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Integrated Disease Management Wilt of Lentil Caused by *Fusarium oxysporum* f. sp. *Lentis*

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Abstract- Effect of chemical, bio-agents and *Rhizobium* was tested alone and in combination to see their individual as well as combined effect on wilt disease management in pot under net house conditions. Eighteen treatments were under taken in this study, among them highest per cent disease control (70.89%) was recorded with *Rhizobium* (ST)+ Carbendazim.(ST)+ *Pseudomonas sp*.(SoilT) followed by *Rhizobium*(ST)+Carbendazim.(ST)+ *Bacillus subtilis* (SoilT) (67.05), *Rhizobium* (ST)+Carbendazim. (ST)+T.h. (64.64%), *Rhizobium*(ST) + soilT *T.harzianum* (63.36%), *Rhizobium*(ST) + Carbendazim. (ST) (59.47%), *Rhizobium*(ST) + *Pseudomonas fluorescens* (SoilT) (58.94%), *Rhizobium*(ST)+*Bacillus subtilis* (SoilT) (57.12%), *Rhizobium(ST)* + *T.harzianum*(SoilT) (56.66%), *Rhizobium*(ST) + *T.harzianum*(ST) (56.41%), Carbendazim.(ST) (52.48%), *Pseudomonas fluorescens* (SoilT) (49.92%), *Bacillus subtilis (*SoilT)(46.24%), *T. harzianum* (SoilT) (43.52%), *Pseudomonas fluorescens* (ST) (42.08%), *Bacillus subtilis (*ST) (39.04%), *T. harzianum*(ST) (35.89%) and *Rhizobium*(ST) (17.58%) as compared to untreated pots during 2016-17.

Keywords -Biocontrol agent, Fusarium, Lentil, rhizobium sp. and fungicides.

I. INTRODUCTION

Lentil (*Lens culinaris* Medik.) is one of the major grain legume crops and play very important role in the supply of the protein to under nourished vegetarian population of the country. It is mainly grown in North-Eastern plain zone as sole and intercrop under rain-fed conditions. It suffers from a number of diseases. Wilt of lentil caused by *Fusarium oxysporum f. sp. lentis* is one of the most wide spread and destructive disease where ever crop is grown. Lentil is cultivated as a rain fed crop in all India about 1.34 million ha area with 1.02mt production and 759 kg/ha productivity (**Abraham, 2015**). In India lentil is predominantly grown in the North, particularly in Uttar Pradesh, Madhya Pradesh, Bihar and West Bengal. In Uttar Pradesh, it is grown in 620.000 lakh/ha area with 452.000lakh tones production and 732.0 kg/ha productivity (**Ahmad, *et al.*, 2018**).Many attempts have been made to control this disease using chemical, biological, varietal and cultural methods **(Ram and Pandey, 2011; Sinha and Sinha, 2004; Khan and Mehnaz, 2003; Srivastava *et al.*, 2000**). None of the control measures found to be effective individually at field level. Seed treatment with fungicide, *Rhizobium* and bio-agents are most commonly used methods are often used in integrated management. However, the present investigation deals with the integrated management of lentil wilt by integrating chemical, bioagents.

II. MATERIAL & METHODS

Experiment was conducted in pots under net house conditions with sterilized soil. Soil inoculated with *F. oxysporum* f.sp. *lentis* 5% inoculum Chemical, bio-agents and *Rhizobium* was tested alone and in combination to see their individual as well as combined effect on disease management. For seed treatment fungicide (carbendazim), bioagent (*T. harzianum*) and *Rhizobium*, integration of these treatments, the seed was first treated with carbendazim (0.2 per cent) followed by 24 hours later with *Trichoderma harzianum* (0.4 per cent) than *Rhizobium* (0.2 per cent) and soil treatment. The treated seeds was sown in the pots. The seed of lentil (susceptible variety- L 9-12) was sown in each pot (15 seed per pot) where finally 10 plants was maintained. The experiment was conducted in CRD with 18 treatments including control.

Treatment details:
Variety- L 9-12
Replication-3; Design-CRD; Treatments-18
T_1-Seed treatment with *Rhizobium leguminoserum*@0.2g/kg
T_2-Seed treatment with *Bacillus subtilis*. @10 g/kg
T_3- Seed treatment with *Trichoderma harzianum*@4g/kg

