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Evaluation of Faba Bean (Vicia Faba) Varieties Against Chocolate Spot (Botrytis Fabae) Disease in East Gojjam Zone, Ethiopia

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Abstract
Though, faba bean has an important place in Ethiopian national dietary and is consumed in various forms, the average yield of faba bean is very low. Its production is severely challenged by biotic factors. Chocholet spot (Botrytis fabae) is major biotic factor that reduced faba been grain yield. Thus, this study was designed to evaluate and screen faba bean varieties against this disease at farmers' fields of major faba bean growing area of East Gojjam zonen in Gozamin, Sinan and Debay Tilatgen Districts. The field study was conducted with seventeen faba bean varieties of one local control and sixteen released varieties in Complete Randomized Block Design replicated three times. The reaction of faba been varieties to B. fabae was significant (P<0.001). B. fabae was prevalent in all experimental fields posing a significant yield loss with their highest and least severity was recorded at Gebelecho and Dosha varieties, respectively when comparing to the local control. The area under disease progress curve was significant (P<0.001). Yield and yield parameters were significantly (P<0.001) different in all locations. In general Dosha, Tumsa, Wolki and Hachalu varieties were high yielder and resistant to B. fabae in all localities. Therefore in the future, in the study areas, the farmers should plant among these four varieties which are high yielder and resistant to B. fabae.
Keywords: Chocholet spot, Dosha, Tumsa, and Wolki

1. INTRODUCTION

Faba bean (*Vicia faba* L.) also referred to as broad bean, horse bean and sometimes field bean occupies nearly 3.2 million hectare worldwide (Torres *et al*., 2006). In Ethiopia, faba bean is grown in the highlands (1800-3000 m.a.s.l) where the need for cold temperature is met (Yohannes, 2000). It is believed that the crop was introduced to Ethiopia from the Middle East via Egypt around 5000 B.C., immediately after domestication (Asfaw *et al.*, 1994).

Currently, in Ethiopia the area devoted to faba bean production is 427696.8 ha and from which 8780108.79 qt yield has been encountered (CSA, 2016). Faba bean has an important place in the Ethiopia national dietary and is consumed in various forms. In other parts of the world, the green immature beans are boiled and eaten as vegetable. The mature seeds may be used for feeding livestock such as swine, equine, and poultry while stalks or haulms may be used as feed for other animals. The stalks are also used as firewood for cooking. The contribution of faba bean in improving soil fertility is well documented. The crop can be grown for green manure and silage. Production in Ethiopia is totally rain-fed on nitosols and cambisol type of soils (Gemechu and Mussa, 2002). In spite of huge importance, the productivity of Faba bean in Ethiopia remains far below the crop's potential greater than 3 ton/ha (Gedeyon, 2017). Amhara and Oromiya are the two major pulse-producing regions in Ethiopia. The Amhara Region has the largest pulse area (43.7%) and contributes to the highest production (47%) in the country followed by Oromiya Region that has 38% of the area and contributes 39% to national production (CSA, 2007).

The average yield of faba bean under small-holder farmers is not more than 2 t ha-1 (CSA; 2016), despite the availability of high yielding varieties (> 3 t/ha) (Gedion, 2017). The low productivity of the crop is attributed to susceptibility to biotic and abiotic stresses (Sahile *et al*; 2008 and Mussa *et al*; 2008). From the biotic category, diseases are important factors limiting the production of food-legume crops as a whole and faba bean specifically in Ethiopia (Nigussie *et al* 2008). More diseases are affecting faba bean, but only a few of them have either major or intermediate economic significance. Among these, fungi are the largest and perhaps the most important groups affecting all parts of the plant at all stages of growth great importance to faba bean (Nigussie *et al* 2008). Diseases such as chocolate spot (*Botrytis fabae* Sard.), rust (*Uromyces Vicia fabae*), black root rot (*Fusarium solani*), and foot rot (*Fusarium avenaceum*) are among fungal groups that contributes to the low productivity of the crop (Nigussie *et al* 2008).

