Yield Loss Due to Scald and Net Blotch on Barley in North Shewa

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Abstract

An experiment was conducted to assess the yield loss of barley due to scald (*Rhynchosporium secalis*) and net blotch (*Pyrenophora teres*) at Ankober and Faji North Shewa during the 1999 and 2000 'meher' seasons. The trial was laid out in a split plot design with three replications using Mirsrach variety and local landrace in main plots and a fungicide Propiconazole (Tilt 250 EC) in sub plots. The disease pressure was almost non on the sprayed plots. The unsprayed treatments had significantly reduced grain yield, straw yield and thousand-kernel weight, at both locations and in both years, as compared to the sprayed treatments. However, there was no significant difference between varieties as well as among the interactions of varieties and fungicides. In 1999, mean grain yield losses of 19.87 and 4.86% were obtained at Ankober and Faji, respectively, while in 2000 both the disease pressure and the yield losses were very high resulting in 37.39 and 14.49% mean grain yield losses at Ankober and Faji, respectively. Therefore, there is a need for scald and net blotch diseases control measures at the highlands of North Shewa, particularly at the surroundings of Ankober area.

Key words: Yield loss, Scald, Net blotch, barley

Introduction

Barley, *Hordeum vulgare* L., is the world's fourth important cereal crop. The total area sown and production of barley in the world in 1996 were 66.5 million ha and 155 million t, respectively (Crop Protection Compendium 2000). Africa shares only 3.4% of the total world production. In tropical Africa, Ethiopia is the only country where barley is a major crop (Onwueme & Sinha 1991) and it is one of the important staple food crops.

Area and production of barley in Ethiopia is about 874000 ha and 10.8 q/ha. In North Shewa it is about 38950 ha and its production is 10.8 q/ha (CSA 2000).

Ethiopia is considered a center of diversity for barley. Ethiopian cultivars have been extensively used in breeding programs throughout the world especially to incorporate resistance to diseases such as BYDV, smuts, powdery mildew, scald and net blotch, as well as to improve protein quality (Yitbarek et al. 1996).

In the highlands of North Shewa, smallholder farmers produce barley extensively. The area has bimodal type of rainfall with a main season, locally called 'meher', (June to September/October) and a short season, 'belg' (January/February to May). Barley is produced in both seasons.

In spite of its importance the production and productivity of barley at farmers level is below 11 qt/ha in the highlands of North Shewa (CSA 2000). This is attributed to different factors, among which diseases play the major role. Previous studies on yield losses of barley due to some important diseases were carried out in other parts of the country. Among the diseases, scald (*Rhynchosporium secalis*) caused a yield reduction of 21–67% for different seasons and cultivars. Net blotch (*Pyrenophora teres*) caused up to 34% yield loss (Bekele et al. 2001, Eshetu 1985, Getaneh & Fekadu 2001). Both scald and net blotch are the most common foliar diseases of barley in the highlands of North Shewa, particularly on farmers' fields of Ankober and Faji.

Therefore, actual assessment of yield loss of barley due to the above foliar diseases is essential to set research priority at North Shewa conditions.

Materials and Methods

Barley yield loss assessment study due to barley scald and net blotch diseases was carried out on farmers' fields for two years (1999 and 2000) during the main season at Ankober and Faji.

The trial was laid out in a split plot design with three replications using the varieties, Misrach and a local landrace of the respective locations, in main plots and fungicide in sub plots. The plot size was 10 m x 10 m, with harvested plot size of 3 m x 3 m. Fertilizer was applied at a rate of 125/75kg of DAP/UREA at planting and seed rate was 125 kg/ha. The fungicide Propiconazole (Tilt 250 EC) was sprayed on the treated plots every 15 days and 5 times per season at a rate of 0.5 l/ha product starting from the appearance of the diseases.

