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Evaluation of integrated disease management for malt barley production in bale highlands, South-Eastern Ethiopia

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Abstract

Malt barley is one of the most important cereal crops cultivated in South-eastern Ethiopia. However, the regional production and quality for malt brewery is threatened by major barley diseases among which net blotch caused by (*Pyrenophora teres*) is the most important one. A field experiment was conducted to evaluate the variety, fungicide and their interaction on disease severity, yield and yield related traits in malt barley at four locations, in 2010 belg and meher cropping seasons. The experiment was conducted using three malt barley varieties and four levels of fungicide application in split plot design with three replications. Application of Tilt 250 EC at 7-10 days intervals, two times application at GS30-31&GS39-41 and one time application at GS39-41 have provided better net blotch management as compared to nil application. Moreover, Tilt 250 EC applied treatments gave grain yield, 1000-kernel weight and hectoliter weight increment in most cases. At least one time fungicide application at GS39-41 provided effective net blotch management and improved malt barley yield and yield related malt quality parameters. With problems associated with environmental pollution, fungicide cost, labor cost and sprayer renting cost, continuous fungicide application is not recommended though it gave excellent malt barley disease control in most occasions across the years.

Keywords: Fungicide, malt barley, net blotch, variety

INTRODUCTION

In Ethiopia, malt barley (*Hordeum vulgare*) grain is used for both malt and food purposes although the major part of a production is used as a raw material to produce malt that subsequently used for beer production. Malt yield and malt quality depends on production potential; capability of accumulating assimilates in interaction with soils and weather conditions. Yield and yield quality are also largely affected by cultural practices, an integral part of which are interventions related to stand protection against weeds, pests and diseases. Of several diseases recorded on barley in Ethiopia, the major diseases net blotch (*Pyrenophora teres*), leaf rust (*Puccinia hodei*) and Scald (*Rhynchosporium secalis*) still incur yield losses as high as 67% depending on the susceptibility of the cultivars and seasons (Eshetu, 1985; Bekele et al., 2001; Bekele, 2005).

Foliar diseases commonly occurring on malt barley in Bale zone are net blotch, scald, leaf rust and powdery mildew (*Blumeria graminis* f.sp. *hordei*) among which the first three are the most important ones that commonly reduce grain yields and quality parameters required (Bekele et. al., 2001; Bekele, 2005). An integrated disease management is primarily depends on varieties and their established resistance back grounds. Currently, several races or pathotypes exist for each pathogen inciting these diseases in Ethiopia. Consequently, the

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Table 1: Effect of varieties on malt barley disease severity, yield and yield related traits at Selka, Ganna (Belg) 2010.

Variety	Net blotch severity (%)	Plant height (cm)	Biomass yield (kg/ha)	Grain yield (kg/ha)	TKW
Misical-21	32.50[a]	79.25[a]	8533.30[a]	757.20[a]	38.94[a]
Holker	30.83[a]	74.41[a]	7916.70[a]	770.20[a]	38.12[a]
Beka	21.66[a]	71.42[a]	8906.30[a]	725.70[a]	40.29[a]
Mean	28.33	75.02	8452.08	751.02	39.12
LSD (5%)	ns	ns	ns	ns	ns
CV (%)	-	13.49	22.82	-	9.24

*TKW= Thousand kernel weight, ns=non-significant difference, means with the same letter within a column are not significantly different

Table 2: Effect of fungicide application frequency on malt barley disease severity, yield and yield related traits at Selka, Ganna (Belg) 2010.

