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# Evaluation of garlic varieties and fungicides for the management of white rot disease caused by *Sclerotium cepivorum* Berk. in West Showa, Ethiopia.

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**Abstract**

In Ethiopia, onion is the most habitually cultivated vegetable and the next widely cultivated vegetable is Garlic(Allium sativum L.). It is mainly produced for the purpose of medical and nutritional treatments. Soil-borne fungus(Sclerotium cepivorum Berk.) spreads the white rot. It is very dangerous for garlic production and it totally destroys its production rate. Therefore, this research work mainly focuses to examine the effectiveness of fungicides involved in garlic production and improve the various varieties of garlic production in terms of its cultivation and also safeguard from the white-rot disease in west Shewa disease in West Shewa, Ethiopia. This field demonstration was done during the 2018/2019 cropping season at Ambo University Gudar Campus. It is arranged on the basis of 5 x 3 factorial treatment along with untreated control plots in an randomized complete block design with 3 replications and also combining five varieties namely Holeta, Chefe, Tseday (G-493), kuriftu and local cultiver (as check) and two fungicides namely Pro-seed plus 63 WS and Tebuconazole (Natura 250 EW). Before planting the Garlic cloves its was treated using fungicies. An entire of fifteen treatments had been examined per replication. On the basis of reducing disease epidemics and intensifying the garlic production over untreated plots, two fungicides had been very effective. These fungicide treated plots pro-seed plus was major effective while reducing the disease epidemics and also provide better production benefits. When compared to untreated plots, pro-seed plus treated plots reduces initial, final incidence and soverity as 57.12%, 35% and 64.25% and also recorded successfully. Then the results showed sufficiently great production rate and it was recorded from Tseday varieties treated with Pro-seed plus 63 WS (3.047t $ha^{-1}$) followed by Kuriftu varieties treated with the same fungicides (2.973t $ha^{-1}$) compared to the untreated control plots. Significantly, higher net profit was obtained from Pro-seed plus 63WS treated varieties compared to Tebuconazole and untreated control plots. Among various garlic varieties, Tseday (G-493) was the favourable in terms of reducing the disease epidemics also provide better production rate in terms of cultivation. However, for wider applications or recommendation of these management options, further research should be conducted with the same varieties combinations with fungicides against white rot under multi locations and in different seasons.

**Key words:** Garlic, White rot, *Sclerotium cepivorum*, Disease epidemics, Fungicides, Pro-seed plus, Tebuconazole.

**Introduction**

Garlic (*Allium sativumL*) belongs to an *Alliaceae* family. It is originated from the arid land at the north-western part of the Tien-Shan Mountain of kirgizia and areas of central Asia(Etoh and Simon, 2002). It is an erect and biennial herb usually grown as an annual crop. It containing a magnificent source of vitamins and minerals that are very crucial for human's health. It also provide various medicinal properities.i.e.(antiseptic,antitumor,antiviral,antifungal and antibacterial) and plays a major role in medicinal herb products for centuries(Deresse, 2010; Sovova and Sova, 2004). In Ethiopia, garlic had been widely used medicinal product and it mostly used to treat various indigestion problems, range of skin and also it used to cure many medical conditions such as heart, high blood pressure common cold, high cholesterol etc. In Ethiopia, economic significance is quite considerable. It is grown for the purpose of spice and also used to give flavoring to various local dishes. It also contributes to government wealth as an export commodity (Dandena and Fekadu, 2006). Cash crops production like garlic and various other spices had been proved that the income-producing activity for farmers, predominately for those whose like smallholder farmers and have limited cultivated land(FAO, 2016).

In 1989-90, the world garlic production is 771,000 ha of lands. It had been widely increasing year to years. In 2016, it reaches 26,573,001 ha of lands with entire production from 6.5 million to 26.6 million tons, and the productivity rate from 8.43 quintals/ha to 180.915 quintals/ha, respectively(FAO, 2016). The total area in Ethiopia under production of garlic in 2016/17 reaches upto 15,381.01 ha and the production rate is approximately reaches 1,386,643.07 quintals, yield 90.15 quintals/ha(CSA, 2016-2017) and 6.71% distribution rate and in the region of West Shewa Zone, the garlic is widely cultivated for the purpose of rain supplemented.

Even though garlic had been widely cultivated in most places, but in some parts of the world, its productivity rate is extensively low due to their genetic, biotic, abiotic, and metabolic factors (Nonnecke, 1989). Various yield issues regard for the low cultivation rate of garlic in Ethiopia. In Ethiopia, various yield issues regards for the low cultivation rate of garlic. The main constrains are i) Deficiency of proper diseases ii) Insect pest management practices iii) Absence if improved planting materials iv) Unsuitable agronomic practices v) Marketing facilities (Zeray and Mohammed 2013). Fungal diseases are the most important limitation for garlic production rate and its productivity. In fungal diseases, Sclerotium cepivorum is caused by white rot, and it a very dangerous disease of garlic production throughout the world including Ethiopia (Dennis, 1986). In Ethiopia, compared to any other kind of vegetable diseases sustenance onion and garlic is the most pressing problem and it is very dangerous to rectify (Mohammed Amin *et al.*, 2014). The region Northern Shewa in Ethiopia, white rot incidence had destroys the farmer's field was delineate at the rate ranging from 37.28 to 42%. The total cultivation loss had been found in the range of 20.7% to 53.4% (Tamire *et al*., 2007). Garlic white rot becoming the prominent issue and it gradually decreases the garlic production rate in various part of the country said by Mengistu (1994).

