<table>
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<tr>
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<th>Antagonistic Activity of <em>Trichoderma</em> Strains Against Pathogenic Fungi of <em>Arachis hypogaea</em> L.</th>
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<td>All Authors</td>
<td>Khin Yuzana and Hla Min Thein</td>
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Abstract

Fungi were isolated from the rhizospheric soils and infected leaves of *Arachis hypogaea* L. (groundnut) collected from Shwe Kyethtauk village, Sagaing Township, Sagaing Region. The fungi were isolated from rhizospheric soil using the Rose Bengal Medium for (KYZN 01), the Potato Dextrose Agar (PDA) medium for (KYZN 02) and (KYZN 03), from the infected leaves using the PDA medium. Pathogenic fungi were isolated from the infected parts of groundnut such as root rot, crown rot and pod rot by using PDA medium. The resulting pathogenic fungi were confirmed (KYZN 04) as *Macrophomina* sp., (KYZN 05) as *Aspergillus* sp. and (KYZN 06) as *Fusarium* sp.. The assay for antagonism was performed on PDA medium by dual culture method. The maximum inhibitory activity of *Trichoderma* strain (KYZN 01) was 69% against *Macrophomina* sp. and followed by 66% on *Fusarium* and 50% on *Aspergillus* sp.. *Trichoderma* strain (KYZN 02) showed maximum inhibition against 61% on *Macrophomina* sp. and followed by 50% on *Aspergillus* sp. and 48% on *Fusarium* sp.. *Trichoderma* strain (KYZN 03) showed the highest effects 72% against *Macrophomina* sp. But minimum inhibition was in 60% on *Fusarium* sp. and 56% on *Aspergillus* sp.. The significant inhibition of all three strains were observed in *Macrophomina* sp.. KYZN 03 was maximum inhibition percentage against on the all pathogenic fungi. All of the *Trichoderma* strains have significantly inhibition on pathogenic fungi which induce the major diseases symptom of groundnut plants. *Trichoderma* strains can be used as effective biocontrol agents for the diseases of groundnut plants.

Keywords

Antagonistic, *Trichoderma* strains, pathogenic fungi

Citation

Issue Date | 2018
Antagonistic Activity of *Trichoderma* Strains Against Pathogenic Fungi of *Arachis hypogaea* L.

Khin Yuzana\(^1\) and Hla Min Thein\(^2\)

**Abstract**

Fungi were isolated from the rhizospheric soils and infected leaves of *Arachis hypogaea* L. (groundnut) collected from Shwe Kyethtauk village, Sagaing Township, Sagaing Region. The fungi were isolated from rhizospheric soil using the Rose Bengal Medium for (KYZN 01), the Potato Dextrose Agar (PDA) medium for (KYZN 02) and (KYZN 03), from the infected leaves using the PDA medium. Pathogenic fungi were isolated from the infected parts of groundnut such as root rot, crown rot and pod rot by using PDA medium. The resulting pathogenic fungi were confirmed (KYZN 04) as *Macrophomina* sp., (KYZN 05) as *Aspergillus* sp. and (KYZN 06) as *Fusarium* sp.. The assay for antagonism was performed on PDA medium by dual culture method. The maximum inhibitory activity of *Trichoderma* strain (KYZN 01) was 69% against *Macrophomina* sp. and followed by 66% on *Fusarium* and 50% on *Aspergillus* sp.. *Trichoderma* strain (KYZN 02) showed maximum inhibition against 61% on *Macrophomina* sp. and followed by 50% on *Aspergillus* sp. and 48% on *Fusarium* sp.. *Trichoderma* strain (KYZN 03) showed the highest effects 72% against *Macrophomina* sp. but minimum inhibition was in 60% on *Fusarium* sp. and 56% on *Aspergillus* sp.. The significant inhibition of all three strains were observed in *Macrophomina* sp.. KYZN 03 was maximum inhibition percentage against on the all pathogenic fungi. All of the *Trichoderma* strains have significantly inhibition on pathogenic fungi which induce the major diseases symptom of groundnut plants. *Trichoderma* strains can be used as effective biocontrol agents for the diseases of groundnut plants.