Disease severity of scald and net blotch was taken in 0–9 scales and disease severity was log (x + 1) transformed (Gomez & Gomez 1984) and used in statistical analyses. The crop was harvested from ground level when it was dry enough for immediate threshing. Total straw yield was estimated by subtracting grain yield from biomass. Percent yield losses due to diseases were calculated from grain yield, straw yield and thousand kernel weight, as the difference between mean yield of fungicide sprayed and unsprayed plots (FAO 1971).

Results

Scald Severity

Scald occurred both in 1999 and 2000 main seasons at Ankober and Faji. Difference in disease severity between sprayed and unsprayed plots was highly significant in both years (Table 1). However, there was significant variation between locations, in which the disease severity was significantly higher ($p < 0.05$) at Ankober than Faji in both 1999 and 2000 seasons.

No significant variation in scald severity was observed between Misrach and local landraces at both locations and in both years. Besides, there was no significant variation among the interactions of chemical and varieties in scald reduction.

Net Blotch Severity

Net blotch occurred both in 1999 and 2000 main (meher) season. However, its severity was very low compared to scald. Differences between sprayed and unsprayed plots were highly significant both at Ankober and Faji in both years.

However, the severity of the diseases in 2000 was significantly higher than 1999 both at Ankober and Faji (Table 1).

Table 1. Scald and net blotch diseases severity combined over locations (Ankober and Faji), 'Meher' 1999-2000.

	1999						2000					
	Scald (0-9)*			Net blotch (0-9)*			Scald (0-9)*			Net blotch		
Treatments	V1	V2	Mean	V1	V2	Mean	V1	V2	Mean	V1	V2	Mean
Sprayed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1(0.1)	0.1b	0.4 (0.1)	0.4 (0.1)	0.4b
Unsprayed	5.0 (0.8)	5.0 (0.8)	5.0 a	3.3 (0.6)	3.3 (0.6)	0.3a	5.3 (0.8)	5.3 (0.8)	5.3a	4.3 (0.7)	4.3 (0.7)	4.3a
Mean	2.5	2.5		1.6	1.6		2.7	2.7				
CV%	6.42			17.34			16.8			19.9		
LSD (0.05)												
V	NS			NS			NS			NS		
Fungicide	0.04			0.07			0.09			0.11		
V x Fungicide	NS			NS			NS			NS		

*Back transformed values of Log transformed disease severity
Values in each column followed by the same letters are not significantly different at 5%
V1 = 'Misrach', V2 = Local landrace, V = LSD for varieties, Fung = LSD for sprayed and unsprayed treatments, V x Fung = LSD for the interactions of varieties and fungicide, NS = non significant.
Values in parenthesis are logx+1 transformed diseases severity.

Table 2. Percent losses in grain, straw yield and thousand kernel weight due to barley scald and blotch disease, combined over locations (Ankober and Faji), 1999 main season

	Grain yield (kg/ha)			Straw yield (kg/ha)			TKW (g)		
Treatment	V1	V2	Mean	V1	V2	Mean	V1	V2	Mean
Sprayed	2342	2350	2346a	34.16	3186	3301a	40.0	42.7	41.3a
Unsprayed	2104	1920.4	2012.6a	3135.9	2431.5	2783.7b	36.7	37.0	36.8b
Mean	2223.7	2135.5		3276.3	2808.9		38.3	39.8	
Loss%	10.2	18.3		8	23.7		8.3	13.3	
LSD (0.05)									
V	NS			NS			NS		
Fungicide	NS			446.84			2.02		
V x Fungicide	NS			NS			NS		
CV%	16.84			15.60			5.50		

Values in each column followed by the same letters are not significantly different at 5%

V1 = 'Misrach', V2 = Local landrace, V = LSD for varieties, Fung = LSD for sprayed and unsprayed treatments, V x Fung = LSD for the interactions of varieties and fungicide, NS = non significant.

No significant variation in net blotch severity was observed between varieties and among interactions between varieties and chemicals throughout the seasons.

