Status of Eyespot and Root Diseases of Barley in West Shewa

Getaneh Woldeab
EARO, Plant Protection Research Center
P. O. Box 37, Ambo, Ethiopia

Abstract

The status of barley eyespot and root rots was assessed along four routes of West Shewa, Ethiopia between 1995 and 1997 cropping seasons. Each season, root samples were collected at seedling, stem elongation and flowering stages. At each stage, about fifty to one-hundred plants were up-rooted along the two diagonals of a field from five farmer's fields per route. The study showed a significant level of eyespot and root rot diseases in the region. The eyespot and root rot diseases occurred as solely or in combination with one another. Incidence of these diseases varied among fields, growth stages, and routes and the diseases increased with the age of barley crop. However, the number of eyespot and root rot infected samples was less when barley was sown after fallow than it was cropped after barley and linseed. The overall incidence of root rot for West Shewa was 49.1%, while that of eyespot was 14.4%. The pathogens involved were *Pseudocercosporella herpotrichoides*, *Cochliobulus sativus*, *Fusarium avenacium* and *Pythium* spp. The latter two pathogens are new records on barley in Ethiopia. Therefore, it can be concluded that eyespot and root rots are important barley diseases in West Shewa.

Introduction

Despite its long history of cultivation and wide range of uses in different communities of Ethiopia, the national average yield of barley is very low (1.0 t $ha.^{-1}$) (CSA 1989). In addition to poor farming practices, low yielding land races and adverse environmental conditions, diseases are one of the major production constraints of barley in this country (Berhane et al. 1996). Above and below ground parts of barley plants are vulnerable to diseases, of which, foot and root rots are widespread on this crop (Attwood 1985, Eshetu 1985, Gair et al. 1983, Mathre 1987). The pathogens causing foot and root rots of barley are many. Of these, *Pythium* spp. (browning root rot), *Fusarium* spp. (brown root/foot rot), *Cochliobulus sativus* (root/foot rot), *Pseudocercosporella herpotrichoides* (eyespot/foot rot), *Gaeumannomyces graminis* (take-all), *Rhizoctonia cerealis/ R. solani* (sharp eyespot) and *Sclerotium rolfsii* (root rot) are the major ones (Attwood 1985, Bockelman et al. 1981, Cook 1962, Eshetu 1985, Gair et al. 1983, Gareth & Clifford 1983, Mathre 1987, Stubbs et al. 1986, Trofimovskaya 1972).

In naturally infected fields, losses from common/dryland root rot (*Cochliobulus sativus* and *Fusarium* spp.) ranged from 6- 20% (Mathre 1987). The effect of these diseases is most severe in years of below normal soil moisture when plants are stressed for water. Eyespot infection kills tillers and plants lodge prematurely. It is severe when the crop is dense and weather conditions are cool and moist (Gair et al. 1983, Mathre 1987). At Holetta, this disease has caused a yield loss ranging 6-21% (Eshetu & Yitbarek 1983, Eshetu 1985). Take-all may also cause up to 50% or more yield losses on barley (Gair et al. 1983, Mathre 1987). Browning root rot is more when plants are growing in wet, compacted soils deficient in phosphorus and organic matter (Attwood 1985, Bockelman et al. 1981, Cook 1962, Gair et al. 1983, Mathre 1987).These diseases build up under continuous cereal growing system. In the absence of the cereal crops, the disease causing organisms survive on root, leaf and stem debris in the soil (Bockelman et al. 1981, Gareth & Clifford 1983).

A study undertaken to examine the occurrence of eyespot in barley at Holetta Agricultural Research Center and farmer's fields around the center indicated the incidence of the disease ranging from 24-27% (Eshetu & Yitbarek 1983). Moreover, in a different study, the presence of *R. cerealis, C. sativus* and *S. rolfsii* was reported in Chilalo districts, Sheno and North Western region of Ethiopia, respectively (Eshetu & Yitbarek 1983, Eshetu 1985, Yitbarek et al. 1996). However, extensive surveys have not been done to inventorize and know the status of eyespot and root rots in the major barley growing highlands of Ethiopia. Especially, attempts have not been made to assess the root diseases of barley in the western highlands of Shewa which occupies about 18% (160,530 ha.) of the total barley area in the country. Seventy five percent of the area in Shewa is allotted to barley (Berhane et al. 1996). Therefore, this survey is undertaken to study the status of eyespot and root diseases of barley in this part of the country.

Materials and Methods

Barley root rots and eyespot surveys were carried out in four independent routes: Ginchi - Jeldu, Gedo - Goben, Ambo - Wonchi and Tikur Inchini - Shenen districts of West Shewa for three seasons starting in 1995. Each season, five farmer's barley fields were selected randomly at each route at an interval of 10 Km along the roadsides. Each field was inspected three times i.e. at seedling, stem elongation and flowering stages of the crop. At each stage, about fifty to one hundred barley plant samples were pulled out along the two diagonals of a field. The soil was washed off from the roots with tap water and the samples were blotted dry and wrapped separately in newsletters. Moreover, leaf sheaths were striped off the stem and the lower internodes were checked for eyespot lesions. When the lesions were not conspicuous, the internodes were split and checked for a typical grayish cottony mycelium. The number of plant samples with and without eyespot lesions were counted separately for each growth stage.

