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Effect Host Plant Resistance and Fungicides Application on Ascochyta blight (*Ascochyta pinodes*) Severity and Yield of Field pea (*Pisum sativum* L.) in Gedeb and Bulle Districts, Southern Ethiopia

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Abstract

Ascochyta blight (A. pinodes) is one of the major diseases menacing field pea (P. sativum L.) production and restraining its productivity in Ethiopia. Using recently improved varieties that are high yielding and tolerant to diseases can increase field pea productivity. However, the level of protection provided by the varieties has not been satisfactory. Fungicides can be used to control pathogens of legume crops when used as early spray. The objective of this study is to evaluate the synergistic effect of host plant resistance and use of fungicides on field pea yield and severity of Ascochyta blight. The treatments are laid out in a randomized complete block design with three replications during the 2020/2021 main crop season. The Ascochyta blight severity was scored with a 1-9 scale at the final pod filling stage when the disease attained maximum and then grain yield was recorded. Application of fungicides reduced disease severity and increased grain yield and hundred-grain weight at all varieties compared to untreated. At Gedeb, the highest mean severity reduction (35.3%) was recorded with the spray of Othello-Top on Megeri variety. The highest (39.1%) mean disease severity reduction was recorded with the spray of Othello-Top on local c. at Bulle. The highest average grain yield of 4127.2 kg/ha and 3571.6 kg/ha were achieved from Burkitu sprayed by a fungicide Othello-Top and Azonine 480 SC at Gedeb, respectively. The heavier seed weight was recorded from Megeri (31.6 gm) with spray of Othello-Top at Gedeb. Therefore, both Othello-Top and Azonine 480 SC can be used for the management of Ascochyta blight disease caused by A. pinodes.

Keywords: *Ascochyta pinodes; Field pea varieties; Pisum sativum; Severity*

Introduction

Field pea (*Pisum sativum* L.) is highly produced in highlands of Gedeo farmers. It is used as a protein source for home consumption as well as for income generation of the poor farmers. Major obstacles in the way of increased pea production are the diseases caused by the fungal, viral and bacterial pathogens (Kemal, 2002).

Ascochyta blight is among very important field pea diseases throughout the world (Lawyer, 1984) and is caused mainly by Ascochyta pinodes, in which this pathogen is the most destructive component of Ascochyta disease "complex" of field pea in Ethiopia (Gorfu and Beshir, 1994). It often causes serious yield and quality losses that were mostly dependent on time and level of infection, host reaction and prevailing local climatic conditions (Nasir and Hoppe, 1998). In Ethiopia, a mean seed yield loss of 31% rising to

about 53% was reported (Gorfu, 2000) warranting a control measure. This pathogen, A. pinodes, affects all stages of field pea crop by decreasing plant growth, biomass, and ultimately the seed yield that were mostly reflected on seed weight and number of seeds per plant (Garry et al., 1998).

Blight symptoms are characterized by discrete brown to black flecks and undefined lesions on leaves, petioles, stems and pods that latter coalesce to form dark black large lesions and blighted foliage of the crop (Beasse et al., 1999). Severe infection at the soil level can sometimes girdle seedlings thereby leading to plant death (Nasir and Hoppe, 1998). A. pinodes is a polycyclic disease where many cycles of spores are produced and continuous infection occurs in the life span of a crop, and thus, very small amount of initial inoculum could probably initiate a serious epidemic. Some research evidences are reported in this regard on Ascochyta blight of field pea.

Field pea varieties having tolerant to Ascochyta blight have been recently released for cultivation in Ethiopia (Geletu et al., 1996). However, lack of high level of resistance and susceptibility of the resistant cultivars to the virulent races were the constraints in use of disease resistance as management option (Mutlu et al., 2005). Many of the systemic fungicides available at present have the advantage and capacity of ease of application and increased efficacy as control options. Maude (1983) emphasized that fungicides used as seed treatment should penetrate the tissue of the seed and eliminates deep-seated infections of pathogens without causing phytotoxicity. New fungicides were recently registered in controlling fungal diseases in Ethiopia. Hence, integration of disease tolerant field pea varieties with various fungicides is available management of an option and essential to successfully manage the disease and mitigate yield losses. The objective of this study is to determine the effect of varieties and fungicides on severity Ascochyta blight and yield.

