Int.J.Curr.Res.Aca.Rev.2025; 13(1): 57-64

International Journal of Current Research and Academic Review

ISSN: 2347-3215 (Online) Volume 13 Number 1 (January-2025)

Journal homepage: http://www.ijcrar.com

doi: https://doi.org/10.20546/ijcrar.2025.1301.007

Determining the Effect of Seed Treatment on Faba Bean (*Vicia faba* L.) Root Rot (*Fusarium solani*) Under Black Verto Soil Conditions

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Abstract

Production of fababean in Ethiopia is constrained by both abiotic and biotic factors. Among biotic factors disease on field like Root rot, Ascochyta blight, Rust and Chocolate spot are major disease of fababean. Field experiment was conducted to test the significance of seed treatments against these diseases in 2015 and 2016 at two locations. Three released variety of fababean V1, V2 and V3 were treated with five different fungicides to test for the effectiveness against different soil borne disease mainly root rot. Kulumsa Agricultural research main station and Arsirobe sub-site were the test location. RCBD design with three replication was used. Phonological data, disease data and seed quality data were recorded and Analysis of variance was done using R software. Mean square of interaction effect of variety, treatments by year over location was tested and the reported as follow. Even though mean square of treatments show variation across location by year the interaction effect of variety*year*location revealed Fungicide 5 consistently results in the lowest severity for Root Rot in Location 1 for Variety 1 across years,1 and 2 followed by Fungicide 4 and Fungicide 3, there is no sufficient information to say what fungicide can reduce the risk of root rots due to confounding effects of weather and agroecology, hence the experiment with inoculation under controlled environment is needed for further recommendations.

Article Info

Received: 18 November 2024
Accepted: 26 December 2024
Available Online: 20 January 2025

Keywords

Treatment, Pathogen, Soil borne, Variety, Fababean, Fungicide.

Introduction

Faba bean (*Vicia faba* L.) belongs to the family Fabaceae a pulse crop grown in many regions in the world due to its high nutritional value Etemadi *et al.,* (2019). *Vicia faba* is an upright annual forage legume that can grow to a height of 1.5-2 m. It has a taproot and many fibrous lateral roots that explore up to 90 cm of the soil area Muehlbauer *et al.,* (1997). Faba bean is a multipurpose crop used for both food and fodder (hay, silage and straw) (Prolea, 2014). Faba bean is a much-appreciated food legume in the Middle-East, the Mediterranean region, China and Ethiopia (Muehlbauer *et al.,* 1997). Faba beans intended for human consumption are harvested when immature. The dried seeds are cooked, canned or frozen. When faba beans are intended for livestock feeding, small-seed varieties with low-tannin, low vicine-convicine and low-trypsin inhibitor contents are preferred (McVicar *et al.,* 2013). Faba beans have been suggested as an alternative protein source to soybean for livestock in Europe (Smith *et al.,* 2013; Jezierny *et al.,* 2010; Blair, 2007). Faba bean plants can be used to make good quality silage (McVicar *et al.,* 2013). Faba bean straw is valued and considered a cash crop in Egypt and Sudan (Muehlbauer *et al.,* 1997). In Sweden, it was used as a lignocellulosic biomass to produce bioethanol and biogas (Petersson *et al.,* 2007). Faba bean is grown for green manure production or as a legume ley in cereal/legume rotations (McVicar *et al.,* 2013; Muehlbauer *et al.,* 1997). Root rots are the most important diseases of faba bean (*Vicia faba* L.) which are caused by *Fusarium solani* (black root rot), *Rhizoctonia solani* (wet root rot) and *Sclorotium rolfsi* (collar rot) in most growing areas. Abdel *et al.,* (1987). A root rot incidence of ≤50% and severity of ≤40% showed high probability of association with season, furrow sowing and weed management practice, whereas vertisols, flat sowing, high soil moisture and high weed density had significant contributions to root rot epidemics Eshetu *et al.,* (2013).