T_4- Seed treatment Carbendazim@ 0.1 % /kg
T_5- Seed Treatment with *Pseudomonas flourescens*@10 g/kg
T_6- Soil Treatment with *Bacillus subtilis*@10 g/kg
T_7- Soil treatment with *Trichoderma harzianum*@4g/kg
T_8- Soil treatment with *Pseudomonas fluorescens* @10 g/kg
T_9- Seed treatment with *Rhizobium leguminoserum*@0.2g/kg+ Seed treatment with *Trichoderma harzianum*@4g/kg
T_{10}- Seed treatment with *Rhizobium leguminoserum*@0.2g/kg+ Seed treatment carbendazim@0.2 %
T_{11}- Seed treatment with *Rhizobium leguminoserum*@0.2g/kg+ Soil treatment with *Bacillu subtilis* @10 g/kg
T_{12}- Seed treatment with *Rhizobium leguminoserum*@0.2g/kg+ Soil treatment with *Trichoderma harzianum*@4g/kg
T_{13}- Seed treatment with *Rhizobium leguminoserum*@0.2g/kg + Soil treatment with *Pseudomonas flourescens*@10 g/kg
T_{14}- Seed treatment with *Rhizobium leguminoserum*@0.2g/kg+ Seed treatment with carbendazim@0.2 % + Seed treatment with *Trichoderma harzianum*@4g/kg
T_{15}- Seed treatment with *Rhizobium leguminoserum*@0.2g/kg+ Seed treatment with carbendazim@0.2 % + Soil treatment with Ba*cillus subtilis*@10 g/kg
T_{16}- Seed treatment with *Rhizobium leguminoserum*@0.2g/kg+ Seed treatment with carbendazim@0.2% + Soil treatment with *Pseudomonas fluorescens*@10 g/kg
T_{17}- Seed treatment with *Rhizobium leguminoserum*@0.2g/kg + Seed treatment with carbendazim@0.2 % + Soil treatment with *Trichoderma harzianum*@4g/kg
T_{18}-Control

Observation recorded
First appearance of disease, disease incidence and per cent disease control were observed 30 and 60 days after sowing. Per cent disease incidence and per cent disease control were calculated by using following formula.

$$\text{Per cent disease incidence} = \frac{\text{Number of infected plants}}{\text{Total number of plants}} \text{ x } 100$$

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

Mass multiplication of *F. oxysporum* f. sp. *lentis*
The test pathogen *Fusarium oxysporum f. sp. lentis* was mass multiplied on sterilized sorghum seeds for pot culture studies. For mass culture of different species of fungi and bioagents,100gm of sorghum seeds was washed thoroughly in tap water and soaked in water for overnight in 250 ml conical flask with addition of 40 ml of water .After removing the water, the seeds was autoclaved for 20 min at15 p.s.i. 5mm fungal disc was cut from the periphery of the fungal growth of different species of *Trichoderma* sp., *Bacillus* subtilis, *Pseudomonas fluorescens*, and *Fusarium oxysporum* f. sp. *lentis* by a sterilized cork borer and inoculated in a center of a substrate contained in a flask with the help of sterilized inoculation needle. 3-4 fungal discs were inoculated in to each flask. 6 flasks were inoculated for each species. of *T. harzianum, T.viride, T.virens, Bacillus subtilis, Pseudomonas fluorescens,* and *Fusarium species*. The inoculated flask was incubated at 25^0c for 15 days for growth and multiplication.

Seed treatment
Lentil a seed was treated with talc based formulation of potential biocontrol agent @ 10g per kg of seed and the seed was used for sowing. For treatment with fungicide, the lentil seeds was treated with companionable and effective fungicide at relevant dosage and sown in the pathogen infested soil in the pots. For treatment with both potential biocontrol agent and fungicide, at first seeds was treated with biocontrol agent followed by compatible fungicide.

Statistical analysis:
The data was analyzed statistically to draw the conclusion. Statistically analyses of laboratory and pot experiment were done by the method of completely Randomized Design (CRD) prescribed by Goon *et al.* (1931). The significance of treatment differences was tested by variance ration test of 5 per cent level of probability.
The observation of per cent inhibition of mycelium growth, disease incidence and disease control were transferred into 'Root sign Transformation' used for statistical analysis. Formula used for such transformed was $= \text{Sin}^{-1} \sqrt{\frac{P}{100}}$.

III. RESULT

Effect of chemical, bio-agents and *Rhizobium* was tested alone and in combination to see their individual as well as combined effect on wilt disease management in pot under net house conditions. Sterilized pot soil was inoculated with *F.*

oxysporum f. sp. *lentis* @ 5%. For seed treatment with fungicide (Carbendazim), bioagent (*Trichoderma harzianum*) and *Rhizobium*, the seed was first treated with carbendazim (0.2%) followed by 24 hours later with *Trichoderma harzianum* (0.4 per cent) than *Rhizobium* (0.2 per cent) presented in Table1.

