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Demonstration of Fungicides for Management of Faba Bean Gall (*Olipidium viciae* Kusano) Disease in North Showa Zone of Central Ethiopia

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ABSTRACT

Aim: The study was conducted to demonstrate effective fungicides to manage faba bean gall under natural infection**.**
Materials and Methods: Two fungicides viz; Noble 25 WP and Ridomil 80 WP were demonstrated alongside control plots.
Results: The results revealed that use of Noble 25 WP and Ridomil 80 WP reducesfaba bean gall explained by reducing AUDPC and percentage severity index (PSI) as well as higher yield. Noble 25 WP recorded the lowest faba bean gall PSI (15%) and AUDPC (855%/days). The yield advantage of the Noble 25 WP and Ridomil 80 WP compared to control was 58.04% and 18.43% respectively. A marginal rate of return of 681.90% and 678.16% were obtained from plots sprayed with Nobble 25WP and Ridomil 80 WP fungicides.
Conclusion: It was concluded that spraying of Noble 25 WP and Ridomil 80 WP reduced "faba bean gall" disease severity and AUDPC. Application of these fungicides gave high yield and net profit than control plots.

Keywords: Faba bean, Fungicide demonstration, Gall, Management.

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Introduction

Faba bean (*Vicia faba* L.) is grown in many countries as a rain-fed and irrigated crop for human food and animal feed and plays important roles in the national economy and agricultural production in various ways. It is one of the most important pulse crops as it has high yield potential and protein-rich grains and hence serves as human consumption and animal feed. In many developing countries it is the major source of protein in their feeding culture. Likewise, in Ethiopia, faba bean is the leading protein source for the rural people and used to make various traditional dishes (Senayit and Asrat, 1994), which otherwise includes mainly cereals or root crops. It's also plays fundamental roles in sustaining agricultural production and productivity through nitrogen fixation and crop ration (Torres *et al.*, 2006 and Braich *et al.*, 2016).

Ethiopia is one of the largest faba bean producers ranked second after China. In highland areas of Ethiopia, faba bean is a major staple food crop among pulses and the most vital legume crop after the staple cereals (Teklay *et al.,* 2018). It is a dominant legume crop in area coverage and production than the other pulses in the country (CSA, 2020). Despite the availability of high yielding varieties, the average national yield of faba bean is 2.16 tonnes/ha (CSA, 2020). Its production and productivity is adversely affected by biotic factors (insect-pests, parasitic weeds, and mainly foliar diseases), abiotic factors (drought, heat, and acidity), and poor agronomic practices causing a steady reduction in many countries. Among the fungal diseases, chocolate spot (*Botrytisfabae*), root rots (*Fusarium* spp.), rust (*Uromycesviciaefabae*), downy mildew (*Peronosporaviciae*), and Ascochyta blight (Ascochyta fabae) are the most destructive constraints to the crop (Beyene *et al.*, 2016; Maalouf *et al.,* 2019). Diseases are among the most important biotic factors, causing faba bean yield reduction. More than 17 pathogens have been reported so far on faba bean, from different parts of the country and the most important yield limiting diseases are chocolate spot (*Botrytis fabae*), rust (*Uromycesviciafabae*), black rot (*Fusariumsolani*), aschochyta blight (*Ascochytafabae*) and faba bean necrotic yellow virus (FBNYV) (Dereje and Tesfaye, 1994). Nowadays the crop is threatening by new gall forming disease (*Olpidiumspp*) with typical symptoms of, green and sunken on the upper side of the leaf, bulged at the back side of the leaf and finally develops light brownish color lesion, chlorotic galls which progressively broaden to become uneven circular or elliptical spots (Endale *et al*., 2014) which is causing yield losses as high as 100%(Chala *et al.,* 2017). The pathogen is now becoming a priority biosecurity threat for the production of the crop in the country (Wulita *et al.,* 2019).The disease was first recorded in Japan in 1912 as faba bean galls (*OlpidiumviciaeKusano*), and also it is a key disease in highlands of Songpan, Xiaojin, Maekang Sichuan Gansu, Tibet and Shanxi provinces of China (Xing, 1984; Li-juan *et al.,* 1993).

So far, a little has been known about Faba bean galls management and only fungicidal management recommendation has been recommended for the growers. Spraying of Ridomil fungicide reduces the disease severity and gave better yields than other fungicides applied and control plots (Bitew *et al.,* 2016). Applications of Bayleton 25 WP and Ridomil gold reduces diseases severity and gave higher yield than control/unsprayed plots (Teklay *et al.,* 2018). Thus, the objectives of this study were to demonstrate effective fungicides for the management of faba bean gall disease.

