SHORT COMMUNICATION

Yield Losses of Fieldpea Due to Ascochyta Blight in Central Ethiopia

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Abstract

An experiment was conducted to assess yield losses of field pea (*Pisum sativum* L.) due to Ascochyta blight mainly caused by *Mycosphaerella pinodes* (Berk. and Blox) Vestergr at two locations (Holetta and Dendi) during two crop seasons (1996 and 1997) using two cultivars (Local-H and Tegengech). Different blight epidemics were contrived in the experimental plots by employing five spray schedules. At Holetta, mean seed yield was reduced from 0.82 to 0.35 t/ha as final blight score increased from 38 to 89% for the two cultivars in 1996 but it did not drop that low in the 1997 crop season, as the disease pressure was generally low. However at Denbi, disease and yield parameters were comparable in both years. Mean seed yield dropped from 1.68 to 1.31t/ha as the disease severity increased from 14 to 66% for the two varieties and seasons. In 1996, mean yield losses of 53 and 28% were obtained at Holetta and Denbi, respectively, while in 1997 only 21% were obtained for both locations being the same. The most affected yield components of field pea were pod set and seed size. These levels of yield losses warrant a control measure against this disease.

Introduction

Among cool-season food legumes, field pea (*Pisum sativum* L.) is the second most important crop grown in Ethiopia (Hailu *et. al.* 1994). The yield of this crop is very low partly due to diseases (Asfaw 1979, Dereje & Tesfaye 1994, Habtu & Dereje 1986) among which Ascochyta blight is the most destructive and widely distributed disease reported in the country (IAR 1997, 1996a, 1996b, Dereje & Tesfaye 1994, Habtu & Dereje 1986). Ascochyta blight of field pea is mainly caused by a fungus called *Mycosphaerella pinodes* (Berk. and Blox) Vestergr which is the perfect stage of *Ascochyta pinodes* (Hagedorn 1985). But, *A. pisi* (Lib.) rarely causes some blighting in association with the former fungus while mainly causes spots on pods and stems. *Ascochyta* blight affects leaves, stems, and pods and severely destroys the crop when conditions are favourable for disease development (Anon 1993, Hagedorn 1985) like that prevailed in the 1998 cropping season at both the test locations, Holetta and Denbi. In addition, the disease occurs during all stages of the crop development being serious on early sown crops (IAR 1997).

There are some rough estimates of yield losses of field pea due to *Ascochyta* blight in some countries. Moderate to severe infection caused yield losses of 50-75% in USA (Hagedorn 1985), over 45% in England (Clulow *et. al.* 1989), and up to 33% in Canada (Warkentin *et. al.* 1996). In Ethiopia, no information is available on the extent of yield losses caused by this disease. Therefore, an experiment was carried out to assess the yield losses of different varieties of field pea having different levels of blight severity.

Materials and Methods

The experiment was carried out at two locations (Holetta and Denbi) during the 1996 and 1997 main crop seasons (June to December) using two cultivars namely Tegegnech (improved and moderately tolerant) and Local-H (susceptible cultivar). A 2x5 factorial experiment (two cultivars and five spray schedules) was arranged in Randomized Complete Block Design (RCBD) with four replications. Individual plot had net area of $16m^2$. The plots were sown on June 23 at Denbi and 26 at Holetta in 1996 and on June 22 at Denbi and 25 at Holetta in 1997 cropping season. Plants were raised following recommended agronomic practices for the two locations (Amare and Adamu, 1994). Because pea aphid (*Acyrthosiphon pisum* Harris) was a problem at Denbi, plots were protected by single foliar spraying of Primicarb (Primor®) at the rate of 0.5kg a.i./ha in both seasons.

To obtain plots with different levels of blight severity, plots were sprayed with Chlorothalonil (Bravo 500®) at the rate of 2.0kg/ha a.i. at 7, 14, 21, and 28 days intervals starting at the onset of the disease. Check plots were not protected by the fungicide.

Agronomic parameters such as stand count per plot at emergence, crop phenology, pods/plant, seeds/pod, and plant height were recorded from 10 randomly selected plants in each plot. At harvesting, seed yield, 1000-seed weight, and biomass were measured. Seed weight was adjusted to 90% dry matter weight after moisture content was determined by oven-dry method.

