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ReviewArticle

# Study on Survival and Infectivity of Faba Bean Gall (Olpidium Viciae Kusano) in Ethiopia

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## ABSTRACT

Among biotic factors that attributed for low yield of faba bea, faba bean gall caused by Olpidium viciae was the newly emerged constraints of production in most faba bean growing in the country. This study was intended: to determine growth requirement, to research out survival and infectivity of faba bean gall through time. The enquiry was carried out for two consecutive years 2018 and 2019. Soil and stubble samples were collected from heavily faba bean gall infected field. Soil sample was stored dry at 4oC and residue samples was stored dry at room temperature after pulverized until the experiment has been started. The experiment was arranged in randomized complete block design with 3 replications. Treatments were evaluated to estimate the infectivity of soil and stubble infected with faba bean gall at 4 months intervals in greenhouse with the period of 4, 8,12,16,20 and 24 months after inoculum collection. Results showed that the significant variation observed between treatments and control check along with experimental time. Significantly ($p \leq 0.05$) mean maximum incidence and severity 76.67% and 23.33 recorded on infected debris followed by infected soil 40% and 20%, respectively while minimum was noted on sterilized soil with disease free seeds (control) in the first experimental time, four months after inoculum collection. In the last experimental time, 24 months after inoculum collection, the mean maximum 26.7 observed on faba bean stubble whereas the lowest 0% severity was recorded on the control. Faba bean gall might survived in infected soil and stubble up to two years. The extension of this work to know the exact pathogen remaining time in the soil, inquiry that would be answered the question whether this pathogen is air borne or not and development of management option in major growing areas were suggested.

**Keywords:** Faba bean gall; infectivity; Olpidium viciae; requirement; survival; residue; soil

## INTRODUCTION

Ethiopia is the world's second largest producer of faba bean after China. In Ethiopia faba bean best grow at an altitude ranging from 2200 to 3000 meter above sea level in cold areas ('Dega') and from 1800 to 2200m above sea level in temperate areas ('weynadega'). Within Ethiopia, the crop covered 3.53 percent of the area allotted to pulses and contributed 3.1 percent to the total pulse production of the country [1]. The low yield is attributed by biotic and abiotic factors. Among biotic factors that attributed for low yield in the country, faba bean gall disease is the newly emerged constraints of faba bean production in most highland of faba bean growing areas in Ethiopia [2]. Faba bean gall, also known as Faba bean blister in China and Japan, caused by Olpidium viciae Kusano, characterizing by strumae of cell proliferation in lesion spots. It was first reported in north Shewa zone of Oromia region in Ethiopia since 2011 in few areas [3]. The disease was first reported as "faba bean gall" in Degem, Bash area of Menz Mama and Mojana Wedera district in North Shoa, Ethiopia in 2011 [3, 4], it was also known as broad bean blister in Japan and china country, and now spread in different parts of central and northern highlands of the Ethiopia

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[5, 6, 7]. So far the disease severity was assessed in the major faba bean growing areas of Ethiopia and mean severity range reported as 6.4% to 64.4% [2, 8]. The results of the survey study across the country showed the mean incidence faba bean gall (FBG) ranged from 5% to 100% while the mean percent severity in-between 1 to 90% [9].

The development of a disease epidemic on plants depends on several factors relating to the host, environment, pathogen and the complex interaction of these factors (Agrios, 2005). Faba bean gall disease intensity quantified (in terms of prevalence (%), incidence (%) and severity (%) with different altitude range in the major faba bean growing of Ethiopia. In attempt to inoculum sources, [11] reported that faba bean gall disease pathogen (Olpidium viciae) was survives in soil and crop debris/residues. But it was no so far studied for how long the pathogen has remained in the residue and/or soil which is paramount for epidemiology. However, the epidemiology of faba bean gall such as survival and infectivity through time, and environmental growth requirement is poorly understood in the country. Thus it was planned to determine growth requirement, investigate survival and infectivity of faba bean gall through time.

# MATERIALS AND METHODS

## SOURCE OF EXPERIMENTAL MATERIALS

Site for experimental materials was selected based on previously faba bean gall infection for collection of Soil and stubble. Soil and stubble samples were collected from faba bean gall infected fields of Medakegn district of West Shewa zone in Ethiopia. Soil (from up to 30 cm depth) and stubble samples were collected separately from heavily faba bean gall infected fields at harvesting time and then dried at room temperature prior to the period of experimentation. The residues were threshed (fragmented) and pulverized to produce small pieces. Soil samples and residue samples were stored dry at 4oC and room temperature, respectively until the experiment has been started.

## STUDY OF FABA BEAN GALL GROWTH REQUIREMENT

Disease free faba bean seeds were obtained from Holeta Agricultural Research Center and planted. Temperature and relative humidity were taken throughout disease development on the host. Disease data such as incidence and severity were recorded continuously at 10 days interval.