Effect on disease incidence:

From the data, it is clear that the least per cent disease incidence (18.27%) was found in the treatment T16- (*Rhizobium* (ST)+ carbendazim (ST)+ *Pseudomonas fluorescens* (Soil T) followed by T15- (*Rhizobium* (ST)+ carbendazim.(ST)+ *Bacillus subtilis (*Soil T) (20.60%), T14-*Rhizobium* (ST)+carbendazim. (ST)+ *T. h.* (22.10%), T17-*Rhizobium* (ST) + Carbendazim (ST) + *T. harzianum* (Soil T) (22.90%), T10-*Rhizobium* (ST) + Carbendazim (ST) (25.33%), T13-*Rhizobium* (ST)+*Pseudomonas fluorescens* (Soil T) (25.66%), T11-*Rhizobium* (ST)+*Bacillus* subtilis (Soil T)(26.80%), T12-*Rhizobium (ST)+T. harzianum* (Soil T) (27.10%) and T9-*Rhizobium* (ST)+*T. h. (*ST) (27.90%) , T4- carbendazim (ST) (29.70%), T8-*Pseudomonas fluorescens* (Soil T) (31.30%), T6- *Bacillus subtilis (*Soil T)(33.60%) T7- *T. h.* (Soil T) (35.30%), T5-*Pseudomonas fluorescens* (ST) (36.20%) , T2- *Bacillus subtilis (*ST) (38.10%) , T3- *T. harzianum* (ST) (40.30%) and T1- *Rhizobium* (ST) (51.51%) as compared to untreated plants (T_{18}) (62.50 %) during 16-17.

Effect on per cent disease control:

The highest per cent disease control (70.86%) was recorded in T16-*Rhizobium* (ST)+ Carbendazim (ST)+ *Pseudomonas fluorescens* (Soil T) followed by T15- *Rhizobium* (ST)+ Carbendazim (ST)+ *Bacillus subtilis* (Soil T) (67.05), T14-*Rhizobium* (ST)+Carbendazim. (ST)+*T .h.* (64.64%) %), T17- *Rhizobium* (ST)+Soil T *T. h.* (63.36%), T10-*Rhizobium* (ST) + Carbendazim(ST) (59.47%), T13-*Rhizobium*(ST)+*Pseudomonas fluorescens* (Soil T) (58.94%), T11-*Rhizobium*(ST)+*Bacillus* subtilis (Soil T) (57.12%), T12-*Rhizobium(ST)+T. harzianum* (Soil T) (56.66%), T9-*Rhizobium* (ST) +*T. h. (*ST) (56.41%), T4- carbendazim (ST) (52.48%),T8-*Pseudomonas fluorescens* (Soil T) (49.92%), T6- *Bacillus subtilis (*Soil T) (46.24%), T7- *T. h.* (Soil T) (43.52%), T5-*Pseudomonas* sp. (ST) (42.08%), T2- *Bacillus sp.(*ST) (39.04%), T3- *T. harzianum* (ST) (35.89%) and T1- *Rhizobium* (ST) (17.58%) as compared to untreated plants (62.50%) T18-control during 2016-17. (Table-1, Fig. 1, 2 & Plate 1, 2 & 3).

