordance with each parent. In standard deviation, the highest value (0.40) was obtained in No. 15. It may be noted that the value was peculiarly large in No. 15. The lowest value (0.11) was noted in No. 5, followed by No. 11 (0.12). 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 (2.61) was also obtained in No. 15, followed by No. 8 (2.48) and No. 11 (2.47). The lowest value in the parental average (2.17) was noted in No. 2, followed by No. 14 (2.20) and No. 7 (2.22). In standard deviation, the highest value (0.37) was obtained in Nos. 9 and 14, followed by No. 6 (0.36). The lowest value (0.15) was noted in Nos. 7, 8 and 15. The relation between values of average and standard deviations was not recognized clearly, either. The average ratio and its standard deviations in the whole combinations were 2.34±0.28.

In view of the variety specificity, the following facts were ascertained. In case of

Table 9. Ratio of length to width of unhusked grains in F_1 hybrids.

♀ \ ♂	Code No.															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1		2.16	2.18	2.37	2.40	2.38	2.08	2.49	2.13	2.22	2.53	2.37	2.12	2.13	2.75	2.18
2	2.14		2.09	2.35	2.33	2.30	2.10	2.40	2.20	2.16	2.43	2.18	2.01	2.03	2.46	2.08
3	2.22	2.04		2.15	2.24	2.28	2.11	2.46	2.19	2.23	2.36	2.26	2.20	1.99	2.67	2.23
4	2.48	2.14	2.35		2.48	2.49	2.32	2.50	2.22	2.36	2.49	2.37	2.28	2.12	2.80	2.39
5	2.45	2.40	2.31	2.51		2.47	2.33	2.52	2.23	2.46	2.53	2.29	2.29	2.26	2.64	2.43
6	2.37	2.27	2.22	2.54	2.25		2.12	2.36	2.20	2.20	2.35	2.38	2.13	1.95	2.56	2.26
7	2.06	1.95	1.98	2.39	2.09	2.09		2.32	1.97	1.92	2.29	2.07	2.03	2.02	2.35	2.00
8	2.39	2.10	2.32	2.51	2.42	2.53	2.36		2.33	2.27	2.58	2.30	2.24	2.24	2.78	2.42
9	2.15	1.95	2.18	2.16	2.14	2.12	1.99	2.16		2.12	2.36	2.03	1.92	1.95	2.42	2.18
10	2.24	2.07	2.23	2.40	2.33	2.40	2.10	2.46	2.14		2.25	2.24	2.10	1.96	2.54	2.18
11	2.56	2.46	2.74	2.68	2.64	2.70	2.54	2.74	2.64	2.41		2.56	2.43	2.48	2.78	2.51
12	2.49	2.16	2.22	2.44	2.71	2.47	2.28	2.57	2.25	2.36	2.59		2.44	2.22	2.81	2.33
13	2.02	1.99	2.08	2.35	2.18	2.30	2.14	2.48	2.11	2.11	2.40	2.26		2.03	2.56	2.16
14	2.11	2.07	1.98	2.13	2.23	2.17	2.11	2.40	1.99	2.00	2.39	2.14	2.08		2.50	2.09
15	2.68	2.57	2.65	2.75	3.44	3.65	2.46	2.82	3.57	3.42	3.11	2.77	3.35	3.48		2.70
16	2.22	2.20	2.22	2.33	2.67	2.33	2.25	2.53	2.16	2.22	2.39	2.24	2.09	2.06	2.50	

Table 10. Averages and standard deviations of three characters in female and male parental levels; ratio of length to width, ratio of length to thickness, ratio of width to thickness, of unhusked grain.

Code No.	Length/Width		Length/Thickness		Width/Thickness	
	Female	Male	Female	Male	Female	Male
1	2.30±0.19	2.31±0.19	3.61±0.32	3.55±0.37	1.57±0.04	1.54±0.06
2	2.21±0.15	2.17±0.18	3.47±0.32	3.35±0.46	1.57±0.07	1.54±0.06
3	2.24±0.16	2.25±0.21	3.38±0.28	3.42±0.38	1.51±0.03	1.52±0.05
4	2.39±0.16	2.40±0.17	3.80±0.28	3.77±0.32	1.59±0.05	1.58±0.07
5	2.41±0.11	2.44±0.33	3.72±0.20	3.76±0.44	1.55±0.05	1.55±0.05
6	2.28±0.15	2.45±0.36	3.55±0.30	3.84±0.46	1.56±0.06	1.58±0.07
7	2.10±0.15	2.22±0.15	3.12±0.25	3.39±0.27	1.49±0.07	1.53±0.08
8	2.39±0.16	2.48±0.15	3.52±0.28	3.82±0.30	1.48±0.07	1.54±0.06
9	2.12±0.14	2.29±0.37	3.12±0.27	3.48±0.49	1.47±0.06	1.53±0.06
10	2.24±0.15	2.30±0.33	3.47±0.29	3.50±0.43	1.54±0.05	1.53±0.04
11	2.59±0.12	2.47±0.20	4.03±0.20	3.82±0.24	1.56±0.04	1.55±0.10
12	2.42±0.18	2.29±0.18	3.76±0.29	3.57±0.34	1.55±0.05	1.55±0.05
13	2.21±0.17	2.25±0.33	3.47±0.26	3.42±0.48	1.57±0.05	1.53±0.05
14	2.16±0.15	2.20±0.37	3.40±0.33	3.35±0.59	1.58±0.09	1.53±0.06
15	3.03±0.40	2.61±0.15	4.47±0.48	3.91±0.23	1.49±0.08	1.50±0.05
16	2.29±0.16	2.28±0.18	3.52±0.27	3.46±0.34	1.54±0.04	1.52±0.08
Whole	2.34±0.28		3.59±0.43		1.54±0.07	

the female parent, Lama, one third of Addey, Tapachini and Champasari varieties showed the values larger than that of the average in the whole combinations (= 2.34). *Indica*, *japonica*, two thirds of Addey, Tokmor Zo and Fudangay varieties showed the values smaller than that of the average in the whole combinations. In case of the male parent, Lama, half of Tokmor Zo, one third of Addey and Champasari varieties showed the values larger than that of the average in the whole combinations. *Indica*, *japonica*, half of Tokmor Zo, two thirds of Addey, Tapachini and Fudangay varieties showed the values smaller than that of the average in the whole combinations. Generally speaking, the larger is the ratio at the time when strain was used as female parent, the larger is it at the time when strain was used as male parent.

To make clear the ratio 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 is shown in Table 11. Seven, 3, 3 and 3 strains showed significances at 0.1%, 1%, 5% levels and no significance even at 5% level, respectively. In the whole strains, correlation coefficient is +0.7005 to the degree of freedom of 118, which is obviously significant at 0.1% level. Generally speaking, the larger is the ratio noted at the time when strain was used as female parent, the larger is it noted at the time when strain was used as male parent. 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

Table 11. Correlation coefficient and linear regression of three characters of female parent (Y) on male parent (X); ratio of length to width (L/W), ratio of length to thickness (L/T), ratio of width to thickness (W/T) of unhusked grain. 0 points; 2.76, 3.88 and 1.53 in the 1st, 2nd and 3rd ratios, respectively, in both female and male parents.

