Prevalence and Control of Fungi Occurring on Seeds of Certain Summer Vegetables

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Fifty-two seed samples of five summer vegetables including cucumber, *karela*, okra, tomato and vegetable marrow, collected from different localities in West Pakistan, were analysed for the fungi occurring on the seeds. Almost all the samples were heavily infested with seed-borne fungi.

The extent of infestation in cucumber, *karela*, okra, tomato and vegetable marrow seed samples ranged from 54 to 63, 53 to 63, 58 to 81, 53 to 61 and 53 to 71 per cent respectively, with an average of 58.7, 57.8, 67.5, 56.8 and 60.4 per cent. The number of disinfested seeds which gave out fungi varied from 16 to 28, 21 to 35, 23 to 35, 27 to 35, and 24 to 38 per cent respectively, with an average of 19.8, 26.3, 28.5, 31.8 and 30.3 per cent.

The fungi generally isolated from the seeds of summer vegetables included species of *Aspergillus*, *Penicillium*, *Rhizopus*, *Alternaria*, *Fusarium*, *Sclerotium*, *Chaetomium*, *Curvularia* and *Helminthosporium*. The species of *Aspergillus* and *Penicillium* were not isolated from disinfested seeds. However, species of *Alternaria*, *Fusarium*, *Chaetomium*, *Rhizopus*, *Sclerotium*, *Curvularia* and *Helminthosporium* were isolated from naturally infested and disinfested seeds.

The seed-borne fungi reduced the germination of seed of the vegetables and increased the mortality of seedlings raised from infested seeds. Five seed-dressing fungicides including Granosan M, Arasan, Agrosan G.N., Dieldrex, Granosan N.I. generally enhanced the germination of seeds of the five summer vegetables.

INTRODUCTION

Orton (1926) and Doyer (1941) have drawn attention to the importance of seeds as carrier of plant pathogens. However, little information is available on the fungi and other pathogens borne on seeds of summer vegetables in West Pakistan. This information is obviously essential to assess the importance of these organisms and to understand the necessity of treating summer vegetable seeds with fungicides to counteract the harmful effects of major seed-borne organisms. The present investigation was undertaken to provide information on the fungi borne on the seeds of summer vegetables in West Pakistan.

The present paper reports a study of the fungi associated with seeds of certain summer vegetables through an analysis of samples of these summer

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vegetable seeds collected from different parts of West Pakistan. The harmful effect of these fungi on the germination of seeds and the effect of dressing seeds of summer vegetables with fungicides to counteract the harmful effect of these fungi was also studied.

REVIEW OF LITERATURE

The fungi occurring on seeds of cucumber (*Cucumis sativus*), okra (*Hibiscus esculentus*), tomato (*Lycopersicum esculentum*) and vegetable marrow (*Cucurbita pepo*) have been studied in other countries of the world. No fungi occurring on *karela* (*Momordica charantia*) seeds appear to have been reported.

Ellis (1951) reported *Colletotrichum lagenarium* on cucumber seeds, whereas *Cladosporium* sp. was recorded on these seeds by Galatchyan (1937). Schmidt (1938) and Groves and Skolko (1944) extended the host range of *Alternaria tenuis* to seeds of cucumber and also recorded *Curvularia trifolii* on cucumber seeds. Schmidt (1938) reported *Gloeosporium lagenarium* on cucumber seeds, whereas Tyner (1945) found cucumber seeds as carriers of *Fusarium* sp.

Silveira (1947) recorded *Ascochyta abelmoschi* from okra seeds, while Taubenhaus (1935) reported *Fusarium vasinfectum* from these seeds.

Alcock (1931) and Walker (1950) reported *Didymella lycopersici* on tomato seeds. Boyd (1935) reported *Phytophthora infestans* and Dolittle (1948) isolated *Alternaria solani*, *Cladosporium fulvum*, *Fusarium* sp., *Pythium* sp. and *Rhizoctonia solani* from tomato seeds. Groves and Skolko (1944) recorded *Stemphylium* sp. from seeds of tomato. Hawkins and Tisdle (1937) reported *Phoma* sp. on tomato seeds while Kadow (1934) isolated *Verticillium albo-atrum* from these seeds. Kendrick (1944) and Martin (1933) isolated *Fusarium* sp. from tomato seeds, whereas Massee (1914) reported occurrence of *Macrosporium solani* on tomato seeds. Samson (1938) recorded species of *Alternaria* and *Fusarium* on tomato seeds.

