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

V. Husked Grains

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Introduction

Kato *et al.*[7] classified varieties of *Oryza sativa* L. into subspecies, *japonica* and *indica*. Many reports have been published on the classification of rice varieties into geographical races. However, the idea of dividing rice varieties is rapidly losing its significance in accordance with further intensive works[2].

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*. Since the consideration using diallel crosses is superior to those using single crosses for looking into combining ability, heterosis and cytoplasmic inheritance, diallel cross was employed here. In the previous papers, crossability, pollen and seed fertilities[3], heading dates[4], some morphological characters of plant[5], morphological characters of unhusked grains[6] and some relations among them were reported. In the present report, morphological characters of husked grains, and some relations among them were mainly described. Other characters, including comparative studies of unhusked and husked grains, were measured and are 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[8], 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. Procedures of the cross and cultivation of the parental and hybrid plants were minutely mentioned in the previous paper[3].

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 husked grains and grain color. Twenty grains were used for the measurement of each strain or combination. The measurements were made at the largest position of the respective character. Calculations, moreover, were made 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 analyses of the 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 (7.32 *mm*) was obtained in No.15, followed by No.5 (5.98 *mm*) and No.4 (5.83 *mm*). The shortest (4.68 *mm*) was noted in No.2, followed by No.7 (4.76 *mm*) and No.14 (4.79 *mm*). Average and standard deviations in the whole strains were found to be 5.43 ± 0.63.

Hybrid; The value of length among diallel crosses is shown in Table 2. A wide range was observed. Length for individual seed level ranged from 7.5 *mm* to 4.5 *mm* and mean length ranged from 6 *mm* to 5 *mm*. In the combination level, the longest (7.26 *mm*) was obtained in the combination, No.15(♀) × No.6(♂), followed by No.15 × No.14 (7.09 *mm*) and No.15 × No.10 (7.03 *mm*). The shortest (4.67 *mm*) was noted in the combination, No.3 × No.14, followed by No.14 × No.7 (4.71 *mm*) and No.14 × No.16 (4.72 *mm*). The differences in length were confirmed to be very large in accordance with the varieties in the respective combination-set.

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

Code No.	Strain	Origin	Variety	Length (*mm*)	Width (*mm*)	Thickness (*mm*)	L/W	L/T	W/T	Color
1	108	Formosa	*Indica*	5.69	2.55	1.69	2.05	3.37	1.51	White
2	563	Japan	*Japonica*	4.68	2.65	1.64	1.77	2.85	1.62	White
3	C7707	Sikkim	Addey	5.14	2.73	1.75	1.88	2.94	1.56	White
4	C7716	〃	Lama	5.83	2.72	1.73	2.14	3.37	1.57	Red
5	C7717	〃	Lama	5.98	2.66	1.82	2.25	3.29	1.46	White
6	C7718	〃	Tokmor Zo	5.68	2.72	1.74	2.09	3.26	1.56	Red
7	C7719	〃	Tokmor Zo	4.76	2.74	1.93	1.74	2.47	1.42	White
8	C7722	〃	Addey	5.64	2.39	1.63	2.36	3.46	1.47	Red
9	C7725	〃	Addey	5.14	2.81	1.76	1.83	2.92	1.60	White
10	C7727	〃	Addey	5.30	2.89	1.75	1.88	3.03	1.65	White
11	C7729	〃	Addey	5.61	2.43	1.66	2.31	3.38	1.46	Red
12	C7732	〃	Tapachini	5.46	2.63	1.80	2.08	3.03	1.46	White
13	C7734	〃	Fudangay	4.97	2.84	1.93	1.75	2.58	1.47	White
14	C7735	〃	Fudangay	4.79	2.83	1.87	1.69	2.56	1.51	White
15	C7754	〃	Champasari	7.32	2.35	1.75	3.11	4.18	1.34	White
16	C7757	〃	Addey	4.96	2.56	1.73	1.94	2.87	1.48	White

Table 2. Length of husked 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
Code No.	1		5.17	5.15	5.48	5.53	5.60	5.02	5.40	5.17	5.17	5.45	5.18	5.07	5.04	5.97	5.04
	2	5.18		4.98	5.58	5.51	5.43	5.05	5.48	5.03	5.09	5.76	5.18	4.93	5.04	5.61	5.06
	3	5.19	4.99		5.07	5.31	5.52	4.82	5.53	5.27	5.13	5.24	5.30	4.89	4.67	6.03	5.05
	4	5.72	5.43	5.69		5.61	5.85	5.39	6.07	5.60	5.85	6.17	5.79	5.43	5.19	6.53	5.54
	5	5.94	5.82	5.46	5.83		5.76	5.58	6.17	5.35	5.66	6.13	5.71	5.60	5.35	6.34	5.41
	6	5.63	5.57	5.67	5.93	5.54		5.39	5.98	5.67	5.80	6.24	5.87	5.41	5.25	6.58	5.49
	7	4.97	4.91	4.83	5.47	5.49	5.15		5.48	4.89	4.81	5.34	5.21	4.77	4.74	5.64	4.79
	8	5.55	5.40	5.61	5.81	5.35	5.68	5.63		5.69	5.60	5.93	5.64	5.43	5.41	6.18	5.48
	9	5.25	5.12	5.02	5.57	5.51	5.55	4.93	5.39		5.11	5.69	5.20	4.91	4.91	5.61	5.04
	10	5.26	5.08	5.09	5.71	5.54	5.71	4.77	5.56	5.45		4.91	5.29	4.99	4.92	5.82	4.98
	11	5.61	5.40	5.61	5.99	5.81	5.36	5.56	5.91	5.53	5.63		5.60	5.44	5.59	6.20	5.54
	12	5.37	5.12	5.26	5.73	6.14	5.64	5.28	5.58	5.34	5.41	5.76		5.45	5.46	6.20	5.35
	13	4.99	5.08	4.92	5.32	5.09	5.47	4.91	5.72	5.00	5.00	5.37	5.25		4.83	5.85	4.89
	14	4.97	4.84	4.77	5.24	5.17	5.34	4.71	5.49	4.88	4.85	5.30	5.10	4.75		5.72	4.72
	15	5.97	5.88	5.94	6.50	6.87	7.26	5.69	6.06	6.96	7.03	6.48	6.13	6.76	7.09		5.95
	16	5.04	5.04	4.95	5.47	5.74	5.41	4.79	5.46	4.97	5.09	5.19	5.11	4.80	4.78	5.90	

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

Code No.	Length (*mm*)		Width (*mm*)		Thickness (*mm*)	
	Female	Male	Female	Male	Female	Male
1	5.30±0.26	5.38±0.33	2.71±0.11	2.70±0.14	1.77±0.10	1.81±0.09
2	5.26±0.26	5.26±0.30	2.78±0.08	2.81±0.08	1.87±0.09	1.88±0.09
3	5.20±0.32	5.26±0.36	2.70±0.13	2.74±0.11	1.85±0.07	1.84±0.09
4	5.72±0.33	5.65±0.34	2.70±0.06	2.72±0.06	1.76±0.06	1.79±0.05
5	5.74±0.29	5.61±0.42	2.71±0.06	2.68±0.12	1.79±0.04	1.77±0.06
6	5.74±0.34	5.65±0.47	2.78±0.09	2.71±0.15	1.78±0.05	1.79±0.06
7	5.10±0.30	5.17±0.34	2.73±0.07	2.71±0.10	1.84±0.05	1.82±0.10
8	5.63±0.21	5.69±0.27	2.62±0.08	2.62±0.06	1.76±0.05	1.77±0.06
9	5.25±0.27	5.39±0.50	2.81±0.08	2.75±0.15	1.90±0.07	1.85±0.11
10	5.27±0.33	5.42±0.54	2.77±0.10	2.74±0.14	1.82±0.10	1.81±0.06
11	5.65±0.22	5.66±0.44	2.59±0.08	2.63±0.09	1.74±0.05	1.75±0.04
12	5.54±0.30	5.44±0.31	2.72±0.10	2.72±0.09	1.80±0.06	1.80±0.07
13	5.18±0.30	5.24±0.50	2.78±0.11	2.72±0.13	1.82±0.08	1.85±0.07
14	5.06±0.30	5.22±0.57	2.78±0.11	2.78±0.17	1.83±0.11	1.87±0.11
15	6.44±0.51	6.01±0.31	2.46±0.15	2.59±0.06	1.77±0.06	1.78±0.03
16	5.18±0.33	5.22±0.33	2.68±0.09	2.67±0.08	1.84±0.07	1.79±0.08
Whole	5.45±0.47		2.70±0.14		1.81±0.09	

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 (6.44 *mm*) was obtained in No.15, followed by Nos.5 and 6 (5.74 *mm*). The lowest value in the parental average (5.06 *mm*) was noted in No.14, followed by Nos.13 and 16 (5.18 *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 and peculiarly large value of 0.51 was obtained in No.15. The lowest value (0.21) was noted in No.8, followed by No.11 (0.22). 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 (6.01 *mm*) was also obtained in No.15, followed by No.8 (5.69 *mm*) and No.11 (5.66 *mm*). The lowest value in the parental average (5.17 *mm*) was noted in No.7, followed by Nos.14 and 16 (5.22 *mm*). In standard deviation, the highest value (0.57) was obtained in No.14. The lowest value (0.27) was also 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 5.45±0.47.