Code No.	L/W			L/T			W/T		
	Correlation coefficient	d. f.	Linear regression	Correlation coefficient	d. f.	Linear regression	Correlation coefficient	d. f.	Linear regression
1	0.9196***	13	Y = 0.958X−0.321	0.7624***	13	Y = 0.639X−0.472	−0.0249	13	—
2	0.7852***	13	Y = 0.652X−1.555	0.6062*	13	Y = 0.578X−0.611	0.4474	13	—
3	0.7894***	13	Y = 0.581X−2.334	0.6630**	13	Y = 0.458X−2.212	0.0061	13	—
4	0.8093***	13	Y = 0.654X−1.643	0.5719*	13	Y = 0.559X−0.374	0.1597	13	—
5	0.6386*	13	Y = 0.243X−2.887	0.5600*	13	Y = 0.290X−1.043	0.0838	13	—
6	0.6918**	13	Y = 0.280X−3.800	0.4838	13	—	0.3019	13	—
7	0.5433*	13	Y = 0.444X−3.558	0.3754	13	—	0.3376	13	—
8	0.4453	13	—	0.0000	13	—	−0.2147	13	—
9	0.5390*	13	Y = 0.204X−4.833	0.5712*	13	Y = 0.479X−2.081	−0.2231	13	—
10	0.7876***	13	Y = 0.374X−3.804	0.7697***	13	Y = 0.525X−2.070	0.1572	13	—
11	0.4306	13	—	0.3392	13	—	0.1391	13	—
12	0.8079***	13	Y = 0.821X−1.377	0.6924**	13	Y = 0.658X−1.258	0.5208*	13	Y = 0.639X+0.004
13	0.7121**	13	Y = 0.344X−3.836	0.5946*	13	Y = 0.416X−2.691	0.4451	13	—
14	0.9856***	13	Y = 0.457X−3.732	0.5933*	13	Y = 0.341X−3.645	0.1701	13	—
15	−0.2215	13	—	−0.0888	13	—	−0.1039	13	—
16	0.7280**	13	Y = 0.864X−0.893	0.6329*	13	Y = 0.846X−1.379	0.7060**	13	Y = 1.371X−0.674
Whole	0.7005***	118	Y = 0.409X−3.049	0.5965***	118	Y = 0.442X−1.832	0.2288*	118	Y = 0.217X+0.053

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

No. 16; 0.67, 0.45, 0.68, 0.68, 0.41, 0.61, 0.43, 0.68, 0.50, 0.58, 0.37, 0.65, 0.57, 0.52, 1.19 and 0.47, respectively. It may be noted that the value was peculiarly large in No. 15. The average and its standard deviations were 0.59 ± 0.19. Those in view of the male parent were as follows in the same order; 0.66, 0.62, 0.76, 0.62, 1.35, 1.56, 0.55, 0.66, 0.60, 1.50, 0.86, 0.74, 1.43, 1.53, 0.46 and 0.51, respectively. Those average and its standard deviations were 0.90 ± 0.40. In reciprocal view, correlation coefficient between them was -0.2215, showing no significance even at 5% level.

In view of the variety specificity, the following facts were ascertained. In case of the female parent, *indica*, one third of Addey, half of Lama, half of Tokmor Zo, Tapachini and Champasari varieties showed the values larger than that of the average in the whole strains ($=0.59$). *Japonica*, two thirds of Addey, half of Lama, half of Tokmor Zo and Fudangay varieties showed the values smaller than that of the average in the whole strains. In case of the male parent, half of Lama, half of Tokmor Zo, one sixth of Addey and Fudangay varieties showed the values larger than that of the average in the whole strains ($=0.90$). *Indica*, *japonica*, five sixths of Addey, half of Lama, half of Tokmor Zo, Tapachini and Champasari varieties showed the values smaller than that of the average in the whole strains. These findings propose a quite interesting problem concerning the strain or variety differentiations.

To make clear the relations between Sikkimese rice and two testers, the differences in the ratio at the time when two testers crossed with Sikkimese rice and reciprocals were calculated. In view of the female parent, the differences in the ratio to *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; 0.18, 0.34, 0.05, 0.10, 0.11, 0.29, 0.20, 0.17, 0.10, 0.33, 0.03, 0.04, 0.11 and 0.02, respectively. Average and its standard deviations in the whole Sikkimese rice were 0.15 ± 0.10. In view of the male parent, the differences of the ratio to *indica* and *japonica* were as follows in the same order; 0.09, 0.02, 0.07, 0.08, 0.02, 0.09, 0.07, 0.06, 0.10, 0.24, 0.11, 0.10, 0.29 and 0.10, respectively. Average and its standard deviations in the whole Sikkimese rice were 0.10 ± 0.07.

It was noticeable that No. 12 showed relatively large values in the differences for each tester when it was used as both female and male parents. No. 5 showed the reversed result. Nos. 4, 8 and 9 showed large values in the differences to each tester at the time when they were used as female parent, but showed small values, when used as male parent. Nos. 13, 14 and 16 showed the reversed results. In reciprocal view, correlation coefficient between them was $+0.0069$, showing no significance even at 5% level.

In view of the variety specificity, the following facts were ascertained. In case of the female parent, two thirds of Addey, half of Lama and Tapachini varieties showed the values larger than that of the average in the whole strains ($=0.15$). One third of Addey, half of Lama, Tokmor Zo, Fudangay and Champasari varieties showed the values smaller than that of the average in the whole strains. In case of the male parent, Tapachini, half of Fudangay and Champasari varieties showed the values larger than that of the average in the whole strains ($=0.10$). Two thirds of Addey, Lama and Tokmor Zo varieties showed the values smaller than that of the average in the whole strains. One third of Addey and half of Fudangay varieties showed the values the same as that of the average in the whole strains.

VI. Ratio of length to thickness

Parent; Ratio of length to thickness of parental plants is shown in Table 1. The largest (4.86) was obtained in No. 15, followed by No. 11 (4.39) and No. 8 (4.20), which were the same order as the ratio of length to width. The smallest (3.14) was noted in No. 14, followed by No. 13 (3.15) and No. 7 (3.17). Average and standard deviations in the whole strains were found to be 3.71 ± 0.48.

Hybrid; The values of ratio of length to thickness (abbreviated as "the ratio") among diallel crosses are shown in Table 12. The wide range was observed. The ratio for individual seed level ranged from 5.5 to 2.5 and mean ratio ranged from 4.8 to 3.0. In combination level, the largest (5.31) was observed in the combination, No. 15×No. 14, followed by No. 15×No. 6 (5.18) and No. 15×No. 9 (4.99), which were similar to the ratio of length to width. The smallest (2.75) was noted in the combination, No. 9 × No. 13, followed by No. 9 × No. 2 (2.76) and No. 7×No. 9 (2.79). The differences in the ratio were confirmed to be very large in accordance with each set of combination.