Fungicide frequency	Net blotch severity (%)	Plant height (cm)	Biomass yield (kg/ha)	Grain yield (kg/ha)	TKW
1	28.88[a]	78.78[a]	8530.6[ab]	785.60[ab]	40.23[a]
2	22.22[a]	81.00[a]	7500.00[b]	962.60[a]	39.95[a]
3	27.77[a]	73.11[ab]	9583.30[a]	684.40[ab]	37.90[a]
4	34.44[a]	67.22[b]	8194.40[ab]	571.60[b]	38.40[a]
Mean	28.33	75.02	8452.08	751.02	39.12
LSD (5%)	ns	**	**	**	ns
CV (%)	-	13.49	22.82	-	9.24

*TKW=Thousand kernel weight, ns=non-significant difference, **=significant difference at 5% LSD test, means with the same letter within a column are not significantly different, 1=one time fungicide application, 2=two times fungicide application, 3=complete control (7-10 days interval), 4= nil application

developing cultivars with satisfactory level of resistance genes to each potential race or pathotype are assumed to be a difficult venture. Moreover, variety with limited inherited resistance back grounds to one or another disease may not do well both in terms of yield and yield quality without fungicide applications. Grain yield losses in malt barley cultivars reach as high as 57% depending on variety and year. Application of fungicide during vegetation can significantly reduce foliar diseases and contribute to the formation of grain yield and some quality parameters in Ethiopia (Bekele, 2005). Previous studies on malt barley disease management was done only at one location, one season or one location and two seasons and thus are not representing wider environments. The objective of this study was thus to evaluate the variety, fungicide and their interaction on disease severity, yield and yield related traits in malt barley in wider environments of Bale Zone.

MATERIALS AND METHODS

The experiment was conducted at four locations (Sinana on farm (Selka), Goba (Sinja), Dinsho and Gassera districts) in Bale Zone during Belg (Ganna) and Meher (Bona) seasons of 2010. Four levels of fungicide Propiconazole (Tilt 250 EC): one time application at GS39-41, two times applications at GS30-31&39-41, frequent application at 7-10 days intervals and nil application treatments formed main plot. Three levels of variety (Beka, Miscal-21 and Holker) formed the subplot treatments. Fungicide and variety were assigned to main and subplots, respectively, in split plot design with three replications and plot size of 2.5m x 1.6 m (8rows). A seed rate of 100kg/ha was used. Experimental plot was fertilized by Diamonium phosphate (DAP) and Urea (41kgN/46kg P2O5)/ha just at planting. A fungicide rate of 0.5 l/ha was mixed with 250 l/ha tap water and applied to experimental units using knapsack sprayer. Disease severity was recorded in percentage on the field and yield and yield related traits like plant height, total biomass, grain yield, hectoliter weight (HLW) and TKW were collected.

Data Analysis

Analysis of Variance (ANOVA) was done by using SAS GLM Procedure (SAS version 9.00, Inst. 2002) and means comparisons for the significantly different variables were made among treatments using Least Significant Differences (LSD) test at 0.05 levels of significance.

RESULTS AND DISCUSSION

Test location: The experiment was conducted at four locations during both cropping seasons (Ganna/Belg and Bona/Meher) in Bale Zone. But during both seasons the trial at two locations, Sinana on-station and Dinsho (in Belg/Ganna season) and Sinana on-station and Gassera (in Meher/Bona season) were failed due to sever shoot

Table 3: Effect of varieties on malt barley disease severity, yield and yield related traits at Gassera, Ganna (Belg) 2010.

Variety	Net blotch severity (%)	Plant height (cm)	Biomass yield (kg/ha)	Grain yield (kg/ha)	TKW
Misical-21	20.41[c]	85.00[b]	13583.00[b]	2985.90[a]	52.86[a]
Holker	41.66[a]	85.67[b]	12104.00[b]	2902.90[a]	46.23[b]
Beka	32.91[b]	103.33[a]	19833.00[a]	3363.40[a]	43.76[c]
Mean	31.66	91.33	15173.61	3084.05	47.62
LSD (5%)	***	***	***	ns	***
CV (%)	21.59	9.56	28.08	27.24	5.10

*TKW=Thousand kernel weight, ns=non-significant difference, ***=highly significant difference at 5% LSD test, means with the same letter within a column are not significantly different

Table 4: Effect of fungicide application frequency on malt barley disease severity, yield and yield related traits at Gassera, Ganna (Belg) 2010.

