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RESEARCH ARTICLE

EFFICACY OF FUNGICIDES FOR THE MANAGEMENT OF CHICKPEA WILT DISEASE CAUSED BY FUSARIUM OXYSPORUM F.SP. CICERI.

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Abstract

Chickpea wilt caused by *Fusarium oxysporum* f.sp. *ciceri* is the most destructive and widespread fungal disease of chickpea. It has drastic effect on yield causing 100 % loss under favorable conditions. An attempt was made to explore the possibilities of controlling the disease through the help of using some fungicides. Experiment was conducted for selection of superior fungicides for the management of chickpea wilt disease under the red and lateritic zone of West Bengal. Ten fungicides were evaluated against the wilt pathogen in *in-vitro* condition with three concentrations, among of them Carbendazim exhibited 100% fungal growth inhibited at 1000 and 1500 ppm. Copper-Oxy Chloride exhibited least effective fungicides for inhibited the fungus growth at all three concentrations, with 51.11 %, 65.56% and 76.67 % inhibition at 500, 1000 and 1500 ppm respectively. In *in-vivo* experiment seven fungicides were evaluated, out of them Carbendazim was best for minimum in wilt incidence with 9.66 % is pooled value of two consecutive years followed by combination fungicides (Tebuconazole + Trifloxystrobin) with 10.12 % disease incidence. Chlorothalonil is the least effective fungicide for the management the disease with 15.18 % disease incidence. The studies revealed that, application of fungicide was significantly effective in managing the wilt pathogen as well as increasing the yield. This would help to farmers for selection of fungicides for managing the *Fusarium* wilt disease of chickpea.

Introduction:-

Chickpea (*Cicer arietinum* L.) is one of the major pulse crops, belongs of the family Leguminosae. It is also known as Bengal gram. Chickpea is a cheap source of protein compared to animal protein. Low yield of chickpea is attributed to several diseases and insect. Despite of different diseases *Fusarium* wilt disease is most important disease of chickpea causes several wilt. Wilt caused by *Fusarium oxysporum* Schlechtend Fr. f.sp. *ciceri* (Padwick) Matuo & K. Sato, is the most important soil-borne disease of chickpea throughout the global and particularly in the India subcontinent, the Mediterranean and California (Nene and Reddy, 1987). The fungus is a primarily soil borne pathogen, however, few reports indicated that it can be transmitted through seeds (Haware et al., 1978). The

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pathogen can infect at all stages of plant growth with more incidences in flowering and pod filling stage. The wilt appeared in field within three to four week after sowing, if the variety is susceptible (Haware, 1990). Early wilting causes more loss than late wilting, but seeds from late-wilted plants are lighter, rough and dull than those from healthy plants (Haware and Nene, 1980). Relatively high temperature with drought may cause up to eighty percent plant mortality (Govil and Rana, 1994). The pathogen is facultative saprophytic and it can survive as mycelium and chlamydospores in seed, soil and also on infected crops residues, buried in the soil for up to five to six years (Haware et al., 1986). Under favorable condition, the wilt infection can damage the crop completely and cause 100% yield loss (Navas-Cortes et al., 2000; Halila and Strange, 1996). In India annual yield loss due to *Fusarium* wilt were estimated at 10% (Singh and Dahiya 1973; Trapero-Casas and Jiménez-Díaz, 1985). The pathogen is mainly soil borne thus seed treatment by fungicides is consider the easiest and most economic way for management of the disease. Therefore the present study was carried out to evaluate the fungicides against *Fusarium* wilt of chickpea both laboratory and field condition.

Materials and Methods:-

***In-vitro* evaluation of fungicides:-**

Ten fungicides with three concentration viz., 500, 1000 and 1500 ppm were evaluated against chickpea wilt pathogen under laboratory condition by following poison food technique (Nene and Thapliyal, 1993).The details of the fungicides used are given table 1.

The test fungus was isolated from wilted chickpea plant, present on farmer's field of lateritic zone of West Bengal on Potato Dextrose Agar (PDA) medium and use standard techniques for isolation and pure culture.