In Table 10, the average 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 (4.47) was obtained in No. 15, which was the same as the ratio of length to width in case of both female and male parents, followed by No. 11 (4.03) and No. 4 (3.80). The lowest value in the parental average (3.12) was noted in Nos. 7 and 9. The differences of the ratio in the parental level were ascertained to be large in accordance with each parent. In standard deviation, the highest value (0.48) was obtained in No. 15, which was the same as the ratio of length to width in case of the female parent. It may be noted that the value was peculiarly large in No. 15. The lowest value (0.20) was noted in Nos. 5 and 11. 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 (3.91) was also obtained in No. 15, followed by No. 6 (3.84). The lowest value in the parental average (3.35) was noted in Nos. 2 and 14. In standard deviation, the highest value (0.59) was obtained in No. 14, which was the same as the ratio of length to width in case of the male parent. The lowest value (0.23) was noted in No. 15, which was the same as the ratio of length to width in case of male parent. The relation between values of average and standard deviations was not recognized clearly, either. The average ratio and its standard deviations in the whole combinations were 3.59 ± 0.43.

In view of the variety specificity, the following facts were ascertained. In case of the female parent, *indica*, Lama, one sixth of Addey, Tapachini and Champasari varieties showed the values larger than that of the average in the whole combinations (= 3.59). *Japonica*, Tokmor Zo, five sixths of Addey and Fudangay varieties showed the values smaller than that of the average in the whole combinations. In case of the male parent, Lama, half of Tokmor Zo, one third of Addey and Champasari varieties showed the values larger than that of the average in the whole combinations. *Indica*, *japonica*, half of Tokmor Zo, two thirds of Addey, Tapachini and Fudangay varieties showed the values smaller than that of the average in the whole combinations. Generally speaking, the larger is the ratio noted at the time when strain was used as female parent, the larger is it noted at the time when strain was used as male parent.

To make clear the ratio in view of the reciprocal combinations, correlation coeffi-

Table 12. Ratio of length to thickness of unhusked grains in F_1 hybrids.

♀ \ ♂	Code No.															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1		3.52	3.39	3.65	3.81	3.88	3.29	3.90	3.42	3.35	4.10	3.79	3.28	3.19	4.25	3.34
2	3.40		3.10	3.94	3.87	3.72	3.45	3.81	3.13	3.30	3.84	3.31	3.11	3.20	3.78	3.01
3	3.34	3.09		3.17	3.39	3.44	3.01	3.81	3.33	3.38	3.63	3.51	3.25	2.95	4.00	3.45
4	4.00	3.32	3.71		3.93	3.90	3.59	4.03	3.41	3.70	4.18	3.89	3.55	3.52	4.31	3.94
5	3.89	3.73	3.65	3.77		3.90	3.43	3.90	3.53	3.82	4.13	3.72	3.50	3.42	3.87	3.59
6	3.90	3.56	3.33	3.98	3.33		3.24	3.57	3.30	3.42	3.81	3.84	3.31	2.95	3.87	3.79
7	3.04	3.09	2.84	3.71	3.26	3.11		3.43	2.79	2.91	3.36	3.08	2.94	3.06	3.36	2.80
8	3.40	2.99	3.47	3.96	3.73	4.08	3.48		3.51	3.47	3.73	3.29	3.34	3.18	3.75	3.45
9	3.05	2.76	3.32	3.09	3.29	3.25	2.83	3.00		3.13	3.38	3.01	2.75	2.82	3.76	3.38
10	3.48	3.09	3.31	3.75	3.46	3.78	3.13	3.78	3.34		3.72	3.51	3.32	2.90	3.96	3.44
11	3.91	3.74	4.40	4.19	4.10	4.19	3.83	4.38	4.13	3.78		3.96	3.88	3.94	4.11	3.83
12	3.81	3.39	3.38	3.99	4.30	4.00	3.38	3.82	3.64	3.60	4.11		3.78	3.43	4.14	3.60
13	3.01	3.25	3.25	3.79	3.40	3.77	3.29	3.83	3.32	3.35	3.86	3.56		3.31	3.82	3.29
14	3.34	3.21	2.92	3.53	3.62	3.68	3.72	3.93	3.04	3.01	3.77	3.25	3.28		3.78	2.97
15	4.21	4.13	3.96	4.33	4.93	5.18	3.82	4.16	4.99	4.80	3.99	4.28	4.88	5.31		4.01
16	3.49	3.32	3.27	3.69	4.02	3.78	3.29	3.89	3.31	3.46	3.70	3.49	3.19	3.13	3.83	

Code No.

cient and linear regression of the ratio of female parent on male parent in the same strain were calculated and is shown in Table 11. Two, 2, 7 and 5 strains showed significances at 0.1%, 1%, 5% levels and no significance even at 5% level, respectively. In the whole strains, correlation coefficient is +0.5965 to the degree of freedom of 118, which is obviously significant at 0.1% level. Generally speaking, the larger is the ratio noted at the time when strain was used as female parent, the larger is it noted at the time when strain was used as male parent. 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; 1.06, 0.93, 1.05, 0.99, 0.71, 1.03, 0.92, 1.09, 1.01, 1.06, 0.66, 0.92, 0.85, 1.01, 1.49 and 0.89, respectively. It may be noted that the value was peculiarly large in No. 15. The average and its standard deviations were 0.98±0.18. Those in view of the male parent were as follows in the same order; 1.17, 1.37, 1.56, 1.24, 1.67, 2.07, 1.00, 1.38, 2.20, 1.89, 0.82, 1.27, 2.13, 2.49, 0.95 and 1.21, respectively. It may be noted that the value was peculiarly large in No. 14. Those average and its standard deviations were 1.53±0.48. In reciprocal view, correlation coefficient between them was −0.0664, showing no significance even at 5% level.

In view of the variety specificity, the following facts were ascertained. In case of the female parent, *indica*, two thirds of Addey, half of Lama, half of Tokmor Zo, half of Fudangay and Champasari varieties showed the values larger than that of the average in the whole strains (=0.98). *Japonica*, one third of Addey, half of Lama, half of Tokmor Zo, half of Fudangay and Tapachini varieties showed the values smaller than that of the average in the whole strains. In case of the male parent, one third of Addey, half of Lama, half of Tokmor Zo and Fudangay varieties showed the values larger than that of the average in the whole strains (=1.53). *Indica*, *japonica*, two thirds of Addey, half of Lama, half of Tokmor Zo, Tapachini and Champasari varieties showed the values smaller than that of the average in the whole strains. These findings propose a quite interesting problem concerning the strain or variety differentiations.

To make clear the relations between Sikkimese rice and two testers, the differences in the ratio at the time when two testers crossed with Sikkimese rice and reciprocals were calculated. In view of the female parent, the differences in the ratio to *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; 0.25, 0.68, 0.16, 0.34, 0.05, 0.41, 0.29, 0.39, 0.17, 0.42, 0.24, 0.13, 0.08 and 0.17, respectively. Average and its standard deviations in the whole Sikkimese rice were 0.27±0.16. In view of the male parent, the differences of the ratio to *indica* and *japonica* were as follows in the same order; 0.29, 0.29, 0.06, 0.16, 0.16, 0.09, 0.29, 0.05, 0.26, 0.48, 0.17, 0.01, 0.47 and 0.33, respectively. Average and its standard deviations in the whole Sikkimese rice were 0.22±0.14.