Soil borne pathogens like S. cepivorum is caused the management of diseases and multipronged management strategy is needed to rectify this disease pandemic. Researches ongoing in Ethiopia is quite limited based on host resistant adverse to white rot. To abolish the white rot diseases management, fungicides is only the most effective options. It totally destroys its spreading activity, so white rot diseases lost its vulnerability. Systemic and non-systemic fungicides gradually destroys the incidence of white rot, so that severity of the disease gradually decreases and it paves the way for good yielding of garlics Tamire *et al*. (2007). The another most effective treatment of reducing the white rot incidence is Tebuconazole and it also reduces the disease progress and increasing the cultivation rate when applied with treatment of clove (Melero-Vara *et al*., 2000; Duff *et al*., 2001). But in Ethiopia, research efforts of these integrated disease management based on garlic yields against white rot is quite limited. Hence, this research work focusses, to examine the garlic varieties and its combined with fungicides for the

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management of white rot disease and to identify the best yields and the effective fungicide and also to evaluate the yield loss in Gudar, West Shewa, Ethipia.

## Methodologies and Materials:

### Illustration of the research work:

The field demonstration was at Ambo University, Gudar block experimental farms, in the course of 2018/19 main cropping season under rain fed. It is located in Addis Ababa from 130 km west at 37°83' East longitude, 8°98' North latitude and altitude range 2000-2010. Its temperature extend between 10-27$^{o}$C and annual rainfall extend between 900-1100, with an average temperature of 18$^{o}$C. The type of soil of the study site is vertisol and its pH value is 6.7(EARO, 2004). The try-out was carried out in field naturally penetrate with white rot's sclerotia (observation of the cultivated field of garlic and onion infected by scelotia at experimental fields before conducting the project.

### Materials to be used for Demonstration:

Varieties used: Five varieties of garlic viz. Holeta (G-HL), Chefe (G-104-1/94), Tsedey (G-493), Kuriftu (G-59-2/94) and local were used for the field trial. Holeta, Chefe, Kuriftu and Tsedey are improved varieties released by Debre Zeit Agricultural Research Center, while the local variety was obtained from locally cultivated by farmers in Guder areas.

**Table I.** Characteristics of garlic varieties used in this experiment.

| Garlic varieties | Genotype | Year of released | Breeder/Maintainer |
|---|---|---|---|
| Holeta | (G - HL) | 2015 | DebreZeit ARC/EIARI/ |
| Chefe | (G -104-1/94) | 2015 | DebreZeit ARC/EIARI |
| Local | * | * | Gudar Farmers |
| Kuriftu | (G-59-2/94) | 2010 | DZARC/EIAR |
| Tsedey | (G-493) | 1999 | DZARC/EIAR |

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**Fungicides used and their Preparation and applications:**

The registered fungicides, Tebuconazole (Natura 250 EW 0.5lts/ha) which is recommended for garlic white rot is used as a standard check and Pro-seed plus 63 WS (200g/100kg) which is registered for soil and seed borne diseases were used, and which were obtained from Lion International Trading PLC, Addis Ababa, Ethiopia. Coating of clove with moistened powders of Pro-seed plus 63 WS had to be done by using 5ml of water to making a slurry of the required fungicide and then 480 g of cloves in a polythene sac by repeatedly roating. Tebuconazole's Cloves dip treatment had done by dipping 480g cloves in 1ml solution of Tebuconazole in 1 liter of water about 5 hours and also each variety are compared with control separately(Getachew et al., 2011).

**Demonstration of Management and Design:**

The demonstration was carried out in a Randomized Complete Block Design (RCBD) along with 3 replications in $3m^2$ plots also 1m spacing in the middle blocks and 0.5m in the middle of plots. The experiment was arranged in two factors at each three and five level (5 x 3) factorial experiment of five varieties and two fungicides along with the untreated control. Uniform size and healthy cloves of garlic varieties treated with fungicides were planted in experimental fields on August 7, 2018 at Gudar Campus. In a plot, the planting was done at five rows along with 0.30m in the middle of rows and plants were between 0.15m in the row.

**Data collection:**

For Each plot, the data for harvest and inital, final plant stand count at emergence. The Disease occurrence (Percent Diseased Plants)had been recorded from each plot. Correspondingly, the percentage of germinated cloves per 30 DAP(Days After Planting) is used to determining the Initial garlic stand establishment. Final garlic stand count is fixed as harvested bulb. Plant height is observed from the 16 randomly selected plant at the highest growth stage. White rot occurrence was observed 6 times every fifteen days of interval from the first appearance of the disease in the plots.

The total number of affected plant were calculated from three middle rows of 12 pre tagged plants per each plot at 45, 60, 75, 90, 105 and 120 DAP (days after planting). The current disease incidence was calculated using the following equation:

$$\textbf{Disease incidence } \% = \frac{\text{Number of diseased plants}}{\text{Total number of plants inspected}} \text{x}100$$

The Bulbs is harvested from the inbetween three rows. The collected bulb from each plot is allowed to make dry for 15 days and get to find out cultivation and other cultivation constituent like diameter of bulb, marketable and total yields, affected bulbs and number of cloves per bulb had been selected from harvested bulbs and severity rate been 0-5 scales, where 0 means healthy; 1 means bulb enclose with mycelium but not rotten; 2 means bulb rotten(1-25%); 3 means bulb rotten(25-50%); 4 means bulb rotten(50-75%) and 5 means bulb rotten(75-100%)(Bertolini and Tian, 1995). The procedure for converting the disease severity scores into percentage and that had been stated below:

$$\text{Disease severity } (\%) = \frac{\text{Total Point score}}{\text{Total number of } \textbf{bulbs} \text{ scored} * \text{highest score on the scale}} \text{X } 100$$

Area under disease progress curve (AUDPC) was calculated for each treatment from the assessment of disease incidence using the formula:

The Assessment of disease occurrences had been used to calculating the Area Under Disease Progress Curve (AUDPC). The formula for calculating AUDPC is

$$AUDPC = \sum_{t-1}^{N-1} [(Y_i + Y_{i+1})(T_{i+1} - T_i) \div 2)$$

Where $Y_i$ = The disease occurrence in terms of percentage at $i^{th}$ computation,

$T_i$ = The time of the $i^{th}$ computation in days from the first computation date

N= The total number of days the disease was examined (Campbell and Madden,1990).

