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SEED-BORNE MYCOFLORA OF *CORIANDRUM SATIVUM* L.

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Abstract

Seed samples of coriander from 15 countries were analyzed for seed-borne mycoflora. Of the 88 samples examined, 14 genera and 24 species of fungi were isolated alongwith certain unidentified yeasts and bacteria. *Alternaria alternata, Fusarium moniliforme* and *Phoma* sp., were predominant in seed samples of Pakistan and India. Other fungi isolated were *Alternaria longissima, A. porri, Ascochyta* sp., *Botryodiplodia* sp., *Botrytis cinerea, Cephalospo rium acremonium, Colletotrichum capsici, Drechslera bicolor, D. rostrata, D. tetramera, Fusarium equiseti, F. oxysporum, F. semitectum, F. solani, Macrophomina phaseolina, Myrothecium roridum, M. verrucaria, Protomyces macrosporus, Pythium spinosum* and *Verticillium albo-atrum*. In pathogenicity tests *F. solani* caused seed rot and wilting of coriander seedlings.

Introduction

Coriander, (*Coriandrum sativum* L.) a condiment known for its medicinal and nutritive value is extensively cultivated in Mediterranean Europe, the Middle East, Asia and Brazil. The dry fruit is an important ingredient of curry powder and contains a volatile oil (Parry, 1921) which is used in medicine and for flavouring. The seed-borne mycoflora of coriander was examined and compared with the published data (Richardson, 1979, 1981, 1983). The pathogenicity of *F. solani* on coriander was also investigated.

Materials and Methods

Eighty eight seed samples of coriander obtained from 15 countries through the courtesy of the Danish Institute of Seed Pathology, Copenhagen, Denmark were examined for seed-borne mycoflora using standard blotter method (Anon., 1966). In pathogenicity experiments seeds surface sterilized with 5% sodium hypochlorite for 5 min., were dipped in spore suspension of *F. solani* and sown in sterilized sand as well as in water agar slants. In another set one month old healthy coriander seedlings were transplanted in sand artificially infested with *F. solani* or roots of healthy coriander seedlings were dipped in spore suspension of *F. solani* before transplanting in sterilized sand.

Results and Discussion

Seed-borne mycoflora: Of the 88 seed samples of coriander, *Alternaria alternata* was isolated from 65.9% samples (Av. 4.42 ± 0.91) followed by *Fusarium moniliforme* (Av. 2.32 ± 0.16) in 56.8% and *Phoma* sp., (Av. 3.44 ± 0.11) in 47.77% of the samples

Table 1. Fungi isolated from seeds of coriander obtained from different countries of the world.

Countries	No. of species tested	*Alternaria alternata* A	*Alternaria alternata* B	*Fusarium moniliforme* A	*Fusarium moniliforme* B	*Fusarium oxysporum* A	*Fusarium oxysporum* B	*Fusarium semitectum* A	*Fusarium semitectum* B	*Fusarium solani* A	*Fusarium solani* B	*Phoma* sp. A	*Phoma* sp. B	Other fungi (No. of infected samples/ Infection percentage
Brazil	2	2	4.25+0.17 (4.00-4.50)	2	1.25±0.17 (1.00-1.50)	1	1.00±0.00 (1.00)	2	2.00±0.00 (2.00)					*Botryodiplodia* sp. (1/5.00) *Colletotrichum capsici* (1/1.00)
China	1	1	2.00±0.00 (2.00)											
Egypt	3	2	2.50±0.70 (1.50-3.50)									1	1.50±0.00 (1.50)	*Botryodiplodia* sp. (1/3.00), *Myrothecium roridum* (1/1.50)
India	36	21	6.49±2.33 (1.00-17.00)	22	5.59±3.66 (1.00-24.00)	2			3.50±0.88 (1.00-24.00)	3	1.83±0.12 (1.00-2.50)	19	3.23±0.35 (1.00-11.00)	*Alternaria longissima* (1/1.00) *Alternaria porri* (3/1.00) *Drechslera rostrata* (1/1.00) *Drechslera tetramera* (4/1.00-7.00) *Botrytis cinerea* (1/4.00) *Macrophomina phàseolina* (2/2.00)
Kenya	2	2	3.75±1.23 (2.00-5.50)	1	1.00±0.00 (1.00)									
Mauritius	1							1	6.00±0.00 (6.00)			1	9.00±0.00 (9.00)	*Colletotrichum capsici* (1/2.00)
Morocco	4	3	2.83±0.62 (1.50-4.00)	2	4.75±0.44 (3.50-6.00)					1	1.0±0.00 (1.00)	1	2.00±0.00 (2.00)	*Botrytis cinerea* (1/2.00) *Pythium spinosum* (1/5.00) *Fusarium equiseti* (2/1.00-5.00)
Nepal	2	1	4.00±0.00 (4.00)		1.00±0.00 (1.00)	1	1.00±0.00 (1.00)							

