FUNGI OCCURRING ON SEEDS OF CERTAIN WINTER VEGETABLES

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Ninety-four samples of seeds of seven winter vegetables analysed in the present investigation were highly infested with fungi. Average infestation in cabbage, carrot, cauliflower, pea, radish, spinach and turnip seeds was 61.0, 81.1, 64.0, 63.6, 60.7, 70.6 and 63.7 per cent respectively, whereas the average number of disinfested seeds which gave out fungi on isolation was 19.0, 40.3, 25.3, 22.1, 19.8, 35.5 and 17.5 per cent respectively.

The fungi isolated from the seeds comprised species of *Penicillium*, *Aspergillus*, *Alternaria*, *Mucor*, *Fusarium*, *Rhizoctonia*, *Helminthosporium* and *Curvularia*. Species of *Penicillium*, *Aspergillus*, *Alternaria* and *Mucor* predominated the isolates from naturally infested seeds. However, species of *Aspergillus*, *Penicillium* and *Mucor* were not isolated from disinfested seeds of these vegetables. Species of *Fusarium*, *Alternaria*, *Rhizoctonia* and *Helminthosporium* predominated the isolates from disinfested seeds.

The seed-borne fungi isolated from disinfested seeds reduced the germination of seeds of the seven winter vegetables. Treatment of seeds of these vegetables with Arasan, Ceresan, Ceresan NI, Agrosan GN and Dieldrex significantly enhanced the germination of the treated seed.

INTRODUCTION

Fungi borne on the seeds of winter vegetables have not been adequately studied in West Pakistan. Treatment of vegetable seeds with fungicides for the control of seed-borne diseases is a routine agricultural practice in advanced countries of the world (Walker, 1948). However, the need and importance of treating vegetable seeds with fungicides has not yet been recognised in Pakistan. This is due to inadequate information on the extent of infestation of vegetable seeds and their harmful effect.

Yunis and Kausar (1966) studied the fungi infesting seeds of five summer vegetables, the extent of their infestation, the harmful effect of seed-borne fungi and the effectiveness of seed dressing fungicides in counteracting their harmful effect. The present investigation was undertaken to provide similar information in respect of seven major winter vegetables.

The present study comprised a survey of the fungi associated with seeds of seven winter vegetables through an analysis of samples of seeds of these

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vegetables collected from different places in West Pakistan. The fungi isolated from seeds of these vegetables were studied for their harmful effects on germination of the seed. The effectiveness of seed dressing fungicides for the control of these seed-borne fungi was also investigated. The present paper reports the results of this investigation.

REVIEW OF LITERATURE

Orton (1926) and Doyer (1941) have drawn attention to the importance of seed as carrier of diseases of vegetables. Walker (1948, 1950, 1952) and Leukal (1948) have suggested different treatments to minimise losses caused by different seed-borne fungi.

Fungi reported on seeds of cabbage include species of *Alternaria, Penicillium, Curvularia, Sphaeronema, Botrytis* and *Phoma* (Atkinson, 1950; Alcock, 1931; Crosier, 1942; Doyer, 1941; Walker, 1948, 1952; Henderson, 1918).

Species of *Alternaria* and *Curvularia* have been recorded from the seed of cauliflower (Atkinson, 1950; Neergaard, 1945; Groves and Skolko, 1944*b*), whereas species of *Sclerotinia, Stemphylium, Alternaria, Cercospora, Trichocladium* and *Phoma* were isolated from carrot seeds (Alcock, 1931; Doyer, 1941; Hooker, 1944; Groves and Skolko, 1944*a*, 1946; Porter, 1949).

Fungi recorded on peas included species of *Fusarium, Curvularia, Cladosporium, Sclerotinia, Trichoderma* and *Corticium solani* (Crosier, 1935, 1942; Snyder, 1932; Groves and Skolko, 1946; Neergaard, 1945). Walker (1948, 1952) suggested seed treatment for minimising the losses caused by *Mycosphaerella pinodes* and *Ascochyta pisi*.

Species of *Ramularia, Colletotrichum, Alternaria, Fusarium,* and *Helminthosporium* have been reported on radish seeds (White, 1945; Schefer, 1950; Groves and Skolko, 1944*b*; Surya Narayan and Bhome, 1961; Atkinson, 1950).

Corprinus lagopus, and species of *Fusarium, Phoma, Colletotrichum, Corticium, Alternaria* and *Aspergillus* were reported from the seeds of spinach (Crosier, 1935; Doyer, 1941; Neergaard, 1945; Surya Narayan and Bhome, 1961), whereas species of *Alternaria, Aspergillus, Curvularia* and *Phoma lingam* were recorded on seeds of turnip (Gibbs and Brien, 1934; Groves and Skolko, 1944*b*, 1945; Surya Narayan, 1961).

