FURTHER STUDIES OF THE INTERLOCUS RECOMBINATION OF THE GLUTINOUS GENE OF RICE[1]

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In pursuance of the work done in 1964 (Li *et al* 1965), six indica glutinous varieties of these original sixteen used in the preliminary trial were chosen for further studies. The choice was made on the basis that there were high frequencies of Gl(+) showing interloci recombinations when these said varieties were in combination with others. Both direct and reciprocal diallel crosses were made. To our greatest surprise, due to some seasonal or other unknown factor or factors, all the pollen grains were being stained brown after twenty such crosses were examined. So the examination was given up finally. In the spring of 1966, the same diallel crosses were made again, and the pollen grains of the F_1 hybrid were again examined in the fall of the same year after the pollen grains were stained with iodine solution. The results obtained were approaching expectation and are shown in Table 1.

In each cross the pollen grains of twenty spikelets were counted. Generally the count would reach a total between 50,000–140,000 grains. A diallel cross of six varieties would mean that there would be 15 such crosses. When direct and reciprocal crosses were also made, there would be 30 such interlocus recombination in all. The highest Gl(+) frequency in a single cross was 66.39 (B×F), and the lowest was 13.80 (E×F). All Gl(+) frequencies in the hybrids were higher than the parental varieties as shown in Table 2.

Form Table 3, the standard deviation of Gl(+) frequency of each cross was calculated using the formula $\sigma=\sqrt{\frac{p(1-p)}{n}}$, while p was the Gl(+) frequency and n was the total grains counted.

In the third column of Table 3, "Fiducial limit, $\pm 3\sigma$" it was calculated to obtain an accurancy of sampling to reach 99.7% efficiency. From these calculations the maximum and minimum frequencies of Gl(+) were calculated.

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Table 1. *Estimates of Gl(+) frequencies of the diallel cross of six glutinous varieties (direct and reciprocal).*

Crosses	No. of pollen grains counted (estimated)	Frequency of Gl(+) ($\times 10^{-5}$)	Crosses	No. of pollen grains counted (estimated)	Frequency of Gl(+) ($\times 10^{-5}$)
5028(A)×5029(B)	120,570	32.34	5029(B)×5028(A)	119,650	25.07
5028(A)×5109(C)	111,469	26.01	5109(C)×5028(A)	111,210	30.57
5028(A)×5110(D)	102,700	59.39	5110(D)×5028(A)	106,990	52.34
5028(A)×5122(E)	96,120	37.45	5122(E)×5028(A)	110,320	18.12
5028(A)×5805(F)	130,840	18.34	5805(F)×5028(A)	141,000	33.33
5029(B)×5106(C)	79,090	32.87	5109(C)×5029(B)	96,210	64.44
5029(B)×5110(D)	69,440	27.36	5110(D)×5029(B)	81,760	64.82
5029(B)×5122(E)	69,200	55.74	5122(E)×5029(B)	56,230	65.80
5029(B)×5805(F)	99,410	66.39	5805(F)×5029(B)	117,180	71.82
5109(C)×5110(D)	103,400	37.71	5110(D)×5109(C)	72,320	55.30
5109(C)×5122(E)	66,210	48.33	5122(E)×5109(C)	63,690	20.34
5109(C)×5805(F)	109,480	31.05	5805(F)×5109(C)	104,680	32.47
5110(D)×5122(E)	91,480	27.32	5122(E)×5110(D)	80,570	31.02
5110(D)×5805(F)	78,430	61.20	5805(F)×5110(D)	81,620	33.08
5122(E)×5805(F)	92,840	14.00	5805(F)×5122(E)	86,920	13.80

Table 2. *Gl(+) frequency of the chosen indica glutinous stocks.*

Accession Code number No.	Original Chinese name	Place of origin	Results of 1964		Results of 1966		Average for both years ($\times 10^{-5}$)
			No. of pollen grains counted (estimated)	Frequency of Gl(+) ($\times 10^{-5}$)	No. of pollen grains counted (estimated)	Frequency of Gl(+) ($\times 10^{-5}$)	
5028 (A)	Yen-no	Mainland China	86,150	3.50	77,090	0	1.80
5029 (B)	Wu-no-tao	Mainland China	91,980	4.30	86,420	6.94	5.60
5109 (C)	Chien-tzu-chu	Taiwan	86,540	6.90	66,420	6.02	6.50
5110 (D)	Mang-hua-chu	Taiwan	84,640	7.10	78,530	6.38	6.70
5122 (E)	Chih-chueh-chu	Taiwan	84,580	0	73,450	2.72	1,30
5895 (F)	Warisan-mochi 2	Taiwan	83,720	0	77,210	0	0

However there were two suppositions to be taken for granted: 1) there was no maternal effect ocurring in the direct and reciprocal cross, and 2) assumption must be made that there was no mutation in the parents. (This was not so as is shown in Table 2). Finally, the genetic map of the glutinous gene was constructed of these six genic sites. From Fig. 1, it can be seen that all