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Consequently, the incidence was expressed as in terms of percent and time in days, AUDPC was expressed in %days.

Disease incidence was transformed using linear model ln(y/l-y) (Campbell and Madden, 1990) transformation before analysis. Transformed data were subjected to linear regression to determine disease progress rate. The disease progress rate for each plot was estimated as the slope of the regression line of the disease progress data. In all cases, DAP (Days after planting) was used as predictor and incidence as response variables.

Each treatment, the relative losses in yield were determined as percentage of that treated plots of the experiment. For each treatments, the losses were calculated separately. Percentage of the protected plots and yield loss was calculated based on the formula of :

$$RYL(\%) = \frac{(Yp - Yt)}{Yp} * 100$$

Where, RYL = Relative Yield Loss in terms of percent

$Y_p$ =Yield from the maximum treated plots

$Y_t$= yield from other plots.

**Data Analysis:**

Data Analysis is done using ANOVA test. It is performed over the complete block designs with factorial arrangement to examine the fungicides effect and various varieties with help of the software mention in(SAS Institute, 2008). Treatment is nothing but when compared by means of Least Significant Difference(LSD) of fisher.

**Analysis based on Cost-benefit:**

In local market, we get the garlic bulbs (Birr ton'1) cost and also the total sale from 1 hectare was calculated. The cost of all local and improved garlic cultivar was birr 24000 per 800 kg. Also, the cost of Tebuconazole, fungicides and Pro-seed plus 63 WS were 625 birr per liter and 960 birr per kilogram, respectively.

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By using the Partial Budget Analysis, the Cost Benefit Analysis were generated. Partial budget Analysis is a way of categorizing data and information respect to the benefits and cost of different agricultural alternatives (CIMMYT. 1988). It provides the benefit value obtained per amount of extra cost incurred percentage. The formula is given as follows:

$$MRR = \frac{DNI}{DIC} * 100$$

Where, MRR = Marginal Returns of Rate

DNI = Difference in Net Income compared with control

DIC =Difference in Input Cost compared with control

By using partial budget, the Subsequent points is considered in the course of cost benefit analysis

1. For all treatments, the costs of total agronomic practices be uniform.
2. For each variety, the price of garlic bulb per tons was taken depend on local price.
3. Labor’s cost was taken depend on local price
4. Benefit and cost be calculated per hectare basis.

## Results and discussions

### White rot incidence, severity and AUDPC

In this research work, we noticed the symptoms of white rot after 40 days of planting. Affected plants shows a symptoms like its leaves be yellowish and become limp. The interaction effect of significant disease occurrence had been observed at every computation dates out of the treatments($P<0.05$). In such a way, when compared to untreated fungicide plots, treated fungicide plots laid a lowest initial and final occurrences of disease, also it was observed and noticed. The results showed that in Pro-seed plus 63 WS treated plots, the final average disease occurrences was reduced by 35% as compared to untreated plots and the treated plots of Tebuconazole reduce final disease occurences by 11% when compare to untreated plots. Hence, the lowest initial and final white rot occurrence was recorded from the interaction of fungicide with a variety as compared with untreated ones.

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The results showed that the lowest initial and final diseases incidence was recorded from Tseday variety treated with a Pro-seed plus **63WS** as compared with other interactions, which was recorded as 2.78 and 33.33%. From the untreated variety, we recorded the highest initial and final occurrences of diseases was recorded. Also specifically local, Holeta and Chefe varieties were the variety which was recorded as the highest final disease incidences as compared to other treatments. The results showed that the variety Tseday and Pro-seed plus 63 WS fungicides were promising in reducing diseases incidence followed by Kuriftu variety and Tebuconazole (Table II).

**Table II.** Interaction effect of fungicide and varieties on white rot occurrences, AUDPC, Severity at Ethiopia in the region of Gudar, West Shewa, during 2018/2019