Chocolate leaf spot disease of faba bean caused by *Botrytis fabae* is the most widespread and destructive disease in Ethiopia with yield reductions of up to 61% on susceptible cultivars (Dereje and Beniwal, 1987). Chocolate spot initially appears as reddish brown spots on leaves, which enlarge and even merge and subsequently lead to sever premature defoliation. Under favourable conditions, it appears on stems, flowers and pods, and this directly affect seed production.

Currently, attempts to control faba bean diseases including *Botrytis fabae* are fundamentally based on plant and environmental management, and synthetic fungicides. Though cultural management options such as altering planting date, crop rotation, and application of potash fertilizer and ditching to improve drainage were employed to lessen complex diseases, the practices were not effective to reduce chocolate spot disease (Xung-yi, 1989).

In addition, chemical control and other preventive measures such as deep ploughing, destruction of plant debris at the end of the season, the avoidance of sites recently used for faba bean crops have proved impractical, because of widespread fungicide resistance pathogens. *B. fabae* and *B.cinerea* were resistance to the benzimidazoles and the dicarboximides (Rhaïem, 2002).

Furthermore, the high cost of pesticides, and other social and health related impacts of conventional agriculture on the environment have, however, recently led to an increased interest in agricultural sustainability and biodiversity conservation (Van der vossen, 2005). Thus, there is a need for alternative plant disease management options that provide effective management of the disease under question while minimizing cost and negative consequences to human health and the environment (Cook *et al.,* 1996; Muleta, 2007). The use of resistant cultivars is widely recognized as the safest, most economical and most effective method for protecting crops from disease (Johnson and Jellis, 1992). The use of resistant cultivars remains the major means to reduce yield losses (Rhaïem, 2002). However, in Ethiopia particularly in Amhara region scanty of information available or no attempts made in the past to identify useful resistance faba bean genotypes against complex fababean diseases. Therefore, the present study was designed to evaluate and screen out different fababean varieties against *Botrytis fabae* disease at farmer's fields of major fababean growing area of East Gojjam zone Ethiopia.

2. MATERIAL AND METHODS

2.1 Description of the Study Areas

The experiment was conducted in Gozamina, Sinan and Debay Tilatgen districts of Eastern Gojjam zone, Amhara regional state Ethiopia. Gozamen District is found an attitude of 2450 meter above sea level. Its annual maximum and minimum temperature and rain fall is 25^0c-11^0c and 1628mm, respectively Whereas, Sinan and Debay Tilatgen Districts are found an altitude of 3000 and 2400 meter above sea level respectively and annual maximum and minimum rain fall is 1200-900 mm and 800-1050 mm respectively. Annual maximum and minimum temperature of Debay Tilatgen District is 10-15^oc (Gashe *et al*, 2017).

2.2 Experimental Design

The experiment was laid out in Randomized Complete Block Design (RCBD) under field condition with three replications in Gozamin, Sinan and Debay Tiltgen districts where faba bean is a major cash crop and prevalence of chocolate leaf spot disease. The experiment was tasted in naturally infected areas by *B. fabae* pathogen using released and local check at each district. A recommended plant spacing of 0.4m between rows and 0.1 m between plants was used. The size of each plot was 2 m long and 2 m wide (4 m^2) with a total of five rows, data was taken from 3 central rows. To reduce the inter plot effect, the blocks was separated by a space of 1.5 m and plots was separated by a distance of 1m. All necessary agronomic practices were done as required.

2.3 Experimental Materials and Treatments

In the present study, the following treatments were used under field condition. All varieties other than the local check were collected from Holeta Agricultural Research Center (Table 1). However, the local check was collected from each district inhabitant small scale farmers.

