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Effect of carbon and nitrogen nutrition on the production and germination of sporangia by *Phytophthora nicotianae* var. *nicotianae*

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Effect of different carbon and nitrogenous compounds in the formation and germination of sporangia of *Phytophthora nicotianae* var. *nicotianae* were examined by flooding OMA grown mycelial discs of the organism with different concentration of the test compounds. The results indicated that nitrite nitrogen and some amino acids such as glycine and glutamic acid were highly stimulatory to production and germination of sporangia of the organism. Valine, histidine and lysine caused moderate to fair production and germination of the pathogen. The data suggested that carbon compounds in general are significantly inhibitory to the production and germination of sporangia of the pathogen. Off the carbon compounds mannitol and maltose, however, induced low level of sporangia production.

Key words : *Phytophthora nicotianae* var. *nicotianae*, egg plant pathogen, fruit rot, production of sporangia, germination of sporangia, nitrogen, carbon nutrition

INTRODUCTION

Eggplant (*Solanum melongena* L.) fruit is a highly nutritous vegetable and is extensively consumed in West Bengal. Fruit rot caused by *Phytophthora nicotianae* var. *nicotianae* is the most serious post harvest disease of eggplant fruits causing heavy economic loss to the farmers (Guha Roy *et al.*, 1986). Under natural conditions zoospores are abundantly produced by the pathogen causing epidemic spread of the disease. Although factors affecting sexual propagation in several species of *Phytophthora* have been extensively studied (Gooding and Lucas, 1959; Brasier, 1969; Riberio, 1983), insufficient information is available regarding the asexual reproduction of the eggplant pathogen. We have previously reported (Guha Roy and Samaddar, 1994) that the eggplant isolate of the pathogen produced abundant sporangia in presence of liquid medium containing salts. The objective of this work was to examine the effects of different carbon and nitrogen sources on the production and germination of sporangia of the pathogen.

MATERIALS AND METHODS

The pathogen was isolated from infected fruits of eggplant and was maintained on Oat meal agar (OMA) at 20°C with monthly subculturing. The production of zoosporangia by the pathogen was investigated following the method of Guha Roy and Samaddr (1994). Mycelial discs obtained from OMA or infected fruits were exposed to water or different nutrient solutions for induction of sporangia. Mycelial discs were placed on glass slides kept in 9 cm Petridishes, flooded with different treatment solutions and incubated at 25°C in the dark. The average number of sporangia produced per microscopic field was determined based on observation of 10 fields. The result was expressed as number of sporangia per mm^2 of the surface of the mycelial disc. Percentage of sporangia germinated was calculated by recording zoosporangia which became empty by liberating zoospores.

RESULTS AND DISCUSSION

Mycelial discs grown on OMA were used for determining the effects of different carbon and nitrogen sources on the production and germination of zoosporangia. The OMA mycelial discs were flooded with different treatment solutions and the numbers of zoosporangia produced and germinated were determined.

Effect of carbon sources

The carbon compounds used were : dextrose, sucrose, maltose, starch and mannitol. The concentration used in the flooding medium were 0.01, 0.1 or 0.5 per cent aqueous solutions (w/v) of the compounds. Mycelial discs flooded with tap water served as control. The number of sporangia produced per mm^2 after indicated days of incubation are presented in Table 1 and Fig. 1. The sporangia after liberation of zoospores became empty and the numbers of germinated sporangia per mm^2 are presented within the parenthesis.

It is evident from the results that all the carbon sources used were significantly inhibitory to the production of zoosporangia as compared to tap water controls. It was of interest that dextrose was most inhibitory and few sporangia produced failed to germinate. Similar results were obtained with starch. It may further be noted that in presence of sucrose, maltose and mannitol some sporangia were produced and 40 to 100 per cent of them germinated (Table 1 and Fig. 1). Apparantly the carbon compounds present in the flooding medium generally and especially glucose were inhibitory to the production and germination of the sporangia by the pathogen. Earlier Yamamoto and Tanino (1961) reported similar glucose inhibition for production and germination of sporangia of *P. infestans.* In general energy rich carbon compounds are stimulatory to asexual reproduction of most of the aquatic Phycomycetes. The biology of this retarding effect of carbon sources on the production and germination of sporangia of different *Phytophthora* species including the eggplant isolate warrants further investigation.

