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Research article

EFFECT OF CONTINUOUS AND ALTERNATE PASSAGE ON THE DEVELOPMENT OF CARBENDAZIM RESISTANCE IN *SCLEROTIUM ROLFSII* CAUSING RHIZOME ROT OF TURMERIC

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ABSTRACT: Culturing of sensitive *Sclerotium rolfsii* (SR-4) on the carbendazim continuously for eight successive passages significantly increased the resistance. Use of carbendazim alternately with Benomyl, Roko, Dhanuka and Ridomil for eight successive passages decreased the resistance in SR-4 carbendazim sensitive isolate.

Keywords: Sensitive, Carbendazim, Turmeric, Isolate.

INTRODUCTION

Turmeric (*Curcuma longa* L.) belongs to the family Zingiberaceae and is believed to be native of China. It is very important condiment. It is used as dye. Turmeric is also used as medicine. Turmeric is used in religious purposes [1]. It is cultivated in Tamil Nadu, Andhra Pradesh, Orissa, West Bengal, Karnataka, Kerala and Maharashtra. It is also cultivated in China and other countries. The crop is severely affected by many diseases. A number of organisms have been reported to cause rhizome rot in storage. These include *Sclerotium rolfsii*, *Aspergillus flavus*, *Cladosporium cladosporoides* and *Macrophomina phaseolina* [2]. Major disease among them is the rhizome rot of turmeric caused by *Sclerotium rolfsii* Sacc. It is very serious disease of turmeric in various states of India. The rhizome rot of turmeric caused by *Sclerotium rolfsii* is managed by using various systemic fungicides [3].

MATERIAL AND METHODS

In vitro studies:-

Continuous Passage

To Study the effect of continuous passage, *in vitro*, wild sensitive isolate SR-4 in each passage was cultured on plates with 8 µg/ml carbendazim in triplicates. Agar disc of 8 mm diameter from the previous passage of the same isolate was placed at the center of each plate in triplicate. In each passage, linear mycelial growth was measured after 4 days.

Alternate Passage

To study the effect of alternate passage *in vitro* wild sensitive isolate SR-4 was cultured on plates with 8 µg/ml carbendazim in triplicates. After 4 days 8 mm diameter agar disc from the previous passage was transferred on the plates containing another fungicide at the same concentration (8µg/ml). The process of such alteration of carbendazim to another fungicide was continued up to eight passages.

In vivo studies

Continuous Passage:-

To study the effect of continuous passage on the development of fungicide resistance in the pathogen *in vivo*, mycelial suspension using 1 culture tube of wild sensitive isolate (SR-4) was prepared. 10 ml mycelial suspension was inoculated on turmeric rhizomes as described earlier and treated with 1 µg/ml carbendazim, 24 hrs before it.

After 4 days mycelial suspension from such infected rhizomes was prepared and applied to healthy turmeric rhizomes treated with 1 µg/ml carbendazim 24 hrs before inoculation. Same procedure was followed up to eight passages.

Alternate Passage

To study the effect of alternate passage on the development of fungicide resistance in the pathogen *in vivo*, 10 ml mycelial suspension using 1 culture tube of wild sensitive isolate (SR-4) was inoculated on the healthy turmeric rhizomes as described earlier and treated with 1 µg/ml carbendazim 24 hrs before it. After 4 days a mycelial suspension from such infected rhizomes was prepared and applied to healthy turmeric rhizomes treated with another fungicide (1 µg/ml). Same procedure was followed up to eight passages.

RESULTS AND DISCUSSION

In vitro studies:-

Continuous and alternate treatment with carbendazim:-

It was seen that growing of *Sclerotium rolfsii* on the medium containing carbendazim for eight successive passages continuously significantly increase the resistance. When it was cultured alternately with other fungicides there was decrease in the development of carbendazim resistance. Carbendazim when used alternately with Benomyl, Roko and Dhanuka there was complete inhibition of *Sclerotium rolfsii* at 6th passage (Table: 1).

Table: 1 Effect of exposure of *Sclerotium rolfsii* to Carbendazim continuous and alternating with other fungicides on the development of resistance during eight successive passages (*In Vitro*)

Fungicides	1	2	3	4	5	6	7	8
Carbendazim Individual	11.00	16.33	20.00	21.33	21.33	21.33	21.33	21.33
Cabendazim Alt.Benomyl	11.00	13.66	11.33	10.00	9.33	00.00	00.00	00.00
Carbendazim Alt.Roko	10.66	12.33	11.66	12.33	9.66	00.00	00.00	00.00
Carbendazim Alt.Dhanuka	10.00	13.66	12.33	11.66	10.00	00.00	00.00	00.00
Carbendazim Alt. Ridomil MZ	10.00	15.66	16.33	15.00	10.00	00.00	00.00	00.00

Tukey; Compare all pair of columns.

P value = P< 0.001

	Standard error of mean (SEM)
Benomyl	1.151
Roko	1.161
Dhanuka	1.201
Ridomil MZ	1.442

In vivo studies

It was observed that continuous treatment of carbendazim in alone for eight successive passages increased the resistance of pathogen. When Ridomil MZ applied alternate with carbendazim there was complete inhibition of the pathogen at fourth passage only. Remaining fungicides checked the infection of pathogen at 5th passage only (Table: 2).

These results are agreeing with other workers. Alternate use of ediphenphos with carbendazim reduced carbendazim resistance in *Septoria nodorum* and *Cercosporella herpotrichoides* [4]. A mathematical model to test different chemicals for their alternate use given was by [5]. Use of mancozeb alternate with metalaxyl to control late blight of potatoes [6]. Multisided action of carbendazim with mancozeb, benomyl, captafol and thiram might be responsible for the complete inhibition or the development of resistance in the *Macrophomina phaseolina* causing charcoal rot of potato [7].

Table: 2 Effect of exposure of *Sclerotium rolfsii* to Carbendazim continuous and alternating with other fungicides on the development of resistance during eight successive passages (*In Vivo*)

Fungicides	1	2	3	4	5	6	7	8
Carbendazim Individual	9.66	10.33	11.33	12.33	14.00	14.66	15.00	15.00
Cabendazim Alt.Benomyl	9.33	11.33	11.66	9.33	00.00	00.00	00.00	00.00
Carbendazim Alt.Roko	9.00	11.33	12.33	10.33	00.00	00.00	00.00	00.00
Carbendazim Alt.Dhanuka	9.33	11.33	11.66	10.33	00.00	00.00	00.00	00.00
Carbendazim Alt. Ridomil MZ	9.00	10.33	10.66	00.00	00.00	00.00	00.00	00.00

Tukey; Compare all pair of columns.
P value= P< 0.001

	Standard error of mean (SEM)
Benomyl	1.100
Roko	1.137
Dhanuka	1.127
Ridomil MZ	1.015

CONCLUSION

Culturing of sensitive *Sclerotium rolfsii* (SR-4) on the carbendazim continuously for eight successive passages significantly increased the resistance. Use of carbendazim alternately with Benomyl, Roko, Dhanuka and Ridomil for eight successive passages decreased the resistance in SR-4 carbendazim sensitive isolate.

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