EXPERIMENTAL RESULTS

1. Isolation of the causal organisms :

Isolation of the causal organisms of damping-off, root-rot, and wilt diseases was carried out from the apparently healthy seeds, and diseased seeds, seedlings and roots collected from different localities in ARE.

Data in Table (3) indicate the frequency of isolated fungi from diseased cumin seeds and plant parts as regard to the different localities (El-Minia and Assiut Governorates).

From data presented in Table (3) Fusarium oxysporum f.sp. cumini followed by F. solani were isolated more frequently from diseased cumin plants collected from different localities El-Minia, Maghagha, El-Minia and Mallawi and Assiut; Dyrout, El-Kossia and Manfalout than the other isolated fungi, whereas, A. alternata and Fusarium solani were isolated from seed samples, collected from the different localities (the same above-mentioned localities), more frequently than the other fungi.

Generally, Fusarium solani, Alternaria alternata and F. oxysporum f.sp. cumini were the most frequently isolated fungi from wilted plants and seeds.

2. Pathogenicity tests :

The pathogenicity of the isolated fungi to commercial cumin variety was tested by planting in infested soil

Table (3) : Frequency of fungi isolated from cumin seeds and wilted plants grown in different locations.

Fungi	Frequency %														
	Wilted plants and rooted roots							Seed samples							Total
	El-Minia			Assiut				El-Minia			Assiut				
	1	2	3	1	2	3	Total	1	2	3	1	2	3	Total	
F. oxysporum	20	21	22	18	19	20	120	5	6	7	6	4	3	31	151
F. solani	15	16	13	14	16	20	94	11	15	13	14	11	12	76	170
F.semitectum	1	2	1	0	0	1	5	3	2	2	3	3	1	14	19
Alternaria alternata	0	0	3	0	0	1	4	2$	39	27	28	26	27	163	167
Drechslera tetramera	1	0	0	0	0	0	1	10	15	8	7	6	5	51	52
Stemphyllium spp.	0	3	0	0	0	0	3	3	4	2	1	8	4	22	25
Curvularia lunata	0	1	0	0	0	0	1	1	1	2	0	1	2	7	8
Verticillium sp.	0	0	0	0	0	1	1	1	2	1	0	0	0	4	5
Cephalosporium sp.	1	0	0	0	0	0	1	1	0	1	0	0	0	2	3
Penicillium sp.	0	0	0	0	0	0	0	6	8	10	9	8	10	51	51
Cladosporium sp.	1	2	0	0	0	0	3	6	8	9	8	9	10	50	53
Aspergillus niger	0	0	0	0	0	0	0	7	11	12	20	8	6	64	64
A. flavus	0	0	0	0	0	0	0	6	5	6	7	16	21	61	61

El-Minia : 1. Maghagha
2. El-Minia
3. Mallawi

Assiut : 1. Dyrout
2. ElKossia
3. Manfalout

using clay No. 25 pots in the greenhouse of the Plant Pathology Research Institute, Agric. Res. Centre, Giza, on November 11th in season 1983.

Results, as percentage of pre- and post-emergence damping-off and healthy survivals, after 21, 45 and 60 days, respectively, are shown in Table (4).

Data in Table (4) lead to the following results : The tested fungi could be arranged descendingly regards their virulence as follows : Fusarium oxysporum f.sp. cumini, F. solani, Aspergillus niger, A. flavus, Penicillium sp., Cladosporium sp., F. semitectum and Alternaria alternata.

1. Fusarium oxysporum f.sp. cumini : was the most destructive, fungus especially isolate No. 4 (from seed), which resulted in the lowest percentage of healthy survival plants.
2. Fusarium solani : Diseased plants showed symptoms of root-rot and wilting 30 days after sowing.
3. Aspergillus niger, A. flavus, Penicillium sp., Cladosporium sp. and F. semitectum : Diseased plants showed symptoms of seed rot.
4. Alternaria alternata : Diseased plants showed symptoms of seed -rot and stem blight or cotyledonary rot.
5. Verticillium sp. and Cephalosporium sp. were avirulent And always associated with Fusarium spp.
6. The rest of fungi : No clear symptoms were investigated.

Table (4) : Effect of soil inoculation with different isolated fungi on the pre- and post-emergence damping-off of commercial cumin variety.

Isolated from	Fungi	Isolate No.	Damping-off		% Healthy survival plants after 8 weeks	Symptoms and remarks
			Pre-emergence	Post-emergence		
Roots of wilted or root rotted plants	*F. oxysporum* f.sp. *cumini*	1	28.00	32.83	48.00	Wilt
		2	24.00	31.60	52.00	"
		3	23.00	32.50	52.00	"
		4	21.00	35.45	51.00	"
		5	26.00	40.60	44.00	"
		6	29.00	36.80	45.00	"
	Fusarium solani	1	20.00	18.90	65.00	Root and colar rot
		2	20.00	18.70	65.00	" "
		3	20.00	17.50	66.00	" "
	Fusarium semitectum	1	20.00	6.25	75.00	Always isolated with *F. oxysporum* or *F. solani*
	F. oxysporum f.sp. *cumini*	1	25.00	28.08	54.00	Wilt
		2	29.00	36.65	45.00	"
		3	22.00	34.65	51.00	"
		4	30.00	37.35	40.00	"
		5	31.00	33.33	46.00	"
		6	29.00	36.68	47.00	"
	Fusarium solani	1	19.00	27.15	58.00	Root rot or colar rot
		2	24.00	22.38	59.00	" "
		3	21.00	17.70	65.00	" "
		4	24.00	27.33	55.00	" "
seds	*Fusarium semitectum*	1	20.00	6.25	75.00	In association with *F. solani* carried with seed tissues)
		2	21.00	6.33	74.00	
	Alternaria alternata	1	22.00	4.23	75.00	Stem blight or cotyledons rot
	Drechslera tetramera	1	16.00	1.20	83.00	No clear symptoms or isolated with others
	Stemphyllium sp.	1	16.00	1.20	83.00	" " " "
	Curvularia lunata	1	16.00	2.38	82.00	" " " "
	Verticillium sp.	1	17.00	1.20	82.00	Usually isolated with *F.* sp.
	Cephalosporium sp.	1	17.00	1.20	82.00	" " " "
	Penicillium sp.	1	26.00	1.40	73.00	Seed rot
	Cladosporium sp.	1	26.00	1.40	73.00	" "
	Aspergillus niger	1	32.00	1.40	67.00	" "
	Aspergillus flavus	1	31.00	1.40	68.00	" "
	Control	1	16.00	2.40	82.00	
	L.S.D. 0.05		3.14	4.77	6.23	

A : Seed health testing :

The seed health test of cumin seed samples was carried out to detect field fungi on, with, and within these seeds.

Identification of isolated fungi was carried out according to cultural characteristics and fungal structures under stereoscopic microscope (binocular) Figures (6, 7 and 8)

1. Examination of ungerminated seeds : (Inspection of dry seed) :

Different seed samples were collected from different localities in ARE (Dayrout, Manfalout, Mallawi and El-Minia).

In the laboratory, the dry seeds were classified partly into seven categories such as, weed, cumin fruit or seed with discoloration or malformation, inert matter, fruits with pedicle, seeds with pedicle, fruits without pedicle and seeds without pedicle. Ten replicates were taken from each sample at random. Each replicate, 10 g., was classified into the abovementioned categories and weighed. Mean quality index of each seed sample should be calculated from quality index of each replicate and not from the mean of each category.

Fungi frequency percent from each category were recorded after 8 days. Data in Tables (5 a and 5 b) lead to the following results:The tested cumin seed samples

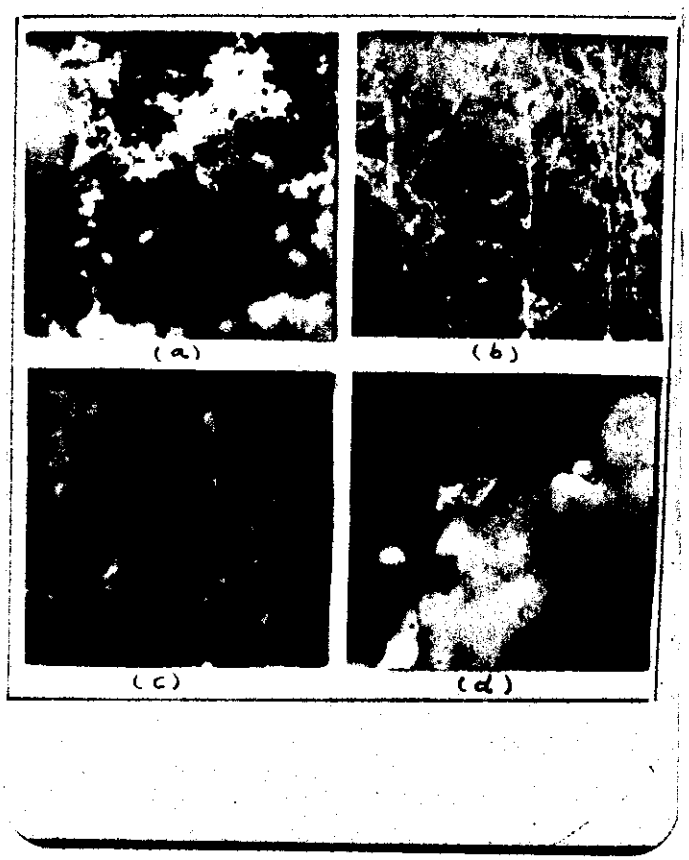


Fig. (6) : Fungi growth on germinated cumin seeds on blotter paper after 8 days; a) F. oxysporum f.sp. cumini, X50, b) F. solani, 50X, c) F. semitectum, 50X, d) Verticillium sp., X50.

Fig. (7) : Fungi growth on germinated cumin seeds in blotter paper after 8 days; a) Cephalosporium sp., X50, Drechslera tetramera, 50X, c) Curvularia lunata, X50, d) Stemphylium sp., X50.

Fig. (8) : Fungi growth on cumin seeds in blotter paper after 8 days; a) Cladosporium sp., X12, b) Aspergillus flavus, X6, c) Penicillium sp., X6, d) Aspergillus niger, X25.

Table (5-a) : The effect of impurities or qualities on seed mycoflora.

Sample No.	Weight of each category (gm.)							Total of weight g.	Quality index %
1*	1.30	0.10	0.10	1.70	2.80	2.20	1.80	10.00	64.00
2**	1.10	0.30	0.10	2.00	2.80	1.70	2.00	10.00	63.67
3***	0.70	0.10	0.40	2.10	2.00	2.30	2.40	10.00	68.50
4****	0.10	0.10	0.20	2.30	2.60	2.20	2.50	10.00	73.00
Mean	0.80	0.15	0.80	2.03	2.55	2.10	2.18	10.00	67.29

Fungi \ Categories	0	1	2	3	4	5	6	Mean
F. oxysporum f.sp. cumini	-	4.00	3.25	3.25	1.25	3.25	1.75	2.79
Fusarium solani		13.75	13.00	7.00	6.00	6.50	5.75	8.67
F. semitectum		8.75	8.75	5.25	3.75	5.00	3.25	5.79
Alternaria alternata		21.75	21.75	22.50	13.50	21.25	11.50	18.75
Drechslera sp.		17.25	17.50	18.00	15.25	16.50	14.50	16.50
Stemphyllium sp.		12.75	13.00	13.25	9.50	10.00	8.25	11.13
Curvularia lunata		4.00	1.75	4.00	2.00	2.25	1.25	2.54
Verticillium sp.		2.75	2.75	2.50	0.75	1.00	0.25	1.67
Cephalosporium sp.		1.25	1.50	1.00	0.50	1.00	0.50	0.96
Penicillium sp.		6.50	29.75	6.00	4.25	5.25	3.75	9.25
Cephalosporium sp.		5.00	25.00	5.00	2.50	3.00	1.75	7.04
Aspergillus niger		4.00	37.50	4.00	1.75	2.00	1.50	8.46
Aspergillus flavus		3.75	27.50	3.50	2.00	1.50	1.00	6.54
Mean		8.12	15.62	7.33	4.85	6.04	4.23	-

L.S.D.$_{0.05}$ for category 0.35
fungi 0.88
interaction 2.16

* Seed sample from Dayrot
** " " " Manfalout
*** " " " Mallawi
**** " " " El-Minia

0,1,2,3,4,5, and 6 are different categories which were explained in page 21.

Table (5 b) : The effect of quality index on emergence, in laboratory, greenhouse, and field.

Location of sample	Sample No.	Quality index %	Germination %, in		
			Lab.	Pots	Field
Dayrout	1	64.00	76.50	73.89	58.44
Manfalout	2	63.67	76.53	74.51	56.56
Mallawi	3	68.50	77.18	75.92	74.23
El-Minia	4	73.00	77.99	76.50	78.77
Mean		67.29	77.05	75.21	67.00

could be arranged descendingly as regards their quality index or germination percent as follows : El-Minia sample, Mallawi, Dayrout, and Manfalout samples.

1. The differences in germination percent of tested seed samples were most clear under field conditions.
2. Inert matter (categ. 2), followed by infected or discolored cumin seeds or fruits (categ. 1) were more contaminated or infected with fungi than the other categories.
3. Seeds without pedicles (categ. 6) were the least contaminated with fungi.

2. Incubation tests :

Cumin seeds or pre-dipped cumin seeds in Czapek's liquid medium for 10 min. were plated on three moist blotters in Petri-dishes at the rate of 25 seeds/dish, four dishes were used as a replicate. Also five surface sterilized cumin seeds were placed in each Petri-dish containing Difco potato dextrose agar medium (PDA), four replicates, each of 20 Petri-dishes, were used for each method. After 8 days incubation, the seeds were examined under stereobinocular microscope for the presence of fungi. Whenever necessary the compound microscope was also used for confirming identifications. percentages of seed borne-fungi were recorded in Table (6).

Table (6) : Effect of both blotter and agar plate (PDA medium) methods on seed borne fungi frequencies of cumin seeds according to ISTA (1966-a).

Methods / Fungi	Blotter test	Blotter test*	Agar-plate	Mean
F. oxysporum f.sp.cumini	2.50	2.75	2.75	2.67
F. solani	6.00	8.75	4.75	6.50
F. semitectum	4.75	5.25	2.75	4.25
Alternaria alternata	19.50	18.00	21.75	19.75
Drechslera tetramera	15.75	14.25	6.25	12.08
Stemphyllium sp.	10.75	10.50	3.25	8.17
Curvularia lunata	2.75	2.25	1.50	2.17
Verticillium sp.	0.75	0.50	0.25	0.50
Cephalosporium sp.	0.50	0.50	0.25	0.42
Penicillium sp.	4.00	4.25	5.00	4.42
Cladosporium sp.	3.25	3.00	6.50	4.25
Aspergillus niger	2.25	2.50	7.50	4.08
Aspergillus flavus	1.75	1.75	8.75	4.08
Mean	5.73	5.71	5.48	-

* Blotter test : Seeds were dipped in Czapek's liquid medium for 10 min.

