The Bioscan 8(1): 59-62, 2013
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.in

EFFECT OF FUNGICIDES AND PLANT EXTRACTS ON UREDOSPORES GERMINATION OF *PUCCINIA RECONDITA* F. SP. *TRITICI*

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KEYWORDS
Fungicides
Plant extracts
Leaf rust
Uredospores
Wheat

Received on :
01.07.2012

Accepted on :
17.17.2012

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ABSTRACT
Wheat is the most important food crop in the world. Of the three rusts, leaf rust caused by *Puccinia recondita* Rob. Ex. Desm. f. sp. *tritici* is the most important fungal disease of wheat which inflicting heavy losses in different parts of the country. *In vitro* evaluation of non-systemic fungicides revealed that maximum inhibition of uredospores germination was observed in mancozeb (54.85%) followed by chlorothalonil (40.89%). Among the different concentrations tried, the maximum inhibition of uredospores germination was at 1000 ppm of mancozeb which inhibited 83.33 per cent uredospores germination followed by same fungicide with 500 ppm (72.31%). Among systemic fungicides, propiconazole found the best for inhibition of 86.03 per cent uredospores germination followed by hexaconazole and penconazole with 77.40 and 72.29 per cent, respectively. Out ot 20 plant extracts, maximum per cent germination of rust uredospores inhibition was recorded in garlic (*Allium sativum*) bulb extract followed by onion (*Allium cepa*) bulb and ginger (*Zingiber officinal*) rhizome with 59.78, 57.70 and 54.81 per cent, respectively.

INTRODUCTION

Wheat (*Triticum* spp.) is the second most important cereal crops in the world. To meet the demand of the growing world population, there is a need for increased wheat production. Ever since the introduction of high yielding varieties of wheat in India, there has been a tremendous increase in production contributing to self-sufficiency for staple food along with rice and other cereals. However, monoculturing sometimes led to many diseases which affecting wheat limits its production potential. Among these the leaf rust caused by *P. recondita* Rob. Ex. Desm. f.sp. *tritici* is the most important fungal disease of wheat since its cultivation started in the world. The rust disease reduces the wheat yield, worldwide by 15 to 20 per cent suggesting loss of 20 to 30 M.T. annually in developing countries (Hanson *et al*., 1982). Rust disease has challenged the cultivation of this crop. In the recent years increased use of potentially hazardous fungicides is a great concern for the environmentalists. Therefore, screening of fungicides under laboratory conditions is more desirable as Filed screening is time consuming, laborious and costly affair. Many fungicides and plant extracts are known to have inhibitory effect on the growth and reproduction of various fungi (Shekhawat and Prasada, 1971; Wadhwani *et al.*, 1986; Ghewande, 1989; Amaresh *et al.*, 1998).The main objective of this study was carried out to evaluate the fungicides and plant extracts for their efficacy against inhibition of uredospores germination under *in vitro* condition.

MATERIALS AND METHODS

All the experiments were laid under *in vitro* conditions. For these, fresh uredospores collected from single pustule of infected leaf of Lal Bahadur wheat variety were dispensed uniformly in sterilized distilled water in culture tubes.

Fungicides

In this experiment, four non-systemic fungicides *viz*., copper oxychloride, mancozeb, chlorothalonil and wettable sulphur and eight systemic fungicides *viz*., carbendazim, hexaconazole, difenoconazole, penconazole, propiconazole, triadimefon, thiophanate methyl and triademorph at 50, 100, 250, 500 and 1000 ppm were tested against leaf rust pathogen (*P. recondita* f.sp. *tritici*) of wheat to know their efficacy on percentage inhibition of uredospores germination. The fungicides and their respective concentrations were prepared by mixing the requisite quantities of fungicides with two times (double concentration) in sterilized distilled water. Fresh uredospores collected from single pustule of infected leaf of Lal Bahadur wheat variety were dispensed uniformly in sterilized distilled water in culture tubes. Single drop of uredospores suspension was placed in the wells of series of cleaned cavity slides by using one ml pipettes to which single drop of different fungicides (double concentration) was also added to get the required concentrations. Treatment without fungicides served as control. Cavity slides containing spore suspension were incubated at 20 $\pm$ 1ºC temperature in a BOD incubator. Four replications of each treatment

Table 1: Effect of non-systemic fungicides at different concentration on per cent inhibition of uredospores germination of *P. recondita* f.sp. *tritici*

Fungicides	Per cent inhibition of uredospore germination* Concentration (ppm)					
	50	100	250	500	1000	Mean
Chlorothalonil	26.65** (19.69)***	30.80 (25.75)	38.33 (38.00)	49.15 (56.75)	53.56 (64.25)	39.70 (40.89)
Copper oxychloride	18.11 (9.31)	23.53 (15.50)	31.33 (26.56)	34.55 (31.69)	45.45 (50.31)	30.59 (26.67)
Mancozeb	30.44 (25.19)	36.52 (34.94)	49.84 (57.94)	58.88 (72.31)	66.70 (83.88)	48.47 (54.85)
Wettable sulphur	15.23 (6.45)	22.13 (13.75)	30.39 (25.13)	33.66 (30.25)	38.63 (38.50)	28.01 (22.82)
Mean	22.61 (15.16)	28.25 (22.49)	37.47 (36.91)	44.06 (47.75)	51.08 (59.24)	
					CD (P = 0.05)	
Fungicide (F)					0.82	
Concentration (C)					0.92	
F x C					1.83	

