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Full Length Research Paper

Two *Peziza* taxa (*Peziza proteana* f. *proteana* (Boud.) Seaver and *Peziza proteana* f. *sparassoides* (Boud.) Korf) new to Iraq and bordering countries

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The present study reports two *Peziza* taxa (Pezizaceae/Ascomycota) collected from Al-Alam province in Salahadine Governorate, North Central Iraq, namely, *Peziza proteana* f. *proteana* and *P. proteana* f. *sparassoides*. Both taxa are reported for the first time from Iraq and for the second time from Asia (including countries bordering Iraq). These two forms of *P. proteana* are very similar microscopically but deviate macroscopically and both are very rare in the study area. Habit, habitat, macroscopic and microscopic features and season of fruit body appearance of the two taxa are presented.

Key words: *Peziza*, *Peziza proteana* f. *proteana*, *Peziza proteana* f. *sparassoides*, Iraq.

INTRODUCTION

Peziza Dill. ex Fri., the type genus of the family Pezizaceae (Norman and Egger, 1999), is the largest genus in this family with 80 to 104 macrofungal species (Korf, 1972; Hawksworth et al., 1995; Spooner, 2001; Kirk et al., 2008) that grow on all types of soil (sand, clay or limestone), rotting wood, burnt ground and dung (Petersen, 1985; Hansen et al., 2001; Barseghyan and Wasser, 2011; Beug et al., 2014). This genus is generally characterized by epigeous, sessile or stipitate, cupulate, turbinate, pulvinate or sparassoid apothecia which range in size from a few millimeters to more than 10 cm in diameter (Hansen et al., 2001; Barseghyan and Wasser, 2011). Members of the genus are considered to be saprotrophs but only a few species are claimed to be mycorrhizal (Maia et al., 1996; Hansen et al., 2001; Barseghyan and Wasser, 2011). This taxonomically complex genus has been well studied in Europe and countries of North and South America but has not given similar attention in Africa, Asia and Australia (Barseghyan and Wasser, 2011). Among Pezizaceae taxa, *Peziza proteana* (Boud.) Seaver is the only species in this family that shows both cupulate (or cup shaped) apothecium, formed by the taxon *P. proteana* f. *proteana* (Boud.) Seaver and sparassoid (or cabbage head like) apothecium formed by the taxon *P. proteana* f. *sparassoides* (Boud.) Korf (Korf, 1973; Beug et al., 2014). The term sparassoid is derived from the name of the basidiomycetous genus *Sparassis* (Korf, 1973). No information is available on *P. proteana* from Iraq and its adjacent countries.

Al-Alam province (34°38′41″N43°42′0″/elevation 96 m) of Tikrit district in Salahadin Governorate, North Central Iraq is located on the Tigris River, about 140 km Northwest of Baghdad, the capital of Iraq. This province is rich in vegetation, comprising different tree species (poplar, willow, pine and several fruit tree species) with

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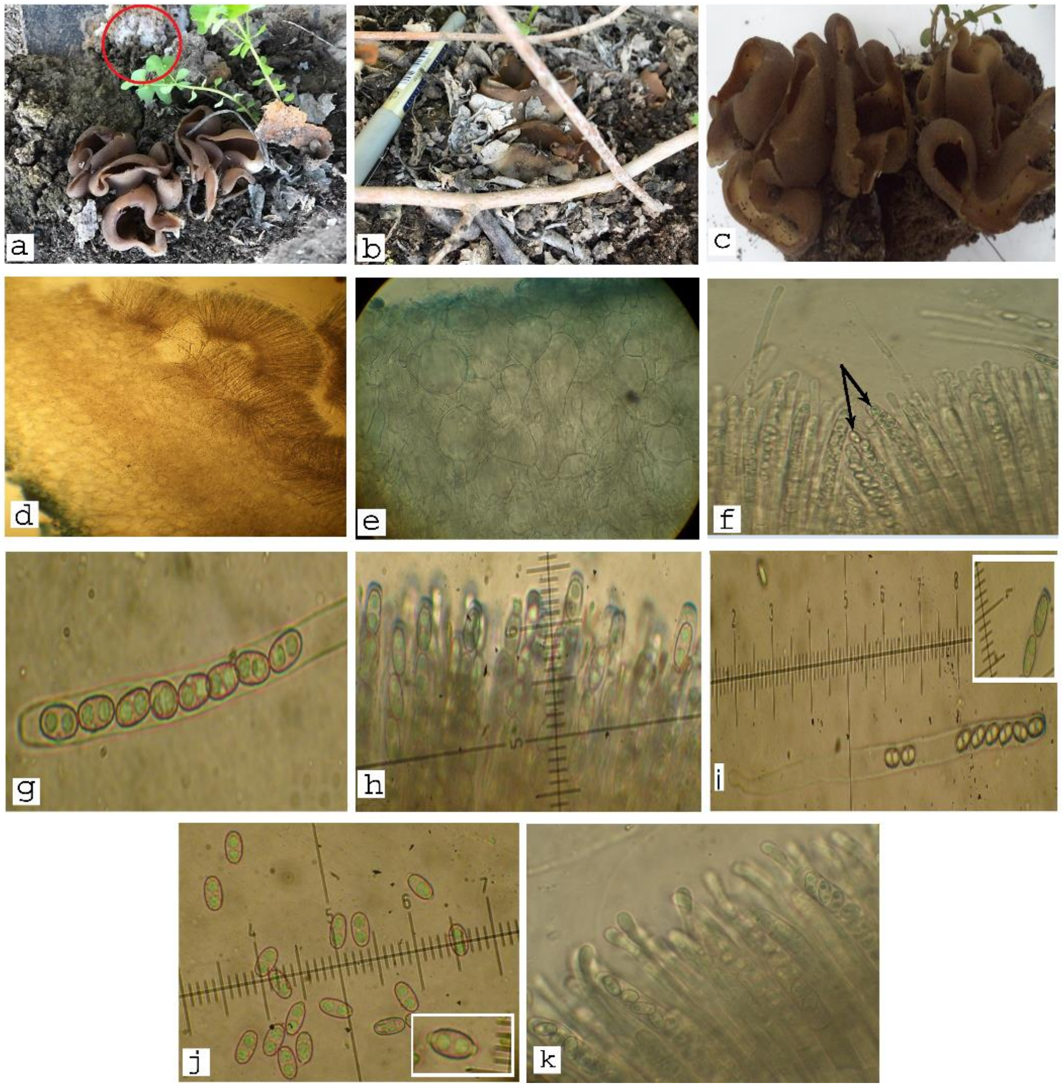

