

FUNGI ASSOCIATED WITH CORIANDER SEEDS GROWN IN RAJASTHAN AND THEIR PHYTOPATHOLOGICAL EFFECTS

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A study of 120 seed samples of coriander belonging to 21 districts of Rajasthan revealed moderately and heavily discoloured seeds besides asymptomatic seeds in dry seed examination. The discolourations varied from browning, whitish grey, purple and brown spots. Eighty eight fungi of 28 genera were recorded of which *Alternaria alternata*, *Aspergillus flavus*, *Curvularia lunata*, *C. pallescens*, *Drechslera tetramera*, *Fusarium moniliforme* and *F. oxysporum* were important. They caused seed discolourations, loss in seed germination, symptomatic seedlings and seedling mortality.

Keywords : Coriander seeds; Phytopathological effects; Rajasthan; Seed- borne fungi.

Coriander (*Coriandrum sativum* L.) is a small aromatic herb which is grown all over the world. In India, it is mainly grown in the states of Andhra Pradesh, Maharashtra, Tamil Nadu, Rajasthan, Uttar Pradesh, Haryana and Madhya Pradesh^{1,2}. In Rajasthan, Ajmer, Bharatpur, Kota, Baran, Bundi, Bhilwara, Udaipur, Chittorgarh, Jaipur, Jodhpur, Jhalawar, Alwar, Sikar and Tonk are the major coriander growing districts^{2,3}. Swarup and Mathur⁴ isolated 8 fungal species and Singh *et al.*⁵ reported 57 fungi of 32 genera. For the last decade no study on the seed- borne fungi associated with seeds of coriander from Rajasthan has been done, hence, the present study has been carried out using a large number of samples from different districts of Rajasthan.

One hundred twenty seed samples of coriander were collected from 21 districts of Rajasthan and were subjected to dry seed examination, washing test, standard blotter method and potato dextrose agar (PDA) plate method⁶. For pretreatment of seeds aqueous solution of sodium hypochlorite with 0.5% available chlorine was used for 3 min.

Dry seed examination: Dry seed examination revealed asymptomatic (1.25-92.75%), moderately discoloured (1.25-78.75%) and heavily discoloured (0.25-22.50%) seeds in 120, 100 and 77 seed samples respectively. The discolourations included browning, purple and whitish-grey discolourations and light to dark brown spots. Thirty eight seed samples also revealed 0.25-5 % incidence of galled seeds caused by *Protomyces macrosporus* Unger from Bharatpur, Bhilwara, Bundi, Chittore garh, Dausa, Dholpur, Ganganagar, Jaipur, Jhalawar, Kota, Sawai Madhopur and Tonk districts of Rajasthan state.

On incubation on moistened blotters, the brown discoloured seeds yielded species of *Fusarium* and *Alternaria*, the purple discoloured seeds *Cladosporium*,

Curvularia and *Drechslera* and the whitish- grey seeds *Macrophoma*. Similar results of discolourations on other crops have also been reported viz. in wheat^{7,8}, coriander⁹, rape and mustard¹⁰⁻¹⁴ and sunflower^{15, 16}. Growth of *Curvularia lunata* on brown- black discoloured seeds of wheat^{7,8} and sorghum¹⁷ has also been reported.

Seed washing test: Seed washing test of 68 samples revealed 12 fungi of 5 genera with spore load (SL, spore load per gm seed) as follows: *Alternaria alternata* (SL, 250-5375), *A. dianthicola* (SL,250-1000), *A. raphani* (SL, 645-825), *A. sonchi* (SL,250-1000), *A. tenuissima* (SL,250-3625), *Curvularia lunata* (SL,250-825), *Drechslera biseptata* (SL,250-700), *D. halodes* (SL,375-900), *D. rostrata* (SL, 250-900), *D. tetramera* (SL,500-1700), *Erysiphe polygoni* (SL,250-9750) and *Protomyces macrosporus* (SL,250-18000).