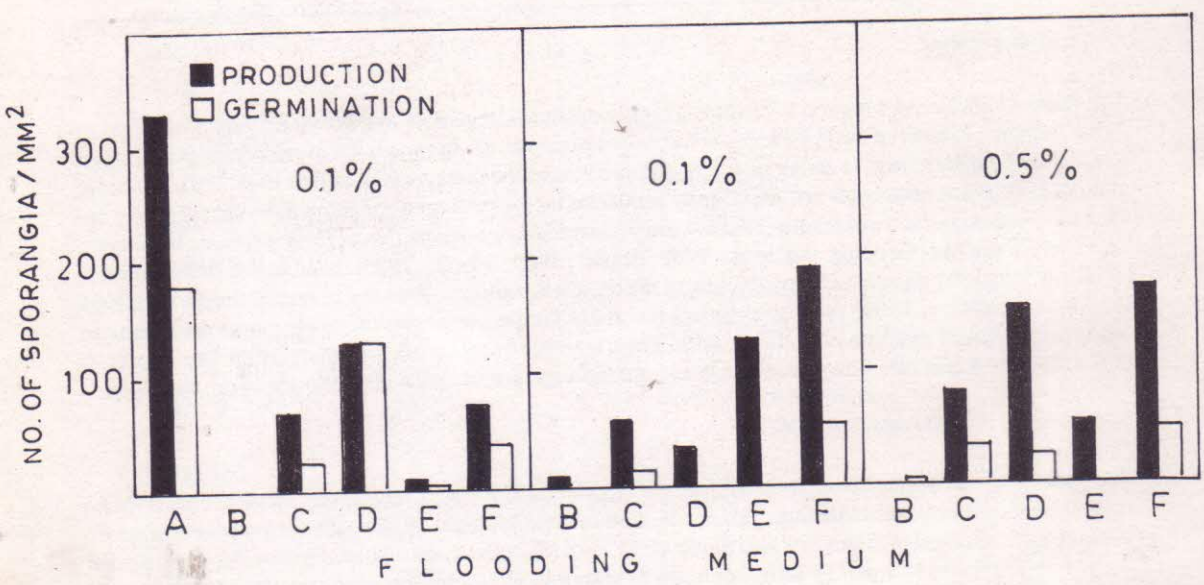

Fig. 1. Comparison of the effects of different carbon sources on the production and germination of sporangia by OMA grown mycelial discs of *P. nicotianae* var. *nicotianae.*

Table 1. Effects of different carbohydrate sources in the flooding medium on the production and germination of sporangia by OMA mycelial discs of *P. nicotianae* var. *nicotianae*

Flooding medium	Concentration	Number of sporangia/mm² after days of incubation					
		2	4	6	8	10	12
Tap water	(Control)	57(0)[a]	159(0)	192(26.2)	327(55.5)	329(100.0)	329(100.0)
Dextrose	0.01%	NP[b]	3(0)	3(0)	3(0)	3(0)	3(0)
	0.1%	NP	8(0)	8(0)	8(0)	8(0)	8(0)
	0.5%	NP	NP	NP	NP	NP	NP
Sucrose	0.01%	18(0)	57(24.6)	61(40.8)	61(40.8)	61(40.8)	61(40.8)
	0.1%	14(0)	46(23.2)	63(28.8)	63(28.8)	63(28.8)	63(28.8)
	0.5%	24(0)	81(42.2)	81(42.2)	81(42.2)	81(42.2)	81(42.2)
Maltose	0.01%	48(0)	96(49.7)	155(74.0)	155(100.0)	155(100.0)	155(100.0)
	0.1%	NP	3(0)	22(0)	33(7.1)	33(55.6)	33(55.6)
	0.5%	1(0)	43(0)	143(15.3)	15(15.4)	154(15.4)	154(18.6)
Starch	0.01%	7(0)	7(0)	7(0)	7(0)	7(0)	7(0)
	0.1%	128(0)	128(0)	128(0)	128(0)	128(0)	128(0)
	0.5%	67(0)	67(0)	67(0)	67(0)	67(0)	67(0)
Mannitol	0.01%	50(0)	53(20.5)	68(55.0)	74(58.8)	74(68.1)	74(68.1)
	0.1%	68(0)	156(32.0)	180(32.0)	191(32.7)	191(34.4)	191(34.4)
	0.5%	60(0)	132(27.0)	166(28.8)	171(29.5)	171(33.6)	171(33.6)