Figure 1. *P. proteana* f. *proteana*. a,b, Fruit body in natural habitat (burnt places). The spsrassoid form (circle) near the cupulate one; c, fruit body general morphology (in lab.); d, hymenium, sub hymenium and excipulum; e, excipulum ectale; f, asci (arrow) and paraphyses; g, ascus (in water); h, I and insert, amyloid asci (note: blue operculum); j and insert, spores (note: spore with nipple-like appendages); k, paraphyses.

many species of shrubs and herbs. The province is expected to harbour a wide variety of macrofungal species. However, Al-Alam area is still unexplored from macrofungal point of view. During field research in this province, two ascomycetous macrofungi samples were collected and identified as *P. proteana* f. *proteana* and *P. proteana* f. *sparassoides*. Both taxa are new to Iraq and bordering countries. In this paper, habit, habitat, macro and microscopic features and season of fruit body appearance of the two *Peziza* taxa are presented.

MATERIALS AND METHODS

Macrofungi samples were collected from different sites within AL-Alam province during March to July, 2017. Habit (solitary, gregarious or other growth forms), habitat (host or substratum), macroscopic (features like fruit body size, shape and color, texture of inner and outer surfaces and flesh color) and microscopic features (like ascus size, shape, no. of spores and staining, paraphyses size and shape, spores size, shape and color) and season of fruit body appearance of the samples were recorded. Samples were photographed in their natural habitat and in the laboratory. Cotton blue in lactophenol, IKI and KOH (10%) were used during the study. Macrofungi samples were identified according to relevant references (Smith, 1975; Hansen et al., 2001; Barseghyan and Wasser, 2007, 2011; Beug et al., 2014; Spooner, 2001). The examined samples were deposited in Department of Biology, College of Education for Pure Sciences, Tikrit University, Iraq.