The symptoms of the disease are manifested by a black discoloration of the main root and lateral roots, beginning at or near the soil level. The above-ground symptoms include a yellowing of the leaves from the lowest part of the plant, and many infected plants do not produce pods. The infected plants ultimately die (Dereje and Tesfaye, 1994). Root rot of faba bean can cause an average yield loss of 45% that can reach 100% when the conditions favor disease development (PPRC, 1996).

Chemical fungicides have been used for the management of black root rot disease of faba bean. Mahantesh *et al.,* and Pandey *et al.,* (2017) have reported that the efficacy of Mancozeb 80% WP against root rot of plant pathogens, whereas 0.25% Copper oxychloride 50 WP with 500 ppm streptocycline was best against leaf spots caused by *Xanthomonas campestris*pv. *Betlicola* Dye, *Colletotrichum capsici* Syd and Root rot, Prabhat Kumar *et al.,* (2016). In Ethiopia Black soil with high rain fall favors the faba bean root rot. Faba bean root rot under Kulumsa and high land Arsi with black soil is very critical problems need solution. Hence this study was targeted to reduce the risk of root rot on Faba bean (*Vicia faba* L) on seed production by using seed treatments with the following objective that include to identify the best fungicide used for seed treatment that reduces the risk of Faba bean root rot.

Materials and Methods

Description of the study location

Three varieties of faba bean fit the Agro ecology (Ashebaka, Chalew and Dida'a) was selected and used for the experiment. Fungicide (Mancozeb 80%wp, Kanzole 25% E.C, proseed plus 63ws, Apron star 42WS and Dynamic 400 FS) was used for seed treatment at recommended rate. Seed treatment was uniformly applied for each treatment and planting date also conducted according to the location based on recommendation. All agronomic practices (weeding, fertilizer and pesticide application) was done as per as recommendation for both location. RCBD design having three replication was used for each location (Kulumsa and Arsi, Robe).

Data collected

Phonological data: **DE- days to emergency**: count or observe whether 50% of plants were emerged from total planted of the plot. **SCnt-Stand count**: A total of plants per plot (4rows) after 15-20 days of planting. **NDP-Number of diseased plants /plot**: number of diseased plants along four rows of each plot was counted at different stages (At soon after emergences, at first weeding, at booting stage and soon after flowering). **Days to Flowering (FD):** Number of days after planting when 50%of plants in the row give the first flower, however, when planting in dry soil incase late on-set of rain, it is counted from the first days to soil wetting sufficient for germination.**Plant Height (PH):** The average height of five random sampled plants in each plot measured in *centimeter* from the ground surface to the top of the main stem at maturity *(sum of heights of five randomly selected plants divided by five).* **Days to Maturity (MD):** Number of days from the date of planting to the date on which 95% of the pods on the plot reached physiological maturity. **GFP- grain filling period**- this trait will be recorded simply by calculating the gap (duration of the days) between days to flowering and days to physiological maturity. **SCnt- stand count at harvesting:** count whole plants in each plots just after physiological maturity.

Diseases Data: About five major faba bean diseases on field have been recorded including Root rot which is the main concern for this study was thoroughly evaluated. These were **Chocolate spot** (CS), **Rust**(R), **Ascochyta blight** (AB) and **powdery mildew** (PM), **root rot** (RR)

Notes: These of foliar diseases and root rot were **rated for** the scale of severity (1-9).whereas: 1=Nil, No visible disease symptom (**immune**) 3= Slight, Some small discrete and a few large lesions **(resistant)**5 = Medium, Some coalesced lesions, many spotting and some defoliation **(moderately resistant)**7 = Severe, Large coalesced lesions with about 50% defoliation, few dead stems/plants **(susceptible)**9 =Very severe, Extensive lesion, severe defoliation stem girdling, many dead plants **(highly susceptible)**

Seed Yield and yield related data: Number of seeds per pod (SPP): Average number of seeds of seeds of five random sampled pods in each plot (*total number of seeds of randomly selected five pods divided by five).*PL- Pod length: measure the length of seed pods from representative samples of selected plants to measure plant height or take another from each plots then take the average of them.

