Evaluation of released faba bean (*Vicia faba* L.) varieties for yield and against chocolatespot (*Botrytis fabae*) disease at Welkayt and Tsegedie district Western Tigray, Ethiopia.

Abstract

Faba bean (Vicia faba L.) has an important pulse crop in the Ethiopian. It is consumed in various forms and contributes to the improvement of soil fertility. However, its production and productivity are affected by biotic and abiotic constraints. Among the biotic constraints, chocolate spot (Botrytis fabae) a serious disease that caused Faba bean crop in the high land areas of western Tigray. The aim of the current study was to evaluate faba bean varieties for grain yield and against to chocolate spot disease under field condition. Field experiment was conducted at Welkayt and Tsegedie district during 2017 cropping season using five released faba bean varieties and one local check. Treatments were evaluated with RCBD and replicated three times. There was significant difference (p<0.01) among tested faba bean varieties and lactation, while, interaction effect of varieties and lactation were non-significant variation (p<0.05). Overall result, maximum grain yield was abstained from variety Hachalu (632kg/ha) followed by Tumsa (611.8kg/ha), while, minimum yield was obtained from variety Obse (384.3kg/ha) at Welkayt. Similarly, in Tsegedie maximum yield was calculated from variety Tumsa (339.8kg/ha) and Hachalu (334.4kg/ha), respectively. Minimum yield was obtained from variety Obse (238.8kg/ha). PSI was significant variation (P<0.05) among faba bean varieties; whereas, disease incidence was non-significant among varieties. Lowest mean disease severity was recorded from varieties Hachalu (15%) followed by Tumsa (17.7%). However, Highest mean value was recorded from Obse variety (30.02%) at Welkayt. Similarly, in Tsegedie lowest disease severity was recorded from varieties Hachalu (28.7%) and Tumsa (28.8%). Highest mean value recorded from varieties Obse (susceptible) (50.13).There waspositivelyand significant correlation among yield and Agronomic traits. However, there was negatively significant yield with PSI at both locations.Varietieswith low disease severity are useful in breeding program aimed at developing with higher resistance of chocolate spot disease.

Key word: *Faba bean, yield, chocolate spot and correlation*

1. Introduction

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Comment [HC5]: May be revised : Vicia faba,chocolaste leaf spot , Resistance

Faba bean (*Vicia faba* L.) is the most important food crop cultivated in the world. It is the main source of protein for many thousands of people. Globally, it is the third most important feed grain legume after soybean (*Glycine max*) and pea (*Pisum sativum* L). According to Food and Agriculture Organization [1], it is grown in 58 countries. It's "king of crop" due to wide adaptability to a range of soil environment, productivity, high nutritive value, and usage in high value medicine. In Ethiopia, faba bean is among the major grain legumes cultivated and used extensively as a break crop in the highlands. It is cultivated in highland (1800-3000masl) areas which receives an annual rain fall of (700-1000mm) and within cooled temperature [2].

The production and productivity of faba bean is affected by abiotic and biotic factors. The biotic constraints include diseases, insect pests, and weeds are limiting the crop yield. Among the biotic constraints of faba bean diseases such as; faba bean gall (*Olpidiumviciae*), faba bean rust (*Uromyces viciae-fabae*), and chocolate spot (*Botrytis fabae*) are the major and the most widespread and destructive diseases. In Ethiopia, the yield-reducing capacity of chocolate spot disease exceeds 61% on susceptible cultivars and 34% in tolerant cultivars [3, 4]. Rust disease and faba bean gall causes yield losses of up to 30% and 30-100%; respectively [5, 6]. The relative significance of aerial fungal diseases and their effect on yield vary in different years and crop production area. However, some of them affect large areas in the country where faba bean is cultivated and cause large losses in quality and quantity of the yield. Chocolate spot is a major limiting factor in the main Faba bean growing region of Ethiopia and yield losses vary from 34-60% [7, 8].