Table 1 (Cont'd)

Countries	No. of species tested	*Alternaria alternata* A	B	*Fusarium moniliforme* A	B	*Fusarium oxysporum* A	B	*Fusarium semitectum* A	B	*Fusarium solani* A	B	*Phoma* sp. A	B	Other fungi (No. of infected samples/ Infection percentage
Pakistan	28	23	7.74±2.49 (1.00-20.00)	15	4.00±0.70 (1.00-10.00)	1	5.00±0.00 (5.00)	3	1.66±0.19 (1.00-3.00)	1	1.00±0.00 (1.00)	14	2.21±0.18 (1.00-4.00)	*Verticillium albo-atrum* (1/1.00) *Cephalosporium acremonium* (1/4.00) *Myrothecium roridum* (1/1.00) *Drechslera bicolor* (2/1.5) *Drechslera rostrata* (1/1.00) *Colletotrichum capsici* (4/1.00.4.00)
Sri Lanka	2	2	5.80±1.55 (3.60-8.00)			1	5.00±0.00 (5.00)	1	5.50±0.00 (5.50)			2	2.00±0.70 (1.00-3.00)	*Fusarium equiseti* (1/1.50) *Macrophomina phaseolina* *Phoma multirostrata* (1/5.00) *Pythium spinosum* (1/1.00) (2/1.00)
Sudan	1	1	6.00±0.00 (6.00)									1	8.00±0.00 (8.00)	
Suriname	1			1	2.00±0.00 (2.00)			1	1.00±0.00 (1.00)	1	2.00±0.00 (2.00)	1	4.00±0.00 (4.00)	*Botryodiplodia* sp. (1/3.00)
Syria	1			1	1.50±0.00 (1.50)							1	1.50±0.00 (1.50)	
Thailand	4	4	3.50±1.27 (2.50-7.00)	2	1.50±0.00 (1.50)			2	1.00±0.00 (1.00)	2	6.75±3.35 (2.00-11.50)			*Fusarium equiseti* (3/1.00) *Verticillium albo-atrum* (2/1.00.3.00) *Myrothecium verrucaria* (2/1.50)
Vietnam	1			1	2.00±0.00 (2.00)					1	1.00±0.00 (1.00)			*Ascochyta* sp. (1/1.00) *Colletotrichum capsici* (1/3.00)
X			4.42		2.32		3.00		2.71		2.41			
Standard Error			0.91		0.16		0.19		0.41		0.31			

A: No. of infected samples. B: Infection percentage. Numbers in parentheses indicate infection range.

(Table 1). It may be mentioned that these fungi were predominant in seed samples of African and Asian countries including Pakistan and India. *Phoma multirostrata* isolated from only one sample of Pakistan was found pathogenic on coriander seedlings causing footrot at the soil level (Hashmi & Ghaffar, 1991).