| **Treatments** | **IWRI (%)** | **FWRI (%)** | **WRS (%)** | **AUDPC** |
|---|---|---|---|---|
| Holeta + Tebuconazole | 16.67$^{e}$ | 55.55$^{c}$ | 13.33$^{bcd}$ | 2667$^{f}$ |
| Holeta + Proseed plus 63 WS | 8.33$^{bc}$ | 41.67$^{b}$ | 12.00$^{bcd}$ | 2000$^{bc}$ |
| Holeta control | 16.67$^{e}$ | 58.33$^{c}$ | 18.67$^{d}$ | 3062$^{g}$ |
| Chefe + Tebuconazole | 8.33$^{bc}$ | 47.22$^{b}$ | 13.33$^{bcd}$ | 2292$^{de}$ |
| Chefe + Proseed Plus63WS | 8.33$^{bc}$ | 41.67$^{b}$ | 6.67$^{ab}$ | 1833$^{b}$ |
| Chefe control | 13.89$^{de}$ | 66.67$^{d}$ | 29.33$^{e}$ | 3188$^{g}$ |
| Tseday + Tebuconazole | 8.33$^{bc}$ | 44.45$^{b}$ | 9.33$^{abc}$ | 2104$^{cd}$ |
| Tseday + Proseed plus 63WS | 2.78$^{a}$ | 33.33$^{a}$ | 4.00$^{a}$ | 1354$^{a}$ |
| Tseday control | 16.67$^{e}$ | 55.55$^{c}$ | 12$^{bcd}$ | 2458$^{ef}$ |
| Kuriftu + Tebuconazole | 8.33$^{bc}$ | 55.55$^{c}$ | 13.33$^{bcd}$ | 2396$^{e}$ |
| Kuriftu + Proseed plus 63WS | 5.55$^{ab}$ | 41.67$^{b}$ | 10.67$^{abc}$ | 1937$^{bc}$ |
| Kuriftu control | 13.89$^{de}$ | 55.55$^{c}$ | 18.67$^{d}$ | 2521$^{ef}$ |
| Local + Tebuconazole | 11.11$^{cd}$ | 47.22$^{b}$ | 16.00$^{cd}$ | 2146$^{cd}$ |
| Local +Proseed plus 63WS | 8.33$^{bc}$ | 44.45$^{b}$ | 9.33$^{abc}$ | 1771$^{b}$ |
| Local control | 16.67$^{e}$ | 66.67$^{d}$ | 42.67$^{f}$ | 2958$^{g}$ |
| **CV (%)** | **25.4** | **7** | **30.7** | **6.1** |
| **LSD (5%)** | **4.68** | **6.05** | **7.9** | **241.8** |

- **CV** stands for Coefficient of Variation;

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- **LSD** stands for Least Significant Difference;
- **IWRI** stands for Initial White rot occurence at 45 Days After Planting (DAP);
- **FWRI** stands for Final white rot occurrence at 120 days after planting (DAP);
- **WRS** stands for white rot severity based on harvested bulbs;
- **AUDPC** stands for Area under Disease Progress Curve;

The severity of disease was examined based on harvested bulbs, also showed that the major differences on treatments ($P<0.05$). Consequently, In an untreated control plots, the severity rate is significantly high. When compared to fungicide treated plots, untreated control plots was recorded highest severity rate. The fungicide treated plots reduced its severity rate upto 64.25% and its was observed in pro-seeds plus 63 WS treated control plots over untreated control plots. Also, Tebuconazole treated plots have lower severity rate when compared to untreated control plots. Tebuconazole treated plots was reduces severity rate upto 46.15% and its was successfully observed. Significant difference of disease severity was recorded the interaction of garlic varieties with a fungicide (Table 2). The highest percentage of diseases severity was recorded from untreated local variety as compared to others (42.67%) and the Disease severity of lowest percentage level was recorded from Tseday variety and also treated with Pro-seed plus63.

Area Under Disease Progress Curve (AUDPC) is used to observe the significant difference among treatments and AUDPC value at ($P<0.05$). The AUDPC lowest rate was observed from Tseday variety treated with Pro-seed plus which is resulted as 1354 % -days as compared to other treatments. The highest AUDPC was recorded from untreated Chefe variety (3188%-days). Even if the two fungicide treatments were effective in reducing white rot incidence, severity and AUDPC as compared to untreated plots, there was no complete total control of garlic white rot. This result is in line with the previous research findings of different authors, Tamire *et al*. (2007) reported that the systemic as well as non-systemic fungicides significantly reduced incidence of white rot, its progress rate, severity, and there by improved garlic yield. Similarly, Duff *et al.* (2001) reported that these Tebuconazole was effective in reducing the incidence, severity and progress of the disease and in increasing the yield when applied as clove treatments. Fullerton and Stewart (1991) also found that, in Tebuconazole treated plots the occurrences of diseases was decreased upto 85% when compared to untreated plots of onion. Fungicide treatments not only protect the plants from white rot diseases at different stages, but it also provide another major advantage to plants. i.e. At the time of harvesting, it reduced the Sclerotia

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formation in the soil and its was reported by Getachew *et al.* (2011). In these research work, we observed that the amount of diseases control by treating with Pro-seed plus 63 WS was much higher than the Tebuconazole and untreated control plots. The result is moreover similar to the treatment of Tebuconazole by Melero-Vara *et al*. (2000). Basal spray is accomplished major reduction in the Progress rate of diseases and the final occurrence of plant death by *Sclerotium cepivorum.* Solarised and Tebuconazole treated cloves also provide similar prominent reduction in occurrence of diseases, severity rate and AUDPC values and they produce quantitative and qualitative cultivation improvement by Prados-Ligero *et al*. (2002). Many other researchers proved that the hybrid of Tebuconazole and a bio control gas improved the control of white rot diseases of onion(Clarkson *et al.*, 2006; Ararsa and Selvaraj, 2013).

**Disease progress rate:**

The outcome of various fungicides on occurrence of diseases was evaluated on 6 times throughout the cropping season. The progress rate of diseases was significantly various among treatments at ($P<0.05$). The Disease progress rate and its coefficient determination on 5 different varieties are given in (**Table III**). Significantly, various diseases development among fungicides treated plots was observed. Lowest progress rate of diseases was observed in Tseday variety treated it with Pro-seed plus (0.009534unit day$^{-1}$) followed by Kuriftu variety treated with Pro-seed plus (0.02272 unit day $^{-1}$). The fastest diseases progress rate was recorded in untreated Chefe variety (0.03339 unit days $^{-1}$).