TSW-thousand seed weight: counts 1000 of seed in number and weight it on appropriate balance. GYLD-Grain Yield: Grain yield in *gram* from the harvestable plot area. It will be adjusted to 10% moisture level to give adjusted yield. Seed Moisture Content: Determined as *percent water content* of the seed. It is measured either by oven drying sample seeds or with the help of moisture tester.

Oven drying involves, weighing sample seed (W1) the oven drying and weighing dried sample seed (W2) and then estimating the *percentage moisture content* = (W1-W2/ W1) x 100 HLW- hectoliter weight: this was taken through filling the seed in weight instrument then read it from adjusted table of the weighing instrument of the Faba bean then record amount of the number written on the table.

Results and Discussion

Data Analysis

The analysis of variance were done using R4.2 software packages for Faba bean seed treatments for two locations Kulumsa and Arsi robe during 2015 and 2016 cropping seasons.

Some important phenological parameters like Days 50% field emergence, Stand count of number of plant at emergency, number of days up to 50% flowering, plant height (cm), days to maturity 90%,grain filling period, plant stand count at harvest and Biomass weight at harvest were recorded for all treatment. The mean square of all varieties treated with Fungicide 1, fungicide3 and Fungicide5 possess early field emergence when compared with control. Treating seed with Fungicide1 showed the result De(17.527), sce(106.58), ph(140.83), sch(204.52) and Bw(5.8055) performed better than control while Fungicide 2and Fungicide 4 are almost equal to control. The average number of days required by the variety to reach its 50% flowering and 95% physiological maturity were 58 and 151, respectively (Tesfaye, 2020).

Reaction to Major Diseases

The interaction plot provides a visual representation of how the severity of different diseases (Root Rot, Aschyta Blight, Rust, and Chocolate Spot) varies across different years, varieties, treatments, and locations.

Seed treatments can reduce faba bean root rot by protecting seeds and seedlings from soil-borne diseases (Yu *et al.,* 2023).

Yearly Trends: - The severity of root rot disease changes over the years for location1 is relatively more when compared with location 2 this can be informative to use seed treatments or other mechanism to reduce root rot damage.

The pattern of over year by location for Ascochyta blight, rust and chocolate spot is not clearly known. This means either seasonal change or different treatment applied make the things complicated.

Location and Variety Differences: - Compare the severity of diseases across two locations and varieties.V1 shows more susceptible than v2 and at Arsi Robe location for both year 2015 and 2016. This can help the seed producer can produce v2 and v3 than V1.

V2 is more affected when compared with V1 andV3 by Plant root rot at Kulumsa location. Hence perseverance of V1 and V3 can reduce root rot at Kulumsa location while there is no significance difference for among varieties for other disease like rust, Ascochyta blight and chocolate spot. **Interpretation of the result**: - Fungicide 5 (blue) consistently results in the lowest severity for Root Rot in Location 1 for Variety 1 across years, 1 and 2 followed by Fungicide 4 and Fungicide 3, Hence Treatment (Fungicide 5) is the most effective for managing Root Rot in both location.

All fungicides are not show much different in Rust control over the years for both Location over year and Variety 3, it might indicate the need for more aggressive management practices or the development of Rust-resistant varieties. From the above interaction plot, we can observe valuable insights into the effectiveness of different treatments, the susceptibility of different varieties, and the impact of location and year on disease severity. The interaction plot shows the severity of Root Rot (RR), Aschyta Blight (AB), Rust (R), and Chocolate Spot (chs) over different years (yr), varieties (var), treatments (trt), and locations (loc).

Table.1 Biophysical description of the experimental locations used for the study.

