THINK INDIA JOURNAL

ISSN:0971-1260
Vol-22-Issue-34-December -2019

In vitro and *in vivo* bio efficacy of some new generation fungicides and antagonistic microbes against Ascochyta blight caused by *Ascochyta rabiei* on Chickpea

Adesh Kumar[1,2],Vipul Kumar[1], Gagan Kumar[1], Naresh Kumar Bhadana[2]and Kabrabam Suraj Jackson[1*]

[1]*Department of Plant Pathology, School of Agriculture, Lovely Professional University, Phagwara (Punjab) India- 144411*

[2]*Department of Plant Pathology, Sardar Vallabhbhai Patel University of Agri. & Tech., Meerut (Uttar Pradesh) India- 250110*

**Corresponding author:surajjackson993@gmail.com*

<Lovely Faculty of Science & Technology>

<School of Agriculture>

ABSTRACT

Experiments were conducted to study the in vitro and in vivo efficacy of some new generation fungicides and antagonistic microbes against Ascochyta blight on chickpea at Experimental farm and laboratory of Lovely Professional University, Phagwara, Punjab during cropping season of 2017-18. Five different fungicides and two bio-control agents were tested against Ascochyta rabiei in laboratory and field conditions. In laboratory conditions, Trichoderma harzianum was recorded more effective than Pseudomonas fluorescens inhibiting up to 63.75 % growth of the pathogen. All the fungicides inhibit pathogen under in vitro condition but Propineb proved best by attaining lowest ED_{50} value of 8.28µg/ml while under in vivo conditions Azoxystrobin gave best results with lowest disease severity of 29.63 per cent among all the fungicides. In case of bio-agents, Trichoderma harzianum gave better results as compared to Pseudomonas fluorescens with disease severity 55.55% and 59.25% respectively. All the treatments improved growth and yield of the crop significantly, with highest yield being recorded in case of Azoxystrobin (752.25 kg/acre) followed by Propiconazole (628.09 kg/acre).

Key words: Chickpea, Ascochyta rabiei, New generation fungicides, Bio-control agents

INTRODUCTION

Chickpea is a major crop in more than 45 nations of Asia, Africa and America. Globally it has a total production of about 10.9 million tonnes sown over an area of about 12.0 million ha and yields 913 kg/ha (FAO, 2010). India ranks first followed by Pakistan, Ethiopia, Burma both in production and acreage contributing approximately 70.7% in the total

ISSN:0971-1260
Vol-22-Issue-34-December -2019

production of the world (FAO, 2011).Among all the diseases which affect the chickpea, Ascochyta blight (caused by *Ascochyta rabiei*) is the most important biotic constraint for chickpea production, causing serious grain yield and quality loss(Gaur & Singh, 1996). It is the most destructive disease in the areas of humid, cool and cloudy climate. Among the 6 continents, Ascochyta blight has been reported in 34 countries and is dispersing fast to the new chickpea growing areas. Ascochyta blight can attack in any growth stage of the plant but the most prominent is flowering to early podding stages.Infection during the maturity of pods generally leads to shrivelled and infected seed (Nene, 1982; Singh, 1998;Akem, 1999).Keeping in view the importance of the disease the present investigation was conducted with an aim to manage the disease causing pathogen using different types of new generation chemicals and some commonly known bio-control agents.

MATERIALS AND METHODS

Isolation and purification of the pathogen

Isolation of *Ascochyta rabiei* was done from infected leaves and pods of chickpea crop fromthe Lovely Professional University (LPU), Phagwara agricultural field.The obtained isolate was identified on the basis of morphological characteristics especially size and shape of conidia and pycnidia (Ashwani Basandrai, 2005; Harveson, 2010; Pande, 2010).

Pure culture of *Trichoderma harzianum* (ITCC no. 6796/11) procured from CSAU&T, Kanpur and dominant strain of *Pseudomonas flourescens* (strain yet to be assessed) was isolated from soils from the field of LPU, Phagwara and were used for *in vitro* studies.

In vitro evaluation of Bio-control agents

Efficacy of *T. harzianum* and *P. flourescens* were tested in laboratory conditions against *A. rabiei* using dual culture technique**.** 5 mm mycelium bit each of *A. rabiei* and *T. harzianum* was inoculated per 90 mm Petri plate containing sterilised and cooled Potato dextrose agar (PDA) medium at opposite ends (Morton and Stroude, 1955). Bacterial inoculum of *P. flourescens* was streaked using a sterile loop into one distal end of Petri plate containing 20 ml of sterilised and cooled PDA media and a 5 mm mycelial bit of *A. rabiei* was inoculated at the opposite distal end of the Petri plate. Three replications were maintained per treatment along

ISSN:0971-1260
Vol-22-Issue-34-December -2019

with Control (check) and the plates were incubated at 25±2°C. Mycelium growth of *A. rabiei* was recorded at 72, 96, 120, 144 and 168 hours post incubation and inhibition per cent was calculated using formula 1 (Vincent, 1947).