Material and Methods

Description of the study area

The study conducted in Bulle and Gedeb districts of the Southern Nations Nationalities People Region, Ethiopia during the 2020/20201 main crop season. Gedeb district is located in Gedeo zone of SNNPR, 160 km from the capital of SNNPR – Hawassa and 74 kilometers from Dilla which is the administrative seat of Gedeo zone. The area of the district is estimated to be 30,909 hectare. The altitude of Gedeb district ranges from 1950 m.a.s.l up to 2650 m.a.s.l, the annual rain fall ranges from 1290 -1800 mm and the temperature ranges from 16-21°C. The land use system of the district is mostly mixed farming system. Most of the land was cultivated by annual crops of 12,756 hectare, perennial crops of 16,372 hectare and the pasture land coverage is 244 hectare (Gedeb district AGP Bureau, 2007). Bulle district is located in the southern part of Hawassa, 117 kilometers (km) from the region's capital in 6°.07'-6°.37' North and 38°.27'-38°.77' East. The district has a total area of 27,300 (ha), with its altitude ranging between 2,001–3,000 meters above sea level (m.a.s.l). Mean annual rainfall of the district is 1401-1800 mm, with mean average temperature ranging between 12.6°–20°C (SARI, 2017).

Field pea varieties

The testing crop was field pea (Megeri and Burkitu variety), which is already adapted and still perform best in the study area. Seeds of Megeri and Burkitu varieties that had been released for production obtained from Holeta Agricultural Research Centers, Ethiopia (EARO, 2010). A 'local cultivar (Gonder)' commonly grown by farmers in the respective study areas included as a check.

Variety	Production domain (m.a.s.l)	Maturity days	Yield (Q/ha)		Year of release
			On-Research site	On-Farmer site	
Megeri	1800-3000	95-150	21-41	15-34	2006
Burkitu	1800-3000	110-163	35-62	20-38	2008

Table 1: *Agronomic characteristics of released Field pea varieties used in the study.*

Treatments

The experiment done by using three new registered fungicides: Matico (Metalaxyl 8% WG+ Mancozeb 64% WP), Azonine 480 SC (Chlorothalonil 400 g/L + Azoxystrobin 80 g/L) (Azoxystrobin 6% + Chlorothalonil 50%) and Othello-Top (Azoxystrobin 200 g/L + Difenoconazole 125 g/L). Fungicides sprayed starting from first disease symptom with company recommended rate. Othello-Top, Azonine 480 SC and Matico WP fungicides applied at the rate of 500ml/ha (10ml/20 liters of water), 500ml/ha (10ml/10 lit of water) and 2.5 kg/ha, respectively.

No	Treatments	No	Treatments
1	Megeri + Othello-Top foliar spraying	7	Burkitu + Matico foliar spraying
2	Megeri + Azonine 480 SC foliar spraying	8	Burkitu + Unsprayed
3	Megeri + Matico foliar spraying	9	Local cv + Othello-Top foliar spraying
4	Megeri + Unsprayed	10	Local cv + Azonine 480 SC foliar spraying
5	Burkitu + Othello-Top foliar spraying	11	Local cv + Matico foliar spraying
6	Burkitu + Azonine 480 SC foliar spraying	12	Local cv + Unsprayed

Table 2: *Treatments used in the study.*

Experimental design

Three fungicides combined with three Field pea varieties in factorial randomized complete block design with three replications and hence there were 12 treatments in each replication. The plot size was 3-m length by 1.2-m width and spacing between plots and blocks was 0.8 m and 1 m, respectively. The spacing between plants and rows was also 0.05m and 0.2m, respectively (EARO, 2010). The recommended agronomic practices uniformly employed to each plot as required in the study period. Field pea plants in the middle two rows used for disease and yield data.

Data collection procedures

Disease Assessment

Ascochyta blight severity recorded on each of 10 sample plants from middle two rows per plot, using 1 –9 scale similar to those utilized by Pande et al.,2011; where, 1, no visible symptoms; 2, minute lesions prominent on the apical stems; 3, lesions up to 5–10 mm in size and slight drooping of apical stems; 4, lesions obvious on all plant parts and clear drooping of apical stems; 5, lesions on all plants parts, defoliation initiated, breaking and drying of branches slight to moderate; 6, lesions as in 5, defoliation, broken, dry branches common, some plants killed; 7, lesions as in 5, defoliation, broken, dry branches very common, up to 25% of plants killed; 8, symptoms as in 7 but up to 50% of the plants killed and 9, symptoms as in 7 but up to 100% of the plants. Disease severity recorded at final pod filling stage when the disease attained maximum (Villegas–Fernandez et al., 2012). The severity grades converted into percentage severity index (PSI) for analysis:

$$Disease\ severity\ index(DSI) = \frac{\sum(score\ x\ number\ of\ plants\ with\ this\ score)}{Total\ number\ of\ plants\ x\ greater\ score}$$

Percentage of disease reduction (DR%) calculated by Edginton et al (1971):

$$DR\ (\%) = \frac{Dc - Dt}{Dc} \times 100$$

Dc is disease on the control plants that treated with only pathogen and Dt is disease on the treated with antagonist and pathogen

Grain Yield and 100-seed weight

Grain yield and 100-seed weight of each plot also determined after threshing. Finally, yield per plot converted to seed yield per hectare basis. The grain yield adjusted to 10% moisture content.