The fungicides suspension was made by adding required quantity of fungicides to the melted PDA medium to obtain the desire concentration. Twenty ml of poisoned medium was

Table 1:- Details of fungicides used in the experiment.

Common name	Chemical name	Trade name
Carbendazim 50 %	Methyl 1H-benzimidazole-2-ylcarbamate	Hilzim 50 % WP
Azoxystrobin 23 %	Methyl (E)-2-{2[6-(2-cyanophenoxy) pyrimidin-4-yloxy]phenyl}-3-methoxyacrylate	Mirador 23 % SC
Propiconazole 25 %	1-[2-(2,4-Dichlorophenyl)-4-propyl-1, 3-dioxolan-2ylmethyl}-1H-1,2,4-traizole	Tilt 25 % EC
Thiophanate Methyl 70%	Dimethyl 4,4'-(o-phenylene) bis (3-thioallophanate)	Carnet 70% WP
Mancozeb 75%	Manganese ethylene bis (dithiocarbamate) polymeric complex with zinc	Indofil M-45 75% WP
Chlorothalonil 75%	2,4,5,6-Tetrachloro isophthalonitrile	Kavach 75% WP
Copper Oxy Chloride 50%	Copper chloride oxide, hydrate	Maincop 50% WP
Carbendazim12%+ Mancozeb 63%	2-(Methoxy carboryl) – benzimidazole + Manganes zinc ethylene bisdithiocarbamate	Sure 75 % WP
Tebuconazole 50% + Trifloxystrobin 25%	(RS)-1-(4-Chlorophynyl)-4,4-dimethyl-3-(1H-1,2,4-triazole-1 ylmethyl)pentan-3-ol + Benzeneacetic acid,(E,E)-alpha-(methoxyimino)-2-[[[[1-{3-(trifluoromethyl) phenyl]ethylidene]amino]oxy]methyl-,methylester	Nativo 75% WDG
Hexaconazole 4% + Zineb 68%	(RS)-2-(2, 4-Dichlorophenyl)-1-(1H-1, 2, 4-triazole-1-yl)hexan-2-ol + Zn ethylene bis dithiocarbamate	Avtar 72% WP

poured in each sterilized Petri plates. Suitable checks were maintained without addition of fungicides for comparison. Five mm mycelium disc of ten days old test fungus was taken from periphery of the culture and was placed in the centre of poisoned medium aseptically and incubated at 26 ± 1^0C for seven days. The diameter of the colony was measured in two directions and the average was recorded after seven days of incubation. Three replications were maintained for each treatment and experiment was designed in Complete Randomize Design (CRD). Percent inhibition of the fungus was calculated by using the following formula (Vincent, 1947):

$$I = \frac{C - T}{C} \times 100$$

Where,
I= Percent inhibition.
C= Radial growth of test fungus in control plate
T= Radial growth of test fungus in treated plate

In-vivo evaluation of fungicides:-
Field experiment was conducted at Agricultural Farm of Palli-Siksha Bhavana, Visva-Bharati, Sriniketan during the *rabi* season of year 2014-15 and 2015-16. The experiment was designed as Randomize Block Design (RBD) with three replications. The plot size was 5 x 3 m^2.

Seven fungicides viz., Carbendazim, Azoxystrobin, Chlorothalonil, Mancozeb, (Carbendazim 12% + Mancozeb 63%), (Tebuconazole 50% + Trifloxystrobin 25%) and (Hexaconazole 4% + Zineb 68%) were selected for these in-vivo studies. In these seven fungicides, two are systemic, two non-systemic and three are combination product. Both systemic and combination product fungicides @ 2000 ppm and non-systemic fungicides @ 3000 ppm concentration use this study. Chickpea variety Mahamaya-2, were selected for the experiment. Before sowing seeds are treated with these selected fungicides. Untreated seed served as control. All agronomic practice was carried out as per recommendations. The data on percent disease incidence and yield were recorded.