#	Test locations	Geographical positions		Altitude (m.a.s.l)	Av. rainfall (mm)	Temperature (°C)		Soil texture	Soil pH
		Latitude	Longitude			Min	Max		
1	Kulumsa	8°1'7"N	39°9'35"E.	2200	920	10.5	24.5	Dark-clay loam	6.5
2	Arsi Robe	08005'N	39010'E	2300	820	10.5	22.8	Verto soils	6

Table.2 Combination of treatments used for the study

Trt #	Code	Description of the treatments combination
1	AC	Ashebeka with no treatment(control)
2	AM	Ashebeka treated with Mancozabe 80Wp
3	AK	Ashebeka treated with Kanzole 25% E.C.
4	AP	Ashebeka treated with proseed plus63WS
5	AA	Ashebeka treated with Apron star 42WS
6	AD	Ashebeka treated with Dynamic 400 FS
1	CHC	Chalew with no treatment(control)
2	CHM	Chalew treated with Mancozabe 80Wp
3	CHK	Chalew treated with Kanzole 25% E.C.
4	CHP	Chalew treated with proseed plus 63ws
5	CHA	Chalew treated with Apron star 42WS
6	CHD	Chalew treated with Dynamic 400 FS
1	DC	Dida.a with no treatment(control)
2	DM	Dida.a treated with Mancozabe 80Wp
3	DK	Dida.a treated with Kanzole 25% E.C.
4	DP	Dida.a treated with proseed plus 63ws
5	DA	Dida.a treated with Apron star 42WS
6	DD	Dida.a treated with Dynamic 400 FS