Incubation methods: All the 120 seed samples were tested by standard blotter method and PDA plate method, and a total of 88 species of 28 genera and 21 species of 11 genera were recorded respectively. The dominant pathogenic fungi recorded were the species of *Alternaria*, *Curvularia*, *Drechslera*, *Fusarium* and *Macrophomina* (Tables 1&2). Among the saprophytic fungi, species of *Alternaria*, *Aspergillus*, *Cephalosporium*, *Chaetomium*, *Cladosporium*, *Fusarium*, *Memnoniella*, *Oidocephalum*, *Penicillium*, *Rhizopus* and *Stachybotrys* were dominant (Tables 1&2). On chlorine pre treatment the number of saprophytic fungi was reduced and their growth was rendered sparse. Seed samples from Ajmer, Bhilwara, Chittore garh, Ganganagar, Jaipur, Jhalawar, Jodhpur, Kota, Pali, Sirohi, Tonk and Udaipur districts revealed relatively higher incidence of various fungi (Tables 1 & 2).

Phytopathological effects: Association of various fungi with the seeds, affected the seed germination adversely which ranged from 0.5-56 % and 0.5- 65% in 120 seed samples each in untreated and pretreated seeds in SBM respectively.

Table 1. Occurrence, incidence range and relative per cent occurrence (RPO) of important fungi recorded in coriander seeds in incubation methods. (120 seed samples studied)

Fungi	Standard Blotter Method						PDA Plate Method		
	Untreated seeds			Pretreated seeds					
	Occurrence	Incidence	RPO	Occurrence	Incidence	RPO	Occurrence	Incidence	RPO
<i>Alternaria alternata</i>	64	0.5-93	53.33	36	0.5-42	30	65	0.5-51	54.16
<i>A. raphani</i>	18	1-25	15	10	0.5-4	8.33	-	-	-
<i>Aspergillus candidus</i>	39	0.5-54	32.5	17	0.5-28	14.16	36	0.5-14	30
<i>A. flavus</i>	86	1-54	71.66	53	0.5-36	44.16	85	0.5-40	70.83
<i>A. fumigatus</i>	57	0.5-39	47.5	25	1-12	20.83	57	0.5-30	47.5
<i>A. nidulans</i>	65	2-50	54.16	33	1-23	27.5	-	-	-
<i>A. niger</i>	53	1-46	44.16	15	0.5-26	12.5	63	1-28	52.5
<i>A. tamari</i>	21	0.5-20	17.5	20	0.5-16	16.66	-	-	-
<i>A. terreus</i>	24	2-22	20	27	0.5-6	22.5	-	-	-
<i>Chaetomium atrosporium</i>	25	0.5-24	20.83	26	0.5-22	21.66	-	-	-
<i>C. bostrychodes</i>	40	0.5-44	33.33	45	0.5-26	37.5	-	-	-
<i>C. globosum</i>	47	0.5-28	39.16	40	0.5-22	33.33	56	0.5-30	46.66
<i>C. murorum</i>	60	1-28	50	37	0.5-44	30.83	-	-	-
<i>Chlamydomyces</i> sp.	-	-	-	10	1-40	8.33	-	-	-
<i>Cladosporium oxysporum</i>	7	2-32	5.83	9	0.5-4	7.5	40	1-10	33.33
<i>Curvularia lunata</i>	58	0.5-30	48.33	31	1-28	25.83	69	2-30	57.50
<i>C. pallescens</i>	47	0.5-72	39.16	29	0.5-50	24.16	72	0.5-35	60
<i>Drechslera tetramera</i>	48	0.5-9	40	20	1-22	16.66	39	0.5-10	32.5
<i>Fusarium moniliforme</i>	32	0.5-20	26.66	11	2-26	9.16	36	1-25	30
<i>F. oxysporum</i>	36	0.5-38	30	34	0.5-34	28.33	64	0.5-35	53.33
<i>F. verticilloides</i>	43	0.5-26	35.83	27	0.5-11	22.5	-	-	-
<i>Memnoniella echinata</i>	21	2-40	17.5	18	0.5-14	15	52	1-10	43.33
<i>Oidocephalum</i> sp.	11	0.5-55	9.16	3	-	-	-	-	-
<i>Penicillium citrinum</i>	19	0.5-32	15.83	16	1-38	13.33	-	-	-
<i>Rhizopus nigricans</i>	68	2-88	56.66	50	0.5-58	41.66	59	1-20	49.16
<i>Stachybotrys parvispora</i>	40	1-30	33.33	33	0.5-24	27.5	-	-	-
Actinomycetes*	19	2-72	15.83	25	1-82	20.83	-	-	-

* A group of filamentous bacteria

Table 2. Number of seed samples studied, occurrence, per cent incidence range and relative percent (RPO) of fungi in seed samples of coriander in various districts of Rajasthan in SBM.