Data in Table (6) indicate that about 13 fungi were isolated from commercial cumin variety seeds by both blotter and agar plate tests. The isolated fungi could be arranged descendingly according to their ~~percentages of~~ frequency in blotter; blotter and agar-plate tests, respectively, as follows : Alternaria alternata (19.50, 18.00 and 21.75 %), Drechslera tetramera (15.75, 14.25 and 6.25%), Stemphyllium sp. (10.75, 10.50 and 3.25 %), Fusarium solani (6.00, 8.75 and 4.75 %), Penicillium sp. (4.00, 4.25 and 5.00 %), F. semitectum (4.75, 5.25 and 2.75 %), Cladosporium sp. (3.25, 3.00 and 6.50 %), Aspergillus niger (2.25, 2.50 and 7.50 %), Aspergillus flavus (1.75, 1.75 and 8.75 %), Fusarium oxysporum f.sp. cumini (2.50, 2.75 and 2.75 %), Curvularia lunata (2.75, 2.25 and 1.50 %), Verticillium sp. (0.75, 0.50 and 0.25 %) and Cephalosporium sp. (0.50, 0.50 and 0.25).

The blotter method proved to be better than the agar plate method but Alternaria alternata, Penicillium sp., Cladosporium sp. and Aspergillus spp. appeared in higher counts on agar plate method which can be attributed to the fact that this medium may favours the growth of these fungi. Fusarium spp. increased by dipping cumin seeds in Czapek's liquid medium for 10 min. before blotting which encouraged the growth of the seed-borne fungi within seed tissues

3. Germination test :

Three seed samples, collected from different localities (Dayrout, Manfalout, and Mallawi) differing in their values of seed-borne fungi percentages, were tested for germination percentage and abnormalities using sand test . The seeds were sown in Petri-dishes, 18 cm. diameter, at the rate of 50 seeds/plate in 8 replicates for each sample. After 21 days incubation, emergence was investigated. Abnormal and normal seedlings percentages were recorded as usual (Tables 7 a, 7 b and 7 c) and Fig. (9). Also, percentages of seed-borne fungi of the above mentioned samples were recorded by the blotter test method .

Results in Table (8 a) and Figs. (3 a, 3 b and 4) show clearly that F. solani was isolated alone and Alternaria alternata with F. solani from categories and 2 of abnormalities respectively.

Filtrate sap of abnormal seedligs (category 1) Fig. (3 a) was tested for germinating surface sterilized bean seeds Giza 4 variety (as indicator) to investigate the induction of growth regulators as the cause of these abnormalities. Results in Table (8 b) show clearly that the filtrate did not contain any growth regulators which could show their effect on bean seedlings.

Table (7 a) : Percentages of seed-borne fungi frequency of cumin seeds and percentage of fungi recovery from different seedling parts of Dayrout seed sample (No.1) and their effect on germination %, abnormal seedlings % and wilted seedlings % of commercial cumin variety, tested according to ISTA (1966-a).

Fungi	Seed-borne fungi %	% Frequency of fungi isolated from different parts of infected seedlings				
		a*	b*	c*	d*	Total
F.oxysporum f.sp.cumini	2.50	3.75	3.00	0.75	0.50	8.00
F. solani	6.00	7.00	8.25	5.50	1.00	21.75
F. semitectum	4.75	3.75	4.25	0.75	0.25	9.00
Alternaria alternata	19.50	3.00	7.50	13.25	12.75	36.50
Drechslera tetramera	15.75	0.50	0.25	1.25	0.75	2.75
Stemphyllium sp.	10.75	0.50	0.50	1.00	0.25	2.25
Curvularia lunata	2.75	0.00	0.00	0.00	0.00	0.00
Verticillium sp.	0.75	0.50	0.00	0.00	0.00	0.50
Cephalosporium sp.	0.50	0.50	0.25	0.00	0.00	0.75
Penicillium sp.	4.00	0.00	0.00	0.00	0.00	0.00
Cladosporium sp.	3.25	0.00	0.00	0.00	0.00	0.00
Aspergillus niger	2.25	0.00	0.00	0.00	0.00	0.00
Aspergillus flavus	1.75	0.00	0.00	0.00	0.00	0.00

% Germination 75.00

% Abnormal seedlings 3.50

% Infected or wilted seedlings 16.00

a* root

b* hypocotyle

c* cotyledonary leaves

d* the first leaves

Table (7 b) : Percentages of seed-borne fungi Frequency of cumin seeds and percentage of fungi recovery from different seedling parts of Manfalout seed sample(No.2) and their effect on germination %, abnormal seedlings % and wilted seedlings % of commercial cumin variety, tests according to ISTA (1966-a).

Fungi	Seed-borne fungi %	% Frequency of fungi isolated from different parts of infected seedlings				
		a*	b*	c*	d*	Total
F.oxysporum f.sp.cumini	12.50	15.75	11.50	0.75	0.00	28.00
F. solani	18.00	18.75	19.50	6.50	0.00	44.75
F. semitectum	2.00	1.25	2.75	1.25	0.00	5.25
A. alternata	37.75	1.75	2.75	15.50	12.00	32.00
D. tetramera	21.25	0.25	0.50	1.00	0.25	2.00
Stemphyllium sp.	18.75	0.50	0.50	0.25	0.25	1.50
C. lunata	3.75	0.00	0.00	0.00	0.00	0.00
Verticillium sp.	0.00	0.00	0.00	0.00	0.00	0.00
Cephalosporium sp.	0.00	0.00	0.00	0.00	0.00	0.00
Penicillium sp.	0.00	0.00	0.00	0.00	0.00	0.00
Cladosporium sp.	0.00	0.00	0.00	0.00	0.00	0.00
Aspergillus niger	0.00	0.00	0.00	0.00	0.00	0.00
Aspergillus flavus	0.00	0.00	0.00	0.00	0.00	0.00

% Germination 65.00
% Abnormal seedlings 9.00
% Infected or wilted seedlings 56.25

a* root
b* hypocotyle
c* cotyledonary leaves
d* the first leaves

Table (7 c) : Percentages of seed-borne fungi frequency of cumin seeds and percentage of fungi recovery from different seedling parts of Mallawi seed sample (No.3) and their effect on germination %, abnormal seedlings % and wilted seedlings % of commercial cumin variety, tests according to ISTA (1966-a).

Fungi	Seed-borne fungi %	% Frequency of fungi isolated from different parts of infected seedlings				
		a*	b*	c*	d*	Total
F. oxysporum f.sp. cumini	6.00	7.25	3.50	0.00	0.00	10.75
F. solani	7.00	8.25	8.25	1.50	0.00	18.00
F. semitectum	3.00	1.25	1.00	1.00	0.00	3.25
A. alternata	17.50	1.25	10.25	9.25	9.25	30.00
D. tetramera	15.50	0.25	0.25	2.25	2.25	1.00
Stemphyllium sp.	8.50	0.00	0.25	0.00	0.25	0.50
C. lunata	4.25	0.00	0.00	0.00	0.25	0.25
Verticillium sp.	0.00	0.00	0.00	0.00	0.00	0.00
Cephalosporium sp.	0.00	0.00	0.00	0.00	0.00	0.00
Penicillium sp.	2.50	0.00	0.00	0.00	0.00	0.00
Cladosporium sp.	0.00	0.00	0.00	0.00	0.00	0.00
Aspergillus niger	1.00	0.00	0.00	0.00	0.00	0.00
Aspergillus flavus	0.00	0.00	0.00	0.00	0.00	0.00

% Germination 68.75

% Abnormal seedlings 6.00

% Infected or wilted seedlings 25.75

a* root

b* hypocotyle

c* cotyledonary leaves

d* the first leaves

Fig.19 The percentage of seed-borne fungi frequency of three cumin seed samples their germination % and infected seedlings %.

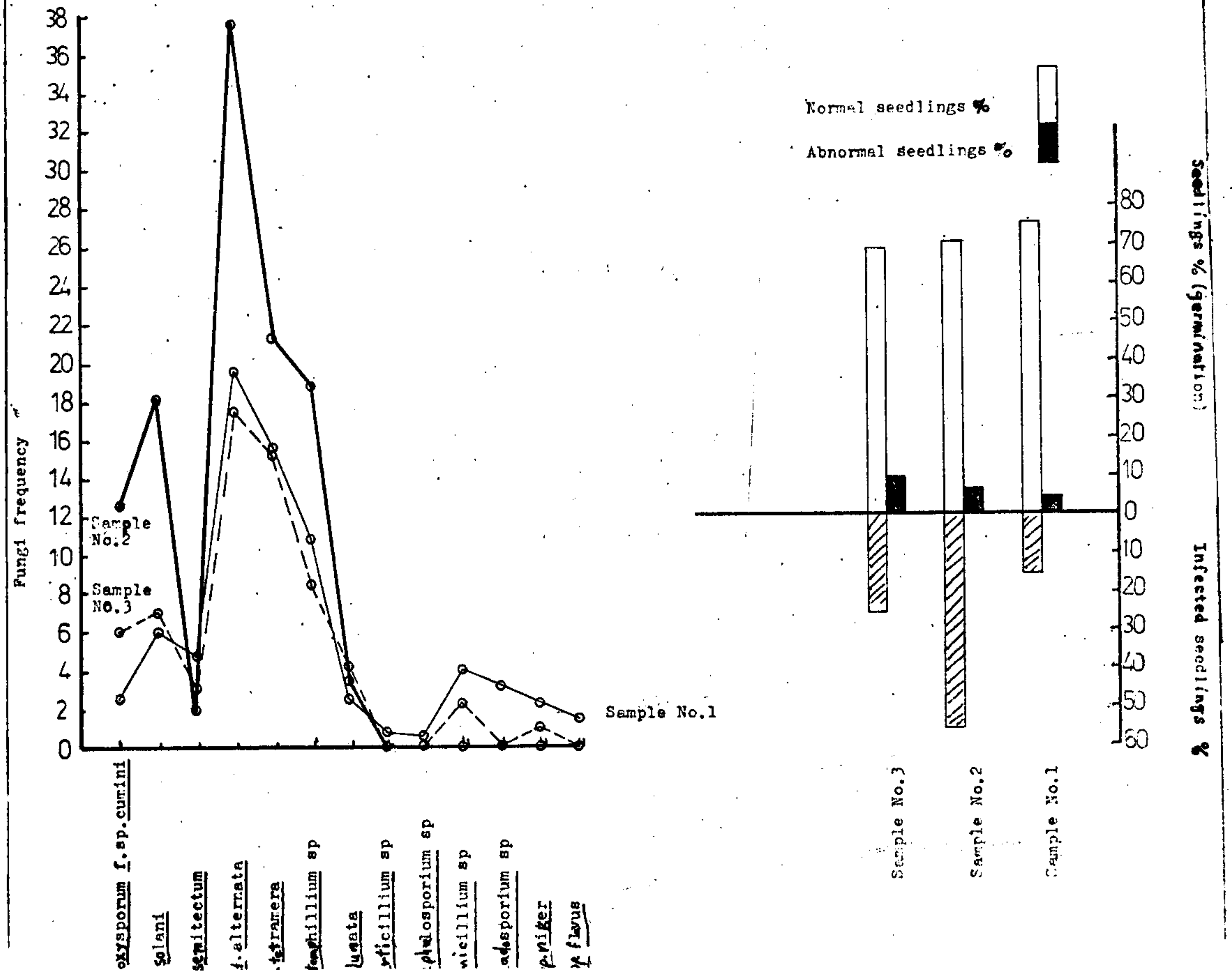


Table (8 a) : Fungi isolated from categories of abnormal cumin seedlings and the effect of filterated sap of normal and abnormal cumin seedling (category 1) on germination of bean seeds of Giza 4 variety

Category of abnormality	Fungi isolated from abnormal cumin seedlings		Effect of filtrated sap of abnormal cumin seedlings on seeds of bean Giza 4 variety					
			Filtrate 1			Filtrate 2		
	F. solani	A. alternata	%Germ. seeds	Hypocotyle length cm.	No. of 2nd roots	%Germ. seeds	Hypocotyle length cm.	No. of 2nd roots
1	+	-	90.00	5.19	4.50	90.00	5.08	4.60
2	+	+	-	-	-	-	-	-

Filterate 1 : Filterated sap of normal seedlings (control).

Filterate 2 : Filterated sap of abnormal seedlings (category 1).

* No abnormal seedlings was noticed.

L.S.D. 05 for hypocotyle length : N.S.
No. of secondary roots : N.S.

Table (8 b) : Effect of different ages of the filtrates of F. solani and Alternaria alternata on the percentage of seed germination of commercial cumin variety.

Fungi	% of seed germination after 21 days**			
	Control	15*	30*	Mean*
Fusarium solani	73.75	68.00	67.75	69.83
Alternaria alternata	73.75	71.50	70.50	71.92

L.S.D. 0.05 for Fungi N.S.
Ages 3.97
Interaction N.S.

* Ages of fungal culture in days

** No abnormal seedlings was noticed

Supposed that fungal filtrates were responsible for inducing abnormal seedlings, filtrates were obtained from cultures in different growth ages of A. alternaria and F. solani previously isolated from abnormal seedlings, and were tested by germinating surface sterilized cumin seeds.

From results shown in Table (8 b), it is clear that the percentage of seed germination decreased by the increase of the age of the fungal cultures. Germination percentage of cumin seed was more affected by Fusarium solani cultural filtrate rather than cultural filtrate of Alternaria alternata. Also, no abnormal seedlings were noticed. Furthermore, results in Tables (8 a and 8 b) indicated that abnormality of seedlings was clearly induced by growth of F. solani (spindle shaped primary root showing browning not giving secondary roots (Fig. 3 a), Category (1), or growth of Alternaria alternata with F. solani (sore shin just under the cotyledonary leaves of the seedling, Fig. (4), category 2. Abnormality of cumin seedlings or bean seedlings (as indicator) was not detected with fungal cultural filtrate or sap filtrate obtained from abnormal seedlings. Results clearly indicated that these abnormalities, could be considered as a phase of pre-emergence and post-emergence damping-off under laboratory conditions which might not be noticed under field conditions.

4. The seedling symptom test :

Diseased seedlings and healthy looking ones were collected from the above-mentioned test and handled independently for transplanting at the rate of 20 seedlings per pot (11 cm. diameter). During one month diseased plants were recorded and picked up for isolation on PDA medium. Percentage of fungi recovery from different seedling parts of the three seed samples and percentage of wilted or infected seedlings were recorded in Tables (7a, 7 b and 7 c).

Data in Tables (7 a, 7 b and 7 c) indicate that 13, 7 and 9 fungi species were isolated from Dayrout, Manfalout and Mallawi seed samples, respectively.