Table1. Released fababean varieties with their agronomic and morphological characteristics

no	Variety name	Year of released	Days to maturity	Yield on farm (kg/ha)	Altitude (m.a.s.l)
1	Wayu	2002	132-145	1000-2300	2100-2700
2	CS20DK	1977	118-132	1500-3500	2300-3000
3	KUSE 2-27-33	1979	135-150	1500-2500	2300-3000
4	Degaga	2002	116-135	2000-4500	1800-3000
5	Bulga 70	1994	143-150	1500-3500	2300-3000
6	Salale	2002	134-146	1800-3200	2100-2700
7	Hachalu	2010	122-156	2400-3500	1800-3000
8	Holeta-2	2001	140-150	1500-3500	-
9	Walki	2007	133-146	2400-5200	1800-3000
10	Adet-Hana	2005	-	-	
11	Moti	2006	108-165	2300-3500	1800-3000
12	Gebelcho	2006	103-167	2000-3000	2300-3000
13	Obse	2007	87-166	2100-3500	1800-3000
14	Dosha	2009	120-130	2300-3900	1800-3000
15	Tumsa	2010	121-176	2000-3800	1800-3000
16	Gora	2013	126-168	2000-4000	1800-3000
17	local	-	-	-	

2.4 Data collected

2.4.1 Disease Data-

Disease severity: was assessed on ten days interval from **12** faba bean crop plants per plot and four plants per row were randomly tagged for data collection. The disease severity index was recorded using a 0–9 scale to determine area of affected plant part according to Ding *et al.* (1993). Percent Disease severity (% Ds) = $100\frac{(V+3w+5x+7y+9z)}{9\,(\text{highest rating value})\,(v+w+x+y+z)}$

Where U = number of plants in class 0, V = number of plants in class 1, W = number of plants in class 3, X = number of plants in class 5, Y= number of plants in class 9, z = number of plants in class 9. The response of the varieties was expressed as the DSI values according to Ding *et al*. (1993). Six resistance levels was used: HR (highly Resistant), DSI ranging between 0 and 2.0; R (Resistant), DSI =2.1–15.0; MR (Moderately Resistant), DSI =15.1–40.0; MS (Moderately Susceptible), DSI =40.1–60.0; S (susceptible), DSI =60.1–80.0; HS (Highly Susceptible), DSI =80.1–100.

The area under the disease progress curve (AUDPC): was calculated from disease severity index as the following formula.

$$AUDPC = \sum_{i=1}^{n} [0.5(x_i + x_{i+1})(t_{i+1} - t_i)]$$

Where: X_i=the cumulative disease severity expressed as a proportion at the i^{th} observation

t_i= time of the i^{th} assessment, n= the total number of observation.

2.4.2. Faba bean growth and yield parameters

Plant height; plant height at maturity was measured from the central three rows pre-tagged plants

Number of pods per plant: number of pods per plant was recorded from **12** pre tagged plants at harvest

Number of seeds per pod: number of seeds per pod was recorded from 12 pre tagged plants. From each plant 10 pods shelled to find out number of seeds

Yield qt/ha: yield per plot was collected from the harvested plots and then converted into qt/ha

2.5 Data analysis

The collected data was subjected to ANOVA to determine the treatment effects. AUDPC and Disease progress (rate) for each treatment was evaluated from disease severity values. The severity grades were converted into percentage severity index using the formula stated above. Duncan's multiple range (DMRT) value was used to separate the treatment means.

3. RESULTS AND DISCUSSION

3.1 Faba bean varieties and Chocolate spot Disease severity under field conditions

The present field experiment result revealed that chocolate spot disease severity was significantly different ($P \leq 0.001$) among the tested varieties in all three experimental locations (Table 2). However, the intensity of Chocolate spot disease was varying within the experimental field and across the three experimental locations

(Table 2). The observed differences in the severity of *B. fabea* in the areas could be existence of variations in the genetic makeup of faba bean (nature of resistance) and aggressiveness of the pathogen among experimental fields and locations; and environmental conditions such as temperature and water (rainfall) might be varied which gives opportunity for the growth and spread of conidia.