Materials and Methods

The experiment was conducted at Degem (hot spot area for the disease) in 2019 main cropping season. A local faba bean variety was used to execute the experiment and seed rate was applied as recommendation in row planting. Two fungicides; Ridomil Gold and Noble 25 MZ were demonstrated. Plot sizes of 10m x 10m with a spacing of 1.5 m between plots were used. The foliar spray fungicides were applied three times using knapsack sprayer starting from the first appearance (at vegetative stage of the crop) of the disease and water was sprayed on control plots. Fungicides were applied as manufacturers' recommendations. Spraying were applied three times at the time of diseases appearance (seedling) and repeated two times before start of flowering and podding stage. Date of seedling emergence and first date of bean gall disease appearance was recorded. Also, diseases severity, Plant height, Number of pod per plant, thousand seed weight and seed yield (grain yield) were recorded.

Data collection

Disease severity*:* was recorded on 20 randomly selected plants in the two central rows of each plot starting from the onset of the disease and repeated after every 10 day intervals. A 0-9 scale was used where 0 = no disease symptom observed, 1 = < 2% plant parts infected, 2 = 2 - 5% plant parts infected, 3 = 6 - 10% plant parts infected, 4 = 11 - 25% plant parts infected, 5 = 26 - 50% plant parts infected, 6 = 51 – 75% plant parts infected, 7 = 76 - 90% plant parts infected, 8 = 91 - 99% plant parts infected, 9 = 100% plant parts infected (Ding et al., 1993).

Disease severity scores were converted into a percentage severity index (PSI) for analysis (Wheeler, 1969).

$$PSI = \frac{Snr}{Npr\ x\ Msc} X100$$

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.

Area under disease progress curve (AUDPC): AUDPC was calculated for each plot using the formula of Shaner and Finney (1977) and expressed in %-days.

$$AUDPC = \sum_{i=1}^{n-1} 0.5(Xi + 1 + Xi)(ti + 1 - ti)$$

Where Xi is the cumulative disease severity at the i^{th} observation; the independent variable 'x' indicates the AUDPC level in percentage; t^i is the time (days after planting) at the i^{th} observation and n is the total number of observations.

Crop Parameters

Plant height (cm): The height of the plant was measured from the ground to the tip of five randomly taken plants at maturity.

Number of pods per plant: The average number of pods per plant was determined from five randomly taken plants.

Hundred seed weight (g): The weight of 100 randomly taken seeds was recorded from each plot.

Total grain yield (t h^{-1}): The grain yield per plot was then converted into yield per hectare basis.

Percent relative grain yield loss (RYL) was calculated as follows:

$$RYL\ (\%) = \frac{(Yp-Yt)}{Yp}x100)$$

Where, RYL = relative yield loss in percent, Yp = yield from the maximum protected plots and Yt = yield from other plots.

Cost - Benefit Analysis

Prices of faba bean seed (Birr ton^{-1}) from a local market and total sale from one hectare were computed. Price of fungicides, labor costs for chemical application and equipment were also recorded. Partial budgeting was used to assess profitability of any new technologies to be imposed to the agricultural business (CIMMYT, 1988).

To measure the increase in net return associated with each additional unit of cost (marginal cost), the marginal rate of return (MRR) was calculated as:

$$\text{MRR} = \frac{\Delta NI}{\Delta \text{IC}}$$

Where, MRR is marginal rate of returns, ΔNI – change in net income compared with control, and ΔIC – change in input cost compared with control.

The following points were considered during cost benefit analysis using partial budget.

- Costs for all agronomic practices were uniform for all treatments within sites.
- Costs of labor and spray equipment were taken.
- Costs, return and benefit were calculated per hectare basis.

Results and Discussion

Disease severity: The newly emerged faba bean diseases “faba bean gall” was first observed at vegetative stage at cropping. At the initial assessment dates, fungicidessprayed and unsprayed plots didn’t showed variation from each other (Table 1). On the other hand, at the final disease assessment date, fungicide application plots showed highly differences in diseases severity.Throughout the season the highest disease severity was recorded from unsprayed control plots. Also in the last disease recording date (64%) highest final percent severities were recorded from those plots (Table 1). In contrast Noble 25 WP sprayed plots showed the lowest diseases severity (15%) also Ridomil 80 WP sprayed plots recorded lower diseases severity (25%) than unsprayed plots. This finding coincides with the result of (Wulita *et al.*, 2019); Alemu and Tadele (2017) who reported that foliar applied fungicides reduced the severity of faba bean galls on faba bean compared to the unsprayed control plots. In general, fungicide application didn’t completely control the development of newly emerged disease “faba bean gall” epidemics but reduces the diseases severity and the loss incurred by the pathogen.

Area under disease progress curve (AUDPC): Both demonstrated fungicide showed lowest AUDPC value than control plots. As, control plots recorded the highest disease score throughout the season also, the highest (1955%) AUDPC value was recorded followed by (1380%) plots received Redomil 80 WP fungicide (Table 2). In contrast Noble 25 WP sprayed plots recorded the lowest AUDPC (825%) value. Belachew B. *et al.*, (2018) also fungicides has been recorded highly effective in reducing area under disease progress curve of faba bean gall disease. Whereas, control plots recorded the highest diseases score throughout the season with a AUDPC value of 1955%.

