Integrated Management of Septoria Blotches of Wheat: Effect of Sowing Date, Variety and Fungicide

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Abstract

The effect of three sowing dates, three bread wheat varieties and two rates of fungicide on management of *Septoria tritici* blotch was studied at six environments. Analysis of the data showed that environment significantly affected all the disease and yield parameters taken, indicating that disease development and severity, kernel weight and yield varied with the different seasons and locations. Late sowing significantly reduced septoria development and severity but had no effect on the first disease appearance, kernel weight and yield. Varieties had significant interactions with the environment for all the parameters, except the first septoria evaluation. Septoria development and severity were higher on the susceptible HAR710 than on HAR1685 and HAR604 though they differed with environment. Kernel weight and yield of the latter two varieties were significantly higher than the other. Variety by sowing date interaction was significant only as far as its influence on kernel weight. HAR604 had a significantly higher seed weight when planted late, while HAR1685 had a higher seed weight when planted at the recommended sowing date. Fungicide application controlled septoria development well and increased both kernel weight and yield. Fungicide by environment interaction significantly reduced disease development, and increased kernel weight and yield. There was no evidence of interaction between varieties and fungicide applications in reducing the disease or increasing the yield. The study indicated that the use of relatively resistant cultivars or fungicide application has a pronounced positive effect on the management of the disease. The significant effect of environment observed, however, indicates that recommendation on the management of the disease is highly influenced by seasons and/or locations. A significant positive correlation among septoria evaluation methods and their negative correlation with kernel weight and yield, indicate that the use of any one of the methods can effectively measure the disease and its effects on yield.

Introduction

Ethiopia is one of the largest wheat producer in sub-Saharan Africa with about 1.1 million ton of production on 0.99 million hectare of land (CSA 1999). Wheat is the fourth most important cereal crop both in area and production after tef, maize and sorghum. It is grown in the Ethiopian highlands at altitudes ranging from1500 to 3000 m (Hailu 1991). At present, wheat is produced solely under rain-fed conditions. Durum and bread types are the two major wheat types produced in the country whose proportion in 1991 was about 60 and 40 percent, respectively. However, this proportion is expected to shift in favor of bread wheat in recent years.

Productivity of wheat in Ethiopia remains low due to a number of socio-economic and technical constraints including diseases (Hailu et al. 1991). Rusts and septoria leaf and glume blotches are the major diseases that economically affect wheat production in the country (Eshetu 1985a). According to Saari & Wilcoxson (1974), the septoria blotches have become a more serious problem with the introduction of high yielding dwarf wheat cultivars, unless they contain genetic resistance.

Management of septoria blotches of wheat with the use of relatively resistant or tolerant cultivars or appropriate cultural practices has been suggested (Krupinsky 1999, van Ginkel & Rajaram 1999, Wiese 1987). Fungicides that could be used for the control of wheat rusts and septoria blotches on large commercial farms and seed production fields have also been recommended (Eshetu 1992). Integrated control measures are often considered as more viable than any single control measure in the management of septoria blotches (Eyal 1981, Eyal et al. 1987). This study was undertaken to investigate the effect of the integration of sowing dates, varieties and fungicide applications on septoria blotch development and grain yield.

Materials and Methods

A three year field experiment was conducted to investigate the integrated effect of sowing date, host resistance and fungicide application on septoria blotch management and yield at the Ambo and Holetta research centers starting from the1998 cropping season. The lay out of the experiment was a split-split plot arrangement of randomized complete block design with sowing dates, varieties and fungicide applications as main, sub and sub-sub plot treatments, respectively. Three planting dates were used: early (about a week before the recommended date), recommended (fourth week of June at both locations) and late (about a week latter than the recommended date, which represents the planting date used by farmers in the area). The three bread wheat varieties used were, HAR1685 ('Kubsa'), HAR604 ('Galema') and HAR710 ('Wabe') that are relatively resistant, moderately resistant and susceptible, respectively, to the septoria blotches. The three fungicide application treatments were Propiconazole (Tilt 250 EC) applied twice when symptoms appeared and about three weeks later at a rate of 0.5l/ha, the same product applied once when the disease was about to reach the flag leaf at a rate of 1l/ha, and an unsprayed control. The sub-sub plot was 3m x 3m in size. The trial contained three replications.

