



Assessment of Faba Bean Gall Disease Intensity in North Shoa Zone of Central, Ethiopia

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Abstract – Faba bean (*Vicia faba* L.) is one of the earliest domesticated food legumes in Ethiopia and is now cultivated on large areas in many countries. It serves as an important role in the socio-economic life of the farming communities. It has an important place in the Ethiopian national diet and is consumed in various forms. However, the productivity of the crop is attributed by biotic and abiotic factors. Among the biotic factors diseases are the major ones. In addition to the previous major diseases, a recently reported gall forming faba bean disease has become a very serious disease that seriously affected faba bean production. As a result a survey was conducted with the objective of finding out the intensity of faba bean gall disease on major faba bean growing districts of North shoa zone of Oromia and Amhara regional states during the main cropping season of 2015. Random sampling was applied to select farm field in each district i.e. every faba bean field at interval of 5-10 km based on vehicle odometers following the main roads and accessible routes were assessed. In the selected fields, faba bean gall disease assessment was made along the two diagonals at five stops in ("X" fashion) using quadrants and data were collected from each stop. During the survey, a total of 126 fields were assessed, of which the disease was prevalent on 103 (81.75%) of the fields with mean incidence and severity of 46.52 and 39.17%, respectively. The disease intensity was varied with altitude, location and type of cultivars. The highest mean disease severity (44.74%) was recorded on altitude above 2800 m.a.s.l. while the least (28.96%) was recorded at altitudes below 2600 m.a.s.l. Local cultivars showed highest disease incidence (32.9%) and severity of (39.7%) than improved cultivar which was showed disease incidence and severity of 20% each.

Keywords – Altitude, Cultivar, Disease Intensity, Faba Bean, Faba Bean Gall.

I. INTRODUCTION

Faba bean (*Vicia faba* L.) is known as a cultivated plant from the very onset of agriculture and is an important crop until the present (Hanelt, 1972; Zohary and Hopf, 2000). Ethiopia is one of the largest and the 2nd faba bean producing countries next to China. The country is considered as the secondary center of diversity and also one of the nine major agro-geographical production regions of faba bean (Asfaw Telaye *et al.*, 1994). It is a grain legume used as a human food and animal feed and plays an important role in the national economy and has high nutritional value. The crop produces the highest percentage of protein (20-41%) per unit land (Crepona *et al.*, 2010) area as compared to all other temperate and tropical pulse crops, including lentil (*Lens culinaris*), common bean (*Phaseolus vulgaris*), chickpea (*Cicer arietinum*) and pea (*Pisum sativum*) (FAOSTAT, 2013). From the economic

standpoint, the crop is a source of cash to the farmers and foreign currency to the country. Ethiopian farmers are also cognizant of the role of the crop in improving soil health by fixing atmospheric nitrogen, and widely use it in rotation with cereals (Sahile *et al.*, 2008b). Despite the availability of high yielding varieties of the crop and its wide economic importance, the average national yield of faba bean under small-holder farmers is not more than 1.89 t ha⁻¹ (CSA, 2014/15). The low productivity of the crop is attributed to susceptibility to biotic and abiotic stresses (Mussa *et al.*, 2008). Among the biotic category, diseases are the most important factors limiting the production of food legume crops as a whole and faba bean specifically in Ethiopia (Berhanu *et al.*, 2003 and Samuel *et al.*, 2008a). Among these, fungi are the largest and perhaps the most important groups affecting all parts of the plant at all stages of growth of faba bean (Nigussie *et al.*, 2008). Diseases such as chocolate spot (*Botrytis fabae* Sardina), rust (*Uromyces fabae*), black root rot (*Fusarium solani* Mart.), and foot rot (*Fusarium avenaceum*) are among fungal groups that contributes to the low productivity of the crop (Berhanu *et al.*, 2003). Furthermore, in recent years, the crop is threatening by a new emerging disease known as Faba Bean Gall (FBG) locally known as "Kormid", causing up to complete crop failure over wide areas within short period of time with disastrous economic consequences (Wulita, 2014). The distribution pattern of the disease was at escalating speed like fire-wood within short period of time (Teklay *et al.*, 2014).

Understanding of disease intensity and different management practices will help to develop an integrated and sustainable diseases management package for faba bean production (Rusuka *et al.*, 1997). Faba bean gall is a new disease but being a new threat, information is lacking on the prevalence, incidence, severity and management aspects of the disease. Therefore, this study was conducted with the following objectives:

- (i) To assess faba bean gall disease prevalence, incidence and severity in North Shoa zone of the country.

