J. Phytol. Res. **21**(1) : 95-100, 2008

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

MANISHA DWIVEDI, KAILASH AGRAWAL and MUKTA AGRAWAL[1]
P.G. Department of Botany, Agrawal P.G. College, Jaipur 302 003, India.
E-mail: agrawalkailash@gmail.com
1. Department of Home Science, University of Rajasthan, Jaipur 302 004, India.

Study of 127 seed samples of fennel (*Foeniculum vulgare*) belonging to 21 districts of Rajasthan state revealed asymptomatic seeds (29-100%), moderately discolored seeds (0.25-51.25%) and heavily discolored seeds (0.25-19.75%) in 127, 91 and 53 samples respectively in dry seed examination. The discolorations included light brown- black spots to general browning of seeds. 76 seed samples showed microsclerotia and black tip of *Cercospora foeniculi* (0.25-48.25%). 88 fungal species of 36 genera were recorded in incubation tests of which *Alternaria alternata, Aspergillus* spp., *Curvularia* spp., *Drechslera tetramera* and *Fusarium* spp. were dominant and pathogenic. These caused loss in seed germination, seedling symptoms and mortality of seedlings.

Keywords: Fennel seeds; Phytopathological effects; Rajasthan; Seed borne fungi.

Introduction

Fennel (*Foeniculum vulgare* Mill.) is an important seed crop of Indian sub-continent[1]. In Rajasthan, it is grown on 6247 ha area producing 3189 m tones and mainly cultivated in Ajmer, Bharatpur, Bhilwara, Dungarpur, Jaipur, Jodhpur, Kota, Pali, Swai Madhopur, Sirohi, Tonk and Udaipur districts[1-3]. The crop harbours many seed-borne fungi as enumerated by Richardson[4]. In India, fungi associated with fennel seeds have been reported from Madhya Pradesh[5], Rajasthan[5], Punjab[5], Uttar Pradesh[5], Bihar[6], Andhra Pradesh[7, 8], Maharashtra[9] and Haryana[10]. Most of the studies have been done on storage mycoflora and since only a meager work has been done, a detailed investigation on fungi associated with fennel seeds grown in the various districts of Rajasthan and their phytopathological effects was carried out.

Materials and Methods

One hundred twenty seven seed samples of fennel collected from 21 districts of Rajasthan were subjected to dry seed examination (400 seeds/sample), washing test, standard blotter method with and without chlorine pretreatment (0.5% for 3 min) and potato dextrose agar (PDA) plate method[11]. The phytopathological effects of fungi on seed germination and seedlings were also studied in incubation tests.

Results and Discussion

Dry seed examination : On the basis of exomorphic symptoms, the seeds were categorized into asymptomatic seeds, moderately discoloured and heavily discolored seeds. Inert matter, broken and damaged seeds, weed seeds and other crop seeds were also recorded. Asymptomatic seeds (29-100%), moderately discolored seeds (0.25-51.25%) and heavily discolored seeds (0.25-19.75%) were recorded in 127, 91 and 53 samples respectively from all the 21 districts. The discolorations included light brown-black spots, to general browning of seeds. Some seeds also showed shrivelling. Samples with relatively heavy incidence of discoloured seeds belonged to Baran, Barmer, Bhilwara, Chittorgarh, Dausa, Jalore, Jhalawar, Jodhpur, Kota, Nagaur, Pali and Sri Ganganagar districts.

Seventy-six seed samples also showed microsclerotia of *Cercospora foeniculi* (0.25-48.25%) on seed surface. There presence was observed mainly on the apical end of the seed. But in heavily discolored seeds, entire seed was covered with microsclerotia (0.25-19.75% on moistened blotters). Eleven seed samples showed 0.25-2% black tips, which on close examination showed aggregation of microsclerotia of *Cercospora foeniculi.* The infected samples were mainly from Baran, Barmer, Bhilwara, Chittorgarh, Ganganagar, Jalore, Jhalawar and Udaipur districts. Incubation of discolored seeds on moistened blotters yielded the species of *Alternaria, Aspergillus, Curvularia, Drechslera, Fusarium* etc.

