

Stability of barley genotypes for earliness, resistance to leaf scald disease and yield in Ethiopia

Lijalem, G.¹, Fetien, A.² & Edema, R.¹

¹College of Agricultural and Environmental Sciences, Makerere University, P.O. Box 7062, Kampala, Uganda

²Department of Crop and Horticultural Science, Mekelle University, P.O. Box 231, Mekelle, Ethiopia

Corresponding author: lijenet@yahoo.com

Abstract

Due to the unpredictable rainfall pattern and shorter growing seasons experienced in recent years in Ethiopia, early-maturing barley (*Hordeum vulgare*) genotypes are preferred by farmers in order to escape moisture stress and to bridge the critical food shortage that occurs in September. However, early-maturing genotypes are usually susceptible to leaf scald disease. Therefore, genotypes that can confer both scald resistance and early maturity are desired. The Barley Core Collection (BCC) was chosen for this study because of its high variability in resistance, maturity, and other aspects. Based on 2004/05 data, 36 genotypes have been selected for study, representing a wide range of maturity and response to scald disease. These genotypes will be tested for scald, maturity and yield in both diseased and protected plots in 3 locations, to test their stability over environments, and to determine the relationship between earliness and scald response.

Key words: *Hordeum vulgare*, *Rhynchosporium secalis*, variability

Résumé

A cause de l'allure imprévisible des pluies et de courtes saisons de croissance qui sont connues ces dernières années en Ethiopie, les génotypes d'orge à maturité précoce (*Hordeum vulgare*) sont préférés par les agriculteurs afin d'échapper à un stress d'humidité et de combler la pénurie alimentaire critique qui se produit en Septembre. Cependant, les génotypes à maturité précoce sont généralement sensibles à la maladie de brûlure des feuilles. Par conséquent, les génotypes qui peuvent conférer à la fois la résistance à la brûlure et la maturité précoce sont souhaités. La collection de base d'orge (BCC) a été choisie pour cette étude en raison de sa grande variabilité de la résistance, de la maturité, et d'autres aspects. Sur base des données de 2004/05, 36 génotypes ont été sélectionnés pour l'étude, représentant un large éventail de maturité et une réponse à la maladie de brûlure des feuilles.

Ces génotypes seront testés pour la brûlure, la maturité et le rendement dans les parcelles malades et celles protégées dans 3 endroits, afin de tester leur stabilité dans les environnements et de déterminer la relation entre la précocité et la réponse à la brûlure.

Mots clés: *Hordeumvulgare*, *Rhynchosporiumsecalis*, variabilité

Background

Barley (*Hordeum vulgare*), the major crop in Ethiopia, is grown in marginal areas across diverse agro-ecological zones under low input conditions. In addition to the erratic and unpredictable rainfall distribution, there are a number of microbial agents that constrain barley production. Among the most damaging microbial agent is *Rhynchosporium secalis*, a fungus that causes leaf scald diseases) (Akar *et al.*, 2004). This disease reduces the photosynthetic area of the leaf. In addition, diseased plants often have fewer ears and smaller and lighter grains. Use of resistant varieties is the best management approach for the disease for farmers who can't afford to purchase chemicals to control the disease.

The general objective of this study is to evaluate the consistency of scald resistance and maturity in the barley core collection (BCC) in three diverse environments. This will facilitate more effective breeding for both stable resistance to leaf scald and earliness. The specific objectives are: 1) To compare, across three diverse locations, the rate and timing of the development of scald symptoms and their severity in barley genotypes of diverse maturities and differing levels of resistance; 2) To determine the effect of these three locations on earliness and yield in these diverse genotypes, independent of the effects of scald; 3) To quantify the effect of scald on earliness and yield in these genotypes in these diverse locations.

