

Research Article

Distribution and Importance of Barley Diseases in South Gondar Zone, Ethiopia

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Abstract

Barley is an important commodity, mostly used as feed for animals, malt and food for human consumption. Diseases are considered as the most important biotic factors that limit the production of the crop in Ethiopia in general and South Gondar zone in particular. However, the statuses of barley diseases distribution and importance have not well studied in this area. Therefore, the present study was conducted to identify the distribution and importance of barley diseases in the study area. Field surveys were carried out at the period of 2021 and 2022 main growing season in major Barley growing districts of South Gondar zone. Survey results revealed the prevalence and intensity of different diseases of Barley across the districts at different levels. Among 93 observed fields, Net blotch was the most prevalent (77.52%) while the maximum severity up to 75% was recorded for scald and highest disease incidence up to 25% was recorded for smut. Therefore, initiation of integrated diseases management option at hot spot area of each disease was suggested, in addition to continuously evaluating the new sources of Barley genotypes for further breeding program.

Keywords

Barley, Net Blotch, Scald, Smut, Prevalence, Survey

1. Introduction

Barley (*Hordeum vulgare*) is an important commodity, mostly used as feed for animals, malt and food for human consumption. Ethiopia is the second largest barley producer in Africa. It accounts nearly 25% of the total production in Africa [1]. Barley is the predominant cereal in the high altitudes (>2000 m.a.s.l.) [2]. Ethiopia is also recognized as a center of diversity for barley having global significance because of its improved traits, including disease tolerance [3, 4]. Traditionally barley is used for making local recipes and drinks and other types of food. Its straw is a good source of animal feed [5]. Because of its multifarious utilities, nutritive value and ever-increasing industrial demand, a substantial yield gains will be needed over the next several decades. But, a number of

biotic and abiotic stresses pose a challenge to increase the production of barley. Like the other cereals, barley also encounter different plant pathogens and succumb to various diseases which result in significant yield reduction and poor grain quality. Among the most important barely diseases, scald (*Rhynchosporium secalis*), blotches (*Helminthosporium spp.*), rusts (*Puccinia spp.*), smut (*Ustilago spp.*), Powdery mildew (*Erysiphe graminis* f. sp. *hordei*) and Septoria leaf blotch (*Septoria* sp.) have been reported in different part of Ethiopia [6, 7]. Currently, South Gondar zone in Ethiopia is one of the potential barleys producing areas where different diseases types are expected to prevail. Due to the fluctuation of environmental condition and the development of patho-

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types of pathogens causing different types of diseases on barley, epidemics and importance of disease may vary from place to place. However, there is little information available on the status of prevalence and intensity of the diseases in this

area. Thus, the study was conducted to update and provide a clear picture of the distribution and intensity of barley diseases in South Gondar zone Ethiopia.