In view of the variety specificity, the following facts were ascertained. In case of the female and male parents, Champasari, Lama, half of Tokmor Zo and one third of Addey varieties showed the values larger than that of the average in the whole combinations (=5.45 *mm*). On the other hand, *indica*, *japonica*, Fudangay, half of Tokmor Zo and two

Table 4. Correlation coefficient and linear regression of three characters of female parent (Y) on male parent (X); length, width, thickness of husked grain. O points, 5.88 *mm*, 2.58 *mm* and 1.77 *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	0.9234***	13	Y = 0.780X−1.415	0.3996	13	—	0.3937	13	—
2	0.8716***	13	Y = 0.721X−1.268	0.6554**	13	Y = 0.746X+0.586	0.8265***	13	Y = 0.790X+0.160
3	0.8319***	13	Y = 0.804X−1.263	0.3004	13	—	0.5360*	13	Y = 0.541X+1.815
4	0.8082***	13	Y = 0.974X−0.166	0.7326**	13	Y = 0.652X+0.707	0.3418	13	—
5	0.5238*	13	Y = 0.380X−0.944	0.5776*	13	Y = 0.282X+2.055	0.3737	13	—
6	0.8047***	13	Y = 0.601X−0.118	0.7952***	13	Y = 0.474X+2.704	0.5431*	13	Y = 0.403X+0.572
7	0.9057***	13	Y = 0.873X−0.818	0.7833***	13	Y = 0.571X+1.486	0.4324	13	—
8	0.4365	13	—	0.6555**	13	Y = 0.720X+0.453	0.3545	13	—
9	0.6246*	13	Y = 0.392X−2.734	0.5593*	13	Y = 0.275X+3.337	0.4816	13	—
10	0.7730***	13	Y = 0.516X−2.385	0.6660**	13	Y = 0.430X+1.852	0.6647**	13	Y = 0.827X−0.497
11	0.5141*	13	Y = 0.611X−0.315	0.2135	13	—	0.0207	13	—
12	0.8134***	13	Y = 0.813X−0.511	0.7639***	13	Y = 0.692X+0.770	0.9481***	13	Y = 1.338X−0.227
13	0.8208***	13	Y = 0.547X−2.199	0.6696**	13	Y = 0.325X + 1.897	0.5408*	13	Y = 0.411X+1.711
14	0.5537*	13	Y = 0.403X−2.930	0.7740***	13	Y = 0.517X+2.440	0.6680**	13	Y = 0.450X+2.553
15	0.2352	13	—	−0.3229	13	—	−0.2294	13	—
16	0.8752***	13	Y = 0.916X−0.258	0.7108**	13	Y = 0.664X+0.516	0.6840**	13	Y = 0.719X—1.078
Whole	0.7880***	118	Y = 0.641X−1.302	0.5197***	118	Y = 0.353X+1.809	0.5792***	118	Y = 0.550X+0.545

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

thirds of Addey 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 one noted at the time when the 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 are shown in Table 4. Basing on the data obtained in this calculation, t-test was made from analyses of variance for reciprocal cross comparisons. From this table, the following facts were ascertained. Ten, 4 and 2 strains showed significances at 0.1%, 5% levels and no significance even at 5% level, respectively. In the whole strains, correlation coefficient is +0.7880 to the degree of freedom of 118, which is obviously significant at 0.1% level. Generally speaking, the longer is the one 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; 0.95, 0.83, 1.36, 1.14, 0.99, 1.33, 0.90, 0.83, 0.78, 1.05, 0.84, 1.08, 1.02, 1.01, 1.57 and 1.12, respectively. The average and its standard deviations were 1.05 ± 0.21. The strain showing large value in this respect had a remarkable difference in length, which were found in the combinations with 15 alien parents, at the time when the strain was used as female parent and alien strains were used as male parents, respectively. In an extreme case, the lengths were 7.26 *mm* and 5.69 *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 were found in the combinations with 15 alien parents, at the time when the strain was used as female parent and alien strains were used as male parents. In an extreme case, the lengths were 5.69 *mm* and 4.91 *mm* in No.9 × No.11 and No.9 × Nos.13 and 14, respectively. In other words, No.9 showed affinities nearly similar to each strain, at the time when No.9 was used as female parent. Those in view of the male parent were as follows in the same order; 1.00, 1.04, 1.17, 1.43, 1.78, 2.11, 0.98, 0.78, 2.08, 2.22, 1.57, 1.03, 1.99, 2.42, 0.97 and 1.23, respectively. It may be noted that the value was peculiarly large in No.14. Those average and its standard deviations were 1.49 ± 0.52. The strain showing large value in this respect had a remarkable difference in length, which were found in the combinations with 15 alien parents, at the time when the strain was used as male parent and alien strains were used as female parents, respectively. In an extreme case, the lengths were 7.09 *mm* and 4.67 *mm* in No.15 × No.14 and No.3 × No.14, respectively. The former value was the nearly largest and the latter was the smallest in the whole combinations (= 240). In other words, No.14 showed affinities remarkably different from each strain, at the time when it was used as male parent. The strain showing small value in this respect had a few differences in length, which were found in the combinations with 15 alien parents, at the time when the strain was used as male parent and alien strains were used as female parent. In an extreme case, the lengths were 6.17 *mm* and 5.39 *mm* in No.5 × No.8 and No.9 × No.8, respectively. In other words, No.8 showed affinities relatively similar to each strain, at the time when it was used

as male parent. In reciprocal views, correlation coefficient between them was −0.0051, showing no significance even at 5% level.

In view of the variety specificity, the following facts were ascertained. In case of the female parent, Tapachini, Champasari, one third of Addey, half of Lama and half of Tokmor Zo varieties showed the values larger than that of the average in the whole strains (=1.05). *Indica, japonica*, Fudangay, half of Addey, half of Lama and half of Tokmor Zo varieties showed the values smaller than that of the average in the whole strains. One sixth of Addey variety showed the value similar to that of the average in the whole strains. In case of the male parent, Fudangay, half of Addey, half of Lama and half of Tokmor Zo varieties showed the values larger than that of the average in the whole strains (=1.49). *Indica, japonica*, Tapachini, Champasari, half of Addey, half of Lama and half of Tokmor Zo varieties showed the values smaller than that of the average in the whole strains. These findings propose quite an 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 were 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; 0.20, 0.29, 0.12, 0.06, 0.06, 0.15, 0.13, 0.18, 0.21, 0.25, 0.07, 0.13, 0.09 and 0.00, respectively. The strain showing large value in this respect had a remarkable difference in length, which were found in the combinations with two testers, at the time when the strain was used as female parent and the testers were used as male parents. In an extreme case, the lengths were 5.72 *mm* and 5.43 *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 were found in the combinations with two testers, at the time when the strain was used as female parent and the testers were used as male parents. In an extreme case, the lengths were 5.04 *mm* in both No.16 × No.1 and No.16 × No.2. In other words, No.16 showed affinities quite similar to each tester, at the time when No.16 was used as female parent. Average and its standard deviations in the whole Sikkimese rice were 0.14±0.08. In view of the male parent, the differences of length for *indica* and *japonica* were as follows in the same order; 0.17, 0.10, 0.02, 0.17, 0.03, 0.08, 0.14, 0.08, 0.31, 0.00, 0.04, 0.00, 0.36 and 0.02, respectively. The strain showing large value in this respect had a remarkable difference in length, which were found in the combinations with two testers, at the time when the strain was used as male parent and the testers were used as female parents. In an extreme case, the lengths were 5.97 *mm* and 5.61 *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 were found in the combinations with two testers, at the time when the strain was used as male parent and the testers were used as female parents. In an extreme case, the lengths were 5.18 *mm* in both No.1 × No.12 and No.2 × No.12. In other words, No.12 showed affinities similar to each tester. Average and its standard deviations in the whole Sikkimese rice were 0.12±0.11.

It was noticeable that Nos.3, 4, 12, 15 and 16 showed large values in the difference from each tester at the time when they were used as female parent, but showed small values, when used as male parent. Nos.5, 9, 11, 13 and 14 showed the reversed results. No.6 showed relatively large values in the differences for each tester when it was used as both female

and male parents. Nos.1, 2, 7 and 8 showed the reversed results. In reciprocal views, correlation coefficient between them was −0.3917, showing no significance even at 5% level. Further relation in the reciprocal combinations was not ascertained clearly.

In view of the variety specificity, the following facts were ascertained. In case of the female parent, Tapachini, two thirds of Addey and half of Lama varieties showed the values larger than that of the average in the whole strains (=0.14). Tokmor Zo, Fudangay, Champasari, one third of Addey and half of Tokmor Zo varieties showed the values smaller than that of the average in the whole strains. In case of the male parent, Champasari, half of Addey, half of Tokmor Zo and half of Fudangay varieties showed the values larger than that of the average in the whole strains (=0.12). Lama, Tapachini, half of Addey, half of Tokmor Zo and half of 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 (2.89 *mm*) was obtained in No.10, followed by No.13 (2.84 *mm*) and No.14 (2.83 *mm*). The narrowest (2.35 *mm*) was noted in No.15, followed by No.8 (2.39 *mm*) and No.11 (2.43 *mm*). Average and standard deviations in the whole strains were found to be 2.66±0.16.

Hybrid; The values of width among diallel crosses are shown in Table 5. The considerable range was observed. Width for individual seed level ranged from 3.2 *mm* to 2.0 *mm* and mean width ranged from 2.9 *mm* to 2.4 *mm*. In the combination level, the widest (2.98 *mm*) was observed in the combination, No.13 × No.1, followed by No.9 × No.14 (2.96 *mm*) and No.10 × No.14 (2.95 *mm*). The narrowest (2.25 *mm*) was noted in the combination, No.15 × No.14, followed by No.15 × No.6 (2.28 *mm*) and No.15 × No.10 (2.30 *mm*). The differences in width were confirmed to be large in accordance with the varieties in the respective combination-set.

In Table 3, the average value and the standard deviations in width in the whole combinations are shown. In view of the female parent, the highest value in the parental average (2.81 *mm*) was obtained in No.9, followed by Nos.2, 6, 13 and 14 (2.78 *mm*). The lowest value in the parental average (2.46 *mm*) was noted in No.14, followed by No.11 (2.59 *mm*) and No.8 (2.62 *mm*). The differences of width in the parental level were ascertained to be large in accordance with each parent. In standard deviation, the highest value (0.15) was obtained in No.15, followed by Nos.1, 13 and 14 (0.11). The lowest value (0.06) was noted in Nos.4 and 5. 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 (2.81 *mm*) was obtained in No.2, followed by No.14 (2.78 *mm*) and No.9 (2.75 *mm*). The lowest value in the parental average (2.59 *mm*) was noted in No.15, followed by No.8 (2.62 *mm*) and No.11 (2.63 *mm*). In standard deviation, the highest value (0.17) was obtained in No.14, followed by Nos.6 and 9 (0.15). The lowest value (0.06) was noted in Nos.4, 8 and 15. 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 2.70±0.14.