Table 1: Integrated disease management of wilt of lentil in 2016-17

Treatment	**Disease incidence**	**% Disease control**	**Disease incidence**	**% Disease control**	**Disease incidence**	**% Disease control**
	30 days	**30 days**	**60 days**	**60 days**	**90 days**	**90 days**
T1-*Rhizobium* (ST)	6.43 (2.63)	17.56 (4.24)	12.87 (3.65)	17.50 (4.24)	51.51 (7.20)	17.58 (4.25)
T2-*Bacillus subtilis* (ST)	4.76 (2.29)	38.97 (6.27)	9.52 (3.16)	38.97 (6.27)	38.10 (6.21)	39.04 (6.28)
T3-*T. har*zianum (ST)	5.00 (2.34)	35.89 (6.02)	10.00 (3.24)	35.89 (6.03)	40.30 (6.38)	35.52 (6.00)
T4-Carbendazim (ST)	3.71 (2.05)	52.43 (7.27)	7.42 (2.81)	52.43 (7.27)	29.70 (5.49)	52.48 (7.27)
T5-*Pseudomonas fluorescens* (ST)	4.52 (2.24)	42.05 (6.52)	9.05 (3.09)	41.98 (6.51)	36.20 (6.05)	42.08 (6.52)
T6-*Bacillus subtilis* (Soil T)	4.20 (2.17)	46.15 (6.82)	8.40 (2.98)	46.15 (6.82)	33.60 (5.83)	46.24 (6.83)
T7- *T.harzianum* (Soil T)	4.41 (2.21)	43.46 (6.62)	8.82 (3.05)	43.46 (6.63)	35.30 (5.98)	43.52 (6.63)
T8- *Pseudo. fluorescens* (Soil T)	3.91 (2.10)	49.87 (7.09)	7.82 2.88)	49.87 (7.09)	31.30 (5.63)	49.92 (7.09)
T9-*Rhizobium* (ST) + *T.h.*(ST)	3.40 (1.97)	56.41 (7.54)	6.97 (2.73)	55.32 (7.46)	27.90 (5.33)	55.36 (7.46)
T10- *Rhizobium* (ST)+carbendazim (ST)	3.16 (1.91)	59.48 (7.73)	6.33 (2.61)	59.42 (7.73)	25.33 (5.08)	59.47 (7.73)
T11- *Rhizobium* (ST) + *Bacillus* subtilis (Soil T)	3.35 (1.96)	57.05 (7.58)	6.70 (2.68)	57.05 (7.58)	26.80 (5.22)	57.12 (7.58)
T12-*Rhizobium (ST)+T. harzianum* (Soil T)	3.38 (1.97)	56.66 (7.55)	6.77 (2.70)	56.60 (7.55)	27.10 (5.25)	56.64 (7.55)
T13-*Rhizobium* (ST)+*Pseudomonas* fluorescens (Soil T)	3.20 (1.92)	58.97 (7.70)	6.41 (2.63)	58.91 (7.70)	25.66 (5.11)	58.94 (7.70)
T14- *Rhizobium* (ST)+carbendazim (ST)+ *T. harzianum* (ST)	2.76 (1.80)	64.61 (8.06)	5.52 (2.45)	64.61 (8.06)	22.10 (4.75)	64.64 (8.06)
T15- *Rhizobium* (ST)+carbendazim (ST)+ *Bacillus subtilis* (Soil T)	2.57 (1.57)	67.05 (8.21)	5.15 (2.37)	66.98 (8.20)	20.60 (4.59)	67.04 (8.21)
T16- *Rhizobium* (ST)+carbendazim (ST) + *Pseudomonas fluorescens* (Soil T)	2.27 (1.66)	70.89 (8.44)	4.55 (2.24)	70.83 (8.44)	18.27 (4.33)	70.86 (8.44)
T17- *Rhizobium* (ST)+carbendazim (ST)+ *T.h.*	2.86	63.33	5.72	63.33	22.90	63.36

(Soil T)	(1.83)	(7.98)	(2.49)	(7.98)	(4.83)	(7.99)
T18- Control	7.80	0.00	15.60	0.00	62.50	0.00
	(2.88)	(0.71)	(4.01)	(0.71)	(7.93)	(0.71)
SEM±	0.065	0.247	0.094	0.245	0.196	0.237
CD	0.186	0.708	0.269	0.702	0.561	0.679
CV	5.351	6.293	5.649	6.239	6.027	6.039

* Figure in parenthesis is root transformed values

Effect on disease incidence:

From the data, it is clear that the least per cent disease incidence (22.21%) was found in the treatment T16- (*Rhizobium* (ST)+ carbendazim (ST)+ *Pseudomonas fluorescens* (Soil T) followed by T15- (*Rhizobium* (ST)+ carbendazim.(ST)+ *Bacillus subtilis (*Soil T) (24.60%), T17-*Rhizobium* (ST)+ carbendazim (ST)+ *T. harzianum* (Soil T) (26.90%), T10-*Rhizobium* (ST)+Carbendazim (ST) (29.33%), T13-*Rhizobium* (ST)+*Pseudomonas fluorescens* (Soil T) (29.66%), T11-*Rhizobium* (ST)+*Bacillus* subtilis (Soil T)(29.80%), T12-*Rhizobium (ST)+T. harzianum* (Soil T) (30.10%) T9-*Rhizobium* (ST) +*T. h. (*ST) (30.90%) T4- carbendazim (ST) (31.70%) T8-*Pseudomonas fluorescens* (Soil T) (36.30%), T6- *Bacillus subtilis (*Soil T) (37.60%), T5-*Pseudomonas fluorescens* (ST) (39.20%), T7 - *T. h.* (Soil T) (40.30%) T2- *Bacillus subtilis (*ST) (41.10%) T3- *T. harzianum* (ST) (44.30%) and T1- *Rhizobium* (ST) (54.51%) as compared to untreated plants (T_{18}) (67.50 %).