**Keywords:** Antagonistic, *Trichoderma* strains, pathogenic fungi

**Introduction**

Groundnut plant is a legume crop that belongs to the family Fabaceae, genus *Arachis*, and botanically named as *Arachis hypogaea* L. It is one of the world's most popular oil seed crops. Its high content of oil and protein makes it an important commodity for both human use and livestock feed (Farag & Zahran 2014).

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1\(^{\text{st}}\) Myanmar-Korea Conference
The largest oilseed crop production area was Mandalay and Magway Divisions, with 149,639 ha and 120,477 ha in rainy seasons (Soe Soe Win 2007). Many plant species have been destroyed by plant pathogens with strongly damaged the crop yield. The fungus infects lower stems of groundnut, which are in contact with the soil as well as pegs, pods and roots (Adhilakshmi et al. 2013). Soil texture affected incidence of root and pod rot of groundnut caused by several fungi i.e. *Fusarium* sp., *Macrophomina* sp., *Rhizoctonia* sp. and *Aspergillus* sp. (Faujdar & Oswalt 1992).

Fungicides are widely used for controlling the various disease of plants. Control the diseases using chemical fungicides lead to pollution of atmosphere and have adverse effects on human health. Microorganisms as biocontrol agents have high potential to control plant pathogens and have no negative effect on the environment (Kavitha & Nelson 2013).

Antagonists are biocontrol agents such as bacteria, fungi, actinomycetes, viruses and nematodes that reduce the number of disease producing activities of the pathogens (Killanie et al. 2011). Biological control agents include strains belong to fungal genera such as *Trichoderma* sp., *Candida* and *Gliocladium* and bacterial genera such as *Bacillus* and *Pseudomonas*. Among the BCAs, *Trichoderma* sp. are the most intensively studied species (Hui 2013). In this study, *Trichoderma* sp. was isolated from the rhizospheric soil of *Arachis hypogaea* L. *Trichoderma* species are free living fungi that occur in nearly all the soils and other natural habitats. Tran (2010) reported that they are not only parasite of fungal plant pathogens but also can produce antibiotics.

The aim of this research work is to study the macroscopical and microscopical characters of *Trichoderma* strains isolated from rhizospheric soil and leaves of groundnut plants. To achieve this aims, the objectives are to isolate and characterize the pathogenic fungus strains from *Arachis hypogaea* L. and to investigate the antagonistic activity of *Trichoderma* strains against the pathogenic fungi of *Arachis hypogaea* L..
Materials and Methods

Study Area
Soil samples and plant material samples were studied from the groundnut plants growing in agricultural regions of Shwe Kyathtauk village, Sagaing Township, Sagaing Region in July 2016.

Collection of Soil Samples
Five soil samples were collected from the rhizospheric soil of healthy groundnut plants in different site of groundnut field in July 2016 (Attitalla et al. 2012).

Isolation of Antagonists
The fungus antagonists were isolated from the rhizosphere soil of groundnut, using serial dilution and pour plate technique on Rose Bengal Medium and Potato Dextrose Agar Medium (Johnson & Curl 1972).

Collection of Pathogenic Plant Samples
Morphological characters of groundnut specimens were studied, then identifications were made using keys and descriptions of Backer and Brink (1965).

Isolation Method for Plant Pathogenic Fungi
Plant pathogenic fungi were isolated by using (Ando & Inada 2004). The identification of Trichoderma strains and pathogenic fungi were identified by Barnett (1955) and Bessay (1952).

