PREVENTION AND CONTROL OF RHIZOME ROT OF TURMERIC CAUSED BY *Aspergillus niger*

M.P. Sharma and A.N. Roy
Plant Disease laboratory, Department of Botany, Agra College,
Agra 282002, India.

Abstract

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Aspergillus niger caused maximum spoilage of turmeric rhizomes at 30°C under 90 percent relative humidity. Fifteen chemicals tested *in vitro*, only bavistin and benomyl prevented its complete growth even at 100 ppm conc.. Both the chemicals prevented rotting in post-inculation *in vivo* application also. However, benomyl was slightly lesser effective in post-inoculation *in vivo* application.

Additional key words: *Aspergillus niger,* rhizome rot, *Curcuma longa*, bavistin, benomyl.

Introduction

Turmeric (*Curcuma longa* L.) is not only an auspicious article in all religious activities but also a constituent of condiments, a dye for wool and silk and a component of ayurvedic medicines. Periodical survey in the last three years have revealed large scale spoilage of seed turmeric in storage in different parts of India. More than 50 percent of the rotted rhizomes were found to be infected by *Aspergillus niger*. The extent of spoilage caused by this fungus under different environmental conditions and formulation of effective post-harvest control measures against it, have been attempted and resultant data are presented in this paper.

Materials and Methods

The pathogenicity of the fungus was established on surface sterilized healty rhizomes following the knife injury method of Tandon and Mishra (6). Intensity of the rhizome rotting was evaluated at 15, 20, 25, 30 and 35°C temperature and 30, 60 and 90 percent relative humidity. Twenty replicates were used for experimantations. The formula of Third et al. (7) was applied for calculating the amount of rot developed on individual rhizomes.

$$\text{percent rot} \quad \frac{W - w}{W} \times 100$$

where

W = the wt. of rhizomes before inoculation.

w = the wt. of rhizomes after removal of rotted portion.

Fifteen chemicals were tested by the poisoned food technique as described by Schmitz (3) for their *in vitro* efficacy against the fungus. The required amount of each chemical was mixed thoroughly in Czapek's medium before pouring in the plates. Four concentrations viz. 100, 500, 1000 and 2000 ppm were employed for the purpose. Ten days old uniform culture of the fungus raised on Czapek's medium was transferred in the adulterated and control plates. The radial growth of the fungus over them was measured after 3, 5 and 7 days of incubation at 30 ± 1°C.

The chemicals found most effective *in vitro* tests were used for *in vivo* control of the present rot disease. Pre-inoculation dip of the healthy rhizomes in each chemical solution was made for 10, 20 and 30 minutes. These rhizomes were inoculated by the fungus after 24 hr. of the chemical treatment. The development of rot was measured after 7, 14 and 21 days of inoculation in each case. Inoculated rhizomes were earlier incubated under optimum conditions (30 ± 1°C and 90 per cent relative humidity). The effective chemicals were also tried in post-inoculation tests. The chemical concentrations, mode of their treatments and evaluation of the treatment effect on rots remained the same as for the pre-inoculation ones.

Results and Discussion

Effect of Temperature: The fungus *Aspergillus niger* Van Tiegh, induced maximum amount of rotting at 30°C (Table 1). With the decrease in the incubation temperature the extent of rotting was progressively decreased, so much so that no rotting was evident at 15 - 20°C even when stored for 21 days. Higher incubation temperature (35°C) also had retarding effect but lesser than at 25°C.

Effect of Relative Humidity: The development of the rot seems to be directly related to the relative humidity of the atmosphere (Table 2). Higher the humidity greater was the amount of the rot produced at all three stages of observations. There was little or no rotting under 30 percent relative humidity, while it attained maximum level under 90 per cent humidity.

Table 1. Percent rot at different temperatures at room RH (55%).

Incubation (days)	Average % rot at different temperatures				
	15°C	20°C	25°C	30°C	35°C
7	0.00	0.00	2.5	12.9	7.2
			(0.04)	(0.19)	(0.32)
14	0	0	6.6	23.1	13.0
			(0.04)	(0.19)	(0.08)
21	0	0	9.3	39.3	21.9
			(0.12)	(0.17)	(0.02)

Table 2. Percent rot at different relative humidity and temperature of 30 ± 1°C

Incubation (days)	Average % rot at different RH (%)		
	30	60	90
7	0.00	11.9	17.1
	(0.00)	(0.06)	(0.23)
14	2.7	29.3	32.9
	(0.01)	(0.64)	(0.24)
21	5.5	37.8	49.3
	(0.02)	(2.35)	(0.14)

Values between brackets represent standard deviation (S.D.)