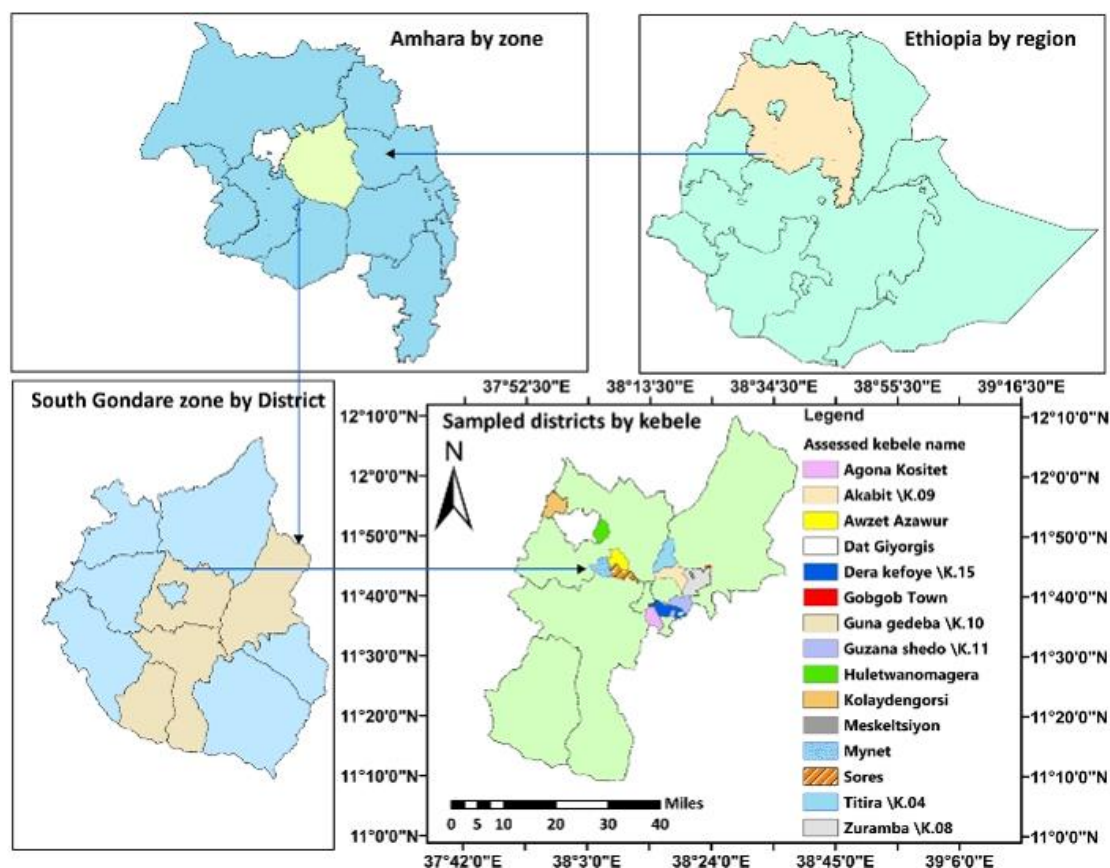


Figure 1. The study area of barley diseases.

2. Materials and Methods

2.1. Description of the Study Area

The survey was conducted in four major barley growing districts of the South Gondar zone in 2021 and 2022 main cropping season. The districts were selected based on their potential to grow barley crop in the South Gondar zone. Based on this, barley survey was conducted in Farta, Estie, Guna Begymdr and Lay Gaynt districts. Total of 93 fields in 15 kebeles were assessed (Figure 1). In the assessed fields three major barley diseases viz., Smut (*Ustilago* spp.), Scald (*Rhynchosporium secalis*) and Net blotch (*Helminthosporium teres*) were recorded.

2.2. Sample Collection

Sampled fields were selected based on the road accessibility and availability of the crop. Samples were collected ap-

proximately within 3-5km distance using the car's odometer. Data were collected both by direct field observation and interviewing of farmers. Prevalence of a disease was calculated using the number of fields affected divided by the total number of fields assessed and expressed in percentage.

$$\text{Disease Prevalence (\%)} = \frac{\text{Number of infected fields}}{\text{Total number of fields assessed}} \times 100$$

Disease incidence was assessed as proportion of plants showing symptoms in the field. The number of plants randomly selected stand showing each disease symptoms were counted and expressed as a percentage of the total number of stands per plot using the following formula:

$$\text{Disease Incidence (\%)} = \frac{\text{Number of infected plants}}{\text{Total number of plants assessed}} \times 100$$

Disease severity on individual plant basis was rated using a visual scale recommended for each disease on Barley crop [8, 9]. Severity scores were converted to percent disease index PDI, [10, 11].

$$= \frac{\text{Percent severity index (\%)}}{\text{Sum of numerical rating}} \times 100$$

$$= \frac{\text{Total number of plant observed} \times \text{maximum rating}}{\text{Sum of numerical rating}} \times 100$$