Formula 1:

$$\text{Per cent inhibition} = \frac{C - T}{C} \text{ x } 100$$

Where,

C = Diameter of fungal growth in control (check)

T = Diameter of fungal growth in treatment

***In vitro* evaluation of fungicides against the pathogen**

Efficacy of five different fungicides *viz.*,Azoxystrobin (Godiwa), Propiconazole (Glitter), Propineb (Antracol), Carbendazim (Humber) and combination of Carbendazim and Mancozeb (Colt) were evaluated against *A. rabiei* under *in vitro* conditions using Poisoned food technique at different concentrations *viz.*, 10, 25, 50, 75 and 100 ppm (Sharvelle, 1960). All the treatments were replicated thrice along with Control (check) and incubated at 25±2°C and per cent inhibition was determined after 7 days post incubation (Vincent, 1947).

Field evaluation of fungicides and bio-agents

Field investigations were carried out in Agricultural Experimental Field of LPU, Phagwara, Geographical location- 31°24'N and 75°69'E, 252 above mid sea level, Punjab from November' 2017 to April' 2018 on 24 plots of 3x3 m^2 with 8 treatments (3 replications each) along with Control in Randomized Block Design (RBD). Seeds of chickpea variety Pb7 were sown on 15thNovember, 2017 following standard planting procedure for chickpea; keeping a spacing of 45 x 15 cm between rows and plants respectively.

Evaluation of market available formulations of Bio-control agents and chemical fungicides (Table 1) were carried out under field condition against A, rabiei on Chickpea crop.

ISSN:0971-1260
Vol-22-Issue-34-December -2019

Test pathogen was inoculated at 35 Days after sowing (DAS) crop period at the rate of 10^6 spores per ml using a power sprayer. First foliar spraying of bio-agents and fungicides was done at 50 DAS followed by two more sprays at 15 days interval. Disease severity was measured using 0-9 scale (Chen et al., 2004) and Per cent disease index was calculated (McKinney, 1923).

Formula 2:

$$\text{Percent disease index (\%)} = \frac{\text{Sum of all disease ratings}}{\text{Total no. of sample X Maximum rating scale}} \text{X100}$$

RESULTS AND DISCUSSION

In vitro evaluation of Bio-control agents against *A. rabiei*

The bio-agents were tested against the fungus using dual culture method and per cent inhibition over control was noted at different hours post inoculation *viz.*, 72, 96, 120, 144 and 168. Table 2, Fig.1 showed that both the bio agents were found effective in decreasing the mycelial growth of fungus. Maximum per cent inhibition over control in mycelial growth at 72 hours post incubation was noted in *T. harzianum* (10.71%) and 3.53% in *P. fluorescens*.

At 96 hours post incubation least per cent inhibition 7.79% and 2.57% was observed in *T. harzianum* and *P. fluorescens* respectively.

At 120 hours, in *T. harzianum* maximum inhibition perc ent was recorded 23.24 followed by *P. fluorescens* (9.09) and at 144 hours post inoculation it was found 37.84% in *T. harzianum* and 13.56% in *P. fluorescens.*

Data at 168 hours after inoculation shown that *T. harzianum* revealed maximum inhibition percent at 63.75 and in *P. fluorescens* it was recorded 37.5 which was quite less than *T. harzianum*.

The variation in per cent inhibition in mycelial development shows the difference in efficiency of both bio-agents, with *T. harzianum* proving more efficacious among the two test Bio-agents against *A. rabiei*. This may be due to the mechanism of antibiosis of the pathogen which has been described by numerous workers in their earlier works (Rajakumar and Aggarwal,

ISSN:0971-1260
Vol-22-Issue-34-December -2019

2005,Çiğdem KüÇük, 2007, andBenzohra *et al.*, 2011). The results obtained undoubtedly shows the need of *in vitro* assessment of more isolates of *Trichoderma spp.* and *Pseudomonas* against *A. rabiei* and other serious phyto-pathogens which could lead to better eco-friendly management of the disease in future.

Efficacy of fungicides against *A. rabiei* under *in vitro* condition

Efficacy of five different fungicides *viz*., Azoxystrobin, Carbendazim + Mancozeb, Carbendazim, Propiconazole and Propineb were evaluated in laboratory conditions using Poisoned Food Technique against *A. rabiei* in different concentrations i.e. 10, 25, 50, 75 and 100ppm.

The data obtained from the experiment (Table 3, Fig.2) revealed that at concentration of 10 ppm maximum inhibition (88.33%) of mycelial growth of pathogen was shown by Propineb which is followed by Propiconazole (83.75%), Carbendazim + Mancozeb (51.67%) and Carbendazim (37.50%). The least inhibition was recorded in Azoxystrobin (26.67%).

At concentration of 25ppm, Propineb showed the complete inhibition (100%) of pathogen growth followed by Propiconazole (88.33%), Carbendazim (78.33%) and Carbendazim + Mancozeb (75.00%). Azoxystrobin showed least inhibition (70.42%).

At 50ppm concentration, four fungicides Propineb, Propiconazole, Azoxystrobin and Carbendazim + Mancozeb showed complete mycelial growth inhibition of fungus followed by Carbendazim (87.5%).

At 75 and 100ppm of concentrations, a complete growth inhibition of pathogen was recorded in case of all the five fungicides tested against the pathogen.

