EXPERIMENTAL RESULTS

IV. EXPERIMENTAL RESULTS

1. Survey of flax powdery mildew in different governorates

Powdery mildew of flax was surveyed in three flax growing governorates in North Delta (Kafr El-Sheikh), middle Delta (El-Gharbiya), and East Delta (El-Sharqiya). Disease incidence and disease severity were used as criteria for evaluating disease intensity in the surveyed fields. The three governorates did not significantly differ in DI and DS. Prevalence of the disease was evaluated within each governorate. Six locations were surveyed in El-Gharbiya and 4 locations in each of Kafr El-Sheikh and Sharqiya. The only significant differences in DI and DS were observed within El-Gharbiya and Sharqiya, respectively (Table 4). The highest disease incidence level (90.5%) was observed in Santa, El-Gharbiya Governorate, while the lowest disease incidence (46.3%) was observed in El-Gemmeiza. Disease incidence in Samanoud, Mahalla, Tanta and Kottour were 87.20, 81.50, 64.00 and 80.10, respectively. The lowest levels of disease severity in El-Sharqiya were observed in Menia El-Kamh (12.57%) and Ibrahimia (10.47%) while the highest levels were observed in El-Qanayat (65.33) and Diyarb Nigm (53.00%). All locations in El-Gharbiya showed no significant differences in disease severity. Similarly, all locations in El-Sharqiya showed no significant differences in disease incidence. All locations of Kafr-El-Shak showed no significant differences in both disease incidence and disease severity. Comparisons between all locations in governorates are presented in Table (4). Significant differences were observed between locations in disease incidence. The highest disease incidence level were observed in Santa (90.50%), Samanoud (81.50%) and

Table (4): Survey of flax powdery mildew in different locations within governorates combined data of 1995/1996 and 1996/1997 growing seasons.

Governorate	Location	Disease intensity variables	
		Disease incidence [a]	Disease severity [b]
El-Gharbiya	Samanoud	87.20	77.06
	Mahalla	81.50	54.45
	Tanta	64.00	49.10
	El-Gemmeiza	46.30	40.18
	Santa	90.50	83.10
	Kotour	80.10	67.42
	Mean	74.93	61.89
Kafr El-Sheikh	Kafr El-Sheikh	63.33	23.94
	El-Riayad	66.00	14.01
	Sidi Salem	61.33	25.77
	Biala	51.33	18.97
	Mean	60.50	20.67
El-Sharqiya	Menia El-Kamh	12.57	4.18
	Ibrahimia	10.47	8.83
	Diyarb Nigm	53.00	57.77
	El-Qanayat	65.33	63.77
	Mean	35.34	33.64
L.S.D. ($P < 0.05$)	Governorate	NS	NS
	Locations	13.56	15.06
	Location within Governorates		
	El-Gharbiya	16.573	NS
	Kafr El-Sheikh	NS	NS
	El-Sharqiya	NS	26.03

[a] Disease incidence is the percentage of infected plants in a random sample of 50 plants/field, three samples/field. Three fields were surveyed in each location.

[b] Disease severity is the percentage of infected leaves/plant in a random sample of 10 plants/10 m^2. Three samples were surveyed in each field and three fields were surveyed in each location.

El-Mahalla (81.50%) without significant in-between. These locations significantly differ with El-Riyad (66.00%), El-Qanayat (65.33%), Karf El-Sheikh (63.33%), Sidi Salem (61.33%), and Diyarb Nigm (53.00%) without significant in between, followed by Biala (51.33%), El-Gemmieza (46.3%) in moderately susceptible. The lowest location in disease incidence were observed in Menia El-Kamh and Ibrahimia (12.57 and 10.47%, respectively). As to disease severity, the highest level were observed in Santa, Samanoud, Kotour, El-Qanayat and Diarb Nigm being 83.10, 77.06, 67.42, 63.77 and 57.77%, respectively. The moderately disease severity infection showed in El-Mahalla, Tanta and El-Gemmeiza (54.45, 49.10 and 40.10%, respectively). The lowest locations in disease severity were observed in Sidi Salem (25.77%), Kafr El-Sheikh (23.94%), Biala (18.97%, El-Riayad (14.01%), Ibrahimia (8.83%) and Menia El-Kamh (4.18%). Infected plants show a profuse development of the mildew on the main stem, on both surface of the leaves, and on the sepals so that in appearance they would seem to have been dusted with a white floury powder. This powder consists of an abundance of microscopic conidia which cover the surface of the attacked portions of the plant (**Muskett and Colhoun, 1947**). Disease symptoms are shown in Figure (1).

Pathography of *Oidium lini* on flax

Flax powdery mildew as other powdery mildew fungi grows over the surface of the host with only limited intrusions by the haustoria, into the epidermal cells. Fig. (2) showed the sequence of events for the development of *O. lini* on cleared detached leaves. Conidia start to germinate after deposition on the leaf, by producing a short tube, the primary germ tube,

A

B

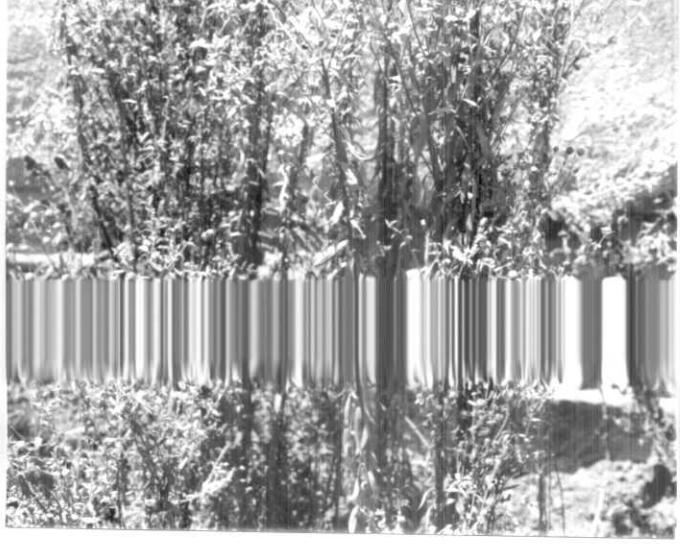
C

Fig. (1): Progressive stages of powdery mildew development on naturally infected flax plants of cultivar Giza 7: C, The first symptoms of the disease appears in the form of powdery spots on leaves.

D

E

Fig. (1): Progressive stages of powdery mildew development on naturally infected flax plants of cultivar Giza 7: **D**, Fungal growth (conidia and mycelium) covers entire leaves, portions of apical branching zone, and floral structures. **E**, Enlarged portion of infected plant (right) showing the typical white floury appearance compared to appearance of healthy



G

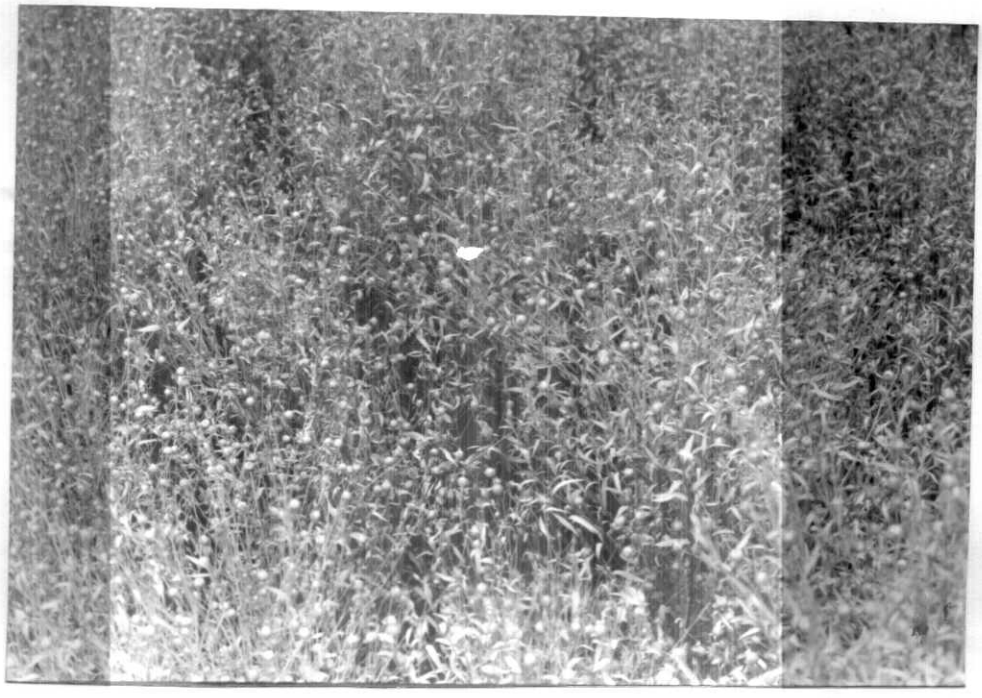


Fig. (1): Progressive stages of powdery mildew development on naturally infected flax plants of cultivar Giza 7: F and G, general appearance of naturally infected area in flax field.

from one side of the conidium Fig. (2A). A second germ tube is produced usually on the opposite side but occasionally on the same side as the primary germ tube. This germ tube elongates and enlarges and forms a cab-shaped appressorial initial (Fig. 2-B). Third and fourth germ tubes usually develops from a polar position, a septum then develops at the proximal end of the appressorial initia (Fig. 2-C). After initiation of third and fourth germ tubes, mycelium grows rapidly with much branching of germ tubes and conidial chains are produced (Fig. 2 D-H). Evidently, the haustoria (Fig. 2 J-K) produced by *O. lini* are the compact type which has been described by **(Bushnel and Gay, 1978)**.

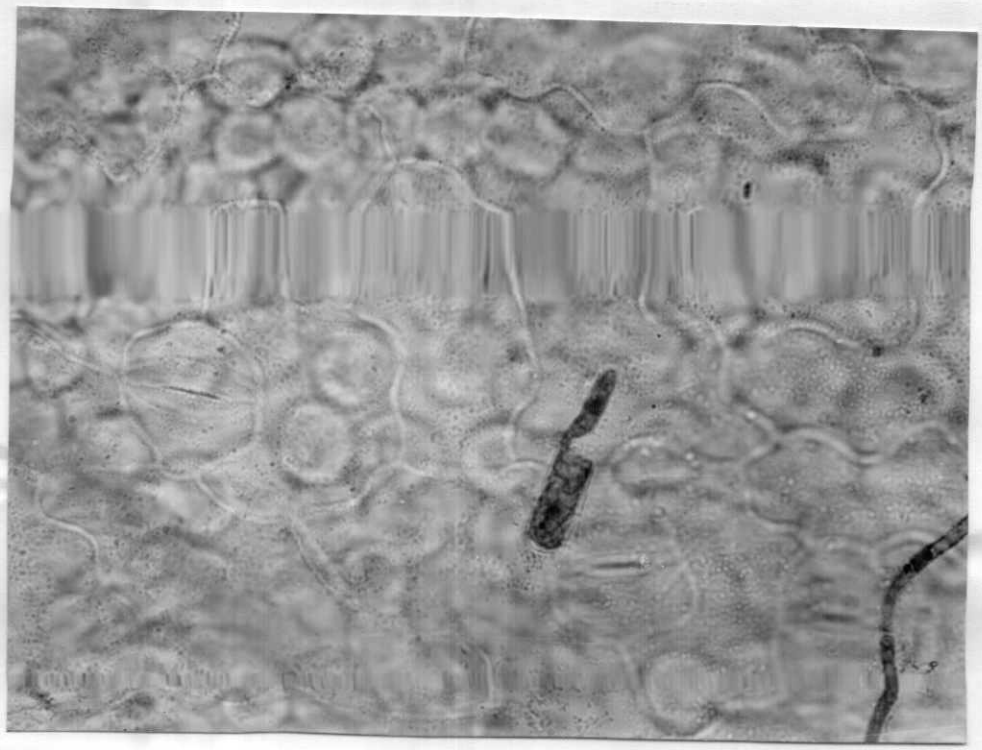
Identification of teleomorph of *O. lini*

1. Characterization of morphological traits of *O. lini* compared to those of *Erysiphe cichoracearum* and *Erysiphe polygoni*

Characterization of morphological traits of O. lini compared to those of E. cichorocearum and E. polygoni

The least significant differences between means were used to compare between each morphological trait (Table 5). Data in Table (5) show *that O. lini* morphotype 3 from flax had the tallest conidiophore length (164.5 µ) followed by *E. cichoracearum* from okra (160.7 µ), *E. cich.* from tobacco (154.0 µ), and *O. lini* morphotype 1 from flax (143.4 µ) without significant differences in between. The shortest condiophore lengths were observed in *E. polygoni* from peas (105.1 µ) and *O. lini* morphotype 2 from flax (123.2 µ). There are highly significant differences in condiophore length of both groups. The length of conidiophore of *E. polygoni* from alfalfa and peas were significantly differed also.

Data showed the length of conidiophore (µ) of *O. lini* morphotype (3) had significantly differences with fungi *O. lini* morphotype (2) *E. polygoni* from peas and *E. polygoni* from alfalfa. Nonsignificant differences were observed between *O. lini* morphotype (3), *E. cichorocearum* from Tobacco.



A
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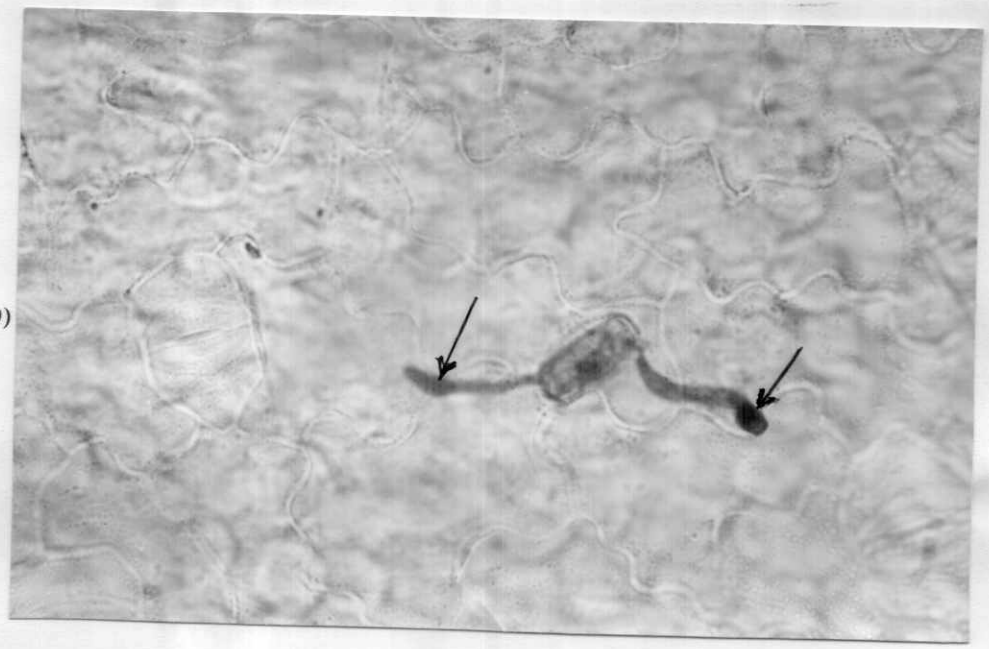
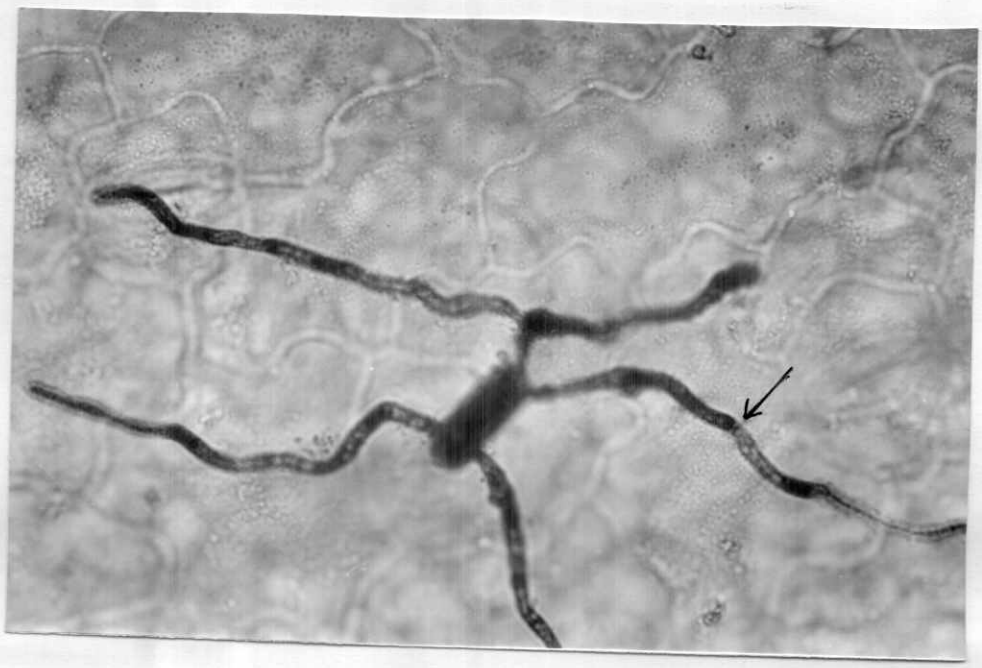
Trypan blue, X400)



B
(Stained with
Trypan blue, X400)

Fig. (2): Sequential stages of *O. lini* development on flax. **A**: Unipolar germination of conidium on upper surface of flax leaf. **B**: Bipolar germination and appressorial initial (arrow).

C
(Stained with
Trypan blue, X400)



D
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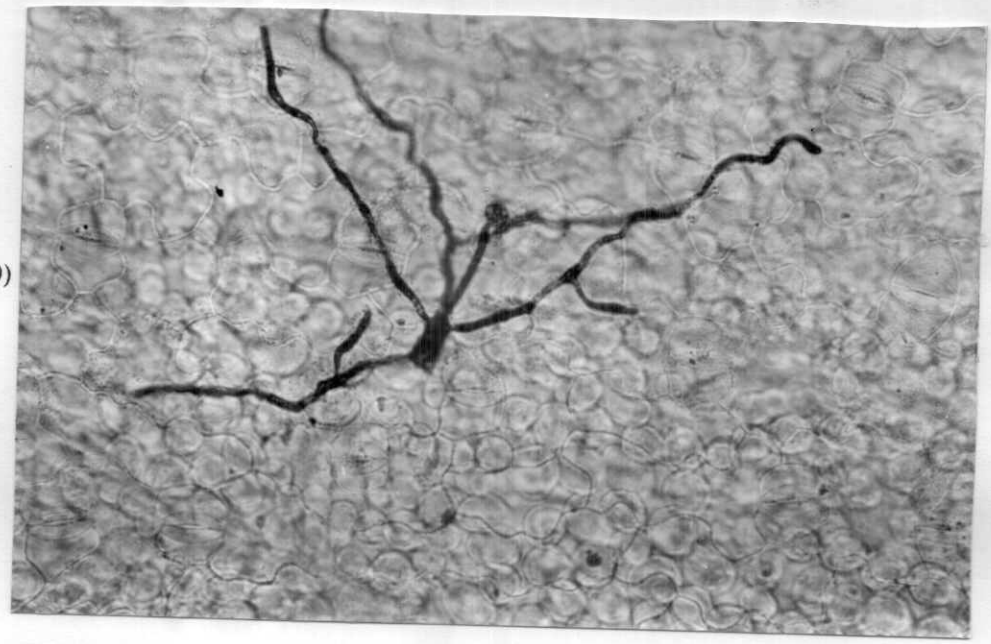


Fig. (2). Sequential stages of *O. lini* development on flax. C-E: Progressive stages of bipolar germination.

E
(Stained with
Trypan blue, X200)

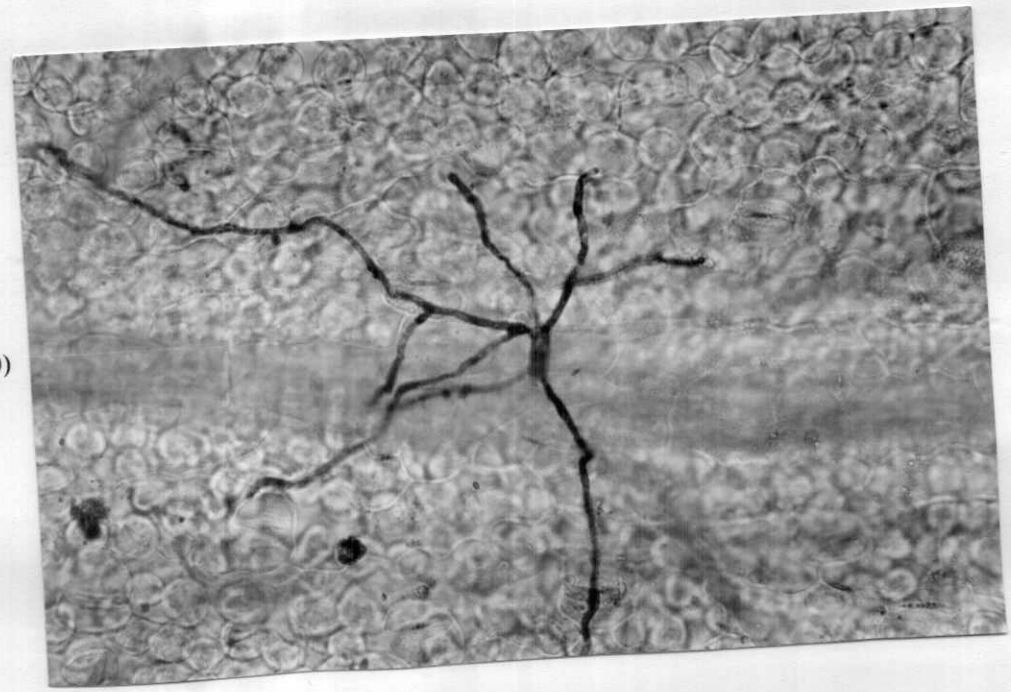


Fig. (2): Sequential stages of *O. lini* development on flax. **C**-**E**: Progressive stages of bipolar germination.