The least Chocolate spot disease severity was recorded from Dosha (10.49%, 11.35%, 11.41%), Tumsa (10.49 %, 13.00%, 14.15%), Walki (10.49%, 13.31%, 14.58%) and Hachalu (10.8 %, 13.33%, 14.58%) varieties at Sinan, Gozamin and Debay Tilatgen districts, respectively. This result is in agreement with the findings of Mekuria and Ashenafi (2015) who reported that the lowest disease severity was recorded from Tumsa, Wolki and Shallo varieties, that is, 11.85, 11.79 and 13.58% at Sinana District and 20.05, 19.81 and 21.6%, respectively at Agarfa District. However, the highest Chocolate spot disease severity was encountered on Gebelecho (23.69%, 20.38%, 11.16%) variety at Debay Tilatgen, Gozamin and Sinan districts, respectively when comparing to all varieties including local check (Table 2). Mekuria and Ashenafi, (2015) similarly reported that maximum disease severity was recorded from Degaga and Gebelcho varieties, that is, 22.16 and 22.1% at Sinana district, and 35.11 and 28.33% at Agarfa District, respectively.

Table 2. Severity index (PSI) of Chocolate leaf spot disease on Faba bean varieties in Eastern Gojjam localities under field conditions

Variety	Percent severity index				
	Gozamen	Sinan	Debaytilatgen	Mean	Disease reaction
Adet hana	16.19cd	10.8ab	15.43gh	14.14	R
Local	18.66b	11.11ab	20.75b	16.84	MR
Tesfa	16.51c	10.95ab	14.69hi	14.05	R
Walki	13.31g	10.49b	14.58hi	12.79	R
Dosha	11.35h	10.49b	11.41j	11.08	R
Obse	13.52fg	10.95ab	15.89f-h	13.45	R
Bulga70	14.59ef	10.74ab	15.75gh	13.69	R
NC-58	16cd	10.74ab	16.96ef	14.57	MR
Kasa	15.53c-e	10.8ab	18.69cd	15.01	MR
Mesay	15.33de	10.74ab	18.76cd	14.94	MR
Gora	17.99b	11.41a	19.91bc	16.44	MR
Gebelecho	20.38a	11.16ab	23.69a	18.41	MR
CS20DK	13.52fg	10.8ab	17.85de	14.06	R
Moti	16.19cd	10.86ab	19.58bc	15.54	MR
Degaga	16.53c	10.8ab	16.71e-g	14.68	MR
Tumsa	13.00g	10.49b	14.15i	12.55	R
Hachalu	13.33g	10.8ab	14.58hi	12.90	R
CV	3.97	4.11	4.74	4.27	

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) is the coefficient of variation MR= moderately resistance

Dosha, Tumsa, walki, Hachalu, Tesfa, CS20DK, Degaga, Adet Hana and obse varieties revealed resistance (R) to Chocolate spot disease severity. The least mean disease severity (11.08%) was encountered on Dosha variety followed by *Tumsa* (12.55%), walki (12.79%) and Hachalu (13.90%) varieties compared to the local control with Chocolate spot disease severity (16.84%) across in the three districts (Table 2). Nevertheless, the present study revealed that Gora, Gebelecho, Degaga, Moti, Kasa and local check varieties were moderately resistant (MR) to Chocolate spot disease.

3.2 Effects of Faba bean varieties on Progression of Chocolate spot severity

The total Area under Disease Progress Curve (AUDPC) was calculated from the Chocolate spot disease severity for 3 months revealed that varieties had significant ($p<0.0001$) effect on progress of Chocolate spot under small scale farmers' field conditions.

The least AUDPC was recorded from Dosha variety with the mean AUDPC of 206.40, 253.48 and 174.22 in Sinan, Gozamin and Debay Tilatgen Districts, respectively, compared to the local check and other varieties. Although the different varieties gave a significant effect on reducing the Chocolate spot disease progression, the highest AUDPC was obtained from Gebelecho variety with the actual mean AUDPC of 242.17, 327.43 and 300.18 Sinan, Gozamin and Debay Tilatgen districts, respectively, compared to the local check and other varieties (Table 3).