1. Dayrout seed sample : Percentages of frequency of isolated fungi from both seeds and seedlings, could be stated as follows :
Fusarium oxysporum f.sp. cumini (2.50 and 8.00 %), F. solani (6.00 and 21.75 %), F. semitectum (4.75 and 9.00 %), Alternaria alternata (19.50 and 36.50 %), Drechslera tetramera (15.75 and 2.75 %), Stemphyllium sp. (10.75 and 2.25 %), Curvularia lunata (2.75 and 0.00 %), Verticillium sp. (0.75 and 0.50 %), Cephalosporium sp. (0.50 and 0.75 %), Penicillium sp. (4.00 and 0.00 %), Cladosporium sp. (3.25 and 0.00 %), Aspergillus niger (2.25 and 0.00 %) and Aspergillus flavus (1.75 and 0.00 %).

The percentages of germination, abnormal seedlings and infected seedlings were 75, 35, and 16 %,respectively.

2. Manfalout seed sample : Percentages of frequency of isolated fungi from both seeds and seedlings, respectively, could be stated as follows :

Fusarium oxysporum f.sp. cumini (12.50 and 28.00 %), F. solani (18.00 and 44.75 %), F. semitectum (2.00 and 5.25 %), Alternaria alternata (37.75 and 32.00 %), Drechslera tetramera (21.25 and 2.00 %), Stemphyllium sp. (18.75 and 1.50 %) and Curvularia lunata (3.75 and 0.00 %).

The percentages of germination, abnormal seedlings and infected seedlings were 65.00, 9.00 and 56.25 %,respectively.

3. Mallawi seed sample : Percentages of frequency of isolated fungi from both seeds and seedlings,respectively, could be stated as follows :

Fusarium oxysporum f.sp. cumini (6.00 and 10.75 %), F. solani (7.00 and 18.00 %), F. semitectum (3.00 and 3.25 %),Alternaria alternata (17.50 and 30.00 %), Drechslera tetramera (15.50 and 1.00 %),Stemphyllium sp. (8.50 and 0.50 %), Curvularia lunata (4.25 and 0.25 %), Penicillium sp. (2.50 and 0.00 %) and Aspergillus niger (1.00 and 0.00 %).

The percentages of germination, abnormal seedlings and infected seedlings were 68.75, 6.00 and 25.75 %,respectively.

It could be noticed clearly that there was a correlation between the percentages of infected seedlings and pathogenic fungi (Tables 4 and 7 a, 7 b and 7 c).

5. Isolation of fungi from seed parts :

One hundred seeds were washed several times in sterilized distilled water and soaked in sterilized water, one seed per tube, for 24 hrs. Seeds were then dissected aseptically to different parts. The different parts of each seed were plated in one dish apart from each other on PDA medium. After 8 days, percentages of fungi recovery from each of different seed parts were recorded and tabulated in Table (9).

Data in Table (9) and Fig. (10) indicate that the testa and seed coat of cumin seed contained most of fungi associated with the whole cumin seed. Results of isolated fungi as regards the part of seed origin are :

1. Fusarium oxysporum f.sp. cumini isolated from seed coat and endospermic tissues only.

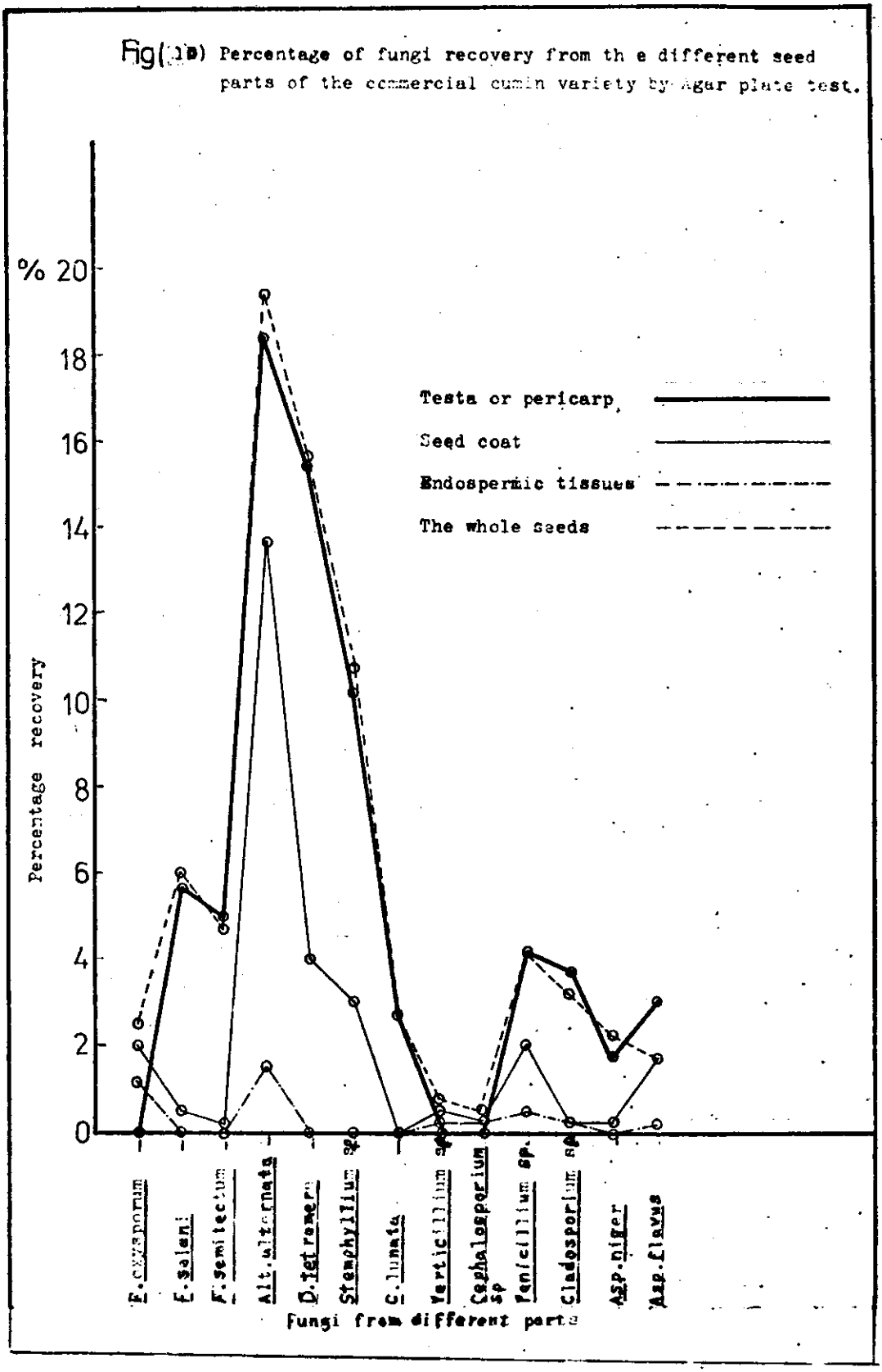
2. Fungi recovered from testa were, Alternaria alternata (18.50), Drechslera tetramera (15.50 %), Stemphyllium sp. (10.25 %), Fusarium solani (5.75 %), F. semitectum (5.00 %), Penicillium sp. (4.25 %), Cladosporium sp. (3.75 %) , Aspergillus niger (1.75 %).

Also, fungi recovered from seed coat were Alternaria alternata (13.75 %), Drechslera tetramera (4.00 %), Stemphyllium sp. (3.00 %), F. oxysporum f.sp. cumini (2.00 %), Penicillium sp. (2.00 %), Aspergillus flavus (1.75 %), F. solani (0.50%), Verticillium sp. (0.50 %), F. semitectum (0.25 %),

Table (9) : Percentage of fungi recovery from the different seed parts of the commercial cumin variety by Agar-plate test.

Parts of seed / Fungi	Testa or pericarp	Seed coat	Endospermic tissues	The whole seed
F. oxysporum f.sp. cumini	0.00	2.00	1.25	2.50
F. solani	5.75	0.50	0.00	6.00
F. semitectum	5.00	0.25	0.00	4.75
Alternaria alternata	18.50	13.75	1.50	19.50
Drechslera tetramera	15.50	4.00	0.00	15.75
Stemphyllium sp.	10.25	3.00	0.00	10.75
Curvularia lunata	2.75	0.00	0.00	2.75
Verticillium sp.	0.00	0.50	0.25	0.75
Cephalosporium sp.	0.00	0.25	0.25	0.50
Penicillium sp.	4.25	2.00	0.50	4.00
Cladosporium sp.	3.75	0.25	0.25	3.25
Aspergillus niger	1.75	0.25	0.00	2.25
Aspergillus flavus	3.00	1.75	0.25	1.75
Mean	5.42	2.19	0.32	5.73

Fig(1B) Percentage of fungi recovery from th e different seed parts of the commercial cumin variety by Agar plate test.



Cephalosporium sp. (0.25 %), Cladosporium sp. (0.25 %) and A. niger (0.25). As for fungi recovered from endospermic tissues were, A.alternata (1.50 %), F. oxysporum f.sp. cumini (1.25 %), Penicillium sp. (0.50 %) and (0.25 %) of Verticillium sp. or Cephalosporium sp. or Cladosporium sp. or Aspergillus flavus.

3. The mean percentage of fungi recovered from testa (5.42 %) was higher than those isolated from seed coat (2.19 %) or endospermic tissues (0.32 %).

B. Laboratory studies :

1. Effect of growth regulators on the linear growth of Fusarium oxysporum f.sp. cumini and F. solani :

Two growth regulators at different concentrations, namely, GA_3 and NAA were used to study their effect on the linear growth of each of Fusarium oxysporum f.sp. cumini and F. solani. Seven concentrations i.e. 0, 5, 10, 20, 40, 80, and 100 ppm of active ingredient of each growth regulator were added to Czapek's medium and mixed thoroughly with the medium just before solidification, then poured into the plates. Mean values of colony diameters of each fungus were recorded as in Table (10).

Results in Table (10) and Fig. (11) indicate that the different concentrations (0, 5, 10, 20, 40, 80, and 100 ppm) of seed growth regulator affected the growth of F. oxysporum f.sp. cumini and F. solani. It was noticed that there was no general trend of the effect of these growth regulators on the linear growth of the tested fungi and there was no clear correlation also. In this respect, the lowest linear growth for F. oxysporum was (38.75 mm) at 40 or 80 ppm of GA_3. Whereas the lowest linear growth for F. solani was (30.75 mm) at 100 ppm of GA_3. The highest linear growth for F. oxysporum was (88.75 mm) at 20 ppm of GA_3 and was (89.25 mm) for the control(0.0).Also, the highest linear growth for F. solani was (86.25 mm) at 5 ppm of GA_3 and was (89.25 mm) for the control (0.0).

Table (10) : Effect of different concentrations (ppm) of growth regulators on the linear growth (mm.) of F. oxysporum f.sp. cumini and F. solani.

Growth regulators	Concentration in ppm	The linear growth of tested fungi in mm.		Mean
		F.oxysporum f.sp. cumini	F. solani	
Gibberellic acid GA_3	0	89.25	89.25	89.25
	5	86.50	86.25	86.38
	10	85.75	80.75	83.25
	20	88.75	63.25	76.00
	40	38.75	33.75	36.25
	80	38.75	40.50	39.63
	100	43.00	30.75	36.88
	Mean	67.25	60.64	
Naphthaline acetic acid NAA	0	89.25	89.25	89.25
	5	76.50	61.25	68.88
	10	80.25	64.75	72.50
	20	41.25	73.00	57.13
	40	74.50	28.00	51.25
	80	27.25	31.25	29.25
	100	18.50	31.00	24.75
	Mean	58.21	54.07	-

$L.S.D._{0.05}$ for

Fungi (A)	= 4.24
Growth regulators (B)	= 0.64
Concentrations (C)	= 1.54
A x B interactions	= 0.90
A x C	= 2.18
B x C	= 2.18
A x B x C	= 3.08

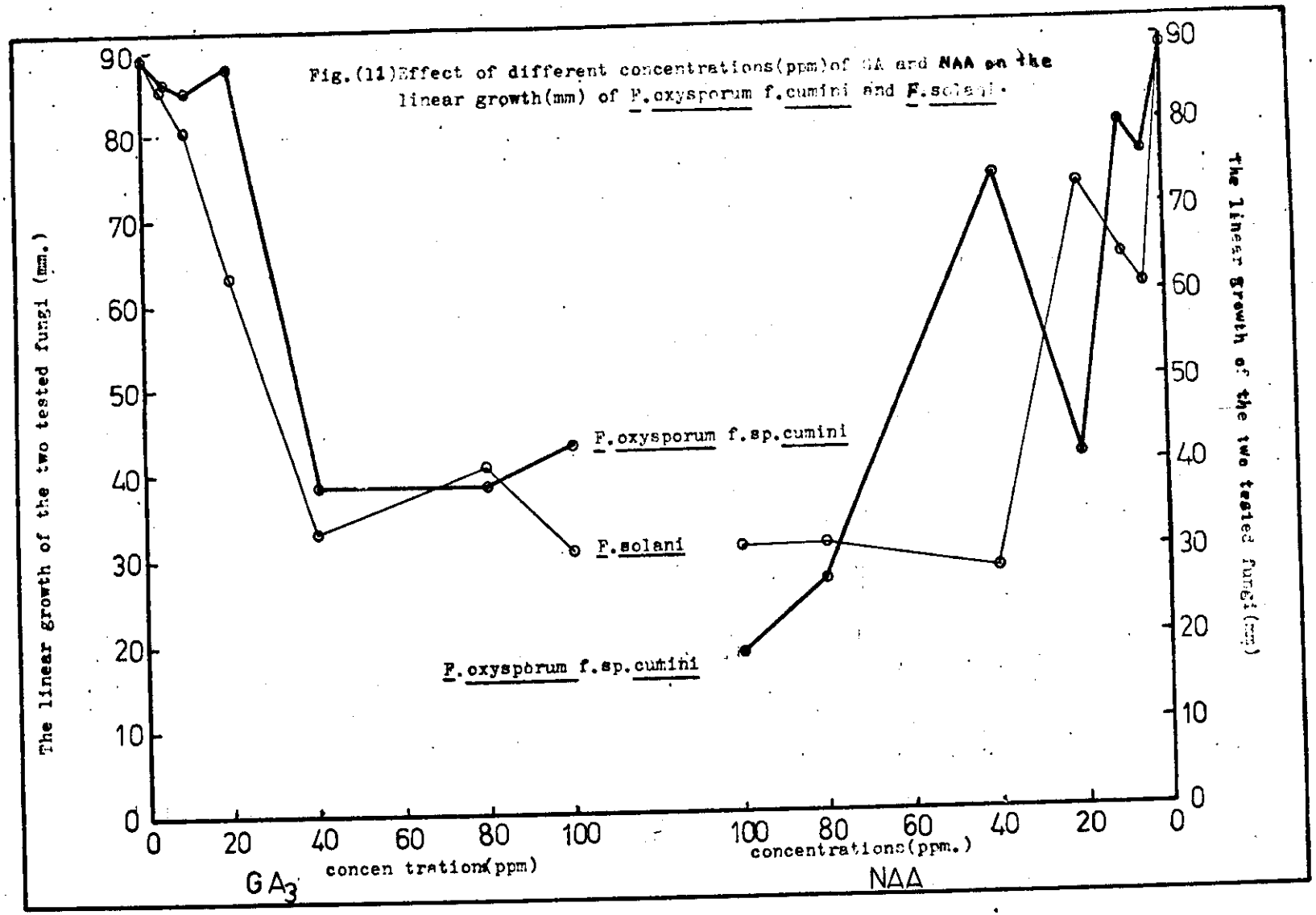


Fig.(11)Effect of different concentrations(ppm)of GA and NAA on the linear growth(mm) of F.oxysporum f.cumini and F.solani.
The linear growth of the two tested fungi (mm.)
F.oxysporum f.sp.cumini
F.solani
F.oxysporum f.sp.cumini
concen trations(ppm)
GA3
concentrations(ppm.)
NAA
The linear growth of the two tested fungi (mm)
0
10
20
30
40
50
60
70
80
90
0
20
40
60
80
100
100
80
60
40
20
0

NAA at 100 ppm gave the lowest linear growth for Fusarium oxysporum (18.50 mm) while the lowest linear growth for F. solani was (28.00 mm) at 40 ppm of NAA. The linear growth of F. oxysporum and F. solani was less affected by 10 ppm of NAA (80.25)mm) and 20 ppm of NAA (73.00 mm) than the rest concentrations of NAA. Generally, linear growth of both fungi was more affected by NAA than GA_3 and higher concentration of each of the two growth regulators.