* Average of three replications; ** Figures indicate Arc sin transformed values; *** Figures in the parenthesis indicate original values

Table 2: Effect of systemic fungicides at different concentration on per cent inhibition of uredospores germination of *P. recondita* f.sp. *tritici*

Fungicides	Per cent inhibition of uredospore germination* Concentration (ppm)					
	50	100	250	500	1000	Mean
Carbendazim	16.77** (8.28)***	22.97 (14.75)	27.13 (20.31)	33.39 (29.81)	38.23 (37.81)	27.70 (22.19)
Hexaconazole	37.41 (36.44)	54.09 (65.13)	71.42 (89.38)	79.32 (96.06)	85.91 (100.00)	65.63 (77.40)
Difenoconazole	35.58 (33.38)	44.98 (49.50)	53.15 (63.56)	61.44 (76.63)	69.00 (86.69)	52.83 (61.95)
Penconazole	39.76 (40.44)	50.31 (58.75)	64.00 (80.31)	69.97 (87.75)	76.65 (94.19)	60.14 (72.29)
Propiconazole	49.66 (57.63)	61.32 (76.50)	79.20 (96.00)	85.91 (100.00)	85.91 (100.00)	72.40 (86.03)
Triadimefon	29.57 (23.88)	38.99 (39.13)	47.82 (54.44)	52.96 (63.25)	57.36 (70.44)	45.34 (50.23)
Thiophanate methyl	23.05 (14.88)	33.35 (29.75)	40.60 (41.88)	45.05 (49.63)	51.08 (60.06)	38.63 (39.24)
Tridemorph	40.63 (41.94)	51.81 (61.31)	62.93 (78.81)	67.64 (85.06)	71.84 (89.81)	58.97 (71.39)
Mean	34.05 (32.11)	44.73 (49.35)	55.78 (65.59)	61.96 (73.52)	67.00 (79.88)	
		CD (P = 0.05)				
	Fungicide (F)	0.69				
	Concentration (C)	0.55				
	F x C	1.54				

* Average of three replications; ** Figures indicate Arc sin transformed values; *** Figures in the parenthesis indicate original values

Table 3: Effect of different plant extracts *in vitro* on per cent inhibition of uredospores germination of *P. recondita* f. sp. *tritici*

Test plant extract	Plant part used	Per cent inhibition of uredospore germination* Concentrations			
		50%	20%	10%	Mean
Aonla	Leaf	40.86** (42.33)***	35.34 (33.00)	26.83 (19.92)	34.34 (31.75)
Ardusi	Leaf	50.56 (59.17)	41.34 (43.17)	32.20 (27.92)	41.37 (43.42)
Barmasi	Leaf	25.77 (18.50)	19.43 (10.58)	12.55 (4.25)	19.25 (11.11)
Bhoyringni	Leaf	41.82 (44.00)	31.45 (26.75)	26.39 (19.33)	33.22 (30.03)
Bougainvillea	Leaf	51.93 (61.50)	42.35 (44.92)	33.92 (30.67)	42.73 (45.70)
Castor	Leaf	37.45 (36.50)	30.04 (24.58)	23.06 (15.00)	30.18 (25.36)
Chrysanthemum	Leaf	44.74 (49.08)	35.80 (33.75)	28.41 (22.17)	36.32 (35.00)
Cotton	Leaf	42.83 (45.75)	34.73 (32.00)	27.21 (20.50)	34.93 (32.75)
Datura	Leaf	55.24 (67.00)	46.32 (51.83)	36.21 (34.42)	45.92 (51.08)
Eucalyptus	Leaf	38.24 (37.83)	29.77 (24.17)	22.49 (14.17)	30.16 (25.39)
Garlic	Bulb	61.61 (76.92)	49.19 (56.83)	42.74 (45.58)	51.18 (59.78)
Ginger	Rhizome	57.88 (71.25)	46.42 (52.00)	40.19 (41.17)	48.16 (54.81)
Mahendi	Leaf	33.81 (30.50)	27.07 (20.25)	17.13 (8.25)	26.01 (19.67)
Lantana	Leaf	45.56 (50.50)	35.44 (33.17)	30.80 (25.75)	37.27 (36.47)
Neem	Leaf	47.85 (54.50)	41.68 (43.75)	33.40 (29.83)	40.98 (42.69)
Onion	Bulb	61.10 (76.17)	46.27 (51.75)	42.48 (45.17)	49.95 (57.70)
Piludi	Leaf	39.31 (39.67)	28.57 (22.42)	22.30 (13.92)	30.06 (25.34)
Ratanjyot	Leaf	35.59 (33.42)	30.42 (25.17)	22.09 (13.67)	29.37 (24.09)
Tulsi	Leaf	48.62 (55.83)	36.85 (35.50)	32.83 (28.92)	39.43 (40.08)
Turmeric	Rhizome	54.32 (65.50)	44.93 (49.42)	34.41 (31.50)	44.55 (48.81)
Mean	45.76 (50.80)	36.67 (35.75)	29.38 (24.61)		
	CD (P = 0.05)				
Plant extract (P)	1.40				
Concentration (C)	0.54				
P x C	2.43				