Effect on per cent disease control:

The highest per cent disease control of (67.09%) was recorded in T 16-*Rhizobium* (ST) + Carbendazim (ST)+ *Pseudomonas fluorescens* (Soil T) followed by T14-*Rhizobium* (ST) + Carbendazim (ST)+*T. h.* (64.29%) T15-*Rhizobium* (ST)+Carbendazim (ST)+ *Bacillus subtilis (*Soil T) (63.55%) T17-*Rhizobium* (ST)+SoilT *T. harzianum* (60.14%) T10-*Rhizobium* (ST)+Carbendazim (ST) (56.54%) T13-*Rhizobium* (ST)+ *Pseudomonas fluorescens* (Soil T) (56.05%) T11-*Rhizobium* (ST)+*Bacillus* subtilis (Soil T) (55.85%) T12-*Rhizobium (ST)+T. harzianum* (Soil T) (55.40%) T9-*Rhizobium* (ST)+*T. h. (*ST) (54.22%) T4- carbendazim (ST) (53.03%) T8-*Pseudomonas fluorescens* (Soil T) (46.22%) T6- *Bacillus subtilis (*Soil T) (44.29%) T5-*Pseudomonas fluorescens* (ST) (41.92%) T7- *T. h.* (Soil T) (40.29%) T2- *Bacillus subtilis (*ST) (39.11%) T3- *T. harzianum* (ST) (34.37%) and T1- *Rhizobium* (ST) (19.24%) as compared to untreated plants (67.50%) T18-control during 2017-18. (Table-2 & Fig.).

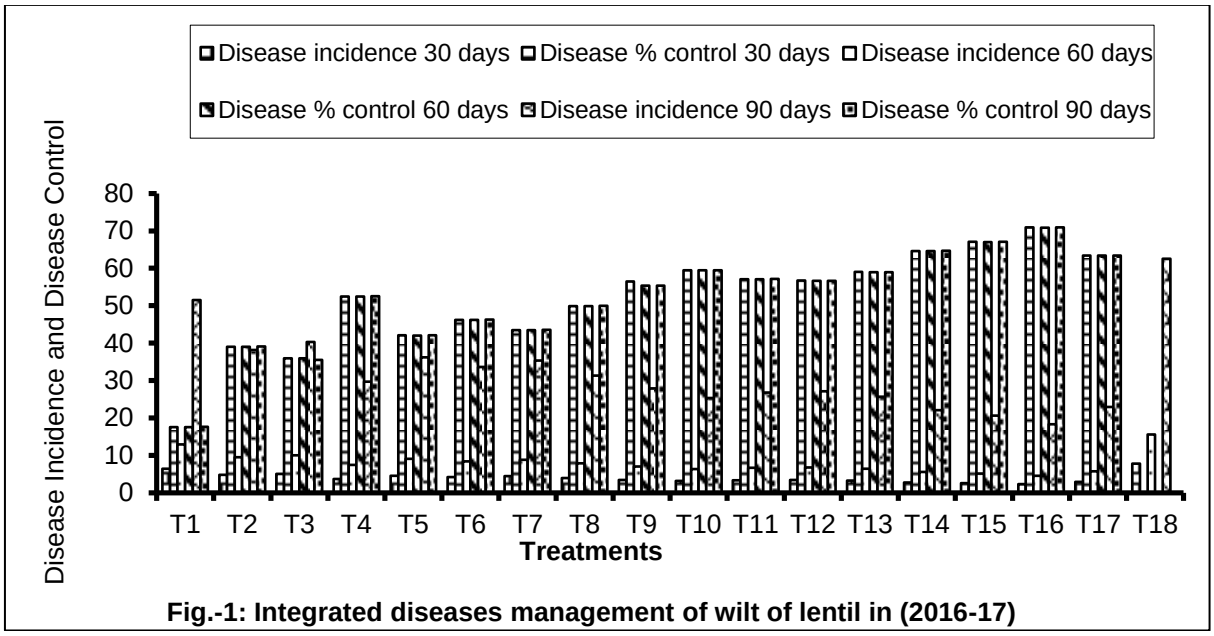

Fig.-1: Integrated diseases management of wilt of lentil in (2016-17)

Table 2: Integrated disease management wilt of lentil in 2017-18

Treatment	Disease incidence	%Disease control	Disease incidence	%Disease control	Disease incidence.	%Disease control
	30 days	**30 days**	**60 days**	**60 days**	**90 days**	**90 days**
T1-*Rhizobium* (ST)	6.81	18.92	13.62	19.26	54.51	19.24
	(2.70)	(4.40)	(3.75)	(4.44)	(7.41)	(4.44)
T2-*Bacillus subtilis* (ST)	5.13	38.92	10.27	39.12	41.10	39.11
	(2.37)	(6.27)	(3.28)	(6.29)	(6.44)	(6.24)
T3-*T. har*zianum (ST)	5.53	34.16	11.07	34.38	44.30	34.37