Fungicides	Net blotch severity (%)	Plant height (cm)	Biomass yield (kg/ha)	Grain yield (kg/ha)	TKW
1	38.33[b]	88.11[a]	12944.00[a]	2584.10[a]	45.95[b]
2	32.78[b]	91.56[a]	15000.00[a]	3046.10[a]	48.00[ab]
3	7.22[c]	91.56[a]	16750.00[a]	3404.90[a]	48.60[a]
4	48.33[a]	94.11[a]	16000.00[a]	3301.20[a]	48.00[ab]
Mean	31.66	91.33	15173.61	3084.05	47.62
LSD (5%)	***	ns	ns	ns	**
CV (%)	21.59	9.56	28.08	27.24	5.10

*TKW=Thousand kernel weight, ns=non-significant difference, **, ***=significant, highly significant difference at 5% LSD test, respectively, means with the same letter within a column are not significantly different, 1=one time fungicide application, 2=two times fungicide application, 3=complete control (7-10 days interval), 4= nil application

fly infestation and water logging problem as a result of erratic rain fall at seedling crop growth stage. In contrast, the trials on the remaining two locations during both seasons received better precipitation and favored disease development (Net blotch). Likewise, good crop stand was established and optimum grain yield was obtained at these locations especially at Gassera and Dinsho (Table 3 & 7).

Analysis of variance: Analysis of variance was done in separate for each location. Variety by fungicide interaction effects was not significantly different for all parameters studied in four locations. Thus, only main effects; variety and fungicide on disease severity, yield and yield related traits were discussed.

Effects of Varieties on Diseases Development, Yield and Yield Related Traits

Net Blotch: In Ganna/Belg season all of the three varieties; Miscal-21, Beka and Holker were almost equally infected at Selka (Table 1). However, at Gassera there is a highly significant difference among the varieties for their response/reaction to net blotch. Likewise, the highest and the lowest net blotch severity was observed on Holker and Miscal-21, respectively (Table 3). During bona/meher season, the three varieties were equally infected at Sinja (Table 5). But at Dinsho the lowest severity was observed on Miscal-21.While Beka and Holker were equally infected (Table 7). Thus, this variation could be attributed to the variation in the pathotypes and/or environmental difference among locations and varietal differences. Tvarůžek et al. (1996) stated that integrated protection of cereals against diseases is primarily based on the variety and its genetically established resistance.

Hectoliter Weight (HLW): Even though there was no statistically significant difference between them, the highest HLW was observed on Beka and Holker**.** Contrary, the lowest HLW was observed on Miscal-21 at Dinsho (Table 7). Comparatively, Beka and Holker revealed higher HLW than Miscal-21.

Thousand Kernel Weight (TKW): Miscal-21 gave significantly the highest TKW at Dinsho, Sinja and Gassera test locations. While the lowest TKW was observed on Beka (Table 3, 5 & 7). At Selka there is no significant difference among the three varieties for their TKW (Table 1). Comparatively, Miscal-21 with the lowest net blotch infection had the highest TKW. Thus, in terms of kernel weight, Miscal-21and Holker are the most fitting varieties for malting, however, TKW of the three varieties was in the range of acceptable for malt factory.

Grain Yield: There was no significant difference among the varieties for their yield at three test sites (Selka, Gassera, Sinja). This data revealed that the three varieties showed almost equal response for yield at these locations (Table 1, 3 & 5). However, at Dinsho there was

Table 5: Effect of varieties on malt barley disease severity, yield and yield related traits at Goba (Sinja), Bona (Meher) 2010.