In view of the variety specificity, the following facts were ascertained. In case of the female and male parents, *japonica*, Tokmor Zo, Tapachini, Fudangay and one third of Addey varieties showed the values larger than that of the average in the whole combinations (=2.70). Half of Addey and Champasari varieties showed the reversed results. Generally speaking, the larger is the one noted at the time when strain was used as

Table 5. Width of husked 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
Code No.	1		2.87	2.83	2.70	2.65	2.71	2.79	2.58	2.86	2.83	2.62	2.56	2.71	2.79	2.54	2.66
	2	2.82		2.90	2.76	2.71	2.78	2.76	2.58	2.82	2.82	2.71	2.81	2.85	2.89	2.64	2.77
	3	2.37	2.85		2.73	2.75	2.87	2.78	2.66	2.68	2.61	2.68	2.79	2.69	2.86	2.58	2.63
	4	2.63	2.79	2.72		2.67	2.71	2.69	2.66	2.76	2.75	2.71	2.66	2.75	2.80	2.59	2.64
	5	2.71	2.68	2.72	2.73		2.67	2.74	2.69	2.78	2.76	2.72	2.77	2.74	2.79	2.63	2.57
	6	2.73	2.78	2.83	2.77	2.66		2.83	2.63	2.86	2.87	2.72	2.79	2.83	2.94	2.63	2.77
	7	2.73	2.82	2.77	2.73	2.80	2.76		2.63	2.81	2.77	2.56	2.74	2.74	2.73	2.60	2.72
	8	2.59	2.72	2.64	2.62	2.60	2.60	2.60		2.73	2.72	2.48	2.61	2.69	2.63	2.48	2.58
	9	2.82	2.91	2.80	2.79	2.88	2.86	2.82	2.69		2.71	2.77	2.76	2.89	2.96	2.68	2.78
	10	2.83	2.82	2.65	2.80	2.80	2.84	2.85	2.73	2.87		2.57	2.76	2.78	2.95	2.65	2.62
	11	2.59	2.67	2.45	2.67	2.54	2.53	2.60	2.54	2.56	2.75		2.64	2.64	2.63	2.47	2.52
	12	2.64	2.86	2.83	2.74	2.62	2.73	2.73	2.59	2.83	2.77	2.63		2.65	2.90	2.58	2.72
	13	2.98	2.94	2.79	2.73	2.79	2.84	2.74	2.61	2.88	2.86	2.60	2.79		2.78	2.64	2.74
	14	2.82	2.92	2.85	2.78	2.75	2.82	2.54	2.69	2.88	2.91	2.69	2.86	2.78		2.60	2.73
	15	2.57	2.72	2.67	2.59	2.39	2.28	2.54	2.50	2.29	2.30	2.43	2.56	2.31	2.25		2.55
	16	2.71	2.81	2.67	2.71	2.53	2.69	2.65	2.56	2.68	2.69	2.60	2.70	2.79	2.83	2.53	

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 are shown in Table 4. Four, 6, 2 and 4 strains showed significances at 0.1%, 1%, 5% levels and no significance even at 5% level, respectively. In the whole strains, correlation coefficient is +0.5197 to the degree of freedom of 118, which is significant at 0.1% level. Generally speaking, the wider is the one 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; 0.33, 0.32, 0.50, 0.21, 0.20, 0.31, 0.26, 0.25, 0.28, 0.38, 0.30, 0.32, 0.38, 0.38, 0.47 and 0.30, respectively. It may be noted that the values were peculiarly large in Nos.3 and 15. The average and its standard deviations were 0.32 ± 0.08. Those in view of the male parent were as follows in the same order; 0.61, 0.27, 0.45, 0.21, 0.49, 0.59, 0.31, 0.23, 0.59, 0.61, 0.34, 0.30, 0.58, 0.71, 0.21 and 0.26, respectively. Those average and its standard deviations were 0.42 ± 0.17. In reciprocal views, correlation coefficient between them was +0.1803, 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*, Fudangay, Champasari and one third of Addey varieties showed the values larger than that of the average in the whole strains (=0.32). Lama, Tokmor Zo and two thirds of Addey varieties showed the values smaller than that of the average in the whole strains. *Japonica* and Tapachini varieties showed the values similar to that of the average in the whole strains. In case of male parent, *indica*, Fudangay, half of Addey, half of Lama and half of Tokmor Zo varieties showed the values larger than that of the average in the whole strains (=0.42). *Japonica*, Tapachini, Champasari, half of Addey, half of Lama and half of Tokmor Zo varieties showed the values smaller than that of the average in the whole strains. These findings propose quite an 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 were 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; 0.48, 0.16, 0.03, 0.05, 0.09, 0.13, 0.09, 0.01, 0.08, 0.22, 0.04, 0.10, 0.15 and 0.10, respectively. It may be noted that the value was peculiarly large in No.3. Average and its standard deviation in the whole Sikkimese rice were 0.12 ± 0.11. In view of the male parent, the differences of the width for *indica* and *japonica* were as follows in the same order; 0.07, 0.06, 0.06, 0.07, 0.03, 0.00, 0.04, 0.01, 0.09, 0.25, 0.14, 0.10, 0.10 and 0.11, respectively. Average and its standard deviations in the whole Sikkimese rice were 0.08 ± 0.06.

It was noticeable that No.12 showed relatively large value in the differences from each tester when it was used as both female and male parents. Nos.5, 6, 9, 10 and 11 showed the reversed results. No.3 showed large value in the differences from each tester at the time when it was used as female parent, but showed small value, when used as male parent. In reciprocal view, correlation coefficient between them was +0.3901, showing no significance even at 5% level.

In view of variety specificity, the following facts were ascertained. In case of the female parent, Tapachini, Champasari, one third of Addey and half of Lama varieties showed the values larger than that of the average in the whole strains (=0.12). Tokmor Zo, Fudangay, two thirds of Addey and half of Lama varieties showed the values smaller than that of the average in the whole strains. In case of the male parent, Tapachini, Fudangay, Champasari and one third of Addey varieties showed the values larger than that of the average in the whole strains (=0.08). Lama, Tokmor Zo and two thirds of Addey 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 (1.93 *mm*) was obtained in Nos.7 and 13, followed by No.14 (1.87 *mm*). The thinnest (1.63 *mm*) was noted in No.8, followed by No.2 (1.64 *mm*) and No.11 (1.66 *mm*). Average and standard deviations in the whole strains were found to be 1.76 ± 0.09.

Hybrid; The values of the thickness among diallel crosses are shown in Table 6. The considerable range was observed. Thickness for individual seed level ranged from 2.3 *mm* to 1.3 *mm* and mean thickness ranged from 1.9 *mm* to 1.6 *mm*. In the combination level, the thickest (2.02 *mm*) was observed in the combination, No.9 × No.2, which was the same as in case of the unhusked grain, followed by No.9 × No.14, No.10 × No.14 and No.14 × No.9 (2.01 *mm*). The thinnest (1.54 *mm*) was noted in the combination, No.14 × No.7, which was also the same as in case of the unhusked grain, followed by No.1 × No.9 (1.55 *mm*) and No.11 × No.3 (1.61 *mm*). The differences in thickness were confirmed to be very large in accordance with the varieties in the respective combination-set.

In Table 3, the average value and the standard deviations in thickness in the whole combinations are shown. In view of the female parent, the highest value in the parental average (1.90 *mm*) was obtained in No.9, followed by No.2 (1.87 *mm*) and No.3 (1.85 *mm*). The lowest value in the parental average (1.74 *mm*) was noted in No.11, followed by Nos.4 and 8 (1.76 *mm*). The differences of thickness in the parental level were ascertained to be large in accordance with each parent. In standard deviation, the highest value (0.11) was obtained in No.14, followed by Nos.1 and 10 (0.10). The lowest value (0.04) was noted in No.5. 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 (1.88 *mm*) was obtained in No.2, which was the same as in case of the unhusked grain, followed by No.14 (1.87 *mm*). The lowest value in the parental average (1.75 *mm*) was noted in No.11, which was the same as in case of female parent, followed by Nos.5 and 8 (1.77 *mm*). In standard deviation, the highest value (0.11) was obtained in Nos.9 and 14. The lowest value (0.03) was noted in No.15, followed by No.11 (0.04). 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 1.81 ± 0.09.

In view of the variety specificity, the following facts were ascertained. In case of the female parent, *japonica*, Fudangay, two thirds of Addey and half of Tokmor Zo varieties showed the values larger than that of the average in the whole combinations (=1.81). *Indica*, Lama, Tapachini, Champasari, one third of Addey and half of Tokmor Zo varieties showed the values smaller than that of the average in the whole combinations. In case of the male parent, *japonica*, Fudangay, one third of Addey and half of Tokmor Zo varieties showed the values larger than that of the average in the whole combinations. Lama, Tapachini, Champasari, half of Addey and half of Tokmor Zo varieties showed the values smaller

Table 6. Thickness of husked 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		1.90	1.90	1.78	1.71	1.76	1.87	1.75	1.55	1.85	1.75	1.68	1.85	1.86	1.76	1.82
2	1.92		2.00	1.79	1.71	1.83	1.82	1.81	1.99	1.97	1.78	1.89	1.93	1.87	1.78	1.94
3	1.85	1.94		1.89	1.84	1.82	1.97	1.80	1.84	1.74	1.79	1.85	1.93	1.97	1.77	1.75
4	1.74	1.88	1.78		1.68	1.80	1.75	1.74	1.87	1.79	1.74	1.66	1.79	1.72	1.72	1.68
5	1.71	1.74	1.80	1.78		1.77	1.84	1.78	1.81	1.81	1.76	1.75	1.85	1.89	1.80	1.78
6	1.70	1.77	1.81	1.78	1.82		1.82	1.73	1.86	1.81	1.72	1.79	1.79	1.86	1.76	1.71
7	1.84	1.85	1.92	1.83	1.81	1.85		1.74	1.91	1.79	1.73	1.92	1.86	1.81	1.85	1.87
8	1.70	1.74	1.75	1.73	1.70	1.72	1.73		1.78	1.80	1.73	1.80	1.86	1.84	1.79	1.79
9	1.90	2.02	1.87	1.91	1.88	1.91	1.94	1.91		1.83	1.80	1.82	1.97	2.01	1.80	1.87
10	1.83	2.00	1.79	1.80	1.83	1.86	1.97	1.75	1.82		1.62	1.79	1.82	2.01	1.78	1.69
11	1.75	1.82	1.61	1.79	1.81	1.72	1.76	1.65	1.73	1.72		1.76	1.78	1.78	1.74	1.72
12	1.75	1.86	1.84	1.71	1.74	1.80	1.88	1.78	1.81	1.79	1.75		1.78	1.96	1.75	1.78
13	2.00	1.94	1.83	1.74	1.80	1.77	1.84	1.78	1.93	1.85	1.72	1.77		1.77	1.82	1.80
14	1.84	1.95	1.95	1.77	1.76	1.74	1.54	1.77	2.01	1.90	1.78	1.93	1.78		1.83	1.93
15	1.75	1.87	1.87	1.74	1.73	1.70	1.74	1.81	1.82	1.76	1.77	1.76	1.76	1.65		1.74
16	1.82	1.97	1.88	1.81	1.78	1.78	1.81	1.80	1.84	1.80	1.76	1.81	1.95	2.00	1.79	

Code No.