ED_{50} and ED_{90} values were calculated by means of linear graph (Table 3, Fig.2). Among all the fungicides tested, Propineb attained the lowest ED_{50} value thereby proving best among the treatments at 8.28µg/ml, preceded by propiconazole (10.39µg/ml), Carbendazim + Mancozeb (11.94µg/ml), Azoxystrobin (12.88µg/ml), while maximum ED_{50} value of 14.78 µg/ml was recorded in Carbendazim. ED_{90} value showed Propineb attaining the minimum value of 64.36 µg/ml, which was significantly different from all other fungicides while Carbendazim showed

ISSN:0971-1260
Vol-22-Issue-34-December -2019

least effective among all the fungicides with maximum ED_{90} value of 128.94 µg/ml. The results of experiment are close with the findings of (F. Demirci, 2003, G. Chongo, 2003 and Pande *et al*., 2005) who stated that Propineb, Propiconazole, Carbendazim and Azoxystrobin are highly effective against the pathogen *A. rabiei* under *in vitro* conditions.

Efficacy of different bio-agents and fungicides under field conditions

Field evaluation of five different fungicides (Propineb, Azoxystrobin, Carbendazim, Carbendazim + Mancozeb, Propiconazole) and two biological control agents (*T. harzianum* and *P. fluorescens*) was done on chickpea at Agricultural Research Farm of Lovely Professional University, Jalandhar during 2017-18 cropping season.

The observations from the field (Table 4, Fig.3) revealed that all the treatments significantly decreased the disease severity and indicated superior to untreated control. At 90 DAS, Azoxystrobin showed maximum inhibition and lowest severity (29.63%) followed by Propiconazole (42.59%) while almost similar results were observed in Propineb and Carbendazim 46.29 and 47.22% respectively while least inhibition of disease was recorded in treatment of Carbendazim + Mancozeb (54.63%). Among the bio- agents, *Trichoderma harzianum* showed lowest severity (55.55%) compared to *Pseudomonas fluorescens* (59.25%) which was all lower than the disease severity recorded in Control (78.70%).

Data obtained from the present investigation points Azoxystrobin as the best chemical measure for the management of Ascochyta blight of Chickpea in field conditions. Earlier investigations by different workers also yielded similar results, concluding Azoxystrobin best for the management of the pathogen (F. Demirci, 2003 and Chongo, 2003). Earlier workers also concluded *T. harzianum* as the best for management of foliar diseases like Leaf spot of Palak caused by *Cercospora beticola* Sacc. (Poornima, 2011) and leaf spot of mulberry caused by *C. moricola* (Siddaramaiah, 1986).

Evaluation of treatments on growth and yield contributing parameters ofchickpea

Various growth and yield contributing parameter viz., No. of primary branches, No. of secondary branches, Shoot length, Root length, Dry root weight, No. of pods per plant, No. of

ISSN:0971-1260
Vol-22-Issue-34-December -2019

grains per plant, 100 grain weight and Average yield /acre of each treatment were evaluated upon maturity of the crop and data presented in Table 5 and 6.

a. Primary branches- Maximum Average No. of primary branches had found in Azoxystrobin (8.66) from all the treatments followed by Propiconazole (7.66) and Carbendazim (6.33). Treatments of Propineb and Carbendazim + Mancozeb had same no. of branches (5.66) and *T. harzianum* and *P. fluorescens* had same no. of primary branches as found in the untreated control.

b. Secondary branches- Azoxystrobin showed maximum average no. of secondary branches (13.33) followed by Carbendazim (11.33), Propiconazole (10.33) and Carbendazim + Mancozeb (9.66). Same no. of secondary branches had found in Propineb and *P. fluorescens*(8.66) while *T. harzianum* and control had near about same results i.e. 6.66 and 6.33 respectively.

c. Shoot length- Among all the treatments, maximum average shoot length (61.66cm) was observed in *T. harzianum* followed by Propiconazole (60.66cm), *P. fluorescens* (56.33cm). The least shoot length (41.33cm) was recorded in Carbendazim + Mancozeb followed by control (39.33cm).

d. Root length- Maximum average root length of 17.50cm was found in *P. fluorescens* followed by Propineb (16.33cm), Propiconazole (15.00cm), *T. harzianum* (14.9cm), Azoxystrobin (14.50cm). The minimum root length (12.16cm) was observed in Carbendazim + Mancozeb followed by untreated control (11.16cm).

e. Dry root weight-*P. fluorescens* showed maximum average dry root weight of 2.26g followed by Propiconazole (2.00g), Azoxystrobin (1.96g). In *T. harzianum* and Propineb near about similar results 1.89g and 1.86g respectively were recored followed by Carbendazim (1.59g) and Carbendazim + Mancozeb (1.32g), with least amount in control (0.82g) dry root weight was found.

f. Pods per plant- As shown in the data table, maximum average pods per plants were observed 177.33 found in Azoxystrobin followed by propiconazole (162.33), Propineb (145.66), and Carbendazim (142.00). The least no. of pods per plant were found in Trichoderma harzianum (112.00) followed by control (105.66).

ISSN:0971-1260
Vol-22-Issue-34-December -2019

h. 100 grain weight- The highest 100 grain weight was recorded in the grains obtained from the pods of *T. harzianum* treatment (15.05g) followed closely by Azoxystrobin (14.74). There was not much difference in the average 100 grain weight of Propiconazole, Propineb and *P. fluorescens* i.e. 13.46, 13.33 and 13.26g respectively. In control it was observed 8.55g.

i. Average yield/acre- Average yield for all the treatments was calculated in terms of acre and were significantly different from each other. The highest yield per acre was detected in case of Azoxystrobin i.e. 752.25kg followed by Propiconazole, Propineb, *T. harzianum*, Carbendazim, *P. fluorescens*, Carbendazim + Mancozeb with yield of 628.09 kg, 561.31kg, 523.93kg, 458.70kg, 427.13kg, 413.65kg respectively and in control it was 260.42kg/acre.