F
(Stained with
Trypan blue, X200)

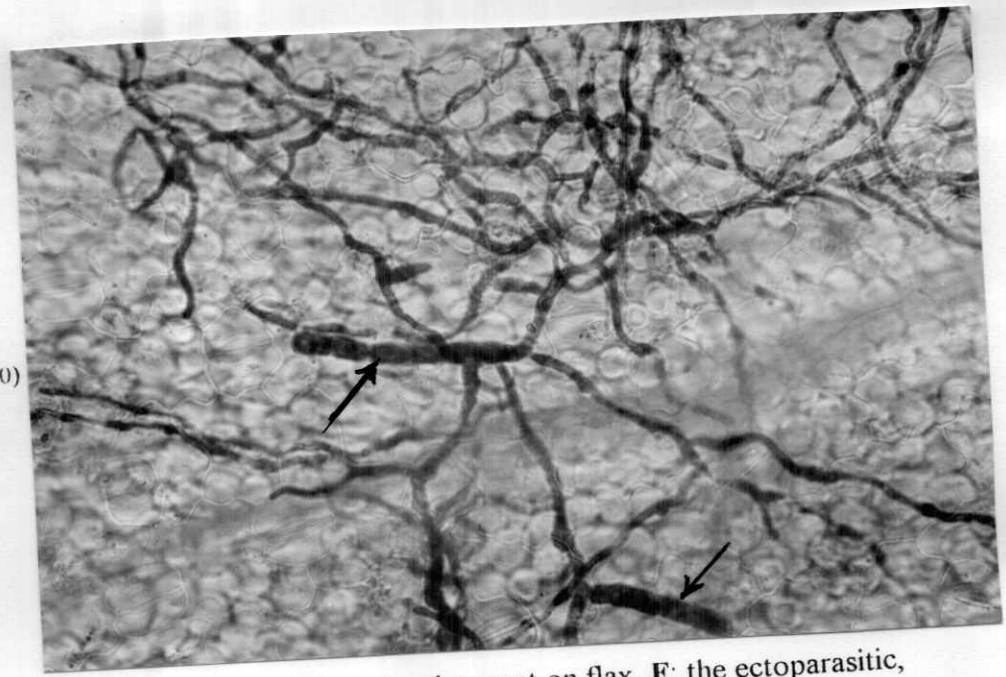
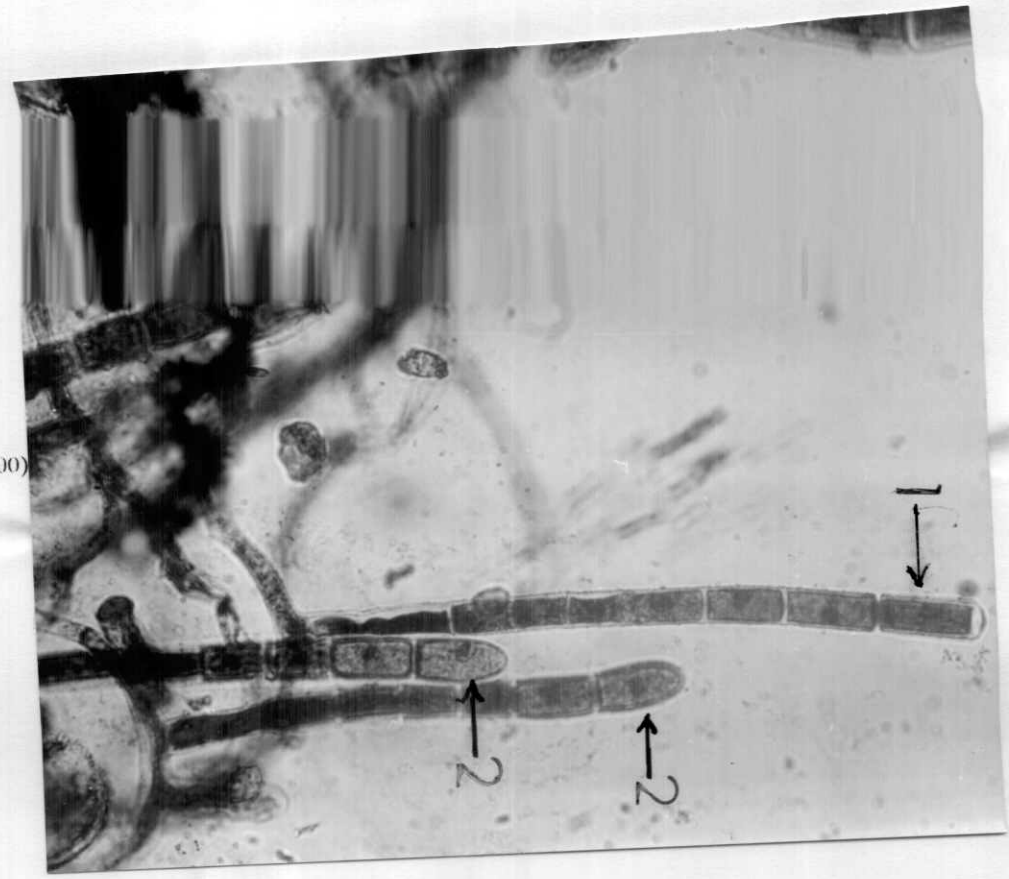


Fig. (2): Sequential stages of *O. lini* development on flax. **F**: the ectoparasitic, hyaline mycelium spreads over leaf surface . Conidiophores (arrows) arise from the mycelium.

G
(Stained with
Trypan blue, X400)



H
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Trypan blue, X400)

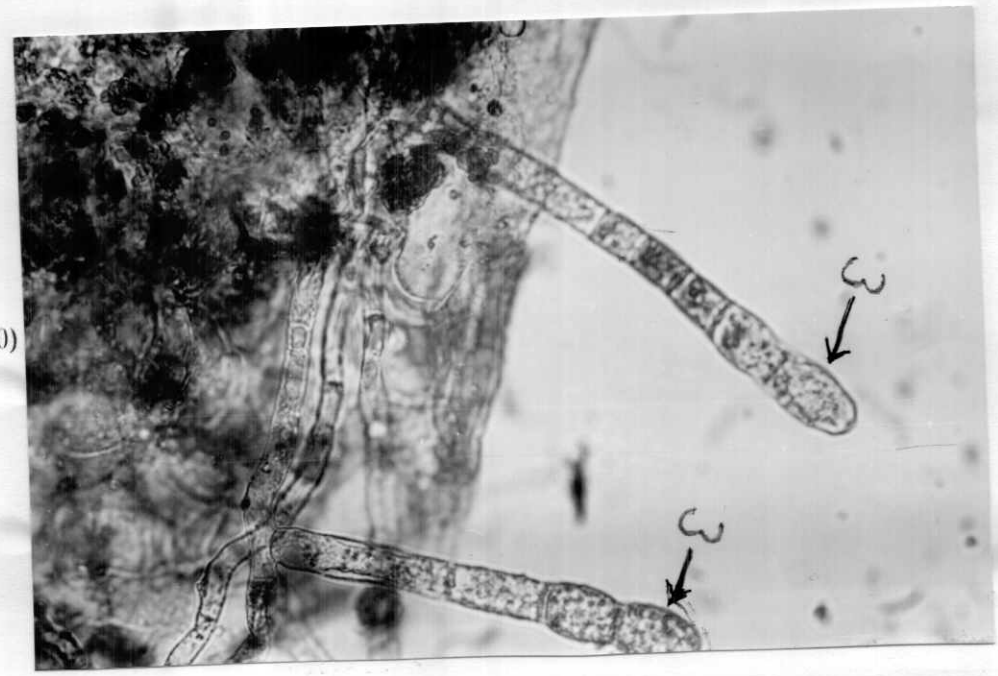

Fig. (2): Sequential stages of *O. lini* development on flax. **G** and **H**., colorless, onecelled conidia are borne singly at the apex of simple, erect condiophores. There are three types of conidia: Cylindrical (morphotype 1), bullet-shaped (morphotype 2) and barrel-shaped (morphotype 3).

Table (5): Means of morphological traits of *O. lini* compared to those of *E. cichoracearum* and *E. polygoni*.

	Morphological trait									
	Length of conidio-phore (µ)	Conidio-phore cells (No.)	Conidiophore basal cell		The first cell above the basal cell		Cell in the middle of the conidiophore		Conidium in the top of conidiophore	
			Length (µ)	Width (µ)	Length (µ)	Width (µ)	Length (µ)	Width (µ)	Length (µ)	Width (µ)
O. lini (1) [a]	143.4	5.7	54.5	9.1	19.6	9.6	19.6	10.4	23.8	11.5
O. lini (2) [b]	123.2	5.4	43.2	8.8	18.5	9.0	20.9	9.2	22.1	10.9
E. cicharacearum from Okra	160.7	8.4	26.9	11.2	17.5	12.5	19.6	16.4	24.6	18.1
E. polygoni from peas	105.1	4.0	26.7	5.5	21.1	7.4	23.5	9.0	31.8	12.2
O. lini (3) [c]	164.5	8.1	47.2	9.1	14.9	9.0	18.0	12.4	12.4	14.3
E. cicharacearum from tobacco	154.0	6.7	72.8	10.1	9.5	9.5	15.4	11.2	22.4	14.6
E. polygoni from alfalfa	140.6	4.9	40.3	5.1	22.0	5.6	17.2	6.0	45.2	12.3
L.S.D. ($P \leq 0.05$)	22.40	0.689	15.77	1.090	4.476	1.159	3.041	1.425	3.127	1.490
L.S.D. ($P \leq 0.01$)	30.22	0.929	21.27	1.471	6.038	1.563	4.103	1.922	4.218	2.010

[a] Morphotype (1) of *O. lini* from flax
[b] Morphotype (2) of *O. lini* from flax
[c] Morphotype (3) of *O. lini* from flax

Also, nonsignificant differences were observed between *O. lini* morphotype 1, 2 and *E. polygoni* from alfalfa.

Due to conidiophore cell number no significantly differences were observed between *P. lini* morphotype 1 and 2, also no significant differences were observed between *O. lini* morphotype 2 and *E. polygoni* from alfalfa or between *O. lini* (3) from flax and *E. cichoracearum* from okra. Significant differences were observed between *O. lini* morphotypes 1, 2, *E. polygoni* from alfalfa and *E. cichoracearum* from tobacco.

As to conidiophore basal cell length, significant differences were observed between *E. cichoracearum* from tobacco and all other fungi. However, no significant differences were observed between *E. polygoni* from alfalfa and *O. lini* morphotype 1, 2.

As to conidiophore basal cell width, no significant differences were observed between *E. polygoni* from peas and alfalfa. Data showed no significant differences between *E. cichoracearum* from tobacco and *O. lini* morphotype (3) from flax. Also, significant differences were observed between *E. cichoracearum* from okra and O. lini morphotype 1, 2, *E. polygoni* from peas, and *E. polygoni* from alfalfa.

Due to the first cell above the basal cell (length) significant differences were observed between *E. cichoracearum* from tobacco and *E. polygoni* from peas and *E. polygoni* from alfalfa. However, nonsignificant differences were observed between *O. lini* morphotypes 1, 2 from flax, *E. polygoni* from peas and *E. polygoni* from alfalfa.

In the first cell above the basal cell (width), comparisons between means showed significant differences were observed between *E. cichoracearum* from okra and *E. polygoni* from peas and *E. polygoni* from alfalfa. No significant differences were observed between *O. lini* morphotypes 1, 2, 3 and *E. cichoracearum* from tobacco.

As to the cell in the middle of the conidiophore (length), significant differences were observed between *E. polygoni* from peas and *E. cichoracearum* from tobacco. Significant differences were observed

between *O. lini* morphotype 1, 2, 3, and E. polygoni from peas. Also, no significant differences were observed between *E. cichoracearum* from tobacco, *E. cichoracearum* from okra and *O. lini* morphotype (3) from flax.

Due to the cell in the middle of the conidiophore (width) no significant differences were observed between *O. lini* morphotype (3) and *E. cichoracearum* from tobacco and *E. cichoracearum* from okra.

Due to the dimensions of condia in the top of the conidiophore (length) significant differences were observed between *O. lini* morphotype (3) and each of *E. polygoni* from peas and *E. polygoni* from alfalfa. No significant differences were found between *E. cichoracearum* from okra and *E. cichoracearum* from tobacco.

As to the width of this trait, no significant differences were observed between *E. polygoni* from peas and *E. polygoni* from alfalfa and each of *O. lini* morphotype 1 and 2. Also, no significant differences were observed between *O. lini* morphotype (3) and *E. cichoracearum* from tobacco.

As to the range of conidiophore morphological traits (Table 6), the maximum values of the length of conidiophore data showed closely related between *E. cichoracearum* from okra, *E. cichoracearum* from tobacco and *O. lini* morphotype (3) being 193.2, 197.6 and 214.2 µ, respectively.

As to conidiophore basal cell, the ranges between conidiophore basal (width) of *E. cichoracearum* from tobacco, *O. lini* morphotype (3), *E. cichoracearum* from okra it was 7.3, 6.3 and 6.2, respectively.

Due to the first cell above the basal cell (width), ranges between *E. cichoracearum* from tobacco, and *O. lini* morphotype (3) as the same as 4.3µ also at the cell in the middle of the conidiophore (width) being 4.2 µ.

As to the conidiophore in the top of conidiophore (width), ranges between *O. lini* morphotype (3), *E. cichoracearum* from tobacco, and *E. cichoracearum* from okra were very closely related being 4.3, 4.3 and 4.2 μ, respectively.

As to the ranges of morphological traits between *O. lini* morphotype 1, 2 and *E. polygoni* from peas and alfalfa closely relatedness could be observed. As conidiophore cells, no ranges between *O. lini* morphotype 1 and *E. polygoni* from peas 54.7 and 58.8 μ, respectively, also between *O. lini* morphotype 2 and *E. polygoni* from alfalfa 109.2 and 113.4, were more closely related.

Due to conidiophore cells, no relatedness could be observed between *O. lini* morphotype 1 and *E. polygoni* from alfalfa. Also in the conidiophore basal cell (width) relationship ranges between *O. lini* morphotype 1 and *E. polygoni* from peas at the same as 2.1 μ.

The phenogram of Fig. (3) constructed based on taxonomic distances (TD) generated from cluster analysis of parameter means shown in Table (5). Taxonomic distance which measures the relatedness between organisms, the smaller the taxonomic distance, the more closely related the organisms. The phenogram included three distinct clusters. In the first cluster, *O. lini* morphotypes 1 and 2 as well as *E. polygoni* from alfalfa belonged to a single cluster (TD = 10.6). It should be noted that the morphological traits of *O. lini* morphotype 2 and *E. polygoni* from alfalfa varied very little. Thus the two fungi were included in a distinct subcluster showing the highest similarity level (TD = 0.6). The second cluster (TD = 10) included the two isolates of *E. cichoracearum* from okra and tobacco in

Table (6): Range of morphological traits used in cluster analysis of *Erysiphe* spp.

	Morphological trait									
	Length of conidio-phore (μ)	Conidio-phore cells (No.)	Conidiophore basal cell		The first cell above the basal cell		Cell in the middle of the conidiophore		Conidium in the top of conidiophore	
			Length (μ)	Width (μ)	Length (μ)	Width (μ)	Length (μ)	Width (μ)	Length (μ)	Width (μ)
***O. lini* (1)** [a]										
Max. [b]	180.6	7	67.7	10.5	29.4	12.6	22.5	12.6	27.3	16.8
Min. [c]	121.8	5	40.0	8.4	12.6	8.4	16.8	8.4	21.0	10.5
***O. lini* (2)** [d]										
Max.	180.6	8	73.5	12.6	25.2	12.6	29.4	12.6	25.2	14.7
Min.	71.4	4	21.0	8.4	10.5	8.4	14.7	8.4	12.6	8.4
***E. cichoracearum* from okra**										
Max.	197.6	10	33.6	12.6	25.2	14.7	25.2	18.9	29.4	18.9
Min.	92.4	5	12.6	8.4	10.5	8.4	14.7	14.7	21.0	14.7
***E. polygoni* from peas**										
Max.	118.7	4	35.7	6.3	27.3	8.4	29.4	12.6	39.9	16.8
Min.	63.0	4	21.0	4.2	11.6	5.3	10.5	6.3	14.7	7.4
***O. lini* (3)** [e]										
Max.	214.2	9	63.0	12.6	21.0	12.6	21.0	14.7	14.7	16.8
Min.	126.0	6	25.2	6.3	10.5	8.4	14.7	10.5	10.5	10.5
***E. cichoracearum* from tobacco**										
Max.	193.2	8	117.6	14.7	12.6	12.6	21.0	16.8	27.3	16.8
Min.	113.4	6	35.7	6.3	8.4	8.4	10.5	10.5	14.7	10.5
***E. polygoni* from alfalfa**										
Max.	201.6	6	92.4	7.1	42.0	6.3	29.4	8.4	54.6	12.6
Min.	88.2	4	12.6	4.2	12.6	4.2	10.5	5.0	33.6	10.5

[a] Morphotype (1) of *O. lini* from flax
[b] Maximum value.
[c] Minimum value.
[d] Morphotype (2) of *O. lini* from flax.
[e] Morphotype (3) of *O. lini* from flax.

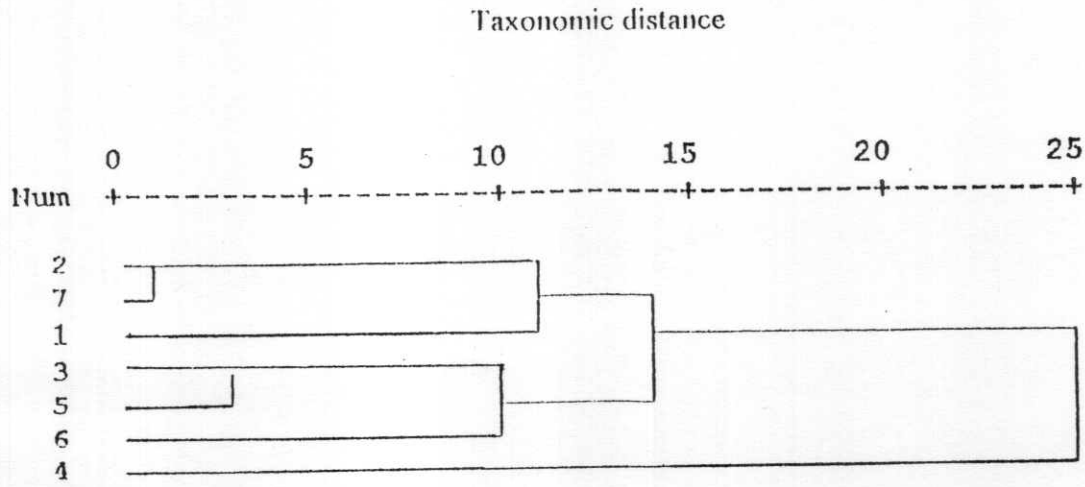

Fig. (3): Phenogram based on average linkage cluster analysis of morphological traits of isolates of *Oidium lini* and *Erysiphe* spp.

1. *O. lini* morphotype 1,
2. *O. lini* morphotype 2,
3. *E. cichoracearum* from okra
4. *E. polygoni* from peas,
5. *O. lini* morphotype 3,
6. *E. cichoracearum* from tobacco,
7. *E. polygoni* from lalfalfa.

addition to *O. lini* morphotype 3. The laterone and *E. cichoracearum* from okra were included in a distinct subcluster showing a high similarity level (TD = 2.4). In this phenogram, isolates from different hosts but belonged to the same species were, as a general rule, clustered with one another. The only exception was the isolate of *E. polygoni* from peas which formed a distinct third cluster unrelated to the their isolate of *E. polygoni* from alfalfa.