Table 3. *In vitro* screening of chemicals against the radial growth of *Aspergillus niger*.

Name of Chemicals	Average radial growth in cm. after 3,5 and 7 days											
	100 ppm			500 ppm			1000 ppm			2000 ppm		
	3	5	7	3	5	7	3	5	7	3	5	7
Bavistin	0	0	0	0	0	0	0	0	0	0	0	0
Benomyl	0	0	0	0	0	0	0	0	0	0	0	0
Biltane	1.4	2.4	3.5	1.2	2.0	3.5	0.7	1.9	2.8	0.5	1.4	2.1
	(0.2)	(0.05)	(0.08)	(0.02)	(0.16)	(0.06)	(0.02)	(0.03)	(0.02)	(0.06)	(0.01)	
Difolaton (captafol)	1.4	1.7	2.7	0.6	1.4	1.7	0	0	0	0	(	0
	(0.04)	(0.02)	(0.02)	(0.01)	(0.04)	(0.02)						
Elosal	1.5	3.2	4.6	1.2	2.7	3.5	1.0	1.4	2.7	0.7	1.1	2.3
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.04)	(0.01)	(0.11)	(0.01)	(0.01)	(0.00)	(0.04)
Maneb	3.5	4.2	5.5	2.8	3.7	5.1	2.00	2.6	3.6	1.0	1.8	2.4
	(0.00)	(0.04)	(0.06)	(0.01)	(0.02)	(0.03)	(0.03)	(0.01)	(0.09)	(0.01)	(0.00)	(0.02)
Microsul (Wettable sulphur)	2.4	4.6	5.7	2.1	3.5	4.3	1.8	2.7	3.8	1.2	1.7	2.3
	(0.07)	(0.01)	(0.01)	(0.00)	(0.00)	(0.02)	(0.01)	(0.01)	(0.00)	(0.00)	(0.04)	(0.01)
Plantvex (oxycarboxin)	2.7	3.7	4.5	1.8	2.8	3.7	1.1	2.1	2.8	0.8	1.8	2.1
	(0.02)	(0.00)	(0.05)	(0.00)	(.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(.03)
Sulfex	2.9	3.8	4.6	2.4	3.4	3.9	1.9	2.7	3.5	1.4	1.9	2.6
	(0.01)	(0.00)	(0.03)	(0.02)	(0.02)	(0.02)	(0.00)	(0.02)	(0.01)	(0.00)	(0.02)	(0.01)
Thiram	2.8	4.4	5.5	2.3	4.0	4.5	1.5	2.8	3.4	1.2	1.7	2.7
	(0.00)	(0.02)	(0.02)	(0.02)	(0.02)	(0.00)	(0.11)	(0.01)	(0.01)	(0.01)	(0.00)	(0.02)
Vitavex (carboxin)	2.7	3.7	4.5	2.1	3.0	4.3	1.8	2.8	3.4	1.1	1.4	2.3
	(0.02)	(0.02)	(0.01)	(0.00)	(0.02)	(0.01)	(0.01)	(0.00)	(0.02)	(0.02)	(0.01)	(0.02)
Zineb	2.9	3.6	4.3	2.1	3.4	4.3	1.8	3.0	3.6	1.1	2.0	3.0
	(0.00)	(0.00)	(0.01)	(0.00)	(0.03)	(0.05)	(0.00)	(0.00)	(0.04)	(0.00)	(0.00)	(.01)
Nystatin (Antibiotics)	1.5	2.9	3.7	1.1	2.4	2.7	0.8	1.6	2.0	0	0.8	1.2
	(0.14)	(0.00)	(0.02)	(0.00)	(0.02)	(0.00)	(0.00)	(0.02)	(0.00)		(0.00)	(0.00)
O.T.C.	1.3	2.1	3.6	1.1	1.5	2.5	0.7	1.0	1.4	0.5	0.7	1.1
	(0.01)	(0.01)	(0.05)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)
Streptomycin	0.7	1.5	2.9	0.6	1.4	0.8	0.3	0.5	0.8	0	0	0.3
	(0.00)	(0.00)	(0.06)	(0.03)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)			(0.00)
Control	3.5	4.8	6.7	3.5	4.8	6.7	3.5	4.8	6.7	3.5	4.8	6.7
	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)

Values between brackets represent S.D.