Disease severity were recorded every week starting at the onset of the disease using percent area covered by infection. Disease parameter, Area Under the Disease Progress Curves (AUDPC) was calculated using the formula developed by Pandey *et. al.* (1989) from six regular disease evaluation scores made during the whole growing season. AUDPC, disease severity at flowering and at physiological maturity (the end of the season) were used to compare different treatments and their effects on seed yield and yield components.

Since it was not possible to completely protect and obtain disease-free check plots in the experiment, percent yield losses were calculated based on estimated seed yield for disease-free plots through regression analysis according to Conway *et. al.* (1989). The formula used to calculate yield loss was

$$YL(\%) = \frac{[Ev - Mv]}{Ey} X\ 100$$

Where **YL(%)** = percent yield loss, **Ey** = estimated yield for disease-free plots through regression analysis and **My** = measured seed yield for each treatment.

Disease and yield data were subjected to statistical analysis using MSTAT-C computer package (MSU, 1988). After ANOVA was performed, means were separated using Duncan's Multiple Range Test at P = 0.05 (Gomez and Gomez, 1986)

Results

Ascochyta blight caused by *Mycosphaerella pinodes* (Berk. and Blox) Vestergr was the main disease observed in the experimental plots at both locations and years. However, low levels of infection (<5%) were recorded for different diseases caused by, *Phoma medicaginis* (Jones) Boerema, *Septoria pisi* West., and *Ascochyta pisi* Lib. at both locations and in both seasons.

At Holetta, blight had started in the last week of July in both the seasons and developed very fast between August 4 and 10 in 1996 and between August 7 and 12 in 1997 when the crop had started to flower. The disease reached maximum severity in Mid-September in both seasons and no increase was observed after that. However at Denbi, blight had started in early August (1-7) in both cropping seasons and developed very fast between August 22 and September 5 in 1996 and between August 21 and 28 in 1997. This time was when the crop was at full flowering stage. The disease reached maximum at the end of third week of September in both seasons at this location.

Spraying of Chlorothalonil at different intervals contrived plots with different level of disease severity that represent different epidemics. This is clearly observed by the values of final disease score and AUDPC for the different treatments

Table 1. Mean disease severity, Area under the disease progress curve, seed yield, and yield losses of field pea for different epidemics at Holetta and Denbi in the 1996 crop season.

Location	Cultivar	Spray interval (week)	Disease severity (%) at flowering and maturity plant stage			Seed yield (t/ha)	Yield loss (%)[2]
			Flower	Mature	AUDPC[1]		
Holetta	Tegegnech	1	17.5c	33.8f	806f	0.88a	21.1
		2	23.5c	50.0e	1175e	0.58b	48.0
		3	27.5bc	60.0d	1592bc	0.50bc	55.2
		4	28.5b	70.1c	1620ab	0.44bc	60.5
		Check	35.0a	87.5a	1540bcd	0.36c	67.7
	Local-H	1	8.0d	42.5ef	685f	0.77a	30.9
		2	21.2c	71.3c	1259de	0.57b	48.9
		3	28.8b	70.0c	1319cde	0.43bc	61.4
		4	31.7ab	83.8b	1483bcd	0.34c	69.5
		Check	32.5a	90.0a	1874a	0.34c	69.5
Denbi	Tegegnech	1	11.3d	15.0f	494f	1.70a	-5.2
		2	15.0c	31.2e	941cd	1.27b	20.7
		3	18.8ab	50.0bc	879cde	1.27b	20.7
		4	20.0a	56.1b	963cde	1.25bc	22.0
		Check	22.5a	67.5a	1356a	1.02cd	36.3
	Local-H	1	12.5d	10.0f	638ef	1.32b	17.6
		2	13.8d	38.8de	774de	1.19bc	25.7
		3	10.8d	46.3c	1024cd	0.98d	38.8
		4	21.2a	58.8b	1081bc	0.87d	45.7
		Check	22.0a	71.2a	1299ab	0.84d	47.6

Means followed by the same letter in each column and location are not significantly different using Duncan's Multiple Range Test (P = 0.05). [1]AUDPC (Area under the blight progress curve in %/day) calculated from six regular records.[2] Yield loss in percent calculated as a drop from the intercept (1.115 t/ha for Holetta and 1.602 t/ha for Denbi) from a regression analysis (Yield = intercept + slope times blight score)

(Tables 1 and 2). Mean seed yield of 1997 was significantly ($P < 0.05$) greater than that of 1996 at Holetta when mean disease severity was significantly ($P < 0.05$) lower. But, both seed yield and disease severity were comparable in both seasons at Denbi (Tables 1 and 2). Consequently, mean yield losses of 53.2% at Holetta and 27.5% at Denbi were recorded in 1996. But yield loss was only 20.5% at both locations (Holetta and Denbi) in 1997 cropping season. Linear regression models incorporated final disease score and AUDPC satisfactorily explained the seed yield of field pea. As a result, percent yield loss increased with increased final disease severity or AUDPC (Tables 1 and 2).