	(2.45)	(5.88)	(3.40)	(5.90)	(6.69)	(5.90)
T4-Carbendazim (ST)	3.96	52.85	7.92	53.05	31.70	53.03
	(2.11)	(7.29)	(2.90)	(7.31)	(5.67)	(7.31)
T5-*Pseudomonas fluorescens (*ST)	4.90	41.66	9.80	41.90	39.20	41.92
	(2.32)	(6.48)	(3.21)	(6.51)	(6.29)	(6.51)
T6-*Bacillus subtilis* (Soil T)	4.70	44.04	9.40	44.27	37.60	44.29
	(2.28)	(6.67)	(3.14)	(6.69)	(6.16)	(6.68)
T7-*T. harzianum* (Soil T)	5.03	40.11	10.07	40.30	40.30	40.29
	(2.35)	(6.37)	(3.25)	(6.38)	(6.38)	(6.38)
T8-*Pseudomonas fluorescens* (Soil T)	4.53	46.07	9.07	46.23	36.30	46.22
	(2.24)	(6.81)	(3.09)	(6.83)	(6.06)	(6.83)
T9-*Rhizobium*(ST)+*T. h.* (ST)	3.86	54.04	7.72	54.23	30.90	54.22
	(2.09)	(7.38)	(2.87)	(7.93)	(5.60)	(7.39)
T10- *Rhizobium* (ST)+ Carbendazim (ST)	3.66	56.42	7.33	56.55	29.33	56.54
	(2.04)	(7.54)	(2.80)	(7.54)	(5.45)	(7.54)
T11- *Rhizobium* (ST)+ *Bacillus* sps.(SoilT)	3.72	55.71	7.45	55.83	29.80	55.85
	(2.05)	(7.49)	(2.82)	(7.50)	(5.50)	(7.50)
T12- *Rhizobium (ST)+T. harzianum* (Soil T)	3.76	55.23	7.52	55.42	30.10	55.40
	(2.06)	(7.46)	(2.83)	(7.47)	(5.52)	(7.47)
T13- *Rhizobium* (ST)+ *Pseudomonas* fluorescens (Soil T)	3.70	55.95	7.41	56.07	29.66	56.05
	(2.05)	(7.50)	(2.81)	(7.51)	(5.49)	(7.51)
T14- *Rhizobium* (ST)+Carbendazim (ST)+ *T. harzianum* (ST)	3.01	64.16	6.02	64.39	24.10	64.29
	(1.87)	(8.03)	(2.55)	(8.05)	(4.95)	(8.04)
T15- *Rhizobium* (ST) +Carbendazim (ST) + *Bacillus subtilis* (Soil T)	3.07	63.45	6.15	63.54	24.60	63.55
	(1.89)	(7.98)	(2.58)	(7.99)	(5.00)	(8.00)
T16- *Rhizobium* (ST) +Carbendazim (ST)+ *Pseudomonas fluorescens* (Soil T)	2.77	67.02	5.55	67.10	22.21	67.09
	(1.81)	(8.21)	(2.46)	(8.22)	(4.76)	(8.21)
T17- *Rhizobium* (ST) +Carbendazim (ST) + *T.h.* (Soil T)	3.36	60.00	6.72	60.16	26.90	60.14
	(1.96)	(7.77)	(2.68)	(7.78)	(5.23)	(7.78)
T 18 Control	8.40	0.00	16.87	0.00	67.50	0.00
	(2.98)	(0.71)	(4.17)	(0.71)	(8.24)	(0.71)
SEM±	0.070	0.233	0.099	0.230	0.202	0.232
CD	0.200	0.668	0.284	0.660	0.578	0.667
CV	5.490	6.043	5.651	5.954	5.882	6.016