Yield Losses

Grain yeld

Grain yield difference between sprayed and unsprayed treatments was significant in all cases except in 1999 at Faji. The mean grain yield difference was 582.4 kg/ha (19.8% loss) at Ankober and 85.5 kg/ha (4.8 % loss) at Faji in the 1999 meher season. For the 2000 meher, the mean yield difference was 1091.9 kg/ha (37.3 % loss) and 481.2 kg/ha (14.4 % loss) at Ankober and Faji, respectively. For over-locations combined analysis, grain yield loss was 333.9 kg/ha (14.2 % loss) and 786.6 kg/ha (25.2 % loss) in 1999 and 2000 season, respectively.

In most of the cases the mean grain yield of the improved Misrach variety was higher, but not significantly, than the landrace. There was significant variation among the interactions between fungicide and varieties in 2000, in which the interaction between local landrace and fungicide was significantly higher than the rest of the interactions.

Straw yield

In most of the cases there was significant difference in mean straw yield between sprayed and unsprayed treatments. However, no significant difference was observed between varieties as well as among the interactions of the factors.

The mean straw yield difference was 787.9 kg/ha (20.4 % loss) at Ankober and 247.7 kg/ha (8.9 % loss) at Faji in 1999. For 2000, the mean straw yield difference was 1033.9 kg/ha (24.5 % loss) and 757.5 kg/ha (15.3 % loss) at Ankober and Faji, respectively. For over locations combined analysis, it was 517.8 kg/ha (15.6 %loss) and 895.7 kg/ha (19.5% loss) in 1999 and2000 seasons, respectively.

Table3. Percent losses in grain, straw yield and thousand-kernel weight due to barley scald and blotch disease, combined over locations (Ankober and Faji), 'Meher' 1999

	Grain yield (kg/ha)			Straw yield (kg/ha)			TKW (g)		
Treatment	V1	V2	Mean	V1	V2	Mean	V1	V2	Mean
Sprayed	2827	3413	3120a	4817	4339	4578a	40.4	40.1	40.2a
Unsprayed	2338.6	2329.1	2333.8b	3909.9	3459.8	3684.86b	35.8	34.0	34.9b
Mean	2582.9	2871		18.84	20.28		11.44	15.35	
Loss%	17.28	31.77							
LSD (0.05)									
V	NS			NS			NS		
Fungicide	185.18			837.04			1.61		
Fung x V	370.4			NS			NS		
CV%	7.21			21.52			4.54		

Values in each column followed by the same letters are not significantly different at 5%
V1 = 'Misrach', V2 = Local landrace, V=LSD for varieties, Fung = LSD for sprayed and unsprayed treatments, V x Fung = LSD for the interactions of varieties and fungicide, NS= non significant.

Thousand kernel weight and number of grains per head

Thousand-kernel weight difference between sprayed and unsprayed treatments was significant in all cases. In 1999, the mean weight difference was 4.7 g (9.9% loss) and 4.3 g (12.3% loss) at Ankober and Faji, respectively. In 2000, it was 7.9 g (20.1% loss) at Ankober and 2.8 g (6.9% loss) at Faji. For over locations combined analysis, it was 4.5 g (10.9% loss) and 5.4 g (13.4% loss) in 1999 and 2000, respectively.

In all the cases, there was no significant variation between Misrach and local varieties except in 2000 at Faji, in which the improved Misrach variety was significantly higher than the local landrace. Similarly, only in 1999 at Faji significant variation was observed among the interaction of fungicides and varieties.

Thousand-kernel weight associated positively and significantly ($p < 0.05$) with grain yield ($r = 0.60$) in 1999, with grain yield ($r = 0.91$) and straw yield ($r = 0.71$) in 2000 at Ankober and only with straw yield ($r = 0.65$) in 1999 at Faji.

Generally, there was no significant difference in number of grains per head between sprayed and unsprayed treatments as well as between varieties and among the interactions of the two factors, except in 2000 at Ankober. In the case of Ankober, the sprayed plots were significantly higher than unsprayed ones and the interaction between local landrace and chemical was significantly higher than the rest of the interactions.