than that of the average in the whole combinations. *Indica* and one sixth of Addey varieties showed the values the same as that of the average in the whole combinations. Generally speaking, the larger is the one 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 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 are shown in Table 4. Two, 3, 3 and 8 strains showed significances at 0.1%, 1%, 5% levels and no significance even at 5% level, respectively. In the whole strains, correlation coefficient is +0.5792 to the degree of freedom of 118, which is significant at 0.1% level. Generally speaking, the thicker is the one 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; 0.35, 0.29, 0.23, 0.22, 0.18, 0.16, 0.19, 0.16, 0.21, 0.39, 0.21, 0.25, 0.28, 0.47, 0.22 and 0.24, respectively. It may be noted that the value was peculiarly large in No.14. The average and its standard deviations were 0.25 ± 0.08. Those in view of the male parent were as follows in the same order; 0.30, 0.28, 0.39, 0.20, 0.18, 0.21, 0.43, 0.26, 0.46, 0.25, 0.18, 0.27, 0.21, 0.36, 0.13 and 0.25, respectively. It may be noted that the values were peculiarly large in Nos.7 and 9. Those average and its standard deviations were 0.27 ± 0.09. In reciprocal views, correlation coefficient between them was +0.2013, 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, japonica,* Fudangay and one sixth of Addey varieties showed the values larger than that of the average in the whole strains (=0.25). Lama, Tokmor Zo, Champasari and five sixths of Addey varieties showed the values smaller than that of the average in the whole strains. In case of the male parent, *indica, japonica,* one third of Addey, half of Tokmor Zo and half of Fudangay varieties showed the values larger than that of the average in the whole strains (=0.27). Lama, Champasari, two thirds of Addey, half of Tokmor Zo and half of Fudangay varieties showed the values smaller than that of the average in the whole strains. Tapachini variety showed the values the same as that of the average in the whole strains in both female and male parents. These findings propose quite an 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 were 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; 0.09, 0.14, 0.03, 0.07, 0.01, 0.04, 0.12, 0.17, 0.07, 0.11, 0.06, 0.11, 0.12 and 0.15, respectively. Average and its standard deviations in the whole Sikkimese rice were 0.09 ± 0.05. In view of the male parent, the differences of thickness for *indica* and *japonica* were as follows in the same order; 0.10, 0.01, 0.00, 0.07, 0.05, 0.06, 0.44, 0.12, 0.03, 0.21, 0.08, 0.01, 0.02 and 0.12, respectively. It may be noted that the value was peculiarly large in No.9. Average and its standard deviations in the whole Sikkimese rice were 0.09 ± 0.11

It was noticeable that Nos.9, 10, 12 and 16 showed relatively large values in the differences from each tester when they were used as both female and male parents. Nos.5, 6, 7, 8, 11 and 13 showed the reversed results. Nos.4, 14 and 15 showed large values in the dif-

ferences from each tester at the time when they were used as female parent, but showed small values, when used as male parent. In reciprocal views, correlation coefficient between them was +0.3297, showing no significance even at 5% level.

In view of the variety specificity, the following facts were ascertained. In case of the female parent, Tapachini, Champasari, half of Addey, half of Lama and half of Fudangay varieties showed the values larger than that of the average in the whole strains (=0.09). Tokmor Zo, one third of Addey, half of Lama and half of Fudangay varieties showed the values smaller than that of the average in the whole strains. One sixth of Addey variety showed the value the similar to that of the average in the whole strains. In case of the male parent, Tapachini and two thirds of Addey varieties showed the values larger than that of the average in the whole strains (=0.09). Lama, Tokmor Zo, Fudangay, Champasari and one third of Addey varieties showed the values smaller than that of the average in the whole strains.

IV. Grain color

Parent; Grain color of parental plants is shown in Table 1. Four strains, Nos.4, 6, 8 and 11, showed red color, and remaining 12 strains showed white color.

Hybrid; Grain color among diallel crosses are shown in Table 7. Marks "+" and "−" mean that grain showed red and white colors, respectively. Red color was found almost in 114 cases from 240 combinations. In 108 combinations, in which cross was made using the strain showing approximately red color for one parent, only 3 combinations showed white color.

From the data found in Table 7, it was concluded that reciprocal differences in this study suggested no considerable cytoplasmic influence on the grain color. Reciprocal differences were not illustrated clearly in the variety level in view of grain color, so far as the considerations were paid to the case of the data shown in Table 7.

V. Ratio of length to width

Parent; Ratio of length to width of parental plants is shown in Table 1. The largest (3.11) was obtained in No.15, which was the same as in case of the unhusked grain, followed by No.8 (2.36) and No.11 (2.31). The smallest (1.69) was noted in No.14, followed by No.7 (1.74) and No.13 (1.75). 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 2.05 ± 0.34.

Hybrid; The values of ratio of length to width (abbreviated as "the ratio") among diallel crosses are shown in Table 8. The considerable range was observed. The ratio for individual seed level ranged from 5.7 to 1.4 and the mean ratio ranged from 3.0 to 1.8. In combination level, the largest (3.18) was observed in the combination, No.15 × No.6, which was the same as in case of the unhusked grain, followed by No.15 × No.14 (3.16) and No.15 × No.10 (3.05). The smallest (1.63) was noted in the combination, No.3 × No.14, followed by No.9 × No.14 and No.14 × No.2 (1.66). The differences in the ratio were confirmed to be very large in accordance with the varieties in the respective combination-set.

In Table 9, 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 (2.64) was obtained in No.15, followed by No.11 (2.20) and No.8 (2.15). The lowest value in the parental average (1.83) was noted in No.14, followed by Nos.7 and 13 (1.87). 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 (0.36) was obtained in No.15. It

Table 7. Grain color of husked grains of F_1 hybrids.

♀ \ ♂	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1		−	−	+	+	+	−	+	−	−	+	−	−	−	−	−
2	−		−	+	+	+	−	+	−	−	+	−	−	−	−	−
3	−	−		−	−	+	−	+	−	−	+	−	−	−	−	−
4	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+
5	+	+	−	+		+	+	+	−	−	+	+	−	−	+	−
6	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+
7	−	−	−	+	+	+		+	−	−	+	−	−	−	−	−
8	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+
9	−	−	−	+	−	+	−	+		−	+	−	−	−	−	−
10	−	−	−	+	−	+	−	+	−		−	−	−	−	−	−
11	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+
12	−	−	−	+	+	+	−	+	−	−	+		−	−	−	−
13	−	−	−	+	−	+	−	+	−	−	+	−		−	−	−
14	−	−	−	+	−	+	−	+	−	−	+	−	−		−	−
15	−	−	−	+	−	−	−	+	−	−	+	−	−	−		−
16	−	−	−	+	−	+	−	+	−	−	+	−	−	−	−	

Code No.

−; White, +; Red

Table 8. Ratio of length to width of husked grains in F_1 hybrids.

♀ \ ♂ Code No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1		1.80	1.82	2.03	2.08	2.07	1.80	2.09	1.81	1.83	2.08	2.03	1.87	1.81	2.35	1.89
2	1.84		1.72	2.02	2.04	1.95	1.83	2.12	1.78	1.80	2.01	1.85	1.73	1.75	2.12	1.83
3	1.92	1.75		1.86	1.93	1.98	1.73	2.08	1.97	1.97	1.96	1.90	1.82	1.63	2.34	1.92
4	2.17	1.95	2.09		2.11	2.16	2.00	2.28	2.03	2.13	2.28	2.18	1.97	1.85	2.52	2.10
5	2.19	2.17	2.01	2.14		2.15	2.04	2.30	1.92	2.05	2.25	2.06	2.04	1.92	2.42	2.11
6	2.06	2.01	2.01	2.14	2.08		1.91	2.27	1.98	2.02	2.29	2.10	1.91	1.79	2.50	1.98
7	1.82	1.74	1.74	2.00	1.96	1.86		2.09	1.74	1.74	2.09	1.90	1.74	1.74	2.17	1.76
8	2.15	1.98	2.12	2.22	2.06	2.18	2.16		2.08	2.06	2.39	2.16	2.02	2.06	2.49	2.12
9	1.86	1.76	1.79	2.00	1.91	1.94	1.75	2.00		1.89	2.06	1.89	1.70	1.66	2.10	1.82
10	1.86	1.80	1.92	2.04	1.98	2.01	1.68	2.04	1.90		1.91	1.92	1.79	1.67	2.20	1.90
11	2.16	2.03	2.29	2.24	2.29	2.32	2.14	2.33	2.16	2.05		2.12	2.06	2.12	2.51	2.20
12	2.03	1.79	1.86	2.10	2.35	2.06	1.93	2.15	1.89	1.95	2.19		2.06	1.85	2.41	1.97
13	1.68	1.73	1.77	1.95	1.82	1.93	1.79	2.11	1.74	1.75	2.07	1.89		1.74	2.22	1.79
14	1.76	1.66	1.67	1.89	1.88	1.90	1.86	2.04	1.69	1.67	1.97	1.78	1.71		2.20	1.73
15	2.32	2.16	2.23	2.51	2.88	3.18	2.24	2.43	3.03	3.05	2.67	2.40	2.93	3.16		2.33
16	1.86	1.80	1.85	2.02	2.26	2.02	1.81	2.13	1.85	1.89	2.00	1.89	1.72	1.69	2.33	

Table 9. 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 husked grain.