2. Effect of hot-air treatment on seed mycoflora; germination percentage and infected seedlings percentage :

In this experiment cumin seeds were exposed to 50 or 60°C for different intervals, i.e. 5, 10, 15 or 20 minutes, in thermo regulated oven. Treated seeds and control were tested for germination percentage (sand test) and data were recorded for seed borne-fungi (seed mycoflora) and infected seedlings percentage using the standard Blotter test and seedlings symptom method, as above-mentioned in seed health testing. Also, spore load in ml. mounting solution, spore load/g of seed wash and spore load/seed, were calculated for seeds before treatment to compare with seed borne-fungi. Spore viability was recorded as before and after treatment.

All data were tabulated in Tables (11 a and 11 b). This experiment was repeated twice in two seasons (1983 and 1984).

Results in Tables (11 a and 11 b) and Figs. (12 a and 12 b) indicate that spore load of 6 and 7 species of fungi obtained after washing cumin seeds, then sedimention of washings in 1983 and 1984 seasons.

In 1983 season, average numbers of spores of fungi in a descending order were, Aspergillus niger, Alternaria alternata, D. tetramera, F. semitectum, F. solani, and Stemphyllium sp.

Spore viability of all fungi was decreased by hot air treatment. For example, the percentage of germination of Alternaria alternata spores decreased from 100 % to 61 %, whereas spore germination of Fusarium solani decreased from 99 % to 55 % and Aspergillus niger spores from 100 % to 50 %.

In this respect, seed germination percentage also decreased by hot air treatment from 70.50 % to 55.0 % and abnormal seedlings percentage was reduced from 6.00 % to 3.00 %. Also, the percentage of infected and wilted seedlings was reduced.

The percentages of frequency of all isolated fungi from seeds were reduced by all hot- air treatments.

Table (11 a) : Quantitative estimation of number of spores per ml., load per gram of cumin seed after washing of seed, and sedimentation and the effect of heating treatment of seeds on the viability of spores loosely adhered to their surface.

Year	Fungi	No. of spores/ ml.	No. of spores/ gm.	No. of spores/ seed	Decrease ; of spore germination %								
					Control	50°C for				60°C for			
						5 min.	10 min.	15 min.	20 min.	5 min.	10 min.	15 min.	20 min.
	A. alternata	162.5	649.4	10.2	100	90	87	81	79	77	70	65	61
	D. tetramera	75.0	299.7	4.7	98	90	81	77	73	73	69	63	62
	Stemphyllium sp.	37.5	149.9	2.3	96	89	83	78	74	74	68	64	60
1983	Aspergillus niger	425.0	1698.3	26.6	100	79	70	69	63	64	60	55	50
	F. solani	37.5	149.9	2.3	99	85	74	71	65	65	63	59	55
	F. semitectum	75.0	299.7	4.7	98	90	83	80	70	66	63	57	54
	F. oxysporum	0.0	0.0	0.0	-	-	-	-	-	-	-	-	-
	A. alternata	150.0	596.4	9.9	100	96	90	83	80	77	70	67	62
	D. tetramera	50.0	198.8	3.3	98	94	89	87	80	75	69	65	59
	Stemphyllium sp.	25.0	99.4	1.7	99	93	88	87	81	75	68	64	57
	Aspergillus flavus	325.0	1292.2	20.3	100	94	90	86	79	77	72	69	64
1984	Cladosporium sp.	562.5	2236.6	35.2	100	95	88	85	80	78	71	68	61
	Penicillium sp.	300.0	1192.8	18.8	97	94	91	85	80	78	71	67	63
	F. solani	0.0	0.0	0.0	-	-	-	-	-	-	-	-	-
	F. semitectum	100.0	397.6	6.3	100	94	89	87	81	79	75	71	68
	F. oxysporum	0.0	0.0	0.0	-	-	-	-	-	-	-	-	-

Table (11 b) : Effect of hot air treatment of commercial cumin variety seeds on seed mycoflora, germination and infected seedlings .

Season	Temperature degree	Control	50°C for				60°C for			
			5 min.	10 min.	15 min.	20 min.	5 min.	10 min.	15 min.	20 min.
1983	Normal seedlings (germination %)	70.50	71.00	70.00	68.00	65.25	65.75	60.00	57.50	55.00
	Abnormal seedlings%	6.00	5.50	5.50	5.50	4.50	4.75	3.25	3.25	3.00
	Infected seedlings%	56.25	56.00	54.75	51.00	43.75	44.75	42.25	37.75	36.25
	Seed-borne fungi %									
	A. alternata	37.75	35.50	32.50	30.00	26.25	26.75	24.50	19.50	15.25
	D. tetramera	21.25	20.00	18.75	15.25	13.75	13.25	10.50	7.50	7.00
	Stemphyllium sp.	18.75	16.50	16.50	12.25	10.00	9.75	7.50	5.50	5.00
	Aspergillus niger	3.75	2.75	2.25	1.25	0.75	0.75	0.50	0.25	0.25
	F. oxysporum	12.50	12.25	11.75	11.00	10.50	10.50	10.25	9.50	8.75
	F. solani	18.00	17.75	16.75	15.00	13.50	13.25	12.00	10.75	10.00
	F. semitectum	2.00	1.50	1.25	0.75	0.75	0.50	0.25	0.00	0.00
1984	Normal seedling (germination %)	75.50	74.75	73.75	73.75	72.75	73.75	71.25	66.75	45.25
	Abnormal seedling %	3.81	3.50	2.63	2.00	1.75	2.00	1.00	1.00	0.81
	Infected seedling %	45.63	41.88	40.00	39.38	26.25	26.25	22.50	10.63	6.88
	Seed borne fungi %									
	A. alternata	15.00	13.25	12.25	12.00	12.75	14.00	9.50	8.50	7.13
	D. tetramera	24.75	24.50	23.75	22.50	22.25	23.75	21.50	19.50	18.25
	Stemphyllium sp.	15.75	15.75	14.00	13.50	13.50	14.00	11.75	9.50	8.50
	Aspergillus flavus	2.25	2.00	2.00	1.25	2.00	1.50	1.00	0.50	0.00
	Cladosporium sp.	6.00	7.25	8.50	7.00	7.50	5.50	3.75	1.75	0.00
	Penicillium sp.	1.50	0.50	2.25	2.00	1.75	0.50	0.50	0.25	0.00
	F. oxysporum	4.50	4.50	3.50	3.75	3.25	3.25	2.00	1.00	0.50
	F. solani	8.00	7.50	5.00	4.50	3.75	1.25	1.00	0.75	0.25
	F. semitectum	5.00	4.00	3.50	3.00	2.50	1.50	1.00	1.00	0.50

L.S.D. 0.05 for :	1983	1984
(1) Normal seedling %	2.11	4.22
Abnormal seedling %	1.13	1.19
Infected seedling %	4.43	4.45
(2) Seed borne fungi %	0.84	1.12
Temperature with time	0.56	0.87
Interaction	2.21	N.S.

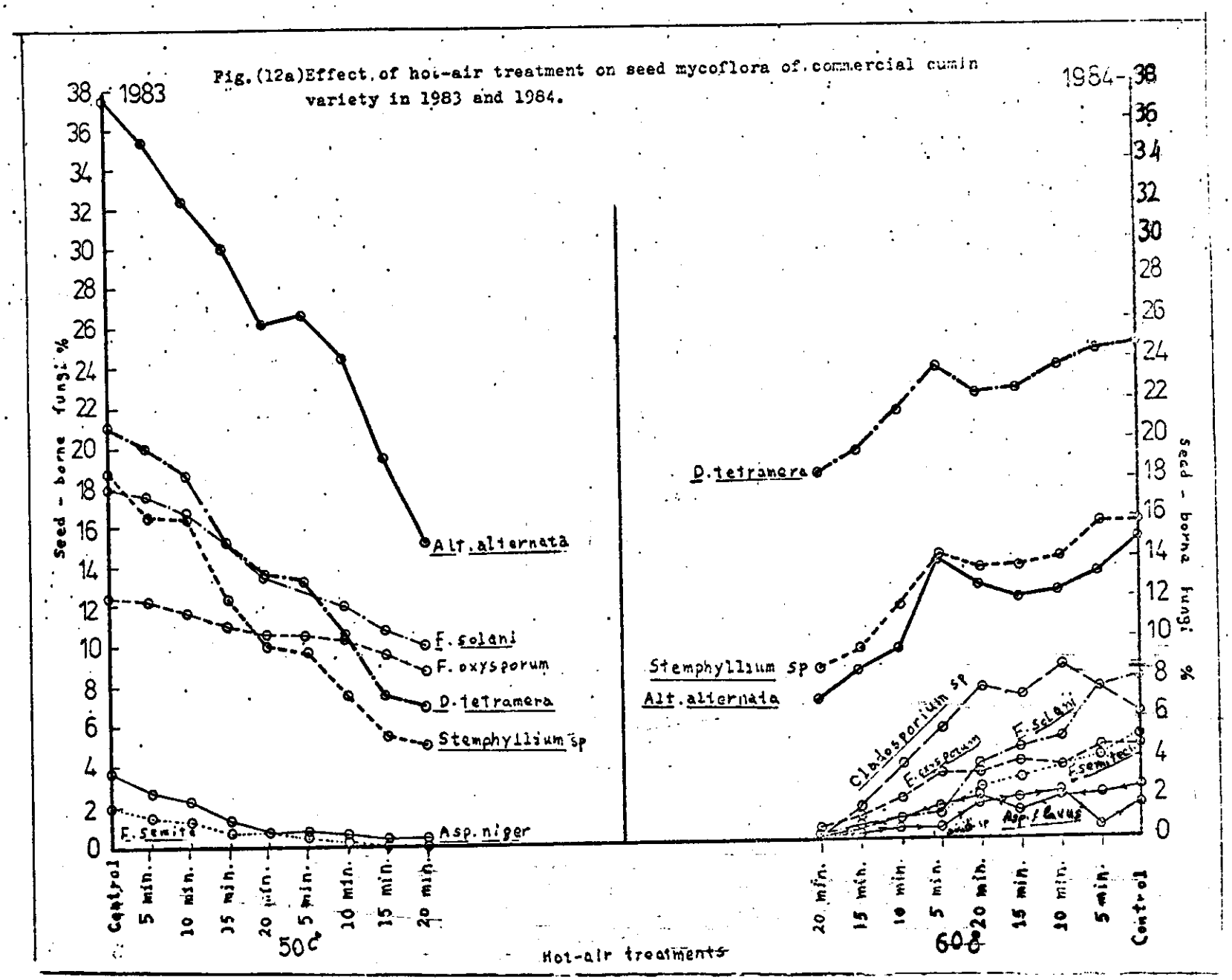


Fig.(12a)Effect of hot-air treatment on seed mycoflora of commercial cumin variety in 1983 and 1984.

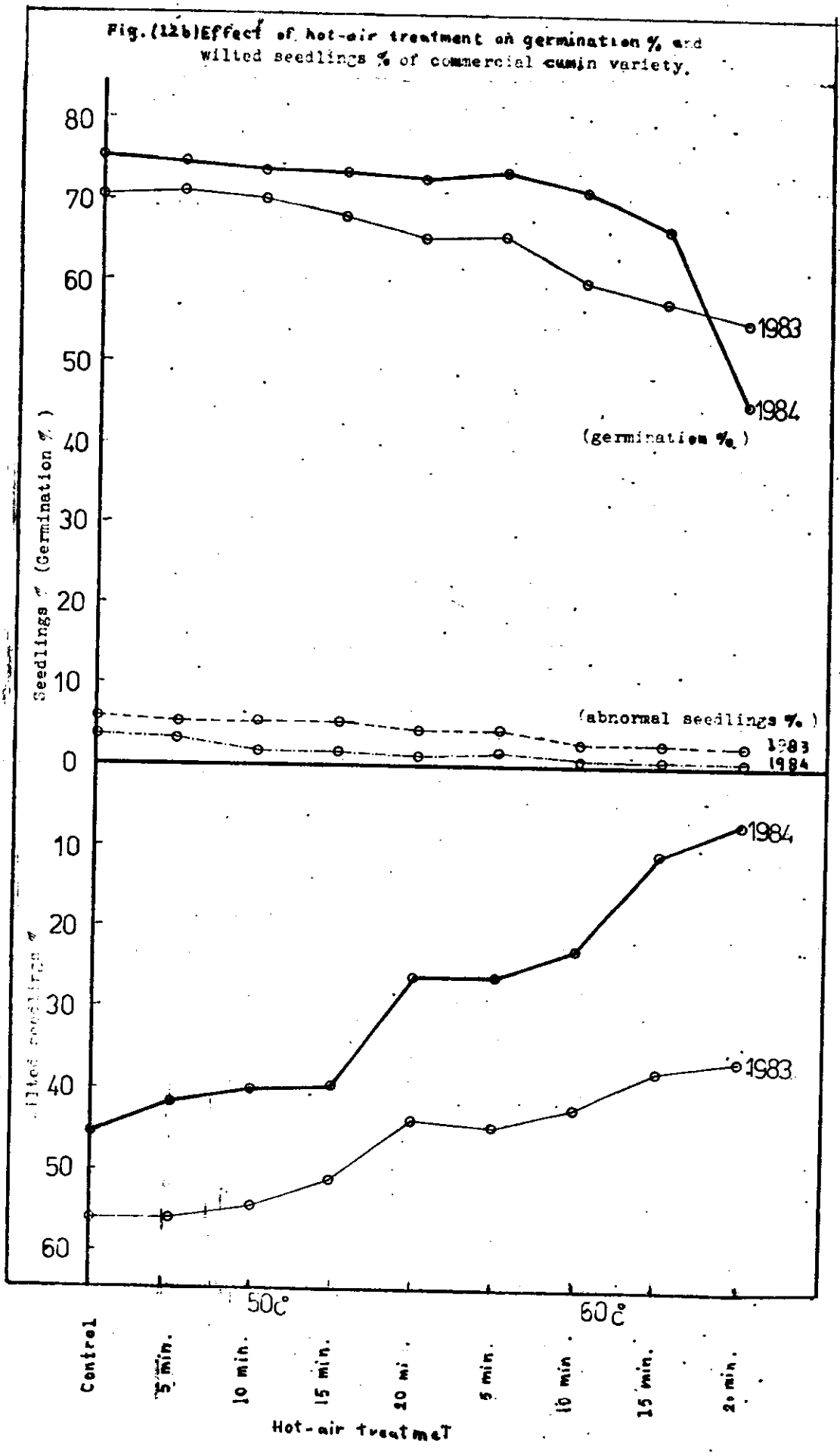


Fig. (12b) Effect of hot-air treatment on germination % and wilted seedlings % of commercial cumin variety.