Discussion

In this trial, it was attempted to quantify actual losses (Marthin 1981) caused by scald (*R. secalis*) and net blotch (*P. teres*) using recommended fertilizer-rate and seed rate conducted as a researcher managed on farm experiment. It was conducted on relatively large plots using the improved cultivar and the landrace mostly planted by the farmers of Ankober and Faji.

Control of scald and net blotch saved a significant amount of grain yield and straw yield, which are known as the principal constituent of farmers production. This was probably due to controlling diseases, which would have reduced photosynthetic surface of the plant by destruction of the leaf tissue or defoliation of leaves or through affecting chloroplasts. Losses resulting from both scald and net blotch diseases are related to the amount of tissue, especially of the upper leaves and spikes, largely destroyed by the fungus (Backelman et al. 1981).

Arguments are still going on that systemic fungicides can interfere with the metabolism of both the host plant and the pathogen (Dereje & Yaynu 2001) and can contribute for the yield increment over the unsprayed ones. In contrast, Sutton & Steel (1983) reported that the effect of Propiconazole on yield and yield components is insignificant. Thus, the significant yield advantage of sprayed plots is mainly attributed to scald and net blotch disease protection.

There was better amount and distribution of rainfall in 2000 than 1999 Meher season at both locations, particularly at Ankober, and that might have favored both the productivity of the crop as well as development of diseases. Compared to 1999, in 2000 Meher season the mean grain yield increased by 13.7%, for mean straw yield by 24.4% on the unsprayed plots. On the sprayed plots, the increment was 24.8% and 27.8% in mean grain yield and mean straw yield, respectively. Consequently, the average loss in mean grain yield increased from 14.2% (1999) to 24.5% (2000), for straw yield from 15.9% to 19.5%. This is in agreement with Martens et al. (1984), who indicated that scald and net blotch diseases are favored when leaves remain wet for long periods of time and scald infection started from a splash dispersed spores (Nyvall 1989).

In addition, there was variation in disease severity and losses between the two locations. Scald and net blotch disease severity was higher at Ankober than Faji. Consequently, the amount of grain yield and straw yield loss was higher at Ankober compared to Faji. This could be attributed to environmental conditions that prevailed in the season at the two locations such as amount of rainfall, wet period, humidity and temperature. The average monthly mean temperature of Debre Birhan, which is around 11 km away from Faji, was below 15 °C for the months June to November in both 1999 and 2000. Ankober is found at higher altitude (> 3000 m) and expected to be cooler than Debre Birhan. According to Griffiths (1988) scald produce spores most efficiently between 10 and 20 °C and optimum infection occurs if humidity is greater than 95% and the leaf is wet for more than 24 hr. Sato and Takeda (1990) also reported that most net blotch infections occur below 15 °C and require between 10 and 30 hr of high humidity.

Although it was not statistically significant, the loss in yield and other components were high for the local variety compared to the improved variety. In 1999 cropping season, the improved variety showed an increased grain yield by 8.2% and straw yield by 15.5%. While in 2000, it had resulted in a loss of 14.4% and 1.4% for grain yield and straw yield, respectively. As there was no significant variation in scald and net blotch severity between the would mean that the two varieties, the above loss reduction improved variety is tolerant to scald and net blotch diseases compared to the local variety.

In all the cases, there was significant variation in thousand-kernel weight between sprayed and unsprayed treatments. This and the highly significant association between thousand-kernel weight and grain yield suggest that the diseases influence on the yields of barley is mainly through their effect on the kernel weight. This finding goes in line with the report of Ishkova (1987) who stated that a reduction in grain size is the most common cause of yield loss due to scald. Martens et al. (1984) also reported that net blotch on barley caused a 6% reduction in thousand-kernel weight.

In conclusion, scald and net blotch diseases warrant control measures at the highlands of North Shewa, particularly at the surroundings of Ankober area. To control these diseases, research should focus on the development of integrated disease management system that will maximize cultural practices, use of resistant cultivars and other cost effective disease management systems.

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