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Screening of Field Pea Genotypes for Aschochyta Blight

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Abstract: Eleven field pea genotypesincluding 2 released varieties (Burkitu, Adi) were evaluated under field condition of Holetta environment using RCBD design to identify resistant genotypes. The current study revealed that considerable variation was found for response against ascochyta blight diseases and yield performance even if high level of resistance materials were not identified. High degree of disease severity was observed at Holetta site. Out of the total 11 genotypes; 2 genotypes (EH 012022-1 and EH 012020-7) were moderately resistant, 3genotypes (Burkitu, Adi and EH 012019-1) were susceptible and the remaining 7 genotypeswere highly susceptible to ascochyta blight disease. Genotypes EH 012020-7 and EH 012019-1were relatively high yielder and moderately resistant. This shows that field pea for resistance to Aschochyta blight is often limited due to the absence of high levels of resistance gene in the studied genotypes of field pea, which along with the highly variable pathogen, has precluded the development of varieties with both high and durable resistance. The present finding is from one year and Holetta location data. The development of ascochyta blight disease (severity) depends on the conduciveness of the environment and growing season. Hence, it is better to repeat this trial in multi-location and season to check disease and yield stability for further breeding purpose.

Key words: Ascochyta Blight · AUDPC · *Mycosphaerella pinodes* · *Pisum sativum* · Yield

INTRODUCTION

Three fungal species: *Ascochyta pisi* Lib., *Mycosphaerella pinodes* (Berk. & Blox.) Vestergr. [Teleomorph of *Ascochyta pinodes* (Berk. & Blox.) Jones] and *Phoma medicaginis var. pinodella* (L.K. Jones). Boerema, are responsible for ascochyta blight disease of field pea (*Pisum sativum* L.). They cause lesions on leaves, stems and pods while the last two species also infect stem bases. All species can be seed-borne and infected seeds show varying degrees of shriveling and discoloration, while other infected seeds remain symptomless. Planting of infected seeds reduces number or vigor of emerging plants.

Ascochyta blight is a very important foliar disease in field peas worldwide.Thedisease is particularly destructive in the temperate zones of Europe, North America, Australia and New Zealand [1-4]. According to Marcinkowska [5, 6]. *M. pinodes* was prevalent on pea in several regions of Poland. The disease is apparent as a severe foliar blight and foot rot, causing yield losses. The yield losses in commercial pea fields were estimated from 10% to 20%, but in some trials were also over 50% [7, 8]. Among the three *Ascochyta* spp. causing blights on field pea *Ascochyta pinodes* [teleomorph = *Mycosphaerella pinodes*] is a major disease of field pea in Ethiopia [9, 10]. Blight infection is as high as 85% around Dembi East Shewa and a mean infection of 18.7% for all areas surveyed (Ada, Adaberga, Selale, Welmera, Weliso and Chelia) were reported [10]. A complete loss of yield due to Ascochyta blight is common, especially in hot-spot areas such as Dembi where there is high natural infectionof the disease [11]. Severe infection of Ascochyta blight causes a substantial seed yield reduction in field pea amounting 22% [9, 12]. A mean seed yield reduction of 0.37 t ha^{-1} (ranging from 1.31 to 1.68 t ha^{-1}) was recordedas the final disease score increased from 14 to 66% [12]. The disease mainly causes defoliation that eventually affects pod set and seed size more than any other yield component. A complete loss of yield due to Ascochyta blight is common, especially in blight hot-spot areas such as Dembi where there is high natural infection of the disease [10].

The pathogen infects all the above ground parts. It is also found in seeds. The pathogen attacks the foliage, which causes spotting and blighting mainly onfield peas

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grown in the wetter parts of the country. Seed infection serves as primary sources of inoculum for new crop and this pathogen has up to 86% transmission efficiency from seed to seedlings [13, 14]. That means there could be a direct invasion of young plants by the fungus when infections originate from the seed.

The main fungus *A. pinodes* that causes blight in field pea survives as sclerotia (thickened mycelia), chlamydospores or pycnidia on straw fragments and in the soil [15] and as infection in the seed and conidia adhere on seed surface [13]. It colonizes pea straw on the surface and in the soil and it competes well as a saprophyte with other soil microflora. When temperatures decrease and sufficient moisture is available under Ethiopian conditions, old pycnidia mature, new pycnidia, perithecia develop and their spores are released. During wet weather, spores are produced on infected plants and transferred on to healthy plants by wind and rain splash. Early sowing and use of infected seeds increase the incidence of the disease. Use of clean seed is advisable, as infected seeds are important sources of inoculum, where other sources are not important [13]. In the absence of seed treatment, however, seed should be held over at least for one year when seed infection is known to be less than 10% [13, 15]. Pea refuse should be disked and ploughed under immediately after harvest before the fungus can be generally dispersed by wind and rain splash.