Inert matter comprised of soil clods, gravel, and plant debris and broken fruit walls of fennel. Broken and damaged seeds included seeds with broken fruit wall/seed coat and seeds splitted into two or more fractions. Seeds of *Asphodelus tenuifolius*, *Chenopodium album* and

Table 1. Occurrence, incidence range and relative percent occurrence (RPO) of important fungi recorded in fennel seeds in incubation methods (127 seed samples studied)

S.No. Fungi	Standard blotter method						PDA Plate Method		
	Untreated seeds			Pretreated seeds					
	Occurrence	Incidence	RPO	Occurrence	Incidence	RPO	Occurrence	Incidence	RPO
1. *Alternaria alternata*	62	0.5-87	48.81	23	1-25	18.11	67	0.5-64	52.75
2. *A. solani*	5	0.5-10	3.93	-	-	-	-	-	-
3. *A. tenuissima*	4	1-10	3.14	-	-	-	-	-	-
4. *Aspergillus candidus*	-	-	-	-	-	-	54	1-12	42.51
5. *A. flavus*	64	0.5-46	50.39	-	-	-	76	0.5-53	59.71
6. *A. fumigatus*	42	0.5-35	33.07	11	1-28	8.66	62	1-48	48.81
7. *A. nidulans*	83	0.5-55	65.35	22	1-10	17.32	59	05-15	46.45
8. *A. niger*	31	0.5-18	24.40	-	-	-	61	0.5-28	48.03
9. *A. parasiticus*	-	-	-	-	-	-	30	0.5-12	23.62
10. *A. sydowi*	5	1-17	3.93	-	-	-	-	-	-
11. *A. terrus*	40	0.5-20	31.49	8	2-11	6.29	38	0.5-20	29.92
12. *Chaetomium atrosporum*	8	0.5-13	6.29	-	-	-	-	-	-
13. *C. bostrychodes*	32	0.5-27	25.19	6	1-10	4.72	-	-	-
14. *C. globosum*	51	0.5-29	40.15	24	1-23	18.89	38	0.5-12	29.92
15. *C. murorum*	81	0.5-33	63.78	27	1-53	21.25	-	-	-
16. *Cladosporium cladosporides*	-	-	-	-	-	-	46	1-10	36.22
17. *Curvularia clavata*	6	1-26	4.72	-	-	-	-	-	-
18. *C. lunata*	82	0.5-49	64.56	24	1-37	18.89	52	1-21	40.94
19. *C.pallescens*	69	0.5-52	54.33	22	1-49	17.32	30	1-10	23.62
20. *Drechslera rostrata*	5	1-10	3.93	-	-	-	-	-	-
21. *D. tetramera*	25	1-15	19.63	-	-	-	48	0.5-37	37.79
22. *Fusarium moniliforme*	80	0.5-78	62.99	17	.5-39	13.38	44	0.5-38	34.64
23. *F. oxysporum*	58	1-51	45.66	23	2-40	18.11	50	0.5-48	39.37
24. *F. proliferatum*	8	2-48	6.29	-	-	-	43	0.5-20	33.85
25. *F. verticillioides*	12	1-42	9.44	-	-	-	-	-	-
26. *Macrophoma* sp.	19	0.5-47	14.96	-	-	-	-	-	-
27. *Memnoniella echinata*	16	1-22	12.59	-	-	-	65	1-63	51.81
28. *Pennicellium citrinum*	6	2-11	4.72	-	-	-	-	-	-
29. *Phoma* sp.	28	1-15	22.04	-	-	-	-	-	-
30. *Rhizopus nigricans*	12	1-39	9.44	-	-	-	42	1-31	33.07
31. *Stachybotrys parvispora*	17	1-53	13.38	6	1-96	4.72	-	-	-
32. *Trichothecium roseum*	7	1-53	5.51	4	1-24	3.14	25	1-21	19.68
33. Actinomyces sp*.	60	0.5-63	47.24	15	1-21	11.81	-	-	-