RESULTS AND DISCUSSION

P. proteana f. *proteana*

Figure 1 shows the macroscopic and microscopic

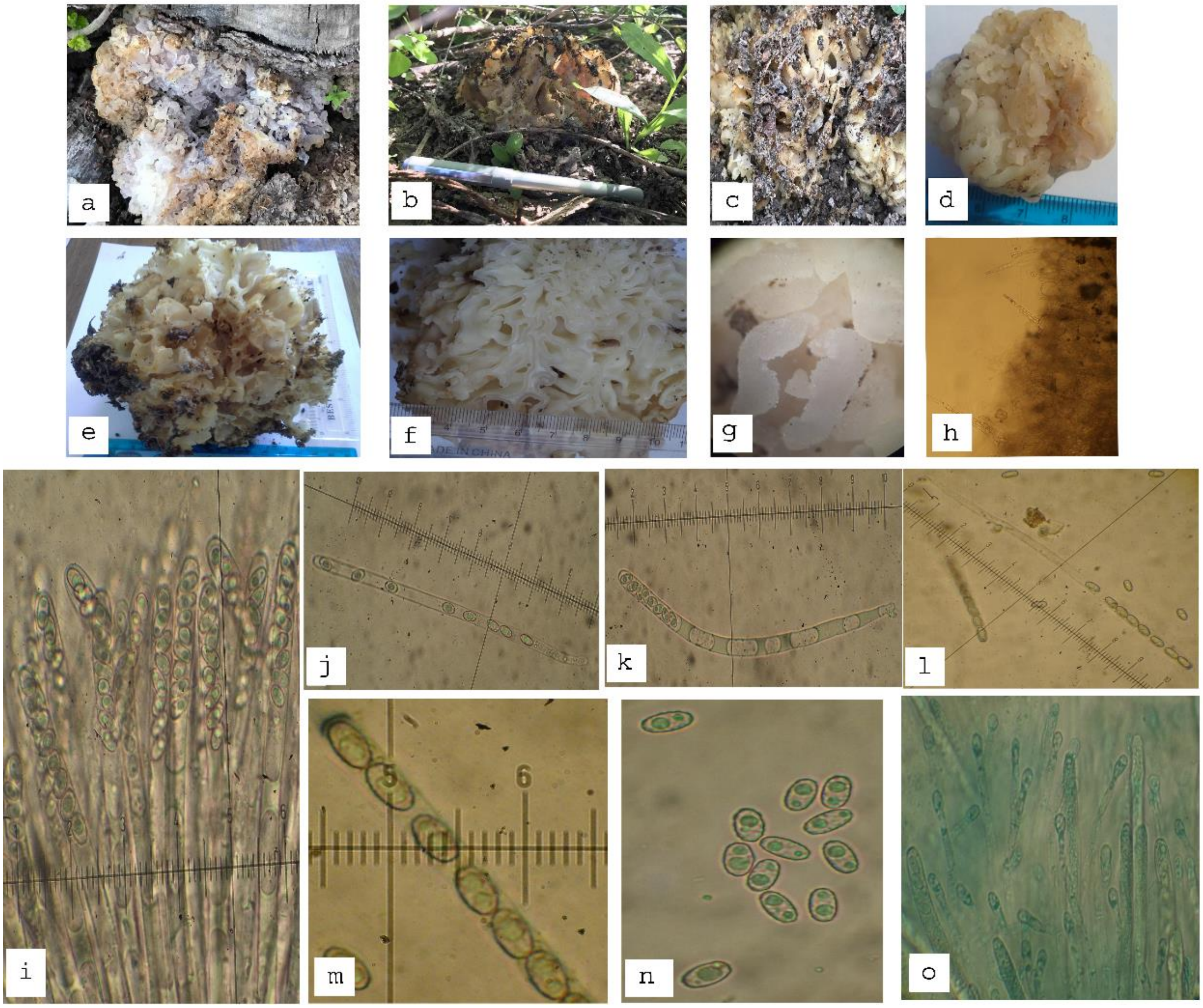

Figure 2. *P. proteana* f. *sparassoides*. a-c, Fruit body in natural habitat; d,e, fruit body general morphology (in lab.); f, sectioned fruit body; g, cups magnified; h, excipulum ectale; i - k, asci (in water); l,m, amyloid asci; n, spores; o, paraphyses.

features as follows:

Macroscopic features: Fruit body 4 to 6 cm across, cup-shaped, expanding with age, sessile; inner surface, concave becoming convex, often umbilicate, white at first, pale lilac or brownish in age; outer surface, white then faintly reddish or lilac; flesh, whitish, thin and brittle.

Microscopic features: Ascospores 10 - 13 × 5 - 7 µm, elliptical, with two oil drops, minutely ornamented with warts when mature, nipples at poles, uniseriate; asci, 220 - 250 × 8 - 10 µm, 8 - spored, cylindric, operculate, amyloid especially around the operculum; paraphyses, cylindrical, sometimes with slightly curved upper part , septate, hyaline, clavate, 5 to 7 µm at the apex. Habit and habitat: Gregarious, both this form and sparassoid form (*P. proteana* f. *sparassoides*) collected together at the same place, under burnt poplar and willow stumps. March to July. North America, uncommon in Europe (Beug et al., 2014).

P. proteana f. *sparassoides*

Figure 2 shows the macroscopic and microscopic features as follows:

Macroscopic features: Fruit body 15 to 40 cm broad, up to 20 cm high, cabbage head-like mass of many small cups lacking stipe; inner surface smooth or wrinkled, individual cups whitish to lilac when young, pinkish tan or brownish in age; outer surface, same color of inner surface, lilac around the base; flesh thin, brittle.

Microscopic features: Ascospores 10 - 13 × 5 - 7 µm, elliptic, minutely ornamented with fine warts at maturity, hyaline, with one or two oil drops, uniseriate, nipples at poles; asci 195 - 300 × 8 - 10 µm, 8 - spored, cylindrical, operculate, amyloid tips especially around operculum; paraphyses clavate, 6 - 8 µm at the apex, 2.5 - 3.0 µm near the base, septate. Microscopically, this form is very similar to the cupulate form but deviates macroscopically. Habit and habitat: Solitary or gregarious under burnt poplar or willow stumps. March to July. Widespread in North America, rare in Europe (Beug et al., 2014), very rare in Asia (Barseghyan and Wasser, 2011). The present paper reports *P. proteana* f. *proteana* and *P. proteana* f. *sparassoides* for the first time from Iraq. The two taxa have not been mentioned in any published information including checklists from countries neighboring Iraq like Iran (Ershad, 2009; Karim et al., 2013), Saudi Arabia (Abou-Zeid and Altalhi, 2006), Syria (John et al., 2004) and Turkey (Sesli and Denchev, 2008; Akata et al., 2014). So the two taxa are reported here as new to these countries. After Barseghyan and Wasser (2011), this is the second report of the two forms of *P. proteana* from Asia. Ecologically, the two fungal forms occur in burnt areas and are independent of the presence of plants (Spooner, 2001; Briffa, 2002; Barseghyan and Wasser, 2007, 2011). However, the two forms are very rare in the study area.