2. Characterization of biochemical traits of *O. lini* compared to those of *E. polygoni* and *E. cichoracearum*

A. Serological protein patterns

Antiserum of healthy flax seeds (S) and powdery mildew infected plants (S1) (in central well) against antigens of healthy (A) and infected host plants (Ai), (in peripheral wells). Antigens of healthy and infected host plants are: flax (A1), (A1i), sunflower (A2), (A2i), alfalfa (A3), A3i), okra (A4), (A4i), tobacco (A5), (A5i), *P. dichotomum* (A6), (A6i) and peas (A7), (A7i). The double diffusion reaction (precipitin bands) between antiserum and antigens were determined.

Figs. (4-17) showed the following results (Tables 7) :

1. Strong precipitin bands were observed when the antiserum of infected flax interacted against antigens of healthy flax (Figs. 8, 13), infected flax (Figs. 7, 8, 9, 10, 12, 13, 14, 15, 16 and 18), and healthy alfalfa (Figs. 8 and 11).
2. Moderately strong precipitin bands were observed when the antiserum of infected flax interacted against antigens of healthy peas, infected peas (Figs. 13, 14, 15, 16, 17 and 18), and infected alfalfa (Figs. 8, 18, 17 and 18).

Table (7): Pereipitin bands obtained during double-diffusion reaction of antiserum of flax healthy seeds (S) and flax infected plants (S1) with powdery mildew against antigens of healthy and infected host plants [a].

Antigens			Flax antiserum	
			Healthy seeds (S)	Infected plants (S1)
Flax	(A1)	Healthy	+	++
	(A1i)	Infected		++
Sunflower	(A2)	Healthy	-	--
	(A2i)	Infected		--
Alfalfa	(A3)	Healthy	-	++
	(A3i)	Infected		+
Okra	(A4)	Healthy	-	--
	(A4i)	Infected		--
Tobacco	(A5)	Healthy	-	--
	(A5i)	Infected		--
Panicum dichotomum	(A6)	Healthy	-	--
	(A6i)	Infected		--
Peas	(A7)	Healthy	-	+
	(A7i)	Infected		+

[a] ++ Strong precipitin bands.
+ Moderately precipitin bands.
- No clear precipitin bands.

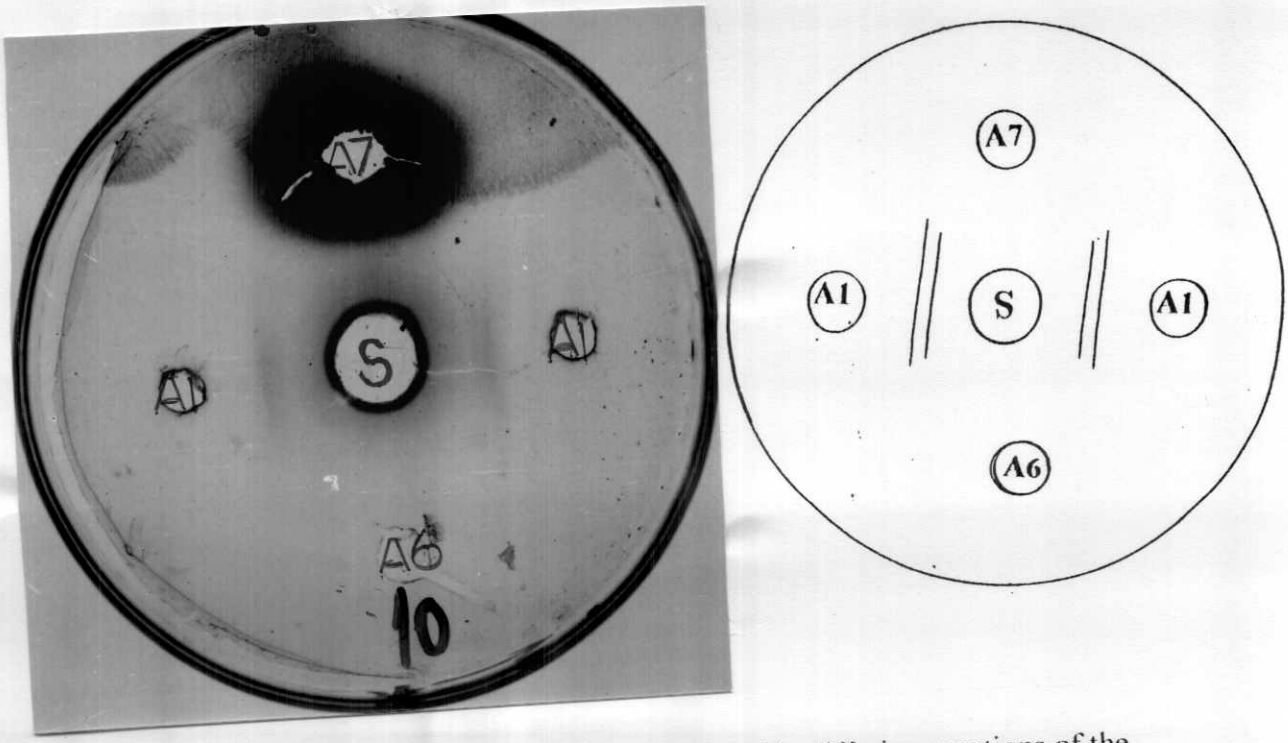

Fig. (4): Photograph and diagram showing the double-diffusion reactions of the antiserum (S) of flax seeds (in central well) against antigens of healthy host plants (in peripheral wells). Antigens are flax (**A1**), *P. dichotomum* (**A6**), and Peas (**A7**).

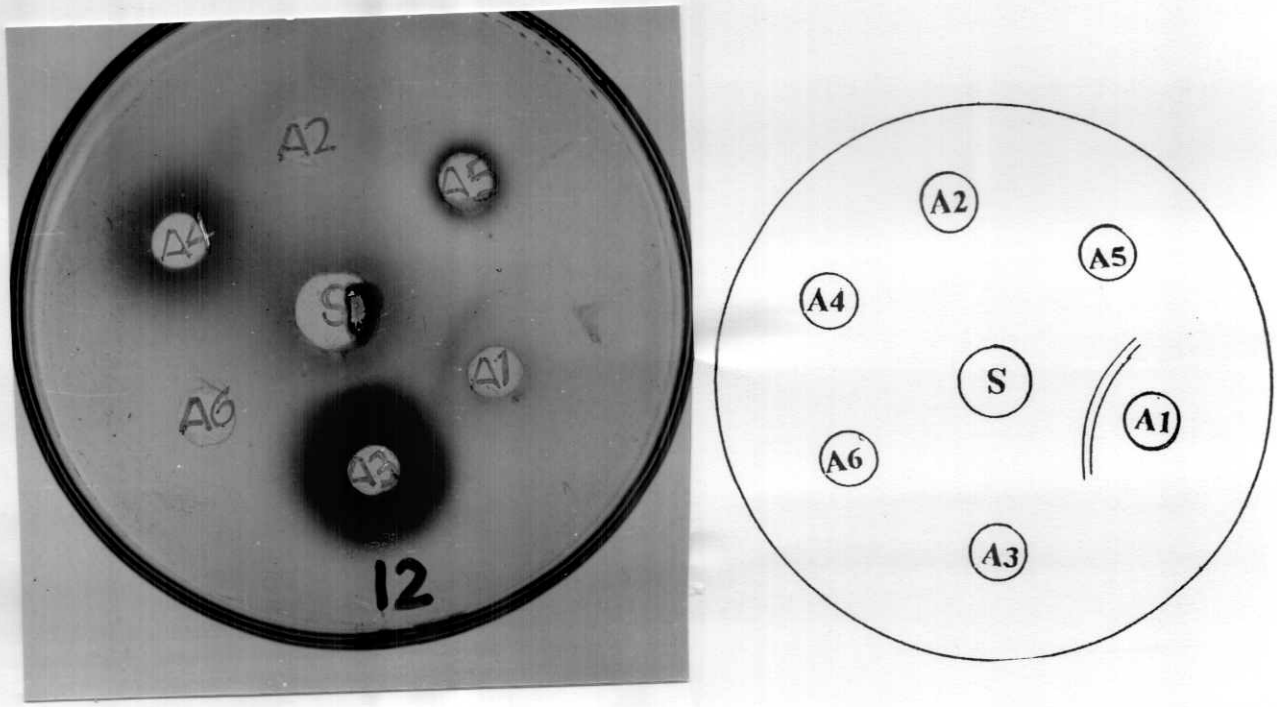

Fig. (5): Photograph and diagram showing the double-diffusion reactions of the antiserum (S) of flax seeds (in central well) against antigens of healthy host plants (in peripheral wells). Antigens are flax (**A1**),Sunflower (**A2**), Alfalfa (**A3**), okra (**A4**), Tobacco (**A5**), and *P. dichotomum* (**A6**).

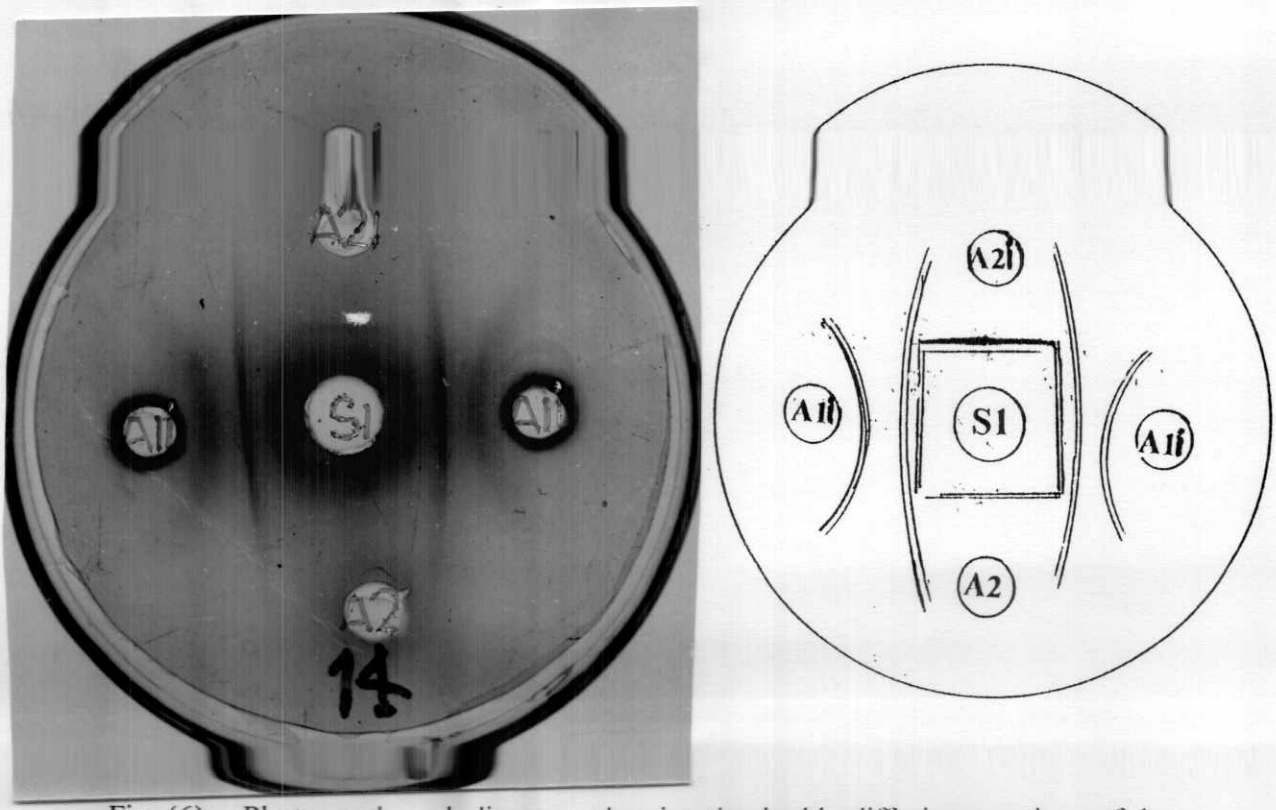

Fig. (6): Photograph and diagram showing the double-diffusion reactions of the antiserum (**S1**) of flax infected with powdery mildew (in central well) against antigens of healthy and infected (**i**) host plants (in peripheral wells). Antigens are flax (A1) and Sunflower (A2).

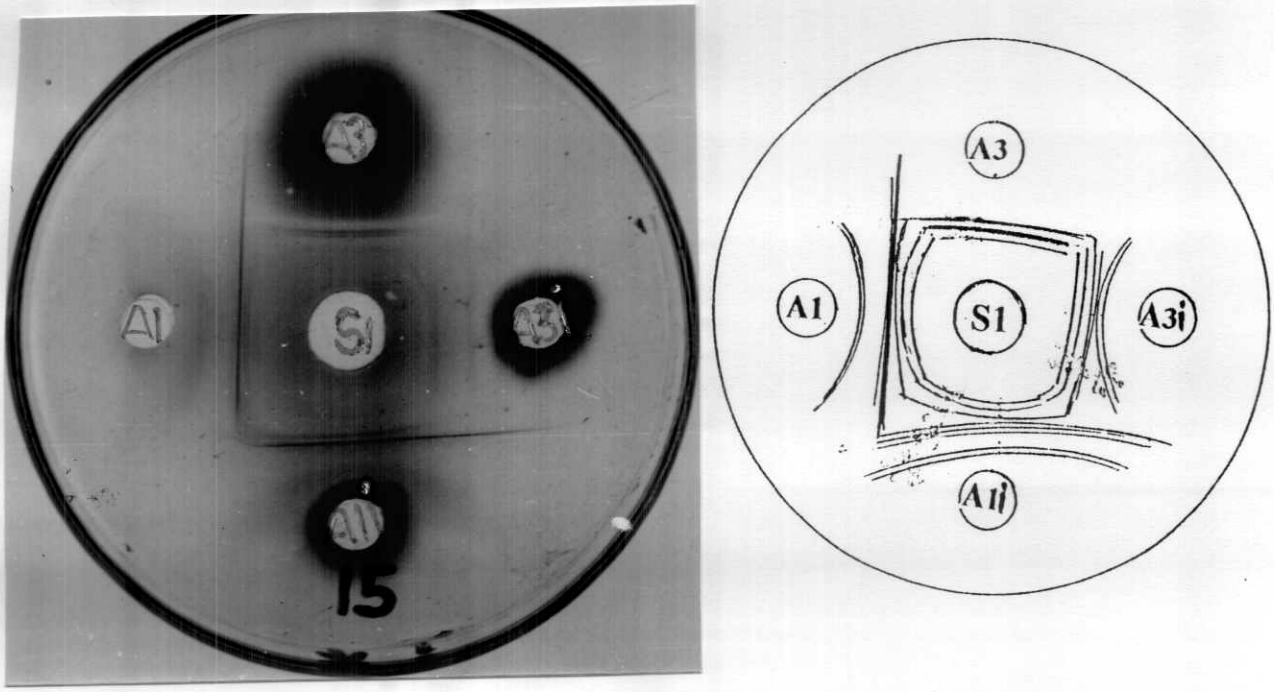

Fig. (7): Photograph and diagram showing the double-diffusion reactions of the antiserum (**S1**) of flax infected with powdery mildew (in central well) against antigens of healthy and infected host plants(**i**) (in peripheral wells). Antigens are flax (**A1**) and infected (**A1i**), alfalfa healthy (**A3**) and infected (**A3i**).

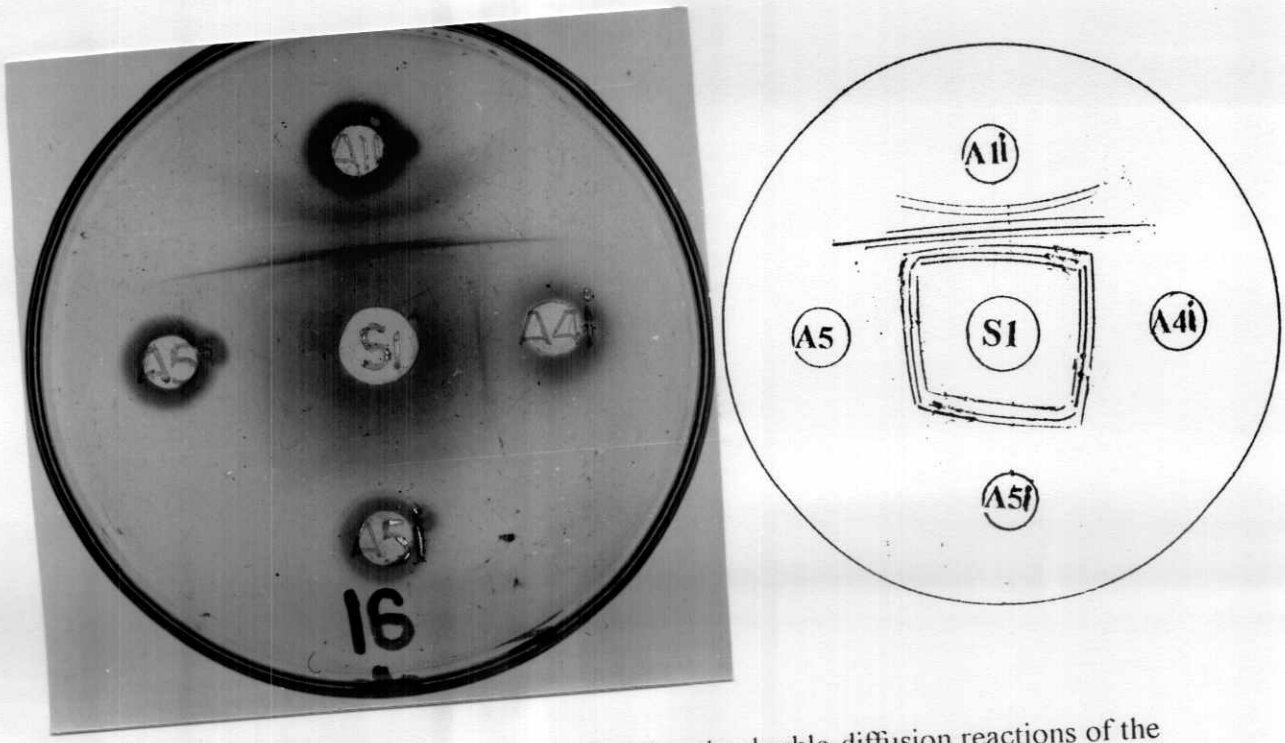

Fig. (8): Photograph and diagram showing the double-diffusion reactions of the antiserum (**S1**) of flax infected with powdery mildew (in central well) against antigens of healthy and infected (**i**) host plants (in peripheral wells). Antigens are flax infected(**A1i**) okra infected (**A4i**) tobacco healthy (**A5**) and infected (**A5i**).

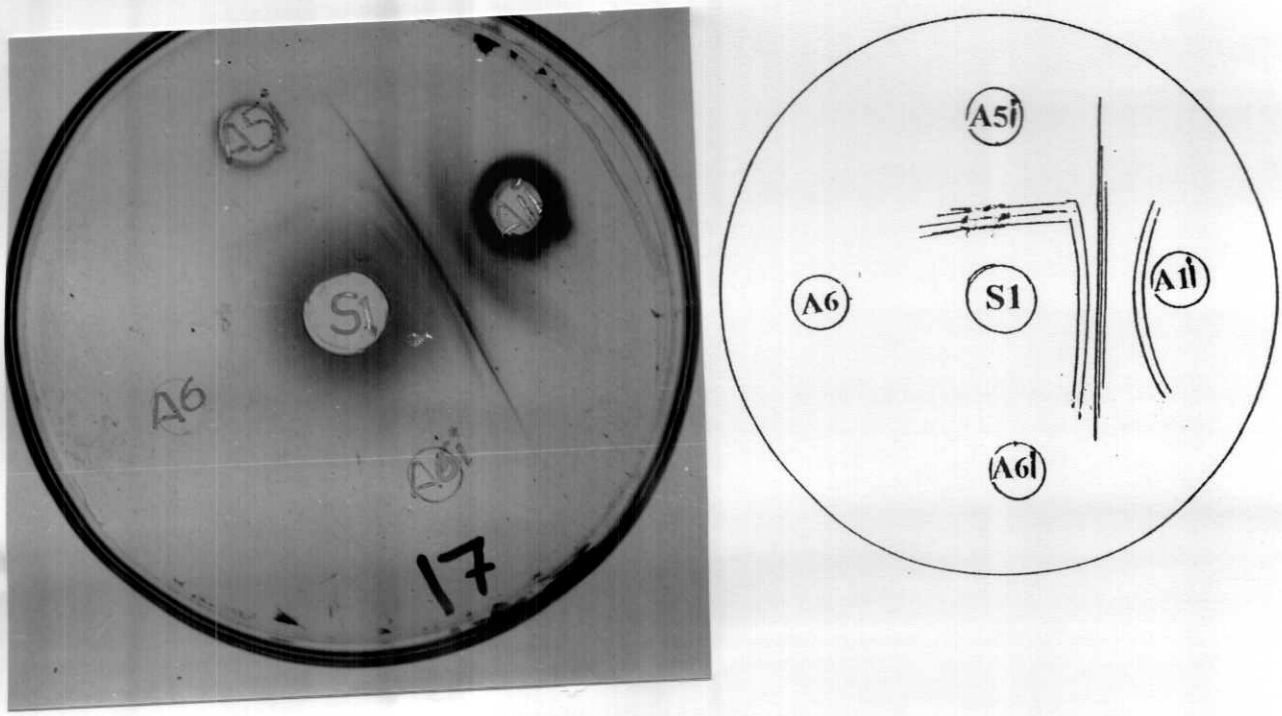

Fig. (9): Photograph and diagram showing the double-diffusion reactions of the antiserum (**S1**) of flax infected with powdery mildew (in central well) against antigens of healthy and infected (**i**) host plants (in peripheral wells). Antigens are flax infected (**A1i**) *P. dichoromum* infected (**A6i**) and healthy (**A6**), tobacco infected (**A5i**).