3. Results and Discussion

3.1. Prominent of Barley Diseases in Studied Areas During 2021 and 2022 Main Growing Season

Three diseases were identified from barley fields assessed in major barley growing districts of South Gondar zone in Ethiopia. Among 93 fields inspected, Net blotch (*Pyrenophora teres*) was the most prevalent (77.52%) followed by Scald (*Rhynchosporium secalis*) (66.41%) and Smut (*Ustilago spp.*) (53.11%). The maximum disease incidence recorded were up to 100%, 88% and 25%, respectively, for net blotch, scald and smut. This could be matched with the previous report of smut disease which is becoming major diseases in some surveyed barley growing agroecological zones in Ethiopia. (Tajudin *et al.*, 2021). On the other hand, highest percent severity up to 75% for scald and 50% for Net blotch were scored (Tables 1-3).

3.2. Distribution of Diseases in Surveyed Areas in 2021 and 2022 Main Growing Seasons

The result revealed that prevalence of net blotch in 2021 was highest at Farta (66.67%), followed by lay Gaynt (64.71%) and

Estie (44.44%) districts (Table 1). Overall, the mean net blotch prevalence was 58.6% across the surveyed district indicating the wide occurrence of the disease in the surveyed barley production fields. The prevalence of net blotch in 2022 ranged from 85.71 to 100% within the different districts, with a mean of 96.43%. The highest disease prevalence (100%) was recorded in Farta, Lay Gaynt and Guna Begymdr followed by Estie (85.71%) districts (Table 1).

Barley net blotch incidence in 2021 production year ranged from 10- 100% across the assessed points, with a mean value of 54.75%. The highest mean disease incidence (75%) was recorded in Farta followed by Lay Gaynt (51.09) and Estie (38.17%). Net blotch incidence in 2022 production year ranged from 0 - 100% across the assessed points. The highest 67.87% mean disease incidence was recorded in Farta, followed by Guna Begymdr (36.7%) districts (Table 1).

Net blotch severity in 2021 production year ranged from 2.5 - 50% across the assessed points, with a mean of 17.01%. The highest mean net blotch severity (25%) was recorded in Farta followed by Lay Gaynt (17.11%) district (Table 1). Similarly, in 2022, the net blotch was ranged from 0 to 35% in different districts with a mean of 5.92%. The highest mean net blotch severity (10.74%) was recorded in Farta followed by Lay Gaynt (7.84%) districts (Table 1). The survey indicates that net blotch affects barley leaves from the earliest crop stages, and could cause yield losses in the study area (Figure 2). This finding is in agreement with [11], who reported that Net blotch is the most prevalent and severe diseases in Ethiopia.

Table 1. Incidence, severity and prevalence of Net Blotch diseases in South Gondar during 2021 and 2022 production seasons.

Year		Altitude range (M)	Incidence		Severity		Prevalence
			Range	Mean	Range	Mean	
2021	Estie	3180-3293	10 – 100	38.17	2.5-25	8.94	44.44
	Farta	2298-3006	50 – 100	75	15 – 45	25.00	66.67
	Lay Gaynt	3080-3287	15 – 100	51.09	3.5 – 50	17.11	64.71
Districts average		2298-3287	10-100	54.75	2.5-50	17.01	58.6
2022	Estie	3180-3293	0-15	4.61	0-2.1	0.76	85.71
	Farta	2298-3006	10-100	67.87	3-25	10.74	100
	Lay Gaynt	3080-3287	0.85-100	27.65	0.25-35	7.84	100
	Guna Begymdr	2822-3115	5-55	36.7	3-5	4.33	100
Districts average		2298-3287	0-100	34.2	0-35	5.92	96.43
Seasons average		2298-3287	0-100	44.43	0-50	11.47	77.52



Figure 2. Barley net blotch disease observed on barley leaves during the survey.