Growth Inhibition Assay by Dual Culture Method
Interaction between antagonistic efficacy of fungi and pathogenic fungi were determined by the method of Thanh et al. 2014.
Percent Inhibition of Radial Growth (PIRG) = $A_1 - A_2/A_1 \times 100$

Where,
$A_1$ = the radius of pathogenic fungi mycelium in the control plate
$A_2$ = the radius of pathogenic fungi mycelium in dual culture plate
PIRG = Percent Inhibition of Radial Growth
Fig. 1  Location map of specimen Collection Site in Shan Ka Lay Kyun village Amarapura Township

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Results

Figure 2.  
A. *Arachis hypogaea* L. with Rhizospheric soil  
B. Surface colony characters of *Trichoderma* strain (KYZN 01) on PDA medium (3 days)  
C. Reverse colony characters of *Trichoderma* strain (KYZN 01)  
D. Hyphae of *Trichoderma* strain (KYZN 01)  
E. Conidia of *Trichoderma* strain (KYZN 01) (arrow)

Figure 3.  
A. *Arachis hypogaea* L. with Rhizospheric soil  
B. Surface colony characters of *Trichoderma* strain (KYZN 01) on PDA medium (3 days)  
C. Reverse colony characters of *Trichoderma* strain (KYZN 01)  
D. Hyphae of *Trichoderma* strain (KYZN 01)  
E. Conidia of *Trichoderma* strain (KYZN 01) (arrow)

1st Myanmar-Korea Conference
Table 1: Characteristics of isolated antagonists fungi

<table>
<thead>
<tr>
<th>Isolated strain</th>
<th>Antagonists fungi</th>
<th>Macroscopical characters</th>
<th>Microscopical characters</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>KYZN 01</td>
<td><em>Trichoderma</em></td>
<td>White green, bright green to dull green. Reverse remains white.</td>
<td>Mycelium are septate. Conidiophores upright. Phialides are single, verticillate. Conidia are obvoid.</td>
<td>Rhizospheric soil</td>
</tr>
<tr>
<td>KYZN 02</td>
<td><em>Trichoderma</em></td>
<td>White to greyish and reverse colony in yellowish.</td>
<td>Conidiophores branch. Phialides are in false whorls. Conidia are globose.</td>
<td>Rhizospheric soil</td>
</tr>
<tr>
<td>KYZN 03</td>
<td><em>Trichoderma</em></td>
<td>White to greyish colouration. Reverse remains white.</td>
<td>Mycelium are septate. Conidiophores branch. Phialides are in false whorl. Conidia are short ellipsoid usually rounded.</td>
<td>Leaf spot</td>
</tr>
</tbody>
</table>

Figure 4. A. Leaf spot disease symptom infected on leaves of groundnut (arrow)
B. Surface clony characters of *Trichoderma* strain (KYZN 03) on PDA medium (3 days)
C. Reverse colony characters of *Trichoderma* strain (KYZN 03)
D. Hyphae of *Trichoderma* strain (KYZN 03)
E. Conidia of *Trichoderma* strain (KYZN 03) (arrow)
Figure 5. A. Leaf spot disease symptom infected on root of groundnut (arrow)  
B. Surface colony characters of *Macrophomina* sp. (KYZN 04) strain on PDA medium (3 days)  
C. Reverse colony characters of *Macrophomina* sp. (KYZN 04)  
D. Hyphae with pycnidia of *Macrophomina* sp.  
E. Conidia of *Macrophomina* sp. (arrow)

Figure 6. A. Leaf spot disease symptom infected on stem of groundnut (arrow)  
B. Surface colony characters of *Aspergillus* sp. (KYZN 05) strain on PDA medium (3 days)  
C. Reverse colony characters of *Aspergillus* sp. (KYZN 04)  
D. Hyphae with pycnidia of *Aspergillus* sp.  
E. Conidia of *Aspergillus* sp. (arrow)
Table (2) Characteristics of pathogenic fungi isolated from infected parts of *Arachis hypogaea* L.

