Evaluation of Faba beans (*Vicia faba* L.) Varieties for Chocolate spot (*Botrytis fabae* L.) Disease Resistance at Sinana and Agarfa district of Bale Zone, Southeastern Ethiopia

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**ABSTRACT**

Field experiments were conducted at Agarfa and Sinana District, south eastern part of Ethiopia with the objective of evaluating faba beans varieties for chocolate spot disease resistant at Sinana and Agarfa district during the main cropping season of 2014. The experiment was conducted using randomized complete block design (RCBD) with three replications. The following eight improved faba bean varieties were used for evaluation: Mosisaa, Moti, Gebelcho, Hachalu, Shallo, Tumsa, Wolki and Degaga varieties. Disease severity was recorded by 1-9 disease severity scale with 1 no symptom and 9 heavy infection from the middle three rows of ten sample plants. Disease incidence was taken by counting the number of infected plants. AUDPC and PSI were calculated from severity. The data were analyzed by SAS computer software version 9.1.3. The result revealed that there were variations between the varieties for their chocolate spot resistant. Maximum Chocolate spot severity, AUDPC and PSI data were recorded at Degaga, Hachalu and Gebelcho varieties at both experimental sites while minimum disease severity, PSI and AUDPC data were recorded from Tumsa, Shallo and Wolki varieties with a mean of Severity of (11.85%, 20.05%), (11.79, 21.6%) and (13.58, 19.81%) at Sinana and Agarfa Districts, respectively. The highest disease incidence was recorded from Hachalu (41.99, 49.79%) and Degaga (42.38, 44.3%) at Senana and Agarfa district, respectively; while the lowest disease incidence was recorded from Tumsa (15.5, 20.52%) and Wolki (19.89%) varieties at Senana and Agarfa Districts, respectively. Therefore, from the result we conclude that Shallo, Wolki and Tumsa varieties were resistant to chocolate spot disease while Degaga, Hachalu and Gebelcho were susceptible varieties. On the other hand Mosisaa and Moti varieties were moderately resistant. Therefore from the result Shallo variety was performing well as compare to the other and recommended to the local farmers.

Key words: Faba bean varieties, Disease severity, Disease incidence, AUDPC, PSI and chocolate spot

**INTRODUCTION**

Ethiopia is the world’s second largest producer of faba bean next to China, its share is only 6.96% of world production and 40.5% within Africa (Chopra et al; 1989). In Ethiopia, the average...
yield of faba bean under small-holder farmers is not more than 1.6 t ha⁻¹ (CSA; 2013), despite the availability of high yielding varieties (> 2 t/ha) (MoA. 2011). The crop is among the major crops grown in Ethiopia. Demand is growing, fuelled by rapid population growth, and the gap between supply and demand continues to increase (ICARDA, 2008). In Ethiopia, faba bean production is primarily a rain fed system and also it is reducing the poverty by, 3% for adopter households moved up at least one 'wealth class', while all non-adopters remained in the lowest class (ICARDA, 2008).

Faba bean production is insufficient because crop yields are low because farmers grow varieties that are susceptible to diseases, insect pests, drought and high summer temperatures (ICARDA, 2008). Faba bean production has declined from 4.8 million ha in 1961 to 2.4 in 2008 with the reduction in production from 4.8 tons per hectares to 4.4 tons per hectares (FAO, 2008). The reasons for the decline in are as even the clear in increase in the productivity per unit as susceptibility to biotic (Sillero et al., 2010) and abiotic stresses (Link et al., 2010). The major diseases affecting faba bean production in the country are chocolate spot (Botrytis fabae), Ascochyta blight (Ascochyta fabae) and faba bean rust (Uromyces viciae-fabae) which are prevalent in prolonged wet seasons (ICARDA, 2008). Chocolate spot and rust became the important diseases worldwide. Viruses were one of them a journey of this crops mainly. Faba bean leaf roll virus (FBLRV) and faba bean necrotic yellow virus (FBNYV) (Fouad, 2011).