Table.3 Analysis of variance (Anova) summary.

```
 Source of Vari  Df     Sum Sq  Mean Sq F value  Pr(>F)
rep               2    4184032   2092016   0.646 0.52544
loc               1       4904      4904   0.002 0.96901
yr                1   13799560  13799560   4.260 0.04045 *
trt               2   17128087   8564044   2.644 0.07385 .
var               2   20683712  10341856   3.193 0.04340 *
rep:loc           2    7916348   3958174   1.222 0.29709
loc:yr            1     559658    559658   0.173 0.67815
loc:trt           2    9384364   4692182   1.449 0.23764
rep:var           4  154414088  38603522  11.917 1.3e-08 ***
loc:var           2     777862    388931   0.120 0.88693
yr:var            2    7894949   3947474   1.219 0.29806
trt:var           4   52800566  13200142   4.075 0.00347 **
rep:loc:var       4    6146100   1536525   0.474 0.75453
loc:yr:var        2     222265    111133   0.034 0.96628
loc:trt:var       4    1421519    355380   0.110 0.97901
Residuals       180  583070266   3239279
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

***=Highly significant,*=significant

Table.4 Mean square for each treatment

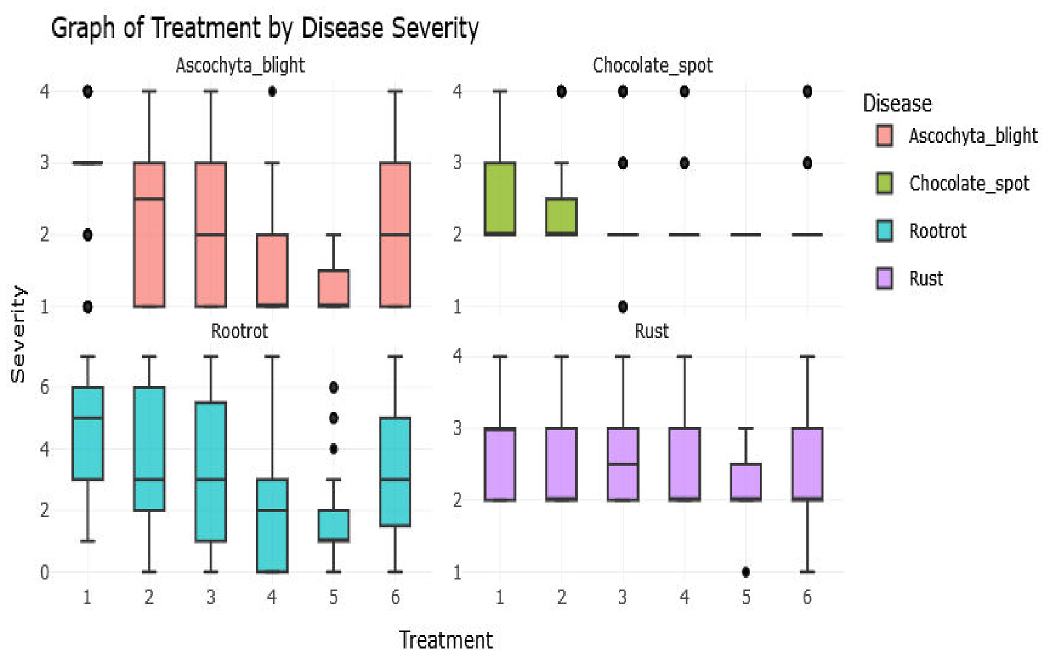
Treatments	ED	PED	DF	PH	DM	GFP	SCntH	Root rot	Aschokyta blight	Rust	Chocolate spot	Yield(kg)/plot	Yield (kg/ha)	MC (%)	TKW(g)	HLW	Ger/n(%)
AC	17.167b	109.5abc	86a	140.67a	180a	94a	205.83a	2.5ab	1b	3a	3a	0.7167bcd	1493.1bcd	12.467a	333.98abc	76.413a	86.667ab
AM	18.5b	104.33bcd	86a	139.33a	180a	94a	207.67a	2.5ab	1b	3a	3a	0.7cd	1458.3cd	12.067a	386.95a	76.187a	86ab
AK	19b	90.67d	86a	142.33a	180a	94a	194.67a	2.5ab	1b	3a	3a	0.7783abcd	1621.5abcd	12a	325.08cd	75.253a	88ab
AP	18b	103bcd	86a	142.5a	180a	94a	195.33a	2.5ab	1b	3a	3a	0.8167abcd	1701.4abcd	12.367a	339.41abcd	75.307a	85.333ab
AA	18.167b	99.33bcd	86a	138.83a	180a	94a	207.17a	2.5ab	1b	3a	3a	0.876abcd	1825abcd	12.367a	354.71abcd	73.653a	83.333ab
AD	18.833b	102bcd	86a	138.17a	180a	94a	193.83a	2.5ab	1b	3a	3a	0.77abcd	1604.2abcd	12.133a	361.15abc	73.8a	81.333ab
CHC	17.667b	111.33ab	86a	139.67a	180a	94a	215.5a	2.5ab	1b	3a	3a	0.84abcd	1750abcd	12.367a	360.13abc	75.86a	84ab
CHM	17.833b	123a	86a	138.83a	180a	94a	206.17a	2.5ab	1b	3a	3a	0.7533abcd	1569.4abcd	12.133a	355.58abcd	73.333a	88.667ab
CHK	18.5b	94.67cd	86a	141.17a	180a	94a	192.5a	2.8333ab	1.6667a	3a	3a	0.7157abcd	1491abcd	12.367a	357.46abcd	74.653a	82ab
CHP	18.167b	106.83bc	86a	142.83a	180a	94a	197.67a	2.5ab	1b	3a	3a	0.8667abcd	1805.6abcd	12a	325.62ab	75.893a	84.667ab
CHA	18.167b	104bcd	86a	137.17a	180a	94a	200.83a	2.5ab	1b	3a	3a	0.5967d	1243.1bcd	12a	375.86abc	75.407a	80.667ab
CHD	17.333b	103.33bcd	86a	136.5a	180a	94a	205.5a	2.5ab	1b	3a	3a	1.09a	2270.8abcd	12.257a	368.58abcd	76.773a	84ab
DC	35a	103.33bcd	86a	139.83a	180a	94a	205.67a	2.5a	1b	3a	3a	0.7967abcd	1659.7d	12.133a	349.3abcd	75.387a	76b
DM	17.833b	101.67bcd	86a	144.54a	180a	94a	200.5a	2.5ab	1b	3a	3a	0.87abcd	1812.5a	12.233a	348.84bcd	76.38a	90.667a