Code No.	Length/Width		Length/Thickness		Width/Thickness	
	Female	Male	Female	Male	Female	Male
1	1.96±0.16	1.98±0.18	2.98±0.24	2.99±0.26	1.52±0.09	1.50±0.07
2	1.89±0.13	1.88±0.16	2.83±0.26	2.80±0.27	1.49±0.05	1.50±0.05
3	1.92±0.16	1.93±0.18	2.82±0.26	2.88±0.30	1.46±0.07	1.49±0.04
4	2.12±0.16	2.08±0.16	3.27±0.24	3.16±0.24	1.54±0.04	1.52±0.04
5	2.12±0.13	2.11±0.25	3.21±0.21	3.17±0.28	1.52±0.04	1.51±0.06
6	2.07±0.17	2.11±0.31	3.25±0.25	3.16±0.32	1.56±0.04	1.52±0.06
7	1.87±0.15	1.91±0.17	2.78±0.21	2.86±0.27	1.48±0.04	1.49±0.06
8	2.15±0.13	2.16±0.12	3.19±0.15	3.21±0.21	1.49±0.05	1.48±0.05
9	1.88±0.13	1.95±0.43	2.78±0.21	2.95±0.35	1.48±0.03	1.50±0.12
10	1.91±0.14	1.99±0.31	2.90±0.25	2.99±0.35	1.52±0.05	1.51±0.07
11	2.20±0.13	2.15±0.19	3.25±0.17	3.23±0.26	1.49±0.05	1.51±0.05
12	2.04±0.17	2.01±0.16	3.09±0.24	3.03±0.26	1.52±0.04	1.51±0.05
13	1.87±0.16	1.94±0.30	2.85±0.23	2.85±0.34	1.53±0.04	1.48±0.07
14	1.83±0.15	1.90±0.36	2.76±0.25	2.82±0.45	1.52±0.07	1.49±0.07
15	2.64±0.36	2.33±0.14	3.66±0.36	3.38±0.22	1.40±0.07	1.45±0.04
16	1.94±0.18	1.97±0.17	2.83±0.26	2.93±0.28	1.46±0.04	1.49±0.06
Whole	2.03±0.26		3.03±0.35		1.50±0.07	

may be noted that the value was peculiarly large in No.15. The lowest value (0.13) was noted in Nos.2, 8, 9 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 (2.33) was also obtained in No.15, followed by No.8 (2.16) and No.11 (2.15). The lowest value in the parental average (1.88) was noted in No.2, followed by No.14 (1.90) and No.7 (1.91). In standard deviation, the highest value (0.43) was obtained in No.9, followed by No.14 (0.36). The lowest value (0.14) was noted in No.15. The relation between values of average and standard deviations was not recognized clearly, either. The average and its standard deviations in the whole combinations were 2.03±0.26.

In view of the variety specificity, the following facts were ascertained. In case of the female and male parents, Lama, Champasari, one third of Addey and half of Tokmor Zo varieties showed the values larger than that of the average in the whole combinations (=2.03). *Indica, japonica,* Fudangay, two thirds of Addey and half of Tokmor Zo 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 the same as that in case of the average in the whole combinations. Generally speaking, the larger is the one 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 reciprocal combinations, correlation coefficient and linear regression of the ratio of female parent on male parent in the same strain were calculated and are shown in Table 10. Nine, 6 and 1 strains showed significances at 0.1%, 1% levels and no significance even at 5% level, respectively. In the whole strains, correlation

Table 10. Correlation coefficient and linear regression of the 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 husked grain. 0 points; 2.36, 3.26 and 1.54 in 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	0.9051***	13	Y = 0.911X − 0.199	0.7450**	13	Y =0.556X − 1.280	0.1542	13	—
2	0.8502***	13	Y = 0.797X − 0.707	0.8630***	13	Y = 0.866X − 0.216	0.5819*	13	Y = 0.716X − 0.607
3	0.7503**	13	Y = 0.622X − 1.829	0.7008**	13	Y = 0.662X − 2.040	0.0972	13	—
4	0.8956***	13	Y = 0.918X − 0.146	0.7216**	13	Y = 0.845X + 0.230	0.3764	13	—
5	0.7642***	13	Y = 0.416X − 1.524	0.6845**	13	Y = 0.520X − 0.459	0.3512	13	—
6	0.8375***	13	Y = 0.461X − 1.857	0.6849**	13	Y = 0.524X − 0.118	0.2432	13	—
7	0.8672***	13	Y = 0.722X − 1.460	0.8149***	13	Y = 0.719X − 1.580	0.3985	13	—
8	0.7137**	13	Y = 0.685X − 0.517	0.5271*	13	Y = 0.629X −0.197	0.2850	13	—
9	0.9205***	13	Y = 0.388X − 3.063	0.5916*	13	Y = 0.488X − 1.981	0.1107	13	—
10	0.7357**	13	Y = 0.343X − 3.007	0.8095***	13	Y = 0.563X − 1.681	0.4991	13	—
11	0.7426**	13	Y = 0.662X − 0.897	0.3028	13	—	0.2966	13	—
12	0.8055***	13	Y = 0.702X − 0.843	0.8799***	13	Y = 0.842X − 0.305	0.4696	13	—
13	0.6739**	13	Y = 0.307X − 3.183	0.7994***	13	Y = 0.524X − 2.072	0.4308	13	—
14	0.6527**	13	Y = 0.294X − 3.695	0.7787***	13	Y = 0.429X − 3.164	0.6555**	13	Y = 0.492X − 1.073
15	−0.1886	13	—	0.6008*	13	Y = 1.173X − 3.136	0.0582	13	—
16	0.8982***	13	Y = 0.821X − 0.539	0.8478***	13	Y = 0.857X + 0.324	0.7094**	13	Y = 1.194X + 1.902
Whole	0.7694***	118	Y = 0.495X − 1.949	0.7774***	118	Y = 0.648X − 0.957	0.4215***	118	Y = 0.363X − 0.637

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

coefficient is +0.7694 to the degree of freedom of 118, which is obviously significant at 0.1% level. Generally speaking, the larger is the one 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; 0.55, 0.40, 0.71, 0.67, 0.50, 0.71, 0.43, 0.51, 0.44, 0.53, 0.48, 0.62, 0.49, 0.54, 1.02 and 0.64, respectively. It may be noted that the value was peculiarly large in No.15, which was the same as in case of the unhusked grain. The average and its standard deviations were 0.58 ± 0.15. Those in view of the male parent were as follows in the same order; 0.56, 0.51, 0.62, 0.65, 1.06, 1.32, 0.56, 0.43, 1.34, 1.38, 0.76, 0.62, 0.23, 1.53, 0.42 and 0.60, respectively. Those average and its standard deviations were 0.79 ± 0.39. In reciprocal views, correlation coefficient between them was -0.1328, showing no significance even at 5% level.

In view of the variety specificity, the following facts were ascertained. In case of the female parent, Tapachini, Champasari, one third of Addey, half of Lama and half of Tokmor Zo varieties showed the values larger than that of the average in the whole strains (=0.58). *Indica, japonica,* Fudangay, two thirds of Addey, half of Lama and half of Tokmor Zo 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 half of Fudangay varieties showed the values larger than that of the average in the whole strains (=0.79). *Indica, japonica,* Tapachini, Champasari, two thirds of Addey, half of Tokmor Zo, half of Lama and half of Fudangay 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 were crossed with Sikkimese rice and reciprocals were calculated. In view of the female parent, the differences in the ratio for *indica* (No.1) and *japonica* (No.2) were as follows in the order from No.3 to No.16, provided that the calculation was made only by the absolute value; 0.17, 0.22, 0.02, 0.05, 0.08, 0.17, 0.10, 0.06, 0.13, 0.24, 0.05, 0.10, 0.16 and 0.06, respectively. Average and its standard deviations in the whole Sikkimese rice were 0.12 ± 0.07. In view of the male parent, the differences of the ratio for *indica* and *japonica* were as follows in the same order; 0.10, 0.01, 0.04, 0.12, 0.03, 0.03, 0.03, 0.03, 0.07, 0.18, 0.14, 0.06, 0.23 and 0.06, respectively. Average and its standard deviations in the whole Sikkimese rice were 0.08 ± 0.06.

It was noticeable that Nos.12 and 15 showed relatively large values in the differences from each tester when they were used as both female and male parents. Nos.5 and 10 showed the reversed results. Nos.3, 4, 8, 9 and 11 showed large values in the differences for each tester at the time when they were used as female parent, but showed small values, when used as male parent. Nos.6 and 13 showed the reversed results. In reciprocal views, correlation coefficient between them was +0.0611, showing no significance even at 5% level.

In view of the variety specificity, the following facts were ascertained. In case of the female parent, Tapachini, Champasari, half of Addey and half of Lama varieties showed the values larger than that of the average in the whole strains (=0.12). Tokmor Zo, Fudangay, half of Addey and half of Lama varieties showed the values smaller than that of the average in the whole strains. In case of the male parent, Tapachini, Champasari, one sixth of Addey,

half of Tokmor Zo and half of Fudangay varieties showed the values larger than that of the average in the whole strains (=0.08). Lama, five sixths of Addey, half of Tokmor Zo and half of Fudangay varieties showed the values smaller than 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 (4.18) was obtained in No.15, which was the same as in case of the ratio of length to thickness in the case of unhusked grain, followed by No.8 (3.46) and No.11 (3.38). The smallest (2.47) was noted in No.7, followed by No.14 (2.56) and No.13 (2.58). Average and standard deviations in the whole strains were found to be 3.10 ± 0.41.

Hybrid; The values of ratio of length to thickness (abbreviated as "the ratio") among diallel crosses are shown in Table 11. The wide range was observed. The ratio for individual seed level ranged from 4.6 to 2.1 and mean ratio ranged from 4.2 to 2.3. In combination level, the largest (4.30) was observed in the combination, No.15 × No.14, followed by No.15 × No.6 (4.27) and No.15 × No.10 (3.99). The smallest (2.37) was noted in the combination, No.3 × No.14, followed by No.16 × No.14 (2.39) and No.10 × No.7 (2.42). The differences in the ratio were confirmed to be very large in accordance with the varieties in the respective combination-set.

In Table 9, 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 (3.66) was obtained in No.15, which was the same as the ratio in case of unhusked grain, followed by No.4 (3.27) and Nos.6 and 11 (3.25). The lowest value in the parental average (2.76) was noted in No.14, followed by Nos.7 and 9 (2.78). 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 (0.36) was also obtained in No.15. It may be noted that the value was peculiarly large in No.15. The lowest value (0.15) was noted in No.8. 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 (3.38) was also obtained in No.15, followed by No.11 (3.23) and No.8 (3.21). The lowest value in the parental average (2.80) was noted in No.2, followed by No.14 (2.82) and No.13 (2.85). In standard deviation, the highest value (0.45) was obtained in No.14, which was the same as the ratio in case of unhusked grain. The lowest value (0.21) was noted in No.8. 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 3.03 ± 0.35.

In view of the variety specificity, the following facts were ascertained. It may be noted that the relations between the values of respective strain and average in the whole strains were quite the same as the relations, which was found in the ratio of length to width. 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 coefficient and linear regression of the ratio of female parent on male parent in the same strain were calculated and are shown in Table 10. Seven, 5, 3 and 1 strains showed significances at 0.1%, 1%, 5% levels and no significance even at 5% level, respectively. In the whole strains, correlation coefficient is $+0.7774$ to the degree of freedom of 118, which is obviously significant at 0.1% level. Generally speaking, the larger is the one 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

Table 11. Ratio of length to thickness of husked grains in F_1 hybrids.