CONCLUSION

ISSN:0971-1260
Vol-22-Issue-34-December -2019

It can be concluded from the present investigation that new generation fungicides which only targets specific sites of the pathogen system like Azoxystrobin, Propiconazole and Propineb proved to be more efficacious against *Ascochyta rabiei* compared to conventional fungicides such as Carbendazim both *in vitro* and *in vivo* conditions. It is worth mentioning that the Bio-control agents used in the present investigation proved to be effective as foliar sprays against the test pathogen, yielding almost similar effects as that of the chemical fungicides. Not only did all the treatments reduced the severity of the pathogen but also increased the growth and yield factors of the plant as compared to the Control.

Age old use of certain conventional fungicides brings changes to the crop-pathogen relationship, with most cases exhibiting negative effects such as development of resistance by the pathogen towards the fungicides and causing damage to the crops. The present investigation has highlighted the options of some new generation fungicides and bio-agents available in the market that can be used for control of *A. rabiei* in a more efficient way. Although further scientific studies on new methods or models of disease management are encouraged to provide a better option of crop health improvement with main emphasis on reduction of chemicals as much as possible.

STATEMENT OF SIGNIFICANCE

This study will help the researcher to uncover the critical areas of minimal dose of chemicals to overcome fear of mammalian toxicity in human consumption and use of soil micro-flora for eco-safe and healthy approach for the management and improvement in qualitative and quantitative yield of the plants.

ACKNOWLEDGEMENT

Authors are thankful to Department of Plant Pathology to provide necessary and on time assistance what was required throughout research work.

REFERENCE

ISSN:0971-1260
Vol-22-Issue-34-December -2019

1. Akem, C. (1999). Ascochyta blight of chickpea: present status and future priorities. *International Journal of Pest Management*, *45*(2), 131-137.
2. Basandrai, A. K., Pande, S., Kishore, G. K., Crouch, J. H., & Basandrai, D. (2005). Cultural, morphological and pathological variation in Indian isolates of Ascochyta rabiei, the chickpea blight pathogen. *The Plant Pathology Journal*, *21*(3), 207-213.
3. Benzohra, I. E., Labdi, B. B. M., & Bnekada, M. Y. (2011). In vitro biocontrol using the antagonist Trichoderma harzianum against the Algerian isolates of Ascochyta rabiei (Pass.) Labr., the agent of Ascochyta Blight in Chickpea (Cicer arietinum L.). *International Journal of Microbiological Research*, *2*(2), 124-128.
4. Chen, W., Coyne, C. J., Peever, T. L., & J. Muehlbauer, F. (2004). Characterization of chickpea differentials for pathogenicity assay of ascochyta blight and identification of chickpea accessions resistant to Didymella rabiei. *Plant Pathology*, *53*(6), 759-769.
5. Chongo, G., Banniza, S., Gan, Y., Wolf, T., & Warkentin, T. (2003, February). Fungicides application timing, sequencing, and tank mixing for controlling blight in chickpea. In *Soils and Crops Workshop*.
6. KüÇük, Ç., KivanÇ, M., Kinaci, E., & Kinaci, G. (2007). Efficacy ofTrichoderma harzianum (Rifaii) on inhibition of ascochyta blight disease of chickpea. *Annals of microbiology*, *57*(4), 665-668.
7. Demirci, F., Bayraktar, H., Babalioğullu, I., Dolar, F. S., & Maden, S. (2003). In vitro and in vivo effects of some fungicides against the chickpea blight pathogen, Ascochyta rabiei. *Journal of Phytopathology*, *151*(9), 519-524.
8. FAO, F. (2011). Available online at: http://faostat. fao. org/site/291/default. aspx. *Food and Agriculture Organization*.
9. FAOSTAT, F. (2010). Disponível em:< http://faostat. fao. org/site/567/default. aspx# ancor>. *Acessado em setembro*.
10. Chongo, G., Buchwaldt, L., Gossen, B. D., Lafond, G. P., May, W. E., Johnson, E. N., & Hogg, T. (2003). Foliar fungicides to manage ascochyta blight [Ascochyta rabiei] of chickpea in Canada. *Canadian Journal of Plant Pathology*, *25*(2), 135-142.