Table 1.Disease progress rates on white rot disease occurrence on the garlic under examine of fungicides on five varieties at the region of West Shewa in Ethiopia.

| **Treatments** | **Intercept** | **Intercept Of SE*** | **progress rate ** of Disease** | **Rate of SE*** | **$R^2$ In terms of (%)** | **Significant** |
|---|---|---|---|---|---|---|
| Holeta + Tebuconazole | -2.646 | 0.153239 | 0.02422 | 0.02348 | 94% | 0.0001 |
| Holeta + Proseed Plus63WS | -3.458 | 0.274383 | 0.02783 | 0.07529 | 88% | 0.0001 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Holeta control | -2.538 | 0.214271 | 0.02533 | 0.04591 | 91% | 0.0001 |
| Chefe + Tebuconazole | -3.426 | 0.268787 | 0.02971 | 0.0722 | 89% | 0.0001 |
| Chefe + Proseed Plus63WS | -3.625 | 0.236035 | 0.02854 | 0.05571 | 91% | 0.0001 |
| Chefe control | -3.163 | 0.322257 | 0.03339 | 0.1038 | 88% | 0.0001 |
| Tseday + Tebuconazole | -3.6 | 0.258694 | 0.03025 | 0.0669 | 90% | 0.0001 |
| Tseday + Proosed plus63WS | -2.104 | 0.758219 | 0.009534 | 0.5749 | 5% | 0.191 |
| Tseday control | -2.839 | 0.192369 | 0.02514 | 0.03701 | 92% | 0.0001 |
| Kuriftu + Tebuconazole | -3.811 | 0.167512 | 0.03517 | 0.0281 | 97% | 0.0001 |
| Kuriftu + Proosedplus63WS | -2.956 | 0.609545 | 0.02272 | 0.37155 | 48% | 0.001 |
| Kuriftu control | -3.109 | 0.262097 | 0.02833 | 0.0687 | 89% | 0.0001 |
| Local + Tebuconazole | -3.215 | 0.214645 | 0.02663 | 0.04607 | 91% | 0.0001 |
| Local +Proseed plus63WS | -3.976 | 0.248679 | 0.03203 | 0.0618 | 92% | 0.0001 |
| Local control | -2.838 | 0.141665 | 0.02875 | 0.02007 | 97% | 0.0001 |

*Parameter estimates for the standard error; $R^2$ = coefficient determination. **Progress rate of disease is measure in terms of unit per days.

Almost similar rate of disease development was observed among untreated garlic varieties (**Table III**). Melero-Vara *et al*. (2000) had reported a similar result in that, they stated garlic cloves treated with Tebuconazole and basal spray was accomplished the significant bargain in the disease progressive rate, in such a way that the final occurrence of death of plant by Sclerotium cepivorum. Furthermore, systemic fungicides had majorly reduced progression rate of white rot diseases and by that means improved garlic cultivation reported by Tamire *et al*. (2007). Parameters are estimates from a linear regression of logistic model Ln(y%1-y) disease occurrence is proportion to time(Days After Planting). Equation of the line denotes the Intercept and Slope.

**Yield and yield components:**

The interaction results showed that significantly varied plant height was observed among treatments at (P <0.05) and the highest plant height was recorded from Tseday variety treated with Pro-seed plus (71.77%) followed by local variety treated with the same fungicide (70.39%) which is statistically not different and the lowest plant height was recorded from untreated Holeta (44.39%) and Chefe (51.13%) varieties.

The total number of harvested bulbs (expressed as % of final stand) was examined and there was a major differences at (P<0.05) among treatments (**Table IV**). Correspondingly, Tseday variety treated with Pro-seed plus 63 WS (3.047t $ha^{-1}$) had achieved the highest range of

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marketable yield was recorded and followed by Kuriftu variety treated with the same fungicide (2.973t ha$^{-1}$) compared to the untreated control plots varieties while the untreated plots gave the lowest yield. The important difference on marketable and total cultivation among garlic varieties were also observed, Tseday variety recorded higher marketable yield compared to the other four varieties (**Table IV**). The results showed that, when compared with Procymidone treated garlic cloves, Tebuconazole treated garlic cloves achieved the highest marketable yields on the attempt conducted heavily infested with sclerotia of Sclerotium cepivorum Duff *et al*.(2001). And consecutively, Prados-Ligero *et al*. (2002) stated that similar significant reduction of occurrence of diseases and severity was observed in Tebuconazole treated cloves, resulting in quantitative and qualitative yield improvement. In these research work, the Pro-seed plus 63 WS treated plots recorded that significantly increases total and marketable yield on Tseday garlic variety as compared to the other four garlic varieties. The other varieties of garlic may be the reason for the host resistant in which similar findings were supported by others garlic white rot control studies (Coley- Smith, 1987; Utkhede and Rahe, 1980).

The relative cultivation losses because of white rot on the marketable bulb cultivation of garlic**.** The dissimilarity of yield losses was detected in middle of the treatments. Losses on bulb yield for different fungicide treated plots were calculated relative to the higher yield recorded plots. When compared with treated plots with fungicide, the untreated (Control) plot's yield losses were noticeably higher. There might be bulb treated with fungicide destroy the sclerotia development in the soil. Likewise, according to Mohammed and Zeray(2013) stated that during favorable weather conditions and when susceptible varieties are in the production system the white rot disease cause 100% cultivation loss. Due to white rot disease in Ethiopia, yield loss had been found between the range of 20.7% to %3.4%( Tamire *et al.,* 2007).