FUNGI	AJM	BRN	BMR	BHR	BHL	BUD	CTG	DSA	DLR	GNG	JPR	JLR	JHW	JDP	KTH	NGR	PALI	SRH	SMP	TNK	UDP	TOTAL	RPO
No. of Samples Studied	8	7	5	5	7	6	9	5	4	4	8	5	6	3	7	4	5	6	6	4	6	120	
<i>Alternaria alternata</i>	4	1	0	4	4	3	4	0	3	4	7	0	0	3	6	6	5	0	1	4	4	5	53.33
<i>A. raphani</i>	4-25	15		3-5	2-12	2-9	4-59		1-5	3-22	4-93			5-9	1-11	0.5-10	2-10		2	2-8	3-28	0.5-93	
<i>A. candidus</i>	4	1	0	3	1	0	1	4	0	0	3	0	0	0	1	0	0	0	0	0	0	18	15
<i>A. flavus</i>	2-25	4		2-15	4		8	1-2			2-25				3							1-25	
<i>A. fumigatus</i>	3	3	0	0	4	5	2	0	0	4	1	0	5	3	6	0	0	0	0	0	3	39	32.5
<i>A. nidulans</i>	2-15	0.5-15			2-4	1-3	5,54			1-4	34		11-12	5-18	1-34					2-6	4	0.5-54	
<i>A. niger</i>	7	5	5	5	7	3	4	3	4	4	7	3	6	1	4	2	1	1	6	4	4	86	71.66
<i>A. tamarii</i>	4-30	6-19	2-10	4-17	2-34	5-10	6-22	2-5	2-6	6-30	6-54	1-17	10-24	2	5-19	2.5	2	18	2-26	6-14	21-46	1-54	
<i>A. terreus</i>	3	6	0	3	6	5	2	4	0	3	3	4	6	3	6	0	1	1	0	1	0	57	47.5
<i>Chaetomium atrosporium</i>	5-10	10-12		2-21	2-8	0.5-12	8,39	3-8		0.5-2	2-10	0.5-6	5-7	0.5-3	10-12		24	2		6		0.5-39	
<i>C. bostrychodes</i>	5	4	0	4	7	6	3	4	0	4	5	0	0	3	5	0	1	1	6	3	4	65	54.16
<i>C. globosum</i>	5-30	17-30		5-8	6-50	2-30	2-23	4-14		8-34	8-32			1-5	19-36		8	14	5-18	6-36	7-28	2-50	
<i>C. murorum</i>	5	5	0	0	7	0	3	0	0	0	5	5	5	2	5	4	1	1	2	3	0	53	44.16
<i>Cladosporium oxysporum</i>	2-20	1-3			2-22		2-24				1-24	3-25	3-6	3,20	1-3	5-10	36	26	8,10	12-46		1-46	
<i>C. lunata</i>	0	3	0	0	3	3	3	0	4	1	0	0	3	0	1	0	0	0	0	0	0	21	17.5
<i>C. pallidum</i>	0	0.5-4			2-6	1-4	10-20	1	5-7	4	3	0	4-12	3	1	0	1	1	0	0	0	0.5-20	
<i>D. tetramera</i>	0	2	5	0	2	0	4	1	0	1	3	0	0	3	1	0	2	4	0	0	0	24	20
<i>F. moniliforme</i>	0	4,6	4-10	5	2,2	3	3-22	2	3	4	4-10	0	0	5-8	8	2	2	4	0	1	0	2-22	
	0	4	0	5	3	0	0	3	3	4	0	0	0	0	0	2	0	0	0	1	0	25	20.83
	3-5	3-5		4-24	2-16		4-24	4-24	4-7	0.5-4					2,2					4		0.5-24	
	4	0	1	5	3	6	0	4	4	0	1	0	0	0	1	4	1	0	6	0	0	40	33.33
	3-6		4	2-10	2-34	0.5-5		2-12	0.5-9		6			2	2	4-20	2		4-44			0.5-44	
	4	0	5	5	3	2	0	0	2	1	4	0	0	2	0	4	5	0	0	4	6	47	39.16
	3-25		4-6	3-16	3-20	2,20			6,10	6	1-28			2,3		1-2	0.5-2			4-8	4-8	0.5-28	
	5	8	4	3	6	5	0	3	4	2	5	0	0	0	2	0	4	0	0	4	5	60	50
	3-20	1-3	6-9	1-19	2-28	2-8		2-5	1-16	2,16	2-28				1,2		2-8			3-10	2-4	1-28	
	0	0	0	0	1	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	5.83
	5	4	0	0	5	5	0	5	4	2	8	0	0	3	5	3	0	0	0	3	6	2-32	
	6-30	1-11			10-22	1-9		2-18	4-27	4,8	2-30			0.5-3	2-5	2-4				2-6	5-9	0.5-30	
	4	3	0	4	3	3	5	0	3	1	5	0	0	0	7	0	0	0	0	4	5	47	39.16
	2-36	0.5-2		2-10	6-26	6-26	2-8		6-33	18	2-72				3-9					2-8	8-56	0.5-72	
	3	6	0	0	4	4	0	0	1	0	6	0	5	0	7	4	0	0	1	1	6	48	40
	4-10	2-14			4-26	4-26		29			8-14		0.5-7		2-14	1-5			2	20	7-24	0.5-9	
	3	0	0	4	2	2	0	0	4	1	3	0	0	0	0	3	0	0	0	4	6	32	26.66
	2-20			3-5	2,2	2,2			2-14	8	2-16					0.5-4				4-12	3-8	0.5-20	

