Effect of the Gpc-B1 gene on F2 population crossed between hard red spring wheat cultivar and Japanese soft wheat cultivars

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INTRODUCTION

The Japanese wheat cultivars are primarily soft wheat and are used in the preparation of Japanese noodles (Udon). The ideal grain protein content in Japanese noodles ranges from 10.0% to 11.0%. In the Kyushu region of Japan, the grain protein content is lower than that required. Therefore, the farmers in this region have to apply more fertilizer than those in other regions.

The Gpc-B1 (grain protein content) gene was originally mapped on the chromosome arm 6BS in a population of recombinant inbred lines derived from the *Triticum turgidum* ssp. *durum* cultivar Langdon (LDN hereafter) and the chromosome substitution line LDN (DIC6B). This gene's effect increased the grain protein, zinc, and iron content. It encodes an NAC transcription factor (NAM-B1) that increases nutrition remobilization from leaves to grains (Cristobal et al. 2006).

Here, we have evaluated the effect of the Gpc-B1 gene in Japanese soft wheat to breed a new soft wheat cultivar with high grain protein content even in the Kyushu region.

MATERIALS AND METHODS

Yecora Rojo-HGPC was the source of the Gpc-B1 gene. Chikugo izumi was the Japanese soft wheat cultivar and Saikai 185, the soft breeding line used. The F2 populations from Yecora Rojo-HGPC/Chikugo izumi and Yecora Rojo-HGPC/Saikai 185 were grown in the experimental field of the National Agricultural Research Centre for Kyushu Okinawa Region (Chikugo, Fukuoka, Japan).

The grain protein content was determined with a Infratec 1241 Grain Analyser. Hardness and thousand kernel weight were determined with the Single-Kernel Characterization System (SKCS) 4100 (Perten Co. Ltd., USA).

Xuhw84 and Xucw108 markers showed polymorphisms between Yecora Rojo-HGPC and the 2 Japanese soft wheats. These polymorphisms were used to identify the plant with the Gpc-B1 gene.

RESULTS AND DISCUSSION

The coefficient of correlation between the grain protein content and thousand kernel weight was –0.299 for Yecora Rojo-HGPC/Chikugo izumi F2 population and 0.017 for the Yecora Rojo-HGPC/Saikai 185 one. In both F2 populations, the grain protein content was not correlated with the thousand kernel weight. Therefore, the high grain protein content did not result from low thousand kernel weight.

Among plants with a soft kernel texture in Yecora Rojo-HGPC/Chikugo izumi F2 population, plants with the Gpc-B1 bb allele (functional genotype) showed a higher grain protein content than those with a non-functional Gpc-B1 gene (significant at 10% level). However, this was not observed among plants with a soft kernel texture in the Yecora Rojo-HGPC/Saikai 185 F2 population.

The reason for this was not clear. The difference between Chikugo izumi and Saikai 185 was the winter behavior. Chikugo izumi was a spring wheat cultivar, while Saikai 185 was a winter cultivar.

The recommended grain ash content of Japanese wheat cultivars is lower than 1.60% because high ash content is associated with the decreased brightness of Japanese noodles (Kruger JE et al. 1994). The Gpc-B1 gene increased not only the protein content but also the zinc and iron content, which may lead to a high ash content and low wheat flour brightness. Moreover, the flour protein content affects noodle discoloration, with a high protein content resulting in decreased noodle brightness (Lang CE et al. 1998).

Table 1 Protein content of cross parents and F2 plants

	hardness	HGPC gene genotype	plant number	Protein content (%)
Chikugo isumi	soft	a		12.9
Yecora rojo-HGPC	hard	b		16.0
F2 plants	all	aa	21	13.9
		bb	23	14.2
	soft	aa	5	13.5
		bb	5	15.0
Saikai185	soft	a		12.9
Yecora rojo-HGPC	hard	b		16.0
F2 plants	all	aa	31	14.0
		bb	33	14.2
	soft	aa	9	14.2
		bb	13	14.1

HGPC gene genotype : a non-functional allele, b functional allele

It was difficult to evaluate the effect of the Gpc-B1 gene on wheat flour quality and yield on F2 plants. It is also difficult to predict the feasibility of developing soft wheat with a high protein content and high flour brightness using the Gpc-B1 gene. At present, we are carrying marker-assisted backcross to produce near-isogenic lines to evaluate the effect of the Gpc-B1 gene in Japanese soft wheat more precisely.