* A group of filamentous bacteria

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

FUNGI	DISTRICTS																						
	AJM	BRN	BMR	BHR	BHL	BUD	CTG	DSA	DLR	GNG	JPR	JLR	JHW	JDP	KTH	NGR	PALI	SRH	SMP	TNK	UDP	TOTAL	RPO
No. Samples Studied	5	4	5	6	10	5	9	5	3	5	9	6	5	8	6	4	7	7	5	6	7	127	
Acrosperia mirabillis	0	0	0	0	0	0	1 1	0	0	0	0	0	1 3	0	0	0	0	4 1-3	0	0	0	6 1-3	4.72
Alternaria alternata	0	4 0.5-10	0	1 1	2 7,30	0	0	0	0	0	2 1	6 1-25	5 5-49	7 1-33	0	4 5-87	6 1-30	7 1-40	5 1-19	6 6-25	7 1-49	62 0.5-87	48.81
A. dianthicola	0	0	1 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5 0.5-5	0	0	6 0.5-5	4.72
Ampullifera foliicola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1 7	0	0	5 1-7	0	0	0	6 1-7	4.72
A. flavus	4 1-25	3 4-19	5 3-11	3 1-30	5 1-7	4 1-46	1 1	0	3 1-5	3 0.5-7	4 1-32	4 2-20	3 1-19	4 3-20	3 1-12	0	3 3-15	3 1-10	3 3-11	3 1-10	3 2-8	64 0.5-46	50.39
A. fumigatus	5 0.5-25	2 2,3	0	0	2 2,3	0	1 1	1 21	3 1-26	4 2-20	2 1,2	3 1-15	3 3-17	4 1-10	0	0	5 1-7	0	5 2-9	0	2 4,35	42 05-35	33.07
A. nidulans	5 2-45	4 5-20	3 3-21	6 0.5-25	6 1-28	3 1-11	6 1-7	1 6	3 1-44	3 1-10	4 5-55	4 1-42	4 7-35	6 6-35	5 2-15	0 0	3 8-11	6 3-41	4 5-18	3 4-15	4 1-17	83 0.5-55	65.35
A. niger	5 3-18	3 0.5-12	0	0	0	0	0	0	0	0	1 1	0	3 1-17	4 1-18	0	0	5 1-7	0	5 0.5-8	0	5 1-5	31 0.5-18	24.40
A. tamarii	0	0	1 2	0	3 1,3	0	0	0	2 1-9	0	0	0	0	0	0	0	0	0	3 0.5-7	0	4 1-5	13 0.5-9	10.23
A. terreus	5 4-20	2 1,3	0	5 0.5-5	1 2	0	1 4	1 6	3 1-17	3 1-5	2 1,7	0	3 1-15	3 1-5	0	0	3 1-5	5 1-12	0	0	3 1-11	40 0.5-20	31.49
Chaetomium atrosporum	0	0	0	0	0	0	0	0	0	0	0	0	0	4 0.5-13	0	0	0	0	4 1-9	0	0	8 0.5-13	6.29
C. bostrychodes	3 2-10	0	3 0.5-3	0	0	0	2 1,7	0	3 1-27	3 1-13	2 1,1	0	0	5 1-10	0	0	0	0	5 3-10	0	6 1-5	32 0.5-27	25.19
C. crispatum	0	3 0.5-3	0	0	1 2	4 0.5-2	0	0	0	0	0	0	0	1 2	0	2 1,5	0	4 1-9	0	0	0	15 0.5-9	11.81
C. globosum	0	4 1-5	3 1-3	0	3 1-10	0	2 1,2	0	0	0	4 1-12	5 0.5-29	3 1-18	0	3 2-5	3 1-9	7 1-12	3 1-11	0	6 1-9	5 7-18	51 0.5-29	40.15
C.murorum	5 5-25	3 1-10	5 0.5-12	6 1-5	6 2-17	5 0.5-0	5 1-9	3	3 1-33	0	4 2-8	4 1-25	3 1-23	3 2-6	6 0.5-10	0	7 2-10	3 6-33	4 3-13	5 2-7	4 1-23	81 0.5-33	63.78
C. olivaceum	0	0	1 1	0	0	0	0	0	0	0	0	0	2 0.5-7	0	0	0	0	0	3 1-6	0	0	6 0.5-7	4.72
C. spinosum	0	0	3 1-5	0	0	0	2 1,4	0	0	0	0	3 3-6	1 2	0	0	0	0	0	2 2,7	0	1 3	12 1-7	9.44
Cunninghamella sp.	1 3	0	1 1	0	1 3	0	0	0	0	0	2 0.5,4	0	0	1 2	0	0	1 1	0	0	1 4	1 1	9 0.5-4	7.08
clavata	0	1 6	2 3,26	0	0	0	0	0	1 2	0	0	0	0	0	0	0	0	0	2 1,2	0	0	6 1-26	4.72
C. lunata	4 0.5-10	4 0.5-35	3 1-5	6 1-40	6 0.5-29	0	0	3 1-9	0	2 1,5	7 1-49	4 1-23	5 1-19	7 2-22	5 1-33	0	4 1-15	7 4-39	4 5-17	4 2-8	7 1-21	82 0.5-49	64.56
C. pallescens	3 1-7	3 0.5-9	2 1,2	5 1-10	7 1-25	0	9 1-20	4 1-5	0	1 3	7 1-10	6 1-8	0	3 2-10	0	1 19	5 10-12	7 1-18	2 4,4	0	4 2-52	69 0.5-52	54.33
D. tetramera	1 2	4 2-10	2 10,15	1 2	4 2,10	0	0	0	0	0	2 1,5	1 1	0	2 2,3	0	1 7	2 1,1	1 6	1 3	2 3,2	1 6	25 1-15	19.63
Fusarium moniliforme	0	3 12-25	3 0.5-30	0	8 1-78	4 2-26	9 3-32	0	0	3 4-8	9 2-63	4 4-5	3 3-12	5 4-21	5 5-15	2 1,9	7 4-11	6 15-28	3 2-5	0	6 1-20	80 0.5-78	62.99
F. oxysporum	1 6	5 1-15	1 2	6 1-51	3 2-44	0	1 8	0	1 8	3 1-10	7 1-25	5 1-8	0	8 2-9	5 1-15	3 4-10	7 5-25	0	2 1,7	0	0	58 1-51	45.66