In 1984 season , almost similar results were obtained, but spore load/ml., spore load/g . and spore load/ seed of most fungi were lower than in 1983 seed sample.

Percentage of frequency of F. oxysporum f.sp. cumini was (12.50 %) and percentage of infected seedlings was (56.25 %) in 1983 season, while frequency of F. oxysporum f.sp. cumini was (4.50 %) and infected seedlings % was (45.63 %) in 1984 season.

The reduction in the percentage of infected seedlings by hot-air treatment was from 56.25 % to 36.25 % of seeds exposed to 60°C for 20 min., in 1983 season and from 45.63 % to 6.88 % of seeds (exposed to 60°C for 20 min.) in 1984 season.

Also, percentages of frequency of F. solani were (18.00 and 8.00 %) in 1983 and 1984 seasons, respectively, and almost similar results could be noticed as regards F. oxysporum f.sp. cumini.

3. Effect of adding different concentrations of active ingredients of fungicides to Czapek's medium on the linear growth (in mm.) of F. oxysporum f.sp. cumini and F. solani :

The effect of adding a series of increasing concentrations of different fungicides (i.e. Benlate 50, Vitavax 75, Vitavax/Thiram, Vitavax/Captan, Thiram, Homai 80,

Captan 75, Dithane M-45, Botec, and RH 5050) on the linear growth of Fusarium oxysporum f.sp. cumini and F. solani is shown in Table (12).

As for F. oxysporum f.sp. cumini, data in Table (12) indicate that significant reduction in the linear growth was noted with the different tested fungicides. The most effective fungicide was Vitavax 75 followed by Vitavax/Captan, whereas Homai 80, Dithane M-45, Benlate 50 and Vitavax/Thiram were moderately effective. On the other hand, Captan 75, Thiram, Botec and RH 5050 were the least effective in this respect.

Clear gradual reduction was concomitant with the increase of respective concentrations of each fungicide, especially those of 100 ppm of Benlate 50, Captan 75, Dithane M-45, and Botec. The other fungicides were more effective and Vitavax 75 almost checked the growth of F. oxysporum f.sp. cumini at 20 ppm, Vitavax/Captan and Homai 80 at 80 ppm.

As regards F. solani, data in Table (12) and Fig.(15) show that significant reduction in the linear growth was noticed with all tested fungicides. Vitavax/Thiram was the most effective fungicide followed by Vitavax/Captan as they inhibited the linear growth of F. solani at relatively lower concentrations of 40 ppm and 60 ppm, respectively, followed by Vitavax 75 at 80 ppm. Homai 80

was moderately effective. Captan 75, RH 5050, Thiram, Benlate 50, Dithane M-45 and Botec were less effective with significant differences between most of them.

4. Effect of fungicidal treatment on seed borne-fungi, germination percentage and infected seedlings percentages :

Seeds of commercial cumin variety was used both in vitro and in vivo to evaluate the efficiency of ten seed-dressing fungicides in controlling seed-borne diseases and soil-borne diseases.

The above-mentioned fungicides were used in dressing cumin seeds at the following rates, i.e. 0.0, 0.15, 0.30, and 0.50 gm./100 g . seeds of each systemic fungicide and 0.00, 0.20, 0.40, and 0.60 g ./100 g . seeds of each contact fungicide. Arabic gum (2 g ./L.) was used as a sticker.

Treated and untreated seeds were tested for germination percentage, seed borne-fungi and infected seedlings using autoclaved sand medium, Blotter method and seedling symptom test, respectively, as above-mentioned in seed health testing.

Spore load of seeds was calculated before treatment and the viability of each fungus was determined.

Data were recorded in Tables (13a and 13b) and Fig. (13).

Table (13 a) : Quantitative estimation of number of spores per ml., load/g . seed, and spore load/seed after washing of seed and sedimentation from two samples of tested seeds.

Year	1983*				1984*			
Fungi	No. of spore/ ml.	No. of spore/ gm.	No. of spore/ seed	Germination %	No. of spore/ ml.	No. of spore/ gm.	No. of spore/ seed	Germination %
A. alternata	162.5	649.4	10.2	100	187.5	747.0	11.7	100
D. tetramera	75.0	299.7	4.7	98	37.5	149.4	2.3	98
Stemphyllium sp.	37.5	149.9	2.3	96	25.0	99.6	1.6	97
Aspergillus niger	425.0	1698.3	26.6	100	0.0	0.0	0.0	-
Aspergillus flavus	0.0	0.0	0.0	-	300.0	1192.8	18.8	100
Curvularia lunata	0.0	0.0	0.0	-	0.0	0.0	0.0	-
Penicillium sp.	0.0	0.0	0.0	-	325.8	1294.8	20.3	100
F. solani	37.5	149.9	2.3	99	100.0	397.6	6.3	99
F. semitectum	75.0	299.7	4.7	98	125.0	498.0	7.8	100
F. oxysporum	0.0	0.0	0.0	-	0.0	0.0	0.0	

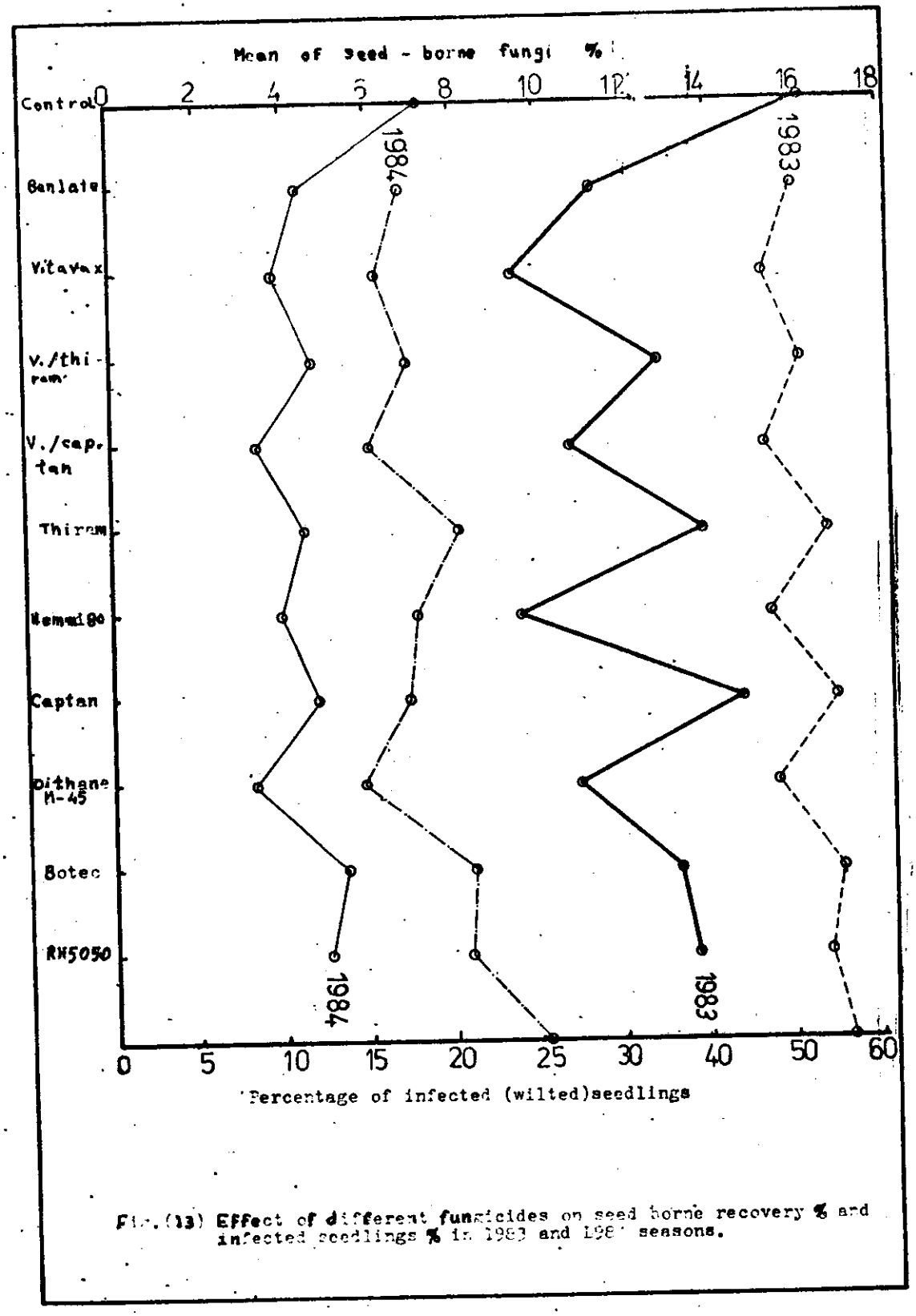


Fig.(13) Effect of different fungicides on seed borne recovery % and infected seedlings % in 1983 and 1984 seasons.

Results in Table (13 a) and Fig. (13) indicate that 6 and 7 species of fungi were isolated in 1983 and 1984 season, respectively. Generally, average numbers of spores of these fungi -in a descending order - were (Aspergillus niger, Penicillium sp.), (Alternaria alternata, Aspergillus flavus), (Drechslera tetramera, Alternaria alternata), (F. semitectum, F. semitectum), (Stemphyllium sp., F. solani) and (F. solani, D. tetramera) in 1983 and 1984, respectively, Stemphyllium sp. alone showed the least spore load in 1984 only. Viability of all fungi spores was above 96 %.

Data as shown in Fig. (13) indicate that the tested fungicides were effective in reducing the numbers of seed-borne fungi.

In 1983 season, the most effective fungicides, in reducing numbers of seed-borne fungi, increasing seed germination and reducing abnormal seedlings and infected seedlings , were Vitavax 75 and Homai 80 followed by Vitavax/Captan and Dithane M-45. Whereas Benlate 50, Vitavax/Thiram and Thiram were moderately effective. On the other hand, Botec, RH 5050 and Captan 75 were the least effective in this respect.

In 1984 season, Dithane M-45 and Vitavax/Captan were the most effective fungicides followed by Vitavax 75 and Homai 80; Benlate 50 and Thiram were moderately effective and

Vitavax/Thiram, Captan 75, RH 5050 and Botec were the least in increasing seed germination . As regards reducing abnormal seedlings , Dithane M-45 was the most effective fungicide followed by Homai 80 and Vitavax 75. However, as for reducing infected seedlings , Vitavax 75 was the most effective followed by Dithane M-45. Whereas, Benlate 50, Vitavax/Captan, Captan, Vitavax/Thiram and Homai 80 were moderately effective. Thiram, RH 5050 and Botec were the least ones in this regard.

The differences in the results between the two seasons could be attributed to differences in spore load and percentage of seed-borne fungi of tested seeds.

C. Pot Experiments :

1. Effect of different intervals of watering, depth of sowing and seeding rate on the incidence of infection with Fusarium oxysporum f.sp. cumini or F. solani or seed-borne diseases to commercial cumin variety :

These experiments were designed in a split-split plot design to study the effect of watering, depth of sowing and seeding date on disease incidence in 1983 and 1984 season.

Commercial cumin variety was used to study the reaction to Fusarium oxysporum f.sp. cumini or F. solani or seed-borne diseases(as affected by intervals of watering, depth of sowing and seeding rate).

Different seeding rates, i.e. 25, 40 and 50 surface sterilized, with ethyl alcohol 70 % for 5 min., or non-sterilized seeds/pot were sown at different depths, i.e. 2, 3, and 6 cm. under soil surface. Three watering intervals were used for irrigating the pots as follows : daily, every other day, and every six days. Five replicates were used for each sub-sub plot.

Data for disease incidence were recorded in Tables (14, 15 and 16) and Figs. (14 a and 14 b). Seed-borne fungi and spore load were aforementioned in Table (13).