* Average of three replications; ** Figures indicate Arc sin transformed values; *** Figures in the parentheses indicate original values

maintained and four hundred germinated and ungerminated uredospores were counted under different microscopic fields for each slide after 24h of incubation. Per cent inhibition of spore germination over control was calculated as per the formula described by Vincent (1947).

Plant extracts

Twenty plants belonging to different families were evaluated against *P. recondita* f.sp. *tritici* in inhibition of uredospores germination *in vitro*. Fresh and healthy 100g plant parts of each plant species crushed in 100mL sterile distilled water in sterilized pestle and mortar to obtain 1:1 extract. Extracted material was filtered through whatman's filter paper no.42. This filtrate was considered as stock solution *i.e.* 100 per cent concentration. Five mL, 2mL and 1mL of each stock solution was mixed in 5mL, 8mL and 9mL of sterilized distilled water to make extract of 50, 20 and 10 per cent concentration of each plant species, respectively. For evaluation of these extracts, standard procedure was followed as described previously in fungicidal testing and fungicides were replaced by plant extracts. A control was kept without adding plant extract.

RESULTS AND DISCUSSION

Non-systemic fungicides

The data (Table1) showed that all the non-systemic fungicides significantly reduced the uredospores germination over control. Maximum inhibition of uredospores germination was observed in mancozeb (54.85%) followed by chlorothalonil (40.89%). copper oxychloride and wettable sulphur showed poor inhibition of uredospores germination *i.e.* 26.67 and 22.82 per cent, respectively. Among the different concentrations tried, the maximum inhibition of uredospores germination was at 1000 ppm of mancozeb which inhibited 83.88 per cent uredospores germination followed by same fungicide with 500 ppm (72.31%).

Among the systemic fungicides (Table 2), propiconazole (86.03%) was the best for inhibition of uredospores germination and significantly superior over other fungicides. Hexaconazole (77.40%) was next followed by penconazole (72.29%), tridemorph (71.39%) and difenoconazole (61.95%). Complete inhibition of uredospores germination of test pathogen was observed at 500 and 1000 ppm of propiconazole and 1000 ppm of hexaconazole. Hexaconazole at 500 ppm found next best fungicide which inhibited the uredospores germination by 96.06 per cent which was at par with 250 ppm of propiconazole (96.00%). Carbendazim found least inhibition of uredospores germination. Similarly, Bhowmik and Amarsingh (1979) found maximum inhibition of germination of uredospore of *P. helianthi* by Dithane M- 45. Jalinder *et al*. (1986) observed that Dithane M-45 proved to be most effective for inhibition of uredospores germination of *P. graminis* f.sp. *tritici*. Nagesh *et al*. (2002) reported the highest inhibition of uredospore germination found by mancozeb and chlorothalonil at 1000 ppm. Mancozeb and chlorothalonil have been reported superior for the inhibition of uredospores germination of *P. helianthi* (Amaresh and Nargund, 2003a). Nagesh *et al*. (2002) also found the complete inhibition of uredospore germination of *P. helianthi* by propiconazole and hexaconazole at 1000 ppm concentration. Amaresh *et al*. (1998) recorded the least inhibition in uredospore germination of *P. helianthi* was observed with carbendazim.

Plant extracts

The data (Table 3) showed the significant reduction in spore germination over control by all the plant extracts taken in this study. The garlic bulbs extract (59.78%) which was significantly superior over other phytoextracts. Onion bulb extract was next best for inhibition of uredospores germination (57.70%) followed by ginger rhizome extract (54.81%) and datura leaf extract (51.08%). Mahendi and barmasi leaf extract showed lowest inhibition of uredospores germination by 19.67 and 11.11 per cent, respectively. Among the different concentrations, the maximum (76.92%) inhibition of uredospores germination was observed in garlic bulb extract at 50 per cent concentration which was statistically at par with onion bulb extract at same concentration.

Saniewska (1998) have also reported the extract from the garlic highly effective in control of rust caused by *P. antirrhini* on snapdragon. Amaresh and Nargund (2003b) observed the maximum per cent inhibition of uredospores germination with *Allium cepa* and *Allium sativum* at all the concentrations tested *i.e.* 10.0, 7.0, 5.0 and 2.0 per cent.

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