Kasetsart J. (Nat. Sci.) 27 : 236 - 239 (1993)

Temperate Cereal Improvement for Sustainable Agriculture : Powdery Mildew Resistence in Barley Lines (Powdery Mildew, *Erysiphe graminis* DC. ex Merat hordei Marchat)

Ngamchuen Ratanadilok[1]

ABSTRACT

During 1991-92, several promissing barley lines from the Temperate Cereal Improvement project were tested in replicated trial for grrain yield potential for malt quality and diseases at the Royal Angkhang stations. Seed samples were taken from the selected lines to Denmark in 1992 for further tests both in the green house for powdery mildew reaction and in the laboratory for final malt quality. The results indicated that there were some high potential barley lines concerning malt quality and disease resistance. Thai 1,2,4 and Thai 5 were powdery mildew resistance with different genetic background and the Thai 2 and 5 were both resistance to the disease and acceptable for malt quality.

Key words : powdery mildew resistance, final malt quality test, sustainable agriculture, *Hordeum vulgare, Erysiphe graminis* hordei, multigene families.

INTRODUCTION

Barley is one of imported crop as malt and malt extracts for brewery, beverages and nutritious foods. Although barley was high in nutritions among other well known cereals for instance; maize, sorghum, rice, and, wheat. Barley scientists had recently emphasized on it's β-glucan or tocotrienol as the major substance for protection against the colon cancer and digestinal tract. Barley grain was found to be a wonderful reservoir of health promoting compounds from basic food nutrient required for normal body maintenance and metabolism for protective agents, active against chronic and acute dibilitating diseases (Newman and Newman 1992). To increase yield production under highland condition in Thailand, barley might face one of common disease problems on the highland like powdery mildew (*Erysiphe* spp.)which would be pronounced under high humidity and low temperature condition where barley could give high grain quality and yield in tropical environment. Moreover the project had observed that the disease could develop on barley plant in some years since 1984 whenever the breeding materials has been tested against common diseases at the Royal Angkhang Station. Until 1992, it was announced that powdery mildew was one of new diseases in barley when it was found on harley at Maekorn, Chiangrai and Smeong, Chiangmai (Cheevaviriyakul *et.al.* 1992). However, the Temperate Cereal Improvement project has found the selected two-row harley, AKB_1, AKB_2 moderately resistant to spot hlotch (*Drechslera sorokiniana*) which is considered to he very important disease in this area. Toojinda *et. al*, 1992). And the disease will be more pronounced as long as the barley production and extension have heen promoted.The objective of this research was to screen barley line not only resistant to spot blotch but also resistant to powdery mildew with high malt quality in order to minimize the pesticide used in food production under sustainable agricultural system.

MATERIALS AND METHODS

All six varieties of two-row and six-row barleys were included in the replicated trial at the Royal

1 Dept. of Agronomy, Faculty of Agriculture, Kasetsart Univ., Bangkok 10900, Thailand.

Angkhang station in Chiangmai province during October 1991-February 1992. The plot size were 10x10m^2, with 4 replications had been observed for diseases as well as yield potential and other agronomic characters under highland condition. The seed samples were taken from selected lines to the National Research Laboratory, Resϕ, Denmark for powdery mildew resistant screening in the greenhouse condition and to the Carlsberg research lahoratory for final malt analyses during April-Septembir 1992.

Determination for powdery mildew reaction

The mildew reaction was determined in the greenhouse at approximately 14°C on 20 barley plants each line inoculated at the 7-9 day old seedlings and scored ahout 10 days later according to the 0-4 scale (Jϕrgensen, 1992). Three isolates cultured from powery mildew (*Erysiphe graminis DC* ex *Merat hordei Marchat*) derived from single colonies were used to score for resistance in the six barley lines as indicated in table 1.

Resistance standard check for disease screening were isogenic line Pallas-10, and 11 (P10, 11) The Thai lines were : BRB_2 (Thai 6), Smeong 1 (Thai 1), and AKB_2 (Thai 2), and other elite lines (Thai 3-5) from the Temperate Cereals Improvement program supported by Kasetsart University Research and Development Instiltute.

Analysis for malt quality

In Carlsberg Laboratory, the malt quality of the same seed lot selected from replicated trials at the Royal Angkhang station had been analysed as final malt quality. The standard check from commercial variety in Denmark (Triumph) was also included as malt standard together with the Thai lines number 1 (Smeong 1) and Thai 6 (BRB_2).

Talbe 1 Reaction of three isolates of powdery mildew on six Thai barley lines.

	Varieties	Infection type to isolate[1]		
		CR 3	C7-6	5874
Thai 1	(SMG1)	4	1-2	1-2
Thai 2	(AKB_2)	0	0-1	0-1
Thai 3		4	3-4	4
Thai 4		0	0-1	0-1
Thai 5		0	0-1	0-1
Thai 6	(BRB_2)	4	4	4
P-10	Mla12 resistant gene	0	4	0-1
P-11	Mla13 resistant gene	0	0	4