Conclusion

This study reports the two forms of *P. proteana* for the first time from Iraq and for the second time from Asia, including countries neighboring Iraq. The two forms are very similar microscopically but differ macroscopically and both are very rarely observed in the study area. Ecologically, forms of this species occur in burned ground and are independent of the presence of vegetation.

CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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Full Length Research Paper

Farm yield evaluation and demonstration of Melkashola tomato variety in central zone of Tigray Region, Ethiopia

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Low production and productivity of tomato in the study area is due to limited use of agricultural inputs, particularly improved seeds and fertilizers. The practice of tomato seed production in central zone of Tigray is almost negligible. The demand for vegetable seed is increasing from time to time. Though vegetable seed production is difficult, there are attempts and efforts to produce them at local level. Strengthening of community based seed multiplication practice is a means to develop the vegetable seed production techniques and business. In order to bring this to practical, this work was conducted in 2013. Farmers research group (FRG) approach was used to implement the research. In 2013, an average yield of 1.2056 q/ha of tomato seed was recorded.

Key words: Tomato, yield, production, seeds, fertilizers.

INTRODUCTION

Tomatoes are among the vegetables identified in the growth and transformation plan (GTP) as a high value vegetable. Tomatoes in Ethiopia are produced mainly in the northern and central rift valley areas. In recent years, commercial tomato production has significantly expanded since national agricultural strategies began, favoring high value cash crops. The total area of land estimated to be covered by tomato farms in 2011/12 marketing year (MY) is 7,255 ha with an estimated yield of 81,970 MT (11.3 MT/ha). Oromia region contributes the lion's share of Ethiopia's total tomato production (56, 279 MT or 68%) with the remaining production coming from Meki (9%), Tigray (5%) and Somali region (4%). It is estimated that more than 254, 000 farmers are engaged in tomato farming (Quintin et al., 2013).

Export market opportunities and the growing local demand for high quality packed vegetables and fruits have grown. The production of processed fruits and vegetables such as tomato paste and fruit juices for the domestic market and tomato and orange concentrate for export market are viable areas of investment in the country. The daily processing capacities of the privately owned factories range from 1250 to 8000 cans. Currently there are five fruits and vegetables processing plants in

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the country. These plants process limited products, namely; tomato paste, orange marmalade, vegetable soup, frozen vegetables and wine (EFDRE, 2015). The public plant processes about 435 tons per year. One of the privately owned plants is located in North Gondar Zone of Amhara region and the other one is located in Sidama Zone of Southern, Nations, Nationalities and Peoples' Regional State (EIA, 2008).

Melkashola Tomato is an open pollinated variety that is released by Melkassa Agricultural research Center in 1998. It is the most preferable tomato variety by the majority of tomato producing farmers in Ethiopia (Beshir and Boshaiki, 2012).

Tomato seed production and maintenance requires special techniques and facility requirement activities. The technologies so far developed have not successfully reached on time to the users due to lack of seed multiplication and maintenance as well as distribution scheme in the country. Most farmers are forced to depend on unknown sources of seed which in most cases, are low in quality and adaptability (IAR, 1998).

The seed supply of this crop is not as sufficient as required by the small scale farmers. Most of seeds available in the market are poor in germination and/or uniformity. In the last few years, seed production research has been conducted to identify the production potential of various vegetable cultivars in different agro-climatic regions of the country; some promising results have been obtained. The seeds should be extracted at appropriate time for higher yield and better quality and it must be dried carefully and immediately by maintaining the genetic purity and raising high quality seed through screening and selecting superior tomato cultivars (IAR, 1998).

Tomato seed production has various advantages. Seed producing farmers will be able to increase their own income from unit area of land. The demand of seed in Ethiopia in general and Tigray region in particular is increasing from time to time. Especially in our region, Tigray, there is a remarkable increase in vegetable production as a result of the increased construction of diversions, dams, springs and increased awareness of farmers in horticultural crop production as a means of alleviating poverty as they have high production potential per unit area. And all this necessitates an opportunity for domestic seed production. Therefore, the domestic seed production has advantages over the imported seed, save hard currency for imported seed. Farmers can get seed with low price and reduce risk of unknown pests and diseases, higher adaptability performance and germination percentages. Therefore, it is important to encourage domestic seed production.