It was noticeable that Nos. 4 and 12 showed relatively large values in the differences for each tester when they were used as both female and male parents. No. 5 showed the reversed result. Nos. 8 and 10 showed large values in the differences to each tester at the time when they were used as female parent, but showed small values, when used as male parent. Nos. 11 and 15 showed the reversed results. In reciprocal view, correlation coefficient between them was −0.1506, showing no significance even at 5% level.

In view of the variety specificity, the following facts were ascertained. In case of the female parent, half of Lama, half of Tokmor Zo, half of Addey and Tapachini varieties showed the values larger than that of the average in the whole strains (= 0. 27). Half of Lama, half of Tokmor Zo, half of Addey, Fudangay and Champasari varieties showed the values smaller than that of the average in the whole strains. In case of the male parent, two thirds of Addey, half of Lama, Tapachini and Champasari varieties showed the values larger than that of the average in the whole strains (= 0. 22). One third of Addey, half of Lama, Tokmor Zo and Fudangay varieties showed the values smaller than that of the average in the whole strains.

VII. Ratio of width to thickness

Parent; Ratio of width to thickness of parental plants is shown in Table 1. The largest (1. 79) was obtained in No. 2, followed by No. 6 (1. 69) and No. 4 (1. 62). The smallest (1. 38) was noted in No. 15, followed by No. 12 (1. 47) and No. 5 (1. 48). Average and standard deviations in the whole strains were found to be 1. 56±0. 09.

Hybrid; The values of ratio of width to thickness (abbreviated as "the ratio") among diallel crosses are shown in Table 13. The considerable range was observed. The ratio for individual seed level ranged from 1. 8 to 1. 2 and mean ratio ranged from 1. 6 to 1. 4. In the combination level, the largest (1. 76) was observed in the combination, No. 14×No. 7, followed by No. 14×No. 6 (1. 70). The smallest (1. 28) was noted in the combination, No. 15×No. 11, followed by No. 8×No. 15 (1. 35) and No. 9×No. 8 (1. 39). The differences in the ratio were confirmed to be very large in accordance with each set of combination.

In Table 10, 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. 59) was obtained in No. 4, followed by No. 14 (1. 58). The lowest value in the parental average (1. 47) was noted in No. 9, followed by No. 8 (1. 48). The differences of the ratio in the parental level were ascertained to be large in accordance with each parent. In standard deviation, the highest value (0. 09) was obtained in No. 14. The lowest value (0. 03) was noted in No. 3. 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 (1. 58) was observed in Nos. 4 and 6. The lowest value in the parental average (1. 50) was noted in No. 15. In standard deviation, the highest value (0. 10) was obtained in No. 11. The lowest value (0. 04) was noted in No. 10. The relation between values of average and standard deviations was not recognized clearly, either. The average ratio and its standard deviations in the whole combinations were 1. 54±0. 07.

In view of the variety specificity, the following facts were ascertained. In case of the female parent, *indica*, *japonica*, Lama, half of Tokmor Zo, one sixth of Addey, Tapachini and Fudangay varieties showed the values larger than that of the average in the whole combinations (= 1. 54). Half of Addey, half of Tokmor Zo and Champasari varieties showed the values smaller than that of the average in the whole combinations. One third of Addey variety showed the values same as that of the average in the whole combinations. In case of the male parent, Lama, half of Tokmor Zo, one sixth of Addey and Tapachini varieties showed the values larger than that of the average in the whole combinations. Half of Tokmor Zo, two thirds of Addey, Fudangay and Champasari

Table 13. Ratio of width to thickness of unhusked grains in F_1 hybrids.

♀ \ ♂	Code No. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1		1.63	1.56	1.54	1.58	1.63	1.59	1.57	1.60	1.51	1.62	1.60	1.55	1.50	1.55	1.53
2	1.59		1.48	1.68	1.66	1.61	1.64	1.59	1.43	1.53	1.59	1.56	1.55	1.57	1.55	1.45
3	1.51	1.52		1.48	1.51	1.51	1.43	1.52	1.53	1.52	1.54	1.56	1.48	1.47	1.50	1.55
4	1.61	1.55	1.58		1.58	1.57	1.55	1.60	1.54	1.57	1.68	1.64	1.56	1.66	1.54	1.65
5	1.59	1.56	1.58	1.50		1.57	1.47	1.55	1.59	1.56	1.63	1.62	1.53	1.51	1.46	1.47
6	1.64	1.57	1.50	1.56	1.48		1.53	1.51	1.50	1.55	1.62	1.61	1.56	1.50	1.51	1.68
7	1.48	1.59	1.44	1.68	1.56	1.49		1.48	1.42	1.52	1.47	1.49	1.45	1.51	1.43	1.40
8	1.43	1.42	1.50	1.58	1.54	1.61	1.47		1.51	1.53	1.44	1.43	1.49	1.42	1.35	1.43
9	1.42	1.42	1.53	1.43	1.54	1.54	1.43	1.39		1.47	1.43	1.48	1.44	1.45	1.55	1.57
10	1.55	1.50	1.48	1.56	1.48	1.58	1.49	1.54	1.56		1.65	1.57	1.58	1.48	1.56	1.57
11	1.53	1.52	1.62	1.56	1.55	1.56	1.51	1.63	1.56	1.57		1.54	1.60	1.59	1.51	1.53
12	1.53	1.57	1.52	1.64	1.58	1.62	1.48	1.49	1.62	1.53	1.59		1.55	1.55	1.47	1.54
13	1.49	1.64	1.56	1.62	1.56	1.64	1.54	1.54	1.57	1.57	1.61	1.57		1.63	1.49	1.52
14	1.58	1.55	1.47	1.66	1.62	1.70	1.76	1.64	1.54	1.51	1.58	1.52	1.58		1.51	1.42
15	1.58	1.61	1.50	1.57	1.51	1.42	1.55	1.47	1.40	1.41	1.28	1.54	1.46	1.52		1.48
16	1.57	1.51	1.47	1.58	1.51	1.62	1.46	1.54	1.53	1.57	1.55	1.56	1.53	1.52	1.53	

Code No.

varieties showed the values smaller than that of the average in the whole combinations. *Indica*, *japonica* and one sixth of Addey varieties showed values the same as that of the average in the whole combinations. Generally speaking, the larger is the ratio at the time when strain was used as female parent, the larger is it at the time when strain was used as male parent.

To make clear the ratio 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 is shown in Table 11. One, 1 and 14 strains showed significances at 1%, 5% levels and no significance even at 5% level, respectively. In the whole strains, correlation coefficient is +0.2288 to the degree of freedom of 118, which is significant at 5% level. Generally speaking, the larger is the ratio noted at the time when strain was used as female parent, the larger is it noted at the time when strain was used as male parent. 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; 0.13, 0.25, 0.13, 0.14, 0.17, 0.20, 0.28, 0.26, 0.18, 0.17, 0.12, 0.17, 0.15, 0.34, 0.33 and 0.16, respectively. It may be noted that the values were peculiarly large in Nos. 14 and 15. The average and its standard deviations were 0.20±0.07. Those in view of the male parent were as follows in the same order; 0.22, 0.22, 0.18, 0.25, 0.18, 0.28, 0.33, 0.25, 0.22, 0.16, 0.40, 0.21, 0.16, 0.24, 0.21 and 0.28, respectively. It may be noted that the value was peculiarly large in No. 11. Those average and its standard deviations were 0.24±0.06. In reciprocal view, correlation coefficient between them was +0.0435, showing no significance even at 5% level.