* Figure given in parenthesis is root transformed value

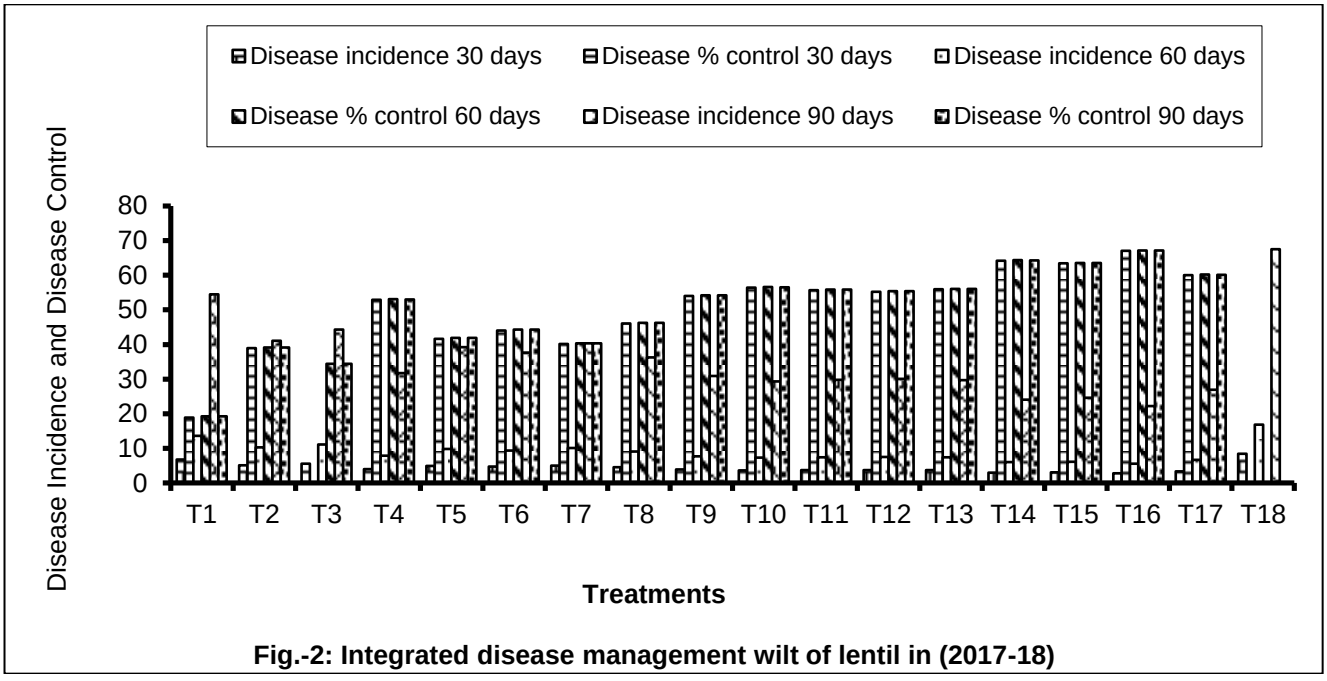

Fig.-2: Integrated disease management wilt of lentil in (2017-18)



T1-*Rhizobium* (ST) **T2-*Bacillus* sp.(ST)** **T3-*T. harzianum*(ST)**



T4-Carbendazim(ST) **T5-*Pseudomonas* sp.*(*ST)** **T6-*Bacillus* sp.(Soil T)**

Plate 1. Integrated diseases management of wilt of lentil



T7-*T. harzianum*(SoilT) **T8-*Pseudo.* sp.(SoilT)** **T9-*Rhizobium(*ST)+*T.h.*(ST)**



T10 *R.*(ST)+carbendazim(ST) **T11-*R*(ST)+*Bacillus* sp.(SoilT)** **T12- *R(ST)+T.harzianum*(SoilT)**

Plate 2. Integrated diseases management of wilt of lentil

T13- *R*(ST)+*Pseudo.*sp. (SoilT) **T14- *R*(ST)+carb. (ST)+ *T.h.* (SoilT)** **T15- *R*(ST)+car.(ST)+ *B. sp.(*SoilT)**

T16- *R*(ST)+car.(ST)+ *Pse. sp.(soil T)* **T17- *R(*ST)+car.(ST)+ T.h.(SoilT)** **T18 Control**

Plate 3. Integrated diseases management wilt of lentil

IV., DISCUSSION

Effect of chemical, bio-agents and *Rhizobium* was tested alone and in combination to see their individual as well as combined effect on wilt disease management in pot under net house conditions. Eighteen treatments was under taken in this study, among them least per cent disease incidence (18.27%) was found in the treatment *Rhizobium* (ST)+ Carbendazim.(ST)+ *Pseudomonas fluorescens* (Soil T) followed by *Rhizobium* (ST)+Carbendazim (ST)+ *Bacillus subtilis (*Soil T) (20.60%), *Rhizobium* (ST)+Carbendazim. (ST)+*T. h.* (22.10%), *Rhizobium* (ST)+Carbendazim(ST)+ *T. harzianum* (Soil T) (22.90%), *Rhizobium* (ST)+Carbendazim.(ST) (25.33%), *Rhizobium* (ST)+*Pseudomonas fluorescens* (Soil T) (25.66%), *Rhizobium* (ST)+*Bacillus* subtilis (Soil T)(26.80%), *Rhizobium (ST)+T. harzianum* (Soil T) (27.10%), *Rhizobium* (ST)+*T. h. (*ST) (27.90%) , Carbendazim.(ST) (29.70%), *Pseudomonas fluorescens* (Soil T) (31.30%), *Bacillus subtilis (*Soil T)(33.60%) *T. h*. (Soil T) (35.30%), *Pseudomonas fluorescens* (ST) (36.20%), Bacillus *subtilis (*ST) (38.10%), *T. harzianum* (ST) (40.30%) and *Rhizobium* (ST) (51.51%) as compared to untreated plants (62.50 %).