II. MATERIALS AND METHODS

1.1. Description of the Study Areas

Field survey was conducted in 2015 main cropping season in major faba bean growing districts of North Shoa zone of Oromia regional state i.e. Sululta, Muketuri, Debre Libanose, Degem, Wore Jarso, Mendida and Kimbibit, and Basona Worana, Mojana wodera, Ankober, Moretina Jirru, Deneba, Angolelana Tera and Hagere Mariam districts of Amhara regional state (Fig. 2). The zone has a bimodal



rainfall distribution and is a typical sub-humid, high altitude agro-climatic zone.

1.2. Assessment of Faba Bean Gall Disease

Field survey of faba bean gall disease was carried out once in the main growing season in the selected districts of North Shoa zone of Amhara and Oromia regions in October 2015. The selected districts were major faba bean producers in the zone. Random sampling was applied to select farm field in each district i.e. every faba bean field at interval of 5-10 km based on vehicle odometers following the main roads and accessible routes were assessed. In the selected field, the faba bean gall disease assessment was made along the two diagonals in an ("X" fashion). Up to five spots per field were assessed using 1m² quadrant at approximately 20-50m far from each other. In each field, plants within the quadrant were counted and recorded as diseased/ infected and healthy/non-infected.

Data on geographical information (latitude, longitude and altitude) of each field was recorded using a GPS (Legend GPS system, Garmin). The GPS data (latitude and longitude) latter used to plot surveyed fields on a map using the computer programmed Arc View 3.0.

The assessment of the disease was based on the disease incidence, the number of diseased plants compared to the total number of assessed plants expressed as a percentage, and on the disease severity, as the infected area of tissue to the total area of tissue expressed as a percentage. The severity of the disease was examined visually on the whole plants within the quadrants and recorded as the percentage of plant part (tissue) affected.

Disease Prevalence (%):

Was calculated as number of fields affected by faba bean gall disease over the total number of fields assessed and expressed as percentages.

$$\text{Disease prevalence} = \frac{\text{No. of fields infected}}{\text{Total no. fields assessed}} \times 100$$

Disease Incidence (%):

Of FBG was assessed by counting the number of diseased plants per total number of plants inspected and expressed as percentage of total plants. Percent disease incidence was computed according to the following equation.

Disease incidence %

$$= \frac{\text{Number of diseased plants}}{\text{Total number of plants inspected}} \times 100$$

Disease Severity (%):

It was recorded by estimating the percentage of leaf and stem area diseased using the 0-9 disease scoring scales (Ding *et al*, 1993). The severity grades were then converted into percentage severity index (PSI) for analysis (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. Means of the severity from each plot were used in data analysis.

During the survey, growers were asked information on locality name, field history, varieties grown, cropping systems, planting date, weeding practices and disease control practices employed fertilizer usage were recorded to determine their relationship with the disease incidence and severity.

III. RESULTS AND DISCUSSION

3.1. Disease Symptom

The symptom of the disease appears on leaves and stems and it also affects the petioles and the pods. The infection starts at the seedling stage and at the initial stage of infection, on the back side or sometimes on the front side of the leaves, chlorotic galls are formed and then progressively enlarged and become light brown, circular or elliptical rough spots (Figure 1). The spot immediately changes to brown lesion and it covers the whole lower leaves and stems and it changes from circular to slightly irregular shape. Mature leaves develop coalescing necrotic spots that are surrounded by white lesions. At the later stage, the galls turn black or brown, the tissues decay and a few galls break to form necrotic areas. Galls often coalesce adjacently to form huge galls, resulting in rolling up (cupping) and abnormal growth of leaves. In severely infected plants, circular to irregularly-shaped brown lesions or galls also appear on stems (Beyene and Wulita, 2012; Dereje *et al.*, 2012). The disease becomes more sever especially 4-5 weeks after planting and the disease intensity gradually decreases (Dereje *et al.*, 2012).

