SUPPRESSION OF POWDERY MILDEW OF FLAX BY THE FOLIAR APPLICATION OF *STREPTOMYCES*

ABSTRACT

It is well known that the most economical control of powdery mildew (PM) in flax is through the use of resistant varieties. Early seeding will reduce the impact of this disease on yield losses by avoiding the early infections and buildup of epidemics. In this study, effects of 16 isolates of *Streptomyces* on PM incidence (PMI), PM severity (PMS), seed yield and straw yield of flax cultivar Sakha 2 were evaluated under greenhouse conditions in 2005 and 2006 growing seasons. On growing of the *Streptomyces* isolates for 6 days in a rotary shaker, the growth mixture (pellets and filtrate) were diluted at two dilutions of 4 and 2% in both water and starch nitrate broth (SNB) medium before application. At the end of the harvest season of 2005, data analysis of variance showed that *Streptomyces* isolates of P=0.01 were the only significant source of variation in PMI. Concerning PMS, *Streptomyces* isolates, kind of diluents and isolates-antagonist dilutions of P=0.01, P=0.01 and P=0.05, respectively, were reported as significant sources of variation. In regards to seed yield, significant variation appeared when *Streptomyces* isolates used had P=0.01. With respect to the effectiveness of increasing seed yield, the *Streptomyces* isolates Da-3, Ma-13, Ps-12, Sc-2 and Sc-11 were found to be the most effective when the means of all isolates were compared. On the other hand, *Streptomyces* isolates, kind of diluents, antagonist dilutions and their interactions were all nonsignificant sources of variation in straw yield. In 2006 growing season, isolates of P=0.01, kind of diluents of P=0.01, different isolates-diluents mixtures of P=0.01, dilutions of antagonist of P=0.05 and isolates-antagonist dilutions interaction of P=0.01 were the only significant source of variation in PMI. Similarly, significant source of variation in PMS was found when the probabilities (P) of isolates, kind of diluents and dilution of antagonist were P=0.01, P=0.05, and P=0.05, respectively. In case of seed yield and straw yield, the *Streptomyces* isolates were the only significant source of variation; and three *Streptomyces* isolates: Qa-53, Qa-51 and Ma-13 were effective in increasing both seed yield and straw yield. Results demonstrated that foliar application of *Streptomyces* spp. could be a successful and environmentally safe alternative to chemical fungicides for controlling PM in flax.

Key words: Flax. *Streptomyces*, Powdery mildew, Antagonist, Foliar application.

INTRODUCTION

Flax (*Linum usitatissimum* L.) is considered the most important bast fiber crop in Egypt, it ranks second after cotton (seedy fiber) regarding economic importance and production (**Mansour, 1998**). Powdery mildew (PM) of flax is caused by *Oidium lini* Škoric. The fungus attacks all the above ground parts of flax (**Aly *et al.*, 1994**). In Egypt, it occurs wherever flax is cultivated when moisture condition and temperature are favorable. Early infection may cause severe defoliation of the flax plant and reduce quantity and quality of yield (**Mansour, 1998**). Currently, all commercially grown flax cultivars are susceptible to the disease, although field observations indicated that some experimental lines were more susceptible than others (**Aly *et al.*, 2001**). Foliar application of fungicides has become the only commercially available management practice for controlling the disease and minimizing associated losses in seed and straw yield (**Aly *et al.*, 1994**

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and **Mansour, 1998**). Complete dependence on fungicides for the disease control carries risks for the producers, in that accurate coverage and distribution of fungicides may not be achieved and there are potential problems with timing of application. Furthermore, increasing concern for the environment will likely mean greater regulation of fungicide usage (**Pearce *et al.*, 1996**). Biological control is a nonchemical measures that has been reported in several cases to be as effective as chemical control (**Elad and Zimand, 1993,** and **Dik and Elad, 1999**).

Streptomyces sp. are gram-positive, filamentous, soil borne bacteria that also occur in the phylloplane (**Narula and Mehrotra, 1987**), especially on dust-covered leaves (**Manning, 1971**).