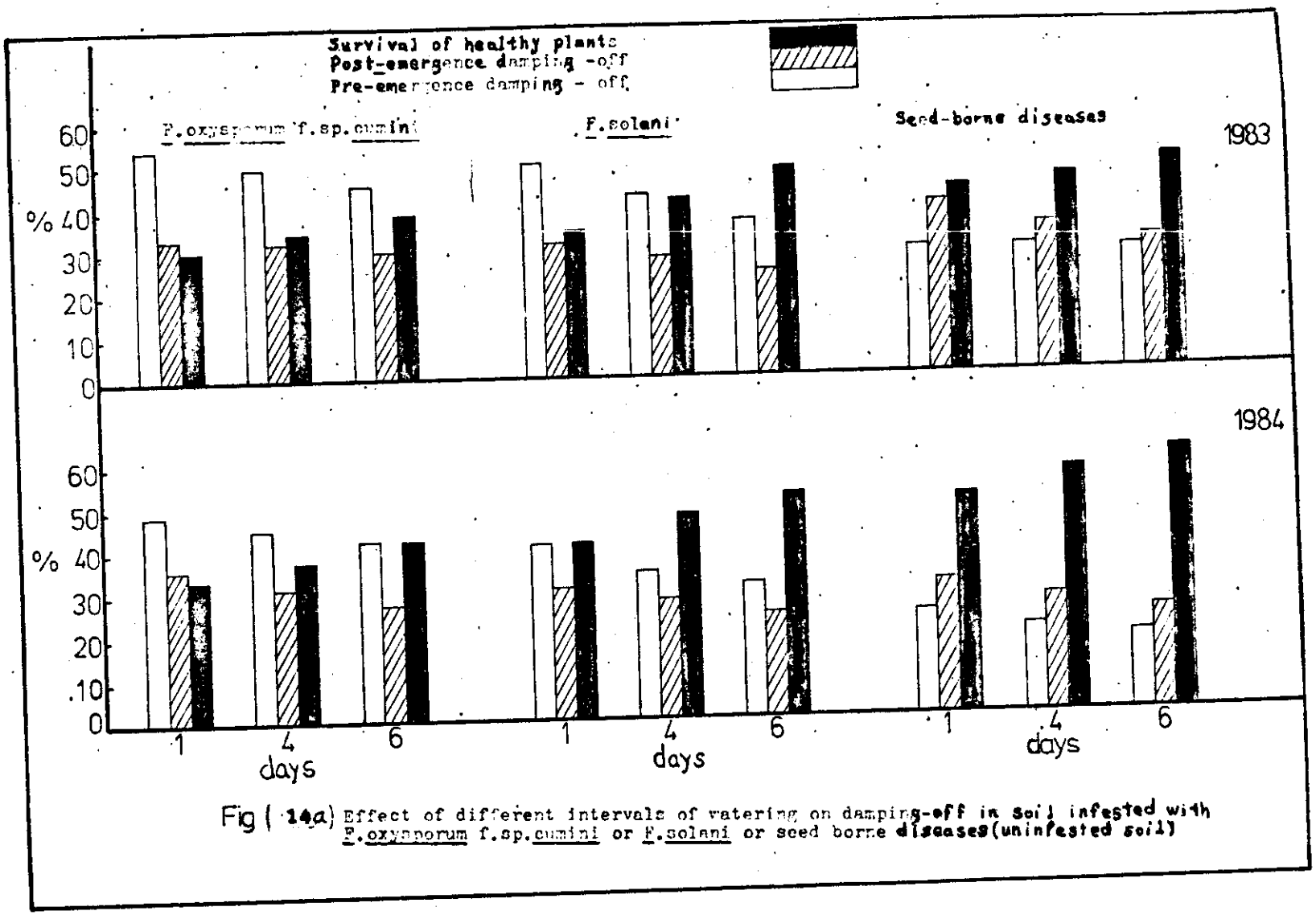


Fig (14a) Effect of different intervals of watering on damping-off in soil infested with F.oxysporum f.sp.cumini or F.solani or seed borne diseases(uninfested soil)

As regards Fusarium oxysporum f.sp. cumini :

Data in Table (14) and Figs. (14a and 14b) clearly show that both pre- and post-emergence damping-off percentages increased with the increase in the depth of planting and also with the decrease in intervals of watering. Also, the increase in seeding rate decreased healthy survival plants.

As regards F. solani :

Data from Table (15) and Figs. (14a and 14b) show similar results as in soil infested with F. oxysporum f.sp. cumini , regards the effects of the depth of sowing, seeding rate and inter-vals of watering.

As regards seed borne fungi :

Data from Table (16) and Figs. (14a and 14b) show similar results as in soil infested with F. oxysporum f.sp. cumini or F. solani .

. Also, the decreasing of number of healthy plants was more clear than the percentage of healthy survival plants, but calcula-tion of the last were recorded for statistical analysis.

Generally, disease incidence of seed borne diseases in 1983 was more than in 1984, this could be attributed to differences in spore load and seed-borne fungi .

2. Effect of soaking cumin seeds in different concentrations of two growth regulators on disease incidence or infection with F. oxysporum f.sp. cumini, F. solani and seed-borne diseases :

GA_3 (20 %) at different concentrations, i.e. 5,10 and 20 ppm and NAA(18.2 %) at concentrations of 20,40 and 80 ppm were used to study their effect on disease incidence. Surface sterilized cumin seeds, with ethyl alcohol 70 % for 5 min., or non-surface sterilized cumin seeds were soaked in different solutions of the two growth regulators for 3 hours.. Seeds were sown in soil infested with F. oxysporum f.sp. cumini or F. solani. At the same time, non-surface sterilized cumin seeds were sown in sterilized un-infested soil.

Seeds soaked in tap water for 3 hours were used as control. These experiments were carried out during 1983 and 1984 seasons.

Data for disease incidence were recorded in Table (17) and Fig. (15). Seed-borne fungi and spore load were aforementioned in Table (12).

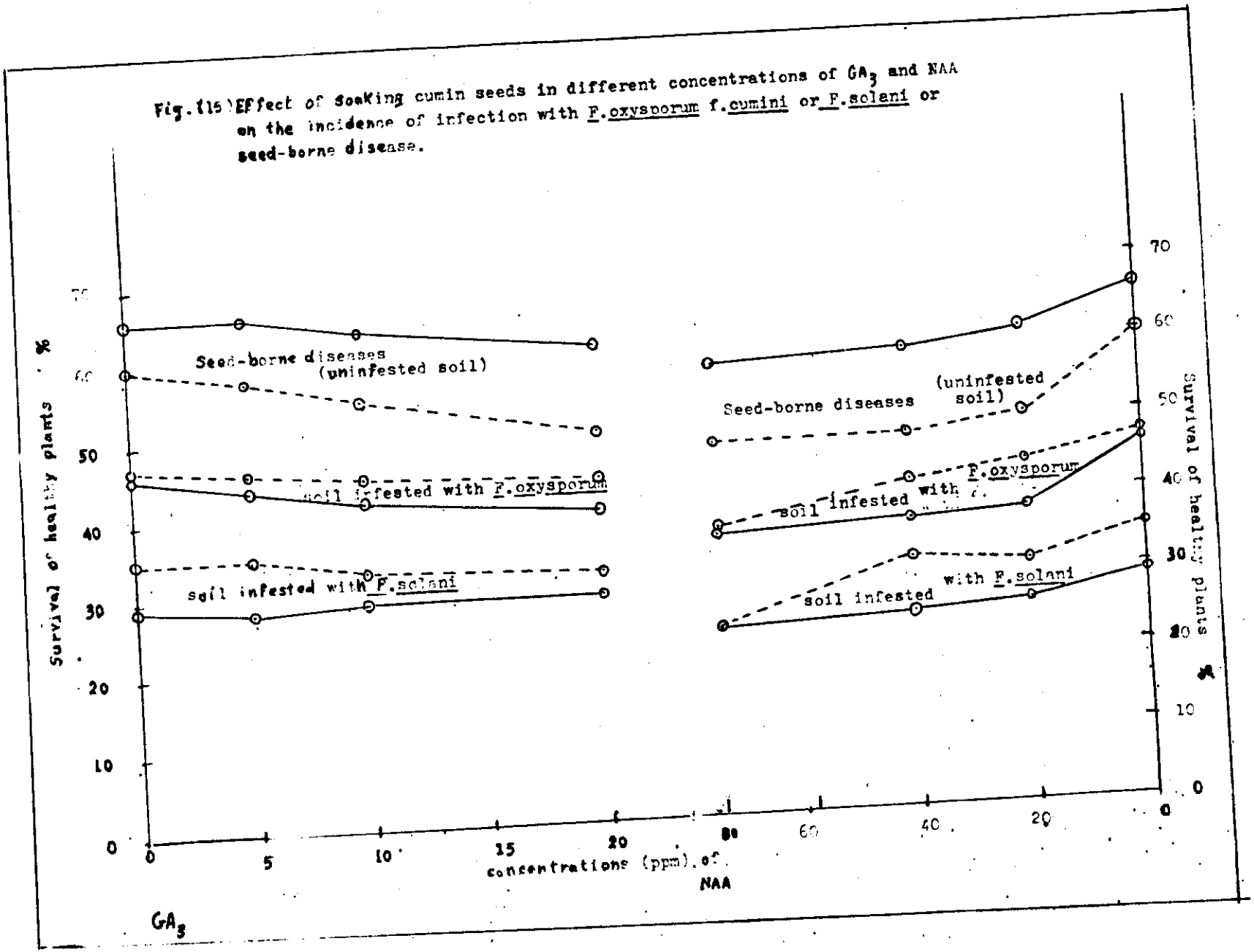
As regards F. oxysporum f.sp. cumini :

The lowest percentage of pre-emergence damping-off (39.00 %) was obtained when seeds were soaked in 10 ppm of GA_3 in 1983 and

Table (17) : Effect of soaking cumin seed in different concentrations of two growth regulators on the incidence of infection with *F. oxysporum* f.sp. *cumini* or *F. solani* or seed borne diseases.

Soil		Non-infested (seed-borne diseases)						Infested with *F. solani*						Infested with *F. oxysporum*					
Treatments	Conc. ppm	Damping-off				Survival of healthy plants after 8 weeks		Damping-off				Survival of healthy plants after 8 weeks		Damping-off				Survival of healthy plants after 8 weeks	
		Pre-emergence		Post-emergence				Pre-emergence		Post-emergence				Pre-emergence		Post-emergence			
		83	84	83	84	83	84	83	84	83	84	83	84	83	84	83	84	83	84
GA_3	5	19.00	20.00	28.40	15.33	58.00	66.00	33.00	36.00	34.30	28.15	44.00	46.00	41.00	49.00	52.48	31.43	28.00	35.00
	10	18.00	20.00	32.90	17.90	55.00	64.00	33.00	34.00	37.25	31.73	42.00	45.00	39.00	48.00	52.48	36.58	29.00	33.00
	20	23.00	24.00	35.00	15.25	50.00	61.00	36.00	36.00	37.50	31.15	40.00	44.00	43.00	51.00	49.18	34.40	29.00	32.00
NAA	20	24.00	24.00	34.18	15.18	50.00	61.00	37.00	34.00	39.70	33.38	38.00	44.00	44.00	52.00	53.55	35.03	26.00	31.00
	40	24.00	28.00	36.73	16.85	48.00	59.00	37.00	35.00	41.28	36.25	37.00	42.00	44.00	51.00	55.33	34.78	25.00	32.00
	80	24.00	28.00	36.83	16.83	48.00	58.00	38.00	35.00	41.90	42.83	36.00	37.00	44.00	55.00	57.10	46.63	24.00	24.00
Water	0	20.00	24.00	25.00	13.15	60.00	66.00	34.00	37.00	30.15	25.43	46.00	47.00	42.00	51.00	47.40	28.63	29.00	35.00
L.S.D. 0.05		2.15	1.41	2.90	NS	2.05	1.62	1.63	NS	2.78	6.03	1.33	2.53	1.76	2.15	2.35	5.19	1.69	2.66

Fig. 15 Effect of soaking cumin seeds in different concentrations of GA_3 and NAA on the incidence of infection with F.oxysporum f.cumini or F.solani or seed-borne disease.



in 5 or 10 ppm of GA_3 (48.00 % or 49.00 %) in 1984 season.

On the other hand, percentages of post-emergence damping-off were increased in all treated cumin seeds in 1983 and 1984 seasons. However, the lowest percentages of healthy survival plants were obtained when seeds were soaked in 80 or 40 ppm of NAA in 1983 and 80 ppm of NAA in 1984 season.

However, it could be noticed that treating the seeds with the tested growth regulators did not increase the percentage of germination than the control but decreased it slightly.

As regards F. solani :

The lowest percentages of pre-emergence damping-off (33.00 % and 33.00 %) were obtained when seeds were soaked in 5 or 10 ppm of GA_3 in 1983 season, while the differences between 1984 values were not significant. The highest percentages of post-emergence (41.90 and 42.83 %) were at 80 ppm of NAA in 1983 and 1984, respectively. All treatments of growth regulators increased the percentage of post-emergence damping-off. The lowest percentages of healthy survival plants were at 80 ppm of NAA.

As regards seed-borne diseases :

These seeds were not surface sterilized and were sown in un-infested soil, also, seed-borne fungi were aforementioned in Table (13).

Data in Table (17) and Fig. (15) indicate that, the lowest percentages of pre-emergence damping-off were at 5 and 10 ppm in 1983 and 1984 seasons, but no differences between 0, 5 and 10 ppm of GA_3 in 1983 season, Whereas, post-emergence damping-off increased in all treatments in 1983 season, but differences between the treatments were not significant in 1984 season. The highest percentage of post-emergence damping-off was in the treatments of 40 or 80 ppm of NAA. Whereas the lowest percentages of healthy survival plants were obtained by the two former concentrations of NAA.

Disease incidence of seed-borne diseases in 1983 was more than in 1984 season.

3. Effect of adding different levels of ammonium sulphate (N), calcium superphosphate (P) and potassium sulphate (K) on disease incidence of cumin plant :

Different levels of ammonium sulphate (N); 0.00, 1.00 g ./pot (200.00 kg./fed.), and 2.00 g ../pot.(400.00 kg./ fed.), calcium superphosphate (P) i.e. 0.00, 1.01 g ./pot (200.00 kg./fed.), and 1.52 g ./pot (300.00 kg./fed.)

and potassium sulphate (K), i.e. 0.00, and 2.58 g ./pot (500 kg./fed.) were added to potted soil infested with Fusarium oxysporum f.sp. cumini or F. solani or un-infested soil, with non-surface sterilized seed in the last case, in the greenhouse to study their effect on disease incidence and survival of healthy plants of cumin plant after 21, 45 and 60 days from sowing. Pots without fertilizers were used as control.

Data in Table (18) and Figs. (16 a, 16 b and 16 c) lead to the following results :

As regards F. oxysporum f.sp. cumini :

1. Both pre- and post-emergence damping-off decreased by the addition of (N) fertilizer alone especially with N_1 (1.00 g./pot or 200.00 kg./fed.) level. Also, the percentages of pre- and post-emergence damping-off did not increase again with the increase of N fertilizer in most cases.

2. Addition of (P) fertilizer alone decreased both the percentages of pre- and post-emergence damping-off especially with the addition of N fertilizers and/or K fertilizers.

3. Addition of (K) fertilizer alone decreased both the percentages of pre- and post-emergence damping-off. The decrease of damping-off % was more clear with (K) fertilizer than addition of (P) fertilizer alone.

Table (18) : Effect of fertilization with different levels of ammonium sulphate (N), calcium superphosphate (P) and potassium sulphate (K) on damping-off and survival of healthy plants of commercial cumin variety after 8 weeks in soil uninfested or in soil infested with F. oxysporum f.sp. cumini or F. solani.