Variety	Net blotch severity (%)	Leaf rust Severity (%)	Plant height (cm)	Biomass yield (kg/ha)	Grain yield (kg/ha)	TKW
Misical-21	20.00[a]	4.60[a]	68.91[c]	5167.00[b]	869.50[a]	41.70[a]
Holker	20.00[a]	6.20[a]	79.16[b]	6000.00[ab]	958.20[a]	37.60[b]
Beka	21.67[a]	7.00[a]	94.16[a]	7500.00[a]	963.90[a]	35.91[b]
Mean	20.56	5.91	80.75	6222.22	930.52	38.40
LSD (5%)	ns	ns	***	**	ns	***
CV (%)	32.70	-	8.17	-	-	7.83

*TKW=Thousand kernel weight, ns=non-significant difference, **, ***=significant, highly significant difference at 5% LSD test, respectively, means with the same letter within a column are not significantly different

Table 6: Effect of fungicide application frequency on malt barley disease severity, yield and yield related traits at Goba (Sinja), (Meher) 2010.

Fungicides	Net blotch severity (%)	Leaf rust Severity (5%)	Plant height (cm)	Biomass yield (kg/ha)	Grain yield (kg/ha)	TKW
1	20.00[b]	7.67[ab]	75.70[b]	5611.00[a]	837.80[a]	38.05[a]
2	20.00[b]	6.00[b]	83.11[a]	6528.00[a]	1020.40[a]	38.30[a]
3	0.00[c]	0.00[c]	79.80[ab]	5583.00[a]	878.60[a]	38.60[a]
4	42.22[a]	10.00[a]	84.44[a]	7167.00[a]	985.40[a]	38.70[a]
Mean	20.56	5.91	80.75	6222.22	930.52	38.40
LSD (5%)	***	***	**	ns	ns	ns
CV (%)	32.70	-	8.17	-	-	7.83

*TKW=Thousand kernel weight, ns=non-significant difference, **, ***=significant, highly significant difference at 5% LSD test, respectively, means with the same letter within a column are not significantly different, 1=one time fungicide application, 2=two times fungicide application, 3=complete control (7-10 days interval), 4= nil application

Table 7: Effect of varieties on malt barley disease severity, yield and yield related traits at Dinsho, Bona (Meher) 2010.

Variety	Net blotch severity (%)	Plant height (cm)	Biomass yield (kg/ha)	Grain yield (kg/ha)	TKW	HLW
Misical-21	16.70[b]	100.41[b]	15875.00[ab]	3576.20[a]	47.82[a]	71.30[b]
Holker	26.70[a]	102.60[b]	15208.00[b]	3165.20[ab]	44.00[b]	73.43[a]
Beka	25.83[a]	125.10[a]	17521.00[a]	2986.10[b]	39.12[c]	73.53[a]
Mean	23.10	109.36	16201.40	3242.50	43.64	72.74
LSD (5%)	**	**	**	**	***	**
CV (%)	-	17.34	16.02	16.63	2.83	3.50

*TKW=Thousand kernel weight, HLW=Hectoliter weight, **, ***=significant, highly significant difference at 5% LSD test, respectively, means with the same letter within a column are not significantly different

significant difference between Miscal-21 and Beka and non-significant difference between Miscal-21 and Holker and Holeker and Beka (Table 7). AT this location, the highest grain yield was obtained from Miscal-21 as compared to the other varieties.

Effects of Foliar Fungicide Application on Disease Development, Yield and Yield Related Traits

Net blotch: Treatment 3, frequently fungicide application at 7-10 days intervals, showed the lowest net blotch severity percentage and gave complete control of the disease at Dinsho, Gassera and Sinja locations in Bale. Similarly, there is highly significant difference among complete control (7-10 interval application), one time, two times spray over the nil application of fungicide in reducing the net blotch severity (Table 4, 6 & 8). In all the above mentioned locations, the highest net blotch severity was recorded on nil application fungicide. But at Dinsho one time and two times spray were not found better than nil fungicide application. There is significant difference between (one time and nil application) and complete control (7-10 days interval) at Dinsho. However, there is no significant difference between two times and complete control (Table 8).