The ability of bacteria, especially actinomycetes, to parasitize and degrade spores of fungal plant pathogens is well established (**Gohel *et al*., 2006**). Lysis of the host structure by secretion of extracellular lytic enzymes is one of the important mechanisms that are involved in the antagonistic activity of biocontrol agents (**Saksirirat and Hoppe, 1991** and **Mathivarnan *et al.*, 1997)**. Among these, chitinase (EC 3.2.1.14), which was isolated from the culture filtrate of *Streptomyces* sp. plays a vital role in the biological control of many plant diseases by degrading the chitin polymer in the cell walls of fungal pathogens (**Haran *et al*., 1993**). An exogenous chitinase from *Streptomyces griseus* was introduced into coleoptile cells of barley by microinjection and the effect of injected exogenous chitinase on the growth and development of the PM pathogen (*Erysiphe graminis* f.sp. *hordi*) was effective in completely digesting houstoria and suppressing the subdequent formation of secondary hyphae of the pathogen (**Toyoda *et al.*, 1991**). Houstoria of *Sphaerotheca pannosa* on rose, *S. fuliginea* on melon and *S. humuli* (*S. macularis*) on strawberry leaves were digested by 0.1% chitinase from *Streptomyces greseus*, confirming that chitin is a major component of the houstorial cell wall (**Ikeda *et al*., 1992**).

It is well known that the most economical control of powdery mildew (PM) in flax is through the use of resistant varieties. Early seeding will reduce the impact of this disease on yield losses by avoiding the early infections and buildup of epidemics (www.flaxcouncil.ca/english/index.php?p=growing8&mp=growing- 28k). The aim of this study was to determine the effect of some *Streptomyces* isolates as a biological agent on PM infection of flax in two greenhouse experiments.

MATERIALS AND METHODS

Streptomyces isolates

A set of 16 *Streptomyces* isolates isolated from soils of different Governorates, i.e., Sc-2, Sc-11 and Ma-13 (Alexandria), Q-44, Q- 51, Qa-53 and Qa-84 (El-Fayoum); Da-3 (Damiatta); Is-10 (Ismailia); PS-12 (Port Said) and Si-1, Si-4, Si-6, Si-8, Si-9, and S16 (Sinai) were used in this study. These isolates were kindly obtained from Department of Agricultural Microbiology, Soil, Water and Environment Research Institute, ARC, Giza, Egypt.

Preparation of *Streptomyces* for antagonistic activity

Sixteen conical flasks each contained 100 ml of starch nitrate broth (SNB) with 3.5% NaCl were inoculated separately with each of the *Streptomyces* isolates and incubated at 28±2^{o}C for 6 days on a rotary shaker (160 rpm).

Antagonistic activity of *Streptomyces* isolates

Seeds of flax cultivar Sakha 2 were planted on 1/12/2004 and 24/12/2005 in 25-cm-diameter clay pots (20 seeds/pot). The pots were distributed in a randomized complete block design of three replications under greenhouse conditions at Plant Pathol. Res. Instit., Giza. PM was allowed to develop naturally, mixture of mycelium and spores of sixteen *Streptomyces* isolates were applied as foliar spray. Two diluents (water and starch nitrate broth (SNB) medium) and two dilutions of *Streptomyces* antagonist (2 and 4 % v/v) were used. The *Streptomyces* mixture was applied to plants when the first sign of the disease was appeared. Two foliar sprays of each *Streptomyces* isolate were applied on 12 and 29 March 2005 and on 4 and 17 April 2006. Powdery mildew incidence (PMI) were determined on 15 plants/pot and Powdery mildew severity (PMS) were rated visually on 19 April 2005 and on 3 May 2006 as described by **Nutter *et al.* (1991**). PMI was measured as the percentage of infected plants/pot. PMS was measured as the percentage of infected leaves/plant in a random sample of 10 plants/pot. At harvest, seed yield and straw yield were recorded for each plant.

Statistical analysis

Analysis of variance (ANOVA) of the data was performed with the MSTAT-C statistical package (A microcomputer program for the design, Management and Analysis of Agronomic Research Experiments, Michigan State Univ., USA). Least significant difference (LSD) was used to compare isolate means, PMI and PMS data were transformed into arc sine angles before carrying out the analysis of variance to produce approximately constant variance. Correlation and regression analysis were performed with a computerized program.