Plant height: Was showed differences among the demonstrated fungicides and control treatments. The shortest (111.0) plant heights were obtained from the unsprayed control plots in the cropping season. On the other hand, the tallest (138.0) plant heights were obtained from plots sprayed with Noble 25 WP fungicide. This result is in line with the finding of DBARC (2015), which reported that faba bean gall diseases significantly reduced the height of the faba bean crop.

Numbers of pod per plant: It was showed highly significant variations among the fungicides and the control. The lowest (20.00) and the highest (21.8) mean numbers of pod per plant were obtained from the unsprayed control plots and Ridomil 80 WP sprayed fungicides. Also, the same result, the highest numbers of pod per plant was recorded on Chlorothalonil and Redomoil sprayed plots (Bitew *et al.*, 2016).

Grain yield and hundred seed weight: Both demonstrated fungicides were gave better grain yield and hundred seed weight than unsprayed control plots (Table 1). Grain yield was significantly increased by fungicide sprays. The lowest (1.07 t. ha^{-1}) grain yield was recorded from unsprayed control plots, while the highest (2.55 t. ha^{-1}) yields were obtained from Noble 25 WP sprayed plots. Generally, both fungicide-treated plots gave a higher grain yield than the unsprayed control plot. Highest hundred seed weight of 46.8g followed by 43.0 g were obtained from Noble 25 WP and Ridomil 80 WP fungicides sprayed plots respectively, whereas, the lowest (37.1 g) were recorded from unsprayed control plot.

Relative Yield Loss in Grain (RYL)

Untreated plot, notably recorded the highest relative yield losses (58.04%) and hundred seed weight losses (20.73) (Table 2). On Ridomil 80WP sprayed plots also recorded 18.43% relative yield loss and 8.12% hundred seed weight losses as compared to plots received Noble 25 WP fungicide as the order mentioned in 2019/20 cropping season.

Cost-benefit Analysis

Results from the assessment of economic returns in this study indicated that fungicide application for faba bean gall disease management demonstration was profitable. Maximum of (ETB 21,826.02) followed by (ETB 18,030.64) net benefits were obtained from plots sprayed Noble 25 WP and Ridomil 80WP as compared to unsprayed control plots (ETB 9,892.69) in the 2019 cropping season (Table 3). Beyene and Abiro (2016) also reported application of bayleton and mancozeb fungicides against faba bean gall disease were more profitable than unsprayed control plots. Also Belachew *et al.*,(2018) reported that three times spraying of Ridomil fungicide result the maximum marginal rate of returns as compared to unsprayed control plots. Also, Rechcing (1997) stated that fungicides are used because they provide effective and reliable disease control, deliver production in the form of crop yield and quality at an economic price and can be used safely.

Table 1. Effect of fungicides on faba bean gall disease severity and on yield and yield component of faba bean

Fungicides	Final DS (%)	PH (cm)	AUDPC%	Pod/plant	Yield ton ha^{-1}	HSW(g)
Noble 25 WP	15	138	825	20.2	2.55	46.8
Ridomil 80 WP	25	133	1380	21.8	2.08	43.0
Control	64	111	1955	20	1.07	37.1

Where:

DS: Disease Severity, PH: Plant Height, AUDPC: Area Under Disease Progress Curve, HSW, Hundred Seed Weight

Table 2. Effect of fungicide application on yield and hundred seed weight of faba bean

Fungicides	Yield ton ha^{-1}	RYL (%)	Hundred Seed Weight (g)	RHSWL (%)
Control	1.07	58.04	37.1	20.73
Ridomil 80 WP	2.08	18.43	43.0	8.12
Noble 25 WP	2.55	0.00	46.8	0.00

Where; RYL: Relative Yield Loss, RHSWL: Relative Hundred Seed Weight Loss

Table 3. Partial budget analysis of fungicide application

Fungicides	Yield ton ha^{-1}	Price (ETB ton^{-1})	Sale revenue	Marginal cost (ETB ha^{-1})	Net profit (ETB ton^{-1})	Marginal benefit (ETB ton^{-1})	Marginal rate of return (%)
Noble 25 WP	2.55	9,245.50	23,576.02	1,750.00	21,826.02	11,933.33	681.90
Ridomil80 WP	2.08	9,245.50	19,230.64	1,200.00	18,030.64	8,137.95	678.16
Control	1.07	9,245.50	9,892.69	0.00	9,892.69	0.00	0.00

Conclusion

It was concluded that spraying of Noble 25 WP and Ridomil 80 WPreduced "faba bean gall" disease severity and AUDPC. Application of these fungicides gave high yield and net profit than control plots. Also, applications of both fungicides were economical and profitable. Thus, it is recommended that these fungicides can beused as one component of the disease management. Thus, variety with the supplement of both fungicides with some cultural practices will increase the crop production.

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