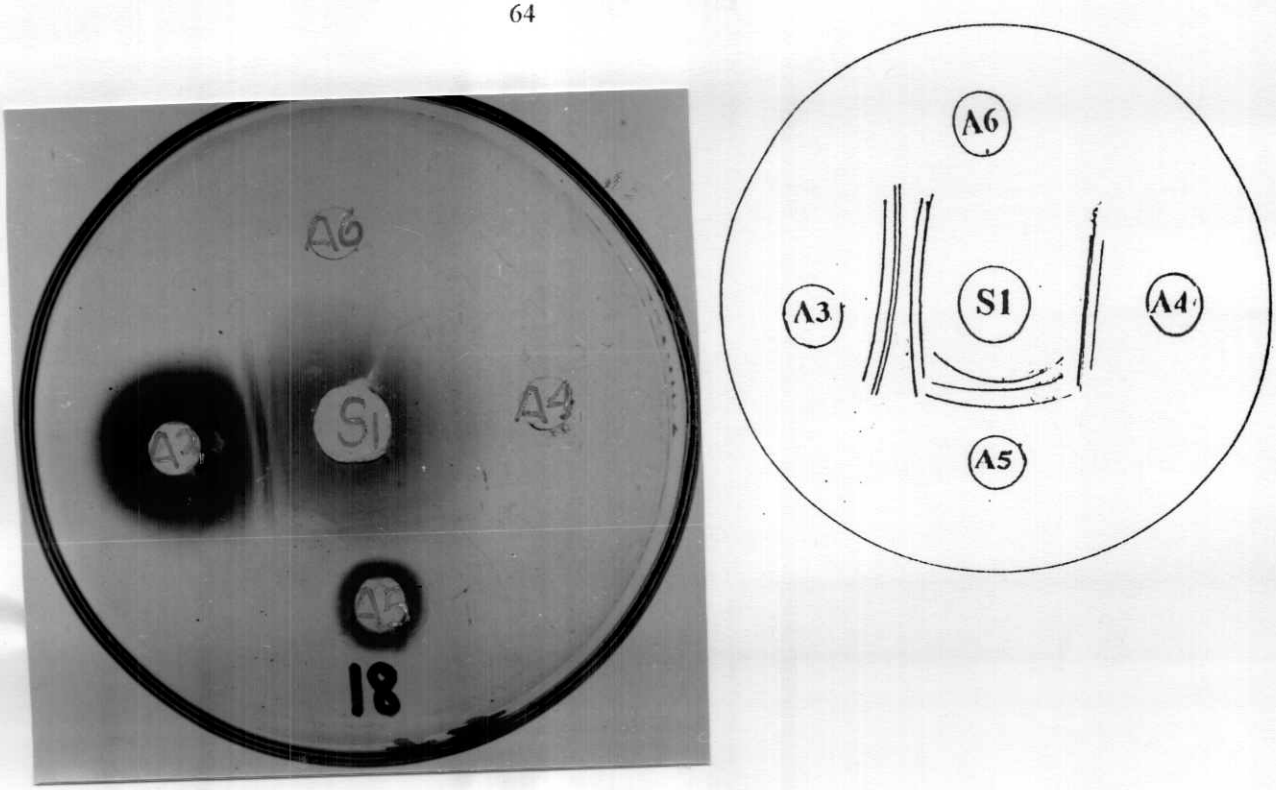

Fig. (10): Photograph and diagram showing the double-diffusion reactions of the antiserum (**S1**) of flax infected with powdery mildew (in central well) against antigens of healthy host plants (in peripheral wells). Antigens are okra (**A4**), tobacco (**A5**) alfalfa (**A3**) and *P. dichoromum* (**A6**).

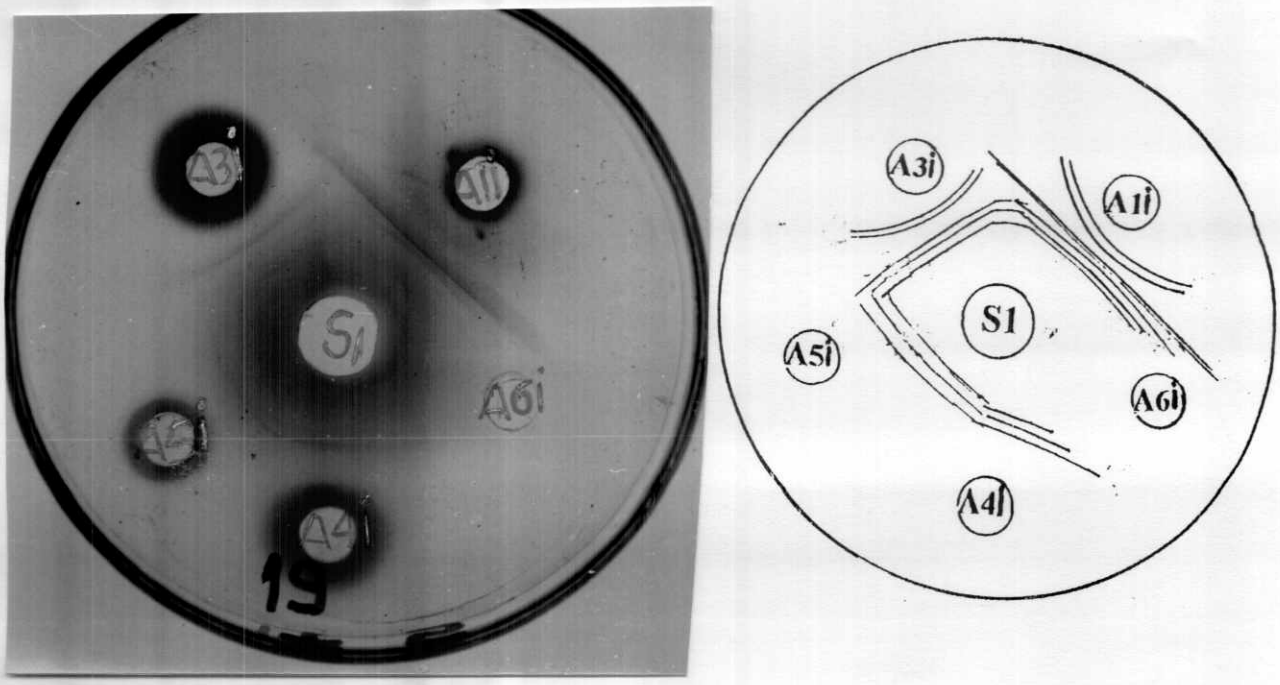

Fig. (11): Photograph and diagram showing the double-diffusion reactions of the antiserum (**S1**) of flax infected with powdery mildew (in central well) against antigens of infected (**i**) host plants (in peripheral wells). Antigens are flax (**A1i**), *P. dichoromum* (**A6i**). okra (**A4i**) tobacco (**A5i**) and alfalfa (**A3i**)

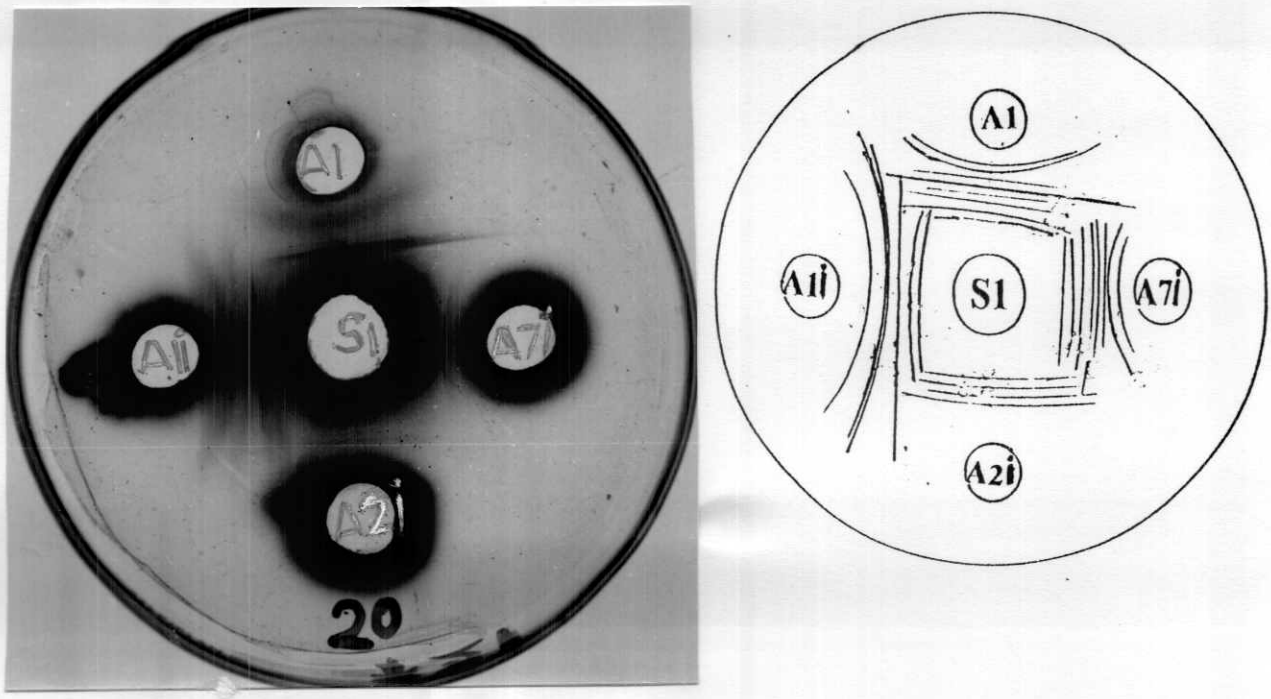

Fig. (12): Photograph and diagram (showing the double-diffusion reactions of the antiserum (**S1**) of flax infected with powdery mildew (in central well) against antigens of healthy and infected host plants (in peripheral wells). Antigens are flax healthy (**A1**) and infected (**A1i**), peas infected (**A7i**) and infected sunflower (**A2i**).

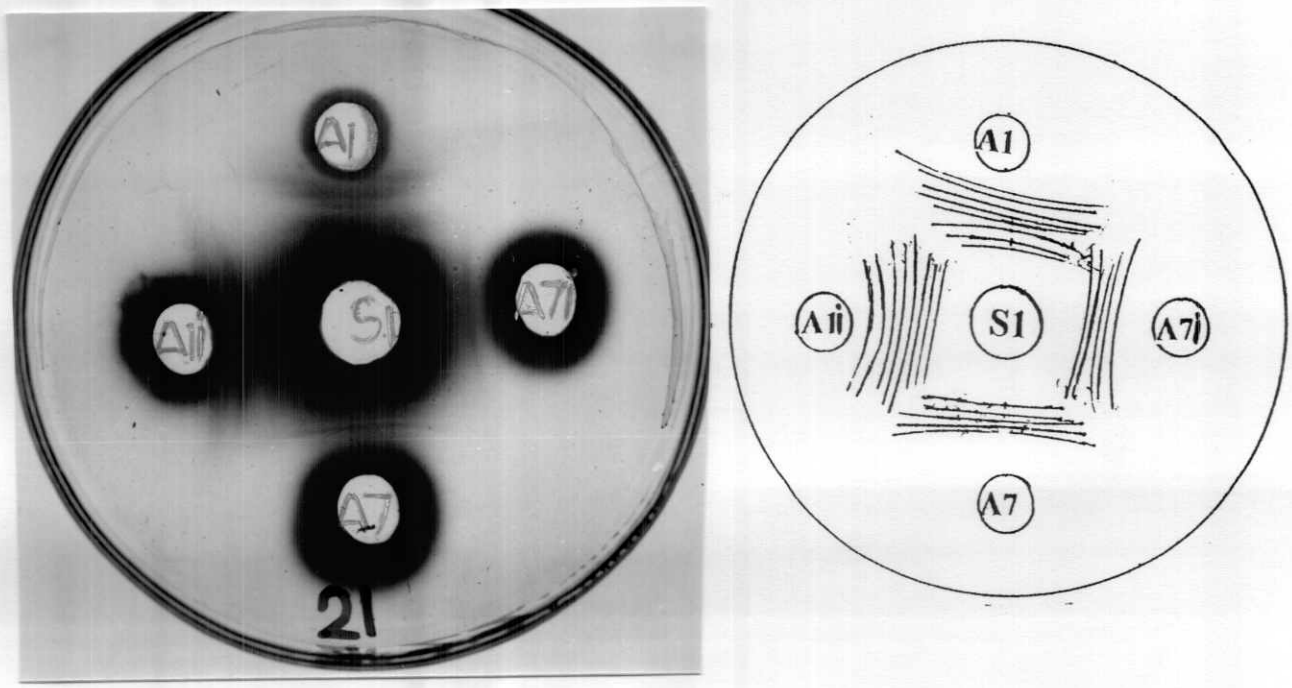

Fig. (13): Photograph and diagram showing the double-diffusion reactions of the antiserum (**S1**) of flax infected with powdery mildew (in central well) against antigens of healthy and infected host plants (in peripheral wells). Antigens are flax (**A1**) and infected (**A1i**), peas infected (**A7i**) and healthy (**A7**).

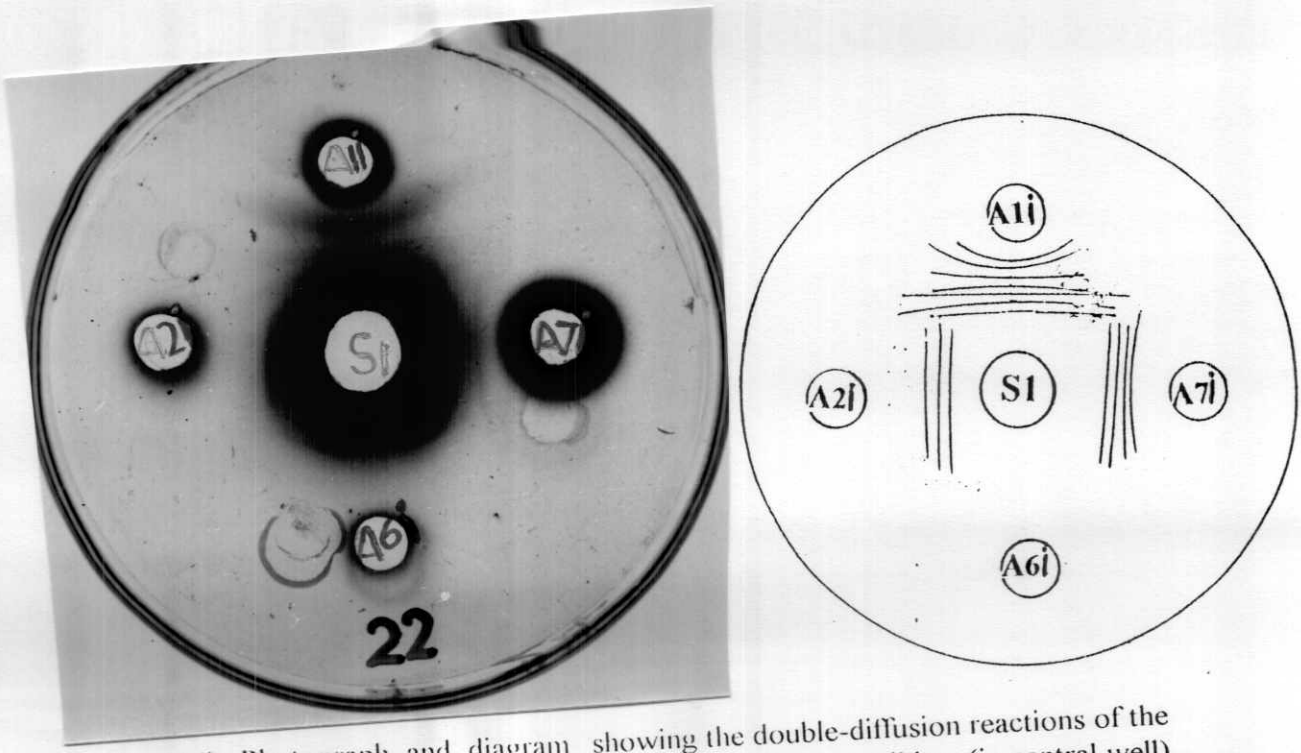

Fig. (14): Photograph and diagram showing the double-diffusion reactions of the antiserum (**S1**) of flax infected with powdery mildew (in central well) against antigens of infected host plants (in peripheral wells). Antigens are flax (**A1i**), peas (**A7i**), *P. dichoromum* (**A6i**) and sunflower (**A2i**).

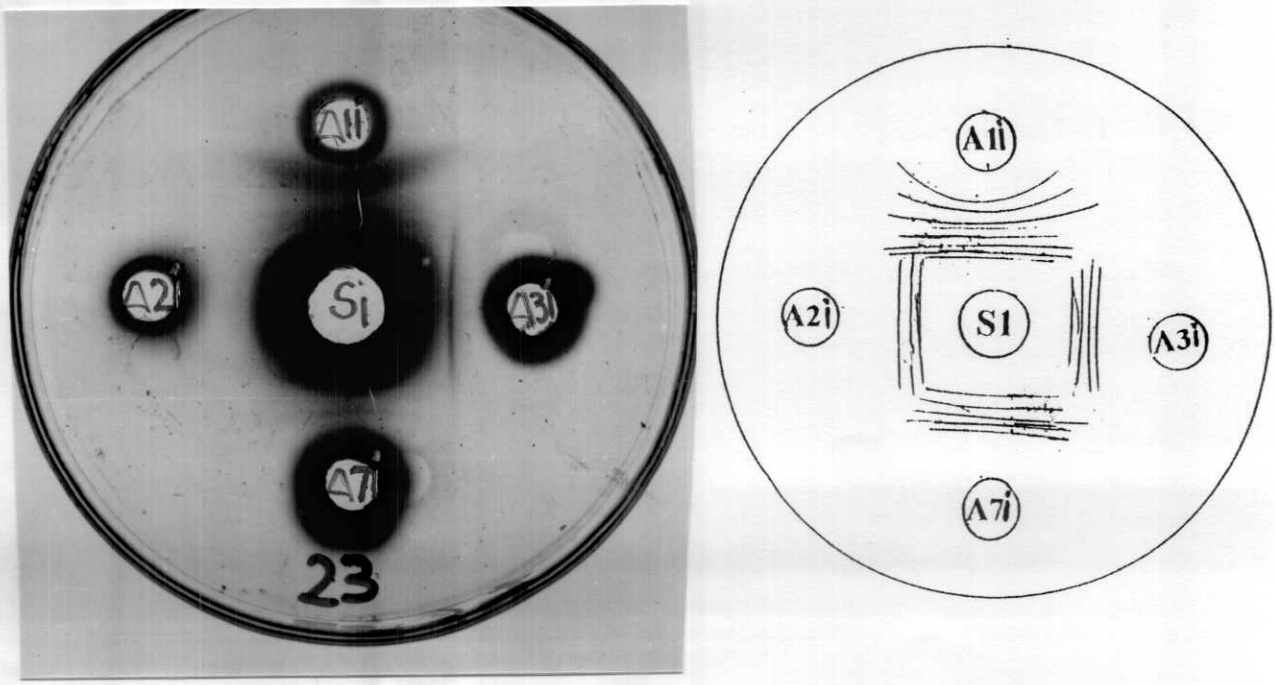

Fig. (15): Photograph and diagram showing the double-diffusion reactions of the antiserum (**S1**) of flax infected with powdery mildew (in central well) against antigens of infected host plants (in peripheral wells). Antigens are flax (**A1i**), alfalfa (**A3i**), peas (**A7i**) and sunflower (**A2i**).