Seed samples of coriander from Pakistan, India and Kenya showed partially to completely hypertrophied fruits filled with chlamydospores of *Protomyces macrosporus*, the cause of stem-gall disease of coriander.

F. semitectum (Av. 2.71 ± 0.41) and *F. solani* (Av. 2.41 ± 0.31) were almost equally distributed in 11.6% of coriander samples of several countries followed by *F. equiseti* (Av. 1.70 ± 0.10) in 10.2% samples, *Colletotrichum capsici* (Av. 1.75 ± 0.01) in 6.0%, *F. oxysporum* (Av. 3.00 ± 0.19) in 4.5%, *Pythium spinosum* (Av. 3.00 ± 0.10) in 3.4%, *Verticillium albo-atrum* (Av. 1.50 ± 0.002) in 3.4%, *Macrophomina phaseolina* (Av. 1.00 ± 0.00) in 3.6%, *Botrytis cinerea* (Av. 3.00 ± 0.35) in 2.2%, *Myrothecium verrucaria* (Av. 1.50 ± 0.00) in 2.2% and *M. roridum* (Av. 1.25 ± 0.00) in 2.2% of the samples tested. *Alternaria longissima, A. porri, Ascochyta* sp., *Botryodiplodia* sp., and *Drechslera tetramera* were present in traces only.

It is interesting to note that fungi of the genera *Aspergillus, Penicillium* and *Rhizopus* were comparatively rare except in a few heavily infected samples. The pathogenic fungi like *Drechslera maydis* (cause of southern leaf blight of corn), *D. rostrata* (cause of southern and northern leaf blight of corn) and *Cephalosporium acremonium* (cause of boll rot of cotton) were also isolated from several samples of coriander.

Pathogenicity tests: In pathogenicity tests, *F. solani* on coriander plants showed yellowing of leaves, chlorotic blotches and stunted growth resulting in root rot and death in 6.8 to 53% of plants in sand and 71.8% in water agar slants (Fig.1, Table 2).

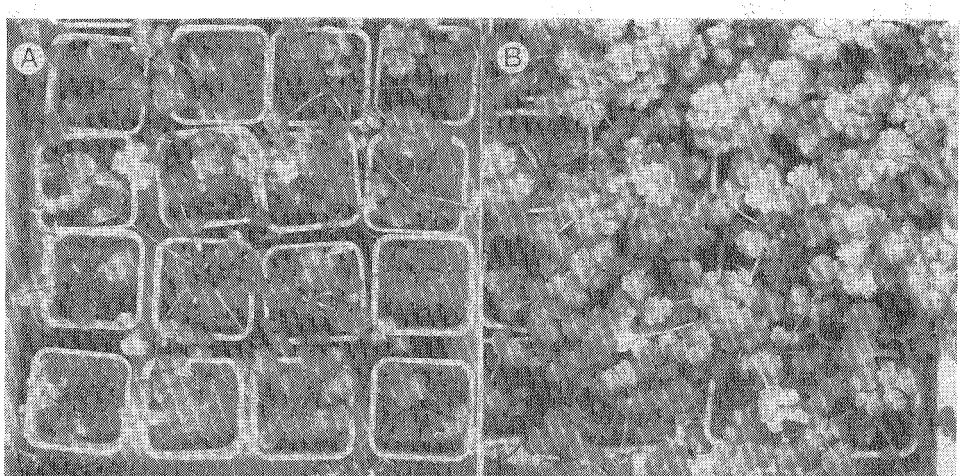

Fig.1. Wilting, stunting and yellowing of leaves in coriander plants due to *Fusarium solani* (A) compared with healthy coriander plants (B).

Table 2. Percent infection of *Fusarium solani* on coriander seedlings.