DK	18.667b	102.17bcd	86a	140.87a	180a	94a	201.17a	2.5ab	1b	3a	3a	1.0733ab	2236.1abcd	12.133a	331.51bcd	76.66a	78.667ab
DP	17.333b	105.5bcd	86a	139.5a	180a	94a	207.17a	2.5ab	1b	3a	3a	0.7867abcd	1638.9abcd	12.233a	354.24abcd	74.98a	88ab
DA	18.833b	103.5bcd	86a	140.5a	180a	94a	203.33a	2.5ab	1b	2.3333b	3.7b	0.93	1930.6abcd	12.333a	351.57abcd	76.22a	88ab
DD	19.167b	104.33bcd	86a	138.97a	180a	94a	196.5a	2.167	1b	2.3333b	3.7b	1abc	2083.3abc	12.167a	307.12d	74.087a	83.333ab
LSD (<0.05)	**1.99**	**1.987**	**1.99**	**1.987**	**1.99**	**1.99**	**1.987**	**2.032**	**2**	**2.03**	**2**	**2.03**	**2.03**	**2.03**	**2.03**	**2.03**	**2.032**
CV	**11.3**	**14.959**	**1.27**	**18.927**	**12.7**	**11.4**	**65.624**	**0.629**	**0.5**	**0.62**	**0.5**	**0.36**	**748**	**0.58**	**50.5**	**4.27**	**14.397**

Table.5 Mean of Interaction effects of phonological data for each treatment.

Interaction effects	De(days)	Sce(#)	Df(days)	Ph(cm)	Dm(days)	Gfp(days)	Sch(#)	Bw(kg)
Control*Loc*Var*Yr	12.94b	113.333a	93.055a	165.2500a	2.888889a	71.9722a	260.861a	9.888889a
Fungicide 1*Loc*Var*Yr	**17.52778a**	**106.5833ab**	91.3889a	**140.8333b**	2.61111a	71.2222a	**204.5278b**	**5.805556b**
Fungicide 2*Loc*Var*Yr	12.88b	112.694a	92.667a	168.5278a	2.638889a	71.0277a	265.6667a	9.72222a
Fungicide 3*Loc*Var*Yr	**18.05556a**	**105.9722ab**	91.722a	**139.5278b**	2.44444a	69.9444a	**204.277b**	**5.861111b**
Fungicide 4*Loc*Var*Yr	13.22b	111.8055a	91.638a	162.7222a	2.500a	71.0833a	254.8333a	10.055556a
Fungicide 5*Loc*Var*Yr	**18.3611a**	**99.527b**	92.44a	**139.6389b**	2.305556a	68.69444a	**197.361b**	**5.47222b**
CV (%)	**4.56**	**9.35**	3.54	**11.54**	5.23	3.78	12.67	2.98
F-value	**1.45**	**0.43**	0.53	**1.67**	1.32	2.12	0.63	0.75

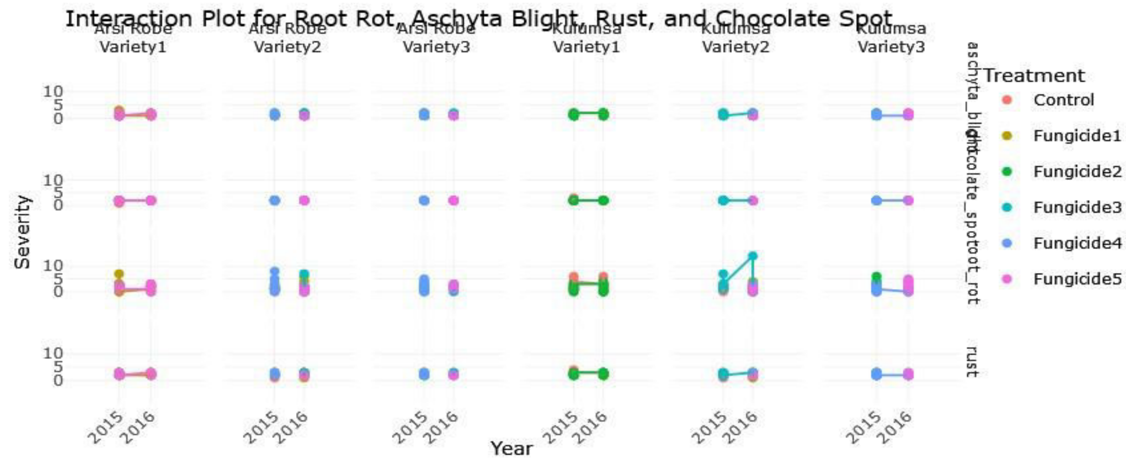
*Means with the same letters are not statistically significant, De=days to 50% emergence, sce =stand count at emergence, df=days to 50% flowering, ph=plant heighted=days to 90%maturity, gfp=grain filling period in days, sch=stand count at harvest, bw =biomass weight in kg .

Figure.1 Interaction effects of fungicide seed treatments across location by year.



The above graph shows the effectiveness of each treatments against diseases such as chocolate spot (*Botrytis fabae*), black root-rot (*Fusarium solani*), and rust (*Uromyces viciae-fabae*) on three varieties of faba bean similar study hed been reported by Chang *et al.,* (2014).

Figure.2 The interaction effect for mean square of variety, year, treatments and location over major Faba bean disease.



From the plot, we can observe the following: 1. the severity of each disease varies across different years, locations, and varieties.2. The effectiveness of each treatment can be compared by observing the severity levels for each disease. To determine which treatment performs best on which variety, location, and year: We can observe the treatment (trt) that consistently shows the lowest severity (y-axis value) for each disease across different facets. Compare the performance of treatments within each facet (combination of loc and var).