Results and Discussion:-

***In-vitro* effect of fungicides:-**
In-vitro evaluation of different fungicides against *Fusarium oxysporum* f.sp. *cicerei* was done by followed poisoned food technique. The fungicides were tasted at 500, 1000 and 1500 ppm concentration each and the observations on percent inhibition of colony growth, over control. The data are presented in table 2.

Among the ten fungicides evaluated, Carbendazim, Propiconazole, and two combination product i.e. (Carbendazim +Mancozeb) and (Tebuconazole + Trifloxystrobin) exhibits completely inhibited (100 % inhibition) the mycelia growth of fungus at 1500 ppm concentration followed by Thiophanate Methyl (96.67 % inhibition) and least inhibition by Copper-Oxy Chloride of 76.67 % inhibition.

At 1000 ppm Carbendazim showed highest inhibition of 100 % on mycelium growth of fungus followed by both Propiconazole and (Tebuconazole + Trifloxystrobin) (96.67 % inhibition) and Copper oxy-chloride showed least effectiveness by inhibiting 65.56 % of fungus growth.

The result obtained at 500 ppm concentration showed that among the different fungicides, Carbendazim was maximum inhibited (96.67 % inhibition) fungus growth followed by Propiconazole (92.22 % inhibition) and least effective is Copper-Oxy Chloride

Table 2:- *In-vitro* evaluation of fungicides against *F. oxysporum* f. sp. *Ciceri*.

Sl. No.	Common name	Trade Name	% Inhibition of mycelium growth		
			Concentration		
			500 ppm	1000 ppm	1500 ppm
1.	Carbendazim 50 % WP	Hilzim	96.67 (79.57)	100.00 (90.00)	100.00 (90.00)
2.	Azoxystrobin 23 % SC	Mirador	78.89 (62.65)	84.44 (66.77)	90.00 (71.63)
3.	Propiconazole 25 % EC	Tilt	92.22 (73.83)	96.67 (79.58)	100.00 (90.00)
4.	Thiophanate Methyl 70% WP	Carnet	87.78 (69.57)	93.33 (75.17)	96.67 (79.92)
5	Mancozeb 75% WP	Indofil M-45	61.11 (51.42)	78.89 (62.71)	91.11 (72.72)
6	Chlorothalonil 75% WP	Kavach	58.89	70.00	81.11

			(50.12)	(56.79)	(64.24)
7	Copper Oxy Chloride 50% WP	Maincop	51.11 (45.63)	65.56 (54.07)	76.67 (61.11)
8	Carbendazim12%+Mancozeb63% WP	Sure	85.56 (67.70)	91.11 (72.72)	100.00 (90.00)
9	Tebuconazole 50% + Tryfloxystrobin 25%	Nativo	88.89 (70.57)	96.67 (79.92)	100.00 (90.00)
10	Hexaconazole 4% + Zineb 68%	Avtar	72.22 (58.21)	85.56 (67.70)	92.22 (73.91)
S. Em. ± CD at 5%			0.8266 2.42	1.15 3.38	0.9535 2.79

* Data parenthesis is Angular Transform Value

of 51.11 % inhibition of fungal growth. Azoxystrobin, Mancozeb, Chlorothalonil and (Hexaconazole + Zineb) were quite effective in inhibiting the mycelia growth of the fungus.

***In-vivo* effect of fungicides:-**

Experiment was carried out during *rabi* season of two consecutive years viz., 2014-15 and 2015-16 to test, the field efficacy of different fungicides against the *Fusarium* wilt disease of chickpea. Comparative efficacy of different fungicides on disease incidence and crop yield are presented in table 3.

The pooled data over two years on the incidence of wilt disease indicated that the fungicide Carbendazim @ 2000 ppm was best in reducing wilt disease of chickpea with least disease incidence of 9.66 % followed by combination fungicides (Tebuconazole + Trifloxystrobin) @ 2000 ppm with disease incidence value of 10.12 % whereas Chlorothalonil @ 3000 ppm with 15.18 % disease incidence proved least effective for the management of the disease.