Disease evaluations included the first septoria appearance (days after planting when the first symptom of septoria blotch observed), and scores taken at 10 to 15 day intervals using the modified double digit 00-99 scale to determine vertical progress and severity of the disease (Eyal et al. 1987). The two digit scores obtained were considered as the numerical disease descriptions and used for statistical analysis. Moreover, 100 flag leaves were randomly collected from each plot at the mid dough stage of the crop and rated on a 0-5 scale (0=no lesions and 5= the whole leaf blighted) to determine severity of the disease on the flag leaf. Kernel weight and yield data were taken at harvest. Data of six environments (3 years by 2 locations) were combined and analyzed using Genstat 5.0 for Windows after checking for homogeneity of error variances using Bartlett's test and observing the deviations of error mean squares.

Results

The combined analysis of variance of treatment effects on the days of first septoria blotch appearance after planting, disease development and severity, seed weight and yield is shown in Table 1. Main effect of environment was highly significant for all disease evaluations, and kernel weight and yield. Sowing dates were only significant for the first, last and mean disease scores and flag leaf rating but not with the first disease appearance, kernel weight and yield. The main effect of varieties was significant for all disease evaluations, kernel weight and yield. Fungicides had significant effect on 00-99 scores, flag leaf rating, kernel weight and yield. Fungicide had no effect on the first diseases appearance as expected since fungicide application was made after first disease appearance.

Table 1. Combined analysis of variance for six environments (2 locations by 3 years) for *Septoria tritici* blotch appearance, disease development, kernel weight and yield.

Source of Variation	df	Mean Square						
		DA	FS	LS	MS	FL	KW	Y/ha
Environment (EV)	5	5944.2**	2328.2**	11713.8**	10550.5**	33.3**	478.5**	7206.4**
Residual	12	43.1	33.7	175.9	122.3	1.2	45.0	233.4
Sowing date (SD)	2	206.7	1408.8**	9794.4**	3328.4**	7.4**	18.2	119.9
EN x SD	10	150.8	225.8*	278.7*	541.0**	2.9**	36.2*	159.1
Residual	24	77.8	73.8	129.0	81.2	0.5	10.5	133.6
Variety (VT)	2	654.5**	2558.1**	13624.1**	9681.4**	77.2**	1764.6**	2571.6**
EV x VT	10	127.5*	69.9	956.0**	169.8**	1.2**	21.6*	441.7**
SD x VT	4	50.3	116.6	117.8	50.5	0.6	35.0**	29.1
EV x SD x VT	20	51.1*	66.1	191.2*	42.3	1.0**	31.6**	84.6*
Residual	72	29.2	56.8	78.1	32.8	0.4	8.9	41.5
Fungicide (FN)	2	0.8	306.4**	6668.6**	2970.5**	20.6**	544.5**	1057.8**
EV x FN	10	11.3*	183.7**	2264.0**	1566.9**	1.6**	123.0**	165.5*
SD x FN	4	7.0	18.4	223.7*	81.3	0.7	2.0	50.4*
VT x FN	4	1.8	17.1	63.5	25.9	1.2**	15.8	33.2
EN x SD x FN	20	3.6	34.2**	193.0**	89.2**	0.8**	17.0*	30.1
EN x VT x FN	20	6.0	25.4*	159.5**	54.5	0.4	9.5	22.8
SD x VT x FN	8	4.1	2.6	124.4*	14.9	0.1	4.3	13.0
EN x SD x VT x FN	40	3.3	426.3	107.6	17.6	0.5	8.8	23.8
Residual	216	3.8	2299.3	65.5	35.5	0.3	8.3	20.6

*** and * are statistically significant at P≤0.01and P≤0.05, respectively.*
DA = disease appearance (days); FS = first septoria 00-99 score; LS = last septoria 00-99 score; MS = mean septoria 00-99 score; FL= flag leaf rating on 0-5 scale; KW = Kernel Weight; Y/ha = yield per hectare

Significant interactions obtained between environment, sowing date, variety and fungicide applications (Table 1). The interaction of environments with variety and fungicide application was highly significant (P≤0.01) for all disease measurements, kernel weight and yield while its interaction with sowing date was significant for first and last (P≤0.05) and mean septoria scores and flag leaf rating (P≤0.01) and kernel weight (P≤0.05). Sowing date interacted highly significantly with variety only to influence kernel weight, (P≤0.01) and with fungicides to influence last septoria score and yield (P≤0.05). There was no significant interaction between variety and fungicide in influencing the disease assessment (except flag leaf rating), kernel weight and yield. The interaction among sowing dates, variety and fungicides was only significant (P≤0.05) for the last septoria scores.