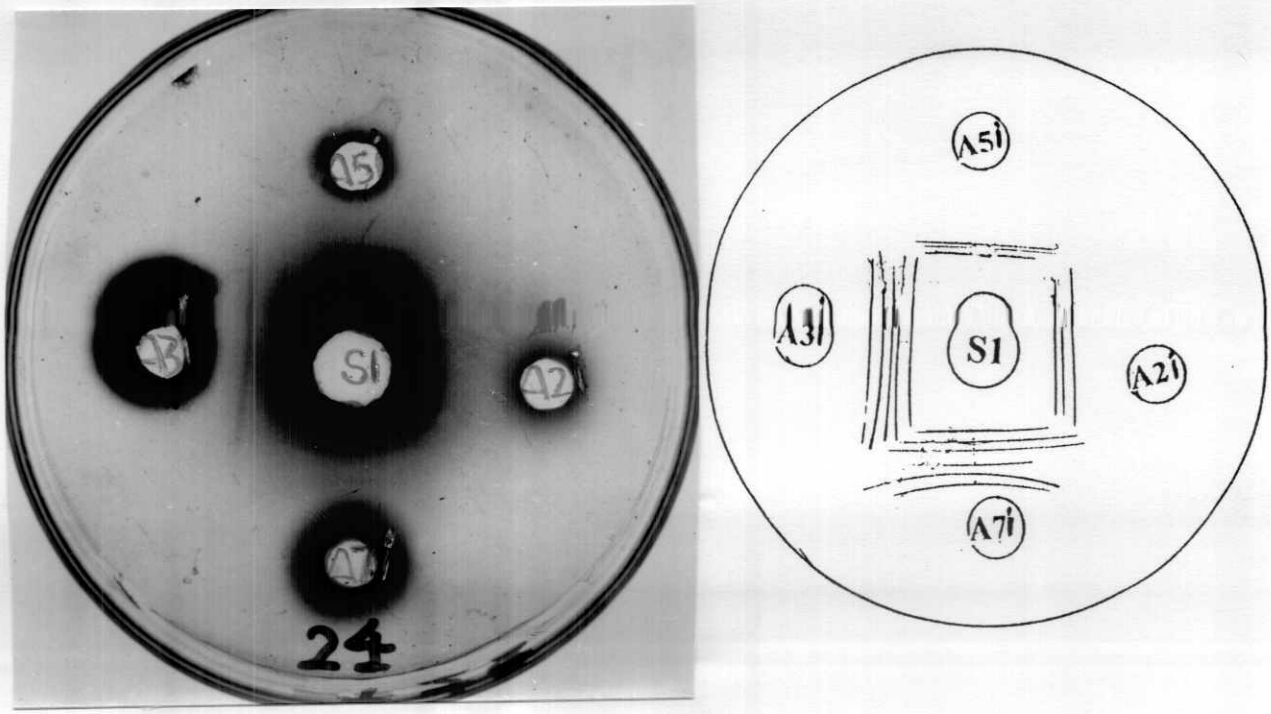

Fig. (16): Photograph and diagram showing the double-diffusion reactions of the antiserum (**S1**) of flax infected with powdery mildew (in central well) against antigens of infected host plants (in peripheral wells). Antigens are tobacco (**A5i**), tobacco (**A2i**), peas (**A7i**) and alfalfa (**A3i**).

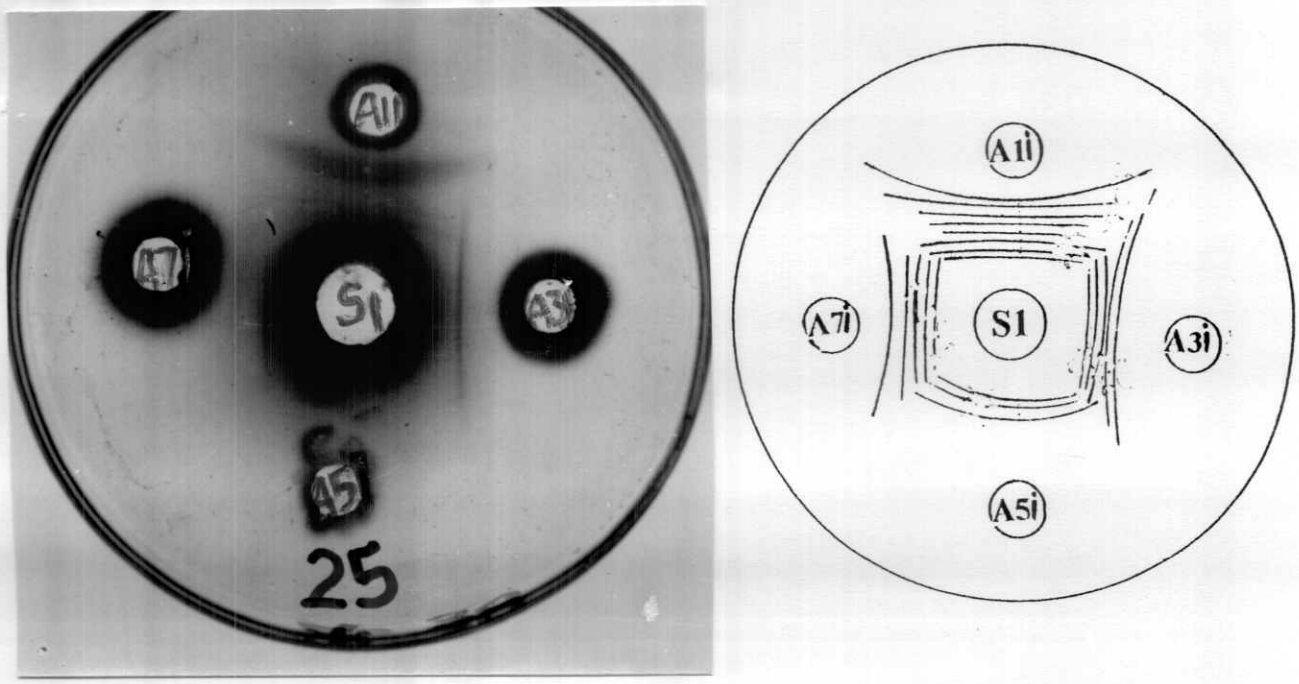

Fig. (17): Photograph and diagram showing the double-diffusion reactions of the antiserum (**S1**) of flax infected with powdery mildew (in central well) against antigens of infected host plants (in peripheral wells). Antigens are flax (**A1i**), alfalfa (**A3i**), tobacco (**A5i**) and peas (**A7i**).

3. Moderately strong precipitin bands were observed between the antiserum of healthy flax seeds and antigens of healthy flax plants (Figs. 5 and 6).
4. Other interaction did not show clear precipitin bans (Figs. 6, 8, 9 and 11).

B. Electrophoretic protein patterns

Protein patterns obtained by SDS-PAGE for *E. polygoni* from peas, *O. lini* from flax, and *E. cichoraceraum* from sunflower are shown in Figs. (18). The phenogram of Fig. (19) was constructed based on Taxonomic distance (TD) generated from cluster analysis of electrophoretic banding patterns of SDS-dissociated proteins shown in Table (8). In this phenogram, *E. polygoni* from peas and *O. lini* from flax belonged to a single cluster (TD = 0.6). This cluster was unrelated to another cluster included *E. cichoracearum* from sunflower.

Effect of relative humidity and temperature on spore germination and length of germ tubes

Analysis of variance (ANOVA) of the effect of relative humidity and temperature on germination of conidia (Table 1 Appendix) showed very highly significant effects of relative humidity (RH), temperature, and their interaction. The comparisons between means of relative humidity showed that the germination of conidia failed to occur at 0.0% relative humidity. The increases in relative humidity improved germination. The increases in relative humidity to 5.2, 26.8, 46.8, 46.8, 66.8, 88.5 and 100% caused highly significant increased in germination from 0.0 at 0.0% RH to 10.187 at 100% RH. Also, significant increase was observed between values in each level of relative humidity which reached its maximum level at 100%

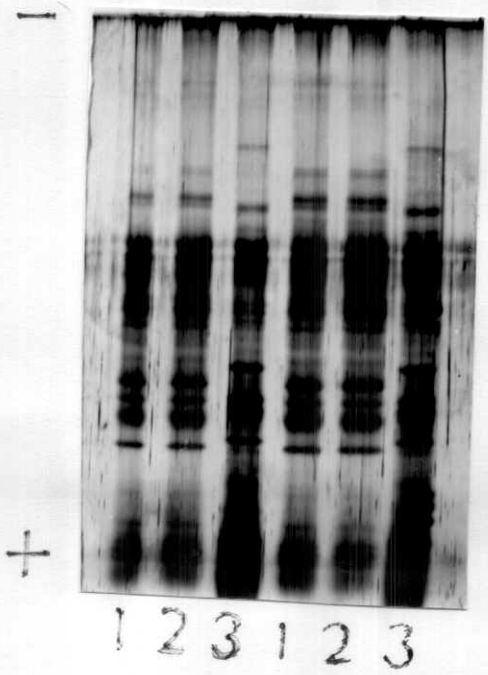

Fig. (18): Protein patterns obtained by SDS-PAGE for *Erysiphe polygoni* from peas (**1**), *Oidium lini* from flax (**2**), and *Erysiphe cichoracearum* from sunflower (**3**).

Table (8): Protein patterns obtained by SDS-PAGE for three powdery mildew fungi.

Band		Fungus		
No.	Rf	*E. polygoni* from peas	*O. lini* from flax	*E. cichoracearum* from sunflower
1	0.02	+	+	+
2	0.11	+	+	-
3	0.28	-	-	+
4	0.36	+	+	-
5	0.38	+	-	-
6	0.40	-	-	+
7	0.45	-	-	+
8	0.46	+	+	-
9	0.48	+	+	+
10	0.49	+	+	-
11	0.50	+	+	-
12	0.51	+	+	+
13	0.52	+	+	-
14	0.53	-	-	+
15	0.54	+	+	-
16	0.55	-	-	+
17	0.56	+	+	-
18	0.57	+	+	-
19	0.58	+	+	+
20	0.59	+	+	-
21	0.60	-	-	+
22	0.62	+	+	+
23	0.63	-	+	-
24	0.64	+	+	+
25	0.65	+	+	-
26	0.67	-	-	+
27	0.68	+	+	-
28	0.70	-	-	+
29	0.73	+	+	+
30	0.76	+	+	-
31	0.80	+	+	+
32	0.82	-	-	+
33	0.83	-	-	+
34	0.85	+	+	-
35	0.89	-	-	+
36	0.92	-	+	-
37	0.93	+	-	-
38	0.94	+	+	+
39	0.97	-	-	+

Rate of flow (Rf) was calculated according to the following formula:

$$\frac{\text{Migration distance of bond (cm)}}{\text{Migration distance of marker (cm)}}$$

\+ The designated band is present.

\- The designated band is absent.

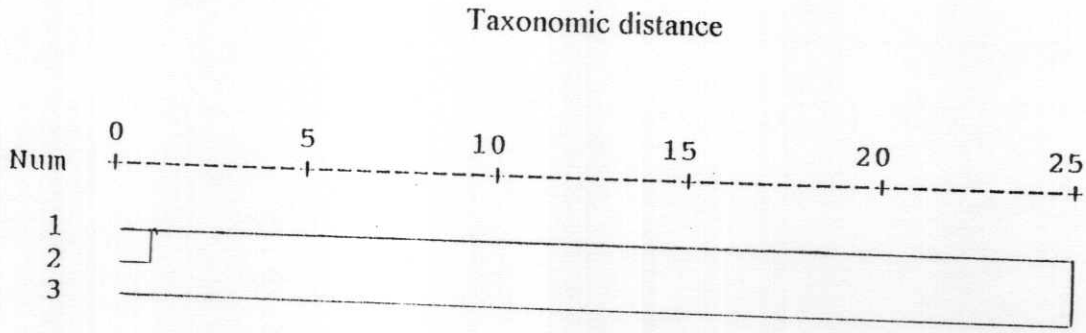

Fig. (19): Phenogram based on average linkage cluster analysis of electrophoretic protein patterns obtained by SDS-PAGE from *Erysiphe polygoni* of peas (**1**), *Oidium lini* of flax (**2**), and *Erysiphe cichoracearum* from sunflower (**3**).

relative humidity. As to the effect of temperature on germination, the data clearly showed that the lowest level of germination was observed at 5°C. The increases in temperature improved germination which reached its maximum level at 25°C. The increases in temperature to 30°C significantly inhibited germination and the increase to 35°C conidia failed in germination. However the increases in temperature caused highly significant differences between 5, 10, 15, 20, 25°C whereas no clearly significant differences were observed between 20°C, 30°C in this respect. Due to the significance of this interaction, a least significant differences (LSD) was used to compare between individual temperature means within RH levels (Table 9). These comparisons showed that the interaction between RH levels and temperatures was due to either change in the magnitude of the differences between temperatures within RH levels or change in the ranking of the temperatures within RH levels. As to temperature at relative humidity 5.2% no germination was observed at 5 and 10°C. The lowest conidial germination was observed at 5 and 30°C. Due to 26.8% RH no germination was observed at 5°C. However, the lowest conidial germination was observed at 10°C and moderately conidial germination was observed at 15, 30 and 20°C. The highest conidial germination observed at 25°C. As to 46.8 RH also no germination was observed at 5°C. The highest conidial germination was observed at 10°C followed by 15 and 30°C, whereas the highest germination was observed at 20°C and 25°C, respectively. As to 66.8, 88.5 and 100% RH conidial germination were observed at all levels of temperatures. The highest level of germination was observed at 25°C and 100% RH. For example, differences between percentages of conidial germination at 15 and 30°C was nonsignificant at relative humidity 100%, however, it was highly

significant at relative humidity 88.5%. The rankings of 25°C and 30°C within 46.8 RH were 6 and 4, respectively; however, within 66.8 RH, their rankings became 7 and 5 respectively. The difference of the two temperatures was significant within each of the two RH levels.

Relative humidity, temperature and their interaction were all very highly significant sources of variation in length of germ tube (Table 3 Appendix). The comparisons between means relative humidity revealed that the lowest length of germ tube was observed at 0.0% relative humidity. The increase in relative humidity improved length of germ tube when 0.0% RH no length of germ tube was observed. However the improved in RH 5.2, 26.8, 46.8, 66.8 and 88.0% increased length of germ tube without significant in between. The maximum increases in length of germ tube was observed at 100% RH which reached its maximum level at 100% relative humidity. The increases in temperature improved length of germ tube. No length of germ tube was observed in 35°C where the lowest length of germ tubes showed at 5°C followed by 10°C without significant differences also no significant difference was observed between length of germ tubes at 20°C and 30°C. Whereas significant difference was observed between 15 and 25°C. The increase of length of germ tube reached its maximum level at 25°C. The increases in temperature to 25°C and 30°C significantly inhibited elongation in germ tube. The comparisons between individual temperature means within RH levels (Table 10) revealed that the RH x temperature interaction was due to change in the magnitude of the differences between temperatures within RH levels. For example, when RH was maintained at 46.8%, no significant difference in length of germ tube was observed between 20°C and 25°C; however, this difference was highly significant when relative humidity was increased to 100%. The rankings of the two

Table (9): Effect of relative humidity, temperature and their interaction on the percentage of conidial germination of *O. lini* from flax after incubation for 24 hours..

Relative humidity (%)	Temperature (°C)							Mean
	5	10	15	20	25	30	35	
0.0	1 0.00	1 0.00	1 0.00	1 0.00	1 0.00	1 0.00	1 0.00	0.00
5.2	1 0.00	1 0.00	2 2.00	4 3.00	5 4.00	3 2.67	1 0.00	1.667
26.8	1 0.00	2 1.67	3 2.30	5 3.33	6 6.33	4 3.00	1 0.00	2.376
46.8	1 0.00	2 2.33	3 3.00	5 4.33	6 7.33	4 3.33	1 0.00	2.903
66.8	2 1.33	3 3.00	4 3.33	6 6.00	7 9.67	5 4.33	1 0.00	3.951
88.5	2 2.00	3 3.67	4 5.00	6 7.67	7 10.67	5 6.67	1 0.00	5.097
100.0	2 4.33	3 5.33	4 9.33	6 16.66	7 26.33	5 9.33	1 0.00	10.187
Mean	1.09	2.29	3.56	5.86	9.19	4.19	0.00	3.740

L.S.D. (Transformed data) for temperature = 0.2518 ($P \leq 0.05$) or 0.3333 ($P \leq 0.01$).
L.S.D.(Transformed data) for relative humidity = 0.2518 ($P \leq 0.05$) or 0.3333 ($P \leq 0.01$).
L.S.D.(Transformed data) for relative humidity x temperature = 0.6661 ($P \leq 0.05$) or 0.8818 ($P \leq 0.01$).

[a] Data were transformed into $\sqrt{X+0.5}$ before carrying out analysis of variance where X is the percentage value. Transformed means are shown in parentheses. Figures from 1-7 are ranking of temperatures within the designated level of relative humidity based on transformed data.

Table (10): Effect of relative humidity, temperature and their interaction on the length of germ tubes (μ) of *O. lini* after 48 hours.

Relative humidity (%)	Temperature (°C)							Mean
	5	10	15	20	25	30	35	
0.0	1 0.00	1 0.00	1 0.00	1 0.00	1 0.00	1 0.00	1 0.00	0.000
5.2	1 0.00	1 0.00	1 0.00	1 0.00	1 0.00	2 2.67	1 0.00	0.381
26.8	1 0.00	1 0.00	2 1.47	3 1.97	5 3.20	4 3.00	1 0.00	1.377
46.8	1 0.00	1 0.00	2 3.23	4 3.73	5 4.30	3 3.33	1 0.00	2.084
66.8	2 1.60	3 1.73	4. 3.47	5 4.27	7 5.87	6 4.33	1 0.00	3.039
88.0	2 2.00	3 2.67	4 3.77	5 4.57	7 8.70	6 6.67	1 0.00	4.054
100.0	2 2.90	3 3.33	4 5.93	6 11.43	7 17.76	5 9.33	1 0.00	7.240
Mean	0.928	1.105	2.553	3.710	5.690	4.190	0.00	

LSD for temperature = 0.7778 ($P \leq 0.05$) or 1.030 ($P \leq 0.01$).
LSD for relative humidity = 0.7778 ($P \leq 0.05$) or 1.030 ($P \leq 0.01$).
LSD for relative humidity x temperature = 2.058 ($P \leq 0.05$) or 2.724 ($P < 0.01$).
Figures from 1-7 are rankings of temperatures within the designated level of relative humidity.

temperatures which were 4 and 5, respectively, within 46.8% RH changed to 6 and 7, respectively, when RH was increased to 100%.

The nonsignificant difference in length of germ tube at 20°C and 25°C at 26.8% RH became highly significant at the RH level of 88.5% . Data in Table 4 Appendix) showed that RH and temperature were equally important as sources of variation in conidial germination while their interaction was the least important source of variation.

Evaluation of foliar spraying of some compounds for disease control under field conditions

The present study was conducted in the 1994/1995 on Giza 7 cv. and 1995/1996 growing seasons on Giza 8 cv.(hereafter referred to as years 1995 and 1996, respectively) to explore the beneficial effect of foliar application of different compounds for control of flax powdery mildew under field conditions. Agronomic traits (yield and yield components) and disease criteria (DI and DS) were used for evaluating the tested compounds.

In 1995, in Sakha, assessment of the effect of the first spray (27 April) showed that Bayfidan was the best for checking disease incidence. Bayleton, Nu-film. TFS Rubigan, Super-Film came next without significant differences in-between. Sodium bicarbonate and ammonium bicarbonate showed no effect on disease incidence compared with control treatment (Table 11). Bayfidan, Bayleton, Nu-Film-17, Rubigan, TFS and Super-film reduced DI by 70.6, 41.2, 40.7, 35.6 and 32.8, respectively compared with control treatment. After the second spray, i.e. on 7 May, Bayfidan still the best chemical compound for control followed by Bayleton, with clear significant differences in-between. Nu-

Table (11): Effect of different compounds used for control of powdery mildew of flax on disease intensity variables on cultivar Giza 7 under field conditions in Sakha and El-Gemmeiza in 1994/1995.

Compounds	Sakha (Giza 7)				El-Gemmeiza (Giza 7)			
	27 April		7 May		8 May		20 May	
	Disease incidence %	Disease severity %	Disease incidence %	Disease severity %	Disease incidence %	Disease severity %	Disease incidence %	Disease severity %
That flowable sulphur	57.0	79.12	67.5	63.61	72.0	70.46	69.0	38.85
Bayfidan	26.0	48.81	30.0	27.76	52.8	30.02	44.5	41.39
Bayleton	52.0	51.11	48.5	39.72	68.0	59.62	71.5	64.50
Rubigan	57.0	57.12	51.5	42.45	48.0	46.74	51.5	40.21
Sodium bicarbonate	84.5	75.75	70.0	73.68	72.0	83.87	85.0	81.22
Potassium bicarbonate	77.5	82.54	69.0	74.28	73.5	81.26	75.0	80.40
Ammonium bicarbonate	88.5	65.57	74.5	79.28	80.5	79.19	78.0	76.32
Nu-Film-17	52.5	64.51	63.5	55.59	68.0	87.18	89.5	84.85
Super Film	59.5	86.34	78.0	65.73	78.0	61.49	87.5	79.26
Control [d]	88.5	82.49	90.0	82.61	79.0	88.23	86.0	93.85
L.S.D. ($P \leq 0.05$)	18.86	NS	13.73	NS	NS	20.11	17.32	21.37
L.S.D. ($P \leq 0.01$)	25.47	NS	18.54	NS	NS	NS	23.38	28.86

[a] Disease incidence (percentage of infected plants in a random sample of 50 plant/pot).