In view of the variety specificity, the following facts were ascertained. In case of the female parent, *japonica*, half of Tokmor Zo, one sixth of Addey, half of Fudangay and Champasari varieties showed the values larger than that of the average in the whole strains (=0.20). *Indica*, five sixths of Addey, Lama, Tapachini and half of Fudangay varieties showed the values smaller than that of the average in the whole strains. Half of Tokmor Zo variety showed the value same as that of the average in the whole strains. In case of the male parent, half of Lama, half of Tokmor Zo and half of Addey varieties showed the values larger than that of the average in the whole strains (=0.24). *Indica*, *japonica*, half of Lama, half of Tokmor Zo, half of Addey, Tapachini, half of Fudangay and Champasari varieties showed the values smaller than that of the average in the whole strains. Half of Fudangay variety showed the value the same as that of the average in the whole strains. These findings propose a quite interesting problem concerning the strain or variety differentiations.

To make clear the relations between Sikkimese rice and two testers, the differences in the ratio at the time when two testers crossed with Sikkimese rice and reciprocals were calculated. In view of the female parent, the differences in the ratio to *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, 0.03, 0.07, 0.11, 0.11, 0.00, 0.05, 0.01, 0.03, 0.15, 0.03, 0.03 and 0.06, respectively. Average and its standard deviations in the whole Sikkimese rice were 0.05±0.04. In view of the male parent, the differences of the ratio to *indica* and *japonica* were as follows in the same order; 0.08, 0.14, 0.08, 0.02, 0.05, 0.02, 0.17, 0.02, 0.03, 0.04, 0.00, 0.07, 0.00 and

0.08, respectively. Average and its standard deviations in the whole Sikkimese rice were 0.06±0.05.

It was noticeable that Nos. 10, 11, 12 and 15 showed relatively small values in the differences for each tester when they were used as both female and male parents. Nos. 6, 7, 8 and 13 showed large values in the differences to each tester at the time when they were used as female parent, but showed small values, when used as male parent. Nos. 3, 4 and 9 showed the reversed results. In reciprocal view, correlation coefficient between them was −0.1119, showing no significance even at 5% level.

In view of the variety specificity, the following facts were ascertained. In case of the female parent, half of Lama, Tokmor Zo, one third of Addey and half of Fudangay varieties showed the values larger than that of the average in the whole strains (= 0.05). Half of Lama, half of Addey, Tapachini, half of Fudangay and Champasari varieties showed the values smaller than that of the average in the whole strains. One sixth of Addey variety showed value the same as that of the average in the whole strains. In case of the male parent, half of Addey, Lama and half of Fudangay varieties showed the values larger than that of the average in the whole strains (= 0.06). Half of Addey, Tokmor Zo, Tapachini, half of Fudangay and Champasari varieties showed the values smaller than that of the average in the whole strains.

PART II. Relations between the respective two characters

I. Length and width

Parent; Correlation coefficient of width on length in parental plants was −0.6986, showing significance at 1% level. Width in all parents are shown in Table 14 in relation to length. Correlation coefficient was −0.6986 to the degree of freedom of 14, which is obviously significant at 1% level. Generally speaking, the wider is the width,

Table 14. Length (*mm*) of the parental plants in relation to their width (*mm*). Figure used in the table shows the number of strains.

Width (*mm*)	Length (*mm*)									Total
	10.20 ⟩ 10.01	8.40 ⟩ 8.21	8.20 ⟩ 8.01	8.00 ⟩ 7.81	7.80 ⟩ 7.61	7.60 ⟩ 7.41	7.20 ⟩ 7.01	7.00 ⟩ 6.81	6.80 ⟩ 6.61	
3.43～3.41							1		1	2
3.37～3.35								1		1
3.34～3.32				1					1	2
3.28～3.26								1		1
3.22～3.20							2			2
3.19～3.17		1		1						2
3.13～3.11						1			1	2
3.10～3.08					1					1
2.92～2.90			1	1						2
2.89～2.87	1									1
Total	1	1	1	3	1	1	3	2	3	16

$\gamma = -0.6986^{**}$ (d. f. = 14), significant at the 1% level.

Table 15. Correlation coefficient and linear regression of the three components: I-width of unhusked grain (Y, O point = 3.23 *mm*) on length of unhusked grain (X, O point = 8.30 *mm*), II-thickness of unhusked grain (Y, O point = 2.18 *mm*) on length of unhusked grain (X, O point = 8.30 *mm*), III-thickness of unhusked grain (Y, O point = 2.18 *mm*) on width of unhusked grain (X, O point = 3.23 *mm*), 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	−0.3701*	28	Y = −0.452X−1.283	−0.3008	28	—	0.7269***	28	Y = 0.676X−1.939
2	−0.1421	28	—	−0.3730*	28	Y = −0.468X−2.006	0.6481***	28	Y = 0.660X−1.968
3	0.0340	28	—	−0.1496	28	—	0.8834***	28	Y = 0.739X−0.813
4	−0.1792	28	—	−0.1344	28	—	0.4964**	28	Y = 0.496X−1.446
5	−0.2502	28	—	−0.2322	28	—	0.8011***	28	Y = 0.559X−1.818
6	−0.3545	28	—	−0.0719	28	—	0.8530***	28	Y = 0.686X−1.359
7	0.0306	28	—	−0.0361	28	—	0.7409***	28	Y = 0.737X−0.705
8	0.1239	28	—	0.1359	28	—	0.8180***	28	Y = 0.879X−0.286
9	−0.3301	28	—	−0.1859	28	—	0.7632***	28	Y = 0.791X−0.662
10	−0.1503	28	—	−0.1074	28	—	0.8758***	28	Y = 0.709X−0.802
11	0.0771	28	—	0.3654*	28	Y = 0.414X−1.167	0.5475**	28	Y = 0.554X−2.132
12	−0.4527*	28	Y = −0.577X−1.967	−0.6219***	28	Y = −0.619X−4.313	0.8073***	28	Y = 0.700X−1.923
13	−0.4068*	28	Y = −0.396X−1.958	−0.3195	28	—	0.7701***	28	Y = 0.650X−1.719
14	−0.4999**	28	Y = −0.419X−1.286	−0.3728*	28	Y = −0.337X−3.133	0.6879***	28	Y = 0.736X−2.083
15	−0.5661**	28	Y = −0.488X−1.737	−0.1876	28	—	0.6266***	28	Y = 0.485X−0.722
16	−0.2299	28	—	−0.3659*	28	Y = −0.531X−5.241	0.6208***	28	Y = 0.716X−1.174
Whole	−0.1976**	238	Y = −0.138X−0.129	−0.1299*	238	Y = −0.081X−1.493	0.7667***	238	Y = 0.684X−1.356

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

the shorter is the length. Linear regression of length on width was calculated as follows; $Y = -0.956X - 2.640$, where Y and X indicate length (1 unit = 0.2 *mm*) and width (1 unit = 0.03 *mm*), respectively. This formula indicates that the length becomes 0.956 *mm* longer, by becoming 1 unit narrower the width (0 points, 8.31 *mm* in length and 3.15 *mm* in width, respectively).