Cont...

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

FUNGI	DISTRICTS																						
	AJM	BRN	BMR	BHR	BHL	BUD	CTG	DSA	DLR	GNG	JPR	JLR	JHW	JDP	KTH	NGR	PALI	SRH	SMP	TNK	UDP	TOTAL	RPO
No. Samples Studied	5	4	5	6	10	5	9	5	3	5	9	6	5	8	6	4	7	7	5	6	7	127	
F. proliferatum	1	1	0	0	0	0	0	0	0	1	0	0	0	2	0	1	1	0	0	0	1	8	6.29
	3	4								3				2,4		10	3				48	2-48	
F. verticillioides	0	0	1	1	1	0	0	0	0	1	0	0	0	1	0	1	1	0	1	3	1	12	9.44
			2	3	13					4				6		1	3		9	14-40	42	1-42	
Macrophoma sp.	0	0	0	5	2	2	1	0	0	1	2	2	0	0	1	1	0	0	0	1	1	19	14.96
				0.5-4	1,3	1,3	4			3	4,4	2,3			1	1				47	7	0.5-47	
Memnoniella	1	0	3	0	2	0	0	0	0	0	1	0	0	3	1	1	0	0	2	0	2	16	12.59
echinata	8		3-7		1,3						2			2-22	1	9			2,4		2,3	1-22	
Oideodendron	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	1	6	4.72
flavum				1,2				6										2		1	2	1-6	
P. citirnum	0	0	0	0	1	0	0	1	0	2	0	0	0	2	0	0	0	0	0	0	0	6	4.72
					11			11		3,3				2,2								2-11	
Phoma sp.	0	2	3	0	4	0	2	0	0	0	2	3	2	0	1	1	1	3	0	1	3	28	22.04
		4,8	1-15		1-7		1,2				3-5	2,6	2,4		2	1	1	2-9		11	2-3	1-15	
Rhizopus	0	1	2	0	1	1	0	0	0	0	1	0	0	0	0	0	1	2	3	0	0	12	9.44
nigrcans		1	18,39		4	10					14						3	1,7	4-12			1-39	
Stachybotrys	2	0	2	1	4	0	0	0	0	0	0	0	0	1	0	1	0	1	2	1	2	17	13.38
parvispora	5		6-16	2	1-5									3		53		1	2,12	5	1,5	1-53	
Trichothecium	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	2	7	5.51
roseum			13		6,12											53		14			21	1-53	
*Actinomycetes**	5	4	1	5	2	3	4	1	3	2	4	3	2	3	0	0	3	5	4	3	3	60	47.24
	0.5-16	1-5	4	1-20	2,8	0.5-6	1-7	11	0.5-20	1,5	1-63	1-5	5,10	3-12			1-5	1-7	1-10	1-10	1-8	0.5-63	