Results and Discussion

To the best of our knowledge, this is the first attempt to biologically control of PM of flax by the application of the *Streptomyces* isolates in Egypt. **Aly *et al.* (1994)** reported that *O. lini* Škoric is the causal agent of PM in flax. They also showed that the fungus attacks all the above ground parts of flax. **Mansour (1998)** mentioned that the fungus occurs wherever flax is cultivated in Egypt. Early infection may cause severe defoliation of the flax plant and reduce quantity and quality of yield. This could be illustrated in Fig. 1.

In this study, effect of *Streptomyces* isolates, kind of diluents and amount of dilution of antagonist on PMI, PMS, seed yield, and straw yield were studied under greenhouse conditions in 2005 and 2006 growing seasons. In 2005, analysis of variance presented in Table 1 showed that *Streptomyces* isolates were the only significant source of variation in PMI. Comparisons of the overall means of *Streptomyces* isolates revealed that the isolates could be divided into 3 distinct groups. Group 1 included Sc-2, Ma-13, Ga-51, Sc-11, Qa-44, and Ga-84, which were the most effective isolates in reducing PMI, the efficiency of this group ranged from 51 to 79%. Group 2 included isolates Qa-53, Da-3, Si-1, and Si-4, which showed intermediate level of efficiency ranged from 35 to 42%. Group 3 included Si-8, S16, Is-10, Si-6, Ps-12, and Si-9, which showed the least efficiency in reducing PMI efficiency from 15 to 26% (Table 2). This could be due to the differences of antagonistic substances (such antibiotics or others) produced by these *Streptomyces* isolates and their variation in effect on PM suppression. Isolates, kind of diluent and isolate x dilution of antagonist interaction were the only significant sources of variation in PMS (Table 1). Due to the significance of this interaction, LSD was used to compare between isolate means within dilution of antagonist. These comparisons showed that when dilution of antagonist was 2%, Sc-2, Sc-11, Ma-13, Qa-44, and Qa-51 were the most effective isolates in reducing PMS, while Ps-12 and Si-9 were the least effective ones. When dilution of antagonist increased to 4%, isolates Sc-2, Sc-11, Ma-13, Qa-44, and Qa-51 were the most effective isolates, while Is-10, Ps-12, and S16 were the least effective ones (Table 3). Isolates were the only significant source of variation in seed yield (Table 1). Comparisons of the overall means of isolates showed that Da-3, Ma-13, Ps-12, Si-1, Sc-2, and Sc-11 were the most effective isolates in increasing seed yield (Table 4). Isolates, kind of diluent, dilution of antagonist, and their interaction were all nonsignificant sources of variation in straw yield (Tables 1 and 5).

In 2006, isolates, kind of diluent, isolate x kind of diluent, dilution of antagonist and isolate x dilution of antagonist interaction were the only significant source of variation in PMI (**Table 7**). Due to the significance of isolate x kind of diluent interaction, LSD was used to compare the individual means of isolates within diluents. Sc-2, Q-44, Qa-53, and Qa-84 were the most effective isolates in reducing PMI, while Si-9, S16, and Si-8 were the least effective isolates in reducing PMI when water was used as a diluent. Sc-2, Qa-44, Qa-53, and Sc-11 were the most effective isolates in reducing PMI and Si-9, and S16 were the least effective isolates in reducing PMI when SNB medium was used as diluent. Due to the significance of isolate x dilution interaction, LSD was used to compare between isolate means within dilutions. It was found that Sc-2, Qa-44, Si-1, and Qa-53 were the most effective isolates in reducing PMI, while Si-9 and S16 were the least effective ones in reducing PMI when the dilution was 2%. When dilution reached to 4%, Sc-2, Sc-11, Qa-44, and Qa-53 were the most effective isolates in reducing PMI, while Si-8, Si-9, and S16 were the least effective ones (Table 7). Isolates, kind of diluent and dilution of antagonist were the only significant source of variation in PMS (Table 6). The overall means of the isolates showed that all isolates were significantly reduced PMS and the most effective isolates in reducing PMS were Qa-44, Sc-2, Si-1, Sc-11, Qa-51, Si-4, and Ma-13. On the other hand, Si-8, Si-9, and S16 were the least effective isolates in reducing PMS compared to the control.