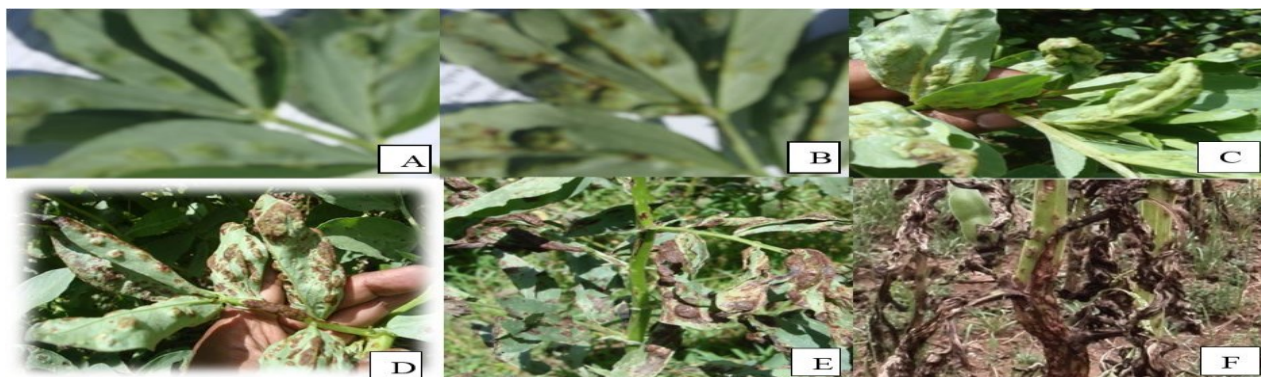


Fig. 1. Symptoms of faba bean gall on the upper (a) lower side (b, c, and d) of the leaves and on all parts of the crop (e and f).



3.2. The Status of Faba Bean Gall

3.2.1. Disease Intensity Across Districts

A total of 126 faba bean fields that includes 67 fields from Amhara and 59 fields from Oromia regions were surveyed from 14 major faba bean producing districts of North Shoa zone. During the survey, FBG disease was observed on 103 (81.75%) of the surveyed fields and it was higher in Amhara region (94.03%) than Oromia region (67.80%). Among the districts surveyed, hundred percent disease prevalence was recorded in six of the districts (Mendida, Mojana Wodera, Deneba, Ankober, Hegere Mariam and Kimbibit) out of which four of them were from Amhara regional state. The over all average disease incidence (46.52%) and severity (39.17) were recorded. An average disease incidence (46.22%) and severity (42.20%) in Amhara region was recorded and it was higher than the disease incidence (32.21%) and severity (38.47%) recorded from Oromia region. Similar result was reported on the survey conducted in 2014; the disease was more severe in Amhara region followed by Tigray and Oromia regions (Endale *et al.*, 2014). The highest disease incidence (64.29%) and severity (57.86%) were recorded at Degem distict in contrast, the least incidence (11.54%) and severity

(23.57%) were recorded in Sululta and Debre Libanose districts of Oromia region, respectively (Table 1).

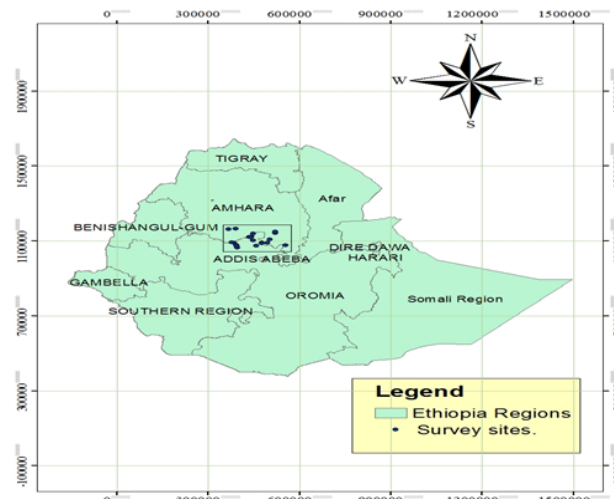


Fig. 2. Map of Ethiopia showing faba bean gall survey districts in North Shoa zone of Amhara and Oromia regions.