[a] Disease severity (percentage of infected leaves/plant in a random sample of 10 plant/plot).

[c] Mean of four replicates.

[d] Plants were sprayed with water.

Film, that flowable sulfur, potassium bicarbonate ranked the next without significant variation between them. Although Super-film, ammonium bicarbonate ranked the first tested compounds but they still effective and reduced DI significantly compared with the control treatment. In this regard, sodium bicarbonate showed moderate effect. On Giza 7 cv.1995 season, assessment of disease incidence after the second spray, assessment of disease incidence after the second spray, was relatively decreased, after the second spray in case of Bayleton, Rubigan, sodium bicarbonate, potassium bicarbonate, ammonium bicarbonate and control treatments, however it was relatively increased in case of TFS, Bayfidan and Super-film compared with disease assessment after the first spray. Thus sodium bicarbonate and ammonium bicarbonate which were ineffective after the first spray caused significantly reduced in disease incidence by 22.2 and 17.2%, respectively compared with control treatment. Efficiencies of Bayleton, Rubigan and potassium bicarbonate increased to 46.1 and 42.8 and 23.3%, respectively compared with the control treatment. On the other hand, the efficiencies of Bayfidan and Nu-Film-17 and Super-Film decreased to 666.7, 29.4, 25.0, 13.3%, respectively. Non of the tested compounds was effective in reducing DS neither after the first or second spray compared with control treatments.

In 1995, in El-Gemmeiza, DI on Giza 7 after the first spray was not significantly affected by any of the tested compounds (Table 11). After the second spray, Bayfidan and Rubigan significantly reduced DI after the second spray 48.3 and 40.1 respectively. That flowable sulphur, Bayleton and potassium bicarbonate reduced DI by 19.8, 16.9 and 12.8%, respectively compared with control treatment. After the first spray, DS was

significantly reduced by Bayfidan, Rubigan, Bayleton and super-film. These compounds reduced DS by 66.0, 47.0, 32.4 and 30.3%, respectively compared with control treatment. After the 2nd spray, sodium bicarbonate, potassium bicarbonate, and Nu-film-17 remained ineffective in reducing DS compared with control treatment. The efficiencies of TFS, Rubigan, increased to 58.6 and 55.9, respectively. Bayfidan and super film showed decreases in efficiencies, thus, their efficiencies decreased to 55.9% and 15.6%, respectively. Ammonium bicarbonate which was ineffective in reducing DS after the first spray reduced DS by 16.7% after the 2nd spray.

In 1996, in Sakha, (Table 12) Bayfidan was the only fungicide which significantly reduced DI on cultivar Giza 8 after the first spray. It reduced it by 73.8%. This fungicide remained effective in reducing DI after the second spray, however, its efficiency decreased to 33.08%. Rubigan was the best one in reducing DI after the 2nd spray, which was reduced by 60.8 followed by Bayfidan and ammonium bicarbonate which reduced DI by 33.1 and 26.9%, respectively. It is worth mentioning that Rubigan was ineffective in reducing DI after the first spray while ammonium bicarbonate significantly increased it. Sodium bicarbonate significantly increased DI after the first spray while it has not effect on DI after the 2nd spray. Disease severity after the first spray was not significantly affected by the application of any of the tested compounds. After the 2nd spray, Bayfidan, Rubigan, sodium bicarbonate and ammonium bicarbonate significantly reduced DS by 62.4, 31.5, 27.1 and 13.3%, respectively.

Table (12): Effect of different compounds used for control of powdery mildew of flax on disease intensity variables on cultivar Giza 8 under field conditions in Sakha and El-Gemmeiza in 1995/1996.

Compounds	Sakha (Giza 8)				El-Gemmeiza (Giza 8)			
	23 April		8 May		4 May		14 May	
	Disease incidence %	Disease severity %	Disease incidence %	Disease severity %	Disease incidence %	Disease severity %	Disease incidence %	Disease severity %
That flowable sulphur	68.50	73.91	74.00	78.29	68.4	58.22	80.5	65.03
Bayfidan	16.50	51.71	43.50	31.74	16.4	10.43	43.5	30.37
Bayleton	63.50	56.78	73.50	78.38	63.5	58.22	73.0	64.17
Rubigan	62.00	30.86	25.50	57.86	44.5	16.45	26.5	32.28
Sodium bicarbonate	77.90	69.71	71.00	61.50	77.5	68.10	71.0	71.16
Potassium bicarbonate	62.50	83.66	71.50	85.85	62.5	83.59	71.5	77.11
Ammonium bicarbonate	76.50	61.31	47.50	73.17	76.5	68.35	57.5	79.40
Nu-Film-17	54.50	70.81	72.00	85.56	72.0	53.78	66.0	58.02
Super Film	63.00	61.94	78.00	82.73	73.0	45.05	78.8	49.95
Control [d]	63.00	67.57	65.00	84.42	75.5	92.39	89.0	88.15
L.S.D. ($P < 0.05$)	19.06	NS	21.00	17.53	17.90	24.62	21.04	22.12
L.S.D. ($P < 0.01$)	NS	NS	NS	16.1	24.17	33.25	NS	NS

[a] Disease incidence (percentage of infected plants in a random sample of 50 plant/pot).

[a] Disease severity (percentage of infected leaves/plant in a random sample of 10 plant/plot).

[c] Mean of four replicates.

[d] Plants were sprayed with water.

In 1996, in El-Gemmeiza, DI on cultivar Giza 8 after the first spray was only affected by the application of Bayfidan, Rubigan which significantly reduced by 78.3 and 41.0%, respectively compared with the control treatment (Table 12). After the 2nd spray, Rubigan, Bayfidan, ammonium bicarbonate and Nu-Film-17 significantly reduced DI by 70.2, 51.1m 35.9 and 25.8%, respectively, compared with control treatment. These tested compounds were effective in reducing DI by different levels of efficiency. Rubigan and Bayfidan showed the highest levels of efficiency in reducing DI by 70.2% and 51.1%, respectively, ammonium bicarbonate and Nu-Film showed moderate levels of efficiency by 35.4 and 24.8%, respectively, the lowest levels of efficiency showed by potassium bicarbonate, sodium bicarbonate and Rubigan which reduced DI without significant differences by 20.2, 19.7, and 18.0 %, respectively.

As to DS after the first spray all tested compounds significantly reduced DS except potassium ammonium and sodium bicarbonate. Bayfidan and Rubigan were the best in reducing DS by 88.7 and 82.2%, respectively. Super-film, Nu-Film-17, Bayleton and TFS, also significantly reduced DS by 51.2, 41.8 and 37.0%, respectively. Potassium bicarbonate was ineffective in reducing DS after each spray.A,bicarbonate ineffective in reducing DS after the first spray, but not after the second spray. All other compounds caused significant reductions in DS after each spray. However, their efficiencies were always lower after the second spray than after the first spray. Bayfidan, Rubigan were the most effective fungicides in reducing DS after each spray. After the first spray, they reduced it by 888.7 and 82.2%, respectively. After the 2nd spray, they reduced it by 65.6 and

63.4, respectively. Applying different tested compounds for disease control resulted in some conflicts as follows:

(1) In some cases DI and DS were relatively lower at the second assessment than those of the first one. For example, Bayleton, Rubigan, sodium bicarbonate, potassium bicarbonate at Sakha, TFS, sodium bicarbonate and ammonium bicarbonate at El-Gemmeiza on Giza 7 cv. in 1995 season and sodium bicarbonate at El-Gemmeiza on Giza cv. in 1995 season and sodium bicarbonate only at both locations on Giza cv. in 1996 season. However, the reverse pattern was observed in other cases i.e. both DI and DS were higher after the second spray than after the first one as in case of Bayleton and Nu-Film at El-Gemmeiza on Giza 7 cv. in 1995 season and RFS, Bayleton and Super film on both locations on Giza 8 cv. in 1996 season. However, in some other cases DI was behaved inversely with DI assessed after the second spray when compared with that assessed after the first one. For instance, DI was increased and DS was decreased in case of TFS, Bayfidan, Nu-film and Super-film in Sakha and Nu-Film, Rubigan and potassium bicarbonate in El-Gemmeiza on Giza 7 in 1995 season and Bayfidan in Sakha and Bayfidan in El-Gemmeiza on Giza 7 cv. in 1995 season and Nu-film in El-Gemmeiza and Rubigan and ammonium bicarbonate in both Sakha and El-Gemmeiza on Giza 8 cv. in 1996 season, the Ds was increased and DI was decreased after the second spray when compared with their corresponding after the first spray. This conflicting in some cases of DI and DS in responses to the application of fungicides is attributed to the following factors:

(a) The nature of the chemical compounds, a group of fungicides, Bayfidan, Bayleton, Rubigan, reduced disease with respect to chemical structure, except of biological activity and degree of systematic (**Siegal, 1981**). (b) Sulphur compounds as TFS exerts its fungicidal action at the surface of plant folliar parts. It does not penetrate into plants and move through them to extent sufficient to protect the new parts of the plant which appear after treatment. (c) Coating polymers i.e. Super-film and Nu-film-17 have been used artificial barries on leaf surface to inhibit folliar pathogen, most of these coating polymers are nonphytotoxic, permeable to gases, resistant to weathering for at least one week, and biodegradable (**Haa, 1990; Ziv and Frederikson, 1987**). (d) Bicarbonate compounds may reduced disease by direct effects on the pathogen. **Homma *et al.*, 1981** found that sodium bicarbonate inhibited canidial formation and germination of *Sphaerotheca fuligimea*. (e) Number of treatments, the period between treatment, natural inoculum under field conditions all this factors were shared by parts of the rule in this conflicting phenomenon.

In 1995, in Sakha, none of the tested agronomic traits of Giza 7 (Table 13) was significantly affected by compound applications, except in case of seed yield per feddan. Nonsignificant differences were observed between the tested compounds and the control treatment. Significant differences were observed between TFS and Bayleton, Rubigan and Super-film. Also significant affected between potassium bicarbonate and each of Bayfidan, Rubigan, Super-Film and Nu-Film-17. This results may be relatively as a results of the variation of the efficiencies of the chemical compound on the plant and pathogen. Yet, some nonsignificant improvement were observed

Table (13): Effect of different compounds used for control of powdery mildew of flax on agronomic traits(yield and yield components) on cultivar Giza 7 under field conditions in Sakha in 1994/1995.

Fungicide	Technical stem length (cm)	Apical branching zone length (cm)	Stem diameter (mm)	Straw weight per plant (g)	No. of capsules per plant	Seed weight per plant (g)	Seed index (g)	Straw yield per fed. (ton)	Seed yield per fed. (kg)
That flowable sulphur	66.38[a]	17.45	2.12	1.89	9.80	0.54	10.67	1.58	195.0
Bayfidan	71.93	14.95	2.27	1.55	8.82	0.47	9.79	2.45	362.0
Bayleton	70.64	19.89	2.47	2.02	12.23	0.59	10.41	1.63	271.0
Rubigan	70.37	13.63	2.40	1.38	7.85	0.44	10.29	2.26	345.0
Sodium bicarbonate	68.86	18.36	2.29	1.79	9.35	0.46	10.12	1.71	293.0
Potassium bicarbonate	71.92	14.58	2.17	1.66	8.27	0.59	9.95	1.35	189.0
Ammonium bicarbonate	71.73	14.19	2.10	1.46	8.15	0.44	13.23	1.66	242.0
Nu-Film-17	72.45	15.40	2.03	1.91	12.35	0.59	13.55	2.20	304.0
Super Film	70.91	14.67	2.47	1.74	10.29	0.34	10.36	2.41	341.0
Control [b]	74.66	16.25	2.23	1.50	8.55	0.35	9.85	2.10	269.0
L.S.D. ($P \leq 0.05$)	NS	NS	NS	NS	NS	NS	NS	NS	112.0
L.S.D. ($P \leq 0.01$)	NS	NS	NS	NS	NS	NS	NS	NS	NS

[a] Mean of four replicates.

[b] Plants were sprayed with water.

with compound applications in almost all agronomic traits except in case of technical stem length which was relatively decreased by all tested compounds compared with control treatments.

In 1996, In Sakha, all agronomic traits were not significantly affected by the application of the tested compounds (Table 14) except seed yield/feddan which was significantly reduced by 45.2% after the application of potassium bicarbonate compared to the control treatment. All the tested compounds significantly increased seed yield compared to ammonium bicarbonate. Bayfidan, TFS, Bayleton were the highest tested compounds increased seed yield/feddan, followed by sodium bicarbonate, Nu-Film-17 and Rubigan. No significant differences were observed between potassium bicarbonate and super film which were the lowest tested compounds in seed yield per feddan. In case of potassium bicarbonate which was observed in Table (14) may be due to phytotoxicity case by application with potassium bicarbonate (**Ziv and Zitter, 1992**).

In 1996, In El-Gemmeiza, all of the tested yield compounds of Giza 8 cv. with the exception of number of capsules and number of fruiting branches, were not significantly affected by the tested compounds, yet, some nonsignificant improvements were observed in some yield components (Table 15). That folawble sulphur (TFS) was the only compound which significantly improved yield components. This compound significantly increased number of capsules and number of fruiting branches per plant 104.6 and 75.6%, respectively, over those in control treatment.

Table (14): Effect of different compounds used for control of powdery mildew of flax on agronomic traits(yield and yield components) on cultivar Giza 8 under field conditions in Sakha in 1995/1996.

Fungicide	Technical stem length (cm)	Apical branching zone length (cm)	Stem diameter (mm)	Straw weight per plant (g)	No. of capsules per plant	Seed weight per plant (g)	Seed index (g)	Straw yield per fed. (ton)	Seed yield per fed. (kg)
That flowable sulphur	76.30 [a]	16.55	2.14	3.46	13.00	0.70	9.93	3.07	995.0
Bayfidan	77.68	18.63	2.44	3.41	12.13	0.69	9.88	4.29	1035.0
Bayleton	81.84	15.99	2.53	3.61	13.27	0.68	9.96	4.03	917.0
Rubigan	75.08	18.78	2.21	3.79	13.06	0.71	9.95	3.78	825.0
Sodium bicarbonate	81.14	19.86	2.63	4.27	18.13	1.02	10.06	3.30	874.0
Potassium bicarbonate	79.56	19.15	2.36	3.94	15.93	0.94	8.97	2.88	436.0
Ammonium bicarbonate	74.09	22.22	2.59	4.59	18.50	1.10	9.95	3.00	770.0
Nu-Film-17	82.02	17.15	2.20	3.33	10.23	0.59	9.67	4.05	848.0
Super Film	75.65	18.18	2.35	3.55	13.28	0.81	9.57	3.61	713.0
Control [b]	75.44	20.43	2.28	3.73	13.67	0.84	10.14	3.67	796.0
L.S.D. ($P \leq 0.05$)	NS	NS	NS	NS	NS	NS	NS	NS	308.0
L.S.D. ($P \leq 0.01$)	NS	NS	NS	NS	NS	NS	NS	NS	NS

[a] Mean of four replicates.
[b] Plants were sprayed with water.

Table (15): Effect of different compounds used for control of powdery mildew of flax on agronomic traits(yield and yield components) on cultivar Giza 8 under field conditions at El-Gemmeiza in 1995/1996.

Fungicide	Technical stem length (cm)	Apical branching zone length (cm)	Stem diameter (mm)	No. of capsules per plant	No. of fruiting branches per plant	No. of seeds per capsule	Straw yield per fed. (ton)	Seed yield per fed. (kg)
That flowable sulphur	67.70 a	15.63	2.74	14.63	23.18	6.48	2.81	1106.70
Bayfidan	71.00	11.20	2.59	7.43	13.33	5.70	3.00	980.65
Bayleton	65.55	10.58	2.75	6.30	10.73	5.73	3.42	1081.50
Rubigan	67.35	10.80	2.57	9.78	16.30	6.55	3.26	947.20
Sodium bicarbonate	69.50	10.43	2.59	7.03	10.43	5.85	4.27	1191.18
Potassium bicarbonate	63.40	12.83	2.39	9.48	14.98	6.23	3.39	987.90
Ammonium bicarbonate	69.90	9.25	2.53	9.25	13.15	6.28	3.57	1008.00
Nu-Film-17	68.23	11.65	2.60	6.90	11.15	5.63	3.39	1027.95
Super Film	68.53	11.13	2.59	9.45	12.73	6.25	3.21	1004.05
Control [d]	70.25	9.33	2.56	7.15	13.20	5.80	3.59	1040.70
L.S.D. ($P \leq 0.05$)	NS	NS	NS	4.30	7.18	NS	NS	NS
L.S.D. ($P \leq 0.01$)	NS	NS	NS	NS	NS	NS	NS	NS

[a] Mean of four replicates.
[d] Plants were sprayed with water.

Effect of sowing date on susceptibility of flax to powdery mildew

Thirteen sowing dates were evaluated as to their effect on powdery mildew intensity variables (PMIV) and yield of flax cultivar Giza 5 in an out-door pot experiment (Table 16). As a general rule, the earlier the sowing date, the less the DI would be. This trend was very obvious on comparing the two earliest sowing dates of 7/11 and 14/11 with the two latest sowing dates of 23/1 and 30/1. Disease severity of the early sowing dates was also lower than that of the late sowing dates; however, the observed differences in DS between sowing dates were nonsignificant. As to the effect of sowing date on straw weight and seed weight, it is evident that the earlier the sowing date, the higher each of the straw weight and seed weight would be.

Reaction of flax genotypes to powdery mildew

a. Field evaluation

Reactions of ten flax genotypes to powdery mildew were evaluated under field conditions in Sakha in 1995 and 1996. The genotypes included 9 elite genotypes derived from intraspecific hybridization and commercial cultivar Giza 7 which was used as a standard cultivar for evaluating the performance of the other genotypes. The objective of this study was to identify genotypes superior to Giza 7 in powdery mildew tolerance. In the first year, there were no significance differences in DI and DS between Giza 7 and any of the tested genotypes that is, none of the tested genotypes was superior to Giza 7 in both DI and DS (Table 17).

Table (16): Effect of sowing dates on disease intensity variables (disease incidence and disease severity) straw weight and seed weight of flax cultivar Giza 5 in an outdoor experiment in 1994/1995.

Sowing date	Disease incidence [a] (%)	Disease severity [b] (%)	Straw weight (g/plant)	Seed weight (g/plant)
7/11/1994	62.0	57.35	0.528	0.154
14/11/1994	60.0	54.14	0.588	0.194
21/11/1994	70.0	63.80	0.520	0.144
28/11/1994	76.0	74.37	0.502	0.142
5/12/1994	60.0	77.19	0.374	0.150
12/12/1994	74.0	72.05	0.208	0.056
19/12/1994	68.8	70.65	0.200	0.048
26/12/1994	78.0	68.17	0.168	0.046
21/1/1995	96.0	84.46	0.182	0.052
9/1/1995	84.0	92.05	0.256	0.048
16/1/1995	90.0	93.93	0.174	0.046
23/1/1995	98.0	93.90	0.128	0.036
30/1/1995	94.0	90.96	0.036	0.026
L.S.D> (P < 0.05)	22.59	NS	0.1502	0.0401

[a] Percentage of infected plants/pot on the last week of April.
[b] Percentage of infected leaves/plant on the last week of April.

Table (17): Disease intensity variables (Disease incidence and Disease severity) and yield of ten flax genotypes tested under field conditions in Sakha in 1995 and 1996 seasons.

Genotype	1995				1996			
	Disease incidence [a] (%)	Disease severity (%)	Straw weight (ton/fed)	Seed weight (kg/fed)	Disease incidence [a] (%)	Disease severity (%)	Straw weight (ton/fed)	Seed weight (kg/fed)
	[b]							
Giza 7	58.25	47.90	3.675	558.060	40.00	46.87	3.632	568.660
420/140/5/10	60.00	43.05	3.077	472.370	29.50	23.82	3.242	489.960
420/4/2/14	71.75	44.99	3.178	482.765	40.50	16.86	3.193	503.742
420/153/9/12	93.50	48.31	3.300	492.943	42.50	67.32	3.269	524.587
421/3/6/4	46.50	28.66	3.153	476.270	53.50	53.20	3.152	491.450
421/43/5/14	60.50	30.65	3.546	554.580	37.00	42.50	3.613	5552.200
421/60/14/4	55.25	30.31	3.355	539.815	37.00	41.27	3.323	516.123
110/3	59.00	66.97	3.680	584.463	62.00	67.94	3.521	563..225
282/37/14/8	63.00	41.98	3.596	585.703	53.50	73.80	3.417	589.752
282/98/19/7	57.00	33.57	3.075	517.985	19.00	43.91	3.114	503.188
L.S.D. ($P < 0.05$)	NS	NS	0.1124	22.23	13.45	20.86	0.2152	19.18

[a] Disease incidence (percentage of infected plants in a random sample of 50 plant/plot).