Table 2. Interaction of Yield and yield components of Garlic varieties treated with fungicides at Gudar, West Shewa, Ethiopia**.**

| **Treatments** | **IPS** | **PH** | **HB** | **NC** | **BD** | **TY** | **MY** |
|---|---|---|---|---|---|---|---|
| Holeta + Tebuconazole | 41.88$^{g}$ | 50.8$^{h}$ | 76.97$^{de}$ | 5.53$^{e}$ | 20.41$^{def}$ | 1.87$^{gh}$ | 0.88$^{h}$ |
| Holeta + Proseed Plus63WS | 52.14$^{f}$ | 55.27$^{fgh}$ | 84.24$^{cd}$ | 6.2$^{de}$ | 23.79$^{bcd}$ | 2.11$^{f}$ | 1.78$^{ef}$ |
| Holeta Control | 29.92h | 44.39i | 72.12$^{ef}$ | 4.73$^{e}$ | 16.16$^{f}$ | 1.74$^{hi}$ | 0.53$^{h}$ |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Chefe + Tebuconazole | 40.17$^{g}$ | 52.15$^{gh}$ | 76.36$^{e}$ | 6.27$^{de}$ | 19.44$^{def}$ | 1.74$^{hi}$ | 0.88$^{h}$ |
| Chefe + Proseed Plus63WS | 51.28$^{f}$ | 59.83$^{def}$ | 84.24$^{cd}$ | 7.2$^{cd}$ | 22.46$^{cde}$ | 2.00$^{fg}$ | 1.29$^{fg}$ |
| Chefe Control | 40.17$^{g}$ | 51.13$^{h}$ | 64.85$^{f}$ | 5.67$^{de}$ | 17.49$^{ef}$ | 1.61$^{i}$ | 0.50$^{h}$ |
| Tseday + Tebuconazole | 73.5$^{cde}$ | 64.68$^{cd}$ | 92.73$^{ab}$ | 9.27$^{ab}$ | 28.74$^{ab}$ | 3.62$^{b}$ | 2.24$^{cd}$ |
| Tseday + Proseedplus63WS | 82.05$^{abc}$ | 71.77$^{a}$ | 95.15$^{a}$ | 9.93$^{a}$ | 32.54$^{a}$ | 4.04$^{a}$ | 3.047$^{a}$ |
| Tseday control | 72.65$^{de}$ | 58.94$^{ef}$ | 84.24$^{cd}$ | 8.4$^{abc}$ | 26.59$^{bc}$ | 2.88$^{d}$ | 1.46$^{fg}$ |
| Kuriftu + Tebuconazole | 66.67$^{e}$ | 60.75$^{de}$ | 93.94$^{ab}$ | 8.67$^{abc}$ | 22.06$^{cde}$ | 3.14$^{c}$ | 2.19$^{d}$ |
| Kuriftu + Proseedplus63WS | 77.78$^{bcd}$ | 69.02$^{abc}$ | 90.91$^{abc}$ | 9.33$^{ab}$ | 24.1$^{bcd}$ | 3.53$^{b}$ | 2.97$^{ab}$ |
| Kuriftu control | 51.28$^{f}$ | 56.25$^{efg}$ | 86.67$^{bc}$ | 8.13$^{bc}$ | 21.54$^{cde}$ | 2.36$^{e}$ | 1.42$^{fg}$ |
| Local + Tebuconazole | 84.62$^{ab}$ | 66.03$^{bc}$ | 95.15$^{a}$ | 8.73$^{abc}$ | 28.28$^{ab}$ | 3.13$^{c}$ | 1.96$^{de}$ |
| Local + Proseed plus 63WS | 90.6$^{a}$ | 70.39$^{ab}$ | 96.97$^{a}$ | 9.07$^{ab}$ | 28.59$^{ab}$ | 3.96$^{a}$ | 2.63$^{bc}$ |
| Local Control | 77.78$^{bcd}$ | 61.07$^{de}$ | 93.33$^{ab}$ | 8.13$^{bc}$ | 21.12$^{def}$ | 2.94$^{d}$ | 0.76$^{h}$ |
| **CV (%)** | **10.1** | **5.5** | **4.9** | **11.8** | **13.6** | **3.3** | **14.97** |
| **LSD (5%)** | **9.17** | **4.87** | **7.34** | **1.54** | **5.32** | **0.15** | **0.41** |

IPS=Initial plant stand (%); PH=Plant Height (cm); HB=Harvested Bulb (%); TY=Total Yield (t/ha); MY-Marketable Yield (t/ha); NC=Number of clove/ bulb; BD=Bulb diameter (cm)

**Cost benefit Analysis**:

Variances indicated that the major difference was detected among treatments on Income Total, Cost of Input, Marginal Cost, Net Benefit (P<0.05). Consecutively, highest net profit was achieved from Pro-seed plus63 WS treated varieties compared to Tebuconazole and untreated control plots. The application of Pro-seed plus 63 WS provided net benefit birr 55275(ETB/ha) in Holeta, 33225(ETB/ha) in Chefe, 112155(ETB/ha) in Tseday (G-493), 108825(ETB/ha) in Kuriftu and 93390 (ETB/ha) in Local. The equivalent value of Rate of margin of return be 5759.38, 3584.38, 7325, 7193.75 and 8665%, respectively (**Table V**). The significant differences among garlic variety on net benefit was observed (P<0.01). Tseday (G-493) variety treated with Pro-seed plus shows highest net benefit (112155) birr $t^{-1}$ over the other four garlic variety with zero and minimum input difference (**Table 5**). The further Cost of input in treated plots of fungicides was 625.00 and 960.00 birr in Tebuconazole and Pro-seed Plus, respectively. It was found that the treated plots of Pro-seed plus 63 WS provided significantly higher net benefit over Tebuconazole and untreated control plots. The best recommendation for treatments not subjected the highest rate of margin of return, reasonably based on comparitively minimum acceptable rate of margin of return and the highest net benefit treatment together with an satisfactory MRR becomes the uncertain recommendation (CIMMYT, 1988).