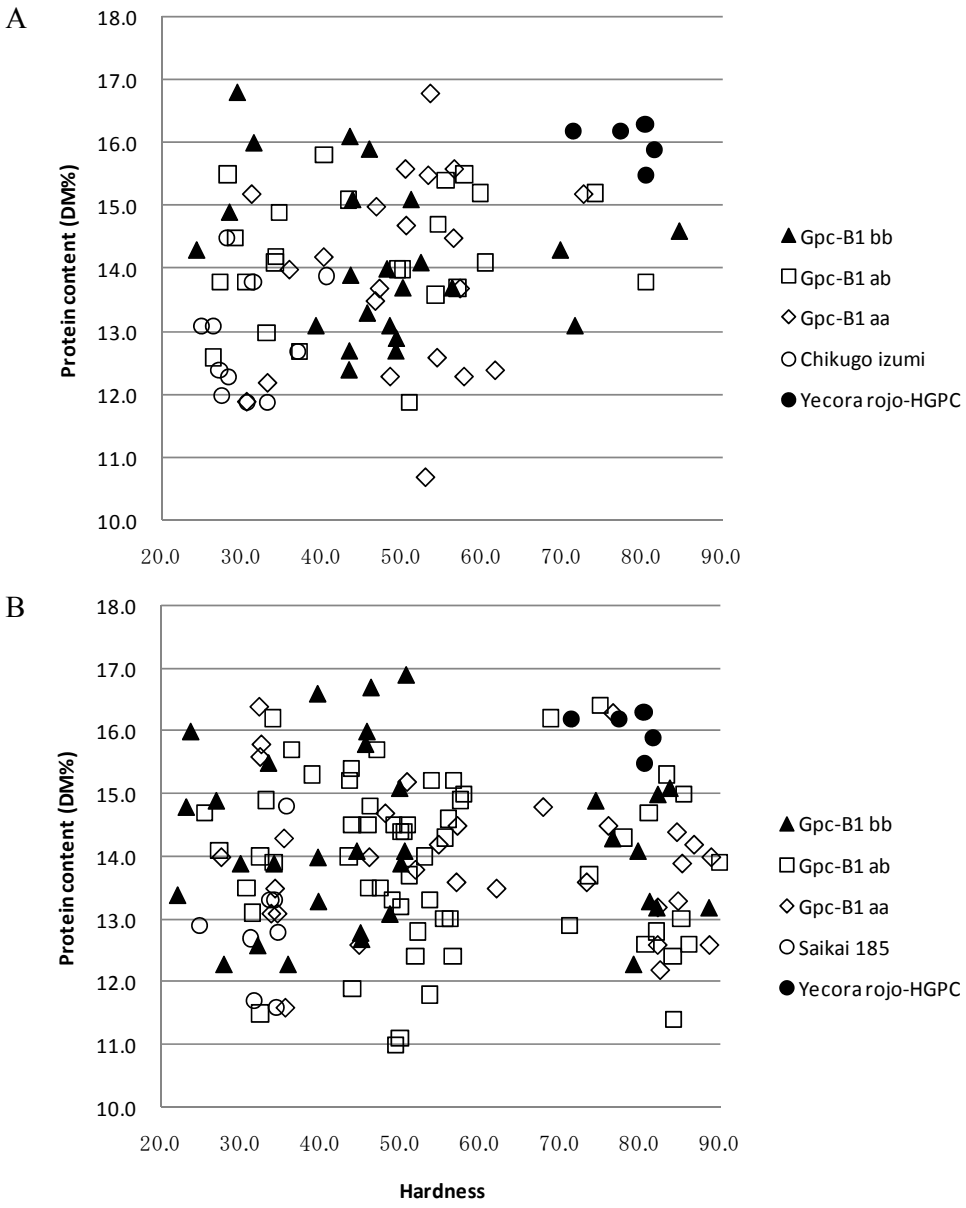

Figure 1
Relationship between protein content and hardness in the F2 population.
A: Yecora Rojo-HGPC/Chikugo izumi F2 population B: Yecora Rojo-HGPC/Saikai 185 F2 population
Gpc-B1aa : non-functional allele Gpc-B1bb : functional allele Gpc-B1ab : hetero allele

ACKNOWLEDGEMENT

We extend our gratitude to Dr. Dubcovsky for providing the wheat cultivar Yecora Rojo-HGPC.

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