Hybrid; Correlation coefficient and linear regression of width on length in the same strain were calculated and are shown in Table 15. Two, 3 and 11 strains showed significances at 1%, 5% levels and no significance even at 5% level, respectively. In the whole combinations, correlation coefficient was −0.1976 to the degree of freedom of 238, which is significant at 1% level. Generally speaking, the longer is the length, the narrower is the width.

II. Length and thickness

Parent; Correlation coefficient of thickness on length in the parental plants was −0.1550, showing no significance even at 5% level.

Hybrid; Correlation coefficient and linear regression of thickness on length in the same strain were calculated and are shown in Table 15. One, 4 and 11 strains showed significances at 0.1%, 5% levels and no significance even at 5% level, respectively. In the whole combinations, correlation coefficient was −0.1299 to the degree of freedom of 238, which is significant at 5% level. Generally speaking, the longer is the length, the thinner is the thickness.

III. Width and thickness

Parent; Correlation coefficient of thickness on width in the parental plants was +0.4017, showing no significance even at 5% level.

Hybrid; Correlation coefficient and linear regression of thickness on width in the same strain were calculated and are shown in Table 15. Fourteen and 2 strains showed significances at 0.1% and 1% levels, respectively. In the whole combinations, value meant significance at 0.1% level. Thickness in all combinations are shown in Table 16 in relation to width. Correlation coefficient was +0.7667 to the degree of freedom of 238, which is obviously significant at 0.1% level. Generally speaking, the wider is the width, the thicker is the thickness.

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

Parent; Correlation coefficient of ratio of length to thickness on ratio of length to width in parental plants was +0.9205, showing significance at 0.1% level. Ratio of length to thickness in all parents are shown in Table 17 in relation to ratio of length to width. Correlation coefficient was +0.9205 to the degree of freedom of 14, which is obviously significant at 0.1% level. Generally speaking, the larger is the ratio of length to width, the larger is the ratio of length to thickness. Linear regression of ratio of length to width on ratio of length to thickness was calculated as follows; $Y = 1.106X + 2.217$, where Y and X indicate ratio of length to width (1 unit=0.1) and ratio of length to thickness (1 unit = 0.1), respectively. This formula indicates that the ratio of length to width becomes 1.106 larger, by becoming 1 degree larger the ratio of length to thickness (0 points, 2.76 in ratio of length to width and 3.96 in ratio of length to thickness, respectively).

Table 16. Width (*mm*) of unhusked grain of all the F_1 hybrids in relation to their thickness (*mm*). Figure used in the table shows the number of combinations.

Thickness (*mm*)	Width (*mm*)																				Total
	3.75 ∫ 3.71	3.70 ∫ 3.66	3.65 ∫ 3.61	3.60 ∫ 3.56	3.55 ∫ 3.51	3.50 ∫ 3.46	3.45 ∫ 3.41	3.40 ∫ 3.36	3.35 ∫ 3.31	3.30 ∫ 3.26	3.25 ∫ 3.21	3.20 ∫ 3.16	3.15 ∫ 3.11	3.10 ∫ 3.06	3.05 ∫ 3.01	3.00 ∫ 2.96	2.95 ∫ 2.91	2.90 ∫ 2.86	2.85 ∫ 2.81	2.80 ∫ 2.76	
2.65～2.61	1																				1
2.60～2.56																					0
2.55～2.51																					0
2.50～2.46					3	2															5
2.45～2.41		1	1			2		1													5
2.40～2.36			1	1	2		3	1	1		1										10
2.35～2.31				1	3	4	3	2		1						1					15
2.30～2.26				3		1	5	2	4		2										17
2.25～2.21					1		3		2			2									8
2.20～2.16					1	1	2	3	6	3	2	2	2								22
2.15～2.11					1	1	1	3	3	2	7	2	2								22
2.10～2.06								2	3	7	6	8	4	7	1						38
2.05～2.01							2		1	4	6	10	11	3	1	3		1	1		43
2.00～1.96								1	1	1	4	5	4	6	7		1			1	31
1.95～1.91										2	1	2	3	2	3	1	3				17
1.90～1.86													1	1		1					3
1.85～1.81															1		1				2
1.80～1.76													1								1
Total	1	1	2	5	11	11	19	15	21	20	29	31	28	19	13	6	5	1	1	1	240

$\gamma = +0.7667^{***}$ (d. f. = 238), significant at the 0.1% level.

Table 17. Ratio of length to width of the parental plants in relation to their ratio of length to thickness. Figure used in the table shows the number of strains.

Ratio of length to thickness	Ratio of length to width										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	
4.90～4.81	1										1
4.40～4.31		1									1
4.20～4.11		1									1
4.10～4.01				1		1					2
3.90～3.81			1								1
3.70～3.61					1	1					2
3.60～3.51										1	1
3.50～3.41							1	1			2
3.40～3.31									1		1
3.30～3.21								1			1
3.20～3.11									3		3
Total	1	2	1	1	1	2	1	2	4	1	16

$r = +0.9205^{***}$ (d. f. = 14), significant at the 0.1% level.

Hybrid; Correlation coefficient and linear regression of ratio of length to thickness on ratio of length to width in the same strain were calculated and are shown in Table 18. All strains showed significances at 0.1% level. In the whole combinations, value meant significance at 0.1% level. Ratio of length to thickness in all combinations are shown in Table 19 in relation to ratio of length to width. Correlation coefficient was +0.9178 to the degree of freedom of 238, which is obviously significant at 0.1% level. Generally speaking, the larger is the ratio of length to width, the larger is the ratio of length to thickness.

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

Parent; Correlation coefficient of ratio of width to thickness on ratio of length to width in parental plants was −0.5359, showing significance at 5% level. Ratio of width to thickness in all parents are shown in Table 20 in relation to ratio of length to width. Correlation coefficient was −0.5359 to the degree of freedom of 14, which is significant at 5% level. Generally speaking, the larger is the ratio of width to thickness, the smaller is the ratio of length to width. Linear regression of ratio of length to width on ratio of width to thickness was calculated as follows; $Y = -0.620X - 3.161$, where Y and X indicate ratio of length to width (1 unit = 0.1) and ratio of width to thickness (1 unit = 0.02), respectively. This formula indicates that the ratio of length to width becomes 0.620 larger, by becoming 1 degree smaller the ratio of width to thickness (0 points, 2.76 in ratio of length to width and 1.58 in ratio of width to thickness, respectively).