In many field pea-producing areas of Ethiopia, faba bean and field pea are grown in mixed cropping for weed suppression and physical support of field pea by faba bean. The major advantage, however, is suppression of foliar diseases [16]. Other advantages include higher seed yield and increased land productivity. Dereje, Gemechu *et al*. and AARC [16-19] reported the importance of mixed cropping of faba bean and field pea to reduce Ascochyta blight. After three seasons study at Holetta and Dembi, Dereje [16] found the lowest disease pressure and maximum yield from a 2:1 faba bean to field pea mixture. Final disease severity dropped from 93 to 70% as field pea proportion in the mixed cropping decreased from 100 (pure stand) to 32%.

Several fungicides were reported as effective for seed dressing or foliar application. Seed treatment with carbendazim provides early protection of seedling infection from the seed source [20]. Foliar application of chlorothalonil, benomyl, thiophanylmethyl and metalaxyl could also control Ascochyta blight in field pea and increase the seed yield reasonably [10]. Field pea crop intended for seed production should be sprayed with chlorothalonil and metalaxyl at the rates of 2.5 and 1 kg a.i/ha, respectively. However, the economics for grain production is questionable.

Chemical spray is recommended if wet and warm weather is likely to prevail for two weeks following foliar application of the crop at or before flowering stage [10]. Beyond this crop stage, the benefit obtained from yield increase due to protection against the blight might not justify fungicide spray.

The level of resistance to Ascochyta blight in field pea genotypes tested (after screening over 800 accessions) is low to be of practical value in the development of resistant varieties [21]. The choice of moderately or partially resistant varieties might prove effective and sources/genotypes with these types of resistance already exist in Canada and Australia [22, 23].

Different alternative to Ascochyta blight control is offered by host plant tolerance. Certain differences are found in tolerance of field pea cultivars to infection with *M. pinodes*. These differences are of practical value and hence should be exploited. Most landraces and existing improved cultivars are tolerant to the disease and provide reasonableyield under moderate blight pressure [10].

Infection level with Ascochyta-complex fungi fluctuates from year to year and region to region depending on local climatic conditions [2, 5, 24]. Therefore evaluation of reaction of different genotypes or selection for resistance can be properly done only in years of disease epidemic [25]. To overcome some of the potential problems of testing in fields with natural disease pressure, incorporation of laboratory prepared inoculum to increase the pathogen population is [23, 26-29]. This study was undertaken to evaluate responses of selected field pea genotypes against Ascochyta blight disease (*A. pisi*) fungi under field conditions. Effect of Ascochyta blight disease severity on yield components was also examined. To identify and select disease resistant/ tolerance field pea genotype. Development and Promotion of Field pea (*Pisum sativum* L.) technologies for improving livelihoods of smallholder field pea growing farmers in the highlands of Ethiopia.

MATERIALS AND METHODS

Experiment Layout and Growth of Plants: Field studies were conducted at the Holetta Agricultural Research Center (HARC), in 2020/2021. Eleven field pea genotypes (Adi, EH 012010-3, EH 012025-2, EH 012019-1, EH 012020-7, EH 012022-1, EH 012009-2, EH 012019-3, Burkitu, EH 012009-4, EH 012004-2) were used for these tests.

Inoculation of field pea plants was done with *Ascochyta pinodes* by natural condition. Experiments were carried out in RCBD design with genotypes. Peas were grown on one-row plots 3.2 m2, 1.5 m long with 50 plants per plot and 50 cm row spacing with four replications. Then tworows of plants per plot were used for evaluation of the seed yield per plant.

Disease Assessment and Statistical Analysis: Disease intensity was assessedfive times during the growing season using a 00-99 scale and the severity of Aschochyta blight was recorded using the double-digit scale (00–99) developed as a modification of Saari and Prescott's severity scale to assess foliar diseases [30, 31]. First assessment was done after symptom development and the next at sevendays intervals. The increase of disease with time was calculated using the formula of Area under Disease Progress Curve (AUDPC) values calculated for each plot using the equations developed by Sharma and Duveiller [32] as follows.

$$AUDPC = \sum_{i=1}^{Ni-1} \frac{(Xi + Xi + 1)}{2}(ti + 1 - ti) \text{ where,}$$

Xi= the cumulative disease severity expressed as a proportion at the i^{th} observation, ti = the time (days after planting) at the i^{th} observation and n= total number of observations.

Analysis of variance was conducted with the General Linear Model procedure in SAS [33]. Duncan Multiple Range Test (DMRT) [34] was used for all mean comparison.

