



# **The Effect of Chemical Seed Treatments on Managing Chocolate Spot [*Botrytis fabae* (S.)] of Faba Bean at Welkayt and Tsegedie, Western Tigray, Ethiopia**

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## **Author's contribution**

*The sole author designed, analysed, interpreted and prepared the manuscript.*

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## **ABSTRACT**

Faba bean (*Vicia faba* (L.)) is one of the important legume crops of the world, mainly it is cash crop and important source of nitrogen in the human diet which corrects the important amino acid deficiencies in cereals. It is considered too low in productivity and chocolate spot (*Botrytis fabae* S.), is one of the economically important fungal disease. Seed treatment using chemical inducers is one of the management options used to control the seed and soil borne diseases. Therefore, research was conducted to determine the efficacy of seed treatment chemicals on controlling chocolate spot and enhance productivity of faba bean. Six (6) seed treatment chemicals, one Cow urine and untreated seed as control were used to manage chocolate spot at Welkayt and Tsegedie under field condition during the 2015 and 2016 main growing seasons in randomized complete block design with three replications. A variety called "Welqi" was used. Combined analysis of variance in locations showed statistically significant at ( $P \leq 0.05$ ) among the treatments of yield and disease reaction data. Minimum disease severity was recorded in Salicylic acid (31.31%) and maximum severity in the control (62.53%). Highest grain yield was obtained from the Salicylic acid treated seed (3198 kg ha<sup>-1</sup>) and the lowest grain yield was from Ascorbic acid (2231 kg ha<sup>-1</sup>) non-

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significant with the control (2488 kg ha<sup>-1</sup>). Salicylic acid and Apronstar were effective in managing chocolate spot providing more than 18.73% yield advantage in faba bean growing areas so that faba bean productivity could be enhanced though the application of these seed treatment chemicals. Therefore, our faba bean producing farmers has to use the salicylic acid in 10 mM concentration to manage chocolate spot below the threshold level.

**Keywords:** *Chocolate spot; disease severity; faba bean yield.*

## 1. INTRODUCTION

Faba bean (*Vicia faba* L.) also called as broad bean, is one of the important legume crops of the world. Mainly it is cash crop and used as nutritious human food in the developing countries which helps as important source of nitrogen in the human diet [1]. It corrects important amino acid deficiencies in cereals. It also plays an important role in fixing atmospheric nitrogen to the soil and used as rotational crop for cereals, so as improving the soil fertility [2].

Faba bean is one of the most important food crops widely produced in the highlands of Ethiopia. The country is second largest producer in the world [3]. However, the national productivity is about 1.9 ton ha<sup>-1</sup> still below its potential [4]. The major limitations to the low production and productivity of faba bean are recorded as diseases, insect pest attacks, parasitic weed, poor agronomic practices, lack of improved cultivars and crop protection technologies [5,6]. Susceptibility to biotic and abiotic stress is one of the leading factors causing low productivity in faba bean [7]. Among the biotic stresses, chocolate spot (*Botrytis fabae*) disease, highly contributes to the low productivity of the crop. It is economically important fungal disease causing yield loss up to 67.5% on susceptible cultivars [8]. Chocolate spot is mostly known to be a disease of faba bean leaves but also affects stem, pods and flowers under favorable condition. It is aggressive under warm and humid conditions mostly at flowering.

A number of scholars like El-hendawy et al. [9], Sahar et al. [10], Abeer et al. [11], Bitew and Tigabie [12] and Mbazia et al. [13] had been conducted a scientific research to manage chocolate spot infection on faba bean. However, it is not yet sufficiently managed the infection on the specified crop. These research findings are suggesting no single method that can able to control chocolate spot effectively rather the use of integrated pest management options together controls the infection to its economically below

threshold level. Using of quality seed for planting, appropriate recommended spacing of planting to allow proper aeration, crop rotation to break the life cycle of the pathogen, appropriate fungicide application and chemical seed treatment are some of the integrated pest management (IPM) options for chocolate spot management [14].

Since soil, crop debris and infected seeds are some of the favorable hosts for the pathogen (Singh et al. 2012), Seed treatment using chemical inducers is one of the integrated pest management options used to manage and control the seed and soil borne diseases in faba bean. Therefore, this research work was carried out to determine the efficacy of seed treatment chemicals on controlling chocolate spot (*Botrytis fabae*) infection on faba bean and enhance the faba bean yield productivity.

## 2. MATERIALS AND METHODS

### 2.1 Description of the Study Area

Experiment was conducted at Wekayt and Tsegedie, Tigray, northern part of Ethiopian controlled under Humera Agricultural Research Center in the 2014/2015 and 2015/2016 main growing seasons.