Table 1. The intensity of “FBG” disease in North Shoa Zone in 2015/16

| Regions | Districts | Altitude range (m.a.s.l.) | No. of fields assessed | Prevalence (%) | Incidence (%) | | Severity (%) | |
|---------|------------------------|---------------------------|------------------------|--------------------|-------------------|--------------|--------------|--------------|
| | | | | | Range | Mean | Range | Mean |
| Oromia | Sululta | 2541-2635 | 13 | 5 (38.46 %) | 0-40 | 11.54 | 0-85 | 24.62 |
| | Muketuri | 2594-2650 | 7 | 5 (71.43%) | 0-50 | 26.43 | 0-75 | 43.57 |
| | Debre Libanose | 2479-2701 | 7 | 4 (57.14%) | 0-40 | 19.29 | 0-45 | 23.57 |
| | Degem | 2614-3123 | 7 | 6 (85.71%) | 0-85 | 64.29 | 0-80 | 57.86 |
| | Wore jarso | 2529-2572 | 9 | 4 (44.44%) | 0-90 | 28.89 | 0-75 | 32.78 |
| | Mendida | 2666-2823 | 7 | 7 (100%) | 35-80 | 62.14 | 35-80 | 52.86 |
| | Kimbibit | 2615-2937 | 9 | 9 (100.0%) | 20-35 | 31.67 | 0-75 | 41.11 |
| | Range/ Subtotal | 2479-3123 | 59 | 40 (67.80%) | 0-90 | 32.21 | 0-85 | 37.03 |
| Amhara | Mojana wodera | 2852-3162 | 9 | 9 (100.00%) | 20-85 | 60.56 | 15-80 | 43.89 |
| | BasonWorana | 2773-3120 | 16 | 15 (93.75%) | 0-85 | 49.69 | 0-75 | 40.00 |
| | Ankober | 3007-3205 | 7 | 7 (100.00%) | 30-80 | 59.29 | 20-75 | 50.00 |
| | Moretina Jirru | 2643-2853 | 9 | 7 (77.78%) | 0-80 | 33.33 | 0-75 | 34.44 |
| | Deneba | 2604-2678 | 8 | 8 (100.00%) | 25-75 | 51.88 | 20-65 | 46.88 |
| | Angolelana Tera | 2775-2948 | 11 | 10 (90.91%) | 0-90 | 41.36 | 0-90 | 43.18 |
| | Hagere Mariam | 2520-2839 | 7 | 7 (100.00%) | 15-40 | 29.29 | 5-60 | 29.29 |
| | | Range/ sub total | 2520-3205 | 67 | 63 (94.03) | 0-90 | 46.27 | 0-90 |
| | Total/ average | | 126 | 103(81.75%) | | 46.52 | | 39.17 |

3.2.3. Intensity of the Disease Across Altitude Ranges

The survey areas falls in altitudes ranges of 2479-3205 m.a.s.l. Among the surveyd fields (126), 24 (19.05%) of the fields were located below 2600 m.a.s.l, while 35.71% was found between altitude ranges of 2600-2800 m.a.s.l and the remaining 45.24% was located above 2800 m.a.s.l. Out of 24 fields in the altitudes less than 2600 m.a.s.l. FBG disease was observed on 13 (54.17%) of the fields, with mean incidence and severity of 21.25% and 28.96% following the same order mentioned. While in the fields located in the altitude range between 2601- 2800 m.a.s.l. the disease was prevalent in 77.78% of the fields with mean incidence and severity of 36.89% and 41.44%, respectively (Table 2). The

highest (96.49%, 49.65% and 44.74%) FBG disease prevalence, incidence and severity were observed in the fields located above 2800 m.a.s.l, in the orderd mentioned. This study showed that the number of faba bean gall affected fields increased as the altitude increased indicating that the disease severity linearly associated with the increases of elevation.

3.2.4. Intensity of the Faba Bean Gall as Affected by Cultivars

Among the total of 126 fields surveyed, 50 of the fields were covered by local cultivars, one field with improved variety (Dagem) and the remaining 75 field with unknown cultivars (Table 2). The improved variety, is one of the



varieties released by the Ethiopian Institute of Agricultural Research (EIAR). This variety recorded an incidence and severity of 20%. The recorded disease prevalence on the local cultivars was 78% with mean incidence and severity of 39.7% and 32.9%, respectively. Even if, fields with improved variety was not enough for comparison/ conclusion this result shows the disease can affect both local cultivars and improved varieties. Beyene (2014), reported that the same variety (Dagem) and also other improved variety, Lalo were infected by this disease. Teklay *et al.*, (2014) and Endale *et al.*, (2014), also noted that the disease affects both local and improved cultivars but the intensities were higher on the local cultivars.

3.2.5. Intensity of Faba Bean Gall as affected by Sprayed/Unsprayed Fields

During the survey, sprayed and unsprayed fields were identified and only 24 growers from the total surveyed fields (126) applied fungicides against foliar diseases of faba bean in general and in the target of faba bean gall but 32 growers' did not use any fungicides at all. Ridomil, Mancozeb and Bayleton, were frequently used fungicides by the growers. There is no qualified difference in disease intensity in sprayed and unsprayed fields. Most of the farmers interviewed did not know the fungicides rate of application, growth stage at which fungicides applied and

specific diseases they were spray for. This result agrees with the report made by Teklay *et al.*, (2014), that most of the local available fungicides were ineffective to manage the disease.