ISSN:0971-1260
Vol-22-Issue-34-December -2019

11. Demirci, F., Bayraktar, H., Babalioğullu, I., Dolar, F. S., & Maden, S. (2003). In vitro and in vivo effects of some fungicides against the chickpea blight pathogen, Ascochyta rabiei. *Journal of Phytopathology*, *151*(9), 519-524.
12. Gaur, R. B., & Singh, R. D. (1996). Effects of Ascochyta blight on grain yield and protein in chickpea. *Indian Journal of Mycology and Plant Pathology*, *26*(3), 259-262.
13. Harveson, R. M., Markell, S. G., Goswami, R., Urrea, C. A., Burrows, M. E., Dugan, F., & Skoglund, L. G. (2011). Ascochyta blight of chickpeas. *Plant Health Progress*, *12*(1), 30.
14. McKinney, H. H. (1923). A new system of grading plant diseases. *J. Agric. Res*, *26*(2), 195-218.
15. Morton, D. J., & Stroube, W. H. (1955). Antagonistic and stimulatory effects of soil microorganisms upon Sclerotium rolfsii. *Phytopathology*, *45*(8), 417-420.
16. Nene, Y. L. (1982). A review of Ascochyta blight of chickpea. *International Journal of Pest Management*, *28*(1), 61-70.
17. Pande, S., Siddique, K. H. M., Kishore, G. K., Bayaa, B., Gaur, P. M., Gowda, C. L. L., & Crouch, J. H. (2005). Ascochyta blight of chickpea (Cicer arietinum L.): a review of biology, pathogenicity, and disease management. *Australian Journal of Agricultural Research*, *56*(4), 317-332.
18. Pande, S., Sharma, M., Gaur, P. M., & Gowda, C. L. L. (2010). *Host Plant Resistance to Ascochyta Blight of Chickpea. Information Bulletin No. 82*. International Crops Research Institute for the Semi-Arid Tropics.
19. Poornima, Y. R. H., & Jagdish, J. (2011). Biological Management of Leaf Spot of Palak Caused by Cercospora beticola Sacc. *Research Journal of Agricultural Sciences*, *2*(3), 655-657.
20. Rajakumar, E., Aggarwal, R., & Singh, B. (2005). Fungal antagonists for the biological control of Ascochyta blight of chickpea. *Acta Phytopathologica et Entomologica Hungarica*, *40*(1-2), 35-42.

ISSN:0971-1260
Vol-22-Issue-34-December -2019

21. Siddaramaiah, A. L., & Hegde, R. K. (1986). Studies on. leaf spot of mulberry (Morus alba L.) caused by Cercospora moricola Cooke with special reference to epodermiology and control. *Plant Pathology Newsletter*, *4*(1-2), 23.
22. Sharvelle, E. G. (1961). The nature and uses of modern fungicides. *The nature and uses of modern fungicides.*
23. Singh, G., & Sharma, Y. R. (1998). Ascochyta blight of chickpea. *IPM system in agriculture: Pulses*, 163-195.
24. Vincent, J. M. (1947). Distortion of fungal hyphae in the presence of certain inhibitors. *Nature*, *159*(4051), 850.

ISSN:0971-1260
Vol-22-Issue-34-December -2019

LIST OF TABLES

Table 1. Trade name, Common name and Source of fungicides and bio-agents used for field investigation

Trade name	Common name	Source
Chemical fungicides		
Godiwa	Azoxystrobin 23%	Dhanuka Agritech Ltd.
Glitter	Propiconazole 25% EC	Mikado Crop Science
Antracol	Propineb 70 WP	Bayer Crop Science
Colt	Carbendazim 12% + Mancozeb 63%WP	Smith N Smith Chemicals Ltd.
Humber	Carbendazim 46.27%EC	Mikado Crop Science
Bio-Control Agents		
Niprot	*Trichoderma Harzianum 0.50% WS*	Pest Control India
Phasal Rakshak	*Pseudomonas fluorescens* 1.0% WP	International Panaacea Ltd.

ISSN:0971-1260
Vol-22-Issue-34-December -2019

ISSN:0971-1260
Vol-22-Issue-34-December -2019

Table 2. Effect of different Bio-control agents on the growth of *A. rabiei* at 25±1°C after 7 days of inoculation

Biocontrol agents	Colony diameter of *A. rabiei* at different hours (mm)					Per cent inhibition over control (%)				
	72 hrs	96 hrs	120 hrs	144 hrs	168 hrs	72 hrs	96 hrs	120 hrs	144 hrs	168 hrs
T. harzianum	16.66^{b}±0.66	23.66^{b}±0.33	25.33^{c}±0.66	29.00^{c}±0.57	29.00^{c}±0.57	10.71	7.79	23.24	37.84	63.75
P. flourescens	18.00^{ab}±0.57	25.00^{ab}±0.57	30.00^{b}±0.57	40.33^{b}±0.88	50.00^{b}±0.57	3.53	2.57	9.09	13.56	37.5
Control	18.66^{c}±0.33	25.66^{a}±0.66	33.00^{a}±0.57	46.66^{a}±1.20	80.00^{a}±0.00	-	-	-	-	-

Value of means having same letter (s) denote no significant difference by DMRT at P ≤ 0:05

Table 3. Effect of different chemical fungicides on the growth of *A. rabiei* at 10, 25, 50, 75 and 100 ppm concentrations and ED values at 50 and 90

Average Colony Diameter (mm)						Percent Inhibition (%)						
	10ppm	25ppm	50ppm	75ppm	100ppm	10	25	50	75	100	ED_{50}	ED_{90}

ISSN:0971-1260
Vol-22-Issue-34-December -2019

Treatment						ppm	ppm	ppm	ppm	ppm	(µg/ml)	(µg/ml)
T_1	58.66^{b}±0.88	23.66^{b}±0.88	0.00^{c}±0.00	0.00^{b}±0.00	0.00^{b}±0.00	26.67	70.42	100.00	100.00	100.00	12.88	94.29
T_2	38.66^{d}±0.88	20.00^{c}±0.58	0.00^{c}±0.00	0.00^{b}±0.00	0.00^{b}±0.00	51.67	75.00	100.00	100.00	100.00	11.94	90.32
T_3	50.00^{c}±1.53	17.33^{d}±0.88	10.00^{b}±0.58	0.00^{b}±0.00	0.00^{b}±0.00	37.50	78.33	87.50	100.00	100.00	14.78	128.94
T_4	13.00^{e}±0.58	9.33^{e}±0.33	0.00^{c}±0.00	0.00^{b}±0.00	0.00^{b}±0.00	83.75	88.33	100.00	100.00	100.00	10.39	82.28
T_5	9.33^{f}±0.88	0.00^{f}±0.00	0.00^{c}±0.00	0.00^{b}±0.00	0.00^{b}±0.00	88.33	100.00	100.00	100.00	100.00	8.28	64.36
T_6	80.00^{a}±0.00	80.00^{a}±0.00	80.00^{a}±0.00	80.00^{a}±0.00	80.00^{a}±0.00	0.00	0.00	0.00	0.00	0.00	-	-