Contd....

FUNGI	DISTRICTS																	TOTAL	RPO			
	AJM	BRN	BMR	BHR	BHL	BUD	CTG	DSA	DLR	GNG	JPR	JLR	JHW	JDP	KTH	NGR	PALI			SRH	SMP	TNK
No. of Samples Studied	8	7	5	5	7	6	9	5	4	4	8	5	6	3	7	4	5	6	6	4	6	120
<i>F. oxysporum</i>	4	0	0	3	7	5	0	0	3	2	4	0	0	0	0	2	0	0	1	0	5	36
	2-18			0.5-3	4-10	4-11			2-14	2-30	2-20				1,2				2	0	1-12	0.5-30
<i>F. verticilloides</i>	5	5	4	3	6	2	0	1	1	0	1	0	0	3	7	0	0	0	1	4	0	43
	3-5	3-10	2-4	2-4	4-26	4-6		4	10		2		0.5-3		1-5				6	7-16		0.5-26
<i>Memnoniella echinata</i>	5	0	0	0	0	0	0	1	2	1	4	0	0	0	0	4	0	0	0	3	1	21
	2-20							4	2,10	8	2-40					2-6				8-16	10	2-40
<i>Olocephalum</i> sp.	0	2	0	5	0	0	0	0	1	0	1	0	0	2	0	0	0	0	0	0	0	11
		1,3		0.5-2					4		55		2,3									0.5-55
<i>P. citrinum</i>	3	5	0	0	0	0	0	0	1	0	3	0	1	0	1	3	1	1	0	0	0	19
	3-5	3-5							4		4,6		4		3	0.5-4	2	32	1	2		0.5-32
<i>Rhizopus nigricans</i>	6	6	5	4	5	5	0	5	3	4	7	3	0	3	3	4	0	1	1	2	1	68
	7-80	7-30	2-6	5-10	2-26	2-20		5-12	4-5	6-66	8-88	2-8		3-5	7-35	2-5	12	18	2,24	60		2-88
<i>S. parvispora</i>	3	4	0	3	5	5	0	0	2	3	3	0	0	0	4	3	1	1	1	1	1	40
	13-20	2-7		2-9	2-22	2-10			4,6	2-5	4-30				3-7	1-10	4	2	2	4	14	1-30
<i>Actinomyces*</i>	0	3	5	0	0	0	0	4	0	0	0	0	5	0	1	0	0	0	1	0	0	19
		2-6	5-54					2-5					10-72		6			2				2-72

*A group of filamentous bacteria

The figure in bold is occurrence and below it the per cent incidence range .