Literature Summary

The genetic diversity of Ethiopian landraces is large, and increases as one goes from lowlands to highlands, with maximum diversity attained at about 2,460 m.a.s.l. (Tanto *et al.*, 2010). Tanto *et al.* (2010) also reported high variability for morphological traits, maturity, and disease resistance, including scald resistance in barley. Engels (1994) found that the mean diversity index for all characters under the study increased with altitude, with major differences seen in days-to-maturity and plant height. A highly negative correlation was found between days-to-heading and disease severity among 155 varieties

collected from various regions across Ethiopia (Van Leur, 2003). Yitbarek *et al.* (1998) indicated that scald severity was negatively correlated with altitude (Fig. 1). According to Van Leur and Gebre (2003), most of the early maturing varieties have shown susceptibility to scald disease.

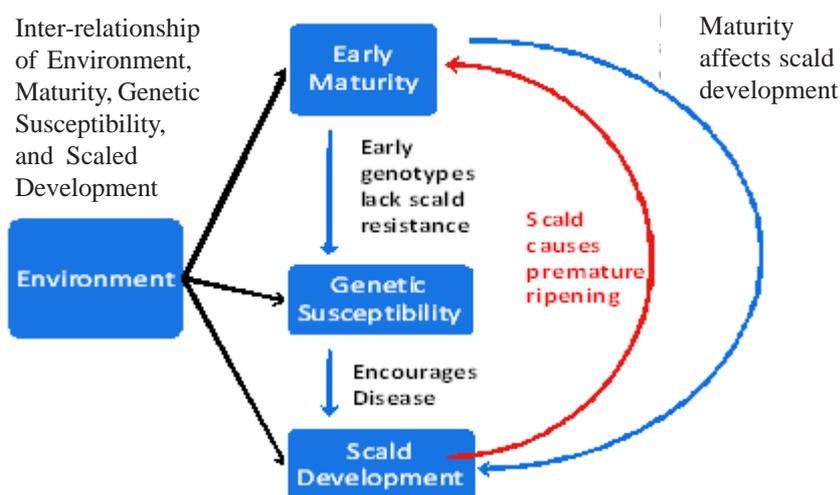


Figure 1. Inter-relationship of environment, disease, maturity, and genetic susceptibility in scald development.

Study Description

The field experiment will be carried out at three locations. The first in Debre Birhan Agricultural Research Centre is located in the Semien Shewa Zone of the Amhara Region, central Ethiopia, about 120 km northeast of Addis Ababa (9°41'N, 39°32'E; 2,840 m.a.s.l and annual precipitation of 1,600 mm, falling mainly between June and September). The second in the Dehub Gondar Zone of the Amhara Region northern Ethiopia (11°50'2 N, 39°09'E; 3275 m.a.s.l with an annual rainfall of 1,580mm). The third experimental site is Korem, in the Dehub Zone of the Tigray Region, northern Ethiopia (12°30'2 N, 39°31'2 E; 2539 m.a.s.l. and a mean annual precipitation of 999 mm).

Experimental material will be obtained from the Ethiopian Barley Core Collection (BCC). BCC is a selected set of accessions, representing the genetic diversity of cultivated barley and the wild species of *Hordeum*, covering the three genepools of barley based on several criteria, including ease of interspecific hybridizations and molecular and cytogenetic analysis (Zhang *et al.*, 2001). The three include i) the primary genepool comprised of *H. vulgare* ssp *vulgare* and *H. vulgare* ssp. *spontaneum*, ii) the second genepool consists of *H. bulbosum*

L., and iii) the third genepool that includes the remaining *Hordeum* species (Pickering and Johnston, 2005).

Comparisons will be made between sprayed and unsprayed plots. Disease in unsprayed plots will be enhanced with spreader rows. There will be 2 replications at each site. Each plot will consist of 5 rows; data will be taken on the three centre rows. Data will be analyzed by ANOVA to determine the effect of location and fungicidal protection on the varietal expression of maturity, disease development, yield and other traits. A GGE biplot will be used to graphically show the pattern of genotype x environment interaction. Correlation and regression analysis will be used to evaluate the effect of scald on earliness and other traits. The progress of disease development will be measured at different stages: seedling stage, pre-flowering, pre-seed formation and during seed formation. Other data, like days to heading, days to maturity, thousand seed weight, yield and yield components will also be measured to quantify the impact of disease.