Water as a diluent significantly reduced PMS ($p \leq 0.05$), on the other hand dilution of antagonist 2% significantly reduced PMS (Table 8). ANOVA presented in Table (6) showed that isolates were the only significant source of variation in seed yield. Comparisons of overall means of isolates revealed that Sc-2, Is-10, Sc-11, Ma-13, Qa-51, Qa-53, and Qa-84 were the most effective isolates in increasing seed yield but Si-4, and Si-9 were the least effective isolates in increasing seed yield compared with the control (Table 9). Isolates were the only significant source of variation in straw yield (Table 6). Comparisons of the overall means of isolates showed that Si-1, Qa-53, Si-8, Qa-51, and Ma-13 were the most effective isolates in increasing straw yield where Sc-2, Da-3, and Si-9 were the least effective isolates in increasing straw yield compared with the control (Table 10). Disease incidence, disease severity and seed yield relationship were shown in Fig. 2. Results showed that when percentages of disease incidence and disease severity increased, the seed yield decreased. In other word, a negative relationship between PM of flax disease incidence, disease severity and seed yield was noted. On the other hand, no significant correlation was observed between straw yield and each of PMI ($r = 0.157$) and PMS ($r = -0.056$).

PMI and PMS were used as criteria for evaluating the antagonistic efficiency of the *Streptomyces* isolates, and seed yield and straw secreted yield were used to study the effect of PM on plant productivity. Disease incidence and disease severity were significantly suppressed and yield was increased by the application of some of the tested isolates. The efficiency of these isolates in controlling the disease could be attributed to the production of extracellular lytic enzymes in particular chitinase or antibiotics. The suppression of PM fungi by chitinase from *Streptomyces* is well documented in the literature (**Toyoda *et al*., 1991; Ikeda *et al*., 1992** and **Haran *et al*., 1993**). The results of the present study indicate that diluents (delivery system) play an important role in determining the efficiency of *Streptomyces* isolates as biocontrol agents. The variability in antagonistic ability among the isolates could be attributed to variation in their ability to produce chitinase. Our results demonstrated that foliar application of *Streptomyces* could be a successful and environmentally safe alternative to chemical fungicides for controlling powdery mildew of flax.