Value of means having same letter (s) denote no significant difference by DMRT at P ≤ 0:05

Table 4. Effect of different treatments on disease severity on chickpea at 45, 60, 75 and 90 DAS on field

Treatment	Percent Disease Index (%)			
	45 DAS	60 DAS	75 DAS	90 DAS
T_1	4.63^{c}±0.93	14.81^{c}±0.93	25.92^{d}±0.93	46.29^{c}±0.93
T_2	7.40^{abc}±0.92	21.29^{b}±0.93	40.74^{b}±2.45	55.55^{b}±3.21
T_3	8.33^{ab}±0.00	18.51^{b}±0.92	31.48^{c}±0.92	47.22^{c}±1.61

ISSN:0971-1260
Vol-22-Issue-34-December -2019

T_4	5.55^{bc}±1.60	8.33^{d}±1.60	20.36^{e}±0.93	29.63^{d}±0.93
T_5	6.48^{abc}±0.92	14.81^{c}±0.93	30.55^{c}±1.60	54.63^{b}±0.93
T_6	5.56^{bc}±0.00	12.96^{c}±0.93	21.29^{e}±0.93	42.59^{c}±3.34
T_7	9.25^{a}±0.93	20.36^{b}±0.93	37.03^{b}±0.93	59.25^{b}±0.93
T_8	8.33^{ab}±0.00	25.92^{a}±0.93	57.40^{a}±0.92	78.70^{a}±0.93

Value of means having same letter (s) denote no significant difference by DMRT at P ≤ 0:05T_1- Propineb, T_2- *Trichoderma harzianum*, T_3- Carbendazim, T_4- Azoxystrobin, T_5- Carbendazim + Mancozeb, T_6- Propiconazole, T_7- *Pseudomonas fluorescens*, T_8- Control

Table 5. Effect of different treatments on the growth attributing factors of chickpea

Treatment	No. of primary branches/plant	No. of secondary branches/plant	Shoot Length (cm)	Root Length (cm)	Dry Root Weight (g)
T1	5.66^{bc}±0.33	8.66^{d}±0.67	53.66^{cd}±2.19	16.33^{a}±1.20	1.86^{b}±0.05
T2	4.66^{c}±0.33	6.66^{e}±0.33	61.66^{a}±1.86	14.9^{ab}±1.32	1.89^{b}±0.02
T3	6.33^{b}±0.33	11.33^{b}±0.33	49.33^{d}±1.20	12.50^{bc}±0.29	1.59^{c}±0.11
T4	8.66^{a}±0.33	13.33^{a}±0.67	55.33^{bc}±2.91	14.50^{abc}±1.26	1.96^{b}±0.13
T5	5.66^{bc}±0.33	9.66^{cd}±0.67	41.33^{e}±1.45	12.16^{bc}±0.44	1.32^{d}±0.04
T6	7.66^{a}±0.88	10.33^{bc}±0.33	60.66^{ab}±1.20	15.00^{ab}±0.58	2.00^{b}±0.06

ISSN:0971-1260
Vol-22-Issue-34-December -2019

T7	4.66^{c}±0.33	8.66^{d}±0.33	56.33^{abc}±0.88	17.50^{a}±1.89	2.26^{a}±0.14
T8	4.66^{c}±0.33	6.33^{e}±0.33	39.33^{e}±1.45	11.16^{c}±0.60	0.82^{e}±0.02

Value of means having same letter (s) denote no significant difference by DMRT at P ≤ 0:05

T_1- Propineb, T_2- *Trichoderma harzianum*, T_3- Carbendazim, T_4- Azoxystrobin, T_5- Carbendazim + Mancozeb, T_6- Propiconazole, T_7- *Pseudomonas fluorescens*, T_8- Control

Table 6. Effect of different treatments on the growth attributing factors of chickpea

Treatment	No. of pods/plant	No. of grains/plant	100 grain weight (g)	Average Yield/acre (kg)
T_1	145.66^{c}±5.21	291.33^{c}±10.41	13.33^{a}±0.84	561.31b^{c}±55.43
T_2	112.00^{ef}±1.73	224.00^{ef}±3.46	15.05^{a}±0.44	523.93^{cd}±9.64
T_3	142.00^{cd}±4.04	284.00^{cd}±8.08	11.23^{b}±0.50	458.70^{de}±20.99
T_4	177.33^{a}±1.45	354.66^{a}±2.91	14.74^{a}±0.28	752.25^{a}±11.80
T_5	135.33^{d}±2.03	270.66^{d}±4.06	10.63^{b}±0.59	413.65^{e}±20.47
T_6	162.33^{b}±2.40	324.66^{b}±4.81	13.46^{a}±0.58	628.09^{b}±20.07
T_7	121.00^{e}±1.53	242.00^{e}±3.06	13.26^{a}±0.78	427.13^{e}±23.00
T_8	105.66^{f}±4.91	211.33^{f}±9.82	8.55^{c}±0.30	260.42^{f}±17.42