3.2.6. Intensity of the Disease Based on Pervious Cropping Season

Among the surveyed (126) fields, pulse crops were covered 44.44% (56 fields) while 55.56% (70 fields) were covered by cereal crops. Fields sown by pulse crops were exhibited 87.5% disease prevalence while cereal sown fields showed (77.14%) disease prevalence. Also, fields sown with pulse crops exhibited a mean incidence and severity of 44.11% and 46.07% while cereal sown fields showed an incidence (46.07%) and severity of (33.5%).

3.2.7. Intensity of the Disease Based on Soil Type

The disease intensity was also varied with the variations of soil types of the fields. An average disease prevalence of (84%, 83.78% and 70%) was recorded on black, brown and red soil types of the fields in that order. Whereas, the mean disease incidence and severity were higher on brown soil fields with 44.35% and 41.61% followed by black soil with a mean incidence (39.6%) and severity (38.53%). While, red soil fields recorded the least disease incidence and severity of (32.75% and 37.25%) respectively.

Table 2. Faba bean gall intensity based on different independent variables in 2015

| Variables | Variable class | No. of fields inspected | Prevalence % | Incidence% | | Severity% | |
|---------------|----------------|-------------------------|--------------|------------|-------|-----------|-------|
| | | | | Range | Mean | Range | Mean |
| Altitude | < 2600 | 24 | 13 (54.17) | 0-90 | 21.25 | 0-85 | 28.96 |
| | 2601-2800 | 45 | 35 (77.78) | 0-90 | 36.89 | 0-100 | 41.44 |
| | >2800 | 57 | 55 (96.49) | 0-95 | 49.65 | 0-100 | 44.74 |
| Cultivar | Improved | 1 | 1 (100) | - | 20.0 | - | 20.0 |
| | Local | 50 | 39 (78) | 0-80 | 39.7 | 0-80 | 32.9 |
| | Unkown | 75 | 63 (84) | 0-80 | 40.0 | 0-80 | 44.2 |
| Soil type | Red | 20 | 14 (70%) | 0-95 | 32.75 | 0-85 | 37.25 |
| | Black | 75 | 63 (84%) | 0-85 | 39.60 | 0-80 | 38.53 |
| | Brown | 31 | 26 (83.87%) | 0-90 | 44.35 | 0-80 | 41.61 |
| Fungicide | Sprayed | 24 | 23 (95.83) | 0-95 | 43.96 | 0-85 | 39.58 |
| | Unsprayed | 32 | 22 (68.75) | 0-85 | 38.60 | 0-95 | 36.88 |
| | Unknown | 70 | 58 (82.86) | 0-90 | 38.00 | 0-100 | 41.86 |
| Previous crop | Pulse | 56 | 49 (87.5%) | 0-90 | 44.11 | 0-80 | 46.07 |
| | Cereal | 70 | 54 (77.14%) | 0-95 | 36.14 | 0-85 | 33.5 |

IV. CONCLUSIONS

The main objective of this survey was to study the status of faba bean gall disease which occurred in recent years and devastated many fields of faba bean. The disease was highly prevalent and the most challenging of faba bean production in the country. The mean prevalence of the disease was 81.75% with a mean incidence and severity of 46.52% and 39.17% in the ordered mentioned. The disease intensity was varied within districts, altitude ranges, type of soil, location and type of cultivars grown. The highest mean diseases severity (44.74%) was recorded on altitude above 2800 m.a.s.l. while the least (28.96%) was recorded on fields at altitudes below 2600 m.a.s.l. The disease was attacked both improved as well as local cultivars. The disease prevalence

was higher on local cultivars than improved once. Among the districts surveyed, the disease was more severe at Dagem, Mendida and Ankober districts, with a mean disease severity of 57.86%, 52.86% and 50.0%, respectively. In fact the disease was the most epidemic and more serious from the data collected and from the information of the growers in the surveyed areas. The epidemic conditions of the disease have significant implication on the production of the crop on the country's economy. This survey information helps to consider some of the information of the disease prevalence, incidence and severity and its association with altitude, soil type, cultivar grown. As well thus, information's gave same clue on the development of integrated disease management options for the disease.



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