Data analysis

The data subjected to analysis of variance (ANOVA) using the general linear modeling (GLM) procedure of SAS-9.2 software (SAS institute inc. 2008). LSD performed at α =0.05% level of significance to denote significant difference between the treatments.

Result and Discussion

Ascochyta severity

The results showed that there was significant ($p<0.05$) interaction among types of varieties used and application of the fungicides in reduction of disease severity (Table 3). Othello-Top was reduced disease severity at all varieties compared to unsprayed. At Gedeb, the highest mean severity reduction (35.3%) was recorded with the spray of Othello-Top on Megeri variety followed by spray of Othello-Top on Burkitu variety (32.7%). Differently, at Bulle the highest (39.1%) mean disease severity reduction was recorded with the spray of Othello-Top on local c. (Gonder). This might be due to the fact that "Othello-Top" fungicide has ability to reduce primary infection and at the same time it is able to manage spreading of ascochyta blight secondary inoculum between neighboring plants. As reported by Mohammed and Fufa, (2014) foliar sprays with Top can effectively manage Ascochyta blight of chickpea (A. pinodes). Fungicides, including mancozeb, chlorothalonil and benomyl, have been used to effectively control ascochyta blight and increase yield (Bretag et al., 2006).

Varieties	Fungicides	Ascochyta blight severity index							
		Gedeb				Bulle			
		Year-2020	Year-2021	Average	PDR	Year-2020	Year-2021	Average	PDR
Megeri	Matico	33.3	77.7	55.5^{c}	0.5	33.3	52.9	43.1^{c}	11.6
	Othello-Top	27.7	44.4	36.1^{g}	35.3	25	45.5	35.3^{ed}	27.7
	Azonine 480 SC	38.8	55.5	47.2^{e}	15.4	33.3	51.9	42.6^{c}	12.6
	Unsprayed	48.6	62.9	55.8^{c}	-	35.3	62.2	48.8^{b}	-
Burkitu	Matico	61.1	70.3	65.7^{a}	1.4	50	60.3	55.2^{a}	1.6
	Othello-Top	37.8	51.8	44.8^{f}	32.7	30.6	52.9	41.8^{c}	25.5
	Azonine 480 SC	55.5	62.9	59.2^{b}	11.1	42.4	67.7	55.1^{a}	1.8
	Unsprayed	55.5	77.7	66.6^{a}	-	44.4	67.7	56.1^{a}	-
Local cultivar/ Gonder	Matico	44.2	48.1	46.2^{e}	6.8	47.2	43.5	45.4^{cb}	14.9
	Othello-Top	33.3	37	35.2^{g}	29	19.4	45.5	32.5^{e}	39.1
	Azonine 480 SC	51.2	37	44.1^{f}	11.1	36.1	38.1	37.1^{d}	30.4
	Unsprayed	43.6	55.5	49.6^{d}	-	61.1	45.5	53.3^{a}	-
Mean		44.2	56.7	50.5		38.2	52.8	45.5	
CV (%)				3.23				5.03	
LSD				1.86				3.66	

Table 3: *Interaction effects of host plant resistance and types of fungicides on Ascochyta blight severity (%) on field pea.*

Grain Yield and 100-seed weight

There was significant ($p<0.05$) interaction between the variety and fungicide application at both locations. Results reported herein indicated that fungicide spray not only suppressed disease severity but also enhanced average grain yield of field pea plants compared to unsprayed control (Table 4). At Gedeb, the highest average grain yield of 4127.2 kg/ha and 3571.6 kg/ha were harvested from Burkitu variety with spray of Othello-Top followed by the application of Azonine 480 SC, respectively. But, the lowest (2009.1 kg/ha) average grain yield was obtained from the local c. with unsprayed plot (Table 4). At Bulle, the highest (2087.0 kg/ha) average grain yield was recorded from Burkitu variety with spray of Othello-Top followed by Megeri variety spayed with Othello-Top (1509.3 kg/ha).

The heavier seed weight was recorded from Megeri (31.6 gm) with spray of Othello-Top at Gedeb (Table 5). Similarly, at Bulle the heaver seed (28.0 gm) was recorded from Megeri variety with the spray of Othello-Top. Generally, in this study and previous ones also, seed yield of field pea was dependent on blight pressure and the varieties used. Application with fungicides reduced the infection of A. pinodes and increased the seed yield. . Garry et al. (1998) also reported that this pathogen, A. pinodes, affects all stages of field pea crop by decreasing plant growth, biomass, and ultimately the seed yield that were mostly reflected on seed weight and number of seeds per plant.