In Ethiopia, the productivity of faba bean is far below its potential due to a number of factors, the biological limitations include inherently low grain yielding potential of the indigenous cultivars and susceptibility to biotic and abiotic stresses (Mussa et al., 2008). The productivity of faba bean in Ethiopia is quite lower (15.2qt/ha) (CSA, 2011), as compared to about 30 qt/ha in UK (Winch, 2006). Faba bean varieties combining disease resistance with desirable traits like large seed sizes and high yield are more preferred by the farmers (De Boef and Ogliari, 2008). In Ethiopia, there are about 20 improved faba bean varieties which are adapted to different agro-ecology and have different disease reaction (IFPRI, 2010). Most farmers in the Ethiopia cultivate local varieties (Thijssen et al., 2008). Local varieties are low yielding and susceptible to both biotic and abiotic factors. Samuel et al. (2008) reported that most local faba bean landraces are highly susceptible to the disease and low yielding.
Bale Zone is one of the strategic areas for the production faba bean in Ethiopia for green and dry seed. Evaluation of high yielding and disease resistant variety is very important for farmers to sustain their production. The production of faba bean is affected by lack of improved varieties and the local varieties are susceptible to certain biotic factors like Chocolate spot and Rust and a biotic factor like Temperature is blow the standard due to this most of the flowers are dropped from the plant and affecting the production of Faba bean. Chocolate spot disease is among the major diseases of faba bean which threaten its productivity in Bale highlands. This raises the issue of sustainability in livelihood as a result of which the tendency for food security can be jeopardized. Hence, growing of other alternative crop species like faba bean is very important. To this end, Evaluation of improved faba bean varieties for identification of chocolate spot disease resistance is among the major measures to be considered to resolve the existing problems of faba bean production and boost the productivity of the crop. Therefore, the experiments were conducted with the objective of:-

✓ To evaluate faba bean varieties for chocolate spot resistance at Sinana and Agarfa Districts.

MATERIALS AND METHODS

The experiments were conducted at Sinana and Agarfa district of Bale Zone, South-eastern Ethiopia during the main cropping season of 2014. The center represents highlands of Bale Zone with high rainfall and characterized by bimodal rainfall types. The main cropping season is locally known as Ganna extends, from half of July to September and the other cropping season locally called Bona extends from March to July. Sinana is located with the attitude range between 2361 - 2396 masl (Ermias et al., 2013) where as Agarfa district found with the attitude range between 2404 – 2501 masl (Ermias et al., 2013). In both location the dominant soil type is clay soil and slightly acidic at Ph of 6.5.

Treatments and Experimental Design

Eight improved faba bean varieties were collected from different research center of Ethiopia and evaluated for their performance for chocolate spot disease under field condition. The Experiments were conducted by RCBD design with three replications. To reduce the inter plot effect, the space between plots and blocks were adjusted at 0.5 and 1m respectively. There were five rows per plot
and intra and inter-row spacing was adjusted 10 cm and 40 cm, respectively. The experiment was conducted with the following varieties; Wolki (EH96049-2), Degaga (R878-3), Moti (EH95078-6), Tumsa (EH99051-3), Hachalu (EH00102-4-1), Gebelcho (EH96009-1), Shallo (EH011-22-1) (MoARD, 2009) and Mosisaa (EH-99047-1) (SARC, 2013).

At the time of planting, all plots were receive a basal application of Diammonium Phosphate (DAP), (18% N, and 20% P) at the rate of 100 kg ha\(^{-1}\). The experimental fields and experimental units were managed as per the recommended practices for faba bean.