It is the most destructive disease, causing large yield losses both in quality and quantity of the crop. Many control measure are possible; such as the use of resistance genotypes, fungicide chemicals, biological and modified cultural practices. Allot of findings were done for the management of chocolate spot disease in the country even in Tigray region. Still, there has not been studied under field condition so far in the high land areas of western Tigray. Accordingly, the present study was conducted to evaluate released faba bean varieties for grain yield and resistance to chocolate spot disease under field condition.

2. Material and Methods

2.1. Description of Study Areas

The field experiment was conducted during the 2017 main crop growing season at two locations, namely: Welkaytdistrict (Tabia Degena) and Tsegedie district (Tabia Endaslasse) western Tigray, Ethiopia as described in (Table 1). The agro ecology of the districts is Dega, weyna Dega and kolla (table 1). In both study areas; major growing crops are wheat, barley, teff and faba bean in the highland areas. Whereas, sesame, sorghum and cotton also in the lowland areas.

Table1. Description of study areas

Location	**Altitude (m.a.s.l)**	**Longitude**	**Latitude**	**Rainfall (mm)**	**Temperature** Max	Min
Welkayt	<2353	13°48'6.6''-14°6'41''N	36°50'29''-37°20'25''E	700- 1800	25°C	17.5°C
Tsegedie	>2700	13°4'25''-14°6'55''N	36°510'29'' -37°05'25''E	700- 3000	25°C	17.5°C

2.2. Experimental Materials and Field Management

The treatments to be evaluated were five released varieties (Hachalu, Gova, Dosha, Obse and Tumsa) and one local check cultivar. The varieties obtained from Holeta Agricultural Research Center.The experiment was laid out in RCBD design with three replications. Each treatment was randomly assigned into a plot area of 5 m row length and 2 m width. The spacing between the blocks and plots were 2 m and 1 m, respectively. A recommended spacing of 10 cm between plants and 40 cm between rows was used for the experiment. Each experimental plot received the same rate of NPS (100kg/ha) and Urea (50kg/ha) fertilizers, and all the other management practices were applied equally and properly as per the recommendations.

2.3. Agronomic Data

Yield components including plant height, number of pod per plant, number of seeds per pod, hundred seed weight and grain yield (kg/ha**)** were determined. Plant height was measured from ten randomly selected plants in each plot. However, number of pod per plant and number of seeds per pod were counted from ten randomly selected plants and pod from each plot, respectively**.** Grain yield (kg/ha**)** was measured fromthreshed, winnowed and cleaned plots separately using a sensitive balance and converted into kilogram per hectare.

2.4. Disease Data

Disease incidence and severity of chocolate spot disease was recorded once at 80and 85 days after planting using the scale of (Hagazy et al. 2012) at Welkayt and Tsegedie, respectively. Where; 0-2%; >2-15%; >15-40%; >40-60%; >60-80%; >080% with response of highly resistance, resistance, moderately resistance, moderately susceptible, susceptible and highly susceptible, respectively. The severity of chocolate spot disease was recorded using the scale 0 - 9 [9] (Table 2).

Disease incidence and severity were calculated using the formula indicated below.

- **Disease incidence (%);** it was calculated by (total infected plant × 100)/total observed plant,
- **Disease severity (%);** it was obtained by (area disease coverage × 100)/total observed area,
- **Percent severity index (PSI %) for easy of analysis;** it was calculated by (sum of rating scales×100)/(No. Of plants scored × maximum score of scale).

Comment [HC6]: PSI or PDI : Per cent disease index ?.

Table2. Infection and scale for recording severity of chocolate spot.

Scale	Justification
0	No disease symptoms
3	Few small disease lesions
5	Some coalesced lesions with some defoliation
7	Large coalesced lesions sporulation lesions, 50% defoliation and some dead plants
9	Extensive, heavy sporulation, stem girdling, blackening and death of more than 80% of plants.