Other fungi :- The following fungi with their per cent incidence range were recorded in a few seed samples only : *Alternaria dianthi* (2-4), *A. dianthicola* (0.5-8), *A. longissima* (0.5-2), *A. radicina* (2-10), *A. tenuissima* (0.5-6), *Aspergillus aculeatus* (0.5-14), *A. lucknowensis* (2-19), *A. ochraceous* (2,3), *A. sydowi* (1-5), *A. versicolor* (1-5), *Bacillidium* sp.(1), *Botrytis cinerea* (2,3) *Chaetomium crispatum* (0.5-14), *C. olivaceum* (1-5), *C. spinosum* (4-16), *C. tortile* (2-5), *Chlamydomyces*(1-40), *Cephalosporium* sp.(2-20), *Cephalophora tropica* (4, 11), *Cladosporium herbarum* (0.5,6), *Curvularia affinis* (2-3), *C. borrierae* (12), *C. penneseti* (2), *C. verruculosa* (6), *Drechslera bisepata* (0.5-4), *D. bicolor* (3,3), *D. ellisi* (2,2), *D. sacchari* (2,2), *Fusarium chlamydosporum* (2), *F. equiseti* (2), *F. pallidorozeum* (2), *Humicola fuscoatra* (2), *Macrophomina phaseolina* (1-10), *Myrothecium roridum* (2), *Nigrospora oryzae* (2,3), *Oidiodendron citrinum* (2-14), *Oidium* sp.(8), *Peecilium chrysogenum* (6), *P. commune*(2), *P. griseofulvum* (2,2), *P. montanense* (5), *P. olsoni* (2), *Peyronellae* sp.(2), *Phoma* sp.(6), *Stachybotrys atra* (2), *S. sansevierae* (16), *Staphylotrichum coccosporum* (1,3), *Ulocladium alternariae* (2).

Abbreviations:

AJM, Ajmer; BRN, Baran; BMR, Barmer; BHR, Bharatpur; BHL, Bhilwara; BUD, Bundi; CTG, Chittorgarh; DSA, Dausa; DLR, Dholpur; GNG, Ganganagar; JPR, Jaipur; JLR, Jalore; JHW, Jhalawar; JDP, Jodhpur; KTH, Kota; NGR, Nagaur; SRH, Sirohi; SWM, Sawai Madhopur; TNK, Tonk; UDP, Udaipur.

The major fungi found hampering seed germination were *Alternaria alternata*, *Aspergillus candidus*, *A. flavus*, *A. fumigatus*, *A. nidulans*, *A. niger*, *Chaetomium globosum*, *C. murorum*, *C. olivaceum*, *Cladosporium oxysporum*, *Curvularia lunata*, *C. pallescens*, *Fusarium moniliforme*, *F. oxysporum*, *Rhizopus nigricans* and *Stachybotrys parvispora*.

Various crop diseases of coriander are known to be caused by the various fungi reported in this study, namely *Protomyces macrosporus* (stem gall), *Erysiphe polygoni* (powdery mildew), *Fusarium oxysporum* (wilt) and *Curvularia pallescens* (root rot) in coriander¹⁻³. Infection of *Alternaria alternata*, *Curvularia lunata*, *C. pallescens* and *Drechslera tetramera* produced browning and brown spots on seedlings. *Aspergillus flavus*, *A. candidus* and *Fusarium oxysporum* turned seedlings week, brown and dry. Seed germination was also hampered due to heavy infection of these fungi. Similar observations have been made by many authors on different crops, as on wheat^{7,8}, rape and mustard¹⁰⁻¹⁴ and sunflower^{15,16} wherein seed-borne fungi caused pre- and post germination losses. It is recommended that since the seeds of coriander harbour a large number of pathogenic fungi, only certified healthy seed should be used for growing purpose. For consumption and export purposes samples should be tested for microbiological contamination and those carrying high inoculum of storage fungi, particularly of toxigenic nature such as species of *Alternaria*, *Aspergillus*, *Fusarium* and *Penicillium* etc should be avoided.

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