<table>
<thead>
<tr>
<th>Isolated strain</th>
<th>Pathogenic fungi</th>
<th>Macroscopical characters</th>
<th>Microscopical characters</th>
<th>Diseases</th>
</tr>
</thead>
<tbody>
<tr>
<td>KYZN 04</td>
<td><em>Macrophomina</em> sp.</td>
<td>White to brown or gray and darken at mature. Reverse remains dark.</td>
<td>Pycnidia are dark to grayish, globose or flattened globose. Conidiophores are septate. Conidia are hyaline, elliptical or oval.</td>
<td>Root rot (root)</td>
</tr>
<tr>
<td>KYZN 05</td>
<td><em>Aspergillus</em> sp.</td>
<td>Pale yellow colony at firstly and turn to black. Reverse remains pale yellow.</td>
<td>Hyphae are septate. Conidiophores are upright, simple. Conidia are spherical</td>
<td>Crown rot (stem)</td>
</tr>
<tr>
<td>KYZN 06</td>
<td><em>Fusarium</em> sp.</td>
<td>White and cottony. Reverse remains pale</td>
<td>Hyphae are septate. Conidiophores branch. Conidia with transverse</td>
<td>Pod rot (pod)</td>
</tr>
</tbody>
</table>

Figure 7. A. Leaf spot disease symptom infected on pod of groundnut (arrow)  
B. Surface colony characters of *Fusarium* sp. (KYZN 06) strain on PDA medium (3 days)  
C. Reverse colony characters of *Aspergillus* sp. (KYZN 06)  
D. Hyphae with pycnidia of *Aspergillus* sp.  
E. Conidia of *Aspergillus* sp. (arrow)
Figure 8. Antagonistic activity of KYZN 01 on Macrophomina sp. after dual cultures for 6 days on PDA medium
A. Control of fungus mycelium
B. Antagonistic interactions between Trichoderma strain and Macrophomina sp.
C. Healthy mycelium with regular normal growth in control culture
D. Malformation of fungal hyphae of Macrophomina sp. (arrow)
E. Regular growth of pycnidia of Macrophomina sp. in control culture
F. Degrading pycnidia of Macrophomina sp. (arrow)

Figure 9. Antagonistic activity of KYZN 01 on Aspergillus sp. after dual cultures for 6 days on PDA medium
A. Control of fungus mycelium
B. Antagonistic interactions between Trichoderma strain and Aspergillus sp.
C. Healthy mycelium with regular normal growth in control culture
D. Malformation of fungal hyphae of Aspergillus sp. (arrow)
E. Regular growth of conidial head of Aspergillus sp. in control culture
F. Conidial head showed malformation of Aspergillus sp. (arrow)
Figure 10. Antagonistic activity of KYZN 01 on *Fusarium* sp. after dual cultures for 6 days on PDA medium
A. Control of fungus mycelium
B. Antagonistic interactions between *Trichoderma* strain and *Fusarium* sp.
C. Healthy mycelium with regular normal growth in control culture
D. Malformation of fungal hyphae of *Fusarium* sp. (arrow)
E. Regular growth of conidial head of *Fusarium* sp. in control culture
F. Conidial head showed malformation of *Fusarium* sp. (arrow)

Figure 11. Antagonistic activity of KYZN 02on *Aspergillus* sp. after dual cultures for 6 days on PDA medium
A. Control of fungus mycelium
B. Antagonistic interactions between *Trichoderma* strain and *Macrophomina* sp.
C. Healthy mycelium with regular normal growth in control culture
D. Malformation of fungal hyphae of *Macrophomina* sp. (arrow)
E. Regular growth of conidial head of *Macrophomina* sp. in control culture
F. Conidial head showed malformation of *Macrophomina* sp. (arrow)
Figure 12. Antagonistic activity of KYZN 02 on *Aspergillus* sp. after dual cultures for 6 days on PDA medium
A. Control of fungus mycelium
B. Antagonistic interactions between *Trichoderma* strain and *Aspergillus* sp.
C. Healthy mycelium with regular normal growth in control culture
D. Malformation of fungal hyphae of *Aspergillus* sp. (arrow)
E. Regular growth of conidial head of *Aspergillus* sp. in control culture
F. Conidial head showed malformation of *Aspergillus* sp. (arrow)