Soil		Non-infested						Infested with F. solani						Infested with F. oxysporum					
Treatments		Damping-off				Survival of healthy plants after		Damping-off				Survival of healthy plants after		Damping-off				Survival of healthy plants after	
		Pre-emergence		Post-emergence				Pre-emergence		Post-emergence				Pre-emergence		Post-emergence			
		83	84	83	84	83	84	83	84	83	84	83	84	83	84	83	84	83	84
N_0	P_0K_0	24.00	25.00	25.00	17.35	57.00	62.00	35.00	37.00	30.83	25.40	45.00	47.00	48.00	51.00	48.20	28.63	27.00	35.00
	P_1K_0	24.00	25.00	23.70	15.95	58.00	63.00	35.00	35.00	29.25	24.63	46.00	49.00	48.00	51.00	48.23	26.20	27.00	36.00
	P_2K_0	23.00	24.00	22.08	15.68	60.00	64.00	35.00	35.00	27.68	23.15	47.00	50.00	48.00	51.00	46.15	26.20	28.00	36.00
	P_0K	23.00	24.00	22.08	15.80	60.00	64.00	35.00	36.00	26.10	23.45	48.00	49.00	47.00	51.00	45.18	25.85	29.00	36.00
	P_1K	23.00	25.00	19.50	14.63	62.00	64.00	34.00	34.00	27.20	24.25	48.00	50.00	47.00	51.00	43.43	22.28	30.00	38.00
	P_2K	23.00	24.00	16.85	14.43	64.00	65.00	34.00	34.00	25.73	22.27	49.00	51.00	46.00	50.00	42.58	20.05	31.00	39.00
N_1	P_0K_0	23.00	25.00	18.18	14.63	63.00	64.00	34.00	34.00	27.40	19.58	48.00	53.00	45.00	46.00	43.85	20.35	31.00	43.00
	P_1K_0	22.00	25.00	17.90	13.30	64.00	65.00	33.00	33.00	25.35	19.38	50.00	54.00	44.00	46.00	42.88	18.40	32.00	44.00
	P_2K_0	22.00	24.00	16.65	14.48	65.00	65.00	33.00	32.00	23.70	17.80	51.00	55.00	42.00	46.00	39.78	18.40	35.00	44.00
	P_0K	22.00	25.00	15.33	13.30	66.00	65.00	33.00	33.00	23.80	17.80	51.00	55.00	42.00	45.00	37.85	19.93	36.00	44.00
	P_1K	22.00	23.00	11.50	11.70	69.00	68.00	32.00	30.00	14.70	15.70	58.00	59.00	40.00	44.00	31.65	17.85	41.00	46.00
	P_2K	22.00	25.00	12.75	10.60	68.00	67.00	32.00	30.00	15.42	15.63	57.00	59.00	40.00	45.00	30.00	16.33	42.00	46.00
N_2	P_0K_0	22.00	26.00	20.48	14.85	62.00	63.00	33.00	33.00	29.78	22.33	47.00	52.00	41.00	51.00	42.28	20.25	34.00	39.00
	P_1K_0	22.00	26.00	20.48	13.45	62.00	64.00	33.00	32.00	25.18	23.50	50.00	52.00	41.00	50.00	39.40	19.23	35.00	40.00
	P_2K_0	22.00	26.00	19.23	13.30	63.00	65.00	32.00	31.00	24.98	23.18	51.00	53.00	42.00	50.00	34.40	19.55	38.00	38.00
	P_0K	22.00	25.00	17.98	13.25	64.00	65.00	34.00	32.00	24.18	22.00	50.00	53.00	41.00	47.00	32.13	20.75	40.00	42.00
	P_1K	23.00	25.00	14.28	13.30	66.00	65.00	33.00	32.00	23.80	20.63	51.00	54.00	41.00	48.00	37.25	19.25	37.00	42.00
	P K	22.00	25.00	15.25	13.30	66.00	65.00	33.00	32.00	22.33	17.58	52.00	56.00	41.00	48.00	37.25	19.25	37.00	42.00
L.S.D. 0.05		NS	NS	3.22	NS	1.61	1.41	NS	1.80	4.40	3.16	2.24	1.84	1.95	2.49	4.34	NS	2.79	2.19

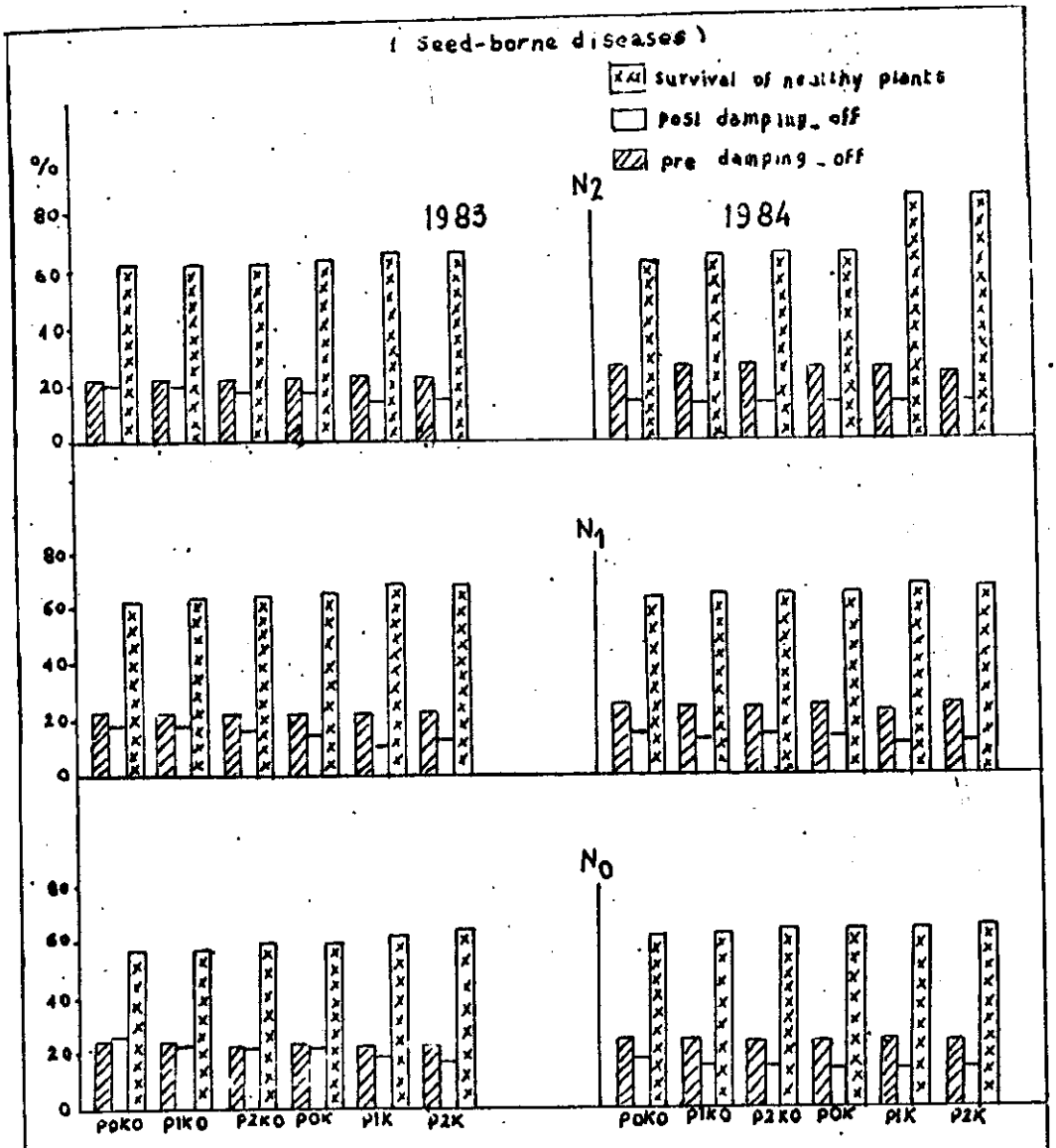


FIG. (16a)Effect of fertilization with different levels of ammonium sulphate(N),ca;superphosphate(P),and potassium sulphate(K)on damping-off and survival of healthy plants of commercial cumin variety in uninfested soil(non-sterilized seeds)in 1983 and 1984 seasons.

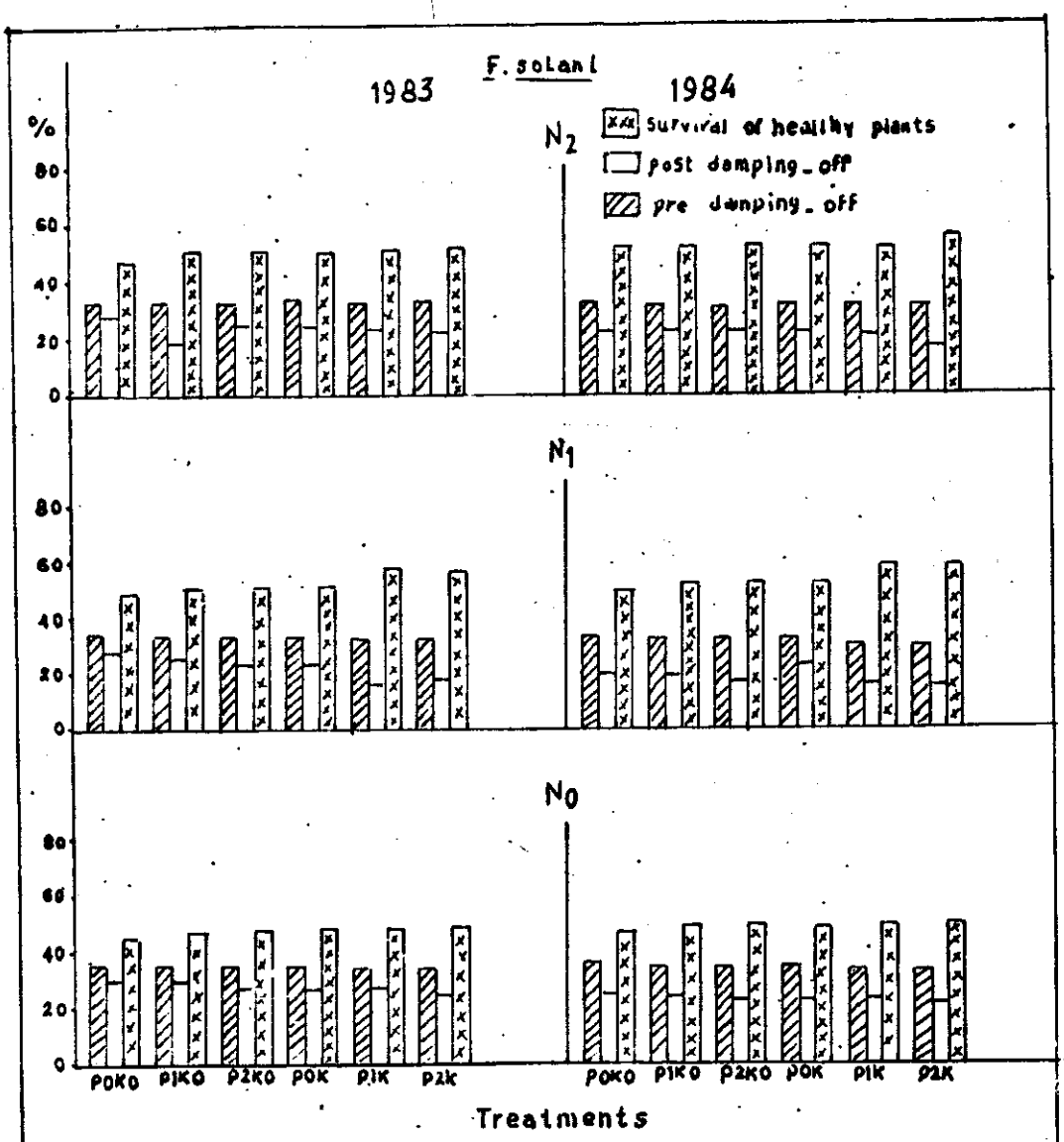


Fig.(16b)Effect of fertilization with different levels of ammonium sulphate(N),ca.superphosphate(P),and potassium sulphate (K) on damping-off and survival of healthy plants of commercial cumir variety in soil infested with F.solani in 1983 and 1984 seasons.

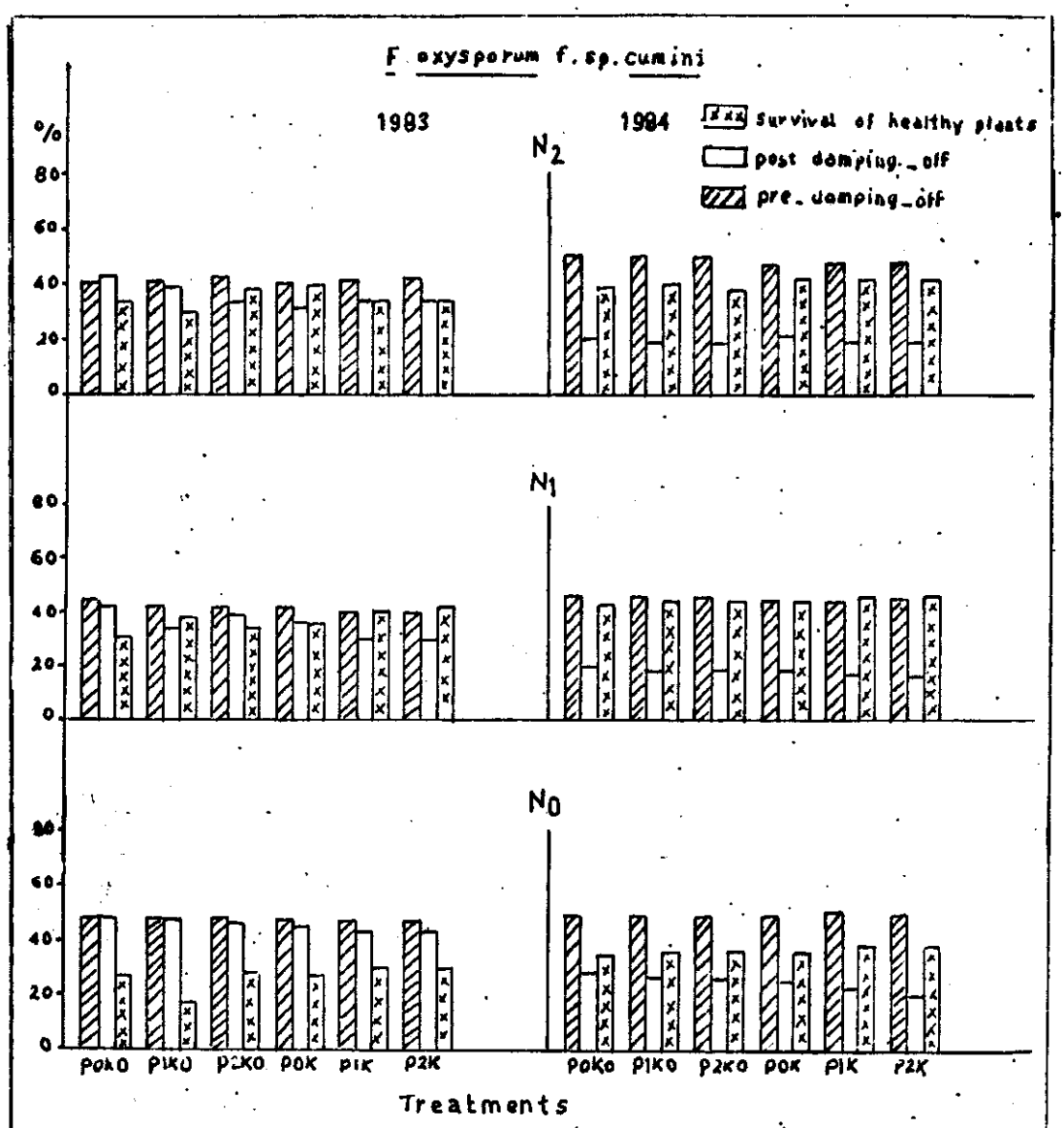


Fig.(16c)Effect of fertilization with different levels of ammonium sulphate (N),Ca.superphosphate(P),and potassium sulphate(K) on damping-off and survival of healthy plants of commercial cumin variety in soil infested with *F.oxysporum* f.sp.*cumini* in 1983 and 1984 seasons.