Value of means having same letter (s) denote no significant difference by DMRT at P ≤ 0:05

T_1- Propineb, T_2- *Trichoderma harzianum*, T_3- Carbendazim, T_4- Azoxystrobin, T_5- Carbendazim + Mancozeb, T_6- Propiconazole, T_7- *Pseudomonas fluorescens*, T_8- Control

ISSN:0971-1260
Vol-22-Issue-34-December -2019

LIST OF FIGURES

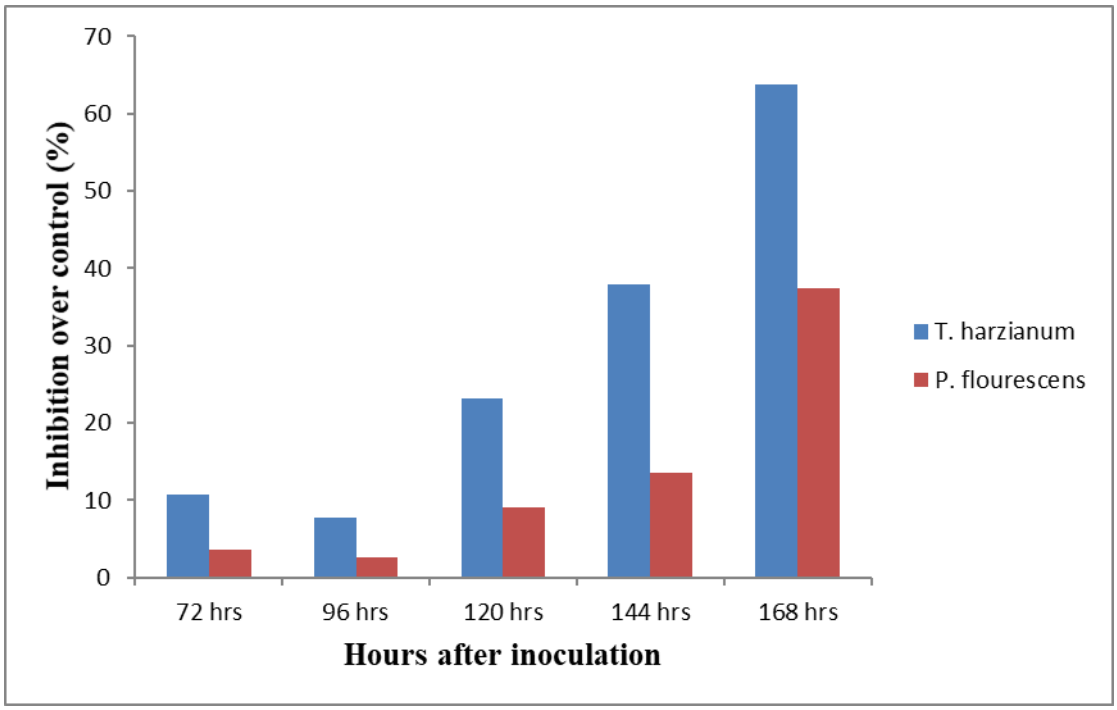


Fig.1. Inhibition percent over control of test pathogen by two different bio-agents at 72, 96, 120, 144 and 168 hours