Prevalence of scald disease in 2022 was highest at Farta and Guna Begymdr (84%), followed by lay Gaynt (54.55%) and Estie (42.86%) districts (Table 2). Overall, the highest scald disease prevalence recorded across the surveyed district indicating the wide occurrence of the disease in the surveyed barley production fields. Barley scald disease incidence ranged from 0- 88% across the assessed points, with a mean value of 14.52%. The highest mean disease incidence (24.75%) was recorded at Lay Gaynt followed by Estie (13.29%), Guna Begmdr (11%) and Farta (9.05) districts. (Table 2). Scald disease severity in 2021 production year ranged from 0 - 75% across the assessed points, with a mean

of 17.01%. This result is similar to the findings of [7], who reported maximum scald disease severity up to 60% was observed in barley field. The highest mean scald disease severity (10.98%) was recorded in Lay Gaynt followed by Farta (7.37%) districts (Table 2). The survey indicates that scald severely affects barley production field and could cause economic losses in the study area (Figure 3).



Figure 3. Barley scald disease observed on farmers' fields during the survey.

Table 2. Incidence, severity and prevalence of Scald diseases in South Gondar during 2022 production seasons.

District	Altitude Range	Incidence		Severity		Prevalence
		Range	Mean	Range	Mean	
Estie	3180-3293	0-82	13.29	0-38	5.96	42.86
Farta	2298-3006	0-40	9.05	3-75	7.37	84.21
Lay Gaynt	3080-3287	0-88	24.75	0-35	10.98	54.55
Guna Begymdr	2822-3115	3-25	11	3-10	5	84
Districts average	2822-3293	0-88	14.52	0-75	7.33	66.41

Prevalence of smut disease in 2021 was highest at Estie (92.59%), followed by Farta (50%) and Lay Gaynt (29.41%) districts (Table 3). Overall, the mean smut disease prevalence was 57.33% across the surveyed district indicating the wide occurrence of the disease in the surveyed barley production fields. The prevalence of smut disease in 2022 ranged from 0.2 to 89.17% within the different districts, with a mean of

48.89%. Barley smut disease incidence in 2021 production year ranged from 1.5- 25% across the assessed points, with a mean value of 10.01%. The highest mean disease incidence (13.4%) was recorded in Lay Gaynt followed by Estie (10.89). Barley smut disease incidence in 2022 production year ranged from 0 - 5% across the assessed points. (Table 3).

Table 3. Incidence and prevalence of Smut diseases in South Gondar during 2021 and 2022 production seasons.

	District	Altitude Range	Range	Mean	Prevalence
2021	Estie	3180-3293	1.5 – 25	10.89	92.59
	Farta	2298-3006	1.5 – 5	5.75	50.00
	Lay Gaynt	3080-32877	5 – 22	13.40	29.41
	Districts average	2822-3115	1.5-25	10.01	57.33
2022	Estie	3180-3293	0-2	0.1	0.2
	Farta	2298-3006	0-5	2.37	89.17
	Lay Gaynt	3080-32877	0-5	0.33	18.18
	Guna Begymdr	2822-3115	3-5	4.33	88
	Districts average	2298-3293	0-5	1.78	48.89
	Seasons average	2822-3293	0-25	5.9	53.11

4. Conclusion

The investigation revealed the spatial distribution, intensity and importance of each major fungal disease of barley during the main growing season. Accordingly, Net blotches (*Pyrenophora teres*), Scald (*Rhynchosporium secalis*), Smut (*Ustilago spp.*) were relatively important and prevalent diseases at the study period. Scald percent incidence ranged from 0-88% while percent severity 0-75%. Diseases Incidence for Net blotch varied from 0 to 100% while the severity fluctuated between 0 - 50% and incidence for smut varied from 0-25%. Therefore, study should continue towards disease management options through identification of host resistance and other disease management options to these diseases for sustainable barley production in the country.

Abbreviations

PDI	percent disease index
EIAR	Ethiopian Institute of Agricultural Research
DI	Disease Incidence

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Conflicts of Interest

The authors declare no conflicts of interest.

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