Laboratory diagnosis were made to diagnose the responsible pathogen of each disease observed on the field. Then duplicate and representative infected root samples were carefully packed, labeled and sent to the Plant Disease Diagnostic and Advisory Laboratory of CABI Bioscience of the United Kingdom for pathogen identification or confirmation.

Since each plant may be infected with more than one pathogen, plants were classified based on the type of symptoms i.e. free, either eyespot or root rot or both eyespot and root rot. At the three growth stages data such as eyespot and root rots incidence (free and infected) were taken on each plant sampled. Moreover, information on the type of the precursor crops was collected during the survey.

Results

Representative samples sent for confirmation/ identification indicated that *Pseudocercosporella herpotrichoides*, *Pythium* spp, *Cochliobolus sativus*, and *Fusarium avenacium* were identified from barley foot and root rot specimens collected in West Shewa. The former two pathogens were found along all routes, while the latter two were identified from samples collected from Ambo–Wonchi and Ginchi–Jeldu routes, respectively.

Root rot infected plants showed thin culms and stunted plant growth, and heads did not emerge from the boots. Eyespot infected plants matured earlier than the healthy ones and produced white heads. The weakened stems also lodged in a random "jackstraws" fashion. The lodged plants did not recover unlike wind-lodged plants, which may recover. Plants that were infected by both eyespot and root rots were severely stunted and white headed with incompletely filled seeds. The healthy plants had normal growth with good spikes.The combined analysis of arc-sine transformation for root rot incidence at three growth stages on sixty farmer's production fields on four routes and three seasons (1995 – 1997) is shown in Table 1. The incidence of root rot was found to be significant ($P < 0.05$) in the region. The incidence of the disease varied among the four routes and three growth stages. Overall, the lowest mean incidence for West Shewa was

20.5% at seedling stage and increased to 39.2% at stem elongation and 49.1% at flowering. The mean incidence of the diseases varied significantly among fields and ranged between 14.2 - 28.7, 33.2 - 47.3 and 42.7 – 57.6% at seedling, stem elongation and flowering stages, respectively. The mean incidence of root rot at the flowering stage over the years was 51.2, 50.8, 44.8 and 49.5% along Ginchi - Jeldu, Gedo - Goben, Ambo - Wonchi and Tikur Inchini - Shenen districts, respectively. The overall incidence of root rot evaluated at flowering was 49.1%.

Mean percent eyespot incidence on barley plant samples at three growth stages along the four routes during 1995 - 1997 crop seasons is shown in Table 2. The variation of eyespot incidence among the four routes and three growth stages was significant ($P < 0.05$). The overall mean incidence for West Shewa was 0.99% at seedling, 7.6% at stem elongation and 14.4% at flowering stages. The incidence of eyespot also varied among fields and it was 0.99 – 30.0 at stem elongation and 0.99 – 48.3% at flowering stages. Eyespot incidence was as high as 36.4, 8.1, 9.1 and 4.0% along Ginchi - Jeldu, Gedo - Goben, Ambo - Wonchi and Tikur Inchini - Shenen districts, respectively. The overall incidence of eyespot for West Shewa when evaluated at flowering was 14.4%.

Combined infection

The present study further confirmed that barley plants could be infected by more than one root pathogen (Table 3). Out of the total samples collected, 44.8% were infected by root rot alone, 38.5% were free from root diseases and 13% of the samples were infected both by eyespot and root rot. Eyespot accounted for only 6.7% of the total infected samples. This result shows that barley plants were vulnerable to both eyespot and root rot diseases.

Table 1. Mean percent root rot incidence on barley plant samples at three growth stages along four routes of West Shewa, 1995 - 1997 crop seasons.

Field No.	Growth Stage*	Routes			
		Ginchi – Jeldu	Gedo – Goben	Ambo – Wonchi	Tikur Inchini – Shenen
1	SS	24.3	21.1	20.3	25.1
	SES	42.7	47.3	40.4	35.7
	FS	51.2	57.2	49.2	49.2
2	SS	20.3	22.8	18.4	17.5
	SES	38.1	40.4	33.2	31.9
	FS	52.7	51.9	42.7	51.9
3	SS	22.8	14.2	22.0	20.3
	SES	41.0	41.0	43.3	34.4
	FS	49.0	48.3	45.7	48.8
4	SS	16.4	17.5	24.3	14.2
	SES	38.6	41.0	35.1	34.4
	FS	45.4	50.8	42.9	45.0
5	SS	22.8	19.4	28.7	17.5
	SES	36.3	41.5	42.1	40.4
	FS	57.6	46.0	43.3	52.4
Mean	SS	21.3	19.0	22.7	18.9
	SES	39.3	42.2	40.0	35.4
	FS	51.2	50.8	44.8	49.5

CV (%) 15.5

LSD_{05}

Routes 2.34

Growth stages 2.03

* = SS - seedling stage, SES - stem elongation stage and FS - flowering stage.