Crosier (1942) reported *Alternaria* sp. and *Miriotlecielia* sp. from the seeds of vegetable marrow. Groves and Skolko (1944) isolated *Alternaria* sp., *Curvularia trifolii* and *Stemphylium botryosum* from vegetable marrow seeds, whereas Tyner (1945) recorded *Fusarium sambucinum* from these seeds.

Prevalence of Fungi Occurring on Seeds of Summer Vegetables

The seed samples of five summer vegetables including cucumber (*Cucumis sativus*), *karela* (*Momordica charantia*), okra (*Hibiscus esculentus*), tomato (*Lycopersicum esculantum*) and vegetable marrow (*Cucurbita pepo*) were analysed for the fungi present on their seeds. Samples of seeds of these vegetables were obtained from vegetable growers of Lahore, Mianwali,

Montgomery and Quetta, and from seed merchants of Peshawar, Gujrat, Lyallpur, Sargodha, Hyderabad, Karachi, Rawalpindi and Multan. While seed samples of the first four vegetables mentioned above were received from the 12 localities mentioned above, those of tomato were received only from Peshawar, Sargodha, Lyallpur and Karachi. Thus, the total number of samples collected and analysed for these studies was 52.

One hundred seeds from each sample were plated on plain agar medium as such and the fungi isolated were transferred to potato-dextrose agar. A similar lot of 100 seeds from each sample was disinfested with mercuric chloride solution, washed in sterilized water and was plated on agar medium. The number of seeds giving out fungi in both cases was counted and is summarised in Table 1. Almost all the samples of the five summer vegetables studied were heavily infested with fungi. The extent of infestation in cucumber, *karela*, okra, tomato and vegetable marrow seed samples ranged between 54 and 63, 53 and 63, 58 and 81, 53 and 61, and 53 and 71 per cent respectively, with an average of 58.7, 57.8, 67.5, 56.8 and 60.4 per cent. The number of disinfested seeds which gave out fungi varied from 16 to 28, 21 to 35, 23 to 35, 27 to 35 and 24 to 38 per cent in cucumber, *karela*, okra, tomato, and vegetable marrow seeds respectively, with an average of 19.8, 26.3, 28.5, 31.8 and 30.3 per cent respectively.

TABLE 1.—*Number of seeds of certain summer vegetables infested with fungi.*

Name of vegetable seeds.	Number of samples studied	Number of seeds giving out fungi when plated as such		Number of disinfested seeds giving out fungi	
		Range	Mean	Range	Mean
Cucumber	12	54—63	58.7	16—28	19.8
Karela	12	53—63	57.8	21—35	26.3
Okra	12	58—81	67.5	23—35	28.5
Tomato	4	53—61	56.8	27—35	31.8
Vegetable marrow	12	53—71	60.4	24—38	30.3

Fungi Infesting the Seeds of Summer Vegetables

The fungi isolated from the seeds and their relative prevalence is given in Table 2. The fungi isolated from the seeds of five summer vegetables comprised species of *Aspergillus*, *Penicillium*, *Rhizopus*, *Alternaria*, *Fusarium*, *Chaetomium*, *Sclerotium*, *Curvularia* and *Helminthosporium*. Species of *Curvularia* was isolated from cucumber seeds only, *Chaetomium* species from *karela* seeds only and *Helminthosporium* sp. from tomato seeds only. *Sclerotium* sp. was isolated from *karela*, okra and vegetable marrow, whereas *Fusarium* species was isolated from *karela*, tomato and vegetable marrow seeds. However, species of *Aspergillus*, *Penicillium*, *Rhizopus* and *Alternaria* were isolated from all the vegetables.

Species of *Aspergillus*, *Penicillium* and *Rhizopus* were isolated from seeds as such and were not generally isolated from disinfested seeds of these vegetables, except that *Rhizopus* sp. was isolated from disinfested tomato seeds. However, *Alternaria* sp. was generally isolated from naturally infested and disinfested seeds of all vegetables, except that it was not isolated from disinfested *karela* seed. The fungi that predominated the isolates from disinfested seeds of cucumber comprised species of *Alternaria* and *Curvularia*, those on okra comprised species of *Alternaria* and *Sclerotium*, those on *karela* comprised species of *Sclerotium*, *Chaetomium* and *Fusarium*, those on vegetable marrow comprised species of *Alternaria*, *Fusarium* and *Sclerotium*, whereas those on tomato comprised species of *Fusarium*, *Helminthosporium*, *Alternaria* and *Rhizopus*.