## SURVIVAL AND INFECTIVITY STUDY OF FABA BEAN GALL (SOIL AND STUBBLE BIOASSAY TEST)

Soil and stubble samples were collected separately from faba bean gall infected fields at harvesting time and stubble dried at room temperature. After drying, soil and stubble were kept for different time of intervals (4, 8, 12, 16, 20, 24 months). Treatments were evaluated to estimate the infectivity of soil and stubble infected with faba bean gall at 4, 8, 12, 16, 20, 24 months after samples were collected from fields and preserved. Sterilized soil potted, and then 20 gram stubble and 40 gm soil were added separately from on the top surface from the infected samples that they were kept at different time intervals. Sterilized soil, soil that has undergone heat using dry heat to kill any pathogens and weed pests using oven dry at the temperature of 180°C for 1 hour sterilization, infected debris, and infected soil added to pots separately. The potted samples were watered and planted with pure seeds of faba bean. Faba bean seeds (diseases free seeds) planted on the sterilized soil used as a check. The experiment was arranged in Randomized complete block design (RCBD) design with three replications. Each pot regarded as an experimental unit in all blocks. In general this experiment was carried out in modern greenhouse which constructed for wheat rusts identification and multiplication process undertaken in Ambo Agricultural Research Center.

Disease data recorded starting from when faba bean gall lesions were first observed. Seedlings were assessed for disease first symptom, disease incidence (%) and severity (%). Diseases incidence was measured as proportion of plants displaying symptoms in the pots. The number of plants reflecting faba bean gall disease signs and/or symptoms were counted and expressed as a percentage of the total number of plants per pot.

$$\text{Diseases incidenece (\%)} = \frac{\text{Number of diseased plants}}{\text{Total number of plants in pot}} * 100$$

Severity of faba bean gall evaluated by observing on the whole plant by means of a visual and infected plant parts.

# RESULTS AND DISCUSSION

Analysis of variance (ANOVA) showed there was significant difference ($p \leq 0.01$) across treatments in each testing four months interval with regard to faba bean gall (FBG) incidence and severity. Marked difference was also observed between treatments infected (soil and debris) and control check along with experimental time under controlled environment. Significantly ($p \leq 0.05$) mean maximum FBG incidence (76.67%) recorded on pots filled out with infected debris followed by infected soil (40%) while minimum incidence (almost no disease symptom) was noted on pots filled out with sterilized soil with disease free seeds (control) in the first experimental time, four months after inoculum collection. In the second experimental time, eight months after inoculum collection, the mean maximum faba bean gall (63.3%) incidence observed on faba bean stubble whereas the lowest incidence was recorded on the control plots. More or less the same result noticed in terms of faba bean gall disease incidence at four, eight, twelve, sixteen, twenty and twenty four months interval after inoculum collection.

The results also exhibited significantly ($p \leq 0.05$) mean maximum FBG severity (23.33%) scored on faba bean stubble compared to the control/check (Table 1). However, no significant variation observed between faba bean gall infected soil and residue through the experimental season with regard to severity, except with control (Table 1 and 2).

This showed that soil and residue of infected faba bean served as inoculum sources of the disease, moreover Olpidium viciae can

be overwhelmed in the soil and residue inoculum up to twenty four months.

In one hand this investigation was in line with the finding of [11] who stated that the faba bean gall disease pathogen more survives in soil and crop debris/residues. Nevertheless, they did not studied for how long the pathogens remained in the residue and/or soil. In the current study it was demonstrated that once the Olpidium viciae infect the soil and/or debris, it can survive up to 24 months (i.e. two years).

On the other hand temperature and relative humidity are among the growth requirement for Olpidium viciae Kusano. Thus this study conducted under controlled environment (temperature maintained in the range of 18-22oC) across the study season, in green house whereas Relative humidity above 78%. As a result the infection and disease symptom development occurred between this ranges so that the disease intensity recorded and presented in Table 1 and 2.

The temperature range for germination of zoosporangium of Olpidium viciae was from 0 to18°C, it will be significantly inhibited below18°C, and was unable to germinate at 20°C, 25°C and 30°C. Temperature apparently affected infection and morbidity of zoospores to plants. Infection and infection occurred between 10 and 25°C, no apparent symptom observed at 5°C although infection occurred, and both were not observed at 30°C or above it. The optimum temperature for infection and morbidity was between 10 and 25°C. The time of keeping high humidity for infection and illness of zoospores was 12h or longer. Light or dark did not result in distinct influence on germination of zoosporangium.