The highest per cent disease control (70.89%) was recorded in *Rhizobium* (ST)+ Carbendazim.(ST)+ *Pseudomonas fluorescens* (Soil T) followed by *Rhizobium* (ST)+Carbendazim (ST)+ *Bacillus subtilis (*Soil T) (67.05), *Rhizobium* (ST)+carbendazim. (ST)+*T. h.* (64.64%), *Rhizobium* (ST)+soil T *T. h.* (63.36%), *Rhizobium* (ST)+Carbendazim (ST) (59.47%), *Rhizobium* (ST)+*Pseudomonas fluorescens* (Soil T) (58.94%), *Rhizobium* (ST)+*Bacillus* subtilis (Soil T) (57.12%) *Rhizobium (ST)+T. harzianum* (Soil T) (56.66%), *Rhizobium* (ST)+*T. h.(*ST) (56.41%), Carbendazim (ST) (52.48%), *Pseudomonas fluorescens* (Soil T) (49.92%), *Bacillus subtilis (*Soil T)(46.24%), *T. h. (*Soil T) (43.52%), *Pseudomonas fluorescens* (ST) (42.08%), *Bacillus subtilis (*ST) (39.04%), *T. harzianum* (ST) (35.89%) and *Rhizobium* (ST) (17.58%) as compared to untreated pots during 2016-17. Similar results was also observed in the year 2017-18. Disease incidence was maximum at 90 days after sowing as compared to 60 and 30 days after sowing in both the years.

Thus, it can be concluded that integration of *Rhizobium*, chemical and biocontrol methods is necessary for successful management of lentil wilt as compared to individual method of wilt management in lentil.

V. CONCLUSION

Effect of chemical, bio-agents and *Rhizobium* was tested alone and in combination to see their individual as well as combined effect on wilt disease management in pot under net house conditions. Eighteen treatments was under taken in this study, among them highest per cent disease control (70.89%) was recorded in *Rhizobium* (ST)+ Carbendazim.(ST)+ *Pseudomonas fluorescens* (SoilT) followed by (*Rhizobium*(ST)+Carbendazim.(ST)+*Bacillussubtilis(*SoilT)(67.05),*Rhizobium* (ST)+Carbendazim. (ST)+*T.harzianum* (64.64%), *Rhizobium* (ST)+soilT*T.harzianum*(63.36%),*Rhizobium*(ST)+Carbendazim.(ST)(59.47%), *Rhizobium*(ST)+*Pseudomonas fluorescens* (SoilT) (58.94%), *Rhizobium*(ST)+*Bacillussubtilis*(SoilT)(57.12%),*Rhizobium(ST)+T.harzianum*(SoilT) (56.66%), *Rhizobium*(ST)+*T.harzianum*(ST) (56.41%), Carbendazim(ST) (52.48%), *Pseudomonas fluorescens* (SoilT) (49.92%), *Bacillus subtilis (*SoilT)(46.24%), *T.harzianum* (SoilT) (43.52%), *Pseudomonas fluorescens* (ST) (42.08%) , *Bacillus subtilis (*ST) (39.04%), *T.harzianum*(ST) (35.89%) and *Rhizobium*(ST) (17.58%) as compared to untreated pots during 2016-17. Similar results was also observed in the year 2017-18.

Least per cent disease incidence (18.27%) was found in the treatment *Rhizobium* (ST)+ Carbendazim.(ST)+ *Pseudomonas fluorescens*(SoilT) followed by (*Rhizobium*(ST)+Carbendazim.(ST)+*Bacillussubtilis(*SoilT)(20.60%),*Rhizobium*(ST)+carbendazim.(ST)+*T.harzianum*(22.10%),*Rhizobium*(ST)+Carbendazim(ST)+*T.harzianum*(SoilT)(22.90%),*Rhizobium*(ST)+Carbendazim.(ST)(25.33%),*Rhizobium*(ST)+*Pseudomonasfluorescens*(SoilT)(25.66%),*Rhizobium*(ST)+*Bacillus subtilis*(SoilT)(26.80%), *Rhizobium(ST)+T.harzianum*(SoilT) (27.10%), *Rhizobium*(ST)+*T.h.(*ST) (27.90%), Carbendazim.(ST) (29.70%), *Pseudomonas fluorescens* (SoilT) (31.30%), *Bacillus subtilis (*SoilT)(33.60%) *T.h.*(SoilT) (35.30%), *Pseudomonas fluorescens* (ST) (36.20%) , *Bacillus subtilis (*ST) (38.10%) , *T.harzianum*(ST) (40.30%) and *Rhizobium*(ST) (51.51%) as compared to untreated plants (62.50 %).

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