ISSN:0971-1260
Vol-22-Issue-34-December -2019

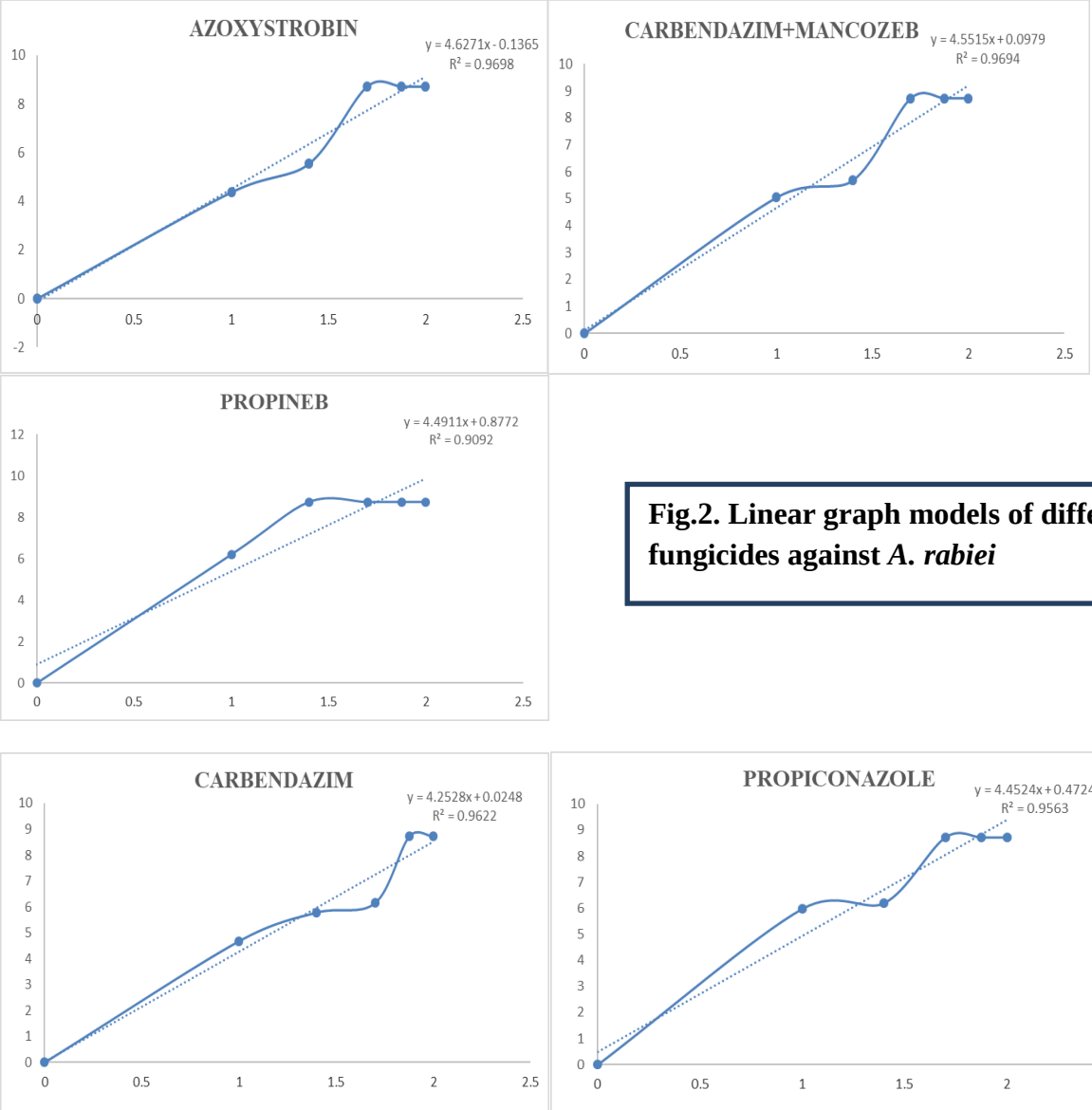
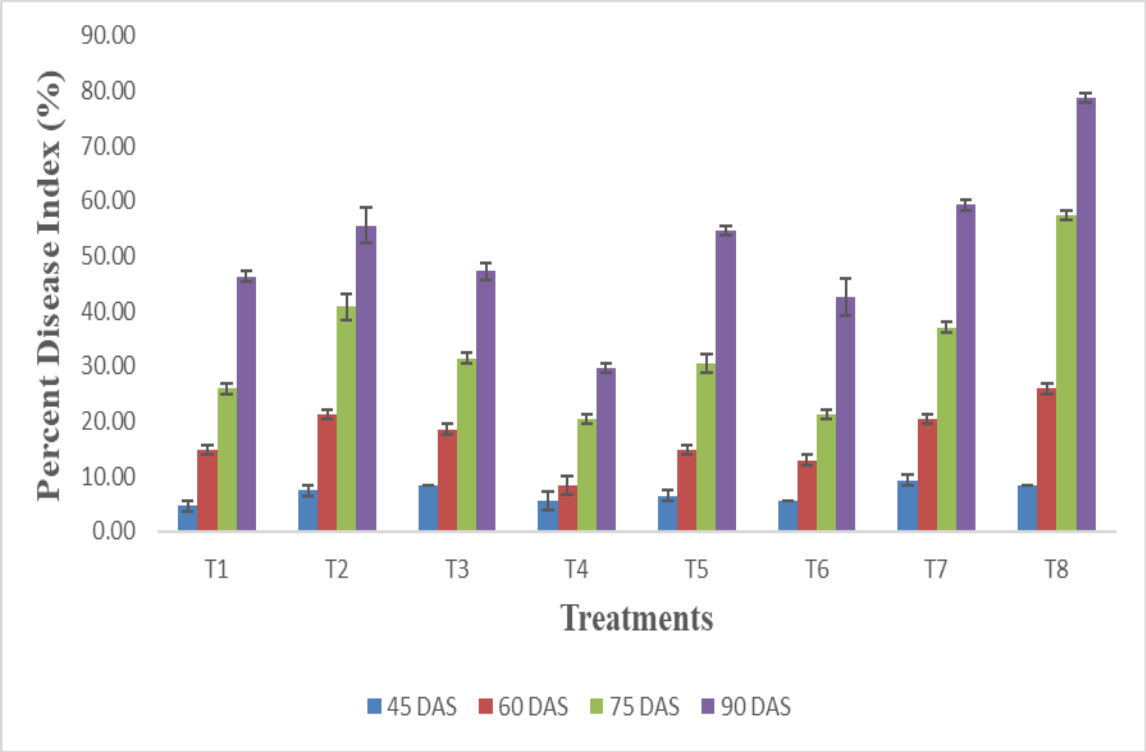


Fig.2. Linear graph models of different fungicides against *A. rabiei*

ISSN:0971-1260
Vol-22-Issue-34-December -2019



T_1- Propineb, T_2- *Trichoderma harzianum*, T_3- Carbendazim, T_4- Azoxystrobin, T_5- Carbendazim + Mancozeb, T_6- Propiconazole, T_7- *Pseudomonas fluorescens*, T_8- Control

Fig.3. Effect of foliar sprays of different treatments on disease severity on the chickpeacrop at different days