♂ \ ♀	Code No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Code No.	1		2.72	2.71	3.08	3.23	3.18	2.69	3.09	3.34	2.80	3.11	3.08	2.74	2.71	3.39	2.77
	2	2.70		2.49	3.12	3.22	2.97	2.78	3.03	2.53	2.58	3.24	2.74	2.55	2.70	3.15	2.61
	3	2.81	2.57		2.68	2.89	3.03	2.45	3.07	2.86	2.95	2.93	2.87	2.53	2.37	3.41	2.89
	4	3.29	2.89	3.20		3.34	3.25	3.08	3.49	3.00	3.27	3.55	3.49	3.03	3.02	3.80	3.30
	5	3.47	3.35	3.03	3.28		3.25	3.03	3.47	2.96	3.13	3.48	3.26	3.03	2.83	3.52	3.04
	6	3.31	3.15	3.13	3.33	3.04		2.96	3.46	3.05	3.20	3.63	3.28	3.02	2.82	3.74	3.21
	7	2.70	2.65	2.52	2.99	3.03	2.78		3.15	2.56	2.69	3.09	2.71	2.57	2.62	3.05	2.56
	8	3.27	3.10	3.21	3.36	3.15	3.30	3.25		3.20	3.11	3.43	3.13	2.92	2.94	3.45	3.06
	9	2.76	2.54	2.69	2.92	2.93	2.91	2.54	2.82		2.79	3.16	2.86	2.49	2.44	3.12	2.70
	10	2.87	2.54	2.84	3.17	3.03	3.07	2.42	3.18	3.00		3.03	2.96	2.74	2.45	3.27	2.95
	11	3.21	2.97	3.49	3.35	3.21	3.12	3.16	3.58	3.20	3.27		3.18	3.06	3.14	3.56	3.22
	12	3.07	2.75	2.86	3.35	3.53	3.13	2.81	3.14	2.95	3.02	3.29		3.06	2.79	3.54	3.01
	13	2.50	2.62	2.69	3.06	2.83	3.09	2.67	3.21	2.59	2.70	3.12	2.97		2.73	3.21	2.72
	14	2.70	2.48	2.45	2.96	2.94	3.07	3.06	3.10	2.43	2.55	2.83	2.64	2.67		3.13	2.45
	15	3.41	3.14	3.18	3.74	3.97	4.27	3.27	3.35	3.82	3.99	3.66	3.48	3.84	4.30		3.42
	16	2.77	2.56	2.63	3.02	3.23	3.04	2.65	3.03	2.70	2.83	2.95	2.82	2.46	2.39	3.30	

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; 0.70, 0.66, 1.04, 0.91, 0.69, 0.92, 0.63, 0.53, 0.72, 0.85, 0.61, 0.79, 0.71, 0.70, 1.16 and 0.91, respectively. It may be noted that the value was peculiarly large in No.15. The average and its standard deviations were 0.78 ± 0.16. Those in view of the male parent were as follows in the same order; 0.97, 0.77, 1.04, 1.06, 1.14, 1.49, 0.85, 0.76, 1.29, 1.44, 0.83, 0.85, 1.38, 1.93, 0.69 and 0.97, respectively. It may be noted that the value was peculiarly large in No.14, which was similar to the difference in case of unhusked grain. Those average and its standard deviations were 1.09 ± 0.33. In reciprocal views, correlation coefficient between them was -0.0548, showing no significance even at 5% level.

In view of the variety specificity, the following facts were ascertained. In case of the female parent, Tapachini, Champasari, half of Addey, half of Lama and half of Tokmor Zo varieties showed the values larger than that of the average in the whole strains ($=0.78$). *Indica, japonica*, Fudangay, half of Addey, half of Lama and half of Tokmor Zo varieties showed the values smaller than that of the average in the whole strains. In case of the male parent, Fudangay, one third of Addey, half of Lama and half of Tokmor Zo varieties showed the values larger than that of the average in the whole strains ($=1.09$). *Indica, japonica*, Tapachini, Champasari, two thirds of Addey, half of Lama and half of Tokmor Zo varieties showed the values smaller than that of the average in the whole strains. These findings propose quite an 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 were crossed with Sikkimese rice and reciprocals were calculated. In view of the female parent, the differences in the ratio for *indica* (No.1) and *japonica* (No.2) were as follows in the order from No.3 to No.16, provided that the calculation was made only by the absolute value; 0.24, 0.40, 0.12, 0.16, 0.05, 0.17, 0.22, 0.33, 0.24, 0.32, 0.12, 0.22, 0.27 and 0.21, respectively. It may be noted that the value was peculiarly large in No.4. Average and its standard deviations in the whole Sikkimese rice were 0.22 ± 0.09. In view of the male parent, the differences of the ratio for *indica* and *japonica* were as follows in the same order; 0.22, 0.04, 0.01, 0.21, 0.09, 0.06, 0.81, 0.22, 0.13, 0.34, 0.19, 0.01, 0.24 and 0.16, respectively. It may be noted that the value was peculiarly large in No.9. Average and its standard deviations in the whole Sikkimese rice were 0.20 ± 0.20.

It was noticeable that Nos. 1, 6, 9, 10, 11, 12 and 15 showed relatively large values in the differences from each tester when they were used as both female and male parents. Nos.5 and 7 showed the reversed results. Nos.4, 8 and 14 showed large values in the differences for each tester at the time when they were used as female parent, but showed small values, when used as male parent. In reciprocal views, correlation coefficient between them was $+0.0229$, showing no significance even at 5% level.

In view of the variety specificity, the following facts were ascertained. In case of the female parent, Tapachini, Champasari, half of Addey and half of Lama varieties showed the values larger than that of the average in the whole strains ($=0.22$). Tokmor Zo, one third of Addey, half of Lama and half of Fudangay varieties showed the values smaller than that of the average in the whole strains. One sixth of Addey and half of Fudangay varieties showed the values same as that of the average in the whole strains. In case of the male parent, Tapachini, Champasari, half of Addey and half of Tokmor Zo varieties showed the values larger than that of the average in the whole strains ($=0.20$). Lama, Fudangay, half of Addey

and half of Tokmor Zo 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 (0.65) was obtained in No.10, followed by No.2 (1.62) and No.9 (1.60). The smallest (1.34) was noted in No.15, which was the same as the ratio in case of unhusked grain, followed by No.7(1.42). Average and standard deviations in the whole strains were 1.51 ± 0.08.

Hybrid; The values of ratio of width to thickness (abbreviated as "the ratio") among diallel crosses are shown in Table 12. A considerable range was observed. The ratio for individual seed level ranged from 2.0 to 1.1 and mean ratio ranged from 1.6 to 1.4. In the combination level, the largest (1.85) was observed in the combination, No.1 × No.9, followed by No.14 × No.7 (1.65) and No.4 × No.14 (1.63). The smallest (1.26) was noted in the combination, No.15 × No.9, followed by No.15 × No.10 and No.15 × No.13 (1.31). The differences in the ratio were confirmed to be large in accordance with the varieties in the respective combination-set.

In Table 9, 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 (1.56) was obtained in No.6, followed by No.4 (1.54) and No.13 (1.53). The lowest value in the parental average (1.40) was noted in No.15, followed by Nos.3 and 16 (1.46). 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.1. The lowest value (0.03) was noted in No.9. 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 (1.52) was observed in Nos.4 and 6. The lowest value in the parental average (1.45) was noted in No.15. In standard deviation, the highest value (0.12) was obtained in No.9. The lowest value (0.04) was noted in Nos.3, 4 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 1.50 ± 0.07.

In view of the variety specificity, the following facts were ascertained. In case of the female parent, *indica*, Lama, Tapachini, Fudangay, one sixth of Addey and half of Tokmor Zo varieties showed the values larger than that of the average in the whole combinations ($=1.50$). *Japonica*, Champasari, five sixths of Addey and half of Tokmor Zo varieties showed the values smaller than that of the average in the whole combinations. In case of the male parent, Lama, Tapachini, one third of Addey and half of Tokmor Zo varieties showed the values larger than that of the average in the whole combinations. Fudangay, Champasari, two thirds of Addey and half of Tokmor Zo varieties showed the values smaller than that of the average in the whole combinations. *Indica* and *japonica* varieties showed the values the same as that of the average in the whole combinations. Generally speaking, the larger is the one 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 reciprocal combinations, correlation coefficient and linear regression of the ratio of female parent on male parent in the same strain were calculated and are shown in Table 10. Two, 1 and 13 strains showed significances at 1%, 5% levels and no significance even at 5% level, respectively. In the whole strains, correlation coefficient is $+0.4215$ to the degree of freedom of 118, which is significant at 0.1% level. Generally speaking, the larger is the one noted at the time when strain was used as female

Table 12. Ratio of width to thickness of husked grains in F_1 hybrids.

♂ \ ♀ Code No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1		1.51	1.49	1.52	1.55	1.54	1.49	1.47	1.85	1.53	1.50	1.52	1.47	1.50	1.44	1.46
2	1.47		1.45	1.54	1.59	1.52	1.51	1.43	1.42	1.43	1.52	1.49	1.48	1.55	1.48	1.43
3	1.28	1.47		1.44	1.50	1.58	1.41	1.48	1.46	1.50	1.50	1.51	1.39	1.45	1.46	1.50
4	1.51	1.48	1.53		1.59	1.51	1.54	1.53	1.48	1.54	1.56	1.60	1.54	1.63	1.51	1.57
5	1.59	1.54	1.51	1.53		1.51	1.49	1.51	1.54	1.53	1.55	1.58	1.48	1.48	1.46	1.44
6	1.61	1.57	1.56	1.56	1.46		1.56	1.52	1.54	1.59	1.58	1.56	1.58	1.58	1.49	1.62
7	1.48	1.52	1.44	1.49	1.55	1.49		1.51	1.47	1.55	1.48	1.43	1.47	1.51	1.41	1.46
8	1.52	1.56	1.51	1.51	1.53	1.51	1.50		1.53	1.51	1.43	1.45	1.45	1.43	1.39	1.44
9	1.48	1.44	1.50	1.46	1.53	1.50	1.45	1.41		1.48	1.54	1.52	1.47	1.47	1.49	1.49
10	1.55	1.41	1.48	1.56	1.53	1.53	1.45	1.56	1.58		1.59	1.54	1.53	1.47	1.49	1.55
11	1.48	1.47	1.52	1.49	1.40	1.47	1.48	1.54	1.48	1.60		1.50	1.48	1.48	1.42	1.47
12	1.51	1.54	1.54	1.60	1.51	1.52	1.45	1.46	1.56	1.56	1.50		1.49	1.48	1.47	1.53
13	1.49	1.52	1.53	1.57	1.55	1.61	1.49	1.47	1.49	1.55	1.51	1.58		1.57	1.45	1.52
14	1.53	1.50	1.46	1.57	1.56	1.62	1.65	1.52	1.43	1.53	1.51	1.48	1.56		1.42	1.42
15	1.47	1.46	1.43	1.49	1.38	1.34	1.46	1.38	1.26	1.31	1.37	1.46	1.31	1.36		1.47
16	1.49	1.43	1.42	1.50	1.42	1.51	1.46	1.42	1.46	1.49	1.48	1.49	1.43	1.42	1.41	