Summary and Conclusion

Seed treatment is one of the important mechanisms to reduce soil borne and seed borne pathogen. The study was conducted to evaluate different fungicide which can help to improve field emergency and quality seed production for faba bean through reducing the significant effect of root rot.

Three variety of faba bean under production was serve as the subject of the study on two location for two consecutive years (2015 & 2016) E.C. From this study Fungicide 5 (blue) figure 2 consistently results in the lowest severity for Root Rot in Location 1 for Variety 1 across years,1 and 2 followed by Fungicide 4 and Fungicide 3, Hence Treatment(Fungicide 5) is the most effective for managing Root Rot in both location.

All fungicides are not show much different in Rust control over the years for both Location over year and Variety 3,it might indicate the need for more aggressive management practices or the development of Rust-resistant varieties.

Generally this there is no sufficiency evidence to say seed treatment can reduce the risk of faba bean root rot. This is due to variable weather condition across location by year. In other cases the experiment was conducted on open field which may result expose to different climate influences.

Recommendations

Seed treatment protects seeds from soil-borne diseases and pests by applying chemicals, biological agents, or physical techniques. From this study Even though mean square of treatments show variation across location by year the interaction effect of variety*year*location revealed Fungicide 5 consistently results in the lowest severity for Root Rot in Location 1 for Variety 1 across years, 1 and 2 followed by Fungicide 4 and Fungicide 3, there is no sufficient information to say what fungicide can reduce the risk of root rots due to confounding effects of weather and agroecology, hence the experiment with inoculation under controlled environment is needed for further recommendations.

Conflicts of Interest

The authors declare no conflict of interest.

Acknowledgements

We would like to thank Ethiopian Institute of Agricultural Research, Particularly Technology multiplication and seed Research directorate for seed laboratory establishment from the beginning, We also acknowledge a team of highland pulse crops Kulumsa Agricultural Research Centre, Specially Mr. Aliyi Robsa for his willing to allow us breeder seed for the study. Finally our special acknowledges is to Wezaro: Tenalem Admasu for her polite and effective work during material

preparation and germination test her contribution was high.

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How to cite this article:

Megersa Bayisa, Astawus Esatu and Hassenseid. 2025. Determining the Effect of Seed Treatment on Faba Bean (*Vicia faba* L.) Root Rot (*Fusarium solani*) Under Black Verto Soil Conditions. *Int.J.Curr.Res.Aca.Rev.* 13(01), 57-64. doi: https://doi.org/10.20546/ijcrar.2025.1301.007