### 2.2 The Description of the Study Area

The study areas (Wekayt and Tsegedie) are known to be naturally hot spot areas for chocolate spot (HuARC report).

**Treatment Description:** Organic and inorganic seed treatment chemicals which have inducing behavior were used for effective control of chocolate spot disease at the specified location. The chemicals used for seed treatment were Salicylic acid (C<sub>7</sub>H<sub>6</sub>O<sub>3</sub>), Oxalic acid (C<sub>2</sub>H<sub>2</sub>O<sub>4</sub>.2H<sub>2</sub>O), Ascorbic acid (C<sub>6</sub>H<sub>8</sub>O<sub>6</sub>), Dipotassium hydrogen phosphate (K<sub>2</sub>HPO<sub>4</sub>), Calcium chloride (CaCl<sub>2</sub>), APRON STAR (C<sub>8</sub>H<sub>10</sub>ClN<sub>5</sub>O<sub>3</sub>S + C<sub>15</sub>H<sub>21</sub>NO<sub>4</sub> + C<sub>19</sub>H<sub>17</sub>Cl<sub>2</sub>N<sub>3</sub>O<sub>3</sub>) and Cow urine (filtered urine) with one control (un-treated). The variety called "Welqi" from

**Table 1. Summary of agro-climatic description for the study areas**

Description	Location	
	Welkayt	Tsegedie
Latitude ( <sup>0</sup> N)	13 <sup>0</sup> 30'34" and 14 <sup>0</sup> 06' 47"	13 <sup>0</sup> 14'21" and 13 <sup>0</sup> 44'46"
Longitude ( <sup>0</sup> E)	36 <sup>0</sup> 50' 58" and 37 <sup>0</sup> 48'33"	36 <sup>0</sup> 27'44" and 37 <sup>0</sup> 45'05"
Altitude (m.a.s.l)	500 - 2400	1053 - 2889
Annual rain fall (mm)	1380	2316
Min-Max temp( <sup>0</sup> C)	11.63 - 23.85	7.8 – 18.6
Soil type	Vertisol Andosol	Humic cambisols

Source: Welkayt and Tsegedie wereda agricultural office, 2017

Holeta Agricultural Research Center which is better adapted and demonstrated at the specified locations was used as experimental material.

**Procedures used for seed treatment:** Aqueous solution was prepared at a concentration of 10 mM for these of Salicylic acid (C<sub>7</sub>H<sub>6</sub>O<sub>3</sub>), Oxalic acid (C<sub>2</sub>H<sub>2</sub>O<sub>4</sub>.2H<sub>2</sub>O), Ascorbic acid (C<sub>6</sub>H<sub>8</sub>O<sub>6</sub>), Dipotassium hydrogen phosphate (K<sub>2</sub>HPO<sub>4</sub>), Calcium chloride (CaCl<sub>2</sub>), 2.5 g of APRON STAR and seven (7) days conserved and filtered Cow urine was mixed with distilled water in 1:1 ratio. Then, known amount of chemicals were mixed and dissolved with distilled water serrowly for complete solubilization. Then, 1 kg of faba bean seed was soaked in the respective chemicals for 24 hours except the Cow urine for 20 minutes and allowed to dry on filter paper for 3 hours under shade/not exposed to direct sunlight. With this finally the treated seeds were planted in the field. All the procedures used were similar with El-hendawy et al. [9].

**Experimental design:** The experiment was arranged in randomized complete block design (RCBD) with three replications at two locations (Wekayt and Tsegedie) with the mentioned agro-ecology (Table 1) and in two years (2015 and 2016). The experiment was conducted on a total area of 230 m<sup>2</sup> having a spacing of 40 cm and 10 cm between rows and plants respectively with 5 rows in a 2 m row length plot. Blocks were spaced by 2 m and plots by 1m. All experimental units were received the same amount and rate of 46 kg ha<sup>-1</sup> P<sub>2</sub>O<sub>5</sub> from NPS (the blended fertilizer of Nitrogen phosphate with sulphur) as per recommendation for these locations [15]. All other recommended agronomic practices were maintained uniformly for all experimental units.

**Data collection:** The major phenological and growth parameters, important yield and yield related traits and disease reaction data was recorded using standard procedures. The disease reaction (severity) data were collected

two times at the crop's flowering stage (60 days) and maturity stage (125 days) after emergence. Five representative plants in the harvestable plot were selected and tagged for the measurement of chocolate spot severity. Leaf severity was scored using (0-9) scoring scale, where 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9 represents free of infection, disease covering less than 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, and disease covering more than 80% of the plant respectively and finally the percentage value was used for analysis [16].

