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Evaluation of different fungicides against early blight of potato (*Solanum tuberosum* L.)

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Abstract
Potato is one of the most important vegetable crops grown in the world. The early blight of potato is common occurance wherever potatoes are grown in the world. The early blight is free from any inhibition caused by weather condition and occurs in cold as well as warm areas. An experiment was conducted to test the inhibition of six different fungicides (Propiconazole, Thiram, Carbendazim, Dithane M-45, Sulphur and Tricyclazole) for controlling the disease under *in-vitro* and field condition during 2021-22 and 2022-23. The highest percent disease controlled with propiconazole exhibited highest percent inhibition (100%) in radial growth and minimum percent inhibition were found in Tricyclazole (10.77%). The field evaluation of different fungicides indicated that Propiconazole (12.76%) was most effective and Tricyclazol (25.63%) least effective for the controlling the disease incidence and also economical in reducing severity of the early blight and increasing yield over control.

Keywords: Early blight, *Alterneria solani*, fungicide evaluation, *in-vitro* and *in-vivo*

Introduction

Potato (*Solanum tuberosum* L.) is one of the most valuable food crops for mankind FAO and in terms of quantities produced and consumed worldwide (FAO, 2005) [4]. The cultivated potato (*Solanum tuberosum* L.) a native of South America has been under cultivation in the Andes and Chilean highlands of that continent for over a thousand years. Its introduction in the early part of the 17th century most probably by the Portugese traders or by British missionaries (Puskernath, 1976) [8]. In value of production it ranks fourth in the world after Wheat (*Triticum aestivum* L.), Rice (*Oryza sativa* L.) and Maize (*Zea mays* L.) (Bowen, 2003) [2]. It is used in a wide variety of table, processed, livestock feed and industrial uses (Feustel, 1987; Talburt, 1987) [5, 10]. Potato provides nutritious food in a diversity of environments and is an important food for the increasing world population, which has potential for increased vitamin C, protein content.

Alterneria solani is a major foliar disease of potato caused by early blight (*Solanum tuberosum* L.) (Ellis and Martin, 1882) [3]. The disease occurs over a wide range of climatic conditions and depends in large part on the frequency of foliage wetting from rainfall, fog, dew or irrigation on the nutritional status of foliage and on cultivar susceptibility. Though losses rarely exceed 20 percent, if left uncontrolled the disease can be very destructive. In potato growing areas intensive fungicide treatment has restricted losses to less than 5 percent.

Material and Methods

The efficiency of different fungicide were conducted at Department of Plant Pathology laboratory of T.D.P.G. College Jaunpur, during 2022-23 using six fungicides and *In-vitro* condition.

Total six fungicides were evaluated under *In-vitro* conditions against *Alterneria solani* using Potato Dextrose Agar Medium (Garbrekiristos, 2020) [6]. Under *In-vitro* condition six fungicides namely Propiconazole, Hexaconazole, Carbendazim, Dithan M-45, Sulphur and Tricyclazole were tested (at 250 ppm) for their respective ability to control the pathogen by poisoned food technique (Schmitz, 1930) [9]. *In-vitro* judging the extent of inhibitory effect on the growth of pathogen and measured the radial growth of pathogen on 2 percent Potato dextrose agar. Each treatment was replicated 3 times with CRD design.

The inhibition of fungal mycelial growth was calculated by

$$I = \frac{C - T}{C} X100$$

Where,
I=percent inhibition of mycelial growth.
C= radial growth of fungus control.
T= radial growth of the fungus in treatment

In-Vivo evaluation of fungicides

The experiment was carried out at Student Research Farm Pilli Kothi of T.D.P.G. College, Jaunpur with spray schedules of different fungicides for the management of early blight of potato cultivars local race was sown on dated 15th November with three replications and seven treatments in RBD (Randomized block design) along with recommended package and practices during 2021-22 and 2022-23. The six fungicides Propiconazole 25% SC- 1%, Hexaconazole 5EC- 1.5%, Carbendazim 50% WP- 1%, Dithane M-45 - 2%. Sulphur 80% WP- 1% and Tricyclazole 75 % WP- 1% were use as foliar spray for regarding the disease incidence in 10 randomly selected plant per plot were examined and the disease incidence in percentage was transformed into analysis statically. The tuber yield per plot were also recorded which was extraploted to give the value of yield in Q./ha.

The percent disease incidence was selected given formula % disease incidence.

$$PDI = \frac{Total\ no.of\ infected\ plant}{Total\ no.of\ plant\ screened} X100$$

Results and Discussion

The results are presented in Table-1 and its corresponding histogram-1 and fig.3 that all tested fungicides inhibit the growth of the pathogen with different magnitude as compared with control.