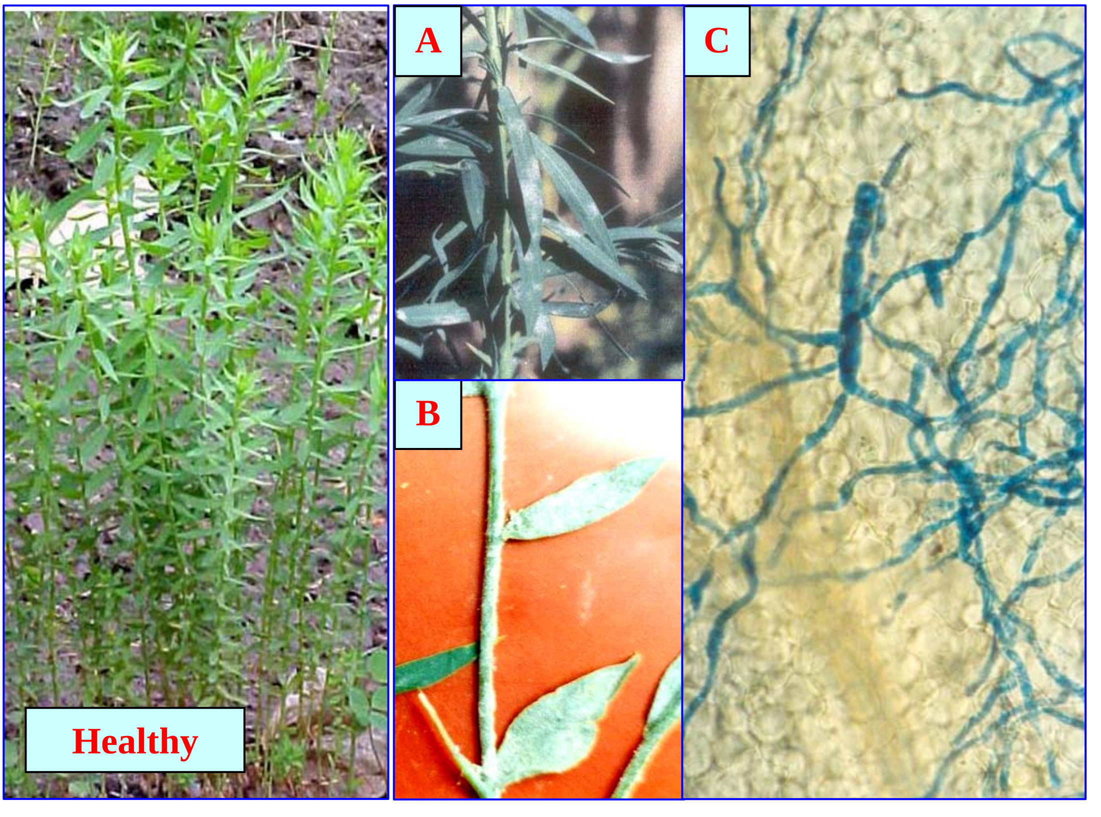

Fig. (1): General view of healthy flax plants show no powdery spots. PM severity on flax leaf (A & B). *O. lini* the causal agent of PM in flax (C).

Table (1): Analysis of variance of the effect of *Streptomyces* isolates, kind of diluent, dilution of antagonists and their interactions on powdery mildew and yield of flax cultivar Sakha 2 under greenhouse conditions in 2005 based on arc-sine transformed data.

Source of variation	df	Powdery mildew incidence			Powdery mildew severity			Seed yield			Straw yield		
		MS	F. value	P>F	MS	F. value	P>F	MS	F. value	P>F	MS	F.value	P>F
Replication	2	1344.455	17.0836	0.0000	1061.387	17.9020	0.0000	0.060	12.9515	0.0000	0.485	0.9298	--------
Isolates (S)	16	2358.642	29.9706	0.0000	2942.617	49.6321	0.0000	0.028	6.0811	0.0000	0.642	1.3212	0.2525
Diluent (r)	1	191.033	2.4274	0.1216	476.076	8.0298	0.0053	0.001	0.1437	--------	0.216	0.4145	--------
S x r	16	121.773	1.5473	0.0923	96.490	1.6275	0.0697	0.004	0.9421	--------	0.458	0.8786	--------
Dilution (C)	1	2.892	0.0368	--------	141.467	2.3861	0.1248	0.003	0.6224	--------	0.394	0.7548	--------
S x C	16	87.100	1.1067	0.3551	109.418	1.8455	0.0313	0.003	0.5927	--------	0.532	1.0199	0.4400
r x C	1	124.004	1.5757	0.2116	79.713	1.3445	0.2483	0.000	0.0765	--------	0.249	0.4767	--------
S x r x C	16	69.620	0.8846	--------	90.706	1.5299	0.0980	0.004	0.7558	--------	0.574	1.1007	0.3607
Error	134	78.699	--------	--------	59.289	--------	--------	0.005	--------	--------	0.521	--------	--------

Table (2): Effect of *Streptomyces* isolates, kind of diluent and dilution of antagonist, and their interactions on incidence[a] of powdery mildew on flax cultivar Sakha 2 under greenhouse conditions in 2005.