Research Application

Thirty six genotypes selected from 176 BBC genotypes were used in the study (Table 1). Preliminary data shown in Figure 2 indicates evidence of presence of early maturing genotypes. Although the general trend seems to indicate that early varieties are more likely to be more susceptible to leaf scald, some late maturing genotypes significantly succumbed to disease. The study is on-going and more conclusions will be made when more data is collected.

Table 1. Groups of genetic material represented in the study.

Group		Number of genotypes
Maturity	Resistant level	
Very early (<79 DLF)	Resistant (scald < 60)	4
Early (79 < DFL < 90)	Resistant (scald < 60)	7
Late (>90 DFL)	resistant (scald < 60)	7
Very early (<79 DLF)	Susceptible	7
Early (79 < DFL < 90)	Susceptible	7
Late (>90 DFL)	Susceptible	4
Total		36

References

Akar, T., Avci, M. and Dusunceli, F. 2004. Barley: Post-harvest operations. http://www.fao.org/fileadmin/user_upload/inpho/docs/Post_Harvest_Compendum_BARLEY.pdf. Accessed on 19 October, 2011.

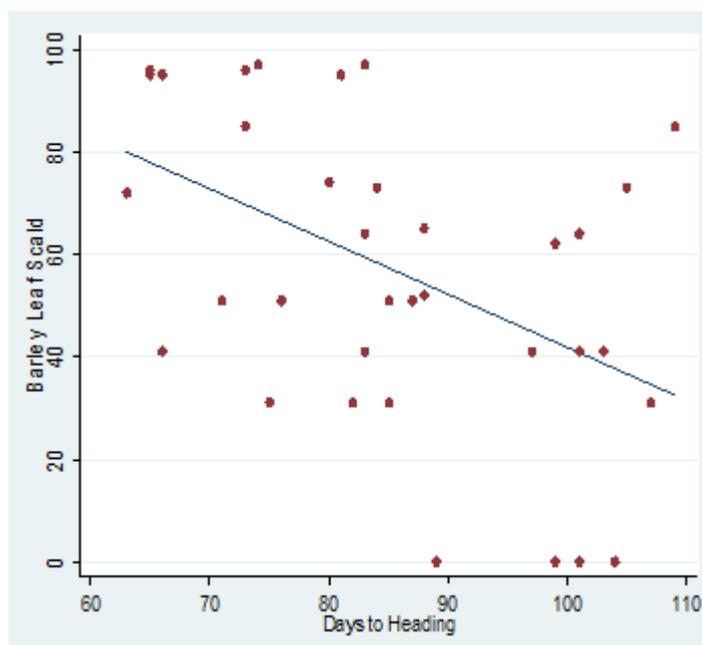


Figure 2. Correlation between DH and Scald disease for the 2004/05 rainy season at Debre Birhan testing site for 36 selected genotypes ($r = -0.54$).

- Engels, J.M.M. 1994. Genetic diversity in Ethiopian barley in relation to altitude. *Genetic Resources and Crop evolution* 41:67-73.
- Pickering, R. and Johnston, P.A. 2005. Recent progress in barley improvement using wild species of *Hordeum*. *Cytogenet Genome Res* 109: 344-349.
- Tanto, T., Rau, D., Bitocchi, E. and Papa, R. 2010. Adaptation and diversity along an altitudinal gradient in Ethiopian barley (*Hordeum vulgare* L.) landraces revealed by molecular analysis. *BioMed Central Plant Biology* 10:121-121.
- Van Leur, J.A.G. and Gebre, H. 2003. Diversity between some Ethiopian farmer's varieties of barley and within these varieties among seed sources, *Genetic Resources and Crop Evolution* 50:351-357.
- Zhang, L., Pickering, R.A. and Murray, B.G. 2001. *Hordeum vulgare* x *H. bulbosum* tetraploid hybrid provides useful agronomic introgression lines for breeders. *New Zealand Journal of Crop and Horticultural Science* 29: 239-246.
- Yitbarek, S., Berhane, L., Fikadu, A., Van Leur, J.A.G., Grando, S. and Ceccarelli, S. 1998. Variation in Ethiopian barley landrace populations for resistance to barley leaf scald and netblotch. *Plant Breeding* 117:419-423.