Data regarding growth revealed that Propiconazole was the most effective fungicide on reducing the growth of mycelium (0.00 mm) with (100%) inhibition over control followed by Hexaconazole (13.5 mm) with (85.00%) inhibition over control, Carbendazim (29.5 mm) with (67.22%) inhibition over control. The next best effective fungicide was Dithane M-45 and Sulphur which showed the average radial growth (40.8 and 73.00 mm) with respect to 54.66 and 18.88 percent inhibition over control respectively. Among the tested fungicide Tricyclazole was least effective which showed maximum average radial growth 80.30 mm. and minimum inhibition over control 10.77 percent. After 25 days of incubation period of all tested fungicides Propiconazole showed maximum inhibition of mycelial growth while the minimum inhibition was showed by Tricyclazole. These findings are also in agreement with Measta *et al.* (2009) [7] who reported that Propiconazole (0.15%) and Hexaconazole (0.15%) were effective in 95.35% and 94.34% spore germination inhibition of Alterneria spp.

***In-Vivo*:-** The result are showed in Table-2, corresponding histogram-2 of trial with six fungicides indicates their effectiveness in minimizing the disease incidence of blight. In the year 2021-22 spraying of fungicides Propiconazole (11.78%) at the interval of 15 days, was most effective minimize the disease incidence and increasing the maximum yield (222.26 Q./ha). The next effective fungicide was Hexaconazole and Carbendazim which showed (13.19% and 15.93%) disease incidence and corresponding yield (22062 q./ha) and (219.39 q/ha) respectively. These were statically at par with each other. Dithane M-45 showed (18.65%) disease incidence and (214.68 Q/ha.) yield and Sulphur showed (21.45%) disease incidence and (201.5 Q./ha) yield. These were statically different from each other. Tricyclazole was showed maximum (24.22%) disease incidence and mininmum (200.0 Q./ha) yield.

In the year 2022-23 Propiconazole was most effective fungicide which showed minimum (13.75%) disease incidence and maximum yield (221.04 Q./ha) yield. The next effective fungicide was Hexaconazole and Carbendazim which showed (15.04% and 18.79%) disease incidence, and corresponding yield (216.28 and 214.72 Q./ha). These were statically different with each other. The next effective fungicide was Dithane M-45 which showed (20.74%) disease incidence and (192.19 Q./ha) yield. The least effective fungicide was Sulphur which showed (24.1%) disease incidence, and (191.1 Q./ha) yield and Tricyclazole was showed maximum (27.05%) disease incidence and minimum (190-03 Q./ha) yield. These findings are also in agreement with Aruna kumara *et al.* (2010) [1] who reported that effective control of the disease is possible with fungicidal application of Mancozeb (0.2%) or Propiconazole (0.1%).

Table 1: Inhibitory effect of different fungicides on the growth of *Alternaria solani In-vitro* after 8 days incubation at 25±27°C.

S. No.	Name of the fungicides	Dose	Radial growth of fungus (mm.)	% inhibition over control
1.	Propiconazole	250 ppm	0.00	100
2.	Hexaconazole	250 ppm	13.5	85.0
3.	Carbendazim	250 ppm	29.5	67.22
4.	Dithane M-45	250 ppm	40.8	54.66
5.	Sulphur	250 ppm	73.0	18.88
6.	Tricyclazole	250 ppm	80.3	10.77
7.	Untreated Control		90.0	-
	C.D.		2.15	

Table 2: Inhibitory effect of different fungicides against the disease incidence and yield of potato.

S. No.	Name of Treatment	Dose (%)	% disease incidence		Mean	Yield (Q./ha)		Mean
			2021-22	2022-23		2021-22	2022-23	
1.	Propiconazole	1 %	11.78	13.75	12.76	222.26	221.04	221.65
2.	Hexaconazole	1.5 %	13.19	15.04	14.11	220.62	216.28	218.45
3.	Carbendazim	1 %	15.93	18.79	17.36	219.39	214.72	217.05
4.	Dithane M-45	2 %	18.65	20.74	19.69	214.66	192.19	203.42
5.	Sulphur	1 %	21.45	24.1	22.78	201.5	191.1	196.3
6.	Tricyclazole	1 %	24.22	27.05	25.63	200	190.03	195.01
7.	Untreated control -		34.81	37.64	36.22	178.13	173.74	175.39
	C.D.		1.85	1.95	1.63	1.00	2.15	1.80