Effect of Seed-borne Fungi on the Germination of the Seeds

The effect of seed-borne fungi on the germination of seeds of summer vegetables was studied in wooden trays, 18×9 inches in size. The soil was disinfested with 2 per cent solution of formalin at the rate of 1½ lbs. per cubic foot of soil. The soil was then covered with water soaked gunny bags for three days and was then left as such for another two days. The wooden trays were then filled with this soil up to two-thirds of their height and were watered. The seeds were sown when the soil moisture was just suitable for planting them. The fungi isolated from the five summer vegetable seeds were grown in 300 ml. conical flasks. A mixture of aerial hyphae and spores of the fungi isolated from seeds of a particular vegetable were taken in a little quantity of water and was used to infest the seeds of that particular vegetable. Before infesting the seeds with seed-borne fungi, seeds of each of the five vegetables were taken and disinfested with 0.1 per cent solution of mercuric chloride. Seeds of vegetables thus infested with seed-borne fungi were sown in trays at the rate of twenty-five seeds per tray. Seeds of a particular vegetable disinfested with

TABLE 2.—*Prevalence of fungi isolated from seeds of certain summer vegetables.*

Name of vegetable seeds	Prevalence of the fungi in per cent.								
	Aspergillus sp.	*Penicillium sp.*	*Rhizopus sp.*	*Alternaria sp.*	*Fusarium sp.*	*Chaetomium sp.*	*Sclerotium sp.*	*Curvularia sp.*	*Helminthosporium sp.*
Cucumber									
(*a*) Seeds as such	28.5	25.0	16.3	14.7	—	..	..	15.3	..
(*b*) Disinfested seeds	..	..	..	43.4	..	..	..	56.5	..
Karela									
(*a*) Seeds as such	18.1	15.9	10.4	13.4	12.3	13.4	16.3	..	..
(*b*) Disinfested seeds	..	..	—	..	28.9	32.0	38.9	..	..
Okra									
(*a*) Seeds as such	16.5	16.3	17.9	24.8	..	..	24.4	..	..
(*b*) Disinfested seeds	..	..	..	45.2	..	..	54.8	..	..
Tomato									
(*a*) Seeds as such	14.9	18.9	11.8	11.8	22.4	..	..	..	19.8
(*b*) Disinfested seeds	..	..	11.4	19.8	36.6	..	..	..	32.0
Vegetable marrow									
(*a*) Seeds as such	19.9	13.8	15.7	21.8	19.1	..	13.3	..	..
(*b*) Disinfested seeds	..	..	..	39.3	36.6	..	24.0	..	..

mercuric chloride and not infested with seed-borne fungi served as check. The experiment was triplicated. The record on germination of seeds and mortality of seedlings was taken and the results are summarised in Table 3.

The seed-borne fungi reduced the germination of the seeds of five vegetables and increased the mortality of the seedlings from seeds infested with these fungi. The germination of cucumber, *karela*, okra, tomato and vegetable marrow seeds was reduced to 20.0, 17.3, 38.7, 18.7 and 13.3 per cent as against 45.3, 49.3, 53.3, 50.7 and 48.0 per cent germination of seeds free of these fungi. The mortality of seedlings from seeds infested with seed-borne fungi was 26.7, 36.2, 20.7, 35.7 and 0.0 in cucumber, *karela*, okra, tomato and vegetable marrow seeds as against 17.6, 13.5, 12.5, 3.3 and 0.0 per cent mortality respectively from seeds of these vegetables free of these seed-borne fungi.

Effect of Seed-dressing Fungicides Against Seed-borne Fungi

The effect of seed-dressing fungicides on the germination of seeds of the five summer vegetables was studied in wooden trays 18 by 9 inches in size. The following fungicides were used at their recommended rates.