Among the seven fungicides evaluated rest four fungicides, like Azoxystrobin @ 2000 ppm, Mancozeb @ 3000 ppm, (Carbendazim + Mancozeb) @ 2000 ppm and (Hexaconazole + Zineb) @ 2000 ppm showed, intermediate results and the disease incidence recorded was 11.04 %, 13.80%, 11.50% and 14.26% respectively.

The effect of various fungicides on the yield of chickpea was also evaluated, and during both the years of study it was found that, highest yield of 1680 kg/ha on 2014-15 and 1674 kg/ha on 2015-16 were obtained from the plots treated with Carbendazim @ 2000 ppm. The pooled data also revealed the same showing a maximum yield of 1677 kg/ha. Correspondingly, a maximum yield increase of 17.77 % over control plot (1424 kg/ha) was also recorded in plots where Carbendazim @ 2000 ppm was treated. Followed by combination fungicides (Tebuconazole + Trifloxystrobin) @ 2000 ppm with yield 1671.50 kg/ha and yield increased 17.38 % over control. The lowest yield found in Chlorothalonil treated plot with 1627.50 kg/ha and increased 14.29 % yield over control. However, all the treatments are significantly differed from the control plot**.**

Table 3:- *In- vivo* evaluation of different fungicides for their efficacy against the wilt disease during 2014-15 and 2015-16

Sl No	Treatments	Does (ppm)	% Disease incidence	Yield (Kg/Ha)	% Disease incidence	Yield (Kg/Ha)	% Disease incidence	% Decrease in disease incidence	Yield (Kg/Ha)	% Increase in Yield
			2014-15		2015-16		Pooled			
1	Carbendazim 50 % WP	2000	9.2 (3.10)*	1680	10.12 (3.25)*	1674	9.66 (3.17)*	55.61	1677.00	17.77
2	Azoxystrobin 23 % SC	2000	11.04 (3.38)	1671	11.04 (3.37)	1665	11.04 (3.38)	49.26	1668.00	17.13
3	Mancozeb 75% WP	3000	12.88 (3.64)	1652	14.72 (3.89)	1643	13.80 (3.77)	36.58	1647.50	15.70
4	Chlorothalonil 75% WP	300	14.72	1632	15.64	1623	15.18	30.24	1627.	14.29

		0	(3.88)		(4.01)		(3.95)		50	
5	Carbendazim12%+Mancozeb63% WP	2000	11.04 (3.38)	1666	11.96 (3.51)	1658	11.50 (3.46)	47.15	1662.00	16.71
6	Tebuconazole 50% + Tryfloxystrobin 25%	2000	10.12 (3.25)	1675	10.12 (3.24)	1668	10.12 (3.25)	53.49	1671.50	17.38
7	Hexaconazole 4% + Zineb 68%	2000	13.80 (3.77)	1645	14.72 (3.89)	1636	14.26 (3.83)	34.47	1640.50	15.20
8	Control		21.29 (4.66)	1427	22.22 (4.76)	1421	21.76 (4.71)		1424.00	
S. Em. ± CD at 5%			0.1972 0.5982	2.76 8.37	0.1795 0.5445	3.44 10.45	0.1421 0.4311		2.27 6.89	

* Data parenthesis is Square root Transform Value

Conclusion:-

In the present study, *In-vitro* testing of fungicides by food poison technique revealed that all the fungicides showed effectiveness in decreasing the fungal growth at increased concentration of the fungicides. The fungal growth was totally inhibited at 1000 and 1500 ppm concentration of Carbendazim. Whereas Propiconazole, (Carbendazim + Mancozeb) and (Tebuconazole + Tryfloxystrobin) inhibited mycelia growth completely only at 1500 ppm.

In *In-vivo* study the chickpea seeds treated with fungicides gave 9.66 to 15.18 % incidence of *Fusarium* wilt as compared to untreated plants, which have 21.76 % incidence. The study revealed that, application of fungicides in both the years, were significantly effective as compared to control in managing the wilt pathogen as well as increasing the yield. This study would help of farmers for selection of fungicides to managing the *Fusarium* wilt of chickpea.

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