[a] Figures in the parenthesis indicate percentage of sporangia germinated and became empty by liberating the zoospores
[b] Not produced

Table 2. Effects of inorganic and organic `N' sources in the flooding medium on the production and germination of sporangia by OMA grown mycelial discs of *P. nicotianae* var. *nicotianae*

Flooding medium	Concentration	Number of sporangia/mm² after days of incubation					
		2	4	6	8	10	12
Tap water	0	57(0)[a]	159(0)	192(26.2)	327(55.5)	329(100.0)	329(100.0)
Potassium nitrate	0.01 M	115(0)	424(0)	448(57.5)	552(60.5)	552(84.5)	552(100.0)
Ammonium chloride	0.01 M	19(0)	45(10.9)	72(10.9)	84(17.3)	84(17.3)	84(17.3)
	0.01%	84(0)	352(0.8)	504(18.2)	710(94.2)	710(94.2)	710(100.0)
Glycine	0.1%	61(0)	108(8.3)	184(42.8)	223(67.5)	223(89.3)	223(100.0)
	0.5%	39(0)	73(18.9)	140(60.0)	185(83.8)	185(85.8)	185.6(100.00)
	0.01%	40(0)	160(0)	281(7.2)	529(10.1)	529(76.4)	529(100.0)
Valine	0.1%	NP[b]	77(0)	218(0)	302(17.2)	302(97.1)	302(100.0)
	0.5%	NP	54(0)	140(0)	246(7.5)	246(83.9)	246(100.0)
	0.01%	37(0)	54(6.4)	53(7.9)	63(7.9)	63(7.9)	63(7.9)
Methionine	0.1%	31(0)	50(0)	50(0)	50(0)	50(0)	50(0)
	0.5%	16(0)	21(19.5)	21(19.5)	21(19.5)	21(19.5)	21(19.5)

Table 2. (Contd.)

Flooding medium	Concentration	Number of sporangia/mm² after days of incubation					
		2	4	6	8	10	12
Tryptophan	0.01%	17(0)	76(14.6)	76(14.6)	76(14.6)	76(14.6)	76(14.6)
	0.1%	8(0)	122(0)	122(0)	122(0)	122(0)	122(0)
	0.5%	7(0)	24(2.0)	24(17.1)	24(17.1)	24(17.1)	24(17.1)
Glutamic acid	0.01%	171(0)	355(1.7)	367(25.4)	700(75.8)	700(84.5)	700(100.0)
	0.1%	236(0)	256(0)	264(0)	476(80.0)	476(91.5)	476(100.0)
	0.5%	144(0)	285(0)	286(18.2)	350(80.1)	350(85.0)	350(100.0)
Histidine	0.01%	31(0)	483(0)	497(0)	529(72.9)	529(82.3)	529(100.0)
	0.1%	41(0)	103(0)	182(0)	400(77.8)	400(91.5)	400(100.0)
	0.5%	37(0)	93(0)	162(0)	311(60.0)	311(92.0)	311(100.0)
Lysine	0.01%	102(0)	153(28.3)	286(35.8)	390(60.2)	390(82.8)	390(100.0)
	0.1%	124(0)	136(0)	260(0)	317(93.3)	317(93.3)	317(100.0)
	0.5%	79(0)	32(0)	159(0)	191(0)	191(97.5)	191(100.0)