Table 1: Area under disease progress curve (AUDPC)of Aschochyhta bight disease of Field pea genotypes during 2020 main cropping season

Genotype	AUDPC	N	Disease Reaction
EH 012025-2	2047.5a	4	HS
EH 012009-2	2003.8ab	4	HS
EH 012009-4	1951.3abc	4	HS
EH 012019-3	1925.0abc	4	HS
EH 012010-3	1920.6abc	4	HS
EH 012004-2	1894.4abc	4	HS
Burkitu	1745.6bcd	4	S
Adi	1684.4cd	4	S
EH 012019-1	1522.5d	4	S
EH 012022-1	1474.4de	4	MR
EH 012020-7	1246.9e	4	MR
CV	10.14		

Means followed with the same letter(s) in the same column are not significantly different at the probability level of (p > 0.05) according to Dunken Multiple range test. CV= Coefficient of variation, R= resistance MR= moderately resistance, MS= moderately susceptible.

Table 2: Mean yieldperformance of Field pea genotypes of kik type affected by Aschochyta blight disease during 2020 main cropping season

Genotype	Mean Yield (Qt/ha)	N
EH 012020-7	21.125a	4
EH 012019-1	19.625a	4
Adi	16.725ab	4
Burkitu	15.700ab	4
EH 012022-1	11.525bc	4
EH 012004-2	7.800c	4
EH 012009-4	7.675c	4
EH 012010-3	7.500c	4
EH 012009-2	6.800c	4
EH 012025-2	6.700c	4
EH 012019-3	6.575c	4
CV	19.84	

Means followed with the same letter(s) in the same column are not significantly different at the probability level of (p > 0.05) according to Dunken Multiple range test. CV= coefficient of variation, Qt/ha=yield in quintal per hectare

RESULTS AND DISCUSSION

Significant differences were observed among field pea genotypes for Aschochyhta bight disease resistance and yieldperformance (Table 1 and 2). The line EH 012019-3 showed lowest mean yield of 6.575c (Table 2) and the line EH 012025-2 showed highest AUDPC of2047.5a (Table 1).The line EH 012020-7 showed the highest mean yield of (21.125a, qt/ha) (Table 2). This line was the most resistant to Aschochyta blight disease among tested pea accessions (Table 1). The last three genotypes showed the highest resistance among those tested to Ascochyta blight fungi. Differences between remaining genotypes for the parameters were smaller.

Ascochyta blight is an important constraint on field pea production worldwide [4]. Infection and disease development depends on primary inoculum and on weather conditions. In this study weassessed responses of selected field pea genotypes to ascochyta blight fungi under field conditions.Among tested genotypes, none were found to possess a high level of resistance to Ascochyta blight, similarly to other reports [7, 8, 23]. Similarly, Kedir [35] reported that considerable variation was found for response against Ascochyta blight diseases and yield performance even if high levels of resistance materials werenot identified and high degree of disease severity was observed at Kofele site. However, some genotypes moderately susceptible were identified. Previously, also reported at Holetta, there are some lines identified as moderately resistant to Ascochyta blight (e.g., IFPI series introduced from Australia) that could be used in the breeding program as source of resistance gene [36]. Pea genotypes of the lowest infection with Aschochyta blight fungi also showed the slowest progress of the disease expressedas relative infection rate.

Our results concerning reduction of yield components are consistent with those previouslyfound by Tivoli *et al*. and Garry *et al*. [3, 26] who found that mycosphaerella blight caused a decrease of number of reproductive nodes per stem, number of pods per stem, as well as number of seed per pod, per stem and reduction in seed size. The highest decrease of yield components was found for treatments with *A. pinodes* and the lowest for treatments with *P. pinodella*. Three pea genotypes among those tested revealed relatively low percentage loss in their seed yield per plant, despite having high disease ratings. This observation supports an earlier report that some cultivars yielded reasonably well under severe disease pressure, while others poorly [8, 37]. Relatively high yielder materials were moderately resistant materials. This finding is in agreement with [35, 36];who reported some high yielder materials were moderately resistance to Ascocayta blight. This illustrates the need to assess the impact of Ascochyta blight on yield in order to identify cultivars that are tolerant to Ascochyta blight. The differences in tolerance may be of practical value.

CONCLUSIONS

Results from present study revealed that considerable variation was found for response against Ascochyta blight diseases even if there were no resistant materials identified.

Out of 11genotypesevaluated; 2 genotypes (18.18%) were showed moderate resistance, 3 genotypes (27.27%) were susceptible and 7 (63.63%) were highly susceptible. This figure shows that field pea for resistance to Aschochyta blight is often limited due to the absence of high levels of resistance gene in the studied genotypes of field pea , which along with the highly variable pathogen, has precluded the development of varieties with both high and durable resistance. The present finding is from one year and Holetta location data. Hence, expanded multi-location and multi-season field trials are essential before varieties are released to farmers to widen the scope of available Ascochyta blight resistant genotypes.

The development of Ascochyta blight disease (severity) depends on the conduciveness of the environment and growing season. Therefore; it is advisable to repeat this trial in multi-location and multi-season to check its disease and yield stability for more confirmation and then to exploit as direct sources to the next stage for general cultivation or may be transferred through hybridization.

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