Pleiotropic effect of waxy gene in indica rice

Although the waxy rice varieties often show poor yield than non-waxy ones, it is still not clear whether the poor yield is due to waxy gene itself or other genes in the less improved waxy varieties. There are few reports on the relation between waxy and other quantitative agronomic characters. Tsai and Oka (1965) reported that there were no significant yield difference between non-waxy and its waxy isogenic line.

Authors observed that waxy caryopses were smaller than non-waxy ones on a same heterozygous plant in spite of their similar husk size. In the case of long grain indica rice, the difference is so clear that waxy and non-waxy grains can be easily identified by pressing their grain tip, because the tip of waxy grain is empty. Similar phenomenon is also observed between waxy and non-waxy sister lines in late generations. These facts suggest that some yield characters can be closely linked to waxy gene or waxy gene itself plays pleiotropic role to the size of caryopsis.

To clarify the relation between waxy gene and agronomic characters related to yield, a series of experiments was conducted at the Bumbong Lima Rice Research Station of the Malaysian Agricultural Research and Development Institute in co-operation with the Tropical Agriculture Research Center, Japan.

Materials used were 5 waxy and 3 non-waxy sister lines selected from a cross between Pulut Lebai Yaakub (waxy) and IR 8 (non-waxy). The crossing was done in 1968/69 main season. Final Wxwx heterozygote selection was done at F_8 generation in 1972/73 main season. The seeds from the heterozygote were planted in row as F_9 line. Although the line did not show any segregation in all of the important agronomic characters, it has maintained the waxy and non-waxy heterozygosity. Five waxy and three non-waxy isogenic homozygotes were harvested individually and the seeds from each

Table 1. Yields of waxy and non-waxy isogenic lines

Line		Block I	Block II	Mean	Group mean
Non-waxy	1	5,493	5,223	5,358	5,345
	2	5,110	5,634	5,372	
	3	5,155	5,454	5,305	
Waxy	4	3,831	5,118	4,475	4,736
	5	4,632	5,118	4,875	
	6	4,183	5,012	4,598	
	7	3,658	5,320	4,489	
	8	4,947	5,538	5,243	

Source	D. F.	M. S.	F. R.	F
Replication	1	1,827,904	1,827,904	10.35*
Treatment	7	2,245,361	320,765	1.82
Between groups	1	1,391,412	1,391,412	7.88*
Within non-waxy	2	5,076	2,538	0.01
Within waxy	4	848,872	212,218	1.20
Error	7	1,236,200	176,600	
Total	15	5,309,465	353,964	($F_{.05}=5.59$)

* Denotes significant at 5% level

plant were sown in September. The 25-day old seedlings were transplanted at the spacing of 25.4 cm × 25.4 cm with a single seedling per hill. The field layout was randomised complete block design with two replications, and the plot size was 9.3 m^2. Urea, Christmas Island Rock Phosphate and muriate of potash were applied at a rate of 90 kg N, 45 kg P_2O_5 and 34 kg K_2O per ha. Urea was split: 1/2 as basal, and 1/4 each applied 21 and 60 days after transplanting. Sixty-four hills were harvested from each plot for measuring yields and 20 hills were sampled for yield component studies.

Yields are presented in Table 1. Although there were no significant differences in yield within waxy as well as non-waxy group, the yield of waxy group (4736 kg/ha) was significantly lower than that of non-waxy group (5345 kg/ha). Grain dimensions and other characters are shown in Table 2. The length and width of caryopsis and 100 grain weight of all waxy lines were clearly less than those of non-waxy lines. The differences between two groups were highly significant (1% level). Comparative values of each character of waxy group to non-waxy were 96.4% in caryopsis length, 95.7% in width and 90.7% in 1000 grain weight. The caryopsis thickness of waxy group was slightly less than non-waxy one, But it was not significant. On the other hand, no significant differences in husk length, husk width and husk weight were found between two groups. The waxy group showed less spikelet number per panicle.

As the materials used were F_{10} sister lines originated from one waxy and non-waxy heterozygous F_8 plant, the theoretical degree of their homogenity might be more than 99.2%. Since the materials are considered as isogenic lines, it seems that all differences between two groups must be due to pleiotropic effects of waxy gene. This means that waxy gene has the pleiotropic effect on caryopsis length, width, weight, grain yield and spikelet number per panicle.

Further experiments were started to confirm whether it is due to pleiotropism or linkage of waxy gene. An experiment done in the following season (1974 off-season) also showed that the caryopsis size of waxy line was statistically smaller than that of non-waxy isogene, and that the small caryopsis size of waxy line was not due to the lack of carbohydrates in plants, but due to some mechanisms disturbing carbohydrate trans-

Table 2. Yield components of waxy and non-waxy isogenic lines

Item		Tiller no. per hill	Spikelet no. per panicle	Sterility (%)	1,000 husk weight (g)	1,000 caryopsis weight (g)	Husk		Caryopsis		
							Length (mm)	Width (mm)	Length (mm)	Width (mm)	Thickness (mm)
Non-waxy	1	12.0	194.5	9.95	5.55	22.25	9.55	2.41	7.03	2.12	1.58
	2	10.0	179.0	9.00	5.70	23.05	9.58	2.31	7.11	2.13	1.62
	3	11.0	186.0	10.25	5.80	22.85	9.60	2.32	7.06	2.14	1.64
	M	11.0	186.5	9.73	5.68	22.72	9.58	2.35	7.07	2.13	1.61
Waxy	4	12.0	165.0	7.00	5.65	20.55	9.51	2.31	6.91	2.04	1.52
	5	11.5	177.0	7.50	5.75	20.45	9.49	2.31	6.74	2.03	1.61
	6	11.0	174.0	6.50	5.60	20.75	9.59	2.31	6.92	2.04	1.52
	7	10.5	165.0	6.95	5.50	20.55	9.50	2.31	6.69	2.03	1.61
	8	12.0	160.5	7.00	5.55	20.80	9.57	2.30	6.85	2.07	1.60
	M	11.4	168.3	6.99	5.61	20.62	9.53	2.31	6.82	2.04	1.57
F Waxy vs. non-waxy		0.49	11.97*	62.52**	0.83	112.5**	1.00	2.09	14.2**	72.0**	1.67

* Denotes significant at 5% level
** Denotes significant at 1% level

location into grains.

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Yok Hwa CHEN *Malaysian Agricultural Research and Development Institute, Malaysia.*
Akio KITSUTAKA *Tropical Agriculture Research Center, Japan.*