Mean values of the various disease assessments, kernel weight and yield as influenced by environment, sowing date, varieties and fungicide applications are presented in Table 2. The disease appeared early (38 days after planting) at Ambo in 1998 and appeared late (61 day after planting) again at Ambo in 2000. Disease appearance at Holetta was between 44 and 47 days after planting. However, the disease development was significantly slower and yield was lower at Ambo in 1998 as compared to 2000 season indicating that there had been some unfavorable condition for both the disease and the crop in the 1998 season. Similar trends were observed at Holetta during those seasons.

Although the disease appeared earlier and the flag leaf rating was higher, the disease scores were significantly lower at late sowing than early and recommended sowing dates (Table 2). However the effects has not significantly affected kernel weight and yield in any way.

Septoria blotch appeared early (44 days after planting), progressed faster and was more severe on the variety HAR 710 (Wabe) and, consequently, its kernel weight and yield were significantly lower (Table 2). The varieties HAR 1685 (Kubsa) and HAR 604 (Galema) behaved similarly in terms of disease development and severity, kernel weight and yield. First, disease appearance was not affected by fungicide application (Table 2). Septoria scores on fungicides treated plots were significantly lower than the untreated control, which resulted in higher kernel weight and yield. Two times application of the half rate (0.5 l/ha) controlled the disease and increased kernel weight and yield significantly as compared to one time application of the full rate (1l/ha) late in the season.

Table 2. Main effects (combined) of environment, sowing date, variety and fungicide on septoria blotch development, kernel weight and yield.

Treatment	Septoria blotch scores (00-99)				FL (0-5)	KW (g)	Yield (q/ha)
	DA	FS	LS	MS			
Environment							
Ambo 98	38	10	54	25	-	32	18
Ambo 99	44	17	78	54	2.8	29	29
Ambo 00	61	23	63	43	3.7	33	36
Holetta 98	47	18	64	40	2.4	33	23
Holetta 99	-	-	81	51	1.6	35	44
Holetta 00	44	23	85	55	3.2	37	35
LSD 0.05	2.12	5.18	4.89	3.85	0.17	1.94	5.69
Sowing date							
Early	48	22	79	49	2.7	32.8	30.1
Recommended	47	17	69	44	2.4	33.4	30.6
Late	45	15	64	40	2.8	33.3	31.8
LSD 0.05	1.85	2.21	2.61	2.07	0.08	ns	ns
Variety							
HAR 1685	48	16	66	40	2.3	34.7	33.5
HAR 604	48	15	65	40	2.1	35.4	32.7
HAR 710	44	23	81	54	3.5	29.4	26.3
LSD 0.05	1.07	1.76	1.96	1.27	0.08	0.66	1.42
Fungicide							
Control	47	19	78	50	3.0	31.2	28.1
2 x 0.5l/ha	47	18	65	42	2.2	34.8	33.2
1 x 1l/ha	47	17	70	42	2.7	33.4	31.2
LSD 0.05	Ns	0.93	1.77	1.30	0.07	0.63	0.99

DA = first disease appearance (days after planting); FS = first septoria score on 00-99 scale; LS = last septoria score on 00-99 scale; MS = mean septoria score on 00-99 scale; FL= flag leaf rating on 0-5 scale; KW = kernel weight in grams; and Y = yield (q/ha)

The major contribution to the interaction comes from the differences in seasons and locations.The disease scores were low in 1998 season at both Ambo and Holetta, and were the highest at Ambo in 1999 and Holetta in 2000 seasons (Fig. 1). The disease was consistently high on variety HAR 710 at all seasons and both locations. However, the reaction of the two relatively resistant varieties varied with environment, particularly with the season. On the other hand, yields were also low in 1998 at both locations (Fig. 2) indicating that factors other than the disease were affecting yield that season. Highest yield was obtained in 2000 at Ambo and in 1999 at Holetta. Yield of the relatively susceptible variety HAR 710 was generally decreasing with latter sowing at Ambo while increasing at Holetta (Fig. 2). The yields of HAR 1685 and HAR 604 was generally better at the recommended sowing date although late planted HAR 1685 and HAR 604 were better yielder at Ambo in 1999 and 2000 and at Hotetta in 1998, respectively.