**Data analysis:** Combined data of randomized complete block design (RCBD) with three replications of two year in two locations were subjected to analysis of variance (ANOVA) to assess the existence of statistically significant difference among the treatments for the characters evaluated. The analysis of variance was computed using Genstat statistical software version 17.1 [17] based on Gomez and Gomez [18] procedure. Treatments and combined interaction effects were considered to be significant at 5% ( $P \leq 0.05$ ) level of significance. Duncan's multiple range test (DMRT) at 5% ( $P \leq 0.05$ ) level of significance was used for mean separation of treatments (Gomez and Gomez, 1984).

### 3. RESULT AND DISCUSSION

#### 3.1 Combined Analysis of Variance

Combined yield and disease reaction data of two locations were subjected to the analysis of variance (Table 2). Computed results for the interaction effect of treatments on yield and disease reaction were showed statistically significant difference ( $P \leq 0.05$ ) among the seed treatment chemicals. The result indicates, different chemicals perform better over other chemicals on different location. The result confirms the probability of getting effective chemicals to control the disease on faba bean at the specified location.

Disease reaction using severity percentage at flowering and maturity growth stages of the crop was estimated in (Fig. 1). The result showed faba bean production, at its early growth stage, was less severe with the chocolate spot infestation whose highest severity value was 10.46% as recorded from seed treated with calcium chloride ( $\text{CaCl}_2$ ) while lowest severity of 4.21% was obtained from apronstar treated seeds. However, as the crop gets higher canopy cover at its around flowering time, the disease (faba bean chocolate spot) infection becomes very severe that it ranges from 31.97% in salicylic acid treated seed to 73.70% in Dipotassium hydrogen phosphate ( $\text{K}_2\text{HPO}_4$ ) treated seed.

Looking for the effectiveness of the chemicals to control chocolate spot, Apronstar was effectively controlling the infection with the least severity record 4.21% at the crop's early growth stage up to flowering and salicylic acid 32.97% at the

crop's late growth stage up to maturity. This result is in contrast with the findings of El-hendawy et al. [9] who reported salicylic acid was the most effective and Ascorbic acid was the highest effective while agreed with Mbazia et al. [13]. In the current investigation, the least chemical in controlling the infection was Dipotassium hydrogen phosphate ( $\text{K}_2\text{HPO}_4$ ) and Ascorbic acid, which are the same with untreated seed that recorded higher severity percentage (72.13%) at maturity stage of the crop.

Continuity of the experiment was conducted in 2016 growing season at both locations but data was harvested only from one location Welkayt due to flood at Tsegedie. Therefore, only one location result was presented in this growing season. Disease reaction using severity percentage at flowering and maturity stages of the crop was estimated in (Fig. 2). The response of seed treatment chemicals on severity