Figure 13. Antagonistic activity of KYZN 01 on *Fusarium* sp. after dual cultures for 6 days on PDA medium
A. Control of fungus mycelium
B. Antagonistic interactions between *Trichoderma* strain and *Fusarium* sp.
C. Healthy mycelium with regular normal growth in control culture
D. Malformation of fungal hyphae of *Fusarium* sp. (arrow)
E. Regular growth of conidial head of *Fusarium* sp. in control culture
F. Conidial head showed malformation of *Fusarium* sp. (arrow)
Figure 14. Antagonistic activity of KYZN 03 on *Macrophomina* sp. after dual cultures for 6 days on PDA medium
A. Control of fungus mycelium
B. Antagonistic interactions between *Trichoderma* strain and *Macrophomina* sp.
C. Healthy mycelium with regular normal growth in control culture
D. Malformation of fungal hyphae of *Macrophomina* sp. (arrow)
E. Regular growth of conidial head of *Macrophomina* sp. in control culture
F. Conidial head showed malformation of *Macrophomina* sp. (arrow)

Figure 15. Antagonistic activity of KYZN 03 on *Aspergillus* sp. after dual cultures for 6 days on PDA medium
A. Control of fungus mycelium
B. Antagonistic interactions between *Trichoderma* strain and *Aspergillus* sp.
C. Healthy mycelium with regular normal growth in control culture
D. Malformation of fungal hyphae of *Aspergillus* sp. (arrow)
E. Regular growth of conidial head of *Aspergillus* sp. in control culture
F. Conidial head showed malformation of *Aspergillus* sp. (arrow)
Table (3) Antagonistic activity of KYZN 01 against mycelia growth of pathogenic fungi

<table>
<thead>
<tr>
<th>Pathogenic Fungi</th>
<th>Control</th>
<th>Test</th>
<th>Percent Inhibition</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Macrophomina</em> sp.</td>
<td>6.5</td>
<td>2</td>
<td>69%</td>
</tr>
<tr>
<td><em>Aspergillus</em> sp.</td>
<td>3</td>
<td>1.5</td>
<td>50%</td>
</tr>
<tr>
<td><em>Fusarium</em> sp.</td>
<td>3</td>
<td>1</td>
<td>66%</td>
</tr>
</tbody>
</table>

Table (4) Antagonistic activity of KYZN 02 against mycelia growth of pathogenic fungi

<table>
<thead>
<tr>
<th>Pathogenic Fungi</th>
<th>Control</th>
<th>Test</th>
<th>Percent Inhibition</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Macrophomina</em> sp.</td>
<td>6.5</td>
<td>2.5</td>
<td>61%</td>
</tr>
<tr>
<td><em>Aspergillus</em> sp.</td>
<td>3</td>
<td>1.5</td>
<td>50%</td>
</tr>
<tr>
<td><em>Fusarium</em> sp.</td>
<td>2.5</td>
<td>1.3</td>
<td>48%</td>
</tr>
</tbody>
</table>
Table (5) Antagonistic activity of KYZN 03 against mycelia growth of pathogenic fungi

<table>
<thead>
<tr>
<th>Pathogenic Fungi</th>
<th>Control</th>
<th>Test</th>
<th>Percent Inhibition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macrophomina sp.</td>
<td>6.5</td>
<td>1.8</td>
<td>72%</td>
</tr>
<tr>
<td>Aspergillus sp.</td>
<td>3</td>
<td>1.3</td>
<td>56%</td>
</tr>
<tr>
<td>Fusarium sp.</td>
<td>3</td>
<td>1.2</td>
<td>60%</td>
</tr>
</tbody>
</table>

Table (6) Percent inhibition by *Trichoderma* strain isoaltes after 6 days of inoculation in dual cultures