1 0 = resistant, 4 = susceptible

RESULTS AND DISCUSSION

Powdery mildew Reaction

There were infection type 0 in the Thai 2 and 5 respond to all three isolates (Table 1). The data also indicated presence of more than one powdery mildew resistance gene in these Thai lines especially the thai 2, 4 and 5. With the identity from the test with the three isolates, it is possible that the resistant genes present in these Thai lines are not any of Mla 7, a8, a9, a10, a11, a12, a13, Ab, at, C, g, h, k, nn, ra Since none of these 15 of about 30 known resistant genes are susceptible to the three isolates used. The isogenic lines Pallas 10 (P10) and Pallas 11 (P11) were used as standard checks for the infection type with known resistant genes Mla12 and Mla13, respectively. The susceptible lines were Thai 3 and Thai 6. These results also demonstrated that multigene families governed resistance with the gene-for-gene-system known to operate in barley powdery mildew interactions. Jorgensen (1992) concluded that there are several Mla resistance genes which are multigene families comprising two or more closely linked resistant genes. Each member of a gene family was unique and independent function, and each member is matched by unique avirulent gene. His results also confirmed and indicated some different resistant genes possess in those Thai lines which might be clustered of genes present as the Mla alleles. And these genes could be presented as multigene families in the Mla region, not single superior genes. Localization of the powdery mildew resistant genes were found to be in the shortarm of chromosome 5 in the order of Hor1. Mla, Hor2 and Ml-ra. This chromosome also contains Ml-k and the complex locus Ml-a with a large number of alleles. The powdery mildew resistance gene is very common in northwest European winter barley varieties, of which many also have the resistance gene Mla6. Mla14 and Ml-h (Doll and jensen, 1986).

Malt quality analysis

Results from the final malt analysis were shown in Table 2. The Danish commercial variety, Triumph was used as standard check for malt quality analysis. The germplasm from Thailand, Thai 1, 3, and 6 were quite low in final extraction values. Both viscosity and β-glucan were found to be too high in the Thai 1

Table 2 Final malt quality anslysis for new barley lines in comparison to standard barley lines grown in replicated trial at Royal Ang Khang Station in 1991/92.

Var.	Final extract (%)	Viscosity 20°C (GP)	N in dried malt (%)	Soluble N (%)	Kolbach index (%)	Wort favor EBC	Wort transparancy	Beta glucan (wortppm)	Saccharitime (min)	Malt quality index
Triumph (local check	83.1	1.56	1.66	0.8	48	3.0	clear	180	5-10	8.0
Thai 1 Smg1	77.3[1]	1.81[2]	1.58	0.66	42	2.3	clear	420 [2]	5-10	2.0
Thai 2 AKB2	79.3	1.58	1.62	0.73	45	2.7	clear	110	5-10	4.5
Thai 3	80.0	2.05[2]	1.58	0.55	35	2.2	opal	550 [2]	5-10	4.0
Thai 4	78.3	1.60	2.03[2]	0.87[2]	43	3.0	clear	190	5-10	3.0
Thai 5	80.2	1.55	1.61	0.76	77	2.0	clear	50	5-10	4.5
Thai 6 BRB2	77.4[1]	1.65	1.31	0.54	41	3.0	clear	110	5-10	4.0

Notes 1=too low; 2=too high. No. 2 and No. 5 were acceptable

and 3. Thai 4 was quite high in protein as shown by high soluble N (87%). However, the Thai 2 and 5 were considered to be acceptable for malt and malt extracts due to their high final extraction and malt quality index together with low β-glucan character. Nevertheless, high β-glucan and protein found in Thai 1, 3 and 4 might be utilized as healthy food for well being people.

Newman and Newman (1992) had analysed the barley milling fractions with emphasis on β-glucan and arabinoxylans. They found significant contribution toward serum cholresterol reduction. And degraded β-glucan in the barley brewers grain possesses cholresterol lowering ability and this effect had been attributed to tocotrienol. Furthermore, they also informed that barley protein which ranged from 8-18 percents (average of 13%) and contains some properties similarly to milk protein which relevant to developing countries as cheaper protein for human food.

CONCLUSION

Among the six Thai lines barley, there were some resistant genes different from the Mla alleles found in European winter barley in the Thai 1, 2, 4 and 5 in relation to the enoculation with three powdery mildew isolates. It was also illustrated that the acceptable lines from Thailand for malt and malt extract were the Thai 2 and 5. Under certain circumstances, the Thai 2 and 5 seemed to be satisfied as they are resistant to the powdery mildew disease and yet possess high malt quality. These elite lines would be further evaluated in the highland for sustainable agriculture program in order to minimize the pesticides used in the agroforestry system in the northern part of Thailand where barley growing is rather possible on highland under rainfed condition.

ACKNOWLEDGEMENT

Thanks should be given to the EEC., National Research Council, the Royal King Project, Thailand. And with gratitudes toward Dr. Jφrgen Larsen, H.P. Jensen and Dr. H. Giese who always gave their meaningful coorperations during author's working period in Denmark.

LITERATURE CITED

Cheevaviriyakul, S., T. Toojinda, C. Chauiprasit and P. Bhirom-Bakdhi. 1992. Barley diseases situation in northern and northeastern Thailand in the Thirteenth National Barley and Wheat Conference, held during August 19-21, 1992. at Royal Cliff Beach Resort Hotel, Pattaya, Chonburi, p.214-222.

Doll, H. and H.P. Jensen. 1986. Localization of powdery mildew resistance gene Ml-ra on barley chromosome 5. Hereditas 105:61-65.

Jørgensen, J.H. 1992. Multigene families of powdery mildew resistance genes in locus Mla on barley chromosome 5. Plant Breeding 108: 53-59.

Newman, C.W. and R.K. Newman. 1992. Nutritional aspects of barley as a food grain in Barley for Food and Malt. ICC/SCF International Symposium held during Sept 7-10. 1992. at Uppsala. Sweden.

Toojinda, T., N.Ratanadilok, S. Cheevaviriyakul, S. Boonraang, C. Chauiprasit and P. Bhirom-Bakdhi. 1992. Potential of Barley Variety BRB.9 Production. In The Thirteenth National Barley and Wheat Conference held during, August 19-21, 1992 at Royal Cliff Beach Resort Hotel, Pathaya, Chonburi. p. 83-89.