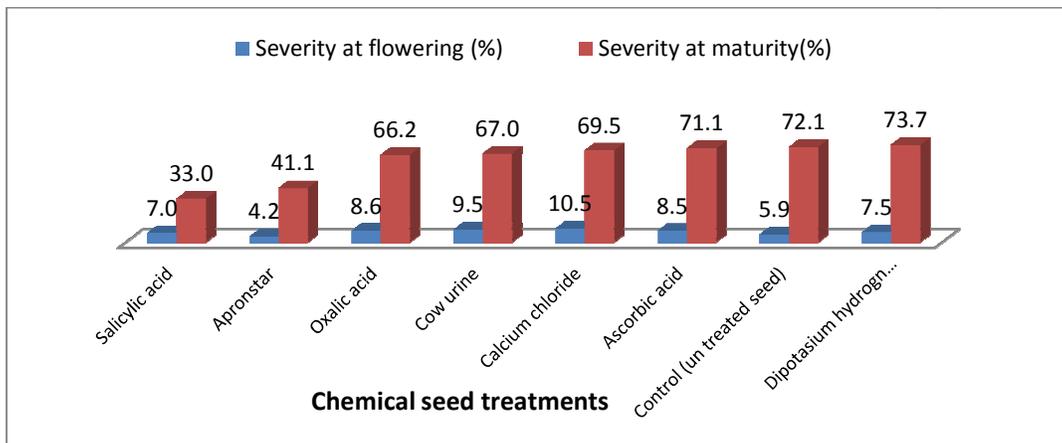


Fig. 1. Response of pathogen severity to the seed treatment chemicals in 2015

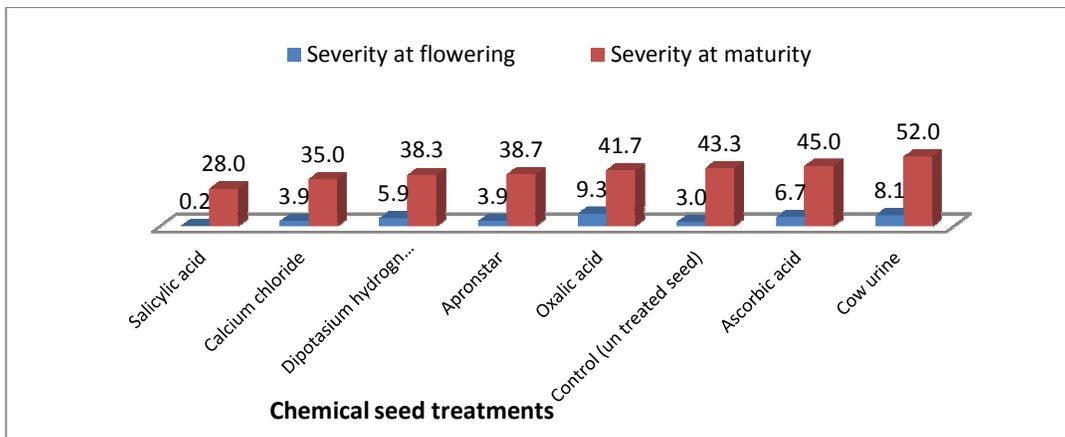
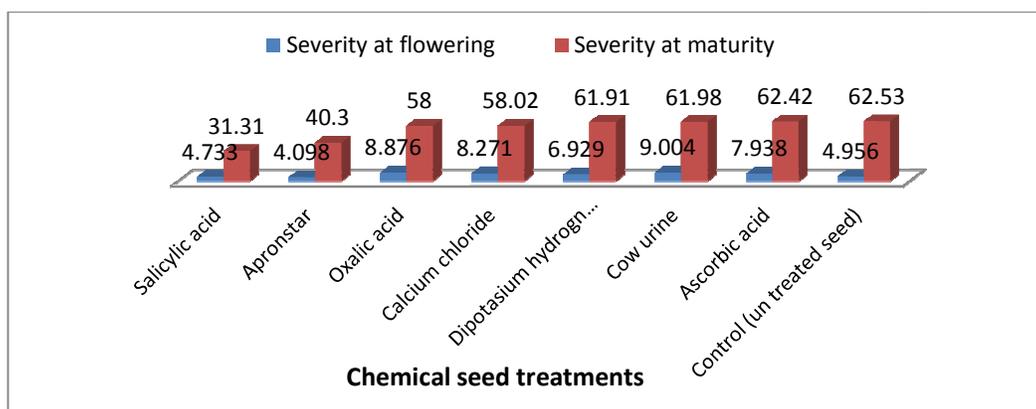


Fig. 2. Response of pathogen severity to the seed treatment chemicals in 2016



**Fig. 3. Combined effect of seed treatment chemicals on controlling chocolate spot in 2015 and 2016**

percentage at 2016 growing season, showed the minimum severity percentage (0.2 and 28%) was recorded from salicylic acid treated seed in both flowering and maturity growth stages respectively followed by Apronstar treated seed (3.87%) in flowering and Calcium chloride treated seed (35%) in the maturity stage while maximum severity was recorded from the Oxalic acid treated seed (9.33%) in the flowering stage and Cow urine treated seed (52%) in the maturity stage.

The combined severity percentage of disease (chocolate spot) presented in Fig. 3, revealed that minimum severity percentage was recorded in Apronstar treated seed (4.09%) at flowering stage and in salicylic acid treated seed (31.31%) at maturity growth stage of faba bean. While maximum severity percentage was recorded in Dipotassium hydrogen phosphate treated seed (9.01%) at flowering and in the untreated seed

(62.53%) at maturity stage of the crop. This result indicates that, Apronstar and salicylic acid chemicals showed consistency in controlling chocolate spot infection on faba bean at the early and late growth stage of the crop respectively in different locations. El-hendawy et al. [9] in green house and Mbazia et al. [13] in field condition were found a research finding that is in-lined with the current investigation. They pointed out that salicylic acid was the effective seed treatment chemical to control chocolate spot on faba bean. But on the contrary, Bitew and Tigabie [12] in their findings suggested that Apron star and salicylic acid were less effective in controlling the infection of chocolate spot in field condition rather Ascorbic acid was effective. This contrasting research findings could be happened due to, different environmental conditions (soil and environmental Temperature, Humidity and Rain fall) may affect different seed treatment chemicals efficacy.