Categories	Expt.1 Seedlings transferred to infested sand	Expt.2 Roots of seedlings dipped in spore-suspension and sown in sterilized sand	Expt.3 Seeds dipped in spore-suspension and sown in: sterilized sand	Expt.3 Seeds dipped in spore-suspension and sown in: water agar slants
Healthy looking plants	05.0	25.4	14.0	15.2
Plants showing necrosis on stem and roots	28.8	55.8	23.5	----
Plants with primary and secondary roots destroyed	20.0	7.0	----	----
Plants with stocky, annelated stem and deformed roots	39.4	11.8	----	----
Dead plants	06.8	----	53.0	71.8
Rotted seeds	----	----	09.5	13.0

Primary and secondary roots were destroyed in 7.0 to 20.0% plants and caused deformation of roots and transformation of stem into a stocky and annellated structure in 11.8 to 39.4% plants (Fig.2). Roots as well as lower part of the stem turned black and showed necrotic lesions in 23.5 to 55.8% plants. In pot experiments, 5.0 to 25.4% plants did not show any above-ground disease symptoms or rotting of the roots. These plants were transferred to bigger pots containing peat soil to examine whether latent infection transformed into pronounced infection. After 6 weeks, 1 cm pieces of petioles and leaves of all the 6 different whorls were transferred to wet filter paper and incubated under NUV for 1 week. Leaves of the outer whorl withered and showed greater infection of *F. solani* (90.0%) with gradual decline of infection in the inner whorls. Leaves of the second and third whorls became reddish brown respectively yielding 80.05 and 68.0% of *F. solani*. Leaves of the fourth whorl were green with yellowish margin and from 39.0% of them *F. solani* was isolated. In the fifth and sixth whorls, leaves were green and healthy looking from which respectively 10.0% and 5.0% showed the presence of *F. solani* (Fig.3).

Where coriander seedlings were transferred into sand infested with *F. solani*, out of all healthy looking plants (Table 2) only 8 plants reached maturity and produced 150 normal and 35 deformed/shrivelled fruits as compared to 536 normal fruits from equal number of control plants. In blotter test 28.0% of normal and 54.3% of deformed fruits from test plants yielded growth of *F. solani* indicating seed to seed transmission of the pathogen.

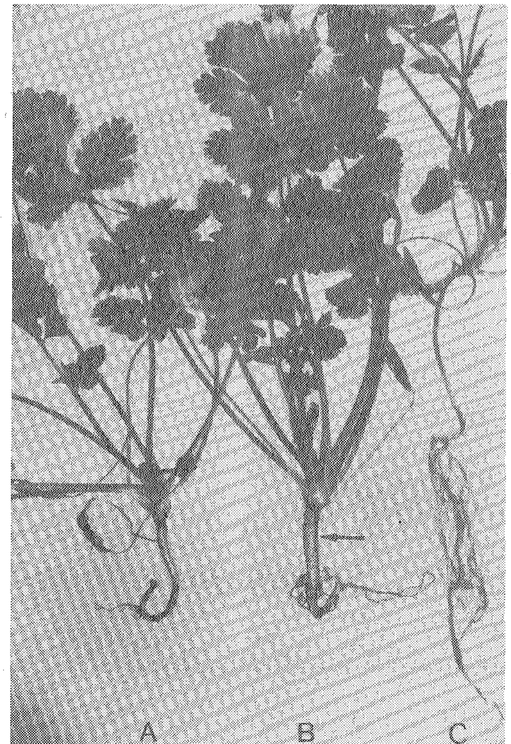

Fig.2. Pathogenicity of *Fusarium solani* in coriander. Coriander plant grown in infested soil showing root rot and stem decay (A). Coriander plant grown in sterilized sand after dipping roots in spore suspension. Note annellations on stocky and shortened stem (arrow) with deformed roots (B). Healthy coriander plant with normal roots (C).

Of the fungi isolated from coriander seeds *Alternaria longissima* has been reported from grains of rice and sorghum (Deighton & MacGarvie, 1968). It is also pathogenic on sesame causing severe foliage blight, stem necrosis and lesions on the capsule (Seung-Hun *et al*., 1982). The role of *A. longissima* in causing disease in coriander plants under field conditions should be explored. *Alternaria alternata, A. longissima, A. porri*, and *Drechslera* spp., found associated with discoloured seeds of coriander presumably reduce the commercial value of seeds.