Interactions of sowing date, variety and fungicides were not significant for disease scores (except the last score), kernel weight and yield (Table 1). However, sowing date by variety interaction influenced significantly the kernel weight (Fig. 3). Kernel weight of the variety HAR1685 was significantly high at early and recommended sowing dates while that of the variety HAR604 was significantly high at late sowing when the disease scores were also low. Kernel weight of the variety HAR710 was not affected by sowing date. Sowing date also interacted significantly ($P \leq 0.05$) with fungicide application to influence last disease scores and yield (Table 1). Ironically, at the early and recommended sowing dates, split application of the fungicide did not significantly affect the last and mean disease scores (data not presented). However, split application of the fungicide significantly reduced these scores and seemed to increase yield at late planting.

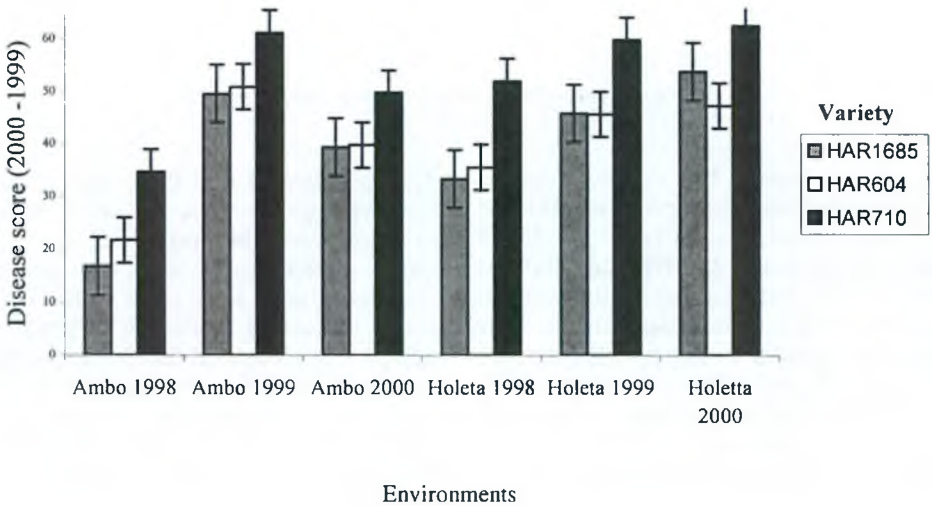

Fig. 1. Effect of environment by variety interaction on mean septoria score.

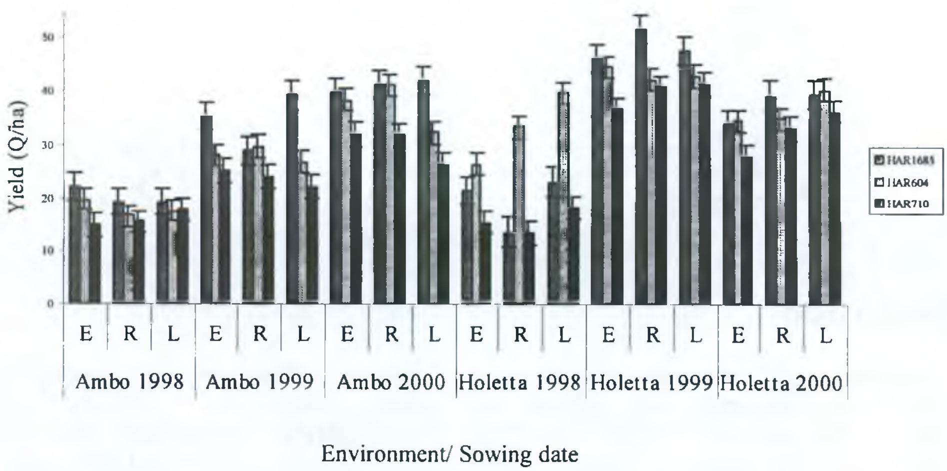

Fig. 2 Effect of environment by sowing date by variety interaction on yield.