**Data collection**

The datas were collected within a week interval with the inner three rows of ten sampled plant. Chocolate spot severity of faba bean was recorded using standard scale of 1-9 (Bernier et al., 1993).

\[
\text{Diseases Severity}(\%) = \frac{\sum (\text{NPC} \times \text{CR})}{\text{NIP} \times \text{MSC}} \times 100
\]

Where:

- NPC = No. of plants in each class rate,
- CR = Class rate,
- NIP = No. of infected plants
- MSC = Maximum severity class rate

- Means of the severity from each plot was used in data analysis. The severity grades obtained was converted in to percentage Severity Index (PSI) (Wheeler, 1969).

\[
\text{PSI} = \frac{\text{Snr}}{\text{Npr} \times \text{Msc}} \times 100
\]

Where: Snr is the sum of numerical ratings, Npr is number of plant rated, Msc is the maximum score of the scale

**Area under disease progress curve (AUDPC)** was calculated using the adapted formula by Cooke (2006) as follows using the severity of each plot in fixed interval of 15 days.

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

Where: \(X_i\) = the average coefficient of infection of the \(i^{th}\) note
\(X_{i+1}\) = the average coefficient of infection of the \(i+1^{th}\) note and
\(t_{i+1} - t_i\) = the number of days between the \(i^{th}\) note and the \(i+1^{th}\) note
\( n = \text{number of observations.} \)

**Disease incidence:** was recorded within infected and non-infected crops and calculated with the following formula.

\[
\text{Disease Incidence (\%)} = \frac{\text{Number of infected plant}}{\text{Total number of plant}} \times 100
\]

**Data Analysis**

Collected data were subjected to the analysis of variance with SAS computer software version 9.1.3 (SAS, 2003). Means were compared with Least Significance Difference (LSD) at 5% probability level.

**RESULT AND DISCUSSION**

**Disease Severity**

Chocolate spot disease was occurred staring from 45DAS of faba bean varieties emergence at Sinana and Agarfa Districts. However, the intensities were varying in both locations. The result showed that there is a significant difference (\( P<0.05 \)) among faba bean varieties at Sinana and Agarfa Districts. In both locations the lowest disease severity was recorded from Tumsa Wolki and Shallo varieties which are 11.85\%, 11.79\% and 13.58\% at Sinana District and 20.05\%, 19.81\% and 21.6\%, respectively at Agarfa District. The average severity for these varieties was also low with 15.95, 16.7 and 17.04\%, respectively. While maximum disease severity was recorded from Degaga, Gebelcho and Hachalu varieties which are 22.16\%, 22.1\% and 20.8\% and 35.11\%, 28.33\% and 5.31\% Sinana and Agarfa District, respectively. Beside to the above, in Agarfa District Moti and Mosisa varieties were the highest disease severity (Table, 1).

Generally, the result revealed that chocolate spot severity was higher at Agarfa District and lower at Sinana site with a mean ranging from 19.81-35.31\% and 11.79 - 22.16\%, respectively. The result of this experiment indicates that the reaction of the individual verities of faba bean varieties for chocolate spot disease was similar with the result of Tafere *et al.* (2012) has reported Tumsa is resistant variety with a chocolate spot severity of 20\%. Similarly, Tamene *et al.* (2015) has reported Tumsa variety were resistant to chocolate spot and Gebelcho variety was moderately resistant. The result was not inline to with the work of Tafere *et al.* (2012) who report that Moti,
Degaga and Gebelcho have a moderate chocolate spot severity. This variation may be due to the variability of environmental conditions as the disease depends largely on environment.

**Disease Incidence**

The result revealed that the disease incidence of chocolate spot was significantly different (P ≤ 0.05) among the tested varieties in both locations. The minimum chocolate spot incidence was recorded from Tumsa (15.5%, 20.52%), Shallo (19.52%, 24.76%) and Wolki (18.80%, 19.89%) varieties at Sinana and Agarfa Districts, respectively. While maximum disease incidence was recorded on varieties of Degaga, Hachalu and Gebelcho varieties, with the average incidence of 42.38, 41.99 and 40.32% and 44.3%, 49.79, and 42.26% at Sinana and Agarfa Districts, respectively (Table 1).

Similar with the disease severity, the chocolate spot incidence was highest at Agarfa site which have a mean incidence of ranging from 19.89-49.79%. While disease incidence at Sinana site was lower and which ranges from 15.5-42.38% (Table 1). This variation may be due to environmental variation between the locations, including high rainfall during the cropping season at Agarfa District. Dereje et al. (1994) reported prolonged rainfall is conducive for chocolate spot development leading to complete crop loss. The high incidence at Agarfa was due to suitable environmental condition. Villegas-Fernández et al. (2010) has reported chocolate spot incidence is strongly influenced by climatic conditions.