Table 3. Effects of faba bean varieties on the progress of Chocolate spot disease under field condition

Variety Name	Area under progress curve (AUDPC)		
	Sinan	Gozamen	Debay Tilat Gin
Dosha	206.40h	253.48j	174.22i
Local	221.59def	319.95b	278.15b
Tesfa	215.05efgh	314.95c	241.12ef
Hachalu	212.50fgh	266.02hi	217.72g
Adet hana	224.77cde	290.11f	247.82de
Obse	219.11defg	289.23f	251.30d
wolki	208.16gh	261.47i	201.81h
NC-58	240.63a	304.60d	253.45d
Kasa	225.21cde	308.06d	267.58c
Mesay	222.89def	295.04e	281.78b
Gora	249.48a	316.84bc	284.24b
Gebelecho	242.17a	327.43a	300.18a
CS20DK	229.78c	279.80g	248.12de
Moti	209.27gh	278.94g	235.82f
Tumsa	210.14gh	263.70i	212.00g
Degaga	222.69def	290.05f	264.58c
Bulga70	234.41c	270.03h	241.71ef
CV	2.72	0.92	1.62

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) is the coefficient of variation.

3.3 Yield and yield components

The result from field experiment revealed that there is a significant ($p<0.0001$) variation between the varieties for various growth, yield and yield component parameters. Though the number of seeds per pod was significant ($p<0.0001$) in Debay Tilatgen, there was no significance difference ($P< 0.05$) between the varieties for this parameter in both Gozamin and Sinan locations (Table 5).

The statistical analysis showed that a significant ($P<0.05$) difference was observed on grain yield of faba bean in three locations. The actual highest mean yield of faba bean was harvested from Dosha variety (40.94Qt/ha and 40.25 Qt/ha) comparing to the local control 19.65 Qt/ha and 21.38 Qt/ha at Gozamin and sinan districts, respectively. In addition, comparable highest grain yield of faba bean was harvested from Tumsa (38.5 Qt/ha and 35.2 Qt/ha) Hachalu (34.6 Qt/ha and 33.25 qt/ ha) and walki (34.1 Qt/ha and 32.58 Qt/ha) varieties when compared to the local control (19.65 Qt/ha and 21.38 Qt/ha) at Gozamin and Sinan districts, respectively. However the least fababa bean grain yield was encountered using Gebelecho (6.1 Qt/ha) varieties at Debay Tilatgen district (Table 5). The present result was comparable with Getnet and Yehizbalem (2017) who reported that the highest yield was obtained from Dosha and Tumsa and the lowest from Moti, Mesay, Kasa, and Bulga70 at Farta in South Gondar, Ethiopia.

Moreover, there were significantly ($P<0.05$) difference among varieties in terms of pods per plant in all experimental locations. The maximum and minimum number of pods per plant, 15.11 and 7.0, 20.0 and 8.7, 13.7 and 11.52, from Dosha and obse, Dosha and Moti, Tumsa and Gora were recorded at Gozamin, Sinan and Debay Tilatgen districts, respectively (Table 5). In the case of seed per pod, in contradiction to other parameters, there was no statistically justifiable variation among treatments at Gozamin and Sinan districtes. However, in Debaytilatgin, there was statistically significant variation ($p<0.0001$) between treatments (Table 5)