* A group of filamentous bacteria.

Abbrevations:

Other fungi:- The following fungi were recorded in a few seed samples (1-3) only:- *Alternaria crassa* (1-9), *A. longipes* (1-5), *A. raphani* (1), *A. solani* (0.5-10), *A. tenuissima* (1-10), *Aspergillus aculeatus* (1), *A. candidus* (1-7), *A. lucknowiensis* (2-5), *A. ochreaceous* (3), *A. sydowi* (4-17), *Botryderma* sp. (1,5), *Botrydiplodia* sp. (1,5), *Botryodtrichum puliferum* (1-5), *Chaetomium tortile* (2-3), *Chaetophoma* sp. (13), *Chlamydomyces* sp. (3,3), *Cladosporium cladosporioidies* (7), *Curvularia* (1-8), *Curvularia affinis* (2), *C. penneseti* (2), *Dictyoarthinium sacchari* (2), *Drechslera biseptata* (1,1) *D. halodes* (1,1), *D. hawaiensis* (3,3), *D. longirostrata* (1), *D. papendorfii* (1), *Drechslera rostrata* (1-10), *D.* state of *Trichometasphar c holmi* (5), *Fusarium equisetc* (2,2), *Fusariella hughesii* (1,1), *Graphium putredinis* (1,2), *Macrophmina phaseolina* (0.5-7), *Myrothecium rordium* (1-3), *Nigrospora oryzae* (2-5%), *Oedocephalum* sp. (6,27), *Pericornia echinochloase* (3), *Pyrenochaeta* sp. (1-11), *Phomopsis* sp. (1), *Rhizoct oniasolani (1,3), Stachybotrys atra (2), S. state of Melanopsamma pomiformis (1), Troula herbarum (2-8)*

AJM,Ajmer;BRN,Bara;BMR,Barmer;BHR,Bharatpur;BHL,Bhilwara;BUD,Bundi;CTG,Chittorgarh;DSA,Dausa;DLR,Dholpur;GNG,Ganganagar; JPR,Jaipur;JLR,Jalor;JHW,Jhalawad;JDP,Jodhpur; KTH,Kota;NGR,Nagaur;SRH,Sirohi;SWM,Sawaimadhopur;TNK,Tonk;UDP,Udaipur

Convolvulus arvensis were common weed seeds. Seeds of gram, rape and mustard, wheat, fenugreek, cumin, ajwain and coriander were also recorded mixed in fennel seed samples. The infected seeds of these crops may act as a source of disease transmission (horizontal spread), but no evidence has been obtained during the present study.