Hybrid; Correlation coefficient and linear regression of ratio of width to thickness on ratio of length to width in the same strain were calculated and are shown in Table

Table 18. Correlation coefficient and linear regression of three components; IV-ratio of length to thickness (Y, O point = 3.88) on ratio of length to width (X, O point = 2.76), V-ratio of width to thickness (Y, O point = 1.53) on ratio of length to width (X, O point = 2.76), VI-ratio of width to thickness (Y, O point = 1.53) on ratio of length to thickness (X, O point = 3.88), 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	0.9126***	28	Y = 1.185X+3.005	0.2616	28	—	0.6095***	28	Y = 0.486X+1.983
2	0.9178***	28	Y = 1.290X+3.863	−0.1359	28	—	0.6548***	28	Y = 0.655X+3.147
3	0.9793***	28	Y = 1.117X+2.027	0.4473*	28	Y = 0.345X+1.215	0.7581***	28	Y = 0.503X+1.295
4	0.8860***	28	Y = 1.165X+3.266	−0.0082	28	—	0.3994*	28	Y = 0.378X+2.165
5	0.9271***	28	Y = 0.846X+1.597	−0.1571	28	—	0.1614	28	—
6	0.9135***	28	Y = 0.864X+1.952	−0.2910	28	—	0.1350	28	—
7	0.8215***	28	Y = 1.006X+1.503	0.0118	28	—	0.6146***	28	Y = 0.805X+3.023
8	0.8450***	28	Y = 1.080X+1.825	0.4798**	28	Y = 0.668X+1.604	0.8377***	28	Y = 1.024X+1.035
9	0.9413***	28	Y = 0.929X+0.879	0.2850	28	—	0.3289	28	—
10	0.9455***	28	Y = 0.890X+1.364	−0.2640	28	—	0.0428	28	—
11	0.6371***	28	Y = 0.564X+1.178	−0.4781**	28	Y = −0.655X−2.218	0.4238*	28	Y = 0.632X+0.896
12	0.8844***	28	Y = 0.973X+1.960	0.0607	28	—	0.4399*	28	Y = 0.364X+1.459
13	0.9224***	28	Y = 0.921X+1.618	−0.1703	28	—	0.2209	28	—
14	0.5906***	28	Y = 0.583X−0.319	0.1295	28	—	0.4378*	28	Y = 0.381X+2.077
15	0.9129***	28	Y = 0.765X+1.208	−0.4767**	28	Y = −0.297X−0.989	−0.1132	28	—
16	0.9003***	28	Y = 1.041X+1.887	0.1381	28	—	0.4872**	28	Y = 0.490X+1.305
Whole	0.9178***	238	Y = 0.954X+1.710	−0.0651	238	—	0.2722***	238	Y = 0.224X+0.763

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

Table 19. Ratio of length to width of all the F_1 hybrids in relation to their ratio of length to thickness. Figure used in the table shows the number of combinations.

Ratio of length to thickness	Ratio of length to width																	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	
5.35～5.21			1																1
5.20～5.06	1																		1
5.05～4.91		1	1																2
4.90～4.76			1	1															2
4.75～4.61																			0
4.60～4.46																			0
4.45～4.31										4									4
4.30～4.16									1	3	3		1						8
4.15～4.01									1	1	4	5	1						12
4.00～3.86						1					3	8	10	8					30
3.85～3.71										1		6	15	13	5	1			41
3.70～3.56													1	10	4	1			16
3.55～3.41													1	6	15	6	1		29
3.40～3.26														3	14	23	5		45
3.25～3.11															1	8	8	1	18
3.10～2.96																4	11	3	18
2.95～2.81																	1	8	9
2.80～2.66																		4	4
Total	1	1	3	1	0	1	0	0	2	9	10	19	29	40	39	43	26	16	240

$\gamma = +0.9178^{***}$ (d. f. = 238), significant at the 0.1% level.

Table 20. Ratio of length to width of the parental plants in relation to their ratio of width to thickness. Figure used in the table shows the number of strains.

Ratio of width to thickness	Ratio of length to width										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	
1.80~1.79										1	1
1.70~1.69						1					1
1.62~1.61				1							1
1.60~1.59		1							1		2
1.56~1.55							1	1	1		3
1.54~1.53		1				1		1			3
1.52~1.51									2		2
1.48~1.47			1		1						2
1.38~1.37	1										1
Total	1	2	1	1	1	2	1	2	4	1	16

$\gamma = -0.5359^{*}$ (d. f. = 14), significant at the 5% level.

18. Three, 1 and 12 strains showed significances at 1%, 5% levels and no significance even at 5% level, respectively. In the whole combinations, value meant no significance even at 5% level. This finding was clearly different from the former 4 relations mentioned above.

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

Parent; Correlation coefficient of ratio of width to thickness on ratio of length to thickness in parental plants was −0.4670, showing no significance even at 5% level.

Hybrid; Correlation coefficient and linear regression of ratio of width to thickness on ratio of length to thickness in the same strain were calculated and are shown in Table 18. Five, 1, 4 and 6 strains showed significances at 0.1%, 1%, 5% levels and no significance even at 5% level, respectively. In the whole combinations, correlation coefficient was +0.2722 to the degree of freedom of 238, which is obviously significant at 0.1% level. Generally speaking, the larger is the ratio of length to thickness, the larger is the ratio of width to thickness.

Discussion

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

i) Morphological characters of grain measured here are said to be relatively stable under several environmental conditions[6]. In spite of this, measurement of awn length was difficult in some cases, because awn is easy to be broken in some case and is very short in another case. The mark "+" and "±" were, then, used in several combinations (Table 8).

ii) The average values of hybrid in the parental level were sometimes larger than that of

the respective parent for several characters (Tables 1, 3 and 10). On the other hand, in view of the standard deviation, it does not necessarily follow that the values of the parental level were larger than that of the respective parent. At this point, the considerations on hybrid vigor or heterosis may as well be borne in mind. Richharia *et al.*[7] found substantial heterosis in height and tillering of F_1 hybrids of rice compared with mid-parental values. Typical varietal representatives of the two distantly related variety groups of rice in combination are to be expected to show considerable hybrid vigor. The strains used in the present study may be belonged to this category. Jennings[2] studied the heterosis in *indica*×*japonica* hybrids of rice, and concluded that large heterotic values were observed in the increased total tillers and other characters. In the present experiment, hybrid vigor was observed in the several characters measured here. For example, in the case of No. 1 in view of thickness of unhusked grain, the average values in parental level were indicated to be 2.02*mm*, 2.08*mm* and 2.12*mm* in pure line, averages for female and male parents, respectively. In combination level, the thicknesses were 2.02*mm*, 1.91*mm*, 2.15*mm* and 2.09*mm* in No. 1, No. 2, No. 1(♀)× No. 2(♂) and No. 2(♀)×No. 1(♂), respectively (Tables 1 and 7). Those considerations were ascertained to be substantial in the several characters measured in the present experiment.