Thousand Kernel Weight (TKW): There is no significant difference among the four levels of fungicide treatments on TKW at Selka, Dinsho and Sinja test locations (Table 2, 6 & 8). Whereas at Gassera even though there is no statistically significant difference between complete control and (two times and nil application), the highest TKW was observed in the former treatment (complete control). But fungicide spray at 7-10 days interval showed significant difference with one time spray (Table 4**).**

Hectoliter Weight (HLW): Fungicide application at 7-10 days interval (complete control) revealed the highest HLW at

Table 8: Effect of fungicide application frequency on malt barley disease severity, yield and yield related traits at Dinsho, Bona (Meher) 2010.

Fungicides	Net blotch severity (%)	Plant height (cm)	Biomass yield (kg/ha)	Grain yield (kg/ha)	TKW	HLW
1	25.60[a]	109.60[a]	16167.00[a]	3169.50[a]	43.64[a]	71.90[b]
2	22.22[ab]	119.00[a]	16861.00[a]	3219.40[a]	43.60[a]	72.93[ab]
3	14.44[b]	107.00[a]	16444.00[a]	3464.30[a]	43.90[a]	74.53[a]
4	30.00[a]	101.90[a]	15333.00[a]	3116.80[a]	43.50[a]	71.64[b]
Mean	23.10	109.36	16201.40	3242.50	43.64	72.74
LSD (5%)	**	ns	ns	ns	ns	**
CV (%)	-	17.34	16.02	16.63	2.83	3.50

*TKW=Thousand kernel weight, HLW=Hectoliter weight, ns=non-significant difference, **= significant difference at 5% LSD test, means with the same letter within a column are not significantly different, 1=one time fungicide application, 2=two times fungicide application, 3=complete control (7-10 days interval), 4= nil application

Dinsho. There is also significant difference between fungicide spray at 7-10 days interval and (one time and nil application) at this test site. But there is no significant difference between two times spray and complete control (Table, 8).

Grain yield: At all test sites fungicide treatments did not show significant difference over the nil application in improving grain yield. Nonetheless, at Dinsho and Gassera fungicide application at 7-10 days interval gave the highest grain yield, even though this detection difference was not statistically different from nil fungicide application (Table 4 & 8). At Selka and Sinja two times fungicide spray revealed better yield than the rest treatments (Table 2 & 6). Similar studies by Kubinec (1998) shows that application of fungicides during vegetation can significantly contribute to the formation of grain yields and to yield quality. Generally this year data revealed that one time, two times and complete control (7-10 days) fungicide application did show variability on yield. Even in some locations fungicide treatments did not show any difference over nil application of fungicide.

CONCLUSION

Malt barley varieties were found to be susceptible to shoot fly and farmers must be advised not to grow these varieties in areas where shoot fly infestation is severe. In most test locations, Tilt 250 EC application at 7-10 days intervals, two times application at GS30-31&GS39-41 and one time application at GS39-41 have provided better net blotch management as compared with nil Tilt 250 EC application. Also, Tilt 250 EC applied treatments gave grain yield, 1000-kernel weight and hectoliter weight increment in most cases. At least one time fungicide application at GS39-41 will provide effective net blotch management and improve malt barley yield and yield related malt quality parameters. However, malt barley cultivation and application of fungicides in shoot fly infested areas cannot be advisable as this pest results in poor crop stand and marginal yield advantages. These results are in line with the results obtained during, 2009 cropping season in Bale and West Arsi zones.

With problems associated with environmental pollution, required fungicide cost, labor cost and sprayer renting cost, continuous fungicide application is not recommended though it gave excellent malt barley disease control in most occasions across the years. Thus, we recommend demonstrating one time Tilt 250 EC application at GS39-41 and two times Tilt 250 EC application at GS30-31 & GS39-41 to farmers in larger plots, in areas where shoot fly infestation is not a threatening and a good crop stand could be obtained.

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