Different authors have reported similar types of discolourations on wheat[12], coriander[13], rape and mustard[14-17] and sunflower[18]. *Fusarium oxysporum* on white discolored chilli[19] seeds and white-crusted okra[20] seeds has been reported. *Curvularia lunata* on brown-black discolored seeds of wheat[12] and on coriander[21] have been reported which supports the present study.

Seed washing test : In seed washing test 9 fungal species of 4 genera were recorded. These were *Alternaria alternata, A. dianthicola, A. raphani, A. tenuissima, Curvularia lunata, C. pallescence, Drechslera hawaiians, D. tetramera* and *Erysiphe polygoni* with spore load of 450-9800, 200-300, 200-450, 250-450, 300-5650, 500-2050, 200-250, 200-300 and 400-16000 spores/gm of seed, respectively.

Incubation tests : In all 81,53 and 19 fungal species belonging to 31,25 and 10 genera were isolated in untreated seeds and pre treated seeds in standard blotter method (SBM) and PDA plate method, respectively (Tables 1,2). Among the pathogenic fungi *Alternaria alternata* (0.5-87%), *Curvularia lunata* (0.5-49%), *C. pallescence* (0.5-52%), *Drechslera tetramera* (1-15%), *Fusarium moniliforme* (0.5-78%), *F. oxysporum* (1-51%) and *Trichothecium roseum* (1-53%) were dominant (>15%). The other fungi found dominant (>20%)were the species of *Alternaria, Aspergillus, Chaetomium, Cunninghamella, Curvularia, Drechslera, Fusarium, Macrophoma, Macrophomina, Memnoniella, Phoma, Rhizopus* and *Stachybotrys.*

Chlorine pretreatment reduced the incidence of saprophytes to a considerable extent and their growth on seed surface was also rendered sparse. *Aspergillus versicolor, Drechslera sacchari, Epicoccum purpurascens, Fusarium chlamydosporum, F. compactum, Penicillium chrysogenum* and *Perichonia byssoides* were observed only on pretreated seeds.

All the fungi recorded in PDA plate method were common to the SBM except *Aspergillus parasiticus*, which occurred only in PDA plate method. The sample obtained from Ajmer, Bhilwara, Chittorgarh, Ganganagar, Jaipur, Jhalawar, Jodhpur, Kota, Pali, Sirohi, Tonk and Udaipur districts showed relatively higher incidence of the fungi.

The standard blotter method was found economical, convenient, efficient and produced higher number of fungal species and in higher counts as compared to agar plate method. Similar findings have also been reported in wheat[12], mustard[14], rape seed[16, 17], sunflower[18] and okra[20] that support the importance of the present study.

Phytopathological effects : The fungi isolated also hampered seed germination of which the mainly responsible were *Alternaria alternata, Aspergillus flavus, Chaetomium globosum, C. murorum, Curvularia lunata, C. pallescence, Fusarium moniliforme, F. oxysporum* and *Rhizopus stolonifer.* The loss in germination may be attributed by the action of enzymes, toxins and exhaustion of seed nutrients by these fungi. Seedling mortality was also observed by the spread of mycelium and sporulation of these fungi.

Infection due to *Alternaria alternata* caused brown-black streaks on hypocotyls, radical browning and seedling mortality. Growth of *Aspergillus flavus* on seed and seedlings caused rotting. *Curvularia lunata, C. pallescence* and *Drechslera tetramera* caused browning and blackening of seedlings while infection due to *Fusarium moniliforme* and *F. oxysporum* produced browning and wilting of seedlings and yellowing of cotyledonary leaves. Various authors have reported similar observations on wheat[12], rape and mustard[14-17], sunflower[18] and coriander[13, 21] suggesting pre- and post emergence losses due to the fungi supporting the present study.

Acknowledgement

UGC, New Delhi is duly acknowledged for providing financial assistance in the form of UGC Research Award to KA.