[a] Figures in the parenthesis indicate percentage of sporangia germinated and became empty by liberating the zoospores
[b] Not produced

Effect of nitrogen source

The nitrogen sources examined were potassium nitrate and ammonium chloride at a concentration of 0.01 M, amino acids, glycine and valine (neutral), methionine (sulphur containing), tryptophan (aromatic), glutamic acid (acidic), histidine and lucine (both alkaline). Concentration of amino acids used were 0.01, 0.1 and 0.5 per cent aqueous solution (w/v). Tap water as flooding medium of OMA mycelial discs served as control. The results are presented in Table 2 and Fig.2. It is evident from the result that the presence of nitrate, glycine, valine, glutamic acid, histidine and lysine caused significant induction of zoosporangia. Ammonium ion, methionine and tryptophan were poor inducers of sporangia. It is apparent from the results that although the concentrations used for each of the amino acids were stimulatory but the stimulation in presence of 0.1 per cent solution was maximum. In general, the germination of sporangia did not occure before 4 days of incubation and had a slower rate than the production irrespective of treatment solutions. After 8 days of incubation, however, in most of the treatment solutions the majority of the sporangia germinated became empty except in presence of ammonium ion, valine, methionine and tryptophan. Apparantly, neutral, acidic or basic amino acids and nitrate ions were stimulatory but ammonium ion and sulphur containing and aromatic amino acids were inhibitory for production and germination of sporangia of the eggplant isolate. Similar observations were made previously using several species of *Phytophthora* (Yoshikawa *et al.*, 1976; Ribeiro, 1983). It was of further interest that in presence of ammonium ion, methionine or tryptophan, although some sporangia were produced but they failed to germinate.

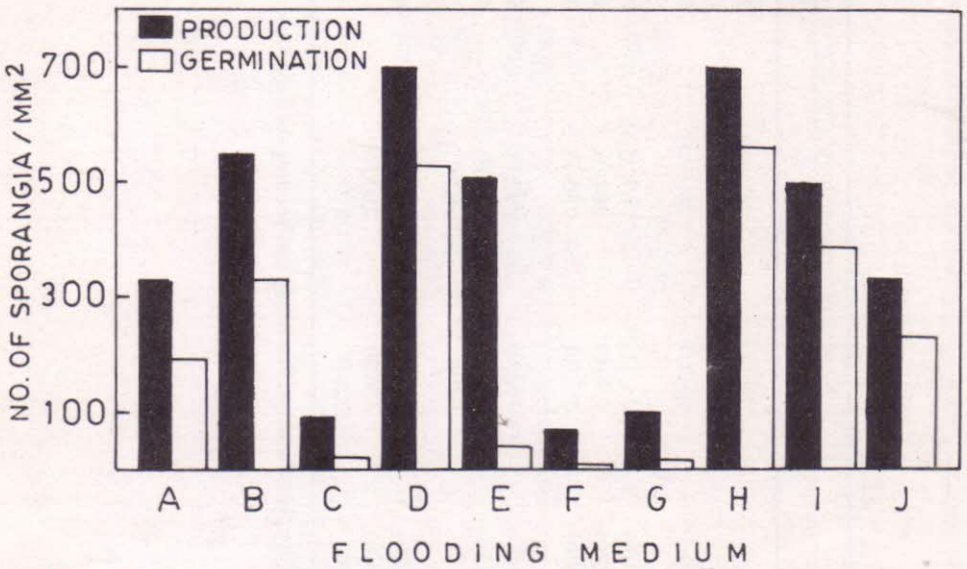

Fig. 2. Comparison of the effects of aqueous solutions of nitrogenous compounds on the production and germination of sporangia of *P. nicotianae* var. *nicotianae*.

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