RESULTS AND DISCUSSION

Ninety-four seed samples of seven winter vegetables including cabbage, cauliflower, carrot, pea, radish, spinach and turnip collected from seventeen

different places in West Pakistan were analysed for the presence of fungi borne externally and internally.

Two methods of isolating fungi present on the seeds were used. One hundred seeds from each sample were plated as such on potato-dextrose agar to study the fungi occurring on the surface of the seed. Another one hundred seeds were surface disinfested with 0.1 per cent mercuric chloride solution for 1 to 1½ minutes and were plated on potato-dextrose agar. Fungi coming out of seeds were transferred to potato-dextrose agar slants for further growth and identification.

Extent of Infestation

Ninety-four samples of seeds of seven winter vegetables analysed for the presence of fungi on the seeds were highly infested with fungi (Table 1). The extent of infestation in cabbage, carrot, cauliflower, pea, radish, spinach and turnip in different samples ranged between 56 and 67, 70 and 96, 42 and 92,52 and 73, 48 and 86, 56 and 80, and 28 and 85; with an average of 61.0, 81.1, 64.0 63.6, 60.7, 70.6 and 63.7 per cent respectively. The number of disinfested seeds of these vegetables which gave out fungi varied from 0 to 38, 35 to 56, 0 to 50, 0 to 45, 0 to 35, 22 to 44 and 0 to 38; with an average of 19.0, 40.3, 25.3, 22.1, 19.8, 35.5, and 17.5 per cent respectively.

TABLE 1.—*Prevalence of fungi isolated from naturally infested and surface disinfested seeds of certain winter vegetables.*

Vegetable seed	Samples analysed	Number of seeds giving out fungi		Number of disinfested seeds giving out fungi	
		Range	Mean	Range	Mean
Cabbage ..	3	56—67	61.0	0—38	19.0
Carrot ..	16	70—96	81.1	35—56	40.3
Cauliflower ..	17	42—92	64.0	0—50	25.3
Pea ..	14	52—73	63.6	0—45	22.1
Radish ..	14	48—86	60.7	0—35	19.8
Spinach ..	15	56—80	70.7	22—44	35.5
Turnip ..	15	28—85	63.7	0—38	17.5

Fungi Infesting Seeds and their Prevalence

The fungi isolated from naturally infested and disinfested seeds of seven winter vegetables and their prevalence are summarised in Table 2. The fungi isolated comprised species of *Penicillium, Aspergillus, Alternaria, Mucor, Fusarium, Rhizoctonia, Helminthosporium* and *Curvularia.*

TABLE 2.—*Percentage of fungi isolated from naturally infested and disinfested seeds of certain winter vegetables.*

Vegetable seed	Nature of seed sample	Percentage prevalence of the fungi isolated							
		Aspergillus sp.	*Penicilium* sp.	*Mucor* sp.	*Fusarium* sp.	*Rhizoctonia* sp.	*Helminthosporium* sp.	*Alternaria* sp.	*Curvularis* sp.
Cabbage	Naturally infested	27.2	28.8	10.8	0.0	0.0	5.9	27.2	0.0
	Disinfested	0.0	0.0	0.0	36.8	18.9	12.6	31.6	0.0
Carrot	Naturally infested	32.1	30.8	26.0	2.5	0.0	0.0	8.6	0.0
	Disinfested	0.0	0.0	0.0	64.5	0.0	0.0	35.5	0.0
Cauliflower	Naturally infested	25.1	26.0	13.9	6.9	0.0	0.0	23.6	4.5
	Disinfested	0.0	0.0	0.0	41.5	15.8	0.0	34.0	8.7
Pea	Naturally infested	28.1	23.3	22.9	2.7	0.0	3.6	19.3	0.0
	Disinfested	0.0	0.0	0.0	48.4	21.7	11.8	18.1	0.0
Radish	Naturally infested	29.2	29.3	10.1	3.4	1.8	4.6	21.6	0.0
	Disinfested	0.0	0.0	0.0	44.5	26.3	3.5	25.7	0.0
Spinach	Naturally infested	27.7	29.7	11.3	0.0	8.6	5.7	17.0	0.0
	Disinfested	0.0	0.0	0.0	46.7	21.2	0.0	32.1	0.0
Turnip	Naturally infested	25.8	27.2	14.6	3.1	0.0	0.0	21.5	7.8
	Disinfested	0.0	0.0	0.0	39.9	14.8	0.0	36.7	8.3

Species of *Penicillium*, *Aspergillus*, *Alternaria*, and *Mucor* predominated the isolates from naturally infested seeds of all vegetables plated as such, and constituted 94.1, 97.5, 88.6, 93.7 90.2 and 85.7 per cent of the isolates in samples of cabbage, carrot, cauliflower, pea, radish and spinach respectively. The remaining isolates comprised species of *Fusarium*, *Rhizoctonia*, *Helminthosporium* and *Curvularia*. *Curvularia* sp. was isolated from seeds of cauliflower and turnip only, whereas *Helminthosporium* sp. was isolated from seeds of cabbage, pea, radish and spinach. *Fusarium* sp. was isolated from seeds of carrot, cauliflower, pea, radish, and turnip, whereas *Rhizoctonia* sp. was isolated from radish and spinach seeds.

