

Evaluation of Host Reaction and Yield Performance of Malt Barley Cultivars to Net Blotch, *Pyrenophora teres* in Bale Highlands, Ethiopia

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Abstracts: The host reaction and yield performance of malt barley cultivars to net blotch, *Pyrenophora teres* disease was tested under natural infection of field at Sinana Agricultural Research Center (SARC) in Maher seasons of 2015. This study was designed to 12 commercial malt barley cultivars under field condition in Randomized Complete Block Design (RCBD) with two replications. The significant differences in severity (%), Area Under the Disease Progress Curve (AUDPC), grain yield (kg/ha), TKW (gm) and Days to Heading (DH) among the malt barley cultivars were observed. The HB-52 (4-68%), HB-1533 (12-54%) and Miscal-21 (4-68%) were scored the lowest ranges of severity index (%), where as IBON-174/03 (639.5%), HB-52 (611.4%) and HB-1533 (593.4%) were recorded the lowest means of AUDPC. The superior yield responses were obtained from HB-52 (1636kg/ha), Taveller (1647.5kg/ha), Miscal-21 (1775.5kg/ha) and Bekoji-1 (1752kg/ha) as compared to other cultivars. The disease severity % was gradually higher as the plant ages from seedling to maturity in all cultivars were tested to net blotch disease. Phenotypical scoring of net blotch on malt barley cultivar with yield performances were in to four categories; the yielder cultivar in the presence of net blotch disease pressure (Traveller, Bekoj-1 and Grace), both disease resistance and yielder cultivar (HB-52, Miscal-21), only net blotch resistance cultivar (HB-1533, IBON-174.03) and Cultivars (Beka, Sabini, Bahati, Fire Gebes and HB-120) were also identified as susceptibility to net blotch at natural infection in field with none yield advantage.

Keywords: Net Blotch, AUDPC, Disease Severity, Host Reaction, Malt Barley, Cultivar

1. Introduction

Barley (*Hordeumvulgare L.*) is one of the cereal crops produced and is used for food and malt production in Ethiopia (Maaza and Lakech, 1996, Zemede, 2002). Small scale farmers are the major barley producers (Getachew *et al.*, 2011). Barley is one of the low yielding and the 3rd ranked cereal crops next to Wheat and Maize accordingly area (11%), Production (9.3%) and productivity (1.9 t/ha) for Meher Season of 2014/15 under farm condition (CSA, 2014) in Bale Zone, Ethiopia. Its production mostly affected by a number of biotic factors such as disease (Stewart and Dagnatchew, 1967; Eshetu, 1985) and insect pests recorded (Adunga and Kemal, 1986) on barley in Ethiopia. The foliar diseases are; (net blotch, scald, and leaf rust), and seed-borne diseases (barley stripe, loose

smut and covered smut) and insect pests (barely shoot fly and aphid) are significantly threatening barley production in Ethiopia.

Net blotch disease caused by *Pyrenophora teres* is one of the major constraints facing barley production in Ethiopia (Yitbareket *et al.* 1996; Bekele *et al.* 2001; Asenakech, 2002; Bekele, 2005). First symptoms of net blotch usually appear when seedlings reach tillering stage, and host reaction may vary with plant age (Tekauz, 1986; Tekauz, 2000; Gupta *et al.*, 2003). The disease affects the foliage of barley and severely reduces its photosynthetic capacity, resulting in yield losses both in food and malt barley and excessive grain protein for malting due to reduced starch accumulation in the kernel, that on malt barley resulting in poor malt quality

(Horsley and Hochhalter, 2004).

It can cause significant financial losses due to yield reductions, ranging from 11.5 to 21.3% on Beka, Holker, HB-52 and HB-120 cultivars, and decreased grain quality (Teshome *et al.*, 2008). The disease causes a grain yield loss on farm in average 28-29% is accounted for net blotch and leaf rust (Bekele *et al.*, 2001) infection. The inoculums of *P. teres* could be moved by wind among neighboring fields, because of the polycyclic nature of the pathogen, little amount of inoculums could enable the disease to reach a high level of epidemic under favorable conditions (Bekele *et al.*, 2004). The management of barley against *P. teres* is important to maximize the crop's yield. Varietal Resistance helps in reducing the amount of fungicide required and the rate of the disease development. The disease resistance has been a major strategy in controlling net blotch of barley in California (Steffenson, 1988). In Ethiopia, from different cultivars of malt barley under production only some has been recognized as the level of resistant to *P. tere* (HARC, 1998/2000). Many attempts have been made to understand the genetic basis of net blotch resistance but, none of them can confer durable resistance to net blotch. At present, the use of resistant barley cultivars is the most effective and economical method of controlling net blotch disease (McDonald & Linde, 2002). Therefore, the objective of the study, it is important to identify the most resistant cultivars and exclude the susceptible ones for a base of successful breeding strategy highly depends on correct choice of parent genotypes.