However, tomato seed production need a special field treatment and requires more detailed attention and handling as compared to field crops. It is generally influenced by environmental factor such as temperature, light and variety type and in addition to this, farmers have lack of awareness on seed production techniques. Hence, in areas where there is a potential of tomato production like in our mandate areas, production of tomato seed techniques is very important. Therefore, the objective of this project was to familiarize and demonstrate tomato seed production techniques.

Objectives

1. To evaluate yield performance of Melkashola tomato variety in farmer field.
2. To train farmers on tomato seed extraction techniques in the study area

MATERIALS AND METHODS

Site description

The demonstration was conducted in Tanqua-Abergelle woreda at Shekatekli irrigation scheme. Abergelle is situated in the central zone of the region which is about 120 km from Mekelle, the administrative city of Tigray. It is located 13°14'06"N latitude and 38°58'50"E longitude. It is agro-ecologically characterized as hot to warm sub-moist low land below 1500 m.a.s.l. The mean annual rain fall and temperature is 350 to 700 mm and 24-41°C respectively. The rain fall is erratic and unproductive nature.

Farmers research group establishment

This demonstration was carried out through the participation of farmers. Farmers Research Group (FRG) was established based on interest and willingness of the farmers to adopt new technologies as they may be doubtful for new things unless they participated in working with adaptation of the technology. The tomato variety known as Melkashola is used for this demonstration work. This variety provided 261 Qt/ha fruit yield in adaptation trail conducted by Abergelle Agricultural Research Center in 2009/2010 and 2010/2011 cropping seasons. The seed multiplication was demonstrated in four farmers land in total area of 0.04 ha. Vegetable producing farmers in the study area participated in the monitoring and support and evaluated the yield performance. Not only this but also, training was given to the farmers to make clear understanding on how to grow and produce vegetable seed particularly tomato.

Plant establishment and fermentation process

In nursery site, the seeds were planted in well prepared seed bed and the seed beds were covered or mulched with grass. Application of 92 g/bed P_2O_5 during sowing and 82 g/bed nitrogen during first hoeing of nursery was provided. After 48 days of planting, healthy and vigorous seedlings were transplanted to the field. The spacing between plants and rows was maintained 30 and 80 cm, respectively. After transplanting 200 kg/ha DAP and 100 kg/urea were applied. All of DAP and half of urea were applied during transplanting and half urea were 42 days of transplanting. This demonstration was carried out through the participation of farmers at Sheka Tekli irrigation scheme.

The crop was harvested at the "dead-ripe" stage when the fruit developed full color. In selecting fruit for seed, true-to-type fruits based on typical color, shape, size and internal fruit characteristics

Figure 1. Growth performance of Melkashola Variety at Sheka Tekli irrigation scheme.

Table 1. Days to maturity, total fruit and seed yield of tomato during demonstration.

Plot	Variety	Days to maturity	total yield (Qt/ha)	Seed yield (kg/ha)
1	Melkashola	115	499	125
2	Melkashola	115	500	130.2
3	Melkashola	115	510	127
4	Melkashola	110	494.85	121
5	Melkashola	122	497.9	99.6
	Mean	115.40	500.35	120.56

were considered. In other words, fruits which were off-type, bruised, misshapen, or diseased fruit were removed before the start of seed extraction. During seed processing, the seeds which show undesirable characteristic were removed. The tomato seed were extracted by the most preferred method (fermentation) which is a natural process that is least harmful to the seed and can destroy bacterial canker and other seed-borne diseases. The harvested fruit was break into pulp, seeds, and juice and then the mixture was poured (“mash”) into a large bucket then fermented for three days. The bucket was stirred three times a day to facilitate fermentation process and to prevent the buildup of fungus. After fermentation is complete the seed is separated by washing, the seed was dried. Though the process is quite simple, there are some important details for performing the process properly.

Data collected

In this demonstration, the phenology parameter of maturity date was recorded to train farmers for planned use of land. Total fruit and seed yield per hectare were also recorded to clearly understand the yield performance of the variety at farmers’ level. The days to maturity of the variety were taken from the entire plot observation of each farmers plot and the mean value was taken. Similarly, the fruit and seed yield performance of the variety was collected in a quadrant. The data were taken in the middle rows of size 3 x 3.5 m between plant and row directions, respectively.

RESULTS AND DISCUSSION

Days to maturity, total fruit and seed yield

The growth and yield performance of Melkashola variety was observed by tomato producing farmers of the study area (Figure 1). As indicated in Table 1, Sheka Tekli irrigation scheme showed high maturity and yield potential of the studied tomato variety (Melkashola).

A day to maturity is the day in which the variety is 80% matured and ready for harvest. Total yield is the yield gain from any commodity both marketable and unmarketable yields (Table 1). In this demonstration, the Melkashola tomato variety matured in 115.40 days. Similarly, Regassa et al. (2012) indicated that Melkashola tomato variety can mature after 100-120 days of transplanting. Supporting this suggestion, Shushay and Haile (2014) also found that Melkashola matured in 117 days of transplanting. According to Beshir et al. (2009), Melkashola tomato variety can be matured in 100-120 days of transplanting.