<table>
<thead>
<tr>
<th>Trichoderma strains</th>
<th>Test Pathogens</th>
<th>PIRG (%)</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Macrophomina sp.</td>
<td>Aspergillus sp.</td>
<td>Fusarium sp.</td>
</tr>
<tr>
<td></td>
<td>KYZN 04</td>
<td>KYZN 05</td>
<td>KYZN 06</td>
</tr>
<tr>
<td>KYZN 01`</td>
<td>69</td>
<td>50</td>
<td>66</td>
</tr>
<tr>
<td>KYZN 02</td>
<td>61</td>
<td>50</td>
<td>48</td>
</tr>
<tr>
<td>KYZN 03</td>
<td>72</td>
<td>56</td>
<td>60</td>
</tr>
</tbody>
</table>

**Discussion and Conclusion**

In this research, the antagonistic activities of *Trichoderma* were studied on pathogenic fungi of *Arachis hypogaea* L. The fungus antagonists, three strains of *Trichoderma* were isolated from the rhizospheric soil and infected leaves of *Arachis hypogaea* L.. *Macrophomina* sp., *Aspergillus* sp. and *Fusarium* sp. were isolated from infected parts of root rot, crown rot and pod rot.

In the present investigation, Rose Bengal Medium was used for *Trichoderma* strains. Johnson & Curl (1972) stated that Rose Bengal Medium is a suitable selective medium for *Trichoderma* strain. KYZN 01 grew rapidly in that medium and the colonies were white green, bright green to dull green and microscopical characters were septate mycelium, upright conidiophore, single phalides and obovoid conidia. These characters of KYZN 01 is accordance with description provided by Barnett (1955). PDA medium was used for KYZN 02 and KYZN 03 according to the methods of Johnson & Curl (1972). The macroscopical characters of KYZN 02 and KYZN 03 was white to grayish colony with yellowish reverse...
colonies. The microscopical characters were branched conidiophores, phialide in false whorls with usually more than 2-3 and possessing globose conidia. The characters were agreement with the statement of Bhale et al. (2013) and Barnett (1955). Therefore, the KYZN 01, KYZN 02 and KYZN 03 were identified as *Trichoderma* strain.

In the present research, pathogenic fungi KYZN 04 was isolated from root rot symptom. In the macroscopical character, the mycelia of KYZN 04 was upright and white to brown or gray and darken at mature. In the microscopical characters, pycnidia are dark to grayish, becoming black at mature; globose or flattened globose. The pycnidia bear septate conidiophores. Conidia are single celled, hyaline and elliptic or oval. The above data are in agreement with those of Kaur et al. (2012). Amusa et al. (2007) also stated that *Macrophomina* sp. can cause root rot, wilt, leaf blight and stem blight in leguminous plants. Therefore, the fungus KYZN 04 was *Macrophomina* sp..

The results have shown that the macroscopical and microscopical characters of KYZN 05 strain was septate and hyaline mycelia. Vesicle subglobose, phialide sterigmata, biseriate conidia arose from the tip of phialide and spherical, 3-4 µm in diameter. Therefore, the fungus of KYZN 05 was *Aspergillus* sp. which supported by Bessay (1952).

The KYZN 06 fungus was white and cottony on PDA medium at room temperature (25ºC) and pH 6.5-7.0 after 3-7 days. The microscopical characters of KYZN 06 was septate hyphae. Conidiophore was long or short, simple or branched bearing terminal phialide from which conidia bears on the upper surface. Bessay (1952) described that *Fusarium* sp. is characterized by hyphae septate, hyaline. Three types of spores produce namely macroconidia, microconidia and chlamydospore. The macroconidia are curved, may be found 3-5 septate, mostly 3 septate. Microconidia are borne on simple phialides arising laterally and abundant, oval-ellipsoid, straight to curved non septate. Chlamydospores are terminal or intercalary, arising singly or in short chains. Therefore, KYZN 06 was confirmed as *Fusarium* sp. according to report of Bessay (1952).