**Figure 1:** Development of Olpidium viciae symptom: (A&B) from infected stubble and soil, (C & D) infected stubble, soil, and sterilized soil with disease free seeds, and (E) typical symptoms developed on the leaf

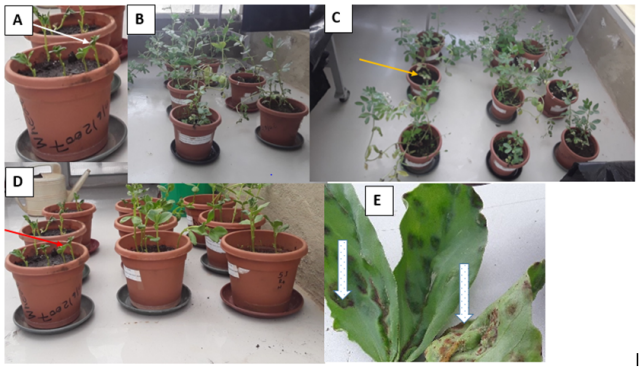


**Figure 2:** Morphology of O. viciae under Olympus compound microscope: (A &C) zoosporangium and (B&D) different size of Zoospores

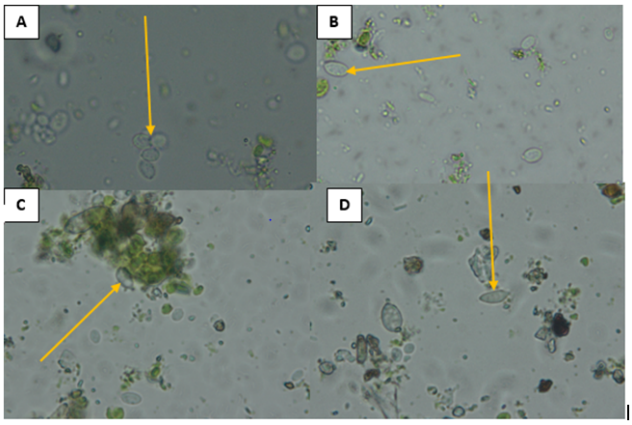


**Table 1:** Mean faba bean gall intensity on infected residues, infected soils and sterilized soil at 4, 8 and 12 months intervals after inoculum collection

| Treatments | 4 months after inoculum collection | | 8 months after inoculum collection | | 12 months after inoculum collection | |
|---|---|---|---|---|---|---|
| | Incidence (%) | Severity (%) | Incidence (%) | Severity (%) | Incidence (%) | Severity (%) |
| Faba bean gall disease infected residues incorporated with sterilized soil | 76.67a | 23.33a | 63.33a | 18.33a | 93.33a | 26.67a |
| Faba bean gall disease infected soil | 40.00b | 20.00a | 30.00b | 16.67a | 33.33b | 20.00a |
| Sterilized soils only (Control-Check) | 0c | 0b | 0c | 0b | 0c | 0b |
| Mean | 39.89 | 14.44 | 31.11 | 11.67 | 42.22 | 15.57 |
| LSD | 30.42 | 9.9963 | 17.722 | 9.25 | 15.113 | 7.5565 |

| | | | | | | |
|---|---|---|---|---|---|---|
| CV (%) | 33.64 | 30.5 | 25.12 | 34.9 | 15.78 | 21.4 |

**Table 2:** Mean faba bean gall intensity on infected residues, soils and sterilized soil at 16, 20 and 24 months intervals after inoculum collection

| Treatments | 16 months after inoculum collection | | 20 months after inoculum collection | | 24 months after inoculum collection | |
|---|---|---|---|---|---|---|
| | Incidence (%) | Severity (%) | Incidence (%) | Severity (%) | Incidence (%) | Severity (%) |
| Faba bean gall disease infected residues incorporated with sterilized soil | 93.33a | 26.67a | 66.67a | 20.00a | 93.33a | 26.66a |
| Faba bean gall disease infected soil | 36.67b | 20.00a | 26.67b | 18.33a | 33.33b | 20.00a |
| Sterilized soil only (Control-Check) | 0c | 0b | 0b | 0b | 0c | 0b |
| Mean | 43.33 | 15.56 | 31.11 | 12.78 | 42.22 | 15.56 |
| LSD | 13.08 | 7.5565 | 31.611 | 7.5565 | 15.113 | 7.5565 |
| CV (%) | 13.32 | 21.43 | 44.82 | 26.08 | 15.78 | 21.42 |

## CONCLUSION AND RECOMMENDATION

Soil and residue/debris served as the best inoculum sources of the faba bean gall. Furthermore, once the disease infects the soil and stubble it can be overwintered in these inoculum sources up to two years and disease epidemic can be outbreak from the soil and debris. Temperature ranged from 18-22°C was the ideal for germination and infection occurrence while relative humidity above 78 favour for disease development. Investigation on whether the faba bean gall disease airborne or not would be suggested for study and development of feasible, environmentally safe management options would be appreciated.

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