2.5. Statistical Analysis

Analysis of variance was done for yield, yield components (date of maturity, plant height, number of pod per plant, seeds per pod and hundred seed weight) and chocolate spot disease (incidence and severity) from the field experiment. Least Significant Difference (LSD) values were used to separate differences among treatment means at 5% probability level. ANOVA was performed using General Linear Model (GLM) Genstat 18 version.

3. Result and Discussion

3.1. Analysis Variance of Yield and Disease Severity (PSI)

In both studied areas (Welkayt and Tsegedie districts); faba bean varieties trial shows a significant difference mean squares values due to difference source of variability in combined ones are presented in (Table3). According to the results of combined ANOVA for grain yield; replication, varieties, location, varieties*location and error were contributed 1093, 26966, 503721, 4145, and 2429 respectively. And also, for PSI replication, varieties, location, varieties*location and error were contributed, 11.31, 329.63, 3310.08, 54.52 and 20.84, respectively (Table 3). The effect location accounted higher from the total variation in grain yield. This indicated the test locations were highly variable and large differences among the test environments on the yield performance of faba bean varieties. On the other hand, varieties and location * varieties interaction effects accounted lower from the total variation in grain yield. Combined analysis result over locations elucidates that locations were highly significant for all traits.Therefore, it could be concluded that locations significantly affected the performance of the tested faba bean varieties. And the interaction effect of variety with location showed insignificance. The previous report on faba bean indicated that the environmental effect accounted for the largest part of the total variation [10].

Table3. Analysis variance of five released faba bean varieties and one local check trial at Welkayt and Tsegedie districts during 2017 cropping season.

Source of variation	Degree of freedom	Mean of square (yield)	Mean of square (PSI%)
Replication	2	1093ns	11.31ns
Varieties	5	26966**	329.63**
Location	1	503721**	3310.08**
Varieties * location	5	4145ns	54.52ns
Error	22	2429	20.84
CV(%)		14.2	14.5

Note; CV: Coefficient variance, ns: Non-significant, PSI: Percentage severity index, **: highly significant difference

3.2. Yield and Yield Component

3.2.1. **Grain Yield:**

The analysis of variance revealed that there were significant (P<0.05) difference between tested faba bean varieties in grain yield. However, Interaction effect of location*varieties was showed non-significant (P<0.05) variation for seeds per pod, plant height, seed yield as well as hundred seed weight. This indicates that the varieties responded similarly to the tested locations for plant height, hundred seed weight and yield or the varieties respond no varieties by interaction for those traits. In Welkayt the mean for yield of tested varieties was ranged from 632.kg/ha-384.3kg/ha. Maximum yield was obtained from variety Hachalu (632kg/ha) followed by variety Tumsa (611.8kg/ha). Minimum yield was obtained from variety Obse (384.3kg/ha) and followed by variety Dosha(475.8kg/ha) (Table).The total grain yield recorded in the study area was lower than the national average yield; this could be due to strong acid nature of the soil in the study areas. In addition, yield of faba bean was greatly affected by chocolate spot disease. Similarly, In Tsegedie the yield of faba bean was ranged from (339.4kg/ha- 238.8kg/ha). The highest yield was obtained from the variety Tumsa (339.8kg/ha) followed by Hachalu (334.4kg/ha) (Table 4). The lowest yield was obtained from varieties Obse (238.8kg/ha), which was susceptible to chocolate spot disease (Table4). Relatively the yield was very low at Tsegedie as compared to Welkayt, it could be due to the soil strong acidic nature. In addition the reduction in yield could be attributed to the high disease incidence. These finding were confirmed by [11], who reported that significant differences were observed in grain yield (kg/ha) in tested Faba bean varieties and accordingly, maximum yield was calculated from variety Hachalu.

3.2.2. Plant Height:

The combined data analysis for plant height was significant difference (P<0.01) among tested released Faba bean varieties (Table 4), on both locations.Accordingly, variety Hachalu(115.1cm) followed by Tumsa (112.1cm) were showed the highest plant height and Obse (96.2cm) revealed the shortest plant height at Welkayt. Similarly,at Tsegedie tallest variety was Govan (111.1cm) and shortest was Obse (83.7cm) (Table 4). This is in line with [12] which showed maximum plant height was recorded for Gora, CS-20DK, and Tumsa with mean scores of 98.30 cm, 94.50 cm, and 91.37cm, respectively.