At Holetta, seed yield of Local-H was lesser than Tegegnech and the disease severity was greater in 1996 than that of 1997. Accordingly, in 1996 mean seed yield was reduced from 0.77 t/ha to 0.34 t/ha as final disease severity increased from 42 to 90% for Local-H. And similarly mean seed yield was reduced from 0.88 t/ha to 0.36 t/ha as final disease severity increased from 34 to 88% for Tegegnech. However, in 1997, the yield did not drop as the disease occurrence was very low at both locations (Tables 1 and 2). But at Denbi, the disease was comparable and so is the seed yield of field pea in the two seasons.

Appropriately, a general yield loss and Ascochyta blight relationship was obtained at Denbi. Hence, yield was estimated by subtracting the products of 0.012 and final disease severity score from 1.861 ($r = -0.78$, $df = 18$, $p = <0.001$). However for Holetta, since the epidemics were not the same for the two years, a general regression model could not be developed. Among yield components, seed size, pods/plant and biomass were significantly ($p < 0.05$) affected by blight infection and were highly correlated ($p < 0.01$) with seed yield. But seeds/pod and plant height were not affected by blight (Table 3).

Table 2. Mean disease severity, Area Under the Disease Progress Curve, seed yield, and yield losses of field pea for different epidemics at Holetta and Denbi in the 1997 crop season.

Location	Cultivar	Spray interval (week)	Disease severity (%) at Flowering and Maturity plant stage			Seed Yield (t/ha)	Yield Loss[2] (%)
			Flower	Mature	AUDPC[1]		
Holetta	Tegegnech	1	12.5c	15.0d	445c	2.37bc	15.5
		2	17.5a	20.0c	570abc	2.37bc	15.4
		3	18.8a	25.0bc	673a	2.12bcd	24.5
		4	16.3ab	31.2b	681a	2.02cde	27.9
		Check	16.3ab	35.0a	607ab	1.71e.	32.2
	Local-H	1	12.5c	12.5d	432c	2.95a	0.0
		2	13.8b	18.1c	492bc	2.44b	13.1
		3	16.2ab	28.8b	567abc	2.10bcd	25.2
		4	17.5a	29.4b	609ab	2.26bcd	19.5
		Check	16.3ab	36.9a	676a	1.91de	31.8
Denbi	Tegegnech	1	12.3d	12.4d	672c	1.79a	6.6
		2	28.8b	30.6c	829b	1.68ab	12.3
		3	35.0a	43.1b	870ab	1.58b	17.3
		4	36.2a	46.3b	931ab	1.32c	30.6
		Check	36.3a	62.5a	1019a	1.19c	37.9
	Local-H	1	18.0c	18.4d	665c	1.82a	4.9
		2	30.0b	29.4	796bc	1.68ab	11.8
		3	38.8a	35.6bc	838b	1.58b	16.7
		4	31.3b	42.5b	846b	1.37c	29.2
		Check	36.3a	63.8a	953ab	1.19c	37.6

Means followed by the same letter in each column and location are not significantly different using Duncan's Multiple Range Test (P = 0.05). [1]AUDPC (Area under the blight progress curve in %/day) is calculated from six regular records. [2]Yield loss in percent calculated as a drop from the intercept (2.879 t/ha for Holetta and 1.986 t/ha for Denbi) from the regression analysis (Yield = intercept + slope times blight score).

Table 3. Effects of Ascochyta blight on yield components of field pea. Mean values of two locations (Holetta and Denbi) and two years (1996 and 1997).