The mean total fruit and seed yield obtained was 500.35 and 1.3 Qt/ha, respectively. This fruit yield is 134.45 Qt/ha more than the fruit yield obtained by Shushay and Haile (2014) which was about 335.9 Qt/ha in Humera district. The highest yield obtained in Abergelle district might be due to suitability of environmental conditions (soil and climate) of the area than Humera district. The variety might express its potential yield when the growing conditions are suitable. Yemane (2016) reported that the seed yield of Melkashola tomato variety ranges from 1 to 1.2 Qt/ha. Therefore, the seed yield obtained in this study provided the maximum yield that can be obtained and seed yield and fruit yield are positively related. Melkassa Agricultural research center also reported that the variety has the potential to produce 430 Qt/ha of fruit yield on research farms.

CONCLUSION AND RECOMMENDATION

In this demonstration, improved tomato Melkashola variety that was selected in previous adaptation trail as better performing variety, was used. The variety provided better performance on fruit and seed yield parameters. Therefore, research on other agronomic practices such as fertilizer rate, spacing and irrigation frequency should be conducted to increase yield.

CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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Full Length Research Paper

Survey of faba bean (*Vicia faba* L.) diseases in major faba bean growing districts of North Gondar

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Field survey was done in North Gondar during 2014/2015 and 2015/2016 cropping seasons with the objective of, assessing the importance of faba bean diseases. Disease severity varied across and within districts. Chocolate spot (*Botrytis fabae*), gall-forming (*Olpidium viciae*), rust (*Uromyces fabae*) and aschochyta blight (*Aschochyta fabae*) were the most dominate and frequently occurring diseases of faba bean. The highest mean severity of chocolate spot (43%) and rust (36%) were recorded at Takusa district whereas the highest mean severity (42%) of gall-forming disease was recorded at Debark district. The association of independent variables with faba bean disease varied among themselves. Variables such as year, altitude, growth stage of the crop and crop conditions were significantly associated with the chocolate spot, gall-forming, and rust diseases. Chocolate spot, gall-forming, and aschochyta blight diseases severity was higher in surveyed fields with an altitude greater than 2,700 m above sea level (masl). However, rust severity was higher in areas with an elevation below 2,200 m.a.s.l. Among growth stages, the highest disease severity of chocolate spot, rust, and aschochyta blight was recorded on fields during the flowering stage. Therefore, integrated disease management options should be developed for the future for those major diseases of faba bean.

Key words: Aschochyta blight, chocolate spot, gall-forming disease, severity, rust.

INTRODUCTION

Faba bean (*Vicia faba* L.) is a grain legume grown worldwide both for human food and animal feed. In addition to its high nutritive value, both in terms of energy and protein contents (24 to 30%), this plant is an excellent nitrogen fixer (Ali et al., 2014; Sahile et al., 2008a; Jensen et al., 2010). It has been produced for centuries in Ethiopia and provides the much needed protein supplement to the diet of rural households. It also plays an important role in the socio-economic life of farming communities and a source of foreign currency to the country (Abebe et al., 2014, Agegnehu and Fessehaie, 2006; Keneni and Jarso, 2002).

Ethiopia is considered as, the secondary center of diversity and also one of the nine major agro-geographical production regions of faba bean (Hailu et al., 2014). The primary producers of pulses are small-

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scale farmers with small and dispersed plots under rain-fed conditions, with substantially lower yields compared to the improved faba bean varieties and international yields (Haile et al., 2016). The crop occupies the largest areas among legumes next to chickpea with an average productivity of 1.67 t/ha under farmers conditions (CSA, 2015). In spite of its huge importance, the productivity of faba bean in Ethiopia remains far below the crop's potential (> 3 t/ha). The major constraints, that limit the realization of full yield potential of faba bean and cause instability in yield, in different parts of the country are both abiotic and biotic constraints (Agegnehu et al., 2006; Agegnehu and Fessehaie, 2006; Sahile et al., 2008b; Shifa et al., 2011).

Diseases are among the most important biotic factors, causing faba bean yield reduction. More than 17 pathogens have been reported so far on faba bean, from different parts of the country and the most important yield limiting diseases are chocolate spot (*Botrytis fabae*), rust (*Uromyces vicia-fabae*), black rot (*Fusarium solani*), aschochyta blight (*Ascochyta fabae*) and faba bean necrotic yellow virus (FBNYV) (Dereje and Tesfaye, 1994).

Nowadays, these crop is threatening by new gall-forming disease (*Olpidium* spp) with typical symptoms of, green and sunken on the upper side of the leaf, bulged at the back side of the leaf and finally develops light brownish color lesion, chlorotic galls which progressively broaden to become uneven circular or elliptical spots (Hailu et al., 2014). Survey data are useful for gaining insights into the occurrence, distribution and relative importance of different crop diseases (Rusuka et al., 1997; Sahile, et al., 2008b). Therefore, the present study was done with an objective of assessing important faba bean diseases in North Gondar administrative zone of Amhara Region.