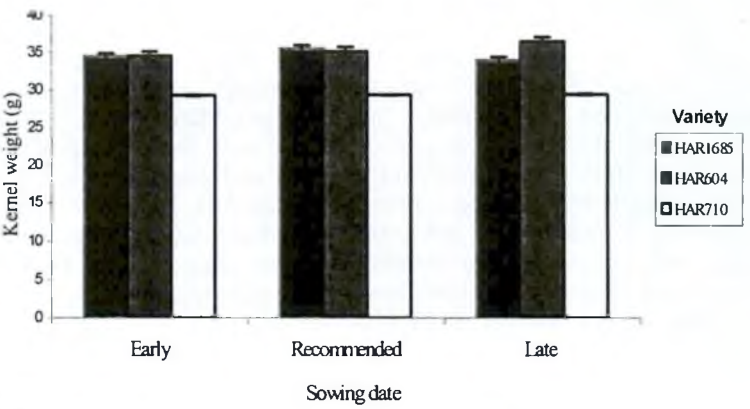

Fig 3. Effect of sowing date by variety interaction on kernel weight.

Correlations among the various septoria blotch evaluations and kernel weight and yield were determined (Table 3). There were significant negative correlations between first, last or mean septoria scores and date of first disease appearance. The longer the number of days for the disease to appear after planting, the lower will be the septoria scores made afterwards indicating the presence of slow rusting type of resistance in some cultivars to the disease. Date of first disease appearance, however, did not significantly correlate to kernel weight and yield. First, last, mean septoria scores positively correlated with each other, and flag leaf rating indicating that all those parameters effectively measured the disease progress and severity. All septoria scores and flag leaf rating negatively correlated with kernel weight and yield indicating that the disease has significant effect on these yield parameters.

Table 3. Pearson correlations among the different septoria blotch assessments, kernel weight and yield.

Assessments	1	2	3	4	5
First disease appearance	-				
First 00-99 score	-0.23**	-			
Last 00-99score	-0.36**	0.41**	-		
Mean 00-99 score	-0.33**	0.46**	0.85**	-	
Flag leaf 0-5 rating	0.09	0.03	0.37**	0.51**	-
Kernel weight	0.08	-0.11*	-0.40**	-0.46**	-0.54**
Yield	0.08	-0.18**	-0.15**	-0.21**	-0.42**

*** and * correlation is significant at P≤0.01 and P≤0.05levels, respectively (2 tailed).*

Discussion

Integration of several management options to minimize the effects of septoria blotches on yields of wheat has been suggested by several workers (Eyal 1981, Krupinsky 1999). Previous studies in Ethiopia indicated that sowing date (Eshetu 1985a), variety (Eshetu 1985b) and fungicides (Eshetu 1992) independently controlled the disease considerably. The effect of the integration of sowing date, variety and fungicide applications has been investigated in this study under very sever septoria blotch condition at Holetta and moderate condition at Ambo.

The combined analysis of the data obtained from these two locations for three years indicated that the main effects of these factors were more pronounced than their interactions. Environment contributed significantly to the differences in disease assessments and yield. This suggests that recommendations from this study will be highly influenced by the conditions in the season (which are very difficult to predict) and the locations. Early planting increases disease progress during the season but kernel weight and yield were not influenced by sowing date. Therefore, recommended planting dates for the respective areas should reasonably be followed. The use of relatively resistant varieties such as HAR 1685 and HAR 604 was the most effective method to control the disease. Application of Propiconazol 250 EC at a rate of 0.5 l/ha at the on set of the diseases and repeated at about 3 to 4 weeks after the first spray was also effective to reduce the disease and increase yield in susceptible varieties in particular and in areas where the disease is very severe. One application of the product at the rate of 1 l/ha just before the disease reached flag leaf could also be recommended for less disease prone areas. Precaution, however, should be taken on the use of fungicides whether or not it is economical to apply on a particular wheat field. Fungicide use for the control of septoria blotch is generally not intended for smallholder private sector under the current farming practices. There was no strong interaction between fungicide application and varieties. The mean disease score derived from scores taken at weekly or ten days interval can be used to determine disease progress during the season. Flag leaf rating may additionally be used to get information on disease severity during grain filling and ripening.

Acknowledgements

The authors acknowledge the technical assistance of W/o Tiruwork Amogne and Ato Ejeta Tolla of Holetta Research Center, Ato Tizazu Tafesse and W/t Elizabeth Terefe of Ambo Research Center. The authors also appreciate the invaluable assistance of Ato Girma Taye and W/o Meaza Demissie of the Biometrics Services, EARO for the analysis of the data.

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