[b] Mean of four replications (plots).

[c] Disease severity (percentage of infected leaves/plant in a random sample of 10 plants/plot.

In the 2nd year, DI on genotype 10 (282/98/19/7) was significantly lower than that on genotype 1 (Giza 7). It is worthy of mention that genotype 8 (110/3) was the least resistant one in terms of DI while genotype 10 (282/98/19/7) was the most resistant one. As to DS, genotype 3 (420/9/2/14) was more resistant than any other genotype including genotype 1 (Giza 7). On the other hand, genotypes 9 (282/37/14/8), 8 (110/3) and 4 (420/153/9/12) showed the highest levels of DS.

In the first year, there was no significant difference in straw yield between Giza 7 and each of genotype 8 (110/3) and 9 (282/37/14/8). Straw yield of all other genotypes were significantly lower than of Giza 7. Seed yield of each of genotype 9 (282/37/14/8), 8 (110/3), 6 (421/43/5/14), and 7 (421/60/14/4) did not significantly differ from that of genotype 1 (Giza 7). Seed yield of each of the other genotypes was significantly lower than that of Giza 7. Evidently, genotypes 6 (421/43/5/14), 8 (110/3), and 9 (282/37/14/8) in addition to genotype 1 (Giza 7) were the best performing genotypes in terms of straw yield and seed yield. In the 2nd year, none of the tested genotypes was superior to genotype 1 (Giza 7) in straw yield or seed yield. There was no significant difference in straw yield or seed yield between genotype 1 (Giza 7) and each of genotype 6 (421/43/5/14) and 8 (110/3).

As to genotype 9 (282/37/14/8), although its straw yield was significantly lower than that of genotype 1 (Giza 7), its seed yield did not significantly differ. Again, genotypes 1 (Giza 7), 6 (421/43/5/14), 8 (110/3) and 9 (282/37/14/8) proved that they were the most productive genotypes in terms of straw yield and seed yield.

b. Greenhouse evaluation

Most of the ten genotypes were as susceptible as Giza 7 in DI and DS when they were evaluated under greenhouse conditions (Table 18). However, genotypes numbers 8 (110/3) and 9 (282/37/14/8) and 4 (420/153/9/12) were more susceptible than Giza 7 in DI. As to DS, most of the tested genotypes were more susceptible than genotype 1 (Giza 7). These genotypes were 8 (110/3), 9 (282/37/14/8), 4 (420/153/9/12), 7 (421/60/14/4), 10 (282/98/19/7) and 6 (421/43/5/14). Genotypes 3 (420/4/2/14) was the most resistant genotypes. Disease severity on this genotypes was lower than that of any other genotypes including genotypes 1 (Giza 7). Straw yield per plant of each genotypes 6 (421/43/5/14), 10 (282/98/19/7), 9 (282/37/14/8), and 8 (110/3) was significantly higher than that of genotype 1 (Giza 7). On the other hand, there was no significant difference in straw yield between genotype 1 (Giza 7) and any of the other genotypes.

Relationships of flax powdery mildew to physical and chemical edaphic factors

Means of powdery mildew intensity variables (DI and DS) of flax cultivar Giza 7 (Table 19) grown in nine soil samples were obtained from different flax-growing areas (Table 20). In samples No. 8 from El-Ibrahimya DI in the first date was as low as 76.67%, this sample showed the lowest EC (0.70 ds/m) Table (20), in sample No. 4 from Sidi Salem DI in the first date increased to 93.33%, Table (19), EC increased to 2.21. That is EC in soil and DI in the first date were positively correlated, the linear correlation coefficient r was 0.713, Table (21). In sample No. 1 from El-

Table (18): Evaluation of powdery mildew intensity variables (DI and DS) and straw weight/plant on ten flax genotypes under greenhouse conditions.

Genotype	Disease incidence [a] (%)	Disease severity [b] (%)	Straw weight/plant (mg)
Giza 7	28.000	9.050	1173
420/140/5/10	50.000	8.290	1321
420/4/2/14	12.000	3.360	1655
420/153/9/12	52.000	28.840	1295
421/3/6/4	36.000	7.770	1593
421/43/5/14	46.000	22.620	2530
421/60/14/4	52.000	25.250	1791
110/3	84.000	48.910	2018
282/37/14/8	72.000	52.070	2182
282/98/19/7	40.000	20.860	2373
L.S.D. (P < 0.05)	23.67	13.47	641.7

[a] Disease incidence was measured as percentage of infected plants / pot).

[b] Disease severity was measured as percentage of infected leaves/plant in each pot.

Table (19): Effect of edaphic parameters measured in nine clay soil samples on powdery mildew intensity variables (DI and DS) and straw weight (g/plant) of flax cultivar Giza 7.

Governorate		Disease incidence %		Disease severity %		Straw weight g/plant
		6 March	27 March	6 March	27 March	
1: El Gharbia	(El-Mahalla)	73.33	100.00	69.78	79.41	0.044
2: Daqahliya	(Shirbin)	80.00	93.33	63.60	81.25	0.032
3: Kafr El-Sheikh 1	(Sidi Salem)	80.00	93.33	78.63	72.38	0.037
4 :Kafr El-Sheikh 2	(Sidi Salem)	93.33	100.00	80.88	86.67	0.047
5 : El-Sharqiya 1	(Hihya)	90.00	96.67	72.14	80.92	0.021
6 : El-Sharqiya 2	(El-Qanayat)	76.67	93.33	57.62	80.47	0.030
7 : El-Sharqiya 3	(Hihya)	83.33	93.33	73.40	78.30	0.049
8 : El-Sharqiya 4	(El-Ibrahimiya)	76.67	93.33	77.42	81.78	0.023
9 : El-Sharqiya 5	(El-Qanayat)	90.00	96.67	78.92	79.02	0.037
L.S.D. ($P < 0.05$)		NS	NS	NS	NS	0.0134

Table (20): Edaphic parameters measured in nine clay soil samples.

Trait		Soil								
		1	2	3	4	5	6	7	8	9
Nitrogen	(ppm)	42.60	22.00	23.00	48.10	24.70	25.50	30.50	27.20	18.97
Phosphorus	(ppm)	2.76	2.20	1.56	3.81	5.52	3.81	0.60	3.60	2.42
Potassium	(ppm)	370.50	936.00	341.60	331.50	370.50	634.10	263.60	331.50	292.50
Iron	(ppm)	23.07	40.23	16.73	38.02	34.53	19.12	23.32	43.98	18.20
Zinc	(ppm)	1.89	1.95	1.64	1.60	2.01	1.30	1.56	1.37	0.94
Manganese	(ppm)	5.27	5.23	6.16	4.61	3.53	7.25	2.44	2.85	2.55
Copper	(ppm)	6.22	7.00	5.43	5.08	4.96	5.14	5.94	5.60	4.15
pH		8.05	7.99	8.35	8.10	8.29	8.15	8.44	8.55	8.29
Saturation percent	%	57.3	50.0	66.7	63.3	58.30	66.7	55.0	53.3	55.7
Electrical conduc.	(ds/m)	0.89	1.28	2.17	2.21	1.45	0.81	1.28	0.70	1.79
HCO3-	(meq/100 g soil)	3.03	2.02	2.53	3.03	1.52	3.03	3.03	2.02	3.03
Cl-	(meq/100 g soil)	2.91	5.82	8.73	12.61	6.79	2.91	4.85	2.91	8.73
SO4=	(meq/100 g soil)	3.33	5.64	13.65	8.54	7.34	3.17	5.29	3.47	8.00
Ca++	(meq/100 g soil)	3.09	4.63	4.12	7.21	4.12	3.09	3.09	3.09	7.21
Mg++	(meq/100 g soil)	2.79	1.74	7.24	2.59	1.76	1.81	2.79	1.81	3.57
Na+.	(meq/100 g soil)	3.12	6.72	13.12	13.85	9.38	3.89	6.72	3.12	8.45
K+	(meq/100 g soil)	0.27	0.39	0.43	0.53	0.39	0.32	0.57	0.38	0.53
Coarse sand	%	1.94	1.25	0.55	3.29	3.07	2.43	2.16	1.92	2.09
Fine sand	%	19.80	7.33	16.48	16.69	16.23	16.98	19.30	16.91	19.19
Silt	%	19.08	29.33	20.37	16.35	19.66	19.94	18.26	19.99	20.01
Clay	%	56.58	60.69	60.50	60.67	58.44	57.15	57.58	58.58	55.71
Calcium carbonate	%	2.60	1.40	2.10	3.00	2.60	3.50	2.70	2.60	3.00

1: El Gharbia (El-Mahalla)
2: Daqahliya (Shirbin)
3: Kafr El-Sheikh 1 (Sidi Salem)
4 :Kafr El-Sheikh 2(Sidi Salem)
5 : El-Sharqiya 1 (Hihya)
6 : El-Sharqiya 2 (El-Qanayat)
7 : El-Sharqiya 3 (Hihya)
8 : El-Sharqiya 4 (El-Ibrahimiya)
9 : El-Sharqiya 5 (El-Qanayat)

Table (21): Relationships of powdery mildew intensity variables (DI and DS) and straw weight (g/plant) of flax cultivar Giza 7 to edaphic factors.

Edaphic parameter		Pearson correlation coefficients [a]				
		Disease incidence [b] on 6/3/1996	Disease incidence on 27/3/1996	Disease severity [c] on 6/3/1996	Disease severity on 27/3/1996	Straw weight (g/plant)
Nitrogen	(ppm)	0.0099	0.7542*	0.1852	0.4850	0.5845
Phosphorus	(ppm)	0.2573	0.3545	0.1129	0.5502	-0.6360
Potassium	(ppm)	-0.1865	-0.2925	-0.7517*	0.1731	-0.4490
Iron	(ppm)	0.1365	0.0469	0.0926	0.6896*	-0.3669
Zinc	(ppm)	-0.1257	0.1768	0.2214	0.0489	-0.0594
Manganese	(ppm)	-0.4375	-0.0643	-0.5735	-0.1679	-0.0249
Copper	(ppm)	-0.5853	-0.2295	-0.4212	-0.0297	0.1280
pH		0.0304	-0.4124	-0.4960	-0.3179	-0.2131
Saturation percent	%	0.0629	0.1059	0.0020	-0.2106	0.1238
Electrical conductivity	(ds/m)	0.7132*	0.2704	0.6205	-0.1167	0.3731
HCO_3^-	(meq/100 g soil)	-0.0390	0.2886	0.0397	-0.0312	0.7977*
Cl^-	(meq/100 g soil)	0.8273**	0.3927	0.6246	0.1791	0.3270
$SO_4^=$	(meq/100 g soil)	0.4704	0.0056	0.5740	-0.4520	0.1491
Ca^{++}	(meq/100 g soil)	0.7969*	0.4695	0.5082	0.3588	0.2523
Mg^{++}	(meq/100 g soil)	-0.0123	-0.1083	0.4616	-0.7723*	0.2986
Na^+	(meq/100 g soil)	0.7265*	0.2227	0.5753	-0.0519	0.2651
K^+	(meq/100 g soil)	-0.1327	-0.2893	-0.4249	0.1234	-0.1298
Coarse sand	%	0.5663	0.5418	0.0443	0.7702*	0.0022
Fine sand	%	0.1001	0.2550	0.4543	-0.1928	0.4244
Silt	%	-0.1389	-0.4873	-0.3531	-0.3732	-0.3957
Clay	%	0.1062	-0.2548	0.1294	0.2368	-0.2991
Calcium carbonate	%	0.1917	0.2752	0.0063	0.2711	0.1060

[a] Significant at $P < 0.05$ (*) o $P < 0.01$ (**).
[b] Disease incidence is the percentage on infected plants/pot.
[c] Disease severity is the percentage of infected leaves/plant in each pot.

Mahalla, sample No. 6 from El-Qanayat and sample no. 8 from El-Ibrahimya, DI in the 2nd date was 73.37, 76.67, and 76.67, respectively, in this soil samples the lowest soil content of Cl (2.91), Table (20). Thus, the correlation between Cl content and the first DI was highly significant (r = 0.8273). The first DI in soil sample No. 1 from El-Mahalla, soil sample No. 6 from El-Qanayat, soil sample No. 8 from El-Ibrahimiya and soil sample No. 7 from Hihya were 73.33, 76.67, 76.67 and 83.33%, respectively, Table (20). The lowest soil content of Ca (3.09) was observed in this soil samples. On the other hand, when Ca concentration in soil increased to 7.21 in soil sample No. 4 from Sidi Salem and soil sample No. 9 from El-Qanayat, the first DI increased to 93.33 and 90.00%, respectively. The correlation between Ca concentration and first DI was significant (r = 0.7969). The first DI in samples No. 1 from El-Mahalla and No. 8 from El-Ibrahimya was 73.33 and 76.67%, respectively, Table (19). This samples contained the lowest concentration of Na (3.12), when DI increased to 93.333% in sample No. 4 from Sidi Salem. This soil sample also showed the highest nitrogen content (48.10), Table (20) when nitrogen concentration decreased to 18.97 in soil sample No 9 from El-Qanayat the 2nd DI decreased to 96.67%, Table (19). In general, nitrogen content and the 2nd DI were positively correlated (r = 0.7242). The correlation between potassium concentration and first DS was negative (-0.7517), Table (21). Thus, when potassium reached its maximum concentration in soil sample No. 2 from Shirbin, the first DS was as low as 63.597. This DS increased to 73.397, when potassium concentration decreased to 263.50. When the second DS was 72.3777% in soil sample No. 3 from Sidi Salem, iron content in this sample

was as low as 16.73. The increase of iron concentration to 43.98 in soil sample No. 8 from El-Ibrahimiya was accompanied by an increase in DS to 81.777%. This implies positive correlation between the two variables (0.6896). The second DS was 72.377% in soil sample No. 3 from Sidi Salem. A negative relationship was observed between Mg and 2nd DS (r = 0.7723). Thus, when this soil sample contained the highest Mg content (7.24). The 2nd DS increased to 80.473 and 81.777, respectively when the Mg content decreased to 1.81 in samples No. 6 from El-Qanayat, and No. 8 from El-Ibrahimia. The 2nd DS in sample No. 4 from Sidi Salem was as high as 86.667% when this soil sample contained the highest level of coarse sand (3.29%). When the coarse sand decreased to 0.55 in sample No. 3 from Sidi Salem. The DS decreased to 72.372%. Thus, the two variables were positively correlated (r = 0.7702). The highest HCO_3 concentration (3.03) was observed in soil samples No. 1 from El-Mahalla, No. 4 from Sidi Salem, No. 6 from El-Qanayat, No. 7 from Hihya, and No. 9 from El-Qanayat. In most of these soil samples the straw weight ranged from 0.03 to 0.05 g/plant. When HCO_3 concentration decreased to 1.52 in sample No. 5 from Hihya, straw weight/plant decreased to 0.02 g/plant. That is, the correlation between the two variables was positive (0.7977).

Effect of different levels of seed rates, nitrogen fertilization, and phosphorus fertilization on flax powdery mildew under field conditions

Effects of seed rate, nitrogen fertilization and phosphorus fertilization on powdery mildew intensity variables (DI and DS), and yield were studied under field conditions in 1995 and 1996. ANOVA presented in Table (2 Appendix) showed that phosphorus and phosphorus x seed rate interaction

were the only significant sources of variation in DI. Due to the significance of this interaction a least significant differences (LSD) was used to compare the individual means of phosphorus rates within seed rates (Table 22). The comparisons of the overall means of phosphorus fertilization levels revealed that all phosphorus levels caused significant reduction in DI. These comparisons showed that flax was seeded at the rate of 35 kg/feddan, each of the two rates of phosphorus fertilization caused significant reduction in DI. However, the reduction was more evident when the rate of phosphorus fertilization was increased to 25 kg/feddan. The increase in rate of phosphorus fertilization from 15 kg/feddan to 25 kg/feddan also caused significant reduction in DI. When flax was seeded at the rate of 50 kg/feddan the rate of phosphorus fertilization should be increased to 25 kg/feddan to obtain significant reduction in DI. Evidently, the increase in phosphorus fertilization from 15 to 25 kg/feddan caused significant reduction in DI. When seed rate was 65 kg/feddan a significant reduction in DI was observed when phosphorus fertilization was increased to 15 kg/feddan. However, no significant difference was observed between the two rates of 15 and 25 kg/feddan. When flax seeded at the highest rate of 80 kg/feddan. The increase of phosphorus fertilization to 15 kg/feddan caused significant reduction in DI. The reduction was more evident when the phosphorus rate was increased to 25 kg/feddan. The increase in phosphorus rate from 15 kg/feddan to 25 kg/feddan also caused significant reduction in DI.

Nitrogen fertilization was the only significant source of variation in DS (Table 22 and 3 Appendix). Comparison of the overall means of nitrogen

Table (22): Effect of seed rate, nitrogen fertilization and phosphorus fertilization on powdery mildew intensity variables (DI and DS) of flax cultivar Giza 7 and agronomic traits (yield and yield components) under field conditions in Sakha in 1995

Treatment	Dis. incid. %	Dis. severity %	Straw yield/ feddan	Seed yield/ feddan	Technical stem length (cm)	Apical B.Z.L. (cm)	Stem diameter (mm)	Straw weight/ plant (g)	No. of capsules/ plant	Seed weight/ plant (g)	Seed index (g)
S1 N0 P0	77.00	53.80	1.680	171.50	61.87	9.24	1.54	0.88	2.13	0.190	10.95
S1 N0 P1	54.50	45.07	0.656	133.00	48.48	5.65	1.28	0.69	2.73	0.127	11.60
S1 N0 P2	39.50	62.56	0.912	145.50	50.77	6.03	1.19	0.48	2.60	0.133	10.85
S1 N1 P0	65.50	57.55	1.278	373.75	58.69	10.13	1.53	1.09	4.34	0.239	10.50
S1 N1 P1	43.00	55.16	1.598	337.75	63.61	9.36	1.50	0.70	4.73	0.244	13.00
S1 N1 P2	55.50	51.05	1.478	246.00	64.96	8.43	1.57	0.79	4.24	0.205	11.50
S1 N2 P0	60.00	63.22	1.535	251.50	64.61	10.27	1.68	0.87	5.04	0.230	10.75
S1 N2 P1	69.50	53.62	1.941	355.00	49.32	8.51	1.51	0.75	3.42	0.144	10.50
S1 N2 P2	27.50	35.43	1.384	238.00	59.58	5.78	1.32	0.48	2.48	0.187	8.84
S1 N3 P0	77.50	62.34	1.962	165.50	65.74	9.03	1.05	0.74	3.41	0.591	10.45
S1 N3 P1	39.00	36.64	2.386	237.00	64.13	9.49	1.68	0.70	3.30	0.615	10.51
S1 N3 P2	48.50	62.99	1.526	204.25	64.76	8.54	1.64	0.80	3.80	0.181	12.14
S1 N4 P0	68.50	67.13	1.798	415.00	63.45	18.46	2.38	1.19	5.93	0.292	10.33
S1 N4 P1	55.00	49.59	1.876	213.25	62.37	8.41	1.50	1.13	3.55	0.404	12.16
S1 N4 P2	34.00	58.02	1.416	286.00	70.46	16.96	2.67	1.86	9.23	0.447	10.63
S2 N0 P0	45.50	69.91	1.712	145.50	52.29	6.23	1.17	0.36	2.38	0.405	9.16
S2 N0 P1	37.00	55.61	1.192	353.75	56.41	7.16	1.60	0.60	2.45	0.220	10.86
S2 N0 P2	62.00	76.06	1.276	307.50	60.19	26.13	1.38	1.54	5.21	0.249	9.32
S2 N1 P0	49.00	46.44	1.555	265.00	63.45	10.02	1.94	0.97	5.75	0.471	10.12
S2 N1 P1	46.00	35.61	1.547	168.25	64.17	8.70	1.62	1.08	5.85	0.340	10.68
S2 N1 P2	51.00	63.81	1.505	153.50	60.85	8.12	1.52	0.72	4.06	0.203	9.24
S2 N2 P0	24.00	38.35	1.452	364.75	59.27	9.96	1.67	0.74	5.02	0.251	11.05
S2 N2 P1	75.50	64.37	1.650	236.00	58.71	8.58	1.67	0.78	3.666	0.193	9.91
S2 N2 P2	62.00	54.27	1.503	367.00	64.45	10..37	1.60	0.79	4.03	0.214	11.16
S2 N3 P0	50.50	46.47	1.999	277.75	60.73	8.38	1.58	0.83	4.48	0.26	11.39
S2 N3 P1	26.50	54.28	1.849	242.75	68.00	11.08	1.90	1.19	5.12	0.241	10.30
S2 N3 P2	51.00	40.69	1.415	215.50	61.98	10.25	1.53	0.89	5.33	0.632	9.92
S2 N4 P0	69.00	71.96	1.476	217.75	63.11	12.32	1.71	1.09	7.73	0.340	9.90
S2 N4 P1	61.50	58.14	1.350	282.75	68.30	10.78	2.12	1.22	5.32	0.267	10.26
S2 N4 P2	72.50	62.17	1.606	177.75	68.34	10.88	2.02	1.08	6.03	0.336	10.07
S3 N0 P0	52.00	66.48	1.538	168.50	54.96	6.89	1.25	0.57	2.60	0.045	10.34
S3 N0 P1	54.50	67.86	2.080	114.25	51.47	8.16	1.36	0.60	3.58	0.327	9.29
S3 N0 P2	51.50	45.22	0.996	160.00	54.88	5.53	1.72	0.63	3.61	0.171	11.34
S3 N1 P0	59.50	73.27	1.354	252.75	62.49	7.09	1.26	0.56	2.47	0.156	12.89
S3 N1 P1	41.00	66.33	2.001	181.75	61.02	15.15	1.76	1.71	8.88	0.500	10.39
S3 N1 P2	38.50	41.12	1.426	236.75	58.25	8.41	4.32	0.54	1.69	0.385	11.51

Table (22): Cont.