MATERIALS AND METHODS

Description of the study area

Field survey was conducted in the main cropping season of 2014/15 and 2015/16 on the major faba bean growing areas of North Gondar. North Gondar is bordered on the South by Lake Tana, West Gojjam, Agew Awi and the Benishangul-Gumuz Region, on the West by Sudan, on the North by the Tigray Region, on the East by Wag Himra and on the southeast by South Gondar.

The altitude of the study area ranged from 1,711 to 3,151 m.a.s.l. Hence, we classified the surveyed districts into three categories; less than 2,200 m.a.s.l, 2,200 m.a.s.l to 2,700 m.a.s.l and greater than 2,700 m.a.s.l.

Survey of faba bean diseases in north Gondar

About 76 farmer's fields were assessed in major faba bean, producing districts in every 5 to 10 km interval along the road ride, to examine faba bean diseases. Diseases severity was recorded by examining visually the whole plants, using percent leaf area affected.

The SAS procedures GENMOD and logistic were used. The importance of the independent variables was evaluated in two ways. First, the association of an independent variable alone with faba bean diseases was examined. Then, independent variables with high association to faba bean diseases were added to reduced multiple variable model. Finally, the likelihood ratio test was used to examine the importance of the variable.

RESULTS AND DISCUSSION

The relative importance of aerial fungal diseases varied among districts. Chocolate spot (*Botrytis fabae*), gall-forming (*Olpidium viciae*), rust (*Uromyces fabae*) and aschochyta blight (*Aschochyta fabae*) were the most dominate and frequently occurring diseases of faba bean, during the two-year survey across districts of N. Gondar administrative zone, Ethiopia. Among the four diseases, chocolate spot, gall-forming disease and rust were the most prevalent diseases compared to aschochyta blight (Figure 1). Likewise, Abebe et al. (2014) reported the importance of those diseases in South Tigray.

Chocolate spot mean severity which ranged from 17.5 to 43.33%, was recorded across surveyed districts. However, the lowest mean severity of the chocolate spot was recorded at Dembia district. In agreement with this finding, it was reported that Debark and Gondar zuria were among the districts where the highest severity of chocolate spot was recorded (Sahile et al., 2008b).

Gall-forming disease had the highest mean severity (42.14%) at Debark district compared to others districts. This agrees with the report of Hailu et al. (2014), who reported gall disease severity related to altitude. Similarly it was reported that, the disease was more important on an elevation between 2,400 and 3,400 m.a.s.l (Li-Juan et al., 1993 and Abebe et al., 2014). This showed that the distribution and severity of the disease were high at higher altitude. However, the disease was widely disseminated in the country and caused an epidemic in short period of time. Thus far, the mechanism of introduction of the disease into the country and its transmission is not known (Hailu et al., 2014). On the other hand, the highest aschochyta severity of 13.61% was recorded at Dabat district. Moreover, rust with the severity of 32.86 and 36.67% was recorded at Gondar zuria and Takusa district, respectively (Figure 1).

The diseases severity may be influenced by certain farming systems, field location and/or season. Hence, the association of independent variables with faba bean diseases varied among themselves. Variables such as year, altitude, growth stage of the crop and crop conditions were significantly associated with the chocolate spot, gall-forming, and rust diseases. However, with the exception of crop conditions, independent variables; year, altitude and growth stage of the crop had a significant association with aschochyta severity (Table 1).

All variables were tested in reduced multiple variable model for the chocolate spot, gall-forming disease, and rust. However, only year, altitude and growth stage of the