Fungi isolated from disinfested seed comprised species of *Fusarium*, *Rhizoctonia*, *Helminthosporium*, *Alternaria*, and *Curvularia*. Species of *Asper-*

gillus, Penicillium and *Mucor* were not isolated from disinfested seeds of these vegetable samples. This indicated that these three fungi which constituted 66.9, 88.9, 74.4, 68.5, 68.8, and 67.6 per cent of the isolates from the naturally infested seeds of these vegetables were essentially surface contaminants. *Curvularia* sp. was isolated from cauliflower and turnip seeds only. However, species of *Fusarium, Alternaria, Rhizoctonia* and *Helminthosperium* predominated the isolates from disinfested seed of all vegetables. Species of *Fusarium, Rhizoctonia* and *Helminthosporium* together constituted 64.4, 64.5, 60.0, 81.9, 74.3, 68.9 and 63.1 per cent of the isolates of samples from cabbage, carrot, cauliflower, pea, radish, spinach and turnip seeds respectively, whereas species of *Alternaria* comprised 31.6, 35.5, 34.0, 18.1, 25.7, 32.1, 36.9 per cent of the isolates from the vegetables. Species of *Fusarium* and *Alternaria* were isolated from the seeds of the seven vegetables. Similarly, *Rhizoctonia* sp. was isolated from seeds of all vegetables except carrot. However, *Helminthosporium* sp. was isolated only from cabbage, pea, and radish seeds.

TABLE 3.—*Effect of seed-borne fungi on the germination of seeds of certain winter vegetables*

Fungi infesting the seed	Emergence of the seed of the vegetables						
	Cabbage	Carrot	Cauliflower	Pea	Radish	Spinach	Turnip
Alternaria sp.	12	10	14	12.5	12	12	14
Fusarium sp.	11	11	14	12	13	12	15
Rhizoctonia sp.	12	—	14	12.5	12	12	14
Helminthosporium sp.	12	—	—	14	11	12	—
Curvularia sp.	—	—	15	—	—	—	14
Check	38	26	45	38	46	33	42
Least significant difference at							
5 per cent level	0.55	0.29	0.49	0.44	0.76	0.25	0.7
1 per cent level	0.75	0.41	0.67	0.6	1.08	0.35	0.96

Effect of Seed-borne Fungi on Germination of Seed

The effect of fungi isolated from disinfested seed on the germination of seeds of seven winter vegetables was studied in wooden trays, 18×9 inches in size. The wooden trays were filled with soil autoclaved for 30 minutes at 120°C. at 15 lbs. pressure per inch. Fifty surface disinfested seeds of seven

winter vegetables were infested with fungi isolated from seeds singly and were planted in the soil in wooden trays. The experiment was run in quadruplicate.

The fungi isolated from disinfested seeds of seven vegetables reduced the germination of the seeds of seven vegetable significantly (Table 3). In general, species of *Fusarium*, *Rhizoctonia*, *Alternaria*, *Helminthosporium* and *Curvularia* were harmful in that order.

Effect of Seed dressing Fungicides on the Germination of Seeds

Five lots of fifty seeds of each of the seven winter vegetables infested with seed-borne fungi were treated with five fungicides (Arasan, Ceresan, New Improved Ceresan, Agrosan GN, Dieldrex) and their germination was studied in wooden trays filled with autoclaved soil. The sixth lot of fifty seeds of each vegetable infested with seed-borne fungi was sown as such to serve as control. The experiment was run in three replications.

TABLE 4. *Effect of treatment of infested seeds of seven winter vegetables with fungicides on the germination of seed.*

	Emergence of infested seed treated with fungicides						
Fungicidal treatment	Cabbage	Carrot	Cauli-flower	Peas	Radish	Spinach	Turnip
Arasan	38.8	29.2	44.0	44.0	41.8	34.3	43.7
Granosan	38.5	28.7	43.5	43.6	40.7	33.5	42.7
Granosan NI	38.5	27.7	42.7	43.1	40.3	32.8	42.7
Agrosan GN	38.2	26.7	42.7	43.0	40.3	32.8	41.8
Dieldrex	38.0	27.0	42.7	43.0	40.3	32.7	41.7
Untreated check	11.7	10.0	14.1	12.7	12.2	12.1	14.5
Least significant difference at							
5 per cent level	0.25	0.10	0.21	0.21	1.0	0.18	0.16
1 per cent level	0.34	0.23	0.29	0.29	1.2	0.24	0.23

Treatment of the seeds of the seven vegetables with the five fungicides improved the germination of seed significantly (Table 4). Arasan proved to be the best fungicide followed by Granosan M, Granosan NI and Agrosan GN.

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