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Sinana</th>
<th>Agarfa</th>
<th>Average</th>
<th>Sinana</th>
<th>Agarfa</th>
<th>Average</th>
<th>Disease reaction</th>
</tr>
</thead>
<tbody>
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<td>Gebelcho</td>
<td>40.32&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>42.26&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>41.29&lt;sup&gt;a&lt;/sup&gt;</td>
<td>22.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>28.95&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>25.5&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>S</td>
</tr>
<tr>
<td>Hachalu</td>
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<td>49.79&lt;sup&gt;a&lt;/sup&gt;</td>
<td>45.89&lt;sup&gt;a&lt;/sup&gt;</td>
<td>20.8&lt;sup&gt;a&lt;/sup&gt;</td>
<td>35.31&lt;sup&gt;a&lt;/sup&gt;</td>
<td>28.05&lt;sup&gt;a&lt;/sup&gt;</td>
<td>S</td>
</tr>
<tr>
<td>Degaga</td>
<td>42.38&lt;sup&gt;a&lt;/sup&gt;</td>
<td>44.3&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>43.34&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>38.95&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>28.91&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>15.0&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>27.53&lt;sup&gt;ab&lt;/sup&gt;</td>
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<td>MR</td>
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<td>22.18&lt;sup&gt;bcd&lt;/sup&gt;</td>
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<td>17.04&lt;sup&gt;cd&lt;/sup&gt;</td>
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<td>Tumsa</td>
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<td>20.52&lt;sup&gt;c&lt;/sup&gt;</td>
<td>17.7&lt;sup&gt;d&lt;/sup&gt;</td>
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<td>19.89&lt;sup&gt;c&lt;/sup&gt;</td>
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<td>CV (%)</td>
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<td>21.29</td>
<td>19.67</td>
<td>13.46</td>
<td>20.95</td>
<td>15.15</td>
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<td>LSD (5%)</td>
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<td>12.56</td>
<td>10.59</td>
<td>3.89</td>
<td>9.82</td>
<td>5.75</td>
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</table>
Means with the same letter at the same column are not significantly different at 5% LSD, DAS= Days after sowing, CV= Coefficient of Variation, LSD= Least Significant difference, S= Susceptible, MR= Moderately Resistant, R= Resistant

**AUDPC and PSI**

Significant difference was recorded among faba bean varieties (P<0.05) for their area under disease progress curve (AUDPC) value at both sites (Table 2). Maximum AUDPC value was recorded from Degag (2535.3%, 1688.8%), Gebelcho (2041.7%, 1694.3 %-) and Hachalu (2502.6, 1538.8 %-) varieties at Agarfa and Sinana site, respectively. While the minimum AUDPC value was recorded from the resistant varieties including Tumsa (1405.0%, 844.4 %), Shallo (1680.3%, 850.0%-day) and Wolki (1413.6, 1013.9%-day) at Agarfa and Sinana site respectively (Table 2).

As compared to the two locations the higher AUDPC datas were recorded from Agarfa site where as the lower AUDPC was recorded at Sinana experimental site. This is may be due to environmental variation of the location. The varieties which have higher AUDPC value indicate the more susceptible one, while varieties which have lower AUDPC value are varieties which are resistant for the diseases (Fernández-Aparicio et al., 2011).

In both locations percent severity index (PSI) was a significant difference (P<0.05) among the faba bean varieties evaluated for chocolate spot. Out of the tested varieties, three of them have highest PSI, Degaga (37.78, 27.90%), Hachalu (37.53, 27.65%) and Gebelcho (32.22, 27.16%), respectively at Agarfa and Sinana site (Table 2). However, the minimum PSI was observed from varieties which were comparatively resistant including, Tumsa, Shallo and Wolki varieties, with a corresponding PSI of (25.31, 20.99%), (27.65, 20.12%) and (25.19, 21.11%) at Agarfa and Sinana site. Similarly, the minimum PSI was obtained comparatively from Sinana site, which indicates lower disease intensity was occurred from this site, while chocolate spot disease intensity was higher at Agarfa site during the experimentation.