Treatment	Dis. incid. %	Dis. severity %	Straw yield/ feddan	Seed yield/ feddan	Technical stem length (cm)	Apical B.Z.L. (cm)	Stem diameter (mm)	Straw weight/ plant (g)	No. of capsules/ plant	Seed weight/ plant (g)	Seed index (g)
S3 N2 P0	55.00	56.55	1.298	181.75	64.69	9.08	1.66	0.81	4.49	0.249	11.53
S3 N2 P1	42.50	70.98	2.151	277.75	62.88	11.56	1.76	1.12	7.01	0.332	9.46
S3 N2 P2	40.50	45.53	1.545	299.50	63.16	9.63	1.60	0.92	5.70	0.305	11.01
S3 N3 P0	76.00	38.12	1.541	188.50	62.69	11.33	1.84	1.42	7.53	0.355	9.39
S3 N3 P1	44.00	49.95	1.631	233.75	63.90	10.42	1.61	0.98	5.87	0.307	12.96
S3 N3 P2	50.00	51.25	1.592	311.50	65.20	12.20	2.38	0.94	5.82	0.252	10.40
S3 N4 P0	67.50	50.72	1.761	352.00	70.78	13.00	1.75	1.10	3.83	0.625	10.22
S3 N4 P1	51.50	57.07	2.528	361.00	63.88	10.69	1.50	0.93	4.15	0.221	9.45
S3 N4 P2	38.50	55.21	1.724	289.00	68.55	11.82	2.01	1.23	6.89	0.551	10.80
S4 N0 P0	65.00	63.25	0.916	119.00	55.00	4.71	1.05	0.82	1.75	0.100	7.22
S4 N0 P1	44.00	63.77	1.224	105.00	51.81	7.31	1.31	0.60	3.40	0.154	9.03
S4 N0 P2	43.50	58.43	0.847	222.00	50.57	5.45	1.18	0.43	2.67	1.207	12.79
S4 N1 P0	69.50	39.93	2.125	272.00	60.33	10.86	1.96	0.92	5.80	0.340	11.21
S4 N1 P1	67.50	40.65	1.749	302.25	63.36	9.10	1.70	0.82	4.32	0.225	9.97
S4 N1 P2	38.00	48.82	1.161	240.50	63.79	9.74	1.63	0.86	4.09	0.192	13.40
S4 N2 P0	78.00	64.69	1.410	237.75	63.32	9.06	1.63	0.91	4.59	0.248	10.83
S4 N2 P1	58.00	66.96	1.549	234.75	63.01	9.72	1.44	0.76	3.26	0.202	9.91
S4 N2 P2	12.50	51.77	1.370	171.25	62.18	9.03	1.51	0.74	3.90	1.463	9.18
S4 N3 P0	64.50	47.43	1.626	281.50	58.45	10.09	1.80	0.79	6.93	0.276	10.19
S4 N3 P1	42.00	38.25	2.058	429.75	64.31	11.09	1.62	0.877	5.63	0.275	11.21
S4 N3 P2	54.00	36.69	1.305	223.75	62.83	6.51	1.33	0.56	2.63	0.366	10.89
S4 N4 P0	81.50	70.69	2.067	275.25	68.27	11.23	1.81	0.97	5.33	0.244	10.24
S4 N4 P1	65.50	58.88	1.912	351.50	68.14	11.91	1.88	1.43	6.82	0.340	9.39
S4 N4 P2	66.50	57.20	2.011	366.00	66.14	9.93	2.04	1.10	5.10	0.214	9.52
L.S.D. P < 0.05 for											
Seed rate S	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nitrogen N	NS	6.385	0.2554	46.53	2.664	2.115	0.201	0.195	1.099	NS	NS
S x N	NS	NS	NS	93.06	NS	NS	NS	NS	NS	0.279	NS
Phosphorus P	6.121	NS	0.1978	NS	NS	NS	NS	NS	NS	NS	NS
S x P	12.240	NS	NS	NS	NS	NS	NS	NS	NS	0.2162	NS
N x P	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S x N x P	NS	NS	NS	161.20	NS	NS	NS	NS	NS	0.483	NS

Seed rates (kg/feddan) were 35 (S1), 50 (S2), 65 (S3), and 80 (S4).
Phosphorus fertilization were 0 (P0), 15 (P1), and 25 (P2).
Nitrogen fertilization rates (kg/feddan) were 0 (N0), 25 (N1), 40 (N20, 55 (N3) and 70 (N4).

levels revealed that a significant reduction in DS was obtained by all nitrogen rates except thereat of 70 kg/feddan, which was ineffective in reducing DS significantly.

Each nitrogen rate significantly increased seed yield, however, no significant differences were detected among the tested nitrogen rates. All nitrogen rates caused significant increase in seed yield compared to the control treatment (No. 1) which did not receive any nitrogen, however, all differences between nitrogen rates were non significant. In the absence of any nitrogen fertilization, the only significant increase in seed yield was obtained when flax was deeded at the rate of 50 kg/feddan. The increases of seed rates to 65 and 80 kg/feddan did not significantly affect seed yield. When nitrogen was applied at the rate of 25 kg/feddan, significant reductions were observed when flax was seeded at the rates of 50 and 65 kg/feddan; however, the increase of seed rate to 80 kg/feddan did not significantly affect seed yield. All differences between seed rates were nonsignificant within this nitrogen rate. When nitrogen was applied at the rate of 40 and 70 kg/feddan non of the tested seed rates cause significant changes in seed yield. When nitrogen was applied at the rate of 55 kg/feddan, seed yield was significantly increase when flax was seeded at the rate of 80 kg/feddan, other seed rates did not show significant effects on seed yield (Table, 22).

In the absence of any nitrogen and phosphorus fertilization, seed yield was as low as 171.50 (Table 22). The increase of phosphorus fertilization to 15 and 25 kg/feddan in the absence of nitrogen fertilization did not significantly increased seed yield compared to the lowest value (105 kg/feddan of $S_4N_0P_1$). It was also observed that in the absence of nitrogen

fertilization even the highest seed and phosphorus rates, seed yield did not significantly differ from the lowest value. When flax was seeded at the lowest rate of 35 kg/feddan, and fertilized with nitrogen of the lowest rate of 25 kg/feddan even in the absence of any phosphorus fertilization the seed yield increase to a level did not significantly differ from the highest value (429 kg/feddan $S_4N_3P_1$).

The highest value of technical stem length was obtained when nitrogen was applied at the rate of 70 kg/feddan. The absence of nitrogen decrease technical stem length to its lowest level. Each of the nitrogen rates of 25, 40 and 55 kg/feddan significantly improved technical stem length compared to the control which did not receive any nitrogen fertilization. However, no significant differences were observed among these three levels (Table 22).

A significant increase in length of apical branching zone length when nitrogen fertilization was applied at the rate of 70 kg/feddan. Lower rates did not significantly improve apical branching zone length compared to the control (N_0 rate).

The highest value of stem diameter was obtained when nitrogen was applied at the rate of 70 kg/feddan. The absence of nitrogen, decreased stem diameter to its lowest level. Each of the nitrogen rates of 25, 40 and 55 kg/feddan, significantly improved stem diameter compared to the control (N_0 rate). However, no significant differences were observed among these levels (Table 22).

The only significant increase in straw weight/plant was observed when nitrogen was applied at its highest rate of 70 kg/feddan (Table 22).

All nitrogen levels significantly increased the number of capsules/plant compared to the control. The only significant difference was observed between the rate of 40 kg/feddan. The difference between the rate of 25 kg/feddan and 55 kg/feddan was nonsignificant (Table 22).

When flax was seeded at the lowest rate of 35 kg/feddan, the nitrogen rate should be increased to 55 kg/feddan to obtain significant increase in seed weight/plant, when flax was seeded at the highest rates, no significant increases were obtained even when nitrogen was applied at the highest rate of 70 kg/feddan (Table 22).

When flax was seeded at the rates of 35, 50 and 65 kg/feddan, no significant increases in seed weight per plant obtained even when phosphorus fertilization was applied at the highest rate o 25 kg/feddan. However, when flax was seeded at the rate of 80 kg/feddan a significant increase in seed weight/plant was obtained when the phosphorus rate was increased to 25 kg/feddan.

The highest weight of seed/plant was obtained by S4N2P2 (seed rate of 80 kg/feddan, nitrogen fertilization 25 kg/feddan, and phosphorus fertilization 25 kg/feddan). The absence of nitrogen fertilization from this treatment ($S_4N_0P_2$) did not significantly affect seed weight/plant. All other treatments significantly decreased seed weight/plant compared to the highest value of $S_4N_2P_2$.

Seed index was not affected by seed rate, nitrogen fertilization, phosphorus fertilization, and their interactions.

In 1996, seed rate, nitrogen, phosphorus and their interactions were all non significant sources of variation (Table 23). Nitrogen and seed rate x

phosphorus were significant sources of variation in straw yield (Table 23). The highest straw yield was obtained when nitrogen was applied at the rate of 25 followed by 70 kg/feddan. However, no significant differences in straw weight was observed between the rates of 40 and 55 kg/feddan and the control treatment. Within any seed rates, the application of phosphorus at the rate of 15 and 25 kg/feddan did not significantly affected straw yield compared to the control treatment (P_0) which did not receive phosphorus (Table 23). However, when flax was seeded at the rate of 35, 65 and 80 kg/feddan significant differences in straw yield observed between the two phosphorus rates of 15 and 25 kg/feddan (Table 23).

Nitrogen was the only significant source of variation in seed yield. All nitrogen rates significantly increased seed yield compared to the control. However, no significant differences were detected among these rates in their effect on seed yield (Table 23).

All nitrogen levels significantly increase technical stem length compared to the control treatment (N_0). However, no significant differences were detected among these rates.

The only significant increase in apical branching zone length was obtained when nitrogen was applied at the rate of 70 kg/feddan.

All nitrogen rates significantly increased stem diameter. There were no significant differences among the rates of 25, 40 and 55 kg/feddan. Similarly the difference between the rates of 40 and 70 kg/feddan was non significant.

All nitrogen levels significantly increased straw weight/plant compared to the control treatment. However, the least significant increase was

Table (23): Effect of seed rate, nitrogen fertilization and phosphorus fertilization on powdery mildew intensity variables (DI and DS) of flax cultivar Giza 7 and agronomic traits (yield and yield components) under field conditions in Sakha in 1996

Treatment	Dis. incid. %	Dis. severity %	Straw yield/ feddan	Seed yield/ feddan	Technical stem length (cm)	Apical B.Z.L. (cm)	Stem diameter (mm)	Straw weight/ plant (g)	No. of capsules/ plant	Seed weight/ plant (g)	Seed index (g)
S1 N0 P0	52.75	78.12	3.696	625.0	70.05	10.42	1.53	2.45	4.68	0.187	9.67
S1 N0 P1	85.75	72.00	4.221	551.0	67.11	13.53	1.65	2.59	6.43	0.332	9.24
S1 N0 P2	64.00	66.63	3.591	546.0	67.75	8.46	1.73	2.26	3.70	0.167	9.07
S1 N1 P0	72.00	68.66	4.683	773.0	78.20	16.77	2.00	2.93	6.78	0.343	10.11
S1 N1 P1	81.75	76.83	5.124	1086.0	79.79	13.33	1.88	3.11	7.83	0.414	10.62
S1 N1 P2	58.75	75.24	3.570	726.0	78.33	16.22	2.11	3.20	14.85	0.484	9.21
S1 N2 P0	79.00	69.62	4.179	932.0	75.10	15.08	2.13	3.03	8.63	0.744	9.17
S1 N2 P1	65.00	78.60	4.431	830.0	81.70	12.83	4.31	2.96	7.60	0.378	10.06
S1 N2 P2	79.25	75.11	4.998	830.0	79.27	19.24	2.30	3.68	11.38	0.586	9.06
S1 N3 P0	71.00	69.49	4.641	1019.0	75.88	13.33	1.92	2.95	7.63	0.380	10.15
S1 N3 P1	72.00	62.34	4.662	988.0	79.86	11.09	1.83	2.70	5.18	0.275	9.61
S1 N3 P2	73.50	69.94	4.144	801.0	77.75	16.56	1.83	2.80	7.00	0.375	9.81
S1 N4 P0	71.25	61.22	4.473	700.0	77.74	17.48	2.31	3.61	19.60	0.626	10.04
S1 N4 P1	49.00	61.71	5.180	1011.0	79.69	14.27	2.21	3.47	9.70	0.592	9.83
S1 N4 P2	62.00	61.98	3.822	638.0	80.83	13.78	2.08	3.15	8.78	0.443	10.12
S2 N0 P0	68.75	71.04	5.166	777.0	72.13	11.57	1.69	2.76	6.53	0.325	9.69
S2 N0 P1	60.50	71.21	3.177	683.0	75.63	9.60	1.65	2.59	4.90	0.251	10.47
S2 N0 P2	67.50	62.57	4.641	846.0	72.21	10.28	1.46	2.49	4.58	0.238	9.43
S2 N1 P0	81.75	65.12	4.851	990.0	74.44	16.57	2.02	3.81	16.33	0.853	9.65
S2 N1 P1	72..75	78.50	4.935	962.0	78.85	14.33	2.02	3.27	7.44	0.478	9.81
S2 N1 P2	79.00	69.11	4.830	953.0	75.16	19.70	2.10	3.68	12.10	0.680	9.53
S2 N2 P0	78.75	54.73	4.424	980.0	77.25	13.52	1.96	2.94	8.43	0.412	9.46
S2 N2 P1	55.25	60.51	4.200	789.0	77.50	16.03	2.16	3.71	11.58	0.628	9.82
S2 N2 P2	76.50	56.14	4.557	833.0	82.04	12.05	1.89	3.18	8.68	0.465	9.79
S2 N3 P0	63.00	64.81	3.927	897.0	77.82	12.69	1.93	2.87	7.48	0.378	10.26
S2 N3 P1	52.00	90.30	4.494	908.0	78.63	15.09	2.33	2.82	6.98	0.279	10.15
S2 N3 P2	71.00	75.18	3.801	714.0	81.61	12.82	1.80	2.74	5.50	0.281	10.08
S2 N4 P0	54.00	72.71	5.019	1012.0	80.13	18.70	2.42	4.82	14.83	0.857	10.13
S2 N4 P1	59.00	74.62	5.040	1127.0	78.16	15.50	2.03	2.58	8.15	0.386	9.44
S2 N4 P2	62.25	66.39	7.287	888.0	68.65	15.27	1.97	3.05	12.28	0.620	10.16
S3 N0 P0	67.75	82.52	4.284	787.0	73.75	9.82	1.59	2.47	4.68	0.220	9.29
S3 N0 P1	64.50	67.92	3.647	884.0	67.18	10.41	1.57	2.51	5.33	0.260	10.06
S3 N0 P2	69.00	74.82	4.872	577.0	75.17	27.97	1.64	2.47	6.80	0.328	9.78
S3 N1 P0	55.00	76.93	4.935	928.0	77.39	9.20	1.84	2.37	3.77	0.162	10.23
S3 N1 P1	64.00	69.35	4.557	766.0	77.12	12.91	1.79	2.93	7.03	0.370	9.39
S3 N1 P2	78.25	66.63	5.124	990.0	78.97	14.11	2.10	3.14	8.83	0.377	9.95
S3 N2 P0	63.75	81.33	4.648	895.0	77.79	16.96	2.27	3.94	15.49	0.880	9.71
S3 N2 P1	56.75	71.76	4.473	873.0	80.98	12.16	1.84	2.92	7.30	0.374	10.34
S3 N2 P2	70.50	77.33	5.859	838.0	77.48	12.33	1.89	2.86	7.83	0.386	10.13

Table (23): Cont.

Treatment	Dis. incid. %	Dis. severity %	Straw yield/ feddan	Seed yield/ feddan	Technical stem length (cm)	Apical B.Z.L. (cm)	Stem diameter (mm)	Straw weight/ plant (g)	No. of capsules/ plant	Seed weight/ plant (g)	Seed index (g)
S3 N3 P0	65.25	59.15	4.242	917.0	78.21	13.12	2.50	3.17	9.18	0.483	9.93
S3 N3 P1	73.50	52.28	4.473	885.0	78.42	14.84	2.03	3.94	11.13	0.521	10.69
S3 N3 P2	70.50	65.43	5.040	984.0	78.82	13.68	1.99	2.94	7.88	0.403	9.67
S3 N4 P0	74.75	48.68	4.599	718.0	80.87	31.69	2.04	3.32	10.48	0.544	9.97
S3 N4 P1	70.75	82.99	4.914	850.0	80.31	14.33	2.11	3.32	9.90	0.539	9.99
S3 N4 P2	61.25	60.89	4.200	982.0	76.44	17.31	2.39	3.99	15.15	0.837	10.29
S4 N0 P0	60.00	62.35	3.109	554.0	73.86	11.57	1.64	2.49	6.00	0.286	9.47
S4 N0 P1	56.25	80.73	3.780	665.0	66.38	9.69	1.51	2.21	4.73	0.219	8.95
S4 N0 P2	67.25	82.29	5.376	714.0	69.00	9.03	1.73	2.23	4.10	0.210	8.76
S4 N1 P0	72.00	72.93	5.012	757.0	77.31	16.06	2.22	2.99	9.83	0.493	9.89
S4 N1 P1	74.00	61.72	4.220	974.0	79.90	15.07	2.31	3.22	11.15	0.589	9.63
S4 N1 P2	72.50	73.88	5.040	1011.0	78.25	15.57	2.11	3.03	9.45	0.637	10.05
S4 N2 P0	59.50	79.35	4.200	892.0	78.89	15.61	2.07	3.05	9.70	0.525	9.51
S4 N2 P1	45.25	65..21	3.906	689.0	71.40	15.22	2.26	3.04	11.55	0.537	10.72
S4 N2 P2	76.50	81.08	4.074	829.0	71.09	12.87	1.84	3.24	7.93	0.449	10.19
S4 N3 P0	70.75	75.91	4.872	906.0	83.13	13.58	2.04	2.81	8.30	0.409	9.96
S4 N3 P1	68.25	76.56	4.494	714.0	81.48	13.28	2.05	2.65	8.28	0.378	10.10
S4 N3 P2	64.50	74.24	4.788	603.0	74.50	17.89	2.39	3.06	12.03	0.597	9.60
S4 N4 P0	59.50	61.42	4.200	1111.0	81.70	21.36	2.33	3.52	7.54	0.791	9.97
S4 N4 P1	64.75	73.87	4.284	713.0	68.52	19.03	2.31	3.68	17.13	0.800	10.32
S4 N4 P2	64.00	71.15	4.340	782.0	79.82	16.79	2.31	3.02	8.68	0.588	9.96
L.S.D. P < 0.05 for											
Seed rate S	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nitrogen N	NS	NS	0.3370	102.9	2.203	8.338	0.149	0.354	2.587	0.123	0..344
S x N	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Phosphorus P	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S x P	NS	NS	0.5841	NS	NS	NS	NS	NS	NS	NS	NS
N x P	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S x N x P	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Seed rates (kg/feddan) were 35 (S1), 50 (S2), 65 (S3), and 80 (S4).
Phosphorus fertilization were 0 (P0), 15 (P1), and 25 (P2).
Nitrogen fertilization rates (kg/feddan) were 0 (N0), 25 (N1), 40 (N20, 55 (N3) and 70 (N4).

obtained by the nitrogen rate of 55 kg/feddan. Nitrogen rates of 25, 40 and 70 did not significantly differ in their effect on straw weight/plant.

All nitrogen levels significantly increased number of capsules/plant compared to the control treatment (N_0). However, the highest significant increase was obtained by the rate of 70 kg/feddan. No significant differences were observed among the other rates.

All nitrogen rates caused significant increases in seed weight/plant. Compared to the control treatment. The highest increased caused by the rate of 70 kg/feddan while the lowest increase caused by the rate of 55 kg/feddan. Other rates did not significantly differ in their effect on seed weight/plant.

Significant increases in seed index were observed when nitrogen was applied at the rate of 55 and 70 kg/feddan. However, no significant difference was observed between these two rates.