References

1. Pruthi J S, 2001, *Major spices of India Crop Management and Post-harvest Technology.* ICAR, Krishi Anusandhan Bhavan, Pusa, New Delhi pp 450.
2. Agrawal K 2001, *Disease status of seed spices. In: seed spices-Production, Quality. Export* (Eds. Agarwal, S.; Sastry; E.V.D. and Sharma R. K). Pointer Publishers, Jaipur. India 59-88.
3. Anonymous 2003, *http:\\www.rajcomb.com*
4. Richardson M J 1990, *An Annotated list of Seed-Borne Diseases.* 4th edn. *Proc. Int. Seed Testing Association.* Zurich, Switzerland pp 387.
5. Swarup J and Mathur R S 1972, Seed mycoflora of some umbelliferous species. *Indian Phytopath.* **25** 125.
6. Bilgrami K S, Prasad T, Thakur M K and Vardhan V 1981, Aflatoxin production isolates of *Aspergillus flavus* from some spices. *Indian Bot. Soc.* (Abstr.) **60** (Suppl.) III15.
7. Regina M and Raman T 1988, Species of *Chaetomium*

isolated from spices. *Indian Phytopath.* **41** (4) 628-629.

8. Singh D S R R, Bhadraiah B and Rama Rao P 1991, Mycoflora and aflatoxin contamination in stored seeds of bitter gourd and *Foeniculum*. *Indian J. Microbial Ecology* **1**(2) 133-135.
9. Pande A and Bangale S 1994, Mycoflora associated with unbelliferous plant parts used in Ayurvedic medicines. *J. Economic and Taxonomic Botany* **18** (1) 83-86.
10. Rani P, Aggarwal A, Seema Rani P and Aggarwal A 1995, Qualitative and quantitative estimation of seed mycoflora of some spices. *Adv. Plant Sci.* **8**(2) 401-403.
11. ISTA 1985, International rules for seed testing. *Seed Sci. and Technol.* **4** 177.
12. Agrawal K, Sharma J, Singh T and Singh D 1987, Black point disease of wheat in Rajasthan, causal fungi and their pathogenecity. *Annals of Biol.* **3**(2) 7-16.
13. Dwivedi M, Agrawal K and Agrawal M 2006, Fungi associated with coriander seeds grown in Rajasthan and their phytopathological effects. *J. Phytol. Res.* **19**(1) 125-129
14. Sharma J, Agrawal K and Singh D 1992, Fungi associated with seeds of mustard (*Bassica juncea* coss) grown in Rajasthan and their Phytopathological effects. *J. Indian Bot. Soc.* **71** 91-94.
15. Sharma J, Agrawal K and Singh D 1993, Incidence and histopathlogy of *Alternaria alternata* in mustard seeds. *J. Indian Bot. Soc.* **72** 241-24
16. Sharma J, Agrawal K and Singh D 1994, Seed borne mycoflora of rapeseed (*Barassica* campestris L.) and its significance. *J. Indian Bot. Soc.* **73** 15-17
17. Sharma J, Agrawal K and Singh D 1994, Incidence and histopathology of *Alternaria alternata* Auct infected rape (*B. campestris*) seeds. *Acta Botanica Indica* **22**(1) 109-112.
18. Godika S, Agrawal K and Singh T 1996, Seed-borne fungi of sunflower grown in Rajasthan and their Phytopathological effects, *J. Phytol. Res.* **9** (1) 61-63.
19. Chitkara S, Singh T and Singh D 1986, *Alternaria tenuis* in chili seeds of Rajasthan. *Biol. Bull. India.* **8** (1) 18-23.
20. Agrawal S 2000, *Seed-borne and post-harvest diseases of okra (Abelmoschus esculentus L. Monech)*. Ph.D. Thesis, Univ. of Rajasthan, Jaipur.
21. Agrawal K and Dwivedi M 2005, Seed borne nature of *Curvularia lunata* in coriander (*Coriandrum sativum* L.) its phytopathological effects and biochemical effects and management. *(Abstr.). Global Conf. II. Ind. Soc. Mycol. and Pl. Path.* pp.325.