3.2.3. Pod per Plant and Seed per Pod:

Number of pod per plant and seed per pod were significant difference (P<0.05) among the all tested varieties (Table 4) at Welkayt. But, there was not statistically significant variation at

Tsegedie. Hachalu, Tumsa and local check ranked first to thred for number of pod per plant (7.27, 6.13 and 5.87), respectively.Lowest pod per plant was recorded from variety Obse (4.4). Maximum seed per pod was obtained from Hachalu (2.87) and Obse (2.8). Minimum seed per pod was recorded from variety Tumsa (2.5) at Welkayt. Seed size is among one of the most important character used for farmers to select better variety.

3.2.4. Hundred Seed Weight:

There was significant variation in the values of hundred seed weight shown by the faba bean varieties, confirming that the genetic variation among varieties at Welkayt. However, there wasn't significant variation (P<0.05) at Tsegedie. Of all tested varieties Hachalu (76g) produced heaviest Seed weight followed by variety (74.77g). While, lowest seed weight local (59.03g) followed by varieties Obse (65.53g) at Welkayt (Table 4). Varieties with highest hundred seed weight have great importance for fetching local and export market with premium price.These varieties are highly demanded even for home consumption.

Table4. Mean performance of five faba bean varieties and one local check for yield and yield parameters at Welkayt and Tsegedie districts during 2017 cropping season.

	Welkayt					Tsegedie				
Varieties	100 SW (g)	NPP	NSP	PH (cm)	GY (kg/ha)	100SW (g)	NPP	NSP	PH (cm)	Yield (kg/ha)
Obse	65.53ab	4.4a	2.8ab	96.2a	384.3a	45.67	4.47	2.60	83.7ab	238.8a
Gova	76b	5.33ab	2.63ab	104.3ab	511.1abc	48.00	5.73	2.40	111.4b	282.7b
Local	59.03a	5.87ab	2.87b	105.4ab	499.2ab	48.03	4.63	2.33	88.33a	246.6a
Dosha	71.7b	5.13ab	2.6ab	100.3ab	475.8a	52.17	4.43	2.40	99.8ab	252.8ab
Tumsa	70.87b	6.13ab	2.5a	112.1ab	611.8bc	55.83	5.70	10.97	8986a	339.4c
Hachalu	74.77b	7.27b	2.87b	114.1b	632c	60.00	6.20	2.50	96.33ab	334.4c
Mean	69.70	5.69	2.70	105.4	519	51.60	5.19	3.90	95.6	282.4
Lsd(5%)	10.21	2.28	0.32	15.38	123.4	15.40	1.62	10.91	20.77	32.82
CV(%)	8.10	22.00	6.60	8	13.1	16.40ns	17.10ns	155.1ns	11.9	6.6

Note; CV: Coefficient variance, cm: Centimeter, GY: Grain yield, g: gram, kg: Kilogram, ha: Hectare, Lsd: List significant difference, NPP: Number of pod per plant, NSP: Number of seed per pod, PH: Plant height, 100SW: Hundred seed weight ns: Non-significant

3.3. **Disease Incidence and Severity (PSI)**

Investigation revealed that the effect of location was statistically highly significant (P<0.001) on percentage severity index (PSI) and incidence of chocolate spot disease. Chocolate spot disease PSI was recorded higher at Tsegedieas compared toWelkayt. The overall average PSI and incidence were recorded 22.4% and 47.1%, respectively in Welkayt. And also in Tsegedieaverage PSI and incidence were 76.4% and 41.62%, respectively (Table5). The variation in infection could be due to variability in climatic situation including temperature and moisture, as well as edaphic properties such as soil texture and acidic soil. Since the elevation for the study areas, Tsegedie was relatively higher than Welkayt, this may favor disease development. Besides, the moist and rainfall condition of the experimental site in Tsegedie may create conducive micro-environment for development of the disease. Differences in farm activities dictating the amount of inoculum in the field such as choice crop cultivars/varieties and crop rotation could also the reason for variation in disease pressure among testing locations. The result in lined with [13] reported that maximum percent of chocolate spot disease incidence and severity were recorded on Fields at high altitude (>2700masl) than low altitude (<2500).