2. Materials and Method

2.1. Experimental Site

Experiments were conducted during Maher season (August-December, 2014) at Sinana Agricultural Research Center (SARC) on-station research site, Oromia, Ethiopia. It is situated at a distance of 463 km south east of Addis Ababa and 33 km east of Robe town (capital of Bale zone) on the road to Sofumar cave. The research site 2400 meters above sea level represented the high altitude of barley production areas and located at 7°7'N latitude and 39°40'E longitude. The experimental area was characterized by cambic verity soil with pH ranges of 6.3-7 (slightly acidic) at the depth of 0-15 cm. The monthly averages of minimum and maximum temperatures are 9.42 and 21.16°C, respectively.

2.2. Experimental Materials and Treatments

The experiment was conducted on screening of barley released cultivars were collected from Ethiopian National and Regional Research Center for their response to net blotch diseases for field test. The experiments were conducted for the 12 malt barley released cultivars (Table 1). Each variety was sown in four rows, with row length of 1.25m, 10 grams of seeds sown per plot. Cultivars were arranged in completely randomized block design (RCBD) with two replications. The space between rows and block was 20cm

and 40cm respectively and other agronomic practices were followed as per local practices.

Table 1. List of Malt barley cultivars released from different research centers in Ethiopia.

No.	Cultivars	Year of released
1	IBON174/03	2012
2	Sabini	2011
3	Bahati	2011
4	Fire gebis	2010
5	Bekoji	2010
6	HB-1533	2004
7	HB-52	2001
8	HB-120	1994
9	Holker	1979
10	Beka	1976
11	Traveller	2013
12	Grace	2013

2.3. Disease Severity Assessments

Net blotch disease severity was assessed five times from the middle of two rows from ten (10) randomly-selected and tagged barley plants at every 7 days starting from 80 days after planting (DAP) and this were through the growing season until the crop was mature (Arabi, 2004). Due to the continuous presence of the disease in the experimental areas the barley lines were screened under natural infection (Jebbouj and Yousfi, 2010; Harrabi and Kamel, 1990). A severity assessment was done on a scale of 0 – 9 severity scale with 0 representing no infection and 9 when all barley leaves dry due to infection by the fungus; after assessment, the barley cultivars were grouped as follows: 0-3 = Resistant, 4-5 = moderately resistant, 6-7 = moderately susceptible, 8-9 = Susceptible, the disease severity scores were also converted to percentage severity index (PSI) (Silvar, et al., 2009; Serenius, 2006; Agrios, 2005).

$$PSI = \frac{S_{nr}}{N_{pr} \times M_{sc}} \times 100$$

Where S_{nr} is the sum of numerical ratings; N_{pr} is the number of plants rated; and M_{sc} is the maximum score on the scale.

2.4. Area Under Disease Progress Curve (AUDPC)

The rate of disease increase in the field and the cumulative amount of the disease over a time (expressed as area under disease progress curve) provides use full overall measures of disease progress. Area under the Disease Progress Curve (AUDPC) was calculated for all cultivars according with the following function (Arabi, 2003; Jayasena, 2007; Harrabi, 1996).

$$AUDPC = \sum_{i=1}^{n-1} 0.5(Y_{i+1} + Y_i)(t_{i+1} - t_i)$$

Where Y_i is the percentage of disease severity index at i^{th} assessment; t is the time of the i^{th} assessment in days from the

first assessment date; and *n* is the total number of days disease severity was assessed.

2.5. Yield and Yield Components

Data of the yield and yield components were recorded from the two central rows for each treatment. Days to heading: the numbers of days from planting to the time when 50% of plants showed head on plot basis. The weight of thousand kernels sampled at random from the total grains harvested from each experimental plot was measured. Grain yield in gram per plot (gm/plot) at 12.5% moisture content was recorded and translated to kg/ha.