Cultivar	Spray interval (weeks)	1000-seed (g)	Pods/plant	Seeds/pod	Plant height (cm)	Biomass (t/ha)
Tegegnech	1	197a	8.0a	3.8a	136a	5.7bc
	2	183b	7.3bcde	3.6a	137a	5.7bc
	3	179bc	7.5bcd	3.8a	140a	5.5bc
	4	178bc	7.3bcde	3.4a	135a	5.3c
	Check	170c	6.2f	3.7a	142a	4.6d
Local-H	1	152d	8.2a	3.8a	133a	6.6a
	2	146de	7.8ab	3.7a	130a	5.8bc
	3	144def	7.7abc	3.7a	140a	5.6bc
	4	143def	6.9e	3.3a	132a	5.5bc
	check	139f	6.0f	3.5a	136a	5.3c

Means followed by the same letter in each column are not significantly different using Duncan's Multiple Range Tesse (P = 0.05)

Discussion

This is the first report on the extent of yield losses of field pea caused by *M. pinodes* from detailed experimental studies. Results of both years (1996 and 1997) and both locations (Holetta and Denbi) indicated that yield losses caused by different epidemics of Ascochyta blight were substantial on both cultivars (Tegegnech and Local-H) used in this experiment and under the environmental conditions prevailed in these sites. The disease was more severe in 1996 than in 1997 at Holetta while comparable in both seasons at Denbi. However, it was more severe at Holetta than at Denbi in 1996 and vis versa in 1997. This was evidenced by the magnitude of both final disease score and AUDPC, and seed yield at these locations (Tables 1 & 2). This was most probably due to environmental conditions prevailed at Holetta in the 1997 cropping season which did not favour blight development but unusually enhanced crop yield. This result showed that this disease has a potential to cause enormous losses in yield in the epidemic-prone regions of the country.

Disease severity before spraying was not significantly different ($p = 0.32$) for the different treatment plots. But upon treatment application, different disease severity classes or treatments, were produced in gradient such that each had different blight value that was evidenced by final disease score and AUDPC at both locations and in both years (Tables 1 & 2). This clearly indicated that the treatments applied produced different epidemics which intern produced different seed yield levels. This was a useful method which helped us to establish the relationship between yield losses in the field and severity of Ascochyta blight. Several workers had used a similar technique to establish yield loss and disease severity relationships of different diseases of field crops (Teng 1981, Keller *et al.* 1986, Yang *et al.* 1991, Wilson & Gates 1993, Wilson *et al.* 1991). However, disease rating in field pea was difficult than other crops, referred above, due to its crawling growth habit.

The fungicide (Chlorothalonil) used in this experiment was selected for its lack of possible effects on crop physiology and is a protectant product with activity against Ascochyta blight in field pea (Warkentin *et al.* 1996, IAR 1996a, 1996c).

When seed yield was regressed on final disease severity score ($R^2 = 0.86$) or AUDPC ($R^2 = 0.88$), there was a strong linear relationship ($p = < 0.01$). From these relationships the theoretical maximum yield or seed yield at zero disease severity was estimated and was used to calculate the percent yield loss. This is because, there was no any disease-free plot in the experiment, hence, estimation of the seed yield for disease-free plots was sought appropriate. Conway *et al.* (1990) also used this method to establish the relationship of severity of *Cercospora* blight and yield of Asparagus. He & Yang *et al.* (1991) and Wilson & Gates (1993) recommend to use this method for loss assessment trials that couldn't obtain disease-free plots in their treatments.

The intercepts from the linear regression equations represent this theoretical maximum yield of each cultivar in the absence of disease-free treatment (Conway *et al.* 1990). Intercept values for this experiment were always greater than the most protected (every week sprayed) plots except for Local-H in 1997 at Holetta and Tegegnech in 1996 at Denbi. Generally the intercepts had lowest yield losses, but greater than zero, in most cases (Tables 1 & 2) indicating a clear trends of yield losses in this experiment. And these values were not very far from those measured for most diseased plots in the experiment.

Mean yield losses of 53.3% in 1996 and 20.5 in 1997 were obtained at Holetta. This difference was attributed to the unusual rainfall patter prevailed in the 1997 cropping season which did not favour disease development. Early cease of the season and lower amount of rainfall occurred in this particular year during the 1997 crop period.

Generally, in the 1997 cropping season, the seed yield was greater and percent yield loss was lesser than that obtained in the previous year. Seed yield of field pea depended on the level of disease infection in both the years. Ascochyta blight has a potential to cause enormous damage to field pea crops when rain prolongs and increases in amount. And therefore, is proved to be an economically important disease of field pea in the central Ethiopia.

Highly significant ($p < 0.01$) correlation were found between seed yield and some yield components (1000-seed weight, pods/plant, and biomass) while none with seeds/pod and plant height. The most affected yield components of field pea were pod set and seed size.

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