**Table V**. Analysis of Partial budget for the management of garlic white rots by means of fungicides and host resistance in Gudar West Shewa, Ethiopia.

| **Treatments** | **Cost benefit data** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | MY | SP | SR | TIC | MC | NB | MB | MRR |
| Holeta + Tebuconazole | 0.88 | 45000.00 | 39465.00 | 24625.00 | 625.00 | 14840.00 | 14855.00 | 2376.80 |
| Holeta + Proseed Plus | 1.78 | 45000.00 | 80235.00 | 24960.00 | 960.00 | 55275.00 | 55290.00 | 5759.38 |
| Holeta control | 0.53 | 45000.00 | 23985.00 | 24000.00 | 0.00 | -15.00 | 0.00 | 0.00 |
| Chefe + Tebuconazole | 0.88 | 45000.00 | 39600.00 | 24625.00 | 625.00 | 14975.00 | 16160.00 | 2585.60 |
| Chefe + Proseed Plus | 1.29 | 45000.00 | 58185.00 | 24960.00 | 960.00 | 33225.00 | 34410.00 | 3584.38 |
| Chefe control | 0.51 | 45000.00 | 22815.00 | 24000.00 | 0.00 | -1185.00 | 0.00 | 0.00 |
| Tseday + Tebuconazole | 2.24 | 45000.00 | 100665.00 | 24625.00 | 625.00 | 76040.00 | 34205.00 | 5472.80 |
| Tseday + Proosed plus | 3.05 | 45000.00 | 137115.00 | 24960.00 | 960.00 | 112155.00 | 70320.00 | 7325.00 |
| Tseday control | 1.46 | 45000.00 | 65835.00 | 24000.00 | 0.00 | 41835.00 | 0.00 | 0.00 |
| Kuriftu + Tebuconazole | 2.20 | 45000.00 | 98865.00 | 24625.00 | 625.00 | 74240.00 | 34475.00 | 5516.00 |
| Kuriftu + Proosed plus | 2.97 | 45000.00 | 133785.00 | 24960.00 | 960.00 | 108825.00 | 69060.00 | 7193.75 |
| Kuriftu control | 1.42 | 45000.00 | 63765.00 | 24000.00 | 0.00 | 39765.00 | 0.00 | 0.00 |
| Local + Tebuconazole | 1.96 | 45000.00 | 88200.00 | 24625.00 | 625.00 | 63575.00 | 53375.00 | 8540.00 |
| Local +Proseed plus | 2.63 | 45000.00 | 118350.00 | 24960.00 | 960.00 | 93390.00 | 83190.00 | 8665.63 |
| Local control | 0.76 | 45000.00 | 34200.00 | 24000.00 | 0.00 | 10200.00 | 0.00 | 0.00 |

MY=Marketable Yield (t/ha); SP=selling price ((Birr $t^{-1}$); SR=Selling Revenue; TIC= Total input cost (ETB/ha); MC=Marginal Cost (ETB/ha); NB=Net Benefit(ETB/ha); MB=Marginal Benefit (ETB/ha); MRR= Marginal Rate of Return (%)

## Conclusions

The present study identified that white rot incidence, severity, AUDPC, Progress Rate of disease and other cultivation and cultivation components was varied of fungicides and its various varieties. Eventhough, if two fungicides had been effective in reducing the Occurrence of diseases, Severity of diseases, Progress rate of diseases and AUDPC over untreated control plots, Pro-seed plus 63 WS is also the effective way to reducing the Occurrences of diseases, severity of diseases, Progress rate of diseases and area under progress than the Tebuconazole treated plots. Moreover, higher increment on overall and marketable cultivation as well as other cultivars and cultivars components was observed in Proseed plus 63 WS treated plots as compared to Tebuconazole and untreated control plots. Although it is not as much as effective as Pro-seed plus Tebuconazole was also reduce the incidence, severity, Progress rate of diseases and the area beyond progress curve as compared to untreated varieties. Among garlic varieties, Tseday (G-493) was promising in terms of reducing the epidemics of diseases and provide best total and marketable bulb yield and yield components followed by Kuriftu (G-59) varieties. So, as this experiment showed Tseday varieties treated with Proseed plus 63 WS was the most worthwhile in terms of reducing the epidemics of diseases and also intensifying the cultivars and cultivars components as compared to others. However, for wider applications or recommendation of these management options, further research should be conducted with the same varieties combinations with fungicides against white rot under multi locations and in different seasons.

## Significance statement

The present study revealed that help the researcher to direct their attentions and implement of integrated control strategies needs comprehensive studies on the efficacy of plant protection on different varieties at different application intensity.

## References

[1] Amin, M., Tadele, S. and Selvaraj, T. (2014). White rot (*Sclerotium cepivorum*-Berk) an
[2] aggressive pest of onion and garlic in Ethiopia: An overview. Journal of Agricultural
[3] Biotechnology and Sustainable Development, 6: 6-15. 11.
*[4]* Ararsa, L. and Selvaraj, T. (2013). Evaluation of *Arbuscular mycorrhizal* fungi and *Trichoderma*
[5] *Species* for the control of onion white rot (*Sclerotium cepivorum* Berk) J. Plant Pathol.
[6] Microbiol. 4:159.
[7] Campbell, C.L. and Madden, V.L. (1990). Introduction to Plant Disease Epidemiology,
[8] Wiley, New York, USA.