Table 5. Mean yield and yield components of Faba bean varieties

Varieties	Yield and yield components											
	Gozamen				Sinan				Debaytilatgen			
	YPHkg	Ph	NPPP	NSPP	YPHkg	ph	NPPP	NSPP	Yphkg	Ph	NPPP	NSPP
Dosha	4094.33 a	144.33a	10.67de	3.05a	4025.00a	145.05a	10.66g	3.05a	655.00jk	73.72f	12.29f	2.04fg
Tumsa	3460.33 b	144.89a	8.00f	3.16a	3325.00e	141.16c	8.89h	3.16a	721.00j	69.11hg	11.52g	1.92g
Walki	3411.67 b	143.72a	11.83b-d	2.88a	3258.33ef	144.89a	12.31ef	2.88a	841.67hi	79.67c-e	13.27c-e	2.21c-e
Gora	3265.00 c	142.17 a	12.11b-d	3.05a	2550.00h	144.45a	11.86fg	3.05a	1533.33a	84.95ab	14.16a-b	2.36ab
Bulga70	3091.67 d	130.06c	15.11a	2.94a	1900.00k	130.39h	15.61b	2.94a	1525.00a	85.55a	14.26a	2.37a
Moti	2768.33 e	145.22a	8.22f	3.05a	3575.00d	144.33a	8.72h	3.05a	1070.00g	75.39ef	12.56ef	2.09ef
Degaga	2604.33 f	137.33 b	13.94ab	2.72a	3016.67g	131.46h	14.33bc	2.72a	1151.67ef	67.50h	11.51g	1.92g
Mesay	2575.00f	138.28 b	11.33cd	3.00a	2533.33h	137.94e	12.02fg	3.00a	1091.67fg	81.88a-c	13.65a-c	2.27a-c
Obse	2545.67gf	143.44a	7.05f	3.05a	2558.33h	144.83a	8.36h	3.05a	826.00i	79.26c-e	13.21c-e	2.20c-e
Gebelech	2541.67gf	138.77 b	8.75 ef	*2.88a*	2291.67i	136.09fg	12.45d-f	2.88a	610.00k	72.16fg	12.03fg	2.00fg
Hachalu	3526.00b	142.47a	10.99c-e	2.94a	3852.67b	145.11a	12.73c-f	2.94a	900.00hi	81.70a-c	13.61 a-c	2.27a-c
Cs20dk	2500.00gf	136.11b	13.45a-c	3.00a	3475.00d	136.52fg	13.78 c-e	3.00a	1191.67de	81.27a-c	13.54a-c	2.25a-c
Kasa	2495.00gf	138.27b	12.44b-d	2.83a	3158.33f	139.16d	13.66c-e	2.83a	1246.00cd	76.11d-f	12.68d-f	2.11d-f
Adethan	2433.33 g	142.95a	14.00ab	3.05a	3711.67c	142.94b	20.00a	3.056a	1408.33b	81.943a-c	13.65a-c	2.27a-c
Nc-58	1971.67 h	122.26 d	12.27b-d	2.67a	3191.67f	135.50g	13.00c-f	2.67a	1292.33c	80.44b-d	13.40b-d	2.23b-d
Tesfa	1840.00 i	137.95b	13.26a-c	3.00a	2308.33i	137.05ef	13.08c-f	3.00a	1270.00cd	82.35a-c	13.72a-c	2.28a-c
Local	1965.00 h	110.97e	12.66a-d	2.67a	2138.33j	107.44i	14.05cd	2.66a	912.33h	80.83a-c	13.47a-c	2.24a-c
Cv	2.74	1.33	11.37	8.60	2.23	0.50	6.84	8.601	4.27	3.18	3.24	3.24

* 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) is the coefficient of variation YPHkg=yield per hectare per kilogram, NPPP= No pod per plant, NSPP= no seed per pod, Ph= plant height

4. CONCLUSION AND RECOMENDATION

Evaluating of faba bean varities against chocholet spot diseases were highly significant (p< 0.0001). Dosha, Tumsa, walki and Hachalu varietyies, generally were high yielder and revealed resistance (R) to chocholet leaf spot diseases comparing to the local control and other varieties in all localities. However, Gora and Gebelecho varieties were low yielder though moderately resistant to chocholet leaf spot diseases in all locations.

Therefore in the future, the farmers should plant Dosha, Tumsa, Walki or Hachalu faba bean varieties to maximize production and productivity in the study localities.

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