The level of antagonistic effects showed inhibition of fungal pathogens with varying effectiveness. It was based on the values of percent inhibition of radial growth (Thanh et al. 2014). The three strains of *Trichoderma* showed inhibition of fungal pathogen *Macrophomina* sp., *Aspergillus* sp. and *Fusarium* sp. with varying effectiveness. The direct confrontation of antagonistics against the pathogenic fungi. The inhibition
on pathogenic fungi due to antagonistic activities ranged from 50 to 69%, 48 to 61% and 60 to 72% by KYZN 01, KYZN 02 and KYZN 03, respectively. The maximum inhibitory activity of *Trichoderma* strain KYZN 01 was 69% against *Macrophomina* sp. and followed by 66% on *Fusarium* and 50% on *Aspergillus* sp.. *Trichoderma* strain KYZN 02 showed maximum inhibition against 61% on *Macrophomia* sp. and followed by 50% on *Aspergillus* sp. and 48% on *Fusarium* sp.. *Trichoderma* strain KYZN 03 had the highest effects against 72% *Macrophomina* sp. but minimum inhibition is in 60% on *Fusarium* sp. and 56% on *Aspergillus* sp.. The maximum inhibitory activity of all three strain of *Trichoderma* inhibited against *Macrophomina* whereas it inhibited against *Aspergillus* sp. at minimum scale. The maximum inhibitory activity of *Trichoderma* strain KYZN 03 was 62.7% (mean) against *Macrophomia* sp., *Aspergillus* and *Fusarium* sp.. KYZN 03 showed parasitic behavior against *Macrophomina* sp. by coiling around the host hyphae and degrading it.

Sreedevi *et al.* (2011) described that the antagonistic activites of *Trichioderma harzianum* and *Trichoderma viride* against on *Macrophomina phaseolina*. *Trichoderma harzianum* inhibited the growth of *M. phaseolina* upto 64.7% followed by *T. viride* 47%. In this investigation, KYZN 03 inhibited the growth of *Macrophomina* sp. and the highest percentage inhibition was (72%). *Trichoderma* sp. over grew the host resulting into complete degradation of the *Macrophomina* sp.. KYZN 01 and KYZN 02 gave minimum inhibition of *Macrophomina* sp. with rating 69% and 61%.

Sneha & Satya Prasad (2014) reported that the *Trichoderma* species inhibited the growth of oilseed-borne fungi like *Aspergillus flavus*, *Alternaria alternata*, *Curvularia lunata*, *Fusarium montiliforme*, *Fusarium oxysporium*, *Rhizopus nigricals*, *Penicillium chrysogenum* and *P. notatum*. In the present research, *Aspergillus* sp. was found to be abnormal growth of hyphae and conidial head under microscope due to attack of *Trichoderma* strains. KYZN 03 showed a good inhibition of *Aspergillus* sp. and gave the maximum percentage (56%). KYZN 01 and KYZN 02 showed the same inhibition condition (50%) on *Aspergillus* sp.

Khang *et al.* (2013) stated that the isolate *Trichoderma harzianum* were screened against *Fusarium* sp. following dual plate culture technique. The isolates of *Trichoderma harzianum* are found to be most effective and show the highest inhibition 71.69% and then the lowest inhibition is 50.91% in radial growth. In this study, KYZN 01, KYZN 02 and KYZN 03 isolates grew considerably faster on PDA in the same condition of culture. These
Trichoderma sp. isolates were able to inhibit the mycelial growth of Fusarium sp. by the range of 48% to 66%. Maximum inhibition zone (66%) was exhibited by the isolate KYZN 01 while the minimum (48%) inhibition was found by the isolate KYZN 02. Therefore, all of these Trichoderma strains have significantly inhibited on pathogenic fungi which infected on groundnut plants. Under the microscope, it was observed that hyphae of KYZN 02 and KYZN 03 coiled around hyphae of Fusarium sp. and finally segmentation of its mycelial tips.

In conclusion, three strains of Trichoderma were undertaken for the biological control of fungal disease in groundnut plants. Three strains of Trichoderma are potential to inhibit the growth of plant pathogens. The Trichoderma strains significantly inhibited the mycelium growth of plant pathogenic fungi and reduced disease severity in groundnut plants. Hence, it is recommended that Trichoderma strain can be used as effective biocontrol agents to control plant diseases.

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