2.6. Statically Analysis

Disease parameters (disease severity) PSI, AUDPC and yield and yield component were subjected to analysis of variance (ANOVA) using Statistical Analysis System (SAS) version 9.1 (SAS, 2002). Data on disease severity were transformed using logistic transformation before statistical analysis. Means were compared by Duncan's multiple range tests at 5% significance level.

3. Results and Discussion

3.1. Disease Severity

The percent severity index of *P. teres* to all malt barley cultivars were increased on all day's disease severity assessment. The maximum or the peak mean disease severity index (6-89%) at 80-108 DAP cultivars were observed in Beka, Sabini, Bahati, Traveller, Bekoj-1, HB-120, Fire-Gebs, Grace to *P. teres* disease reactions (Figure 1). The disease severity index % was increased as the plant stage increased to maturity in all malt barley cultivar tested. Williams *et al.*, 2003 reported that the resistance genes in the genotype are only effective at seedling stage of plant growth and not effective at adult plant stage of growth. Resistance to net blotch can be maintained or improved as the plant matures (Gupta *et al.*, 2003; Tekauz, 2000). Research finding at Holeta Agricultural Research Center (HARC) by Teshome *et al.* in 2008 on effects of net blotch on malt barley yield and grain quality were reported that the significant differences among cultivars (HB-52, Beka, Holker and HB 120) in percentage severity index were observed; Beka and Holker were found to be more susceptible to net blotch compared to HB-52 and HB-120 cultivar were tested.

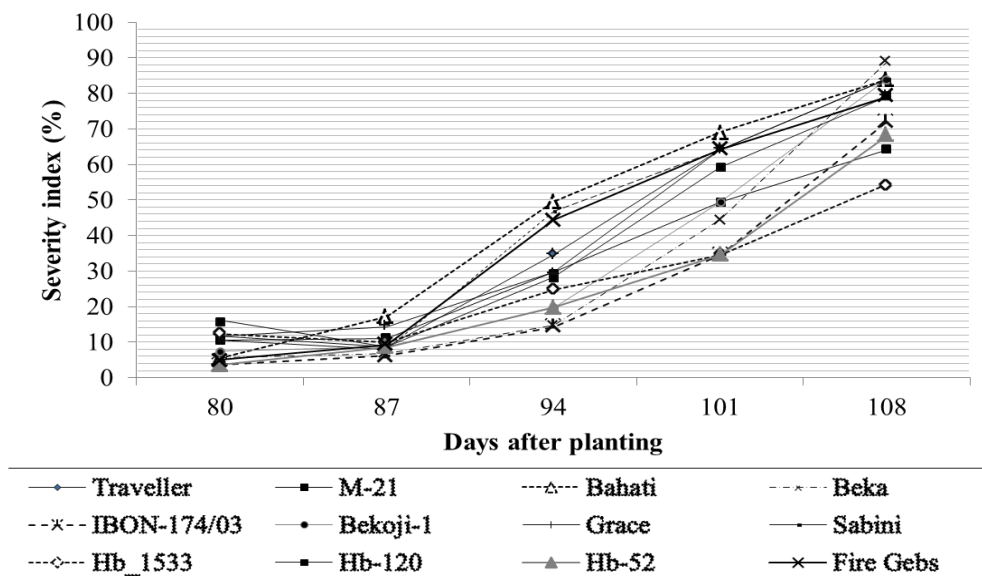


Figure 1. Net Blotch Disease Progress Curve (percent severity index) with released malt barley cultivars.

3.2. Area under Disease Progress Curve (AUDPC)

The AUDPC was significantly different ($P < 0.05$) among the malt barley cultivars screening for their reaction to Net blotch disease. The lowest AUDPC 639.5% (IBON-174/03), 611.4% (HB-52) and 593.4% (HB-1533) were significantly differences obtained when they compared to other cultivars of 1012.8% (Beka), 1112.8% (Bekoji-1), 862.2% (HB-120), 1068.8% (Traveller), 1073.8% (Grace), 1119.2% (Fire Gebs), 1164.5% (Sabini) and 1263.9% (Bahati) tested for their response to Net Blotch disease (Table 2). During this study a

variation in resistance to net blotch disease of malt barley released cultivars were responded due to genetically differences. Previous finding were also revealed that varied response by barley lines confirms to disease may be under the control of several resistant genes (Arabi *et al.*, 2003; Liu *et al.*, 2011). Type and quantity of phytoalexin produced due to infection by the fungus may have caused the varied response between hosts (Agrios, 2005) and disease occurrence in a population of plants depends on the level of host resistance and amount of initial inoculums presents (Campbell and Madden, 1990).