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; 0.41, 0.17, 0.30, 0.15, 0.15, 0.16, 0.14, 0.13, 0.13, 0.18, 0.20, 0.15, 0.16, 0.23, 0.23 and 0.10, respectively. It may be noted that the values were peculiarly large in Nos.1 and 3. The average and its standard deviations were 0.19 ± 0.08. Those in view of the male parent were as follows in the same order; 0.33, 0.16, 0.14, 0.16, 0.19, 0.28, 0.24, 0.18, 0.59, 0.29, 0.16, 0.17, 0.27, 0.27, 0.12 and 0.20, respectively. It may be noted that the value was peculiarly large in No.9. Those average and its standard deviations were 0.23 ± 0.11. In reciprocal views, correlation coefficient was +0.0046, 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*, Champasari, one third of Addey and half of Fudangay varieties showed the values larger than that of the average in the whole strains (=0.19). *Japonica*, Lama, Tokmor Zo, Tapachini, two thirds 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, *indica*, Tokmor Zo, Fudangay and one third of Addey varieties showed the values larger than that of the average in the whole strains (=0.23). *Japonica*, Lama, Tapachini, Champasari and two thirds of Addey varieties showed the values smaller than that of the average in the whole strains. These findings propose quite an 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 were crossed with Sikkimese rice and reciprocals were calculated. In view of the female parent, the differences in the ratio for *indica* (No.1) and *japonica* (No.2) were as follows in the order from No.3 to No.16, provided that the calculation was made only by the absolute value; 0.19, 0.03, 0.05, 0.04, 0.04, 0.04, 0.04, 0.14, 0.01, 0.03, 0.03, 0.03, 0.01 and 0.06, respectively. Average and its standard deviations in the whole Sikkimese rice were 0.05 ± 0.05. In view of the male parent, the differences of the ratio for *indica* and *japonica* were as follows in the same order; 0.04, 0.02, 0.04, 0.02, 0.02, 0.04, 0.43, 0.10, 0.02, 0.03, 0.01, 0.05, 0.04 and 0.03, respectively. It may be noted that the value was peculiarly large in No.9. Average and its standard deviations in the whole Sikkimese rice were 0.06 ± 0.10.

It was noticeable that No.10 showed relatively large value in the differences from each tester when it was used as both female and male parents. Nos. 4, 5, 6, 7, 8, 11, 12, 13, 14, 15 and 16 showed the reversed results. No.3 showed large value in the differences for each tester at the time when it was used as female parent, but showed small value, when used as male parent. No.9 showed the reversed result. In reciprocal views, correlation coefficient between them was +0.0426, showing no significance even 5% level.

In view of the variety specificity, the following facts were ascertained. In case of the female parent, half of Addey variety showed the values larger than that of the average in the whole strains (=0.05). Half of Lama variety showed the value same as that of the average in the whole strains. The remaining 10 strains showed the values smaller than that of the average in the whole strains. In case of the male parent, one third of Addey variety showed the values larger than that of the average in the whole strains (=0.06). The remaining 14 strains showed the values smaller than that of the average in the whole strains.

PART II. Relation between the respective two characters

I. Length and width

Parent; Correlation coefficient of width on length in parental plants was −0.6233 to the degree of freedom of 14, which is obviously significant at 1% level and was same as that of unhusked grain. Generally speaking, the wider is the width, the shorter is the length. Linear regression of length on width was calculated as follows; $Y=-0.805X-1.541$, where Y and X indicate length and width, respectively. This formula indicates that the length becomes 0.805 *mm* longer, by becoming 1 unit narrower in width (0 points, 5.93 *mm* in length and 2.62 *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 13. Eight, 3, 2 and 3 strains showed significances at 0.1%, 1%, 5% levels and no significance even at 5% level, respectively. In the whole combinations, correlation coefficient was −0.6698 to the degree of freedom of 238, which is significant at 0.1% 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 −0.3100, 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 13. Two, 3, 2 and 9 strains showed significances at 0.1%, 1%, 5% levels and no significance even at 5% level, respectively. In the whole combinations, correlation coefficient was −0.4981 to the degree of freedom of 238, which is significant at 0.1% 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 +0.5766 to the degree of freedom of 14, which is significant at 5% level. Generally speaking, the wider is the width, the thicker is the thickness. Linear regression of width on thickness was calculated as follows; $Y=0.481X-0.791$, where Y and X indicate width and thickness, respectively. This formula indicates that the width becomes 0.481 *mm* wider, by becoming 1 unit thicker the thickness (0 points, 2.62 *mm* in width and 1.77 *mm* in thickness, respectively).

Hybrid; Correlation coefficient and linear regression of thickness on width in the same strain were calculated and are shown in Table 13. Nine, 1, 4 and 2 strains showed significances at 0.1%, 1%, 5% levels and no significance even at 5% level, respectively. In the whole combinations, correlation coefficient was +0.5922 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 (abbreviated as "R·L/T") on ratio of length to width (abbreviated as "R·L/W") in parental plants was +0.9282 to the degree of freedom of 14, which is obviously significant at 0.1% level (Table 14). Generally speaking, the larger is R·L/W, the larger is R·L/T. Linear regression of R·L/W

Table 13. Correlation coefficient and linear regression of the three components; I — width of husked grain (Y, 0 point =2.58 *mm*) on length of husked grain (X, 0 point = 5.88 *mm*), II — thickness of husked grain (Y, 0 point =1.77 *mm*) on length of husked grain (X, 0 point = 5.88 *mm*), III — thickness of husked grain (Y, 0 point =1.77 *mm*) on width of husked grain (X, 0 point = 2.58 *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	−0.4988**	28	Y = − 0.602X + 0.406	−0.4685**	28	Y = − 0.656X − 1.560	0.4359*	28	Y = 0.505X − 0.463
2	−0.7145***	28	Y = − 0.624X + 1.788	−0.7275***	28	Y = − 1.101X − 0.984	0.6811***	28	Y = 1.339X − 2.280
3	−0.2917	28	—	−0.6229***	28	Y = − 0.775X − 0.833	0.6893***	28	Y = 0.893X − 0.333
4	−0.5537**	28	Y = − 0.290X + 3.044	−0.2767	28	—	0.5095**	28	Y = 0.910X − 2.327
5	−0.5742***	28	Y = − 0.441X + 1.694	−0.3080	28	—	0.4340*	28	Y = 0.380X − 0.494
6	−0.6532***	28	Y = − 0.617X + 2.606	−0.3389	28	—	0.6234***	28	Y = 0.445X − 0.931
7	−0.4305*	28	Y = − 0.380X + 0.807	−0.2612	28	—	0.8546***	28	Y = 1.355X − 1.704
8	−0.2728	28	—	−0.2355	28	—	0.2185	28	—
9	−0.7190***	28	Y = − 0.669X + 1.635	−0.1507	28	—	0.3360	28	—
10	−0.5077**	28	Y = − 0.421X + 2.040	−0.2435	28	—	0.6031***	28	Y = 0.683X − 0.691
11	−0.0364	28	—	0.1418	28	—	0.4081*	28	Y = 0.362X − 1.084
12	−0.4495*	28	Y = − 0.405X + 1.787	−0.4452*	28	Y = − 0.490X − 0.407	0.6514***	28	Y = 0.797X − 1.385
13	−0.5923***	28	Y = − 0.519X + 1.049	−0.3885*	28	Y = − 0.350X + 0.660	0.5789***	28	Y = 0.595X + 0.217
14	−0.8584***	28	Y = − 0.657X + 0.593	−0.3509	28	—	0.7096***	28	Y = 0.898X − 0.969
15	−0.8299***	28	Y = − 0.684X + 0.406	−0.4992**	28	Y = − 0.248X + 0.737	0.4619*	28	Y = 0.278X + 0.491
16	−0.6580***	28	Y = − 0.541X − 0.622	−0.5558**	28	Y = − 0.706X − 1.778	0.6370***	28	Y = 0.983X − 0.368
Whole	−0.6698***	238	Y = − 0.599X + 0.851	−0.4981***	238	Y = − 0.483X − 0.041	0.5922***	238	Y = 0.643X − 0.309

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

Table 14. 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
	3.20 ≀ 3.11	2.40 ≀ 2.31	2.30 ≀ 2.21	2.20 ≀ 2.11	2.10 ≀ 2.01	2.00 ≀ 1.91	1.90 ≀ 1.81	1.80 ≀ 1.71	1.70 ≀ 1.61	
4.20～4.11	1									1
3.50～3.41		1								1
3.40～3.31		1		1	1					3
3.30～3.21			1		1					2
3.10～3.01					1		1			2
3.00～2.91							2			2
2.90～2.81						1		1		2
2.60～2.51								1	1	2
2.50～2.41								1		1
Total	1	2	1	1	3	1	3	3	1	16

$r = +0.9282^{***}$ (d. f. = 14), significant at the 0.1% level.

on R·L/T was calculated as follows; $Y = 1.070X + 1.585$, where Y and X indicate R·L/W and R·L/T, respectively. This formula indicates that R·L/W becomes 1.070 larger, by becoming 1 degree larger R·L/T (0 points, 2.36 in R·L/W and 3.26 in R·L/T, respectively).

Hybrid; Correlation coefficient and linear regression of R·L/T on R·L/W in the same strain were calculated and are shown in Table 15. Fifteen and 1 strains showed significances at 0.1% and 1% levels, respectively. In the whole strains, correlation coefficient was +0.8987 to the degree of freedom of 238, which is obviously significant at 0.1% level. Generally speaking, the larger is R · L/W, the larger is R · L/T (Table 16).

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

Parent; Correlation coefficient of ratio of width to thickness (abbreviated as "R · W/T") on R · L/W in parental plants was −0.5971 to the degree of freedom of 14, which is significant at 5% level. Generally speaking, the larger is R · W/T, the smaller is R · L/W. Linear regression of R · L/W on R · W/T was calculated as follows; $Y = -0.650X - 0.700$, where Y and X indicate R · L/W and R · W/T, respectively. This formula indicates that R·L/W becomes 0.650 larger, by becoming 1 degree smaller R · W/T (0 points, 2.36 in R·L/W and 1.49 in R·W/T, respectively).