iii) In comparison with the data obtained in female and male parents, the following facts were found. Average values of practical values in the female parent were always similar to that of the male parent. On the other hand, average values of standard deviations in the female parent were always smaller than that of the male parent, excepting the case of ratio of width to thickness. In case of width and thickness, some strain showed the largest or smallest in the same strain in common with two characters. It may be said that the two characters have some characteristics common to genic action (Table 3). In case of ratio of length to width in No. 15, the practical values were the largest in the whole strains both in female and male parents. But it may be noticeable that the respective standard deviations were the largest and the smallest in the whole strains in female and male parents, respectively (Table 10). It was a peculiar phenomena that the practical value and its standard deviation were the largest and smallest in the whole strains in male case of ratio of length to thickness in No. 15, respectively. No. 14 showed the reversed result in this respect (Table 10). In length, all strains showed similar tendency in female and male parents in comparison with the practical values for the average in the whole strains, excepting for 1 strain, No. 12, Tapachini variety. Such tendency could not be found in other characters.

iv) From the data of reciprocal relations, it was clearly ascertained that some sets of combinations were always observed to have been slipped out from the standard pattern and in exceptional regions for several characters. Those tendencies were found in several combinations in common for several characters, for example, No. 2×No. 9, No. 6×No. 5, No. 9×No. 15, No. 14×No. 15 and others. Moreover, some segregations were found in the distribution of the values in view of reciprocal comparisons. For example, in case of the male parent, values of length, ratio of length to width and ratio of length to thickness in the whole combinations (Table 5) segregated for the larger and the smaller groups, showing the gaps found within 9.2*mm* to 8.8*mm*, 3.1 to 2.9 and 4.7 to 4.5, respectively. Those two phenomena may be duely attributed to the actions of gene.

In reciprocal view, it may be noticeable that Nos. 8 and 15, showed no significance even at 5% level in all six characters (Tables 4 and 11). Six, 4, 3, 1 and 2 strains showed significances in 4, 3, 2, 1 and 0 characters, respectively. This characters may be used for hetero- or homozygosis in each strain. In width, thickness and ratio of width to thickness, only 3, 1 and 2 strains showed significances, respectively, but the whole combinations of these three characters showed significances at 0.1, 1 and 5% levels, respectively (Tables 4 and 11). In spite of negative correlation found in the reciprocal comparisons, all of them constantly showed no significant differences. So, it was concluded that reciprocal differences suggested no considerable cytoplasmic inheritance which has been reported in this experiment. The known ones are the maternal effect on grain weight[1]. However, as the analyses and conclusion have left severel points in question, further analysis may be performed sincerely.

v) Six relations between the respective characters were analyzed, basing on correlation coefficient and linear regression calculated. In view of parental plants, 3 cases showed significances. In view of the whole combinations, five cases showed significances. Three, 6, 3 and 4 strains showed significant correlations in 5, 4, 3 and 2 relations between respective two characters, respectively. It was noticeable that 2 relations, *i.e.*, the one between width and thickness, and the other between ratio of length to width and ratio of length to thickness, showed significances in the whole strains. These tendencies may be based on the following facts. Some strain showed the largest or smallest in the same strain in common with these characters.

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 the latter. For example, correlation coefficients were of no significance and of some significance in the former and the latter, respectively, in cases of length and thickness, width and thickness, and ratio of length to thickness and ratio of width to thickness. In view of each set of combination, it was noticeable that some sets of combinations, *i.e.*, No. 6×No. 15, No. 8×No. 15, No. 15×No. 11, were found to have been slipped out from the standard pattern and in 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.

vi) The differences between the maximum and the minimum values of the six characters for each parent were, in case of the male parent, somewhat larger than that in case of the female parent, excepting for No. 15. In this strain, it may be noticeable that the differences were moreover very large in the female and male parents. These facts may perhaps suggest the existence of some readiness or un-readiness in the cross-ability and variety differentiation.

The differences in the respective characters at the time when two testers crossed with Sikkimese rice and reciprocals were calculated. In reciprocal view, correlation coefficients between the female and male parents were significant only in length, and nearly significant in thickness. The differences in this respect showed the similar tendency in No. 6, concerning length, width and thickness. It was noticeable that the differences against *japonica* (No. 2) were almost larger than that against *indica* (No. 1) in case of width and thickness, but smaller in case of ratio of length to width. In variety specificity, however, no clear tendency was commonly ascertained in the whole

characters measured.

vii) Tateoka[8] described that *O. minuta* may be different from *O. officinalis*, which are the wild rice species belonging to the genus *Oryza*, in spikelet width, but not in spikelet length. On account of the fact that spikelet width was assumed to be important character, which can be used in distinguishing rice species or strains, it may be looked upon as something reasonable that spikelet width and ratio of length to width (= spikelet shape) were adopted in the present experiment.

Summary

Succeeding to the previous papers[3,4], 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, seven characters, *i.e.*, length, width, thickness, awn, ratio of length to width, ratio of length to thickness and ratio of width to thickness of unhusked grains, and the mutual relationships were described. The main results obtained during this study were summarized as follows:

1) Length of parental plants and F_1 hybrid were both 7.55 *mm* in average. In view of reciprocal combinations, 13 strains and the whole combinations showed positive significances. Width of parental plants and F_1 hybrid were 3.18 *mm* and 3.25 *mm* in average, respectively. In view of reciprocal combination, 3 strains and the whole combinations showed positive significances. Thickness of parental plants and F_1 hybrid were 2.05 *mm* and 2.12 *mm* in average, respectively. In view of reciprocal combination, 1 strain and the whole combinations showed positive significances. Awn of parental plants and F_1 hybrid were found in 7 strains and 143 combinations, respectively. Ratio of length to width of parental plants and F_1 hybrid were 2.39 and 2.34 in average, respectively. In view of reciprocal combination, 13 strains and the whole combinations showed positive significances. Ratio of length to thickness of parental plants and F_1 hybrid were 3.71 and 3.59 in average, respectively. In view of reciprocal combinations, 11 strains and the whole combinations showed positive significances. Ratio of width to thickness of parental plants and F_1 hybrid were 1.56 and 1.54 in average, respectively. In view of reciprocal combination, 2 strains and the whole combinations showed positive significances.

2) The differences of the respective character in the parental and combination levels were ascertained to be very large 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 seven 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 characters were analyzed and showed the following results. In view of parental plants, 3 cases showed significances at 0.1%, 1%, and 5% levels each. In view of the whole cross combinations, 3, 1, 1 and 1 cases showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively.

References

1) Chandraratna, M. F. and Sakai, K. I.: *Heredity* **41**, 365-373 (1960)
2) Jennings, P. R.: *Intern. Rice Res. Inst., Technical Bull.* **5**, 1-63 (1966)
3) Katayama, T. C.: *Mem. Fac. Agr. Kagoshima Univ.* **10**, 1-35 (1974)
4) ——————: *ibid.* **11**, 1-55 (1975)
5) Kato, S., Kosaka, H., Hara, S., Maruyama, Y. and Takiguchi, Y.: *Jour. Dep. Agr. Kyushu Imp. Univ.* **2** (9), 241-276 (1930)
6) Matsuo, T.: *Bull. Nat. Inst. Agr. Sci. Series D* (in Jap. with Eng. Sum.) **3**, 1-111 (1952)
7) Richharia, R. H. and Misro, B.: *J. Bio. Sci.* **2** (2), 35-47 (1959)
8) Tateoka, T.: *Bot. Mag. Tokyo* **75**, 418-427 (1962)