TABLE 3.—*Effect of seed-borne fungi on the germination of seeds and mortality of seedlings.*

Name of vegetable	Seeds infested with seed-borne fungi.		Seeds free of seed-borne fungi.	
	Germination (per cent)	Mortality (per cent)	Germination (per cent)	Mortality (per cent)
Cucumber	20.0	26.7	45.3	17.6
Karela	17.3	46.2	49.3	13.5
Okra	38.7	20.7	53.3	12.5
Tomato	18.7	35.7	50.7	5.3
Vegetable marrow	13.3	10.0	48.0	0.0

The seeds of a particular summer vegetable were disinfested with 0.1 per cent solution of mercuric chloride and were later infested with a mixture of inoculum from cultures of seed-borne fungi isolated from that particular vegetable. Seventy-five seeds of each vegetable thus infested were treated with each of the five fungicides: Granosan M, Arasan, Agrosan GN, Dieldrex and Granosan NI. Seeds infested with these fungi and not treated with fungicides

served as check. Seeds of vegetables thus treated were sown in wooden trays at the rate of twenty-five seeds per tray. The experiment was triplicated. The effect of seed-dressing fungicides on the germination of infested seeds was recorded and is presented in Table 4.

TABLE 4.—*Effect of seed dressing fungicides on the germination of infested seeds of certain summer vegetables.*

Fungicides	Germination (per cent)				
	Karela	Cucumber	Okra	Tomato	Vegetable marrow
Granosan M. ..	72.0	58.7	60.0	18.7	77.3
Arasan ..	78.7	76.0	78.7	60.0	81.3
Agrosan GN. ..	78.7	66.7	48.0	56.0	32.0
Dieldrex ..	81.3	73.3	61.3	34.7	66.7
Granosan NI. ..	65.3	78.7	62.7	34.7	26.7
Check ..	40.0	33.3	30.7	16.0	22.7
Least significant difference:					
at 5 per cent ..	6.46	7.61	4.52	8.88	9.84
at 1 per cent ..	9.19	10.83	6.43	12.64	14.00

The germination of the seeds of the five summer vegetables was generally enhanced significantly by the five fungicides tried, except that the increase was non-significant by the use of Granosan M. on tomato seeds and Granosan NI. on vegetable marrow seeds. Granosan NI., Arasan and Dieldrex were the best fungicides for cucumber, Dieldrex, Agrosan GN. and Arasan for *karela*, whereas Arasan was the best for okra, and tomato and Arasan and Granosan M. were the best fungicides for vegetable marrow seeds.

DISCUSSION

The prevalence of fungi borne on fifty-two representative samples of seeds of five summer vegetables including cucumber, *karela*, okra, tomato and vegetable marrow from West Pakistan has revealed that the seeds of these vegetables were heavily infested with different seed-borne fungi. The infestation of seeds varied from 54 to 63, 53 to 63, 58 to 81, 53 to 61 and 53 to 71 per cent in cucumber, *karela*, okra, tomato and vegetable marrow respectively. The

disinfested seeds of these vegetables gave out fungi in 19.8, 26.3, 28.5, 31.8 and 30.3 per cent cases respectively. None of the samples collected was free of seed-borne fungi.

The fungi isolated from seeds included species of *Aspergillus, Penicillium, Rhizopus, Alternaria, Fusarium, Sclerotium, Chaetomium, Curvularia* and *Helminthosporium. Aspergillus* and *Penicillium* species were not isolated from disinfested seeds, whereas species of *Rhizopus, Alternaria, Fusarium, Helminthosporium, Chaetomium, Curvularia* and *Sclerotium* were isolated from infested as well as disinfested seeds.

The seed-borne fungi reduced the germination of the vegetable seeds infested with these seed-borne fungi. In *karela*, germination was reduced from 49.3 to 17.3 per cent, in cucumber from 45.3 to 20 per cent, in okra from 53.3 to 38.7 per cent, in tomato from 50.7 to 18.7 per cent and in vegetable marrow from 48 to 13.3 per cent.

The germination of the seeds of the five summer vegetables was generally enhanced significantly by the five fungicides tried, except that the increase was non-significant by the use of Granosan M. on tomato seeds and Granosan NI. on vegetable marrow seeds. Granosan NI., Arasan and Dieldrex were the best fungicides for cucumber; Dieldrex, Agrosan GN. and Arasan for *karela*; whereas Arasan was the best for okra and tomato and Arasan and Granosan M. were the best fungicides for vegetable marrow seeds. The results of the present investigation are in conformity with those of Taylor and Rupert (1946) for cucumber, okra and tomato. No trial with fungicides appears to have been reported on *karela* and vegetable marrow seeds.

The present investigation on the prevalence of the fungi on summer vegetable seeds is essentially exploratory, but has proved the importance of the fungi occurring on summer vegetable seeds and their treatment with seed-dressing fungicides. Similar studies with other summer vegetables are indicated.

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