[9] CIMMYT. (1988). Farm Agronomic data to farmers' recommendations: Economic training
[10] manual. International Maize and Wheat Research Center, Mexico, 124p.
[11] Clarkson, J.P., Mead, A., Payne, T. and Whipps, J.M. (2006). Effects of environmental
[12] factors and *Sclerotium cepivorum* isolate on sclerotial degradation and biological control of
[13] white rot by *Trichoderma*. Plant Pathol. 53:353- 362.
[14] Coley- Smith, J.R. (1987). Survival of plant pathogenic fungi in soil in the absence of host
[15] plants. In: Soil borne plant pathogens, Schippers B, Gams W (Eds.), Academic Press, New
[16] York, USA
[17] CSA (Central Statistical Agency) (2016/ 2017). The preliminary results of area, production
[18] and yield of temporary crops. Statistical Bulletin, Volume 1, Addis Ababa, Ethiopia.
[19] Dennis, A.J., (1986). *Botrytis* neck rots of onion. Plant disease. http://cru.cahe.wsu.edu/CEPublications/eb1359/eb1359.html.
[20] Deresse, D. (2010). Antibacterial effect of garlic (*Allium sativum*) on *Staphyloccus aureus*; An in vitro study. Asian Journal of Medical Sciences 10: 62-65.
[21] Duff, A.A., Jackson, K.J. and O'Donnell, W.E. (2001). Tebuconazole (Folicur®) shows
[22] potential in the control of white rot (*Sclerotium cepivorum*) in garlic in subtropical
[23] Queensland, Australia. Proceedings of the 2nd International Symposium on Edible
[24] Alliaceae. Pp. 247-250.
[25] Ethiopian Agricultural Research Organization (EARO) (2004) .Directory of released crop
[26] varieties and their recommended cultural practices. Addis Ababa, Ethiopia.
[27] Etoh, T. and Simon, P. (2002). Diversity, fertility and seed production in garlic. In: Rabino witch, H. and Currah L. (Eds) *Allium* Crop Science: Recent Advances. CABIPp. 101-118.
[28] FAO (Food and Agricultural Organization Statistics) (2016). Garlic, production quantity (tons)
[29] for Ethiopia.
[30] Fekadu, M .and Dandena, G. (2006). Review of the status of vegetable crops production and
[31] marketing in Ethiopia. Uganda Journal of Agricultural Sciences, 12: 26 -30.
*[32]* Fullerton, R.and Stewart, A. (1991). Chemical control of onion white rots (*Sclerotium*
[33] *cepivorum* Berk) in the Pukekaohe district of New Zealand. New Zealand J. Crop. Hort. Sci.
[34] 19:121127.
[35] Getachew, T., Eshetu, D. and Tebkew, D. (2011). Management system of onion and garlic
[36] production and productivity technique by using fungicides (in Amharic) Debre Zeit
[37] Agricultural Research Centre (2nd edn.) Pp. 29-34.
*[38]* Kero, J. 2010. Survey and serological identification of viruses infecting Garlic (*Allium sativum)* in Ethiopia. M.Sc.,Thesis, Addis Ababa University, Addis Ababa, Ethiopia Pp.67

ISSN 2515-8260 Volume 07, Issue 06, 2020

[39] Mengistu, H. (1994). Research on vegetables disease in Ethiopia. In: Proceedings of the
[40] Second National Horticultural Workshop of Ethiopia, Herath, Dessalegne L (Eds.), Ethiopia
[41] Melero-Vara, J.M., Prados-Ligero, A.M. and Basallote-Ureba, M.J. (2000). Comparison of
*[42]* physical, chemical and biological methods of controlling garlic white rot (*Sclerotium*
[43] *cepivorum* Berk.). European Journal of Plant Pathology 106: 581-588.
[44] Nonnecke., I.L. (1989). Vegetable Production. Springer. New York, pp. 657 - 659.
[45] SAS Institute. (2008). SAS Institute Inc,Guide for Personal Computers. Cary, NC 2008
[46] Sovova, M. and Sova, P. (2004). Pharmaceutical importance of Allium sativum L., pp. 117-
[47] 123 Hypolipemic effects in -vitro and in- vivo (in Czech). Vol. 53 (3) CeskaSlovFarm.
[48] Prados-Ligero, A.M., Bascon-Fernandez, J., Calvet-pinos, C., Corpas-Hervias, C., Ruiz, A.L.
[49] and Melero-Vara, J.M. (2002). Effect of different soil and clove treatments in the control
[50] of white rot of garlic. Journal of Applied Biology 140:247:253.
[51] Tamire, Z., Chemeda, F., Sakhuja. K. P. and Seid, A. (2007). Yield loss assessment of garlic
[52] due to white rot (*Sclerotium cepivorum*), Addis Ababa, Ethiopia.
[53] Tian, S.P. and Bertolini, P.(1995). Effects of temperature on mycelial growth and spore
[54] germination of *Botrytis allii* in culture and on its pathogenicity to stored garlic bulbs. Journal of plant pathology 44:1008-1015.
[55] .Utkhede, R.S. andRahe, J.E.(1980). Treatment of muck soil with onion oil to control onion
[56] white rot. Canadian Journal of Plant Pathology 4: 153-155.
[57] Zeray, S. and Mohammed, Y. (2013). Searching and evaluating of cost effective management
[58] options of garlic white rot (*Sclerotium cepivorum* Berk) in Tigray, Northern Ethiopia. J. Plant Pathol. Microb. 4: 189.