Table 4. The effect of pre-inoculation treatment with 100 ppm of bavistin and benomyl on the development of rhizome rot of turmeric at 90% R.H. and 30 ± 1°C.

Chemicals	Treatment time (min)	Average % rot Incubation (days) 7	4	21
Bavistin	10	0	0	0
	20	0	0	0
	30	0	0	0
Benomyl	10	1.7	2.6	4.0
		(0.03)	(0.03)	(0.02)
	20	0	0	0
	30	0	0	0
Control		17.1	32.9	49.3
		(0.23)	(0.24)	(0.14)

* Values between brackets represent S.D.

***In Vitro* Efficacy of the Chemicals:** All the tested chemicals inhibited the *in vitro* growth of the fungus at all the four concentrations employed presently (Table 3). Of them bavistin and benomyl were the most effective ones, as they inhibited the fungal growth completely even at 100 ppm concentration. Therefore, these two systemic fungicides were selected for *in vivo* control.

***In Vivo* Control of the Rot:** The two selected chemicals completely eliminated the fungus in *in vivo* when applied 24 hr. after inoculation. No rottage was visible even up to 30 days of storage in this case. The treatment was also equally effective against rot caused by *Aspergillus flavus* (5). The treatments given 24 hr. before inoculation were also considerably effective in checking the rhizome rot. Bavistin was the most effective amongst them as it completely protected the rhizomes. Benomyl was only slightly lesser effective in this respect, as it allowed 1.7 to 4.0 percent rot when the treatment time was 10 minutes. No rotting was however, evident when the treatment time of this chemical was enhanced from 20 to 30 minutes (Table 4).

Rhizome rots of seed turmeric caused by *Pythium aphanidermatum* (1) and *Sclerotium rolfsii* (2) have been reported to be prevalent in Krishna and Guntur districts of Andhra Pradesh. *A. niger* incited rot of turmeric has recently been reported from India (4). The typical symptoms include formation of cavities in the hearts of the rhizomes. The cavity is covered by white fluffy mycelia showing luxuriant sporulation. *A. niger* developed greater amount of rot at 30°C probably because of shriveling and cracks that developed in rhizomes at this temperature which was utilized by this fungus as avenues for infection. Such a situation can be visualized to occur in large scale storage during which, a temperature range of 30 - 32°C prevail in stored turmeric in contrast to wide variation in open atmosphere (25 - 38°C). With the advent of rainy season, there was sudden spurts in percent rotting in storage, mainly because in addition to optimum temperature (nearer to 30°C), the fungus is now getting optimum relative humidity (85 - 100 percent) as well, which enable it to manifest maximum rotting potential (Table 2).

The studies undertaken presently show that the post-harvest rot of seed turmeric as caused by *A. niger* can be successfully prevented and controlled by pre-inoculation treatment with 100 ppm concentration of bavistin and benomyl, which is an economiccally feasible proposition.

الملخص

شارما، ن. ب. و أ. ن. روي. 1987. وقاية ومكافحة مرض تعفن جذامير نبتة «الكركم» الذي يسببه الفطر *Aspergillus niger*. مجلة وقاية النبات العربية 5 : 38 - 35

سبب الفطر *Aspergillus niger* تلفاً في جذامير نبتة «الكركم» تحت درجة حرارة 30 +1°م ورطوبة نسبية 90%. تمّ اختبار 15 مادة كيميائية خارج الجسم الحي (في المختبر) ووجد أن المادتين بافيستين وبينوميل منعتا اكتمال نمو هذا الفطر حتى بكثافة 100 جزء بالمليون. ومنعت المادتان كذلك حدوث التلف عند عدوى الجسم الحي بعد المعاملة بالمبيدين كل على حدة. وقد أظهر المبيد بينوميل فعالية أقل من المبيد بافيستين.

كلمات مفتاحية : اسبيرجيلوس نايجر، تعفن الجذامير، كركوما لونغا، بافيستين، بينوميل.

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