3.3. Grain Yield (kg/ha), Thousand Kernel Weight (TKW) and Days to Heading (DH)

The lowest grain yield in kg/ha was harvested from plot cultivars of Bahati (680kg/ha), Sabini (1130kg/ha) were significantly different from the variety of HB-52 (1636kg/ha), Taveller (1647.5kg/ha), M-21 (1775.5kg/ha), Bekoji-1 (1752kg/ha). The cultivars of Beka (1372.5kg/ha), IBON-174/03 (1372.5kg/ha), Grace (1501kg/ha), Hb1533 (1427kg/ha), Hb-120 1244.5kg/ha) and Fire Gebes (1467.5kg/ha) are more or less similar grain yield in kg/ha were obtained during test of variety reaction to net blotch disease assessments (Table 2).

Effect of cultivars response to net blotch disease was obtained the highest Thousand Kernel Weight (TKW) from HB-120 (49.5). The net blotch disease may not effect to reducing the TKW on HB-120 variety. The similar occasion was also observed in variety of IBON-174/03 (39.5) as the minimum yield it has. But, the other rest cultivars of TKW results may shows direct relation with yield grain harvested in kg/ha (Table 2). This independent variable were varied due to the effect of net blotch disease intensity occurred on malt barley cultivars. These difference can also in relation with the decrease in the photosynthetic capacity, leading to a decrease in the carbohydrates level in the kernel (Horsley and Hochhalter, 2004; Jayasena *et al.*, 2007; Jebbouj and Youfsi, 2009).

The days to heading (DH) shows the significant difference between cultivars tested to their response on net blotch disease. The highest days to heading on variety of Traveller (88) was significantly different from Fire-Gebes (72.5), Grace (70.5) and M-21 (69.5), but not differ from Bahati, Beka, IBON-174/03, Bekoji-1, Sabini, HB-120 and HB-52 (Table 2).

Table 2. Responses of yield components of malt barley cultivars to mean level ADUPC of Net blotch disease.

Cultivars	AUDPC	Grain yield (kg/ha)	1000 kernel weight	Days to heading
Traveller	1068.8	1647.5	40.85	88
Miscal-21	892.3	1775.5	41.3	69.5
Bahati	1263.9	680	31.5	75
Beka	1112.8	1372.5	37.8	75
IBON-174/03	639.5	1355.5	39	75
Bekoji-1	862.2	1752	36.1	76
Grace	1073.8	1581	32	70.5
Sabini	1164.5	1130	35.1	73.5
HB-1533	593.4	1327	40.4	67.5
HB-120	1006.8	1244.5	39.5	79
HB-52	611.4	1636	33.8	82
Fire Gebes	1119.2	1267.5	35.2	72.5
Means	941.6	1416	37.8	75.3
Lsd	348	574	10	14
CV (%)	17	25	15	9

4. Summary and Conclusion

Net blotch is a destructive foliar fungal disease of barley, caused by the *Pyrenophora teres* fungus and continues to develop the lesions continue to elongate, following the veins, and are often surrounded by a yellow margin causes infection to considerable yield losses in barley. The present finding

were on evaluation of host reaction and yield performance of malt barley cultivars to net blotch were tested in Bale Highlands at Sinana Agricultural Research Center. These cultivars were identified as resistance to net blotch and have a better yield performance could be recommended for farmers, state and private farms of commercial production and also those merits they have could be incorporated into breeding programs for germplasm enhancement in net blotch disease resistance and high yielder variety developments. There is need to characterize barley (malt and food) commercial cultivars and different genotypes (crosses and land race collection) in to molecular levels at different stage of growth (especially, at seedling and adult stage) resistance. Multiple location studies with the same commercial cultivars and other cultivars in both malt and food should be important to confirm the responses in different environments since, environment were found to play a major role in the reaction of net blotch to different hosts. The effect of net blotch disease to malt grain quality parameters on the same cultivars also should be checked.

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