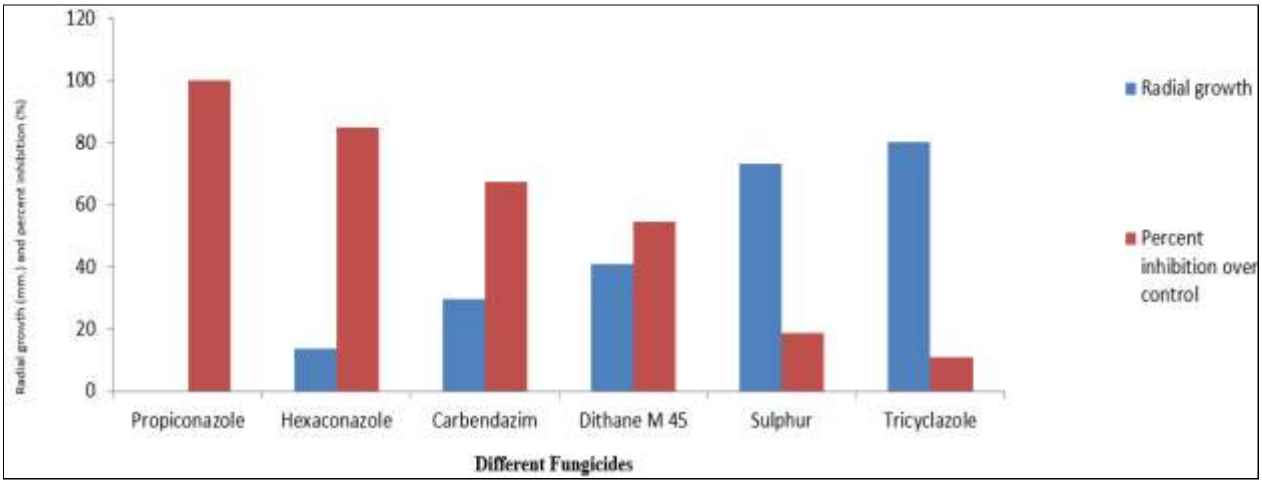

Fig 1: Effect of fungicide on the growth of *A. solani* under *In-vitro* during 2022-23

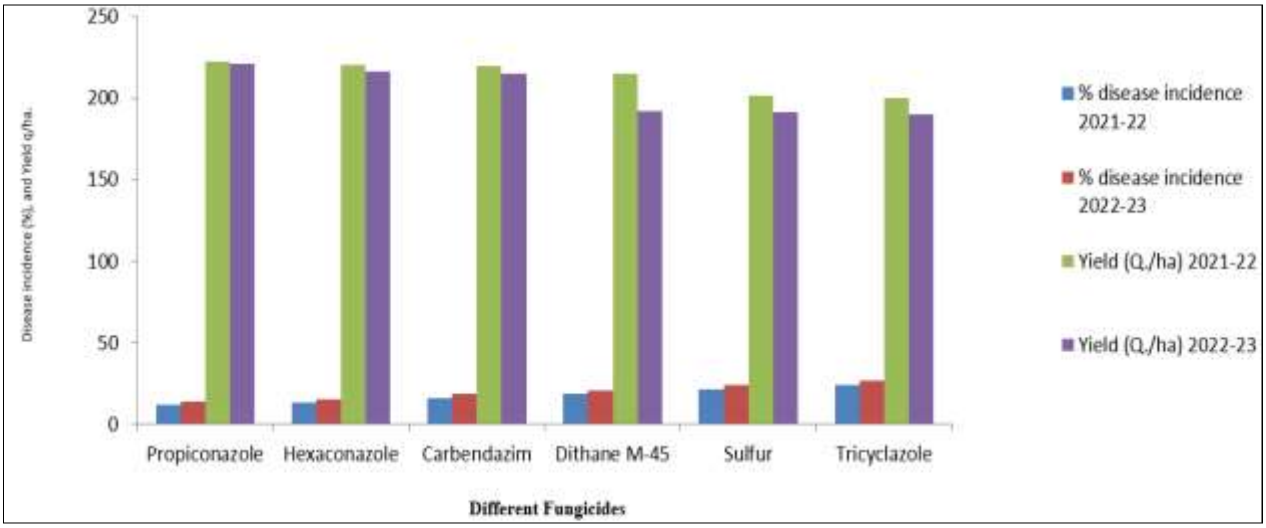

Fig 2: Effect of different fungicides average disease incidence and yield of potato under *In-Vivo* during 2021-23

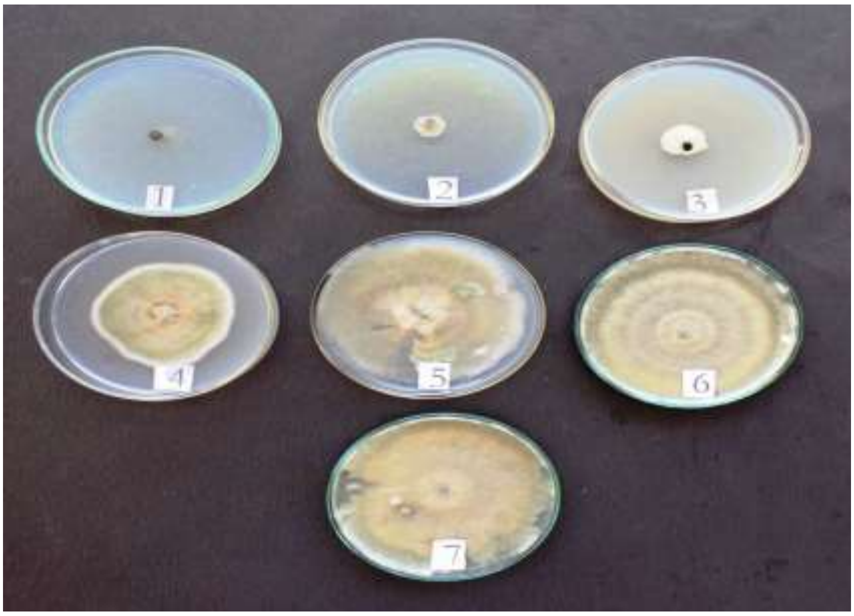

Fig 3: Inhibitory effect of different fungicides on the growth of *Alternaria solani In-vitro.*

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