Chocolate spot disease severity was statistically significant variation (P<0.05) among the tested faba bean varieties at Welkayt. However, incidence wasn't significant variation (P<0.05) among faba bean varieties. The highest mean chocolate spot severity was measured on the Obse variety (30.27%) followed by variety Dosha (24.2%). However, there wasn't significant variation with other varieties except with Hachalu. Lowest mean severity was recorded from variety Hachalu (15%) (Table6). Hachalu was highly significant variation with all varieties except with Tumsa variety. Hachalu and Tumsavarieties had low infection expressed resistance and moderately resistant to chocolate spot disease, respectively. The result of analysis of variance was statistically significant variation (p<0.05) among the faba bean varieties on the PSI, atTsegedie. But, disease incidence wasn't significant (P<0.05) difference between varieties. Maximum severity was calculated from variety Hachalu (28.73%) followed by variety Tumsa 29.83%). Minimum severity was calculated from variety Dosha (50.13%) followed by variety Obse (48.23%). In this study area, Hachalu and Tumsavarieties had moderately resistant, except Dosha (susceptible); Gova, Obse and local varieties were moderately susceptible to chocolate spot disease severity.

The result indicates that these faba bean varieties possess certain genes for resistance to chocolate spot disease caused by the pathogen Vicia faba L.; these varieties may be useful as source of resistance (for the development of resistant varieties) in the faba bean-breeding program. Besides, growing the varieties that display very low level of disease severity (resistance varieties) may reduce damage and yield loss in areas where chocolate spot disease is most prevalent. The use of resistant variety is the most practical, cost-efficient, and environmentally safe control method for the management of chocolate spot diseases. The result was lined with [14] who reported that some released faba bean varieties and local cultivars display low level of disease symptom and resistant to chocolate spot disease, others were showed moderately resistant. In addition, previous reports indicated that most improved varieties were moderately resistant to moderately susceptible for most faba bean fungal disease [15]. The result Harmony with [16] who reported that Tumsa variety was moderately resistant to chocolate spot. In addition [11], studied Hachalu, had better effect in reducing chocolate spot epidemics, increased seed yield and higher economic benefits over the local cultivar. And also the result was supported by [17] who reported that lowest disease severity (which is moderately resistance to chocolate spot disease) was recorded from variety Tumsa followed by variety moti.

Table5.Effects of location onfaba bean yield and chocolate spot disease (incidence and PSI) at Welkayt and Tsegedie districts.

Location	Yield (kg/ha)	Incidence (%)	PSI (%)
Welkayt	519a	47.1a	22.4a
Tsegedie	282.3b	76.47b	41.62b
Mean	400.65	61.785	32.01
Lsd(5%)	212.7	24.67	17.46
CV(%)	43.21	29.45	33.57

Note;CV: Coefficient variance, Kg: Kilogram, LSD: List significant difference, PSI: Percentage severity index

Table6. Reaction and mean value of percentage severity index (PSI) of faba bean varieties and local check at Welkayt andTsegedie districts.