Table 3. *Gl(+) frequencies with their standard deviation of the diallel crosses.*

Cross	Frequency of Gl(+) ($\times 10^{-5}$)	Fiducial limit, ± 36 ($\times 10^{-5}$)	Fiducial interval of Gl(+) frequency, ($\times 10^{-5}$)	
			Maximum	Minimum
B	28.7	±10.38	39.08	18.32
C	28.3	±10.71	39.01	17.56
A × D	60.6	±16.11	76.71	44.49
E	27.1	±10.86	37.96	16.24
F	26.1	± 9.30	35.40	16.80
C	50.2	±16.05	66.25	34.15
B × D	47.6	±16.83	64.43	30.77
E	60.6	±21.72	82.32	38.88
F	40.2	±12.90	53.10	27.30
D	45.0	±15.18	60.18	29.82
C × E	34.6	±15.48	50.08	19.11
F	31.7	±14.10	45.90	7.70
D × E	29.1	±12.33	41.43	16.77
F	46.9	±16.23	63.13	30.67
E × F	13.9	± 8.34	22.24	5.56

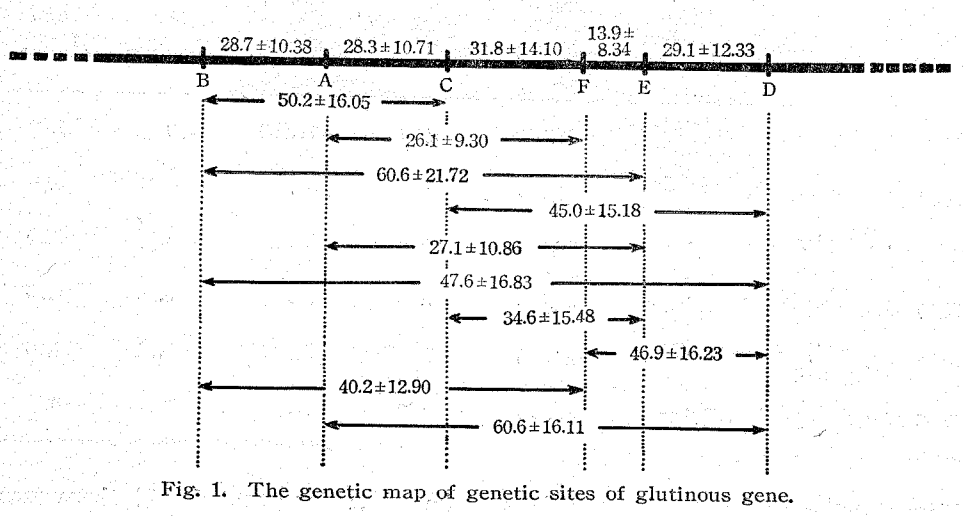

Fig. 1. The genetic map of genetic sites of glutinous gene.

of these sites are independent from each other. There is no occurance of overlapping. All the Gl(+) frequencies seemed to fall within the fiducial interval of Gl(+) frequency. The order of the genic sites may be established as shown in Fig. 1. Unlike maize (Nelson 1959, 1962) there are only a few

gene markers on chromosome XII of rice where the locus gl is located. Furthermore there seems to be impossible to obtain population large enough to compare with the maize work using conventional backcross technique. Naturally, the orientation of the genic sites in this glutinous gene with respect to other gene markers will remain to be undisclosed. The results of the biochemical analysis of these six different glutinous varieties as well as one non-glutinous variety (Schoch 1964a, 1964b) are:

variety		Amylose %
Non-glutinous	T. N. No. 1	28.60
Glutinous	5029	11.36
Glutinous	5028	12.64
Glutinous	5805	10.56
Glutinous	5122	10.28
Glutinous	5110	10.00
Glutinous	5109	0.00

Summary

Using diallel cross of six indica varieties of glutinous rice which had different origin and were chosen on the basis of having high GI(+) frequency when they were in combination with other varieties in the preliminary trial, six genic sites were clearly demonstrated. All of these were independent from each other showing no overlapping effect. The order of these sites was mapped out and the deviation were all within the limitations set for sampling error. The biochemical analysis of these glutinous varieties disclosed that the percentage of amylose would vary and one of these showed a complete absence of amylose.

水稻糯性因子 (Glutinous gene) 之研究

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根據水稻糯性因子初步試驗的結果，(Li et al 1965) 自 GI(+) 頻度的雜種中，選出了六個 indica 親本作完全互交 (Diallel crosses)，對六個親本及30個雜交植株，作非糯性花粉頻度之分析，由第三表及第一圖中，顯示出六個 Genic sites 均各自獨立，而無重疊 (Over Lapping) 的效果發生，以及各 Genic Site 均可在標準偏差的有效範圍之內，依其 GI(+) 頻度的大小，畫出六個 Site 之間的相對位置。

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