Of the species of *Myrothecium* which were detected in low percentages from coriander seeds, *M. verrucaria* is reported for producing toxins Muconomycin A (Vittimberga, 1963) and *M. roridum* for Roridin A and B (Harri *et al.*, 1962). A natural outbreak of myrotheciotoxicosis is reported to occur in sheep grazing rye straw infected with *M. verrucaria* in the Soviet Union (Vertinskii *et al.*, 1967). Although myrotheciotoxicosis has not been reported in man so far, possible health hazard due to consumption of large quantities of coriander infected with mycotoxic fungi in the third world countries should receive due attention.

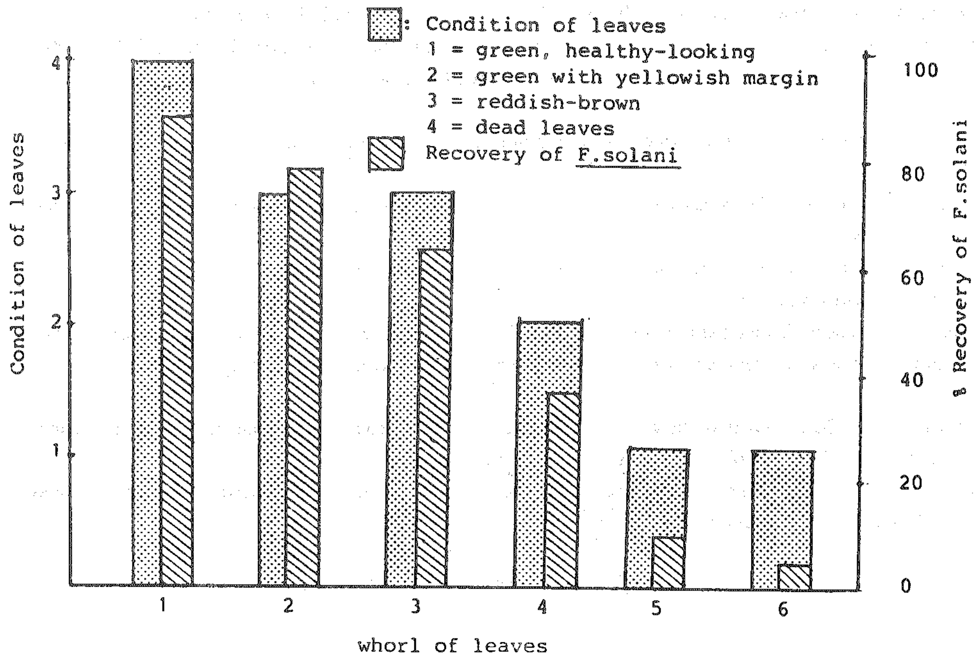

Fig.3. Per cent recovery of *Fusarium solani* from healthy looking plants of coriander. (100 plants were used). Condition of leaves. 1 = green, healthy-looking, 2 = green with yellowish margin, 3 = reddish-brown, 4 = dead leaves, Recovery of *F. solani*

Association of *M. phaseolina* with seed samples of coriander would suggest the possibility of the fungus in producing root rot disease. The cumulative pathogenic potential of *Fusarium* spp., on coriander seeds as detected by blotter test indicates that the pathogens caused abnormal seedlings or a decrease in germination capacity. *F. solani* has been reported to cause foot rot in several other hosts such as broad bean, phaseolus bean and pea (Neergaard, 1979). Wilting and necrotic effect of *F. solani* on coriander is similar to that of *F. solani* in fenugreek seelings (Hashmi, 1988). However, the disease symptoms on roots of the two hosts are quite different. In coriander roots, *F. solani* produced annellations whereas beadlike swellings were observed in fenugreek roots.

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