Hybrid; Correlation coefficient and linear regression of R · W/T on R · L/W in the same strain were calculated and are shown in Table 15. Two, 4 and 10 strains showed significances at 0.1%, 1% levels and no significance even at 5% level, respectively. In the whole strains, correlation coefficient was −0.3006 to the degree of freedom of 238, which is significant at 0.1% level. Generally speaking, the larger is R · W/T, the smaller is R · L/W.

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

Parent; Correlation coefficient of R · W/T on R · L/T in parental plants was −0.3048, showing no significance even at 5% level.

Hybrid; Correlation coefficient and linear regression of R · W/T on R · L/T in the

Table 15. Correlation coefficient and linear regression of the three components; IV — ratio of length to thickness (Y, 0 point = 3.26) on ratio of length to width (X, 0 point = 2.36), V — ratio of width to thickness (Y, 0 point = 1.54) on ratio of length to witdh (X, 0 point = 2.36), VI — ratio of width to thickness (Y, 0 point = 1.54) on ratio of length to thickness (X, 0 point = 3.26), 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	0.5565**	28	Y = 0.846X + 0.335	−0.1126	28	—	0.3888*	28	Y = 0.369X − 0.067
2	0.8995***	28	Y = 1.555X + 2.857	0.2438	28	—	0.5137**	28	Y = 0.313X − 0.310
3	0.9437***	28	Y = 0.944X − 0.263	0.0641	28	—	0.3310	28	—
4	0.9088***	28	Y = 1.318X + 2.883	−0.1165	28	—	0.2552	28	—
5	0.9120***	28	Y = 1.143X + 2.172	−0.5281**	28	Y = − 0.492X − 2.031	−0.1928	28	—
6	0.9067***	28	Y = 1.057X + 2.216	−0.7120***	28	Y = − 0.575X − 1.614	−0.4433*	28	Y = − 0.307X − 0.274
7	0.9258***	28	Y = 1.471X + 2.416	−0.0439	28	—	0.3505	28	—
8	0.8301***	28	Y = 1.146X + 1.759	−0.2537	28	—	0.1825	28	—
9	0.7655***	28	Y = 0.820X − 0.386	−0.1834	28	—	0.1359	28	—
10	0.9355***	28	Y = 1.143X + 1.553	−0.3541	28	—	−0.0779	28	—
11	0.8222***	28	Y = 1.053X + 1.831	−0.5233**	28	Y = − 0.558X − 2.456	−0.1008	28	—
12	0.9221***	28	Y = 1.301X + 2.534	−0.0037	28	—	0.2366	28	—
13	0.9811***	28	Y = 1.149X + 1.109	−0.5364**	28	Y = − 0.442X − 3.341	−0.2989	28	—
14	0.9355***	28	Y = 1.214X + 1.397	−0.5097**	28	Y = − 0.404X − 3.340	−0.0099	28	—
15	0.9509***	28	Y = 0.961X + 1.451	−0.8799***	28	Y = − 0.499X − 3.251	−0.5242**	28	Y = − 0.336X − 3.004
16	0.8881***	28	Y = 1.377X + 1.821	0.0622	28	—	0.4697**	28	Y = 0.282X − 1.214
Whole	0.8987***	238	Y = 1.181X + 1.614	−0.3006***	238	Y = − 0.249X − 2.254	−0.0056	238	—

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

Table 16. 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
	3.20 ≀ 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	1.90 ≀ 1.81	1.80 ≀ 1.71	1.70 ≀ 1.61	
4.30 ~ 4.21	2																2
4.20 ~ 4.11																	0
4.10 ~ 4.01																	0
4.00 ~ 3.91		1		1													2
3.90 ~ 3.81		1	1														2
3.80 ~ 3.71							2	1									3
3.70 ~ 3.61						1				1							2
3.60 ~ 3.51							1	2	2	1							6
3.50 ~ 3.41								1	5	5	2						13
3.40 ~ 3.31								1	1	2	3	2		1			10
3.30 ~3.21									1	4	14	7	1				27
3.20 ~ 3.11									1	1	9	18					29
3.10 ~ 3.01											5	16	13	3			37
3.00 ~ 2.91												4	11	6			21
2.90 ~ 2.81													10	7	1		18
2.80 ~ 2.71														13	5		18
2.70 ~ 2.61														8	13		21
2.60 ~ 2.51														1	13	1	15
2.50 ~ 2.41															4	8	12
2.40 ~ 2.31																2	2
Total	2	2	1	1	0	1	3	5	10	14	33	47	35	39	36	11	240

$r = +0.8987^{***}$ (d. f. = 238), significant at the 0.1% level.

same strain were calculated and are shown in Table 15. Three, 2 and 11 strains showed significances at 1%, 5% levels and no significance even at 5% level, respectively. In the whole strains, correlation coefficient was −0.0056 to the degree of freedom of 238, showing no significance even at 5% level.

Discussion

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

i) 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 9). On the other hand, in view of the standard deviation, it did 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.*[10] found substantial heterosis in height and tillering of F_1 hybrids of rice in comparison 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 included into this category. For example, in case of No.1 in view of thickness of husked grain, the average values in parental level were indicated to be 1.69 *mm*, 1.77 *mm* and 1.81 *mm* in pure line, averages for female and male parents, respectively. In combination level, the thicknesses were 1.69 *mm*, 1.64 *mm*, 1.90 *mm* and 1.92 *mm* in No.1, No.2, No.1(♀)×No.2(♂) and No.2(♀)×No.1(♂), respectively (Tables 1 and 6). Those considerations were ascertained in the several characters measured in the present experiment.

ii) In comparison with the data obtained in female and male parents, the following facts were ascertained. Average values of practical values in the female parent were always nearly similar to that of the male parent. On the other hand, average values of standard deviations in the female parent were mostly smaller than that of the male parent, excepting in 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 applicable 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 9). It was a peculiar phenomenon that the practical value and its standard deviation were the largest and nearly 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. 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 No.12, Tapachini variety. Such tendency could not be found in other characters.

iii) 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 for several characters, for example, No.2×No.9, 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 segre-

gated for the larger and the smaller groups, showing the gaps found with 6.4 *mm* to 6.3 *mm*, 2.8 to 2.7 and 3.8 to 3.6, respectively. Those two phenomena may duely be attributed to the actions of gene.

In reciprocal views, it may be noticeable that three strains, *i.e.*, Nos.2, 14 and 16, showed significances in all six characters (Tables 4 and 10). Three, 4, 5, 2, 1 and 1 strains showed significances in 6, 5, 4, 3, 2 and 1 characters, respectively. These characters may be used for hetero- or homozygosis in each strain. In ratio of width to thickness, only 3 strains showed significances, but the whole combinations of this character showed significance at 0.1% level. In spite of the negative correlations found in the reciprocal comparisons, all of them constantly showed no significant difference. So, it was concluded that the reciprocal differences suggested no considerable cytoplasmic inheritance reported in this experiment. The known ones are the maternal effect on grain weight[1]. However, as the analyses and conclusions have left several points in question, further analysis may be performed sincerely.

iv) Six relations between the respective characters were analysed, basing on correlation coefficient and linear regression calculated. In view of parental plants, 4 cases showed significances. In view of the whole combinations, 5 cases showed significances. One, 5, 3, 5, 1 and 1 strains showed significant correlations in 6, 5, 4, 3, 2 and 1 relations between the two characters, respectively. It was noticeable that 1 relation, *i.e.*, the one between ratio of length to thickness and ratio of length to width, 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. It may be a peculiar phenomenon that No.15, Champasari variety, showed significant correlation only in one case in the respective characters (Tables 4 and 10), but showed significant correlations in the whole cases in the comparative characters (Tables 13 and 15).

In comparing the parental pure line and parental average in hybrid combinations, at the time when some strain was crossed with alien strains, it was ascertained that correlation coefficients were sometimes different in the former and in the latter. For example, correlation coefficients were of no significance and of some significance in the former and in the latter, respectively, in case 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 set 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.

v) 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 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 crossability and variety differentiations.

The differences in the respective characters at the time when two testers crossed with Sikkimese rice and reciprocals were calculated. In reciprocal views, correlation coefficients between the female and male parents were no significant in all characters. It was noticeable that the differences against *japonica* (No.2) were always larger than that against *indica* (No.1) in case of width and thickness, but smaller in case of the ratio of

length to width. In variety specificity, however, no clear tendency was commonly ascertained in the whole characters measured.

vi) Tateoka[11] described that *O. minuta* may be different from *O. officinalis* 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 varieties or strains, it may be looked upon as something reasonable that width and ratio of length to width in husked grains should be adopted as similarly as in the case of unhusked grains.

vii) There is a general trend to apply the term "synchrony" to intra-plant variance of a character like ear emergence. Thus, plants with the least intra-plant variance are considered more synchronous. Synchrony has been used to describe characters other than ear emergence to reflect intra-plant variance, the higher synchrony denoting least intra-plant variance[9]. In this paper, standard deviations in a plant were applied to determine the uniformity. Such approach could be used in the future.

Summary

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

1) The lengths of parental plants and F_1 hybrid were 5.43 *mm* and 5.45 *mm* in average, respectively. In view of reciprocal combinations, 14 strains and the whole combinations showed positive significances. The widths of parental plants and F_1 hybrid were 2.66 *mm* and 2.70 *mm* in average, respectively. In view of reciprocal combinations, 12 strains and the whole combinations showed positive significances. The thicknesses of parental plants and F_1 hybrid were 1.76 *mm* and 1.81 *mm* in average, respectively. In view of reciprocal combinations, 8 strains and the whole combinations showed positive significances. Red grain color of parental plants and F_1 hybrid were found in 4 strains and 114 combinations, respectively. The ratios of length to width of parental plants and F_1 hybrid were 2.05 and 2.03 in average, respectively. In view of reciprocal combinations, 15 strains and the whole combinations showed positive significances. The ratios of length to thickness of parental plants and F_1 hybrid were 3.10 and 3.03 in average, respectively. In view of reciprocal combinations, 15 strains and the whole combinations showed positive significances. The ratios of width to thickness of parental plants and F_1 hybrid were 1.51 and 1.50 in average, respectively. In view of reciprocal combinations, 3 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 analysed and showed the following results. In view of parental plants, each one case showed significances at 0.1%(+), 1%(−), 5%(+) and 5%(−) levels. In view of the whole cross combinations, 2, 3 and 1 cases

showed significances at 0.1%(+) and 0.1%(−) levels and no significance even at 5% level, respectively.

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