Table 2. Mean percent eyespot incidence on barley plant samples at three growth stages along four routes of West Shewa, 1995 - 1997 crop seasons.

Growth Stage		Routes			
		Ginchi - Jeldu	Gedo-Goben	Ambo – Wonchi	Tikur Inchini – Shenen
1	SS	0.99	0.99	0.99	0.99
	SES	21.9	0.99	11.5	0.99
	FS	41.5	0.99	7.5	3.1
2	SS	0.99	0.99	0.99	0.99
	SES	21.9	0.99	0.99	0.99
	FS	31.9	7.5	12.9	3.1
3	SS	0.99	0.99	0.99	0.99
	SES	30.0	0.99	0.99	0.99
	FS	48.3	0.99	6.5	7.5
4	SS	0.99	0.99	0.99	0.99
	SES	19.4	3.1	0.99	0.99
	FS	34.0	25.1	0.99	3.1
5	SS	0.99	0.99	0.99	0.99
	SES	14.2	10.5	8.1	0.99
	FS	34.0	25.1	17.5	3.1
Mean	SS	0.99	0.99	0.99	0.99
	SES	21.7	3.3	4.5	0.99
	FS	36.4	8.1	9.1	4.0

CV (%) 7.2
LSD05
Routes 2.45
Growth Stage 2.14

Effects of precursor crops

Results on the influence of precursor crops and fallow on the incidence of root rot and eyespot proved that root rot and eyespot infection was the highest when barley was followed by linseed and barley than when barley was preceded by fallow (Table 4).

Table 3. Percent of barley plant samples with eyespot/root rot symptoms observed along four routes of West Shewa, 1995 - 1997 seasons.

Type of disease	Route				
	Ginchi –Jeldu	Gedo -Goben	Ambo – Wonchi	Tikur Inchini - Shenen	Mean
Free	29.7	39.1	44.7	40.4	38.5
Eye spot (ES)	22.7	3.1	5.7	3.1	6.7
Root rot (RR)	38.1	48.6	43.3	49.3	44.8
ES + RR	28.3	11.1	8.9	3.1	12.9

CV(%) 27.3
LSD 05
Type of diseases 3.34

Table 4. Influence of precursor crops and fallow on the incidence of root rot and eyespot across the survey routes of West Shewa, 1996 - 1997 seasons.

Precursor crop	Number of fields	Root rot (%)	Eyespot (%)
Linseed	7	79.1	11.9
Barley	15	72.8	19.5
Fallow	14	70.1	8.7

Discussion

Among the pathogens involved as causal agents of barley root rot in West Shewa, *Pythium* spp and *Fusarium avenacium* were identified for the first time in Ethiopia. Moreover, analysis of more samples collected at seedling, stem elongation and flowering stages may reveal more root pathogens affecting barley in West Shewa.

Barley disease surveys conducted between 1995 - 1997 in West Shewa revealed the presence of eyespot and root rot diseases at a very high level. This finding further shows that the distribution and incidence of the diseases on the local barley varieties were similar in all the barley fields, routes and years. The incidence of eyespot and root rot increased with the growth stages of the crop and this shows that the crop becomes more vulnerable to disease with age, confirming earlier findings (Mathre 1987, Wiese 1977).

There was no reliable meteorological data available for all of the areas surveyed. However, according to information obtained from development agents of the districts and experts working in the Zonal Ministry of Agriculture, Ginchi - Jeldu route received more rain than other routes. Barley in the area was sown continuously at a high seed rate due to shortage of arable land. As a result, high eyespot incidence (36.4%) with more white headed and lodged plants was recorded in this area. This could be due to the high soil moisture, dense crop canopy, high humidity near the soil surface and monocropping of barley that may increase the incidence of the disease (Gair et al. 1983, Mathre 1987, Wiese 1977). Eyespot was also more rampant on fields that were cropped barley after barley and it was less when barley was cultivated after linseed and least after fallow. Wiese (1977) also showed that since *P. herpotrichoides* dies out with the decay of infected residues, crop rotations for one or more years are advisable to reduce the incidence of eye spot.

The incidence of root rot was slightly less on barley fields planted after fallow than when it was cropped after linseed and barley. This indicates that carry over of the pathogens through infected roots, leaves and stem debris in the soil may take place. Long rotations (5 years) with non-grass crops were reported to be one of the control measures used to reduce these diseases (Mathre 1987, Wiese 1977, Bockelman et al. 1981).

Therefore, it can be concluded that eye spot and root rot are important diseases in West Shewa. In order to reduce the incidence and severity of these diseases, and increase the yield per unit area of land, effective management strategies have to be designed.

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