Generally, the chocolate spot severity, incidence, AUDPC and PSI data indicated that Tumsa, Wolki and Shallo varieties were resistant to chocolate spot disease at both locations. On contrary, Hachalu, Degaga and Gebelcho varieties were susceptible to the disease on both locations. On the other hand, Mosisaa and Moti were moderately resistant.
Table 2. Area under disease progress curve (AUDPC) and Percent severity index (PSI) of chocolate spot disease at Agarfa and Sinana Districts

<table>
<thead>
<tr>
<th>Varieties</th>
<th>PSI Agarfa</th>
<th>PSI Sinana</th>
<th>AUDPC (%) Agarfa</th>
<th>AUDPC (%) Sinana</th>
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</thead>
<tbody>
<tr>
<td>Gebelcho</td>
<td>32.22&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>27.16&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2041.7&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>1694.3&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>Hachalu</td>
<td>37.53&lt;sup&gt;a&lt;/sup&gt;</td>
<td>27.65&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2502.6&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1538.8&lt;sup&gt;a&lt;/sup&gt;</td>
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<tr>
<td>Degaga</td>
<td>37.78&lt;sup&gt;a&lt;/sup&gt;</td>
<td>27.90&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2535.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1688.8&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Mosisaa</td>
<td>31.36&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>21.85&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>1958.3&lt;sup&gt;ab&lt;/sup&gt;</td>
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<td>Moti</td>
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<td>Shallo</td>
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<td>Tumsa</td>
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<td>844.4&lt;sup&gt;c&lt;/sup&gt;</td>
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<tr>
<td>Wolki</td>
<td>25.19&lt;sup&gt;b&lt;/sup&gt;</td>
<td>21.11&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>1413.6&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1013.9&lt;sup&gt;bc&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Means with the same letter at the same column are not significantly different at 5% LS, PSI = percent severity index, AUDPC = area under disease progress curve, CV= Coefficient of Variation, LSD= Least Significant difference

Figure 1. Disease Progress curve (DPC) for chocolate spot diseases of faba bean varieties at Sinana site (A) Susceptible varieties (B) Moderately resistant (C) Resistant varieties
The disease progress curve (DPC) of the varieties was shown on Figure 1 and 2. The progress curve indicates that there were a fast growth of chocolate spot disease for susceptible varieties including Degag, Hachalu and Gebelcho varieties at both sites. While the rate of disease progression was slow for resistant varieties (Tumsa, Shallo and Wolki) and the graph was more or less sloppy (Figure 1 and 2). Similarly the disease progression was moderate for moderately resistant varieties (Mosisaa and Moti) at both sites. The maximum disease severity was recorded from the sixth score for all varieties at both locations.

**CONCLUSION AND RECOMMENDATION**

Chocolate spot disease is the major biotic problem that affects the productivity of faba bean varieties at Bale Zone. Identification of faba bean varieties for high yield and resistance for chocolate spot disease is impressive for Bale areas. Generally, this finding revealed that chocolate spot disease is the most important disease affecting faba bean in Ethiopia causing considerable reduction in yield. Even if chocolate spot severity and incidence were occurred at both locations the disease was more severe at Agarfa District, while minimum chocolate spot severity and incidence were recorded at Sinana District for all varieties. By this experiment resistant, moderately resistant and susceptible varieties for the disease were identified for the locations.
The result revealed that from the evaluated eight faba bean varieties three of them, namely Tumsa, Wolki and Shallo varieties were resistant to chocolate spot disease. Therefore, these varieties are recommended for the farmers in the study area to in their farming plan for considering chocolate spot disease problem. The other three varieties were susceptible and two of them were moderately resistant to the disease in the study area.

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