Conclusions and Recommendations

Application of a fungicide Othello-Top, Azonine 480 SC and Matico WP has influenced Ascochyta blight disease development. Similarly, the yield of the field pea was highly influenced by the types of the fungicides. The disease severity was computed as the parameters of the major disease. The lowest average ascochyta diseases severity (32.45%) was recorded from plots that have received application of a fungicide Othello-Top. This indicates that the application of a fungicide Othello-Top is an important field pea production package. The highest average grain yield of 4127.2 kg/ha and 3571.6 kg/ha were achieved from Burkitu sprayed by a fungicide Othello-Top and Azonine 480 SC at Gedeb, respectively. While the lowest average grain yield of 789 kg/ha and 901.8 kg/ha were recorded from local cv an unsprayed plot and Megeri unsprayed plot at Bulle. Therefore, both Othello-Top and Azonine 480 SC can be used for the management of Ascochyta blight disease caused by A. pinodes.

Varieties	Fungicides	Yield (kg/ha)					
		Gedeb			Bulle		
		Year-2020	Year-2021	Average	Year-2020	Year-2021	Average
Megeri	Matico	2291.6	3601.6	2946.6^{bdc}	1526.2	1122.8	1324.5^{cebd}
	Othello-Top	2812.5	4122.5	3467.5^{bac}	1873.1	1145.6	1509.3^{b}
	Azonine 480 SC	2604.1	3914.1	3259.1^{bac}	1734.3	1151.2	1442.7^{bc}
	Unsprayed	1770.8	3080.8	2425.8^{dc}	1179.3	789	984.1^{ed}
Burkitu	Matico	2614.1	3954.1	3284.1^{bac}	1734.3	917.5	1325.9^{cebd}
	Othello-Top	3472.2	4782.2	4127.2^{a}	2312.5	1861.5	2087.0^{a}
	Azonine 480 SC	2916.6	4226.6	3571.6^{ba}	1942.5	1024.2	1483.3^{bc}
	Unsprayed	2465.2	3775.2	3120.2^{bac}	1641.8	1119.9	1380.8^{cbd}
Local culti-var/Gonder	Matico	1736.1	3046.1	2391.1^{dc}	1156.2	931.5	1043.8^{ced}
	Othello-Top	1736.1	3066.1	2401.1^{dc}	1341.2	908.26	1124.7^{cebd}
	Azonine 480 SC	2013.8	3323.8	2668.8^{bdc}	1158.2	1025.1	1091.6^{cebd}
	Unsprayed	1354.1	2664.1	2009.1d	901.8	945.6	923.7^{e}
Mean		2315.6	3629.7	2972.6	1541.7	1078.5	1310.1
CV (%)				22.10			20.36
LSD				1107.3			449.61

Table 4: *Interaction effects of host plant resistance and types of fungicides on yield on field pea.*

Varieties	Fungicides	100-seed wt (gm)					
		Gedeb			Bulle		
		Year-2020	Year-2021	Average	Year-2020	Year-2021	Average
Megeri	Matico	25.1	25.9	25.5^{ecd}	21.1	22.9	22.2^{dce}
	Othello-Top	29.9	30.3	30.1^{ba}	25.9	27.2	26.7^{ba}
	Azonine 480 SC	23	24.6	23.8^{ef}	18.9	21.6	20.4^{fe}
	Unsprayed	25.5	24.2	24.8^{ed}	21.5	21.1	21.3^{de}
Burkitu	Matico	31.6	29.8	30.7^{ba}	27.6	26.8	27.1^{ba}
	Othello-Top	31.4	31.8	31.6^{a}	27.4	28.7	28.0^{a}
	Azonine 480 SC	28.6	31.9	30.2^{ba}	24.5	28.9	26.7^{ba}
	Unsprayed	26.1	30.3	28.2^{bc}	22.1	27.3	24.7^{bc}
Local culti-var/Gonder	Matico	23.3	30	26.6e^{cd}	19.3	27.0	23.2^{cd}
	Othello-Top	31.7	23.8	27.7^{bcd}	27.7	20.8	24.3^{bc}
	Azonine 480 SC	21.1	21.2	21.2^{gf}	17.1	18.2	17.6^{gf}
	Unsprayed	19.2	21.7	20.4^{g}	15.2	18.7	16.9^{g}
Mean		26.3	27.1	26.7	22.3	24.1	23.3
CV (%)				6.62			7.55
LSD				2.98			2.96

Table 5: *Interaction effects of host plant resistance and types of fungicides on 100-seed of field pea.*

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