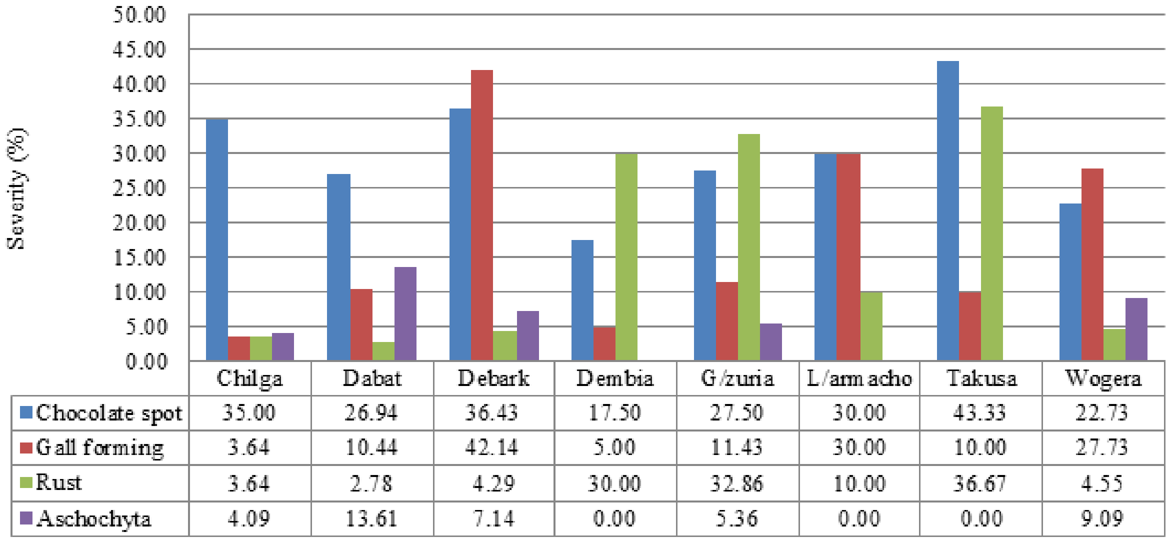

Figure 1. Two years combined mean severity of faba bean disease across districts.

Table 1. Association of independent variables with the faba bean diseases severity.

Source	**Chocolate spot (*B. fabae*)**	**Gall-forming disease (*Olpidium viciae*)**	**Rust (*Uromyces viciae-fabae*)**	**Aschochyta blight (*A. fabae*)**
	Pr > ChiSq	**Pr > ChiSq**	**Pr > ChiSq**	**Pr > ChiSq**
Year	<0.0001	0.0002	<0.0001	<0.0001
Altitude	0.0087	<0.0001	<0.0001	<0.0001
Growth stage	<0.0001	0.0053	<0.0001	<0.0001
Crop condition	<0.0001	0.0013	<0.0001	0.2634

crop was tested in reduced model for aschochyta blight, since crop condition doesn't have association with the disease. High chocolate spot, gall-forming, and aschochyta blight severity were recorded in 2014 cropping season and this might arise from the favorable climatic conditions in the first growing season. In addition to this, chocolate spot, gall-forming, and aschochyta blight disease severity were higher in surveyed fields, with an altitude greater than 2,700 m.a.s.l. In line with this, Sahile et al. (2008b) reported that, the combined effect of year and altitude had a significant effect on chocolate spot development. Gall-forming disease severity was higher on those fields with vegetative state of faba bean, having poor crop conditions and especially in the first season of the survey. Similarly, it was reported that, chocolate spot disease severity was relatively higher above 2500 m.a.s.l. This suggests that, the relatively moist climate at mid and higher altitudes is more favorable for the disease development (Assefa and Gorfu, 1985; Sahile et al., 2008b).

Among growth stage, the highest disease severity of chocolate spot, rust, and aschochyta blight was recorded on fields during the flowering stage. Similarly, it was reported that significant variation in a chocolate spot at flowering, pre-podding and podding stages of faba bean with the highest severity was at flowering (Sahile et al., 2008b). Stoddard et al. (2010) reported that, the most important damage by chocolate spot usually occurs when plants are at flowering stage, since this is when the environmental conditions are often more conducive to disease development, decaying flower petals become more available for the growth of fungus and yield reductions, which may be serious due to spread of the pathogen from the flowers into the developing pods.

Rust severity was higher at flowering and in an areas with an elevation below 2,200 m.a.s.l (Table 2). According to Nigussie et al. (2008), faba bean rust has no significant effect in the highland areas of Ethiopia. Likewise, it was reported that, rust was relatively higher below 2,450 m.a.s.l due to the relative humidity and warm climate that favors the disease development (Dereje and Tesfaye, 1994; Hassen et al., 2011). In agreement with this, Stoddard et al. (2010) reported that rust is favored by warm temperatures (17 to 22°C) and cloudy weather conditions. Overall, the importance and distribution of diseases varied as a result of climatic change and other

Table 2. Analysis of odds ratios of added variables in a reduced model to predict Faba bean disease severity.

Variable	Variable class	Chocolate spot	Gall-forming	Rust	Aschochyta
		Odds ratio	Odds ratio	Odds ratio	Odds ratio
Year	2014	14.88	1785028110	88378980397	0.58
	2015	1	1	1	1
Altitude	<2200	0.82	0.12	7.45	0.43
	2200-2700	0.89	0.31	0.79	0.83
	>2700	1	1	1	1
Growth stage	Full podding	1.15E+09	6.66E-10	0.09	2.33
	Podding	1.77E+09	6.40E-10	0.03	2.51
	Mature	8.5E+08	7.67E-10	0.15	3.99
	Flowering	3.19E+09	0.54	192267848	3.68E+10
Crop condition	Excellent	1.50	0.80	4.05	NS
	Good	1.35	0.77	1.35	NS
	Poor	1	1	1	NS

*NS means there is no significant association.

bio-physical phenomenon.

Chocolate spot, gall-forming and rust diseases were the most prevalent diseases in surveyed districts, with the highest mean severity of 43, 42, and 36%, respectively. On the other hand, chocolate spot and gall-forming diseases were important in areas with higher altitude, compared to rust. Finally, integrated management options should be developed for the future for those major diseases of faba bean in, north Gondar.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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