Varieties	Welkayt			Tsegedie		
	Incidence (%)	PSI (%)	Reaction	Incidence (%)	PSI (%)	Reaction
Obse	56.43	30.27b	MR	78.7	48.23b	MS
Gova	47.91	23.8ab	MR	75.31	46.2b	MS
Local	45.8	23.3ab	MR	76.82	47.57b	MS
Dosha	49.45	24.2ab	MR	88.36	50.13b	S
Tumsa	42.12	17.7a	MR	71.49	28.87a	MR
Hachalu	40.89	15a	R	68.16	28.73a	MR
Mean	47.1	22.4		76.47	41.62	
Lsd(5%)	8.9ns	9.15		10.34ns	7.053	
CV (%)	17.89	22.4		25.35	9.3	

Note; MR: Moderately resistant, MR: Moderately susceptible, ns: Non-significant, PSI: Percentage severity index, R: Resistance and S: Susceptible

3.4. Correlation among Yield, Yield Parameters and PSI

In each experimental site (Welkayt and Tsegedie) showed that significant negative association of yield and yield parameters with PSI. However, among the agronomic parameters such as, yield, Maturity, plant height and hundred seed weight were significant and positively correlated with in each other's, at Welkayt. Whereas, in Tsegedie association between yield, maturity and hundred seed weight was a positive and significantly correlated with PSI (Table 7 and 8). The result was supported by [17], who reported that for high yield positive and significant association with agronomic traits (this indicates that high number of seed per pod, fewer pod with large seed, higher number of pod in plant, heavies hundred seed weight positively affect yield of faba bean varieties). There was a negative and significant association between grain yieldand percentage severity index of chocolate spot disease at both locations (Table7 and 8). This indicates that PSI had a vital role on faba bean grain yield reduction. The result was agreed with [18, 19] reported that yield correlated negatively and significant with disease incidence.

Table7. Association among plant height, number of pod per plant, seed per pod, hundred seed weight, grain yield and percentage severity index at Welkayt.

	100SW	DM	DS	GY	NPP	NSP
DM	-0.24					
DS	-0.42*	-0.26*				
GY	0.4*	0.21*	-0.96**			
NPP	0.15	0.12	-0.02	0.08		
NSP	-0.52**	0.33*	0.14	-0.14	0.21	
PH	0.25*	0.22*	-0.73**	0.76**	0.45*	0.25*

Table8. Association among plant height, number of pod per plant, seed per pod, hundred seed weight, grain yield and percentage severity index at Tsegedie.

	100SW	DM	DS	GY	NPP	NSP
DM	-0.07					
DS	-0.82**	-0.24*				
GY	0.72**	0.35*	-0.93**			
NPP	0.01	0.26*	-0.01	0.1		
NSP	-0.06	-0.08	0.02	-0.08	-0.15	
PH	-0.2	0.12	0.21	-0.15	0.6**	-0.34*

4. Conclusion and Recommendation

Faba bean is the first among pulse crops cultivated in Ethiopia and a leading protein source for the rural people and used to make various traditional dishes. Based on the present study, the performance of faba bean varieties to some extent low yield was obtained as compared with national level. The highest yield was obtained from variety Hachalu followed by variety Tumsa in Welkayt. Lowest yield was obtained from variety Obse. Similarly, ln Tsegedie maximum yield was calculated from variety Tumsa and minimum yield was calculated from variety Obse. In this study, all faba bean varieties were infected by chocolate spot disease at both locations. Disease incidence and severity were lowest at Welkayt as compared to Tsegedie. Disease

incidence was non-significant (P<0.06) difference between varieties on both locations. Lowest mean severity was recorded from Hachalu; which is resistance to chocolate spot and highest mean severity recorded from Obse (moderately resistant) at Welkayt. In Tsegedie; lowest mean severity recorded from Hachalu and Tumsa (moderately resistant). Highest mean severity recorded from Obse (susceptible). There was a positive andstatistically significant correlation between yield and agronomic traits. However, there was a negative and significant correlation yield with PSI at both locations. This disease is economically important and caused high yield loss at the study sites. It can be concluded that Hachalu is moderately resistant to chocolate spot disease and show superior yield and may be recommended for use in chocolate spot disease prone areas in Western Tigray,Ethiopia. Varieties with low incidence and severity useful in breeding program aimed at developing with higher resistance of chocolate spot disease.Further research is needed in future to cover a wide range of environments and verities to screen high yielder and resistant to chocolate spot disease.

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Comment [HC7]: References are not written properly. Revised the references according to journal