4. Addition of combined quantities of the three fertilizers indicated clearly that a balance between the three fertilizers must be in consideration in order to obtain the highest percentages of healthy survivals. The best combination treatments were N_1P_1K (1.00 g . : 1.01 g . : 2.58 g ./pot) and N_1P_2K (1.00 g . : 1.52 g . : 2.58 g ./ pot) in both 1983 and 1984 seasons.

As regards F. solani :

Data from Table (18) and Fig. (16 b) show similar trend of results as in F. oxysporum f.sp. cumini. The lowest percentages of pre- and post-emergence damping-off and the highest percentage of healthy survival plants were with the combinations N_1P_1K (1.00 g . : 1.01 g . : 2.58 g ;/ pot) and N_1P_2K (1.00 g . : 1.52 g . : 2.58 g ./ pot) in both seasons.

As regards seed borne-diseases :

Data in Table (18) and Fig. (16 a) indicate that, the differences between all treatments on pre-emergence damping-off in both seasons and on post-emergence damping-off in 1984 season were not significant. The effect of fertilizer treatments on pre- and post-emergence damping-off was not clear. Also, addition of combined quantities of the three fertilizers indicated clearly that a balance

between them must be in consideration in order to obtain the highest percentages of healthy survivals. In this respect, the best combination treatments were N_1P_1K (1.00 g. : 1.01 g. : 2.58 g./pot) and N_1P_2K (1.00 g. : 1.52 g. : 2.58 g./pot) in both 1983 and 1984 seasons.

4. Effect of different fungicides on disease control :

The effect of seed dressing with different concentrations of systemic fungicides group (Table, 2) (i.e. 0.00 %, 0.15 %, 0.30 %, and 0.50 % by weight) and contact fungicides group (Table, 2) at 0.00 %, 0.20 %, 0.40 %, and 0.60 % by weight) on the percentages of pre- and post-emergence damping-off and healthy survival plants of commercial cumin variety sown in naturally heavily infested soil with either F. oxysporum f.sp. cumini and F. solani was studied in seasons 1983 and 1984. Meanwhile, all previous treatments were carried out in un-infested soil as control. Five replicates (20 pots of each sub-plot) were used for each treatment.

Data illustrated in Tables (19, 20 and 21) and Figs. (17 a, 17 b and 17 c) lead to the following results :

Generally, the percentages of pre- and post-emergence damping-off due to both fungi or seed-borne diseases decreased significantly by increasing the concentration of each tested fungicide.

Table (19) Effect of different concentrations of fungicides on pre- and post-emergence damping-off and healthy survival plants of commercial cumin variety in infested soil with F. carpaticum f.sp. cuminum

Fungicides	Pre-emergence damping-off										Post-emergence damping-off										Healthy survival plants after 8 weeks									
Year	83					84					83					84					83					84				
Concentration	0	1	2	3	Mean	0	1	2	3	Mean	0	1	2	3	Mean	0	1	2	3	Mean	0	1	2	3	Mean	0	1	2	3	Mean
Benlate 50	48.00	26.00	26.00	26.00	31.50	50.00	50.00	41.50	32.00	48.38	48.23	14.85	13.45	12.13	22.17	30.00	21.80	19.25	20.60	22.91	27.00	63.00	64.00	65.00	54.75	35.00	39.00	54.00	54.00	45.50
Vitavax 75	48.00	48.00	34.00	30.00	40.00	50.00	41.00	41.00	30.00	40.50	48.23	48.23	38.05	38.80	43.33	30.00	23.60	22.10	18.93	23.66	27.00	27.00	41.00	44.00	34.75	35.00	45.00	43.00	56.00	45.50
Vitavax/Thiram	48.00	31.00	29,00	26.00	33.50	50.00	39.00	31.00	33.00	38.25	48.23	40.53	40.65	32.30	40.43	30.00	18.05	13.03	8.88	17.49	27.00	41.00	42.00	50.00	40.00	35.00	50.00	60.00	61.00	51.50
Vitavax/Captan	48.00	37.00	34.00	32.00	37.75	50.00	28.00	27.00	27.00	33.00	48.23	44.38	39.10	32.23	40.99	30.00	25.98	24.63	21.78	25.61	27.00	35.00	40.00	46.00	37.00	35.00	53.00	55.00	57.00	50.00
Thiram	48.00	42.00	38.00	26.00	38.50	50.00	36.00	43.00	34.00	40.75	48.23	27.65	28.98	30.95	33.95	30.00	23.22	19.73	19.58	23.23	27.00	42.00	44.00	51.00	41.00	35.00	49.00	44.00	53.00	46.25
homai 80	48.00	42.00	40.00	33.00	40.75	50.00	28.00	30.00	20.00	34.00	48.23	22.45	29.78	14.75	28.80	30.80	12.45	8.45	8.28	14.80	27.00	45.00	42.00	57.00	42.75	35.00	63.00	64.00	66.00	57.00
Captan	48.00	45.00	27.00	27.00	36.75	50.00	43.00	43.00	41.00	44.25	48.23	19.98	12.25	10.95	22.85	30.00	25.73	19.33	13.75	23.70	27.00	44.00	64.00	65.00	50.00	35.00	42.00	46.00	47.00	42.50
Rathene M-45	48.00	33.00	32.00	28.00	35.25	50.00	45.00	41.00	32.00	42.00	48.23	32.83	32.35	33.20	36.65	30.00	11.65	10.15	8.70	15.13	27.00	45.00	46.00	49.00	41.50	35.00	49.00	53.00	62.00	49.75
Dotes	48.00	46.00	35,00	37.00	42.50	50.00	40.00	40.00	32.00	40.50	48.23	40.35	40.58	38.15	41.53	30.00	27.50	29.93	26.43	28.47	27.00	32.00	36.00	35.00	33.50	35.00	43.00	42.00	50.00	44.50
SH 5050	48.00	40.00	29.00	25.00	35.50	50.00	32.00	32.00	32.00	36.50	48.23	20.00	14.08	12.08	23.60	30.00	26.60	27.80	26.35	27.69	27.00	48.00	61.00	66.00	50.50	35.00	50.00	49.00	50.00	46.00

L.S.D. 0.05 for

Place	Pre-		Post-		Survival	
Year	83	84	83	84	83	84
Fungicides	1.43	2.05	1.99	3.29	1.10	2.06
Concentration	1.23	1.43	1.15	1.82	0.24	1.26
Interaction	3.90	4.46	3.64	5.74	0.77	4.00

Table (20) : Effect of different concentrations of fungicides on pre- and post-emergence damping-off and healthy survival plants of commercial cumin variety in infested soil with F. solani

phases	Pre-emergence damping-off									Post-emergence damping-off									Healthy survival plants after 8 weeks								
Year	83					84				83					84				83					84			
Concentration / Fungicides	0	1	2	3	Mean	0	1	2	3	Mean	0	1	2	3	Mean	0	1	2	3	Mean	0	1	2	3	Mean	0	1	2	3	Mean
Benlate 50	35.00	29.00	29.00	26.00	29.50	37.00	37.00	30.00	23.00	33.25	30.82	28.20	28.10	16.18	25.83	25.13	25.40	18.90	19.38	22.28	45.00	48.00	51.00	61.00	51.25	47.00	47.00	52.00	62.00	52.00
Vitavax	35.00	33.00	31.00	29.00	32.00	37.00	29.00	29.00	29.00	31.00	30.82	29.88	27.33	28.68	29.18	25.13	24.15	25.03	19.73	23.59	45.00	47.00	50.00	52.00	48.50	47.00	54.00	53.00	57.00	52.75
Vitavax/Thiram	35.00	27.00	25.00	26.00	26.25	37.00	29.00	29.00	25.00	31.00	30.82	29.98	26.58	25.60	28.25	25.13	18.25	15.33	8.45	16.87	45.00	51.00	55.00	61.00	53.00	47.00	58.00	60.00	65.00	57.50
Vitavax/Captan	35.00	31.00	30.00	28.00	31.50	37.00	31.00	31.00	18.00	29.25	30.82	18.63	18.40	17.03	21.22	25.13	14.08	11.35	15.83	16.67	45.00	56.00	57.00	58.00	54.00	47.00	63.00	61.00	68.00	59.75
Thiram	35.00	34.00	30.00	26.00	31.25	37.00	34.00	32.00	29.00	33.00	30.82	25.73	22.85	14.85	23.56	25.13	23.90	17.70	16.73	20.94	45.00	49.00	54.00	63.00	52.75	47.00	58.00	59.00	59.00	53.00
Kemi 80	35.00	32.00	32.00	32.00	32.75	37.00	23.00	21.00	17.00	24.50	30.82	17.68	17.68	14.75	20.23	25.43	14.05	9.93	7.28	14.18	45.00	56.00	56.00	58.00	53.75	47.00	66.00	71.00	77.00	65.25
Captan	35.00	32.00	32.00	21.00	30.00	37.00	24.00	25.00	23.00	---	30.82	19.23	19.08	17.65	21.70	25.13	13.67	9.30	10.53	14.73	45.00	55.00	55.00	65.00	55.00	47.00	66.00	68.00	69.00	62.50
Dithane M-45	35.00	32.00	29.00	27.00	30.75	37.00	30.00	27.00	27.00	30.25	30.82	29.40	27.88	24.43	28.13	25.13	11.18	10.93	8.2	13.94	45.00	40.00	51.00	55.00	49.75	47.00	62.00	65.00	67.00	60.25
Rotec	35.00	35.00	33.00	33.00	34.00	37.00	34.00	33.00	32.00	34.00	30.82	26.13	25.35	23.88	26.55	25.43	19.45	19.36	16.63	20.20	45.00	48.00	50.00	51.00	48.50	47.00	53.00	54.00	56.00	52.50
EH 5050	35.00	32.00	30.00	26.00	30.75	37.00	35.00	30.00	27.00	32.25	30.82	23.40	17.53	16.25	22.00	25.43	17.70	15.70	12.26	17.78	45.00	52.00	57.00	62.00	54.00	47.00	54.00	59.00	64.00	56.00

L.S.D. C.05 for

Phase	Pre		Post		Survival	
Year	83	84	83	84	83	84
Fungicides	1.61	2.75	3.36	3.20	1.70	1.19
Concentrations	0.76	1.17	1.12	1.67	0.67	1.10
Interaction	2.39	3.69	3.55	NS	2.13	1.50

Table (21) : Effect of different concentrations of fungicides on pre- and post-emergence damping-off and healthy survival plants of commercial cumin variety in autoclaved un-infested soil (area wise)

Phases	Pre-emergence damping-off									Post-emergence damping-off									Healthy survival plants after 8 weeks								
Year	83					84				83					84				83					84			
Concentration	0	1	2	3	Mean	0	1	2	3	Mean	0	1	2	3	Mean	0	1	2	3	Mean	0	1	2	3	Mean	0	1	2	3	Mean
Control																														
Benlate 50	24.00	23.00	22.00	14.00	20.75	25.00	24.00	22.00	11.00	20.50	25.00	22.23	21.05	20.93	22.80	15.95	13.15	12.75	11.15	13.25	57.00	60.00	61.00	68.00	61.50	62.00	66.00	68.00	79.00	68.74
Vitavax 75	24.00	25.00	12.00	6.00	16.75	25.00	17.00	14.00	15.00	17.75	26.00	20.08	19.25	19.15	20.87	15.95	13.23	8.13	7.05	11.09	57.00	68.00	71.00	76.00	68.00	62.00	72.00	79.00	84.00	73.00
Vitavax/Thiram	24.00	20.00	14.00	12.00	17.50	25.00	23.00	16.00	15.00	19.75	25.00	22.53	23.25	22.73	23.38	15.95	7.80	5.98	8.05	9.45	57.00	62.00	66.00	68.00	63.25	62.00	71.00	79.00	78.00	72.50
Vitavax/Captan	24.00	19.00	12.00	12.00	16.75	25.00	12.00	11.00	9.00	14.25	25.00	14.80	16.83	14.65	17.82	15.95	6.78	4.48	5.50	8.18	57.00	69.00	73.00	75.00	68.50	62.00	82.00	85.00	86.00	78.75
Thiram	24.00	18.00	12.00	11.00	16.25	25.00	18.00	15.00	14.00	18.00	25.00	25.63	21.65	15.68	21.99	15.95	8.48	8.18	8.38	10.25	57.00	61.00	69.00	75.00	65.50	62.00	74.00	78.00	79.00	73.25
Ecnal 80	24.00	22.00	21.00	18.00	21.25	25.00	12.00	12.00	8.00	14.25	25.00	15.40	6.28	4.90	12.90	15.95	10.18	7.95	6.50	10.15	57.00	66.00	74.00	78.00	68.75	62.00	79.00	81.00	86.00	77.00
Captan	24.00	19.00	19.00	20.00	20.50	25.00	17.00	16.00	14.00	18.00	25.00	23.50	23.50	21.23	23.31	15.95	15.55	10.68	9.13	12.83	57.00	62.00	68.00	63.00	61.00	62.00	70.00	75.00	78.00	71.25
Difolatan 4-45	24.00	20.00	12.00	12.00	17.00	25.00	19.00	17.00	8.00	17.25	25.00	17.50	14.73	13.53	17.69	15.95	8.75	7.18	4.30	9.05	57.00	66.00	75.00	76.00	68.50	62.00	74.00	76.00	88.00	75.00
Dotes	24.00	18.00	15.00	14.00	17.75	25.00	22.00	21.00	15.00	20.75	25.00	24.45	18.80	18.60	21.71	15.95	15.30	7.53	10.25	12.26	57.00	62.00	69.00	70.00	64.50	62.00	65.00	73.00	75.00	69.25
BM 5050	24.00	24.00	19.00	18.00	21.25	25.00	22.00	20.00	14.00	20.25	25.00	19.78	16.00	14.65	18.86	15.95	8.80	5.03	5.80	8.90	57.00	61.00	68.00	70.00	64.00	62.00	71.00	76.00	81.00	72.50

L.S.D. 0.05 for :

Phase	Pre		Post		Survival	
Year	83	84	83	84	83	84
Fungicides	1.93	3.05	1.43	1.76	1.67	2.00
Concentration	1.17	1.28	0.96	1.26	0.82	0.91
Interaction	3.69	4.05	3.05	NS	2.59	2.88

Fig.(11a)Effect of different fungicides on damping-off of commercial cumin variety sown in soil infested with F.oxysporum f.sp.cumini in 1983 and 1984 seasons.

Fig. (17b) Effect of different fungicides on damping-off of commercial cupin variety in infested soil with F. solani in 1983 and 1984 seasons.

Fig. (17c) Effect of different fungicides on damping-off of commercial cumin variety in autoclaved uninfested soil (seed-borne diseases)in 1983 and 1984 seasons.