**Table 2. Combined mean separation of treatments on yield and disease reaction under field condition**

Treatments	IF(%)	IM(%)	SF(%)	SM(%)	Yield (kg/ha)
Salicylic acid	10.00 <sup>ab</sup>	97.67 <sup>b</sup>	4.733 <sup>ab</sup>	31.31 <sup>a</sup>	3198 <sup>a</sup>
Apronstar	6.89 <sup>a</sup>	85.33 <sup>a</sup>	4.098 <sup>a</sup>	40.30 <sup>b</sup>	2954 <sup>ab</sup>
Oxalic acid	13.56 <sup>bcd</sup>	97.78 <sup>b</sup>	8.876 <sup>c</sup>	58.00 <sup>c</sup>	2572 <sup>bc</sup>
Calcium chloride	14.00 <sup>bcd</sup>	98.89 <sup>b</sup>	8.271 <sup>bc</sup>	58.02 <sup>c</sup>	2519 <sup>c</sup>
Control (un treated seed)	17.33 <sup>d</sup>	100.0 <sup>b</sup>	15.189 <sup>d</sup>	62.53 <sup>c</sup>	2488 <sup>c</sup>
Cow urine	13.11 <sup>bcd</sup>	99.11 <sup>b</sup>	9.004 <sup>c</sup>	61.98 <sup>c</sup>	2475 <sup>c</sup>
Dipotassium hydrogen phosphate	11.22 <sup>abc</sup>	98.67 <sup>b</sup>	6.929 <sup>abc</sup>	61.91 <sup>c</sup>	2431 <sup>c</sup>
Ascorbic acid	15.13 <sup>cd</sup>	99.11 <sup>b</sup>	7.938 <sup>bc</sup>	62.42 <sup>c</sup>	2231 <sup>c</sup>
G.mean	12.66	97.1	8.13	54.56	2608
CV (%)	35.5	12.5	42.8	8.9	11.09
LSD (±)	4.266	11.49	5.78	7.97	704.2

Note: IF(%) = incidence at flowering; IM(%) = incidence at maturity; SF(%) = severity at flowering; SM(%) = severity at maturity in percent

Combined mean separation result using Duncan's multiple range test (Table 2) of seed treatment chemicals revealed that the lowest incidence at flowering (6.89%) and maturity (85.33%) with the lowest severity at flowering (4.098%) was recorded from Apronstar while the highest incidence at flowering (17.33%) and maturity (100%) with the highest severity at flowering (15.19%) was recorded from the control (untreated). This result indicates seed treatment with Apron star is effective in controlling chocolate spot infection at the crop's early stage. However, as the growth stage increases, the effectiveness of Apron star on controlling infection of faba bean chocolate spot becomes decreased.

The lowest severity (31.31%) was recorded from salicylic acid treated seed while the highest (62.53%) from the control (un-treated) seed at the crop's maturity stage. In the disease reaction result (Table 2), it is observed that 11.1% and 10.46% at flowering and 22.23% and 31.22% at maturity crop damage was controlled due to seed treatments using Apron star and salicylic acid respectively. This result agreed with Mbazia et al. [13] finding who reported reduced severity from salicylic acid treated seed. This could be due to the systemic and persistence nature of the chemicals that the less persistence was effective at very early stage of the crop and the higher persistence nature of the chemical controls effectively the infection up to the late stage (maturity).

Regarding the effect of seed treatment chemicals on yield response, the computed combined mean separation presented in (Table 2) revealed that, the highest yield (3198 kg ha<sup>-1</sup>) was obtained from salicylic acid treated seed followed by Apron star treated seed (2954 kg ha<sup>-1</sup>) while the lowest yield was from Ascorbic acid (2231 kg ha<sup>-1</sup>) which was statistically non-significant with the control (2488 kg ha<sup>-1</sup>). Accordingly, the consecutive results showed that the seeds treated using salicylic acid and Apron star were resulted in low severity record (%) and higher yield (kg ha<sup>-1</sup>) providing about 28.5% and 18.73% yield advantage over the untreated seeds respectively. The result is indicating these chemicals were effective in controlling chocolate spot infection on faba bean at Welkayt and Tsegedie districts under field condition. Kubure et al. [15] reported more than 20% yield advantage from improved technologies of varieties.

#### 4. CONCLUSION

Therefore, based on the current investigation, it could be concluded that, by managing chocolate spot infection on faba bean production using seed treatment chemicals like salicylic acid and Apron star, it could be resulted in obtaining of about more than 18.73% yield advantage over the untreated faba bean seeds with non-off the chemicals.

#### DATA AVAILABILITY

Data will be available up on request to the author.

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#### COMPETING INTERESTS

Author has declared that no competing interests exist.

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