Kind of Diluent	Dilution of antagonist (%)	*Streptomyces* isolates											
		Sc-2		Sc-11		Ma-13		Qa-44		Qa-51		Qa-53	
		%	Trans-formed	%	Trans-formed	%	Trans-formed	%	Trans-formed	%	Trans-formed	%	Trans-formed
Water	4	20.00	(21.93)[b]	20.00	(26.07)	36.67	(87.22)	40.00	(39.15)	33.33	(35.22)	63.33	(53.15)
	2	30.00	(32.71)	20.00	(26.50)	43.00	(41.07)	50.00	(45.00)	53.33	(47.30)	53.33	(47.01)
	Mean	25.00	(27.32)	20.00	(26.29)	39.84	(39.15)	45.00	(42.08)	43.33	(41.26)	58.33	(50.08)
Media	4	30.00	(26.50)	40.00	(38.86)	40.00	(39.15)	43.33	(41.07)	33.33	(35.22)	46.67	(42.99)
	2	20.00	(33.00)	43.33	(41.15)	36.67	(37.22)	40.00	(38.86)	36.67	(37.22)	63.33	(53.15)
	Mean	25.00	(29.75)	41.67	(40.01)	38.34	(38.19)	41.67	(39.97)	35.00	(36.22)	55.00	(48.07)
Mean overall		25.00	(28.54)	30.84	(33.15)	39.09	(38.67)	43.34	(41.03)	39.17	(38.74)	56.67	(49.08)
Mean of Dilution	4	59.70	(51.91)										
	2	59.40	(52.19)										

Table (2) Cont.

Kind of Diluent	Dilution of antagonist (%)	*Streptomyces* isolates											
		Qa-84		Da-3		Is-10		PS-12		Si-1		Si-4	
		%	Trans-formed	%	Trans-formed	%	Trans-formed	%	Trans-formed	%	Trans-formed	%	Trans-formed
Water	4	40.00	(39.23)	56.67	(48.93)	83.33	(66.14)	83.33	(70.07)	63.33	(53.07)	60.00	(50.85)
	2	43.33	(41.15)	36.67	(37.22)	53.33	(46.92)	86.67	(76.92)	63.33	(53.85)	53.33	(46.90)
	Mean	41.67	(40.19)	46.67	(43.08)	68.33	(56.53)	85.00	(73.50)	63.33	(53.46)	56.67	(48.88)
Media	4	46.67	(48.08)	63.33	(53.15)	86.67	(72.29)	80.00	(63.93)	63.33	(52.78)	66.67	(54.99)
	2	46.67	(43.08)	66.67	(55.86)	76.67	(61.22)	83.33	(66.14)	60.00	(50.85)	63.33	(52.92)
	Mean	46.67	(45.58)	65.00	(54.51)	81.67	(66.76)	81.67	(65.04)	61.67	(51.82)	65.00	(53.96)
Mean overall		44.17	(42.89)	55.84	(48.80)	75.00	(61.65)	81.34	(69.27)	62.50	(52.64)	60.84	(51.42)
Mean of Dilution	4												
	2												

Table 2. Cont.

Kind of Diluent	Dilution of antagonist (%)	***Streptomyces* isolates**											
		Si-6		**Si-8**		**Si-9**		**S16**		**Control**		**Mean**	
		%	**Trans-formed**	**%**	**Trans-formed**	**%**	**Trans-formed**	**%**	**Trans-formed**	**%**	**Trans-formed**	**%**	**Trans-formed**
Water	4	80.00	(63.93)	60.00	(51.93)	80.00	(63.93)	66.67	(54.99)	93.33	(77.69)	57.64	(50.21)
	2	83.33	(66.14)	80.00	(68.07)	80.00	(63.43)	83.33	(66.14)	93.33	(77.71)	58.61	(52.00)
	Mean	81.67	(65.04)	70.00	(60.00)	80.00	(63.68)	75.00	(60.57)	93.33	(77.70)	58.13	(51.11)
Media	4	80.00	(68.07)	73.33	(59.21)	83.33	(66.14)	73.33	(59.00)	100.00	(90.00)	61.76	(53.61)
	2	70.00	(57.00)	70.00	(57.79)	83.33	(66.14)	66.67	(54.78)	96.67	(83.86)	60.20	(52.37)
	Mean	75.00	(62.53)	71.67	(58.50)	83.33	(66.14)	70.00	(56.89)	98.34	(86.93)	60.98	(52.99)
Mean overall		78.34	(63.79)	70.84	(59.25)	81.67	(64.91)	72.50	(58.73)	95.84	(82.32)	59.56	(52.05)
Mean of Dilution	4												
	2												

		(p≤0.05)	(p≤0.01)
LSD (transformed data) for:	Isolates (S	7.163	9.46
	Diluent (r)	NS	NS
	S x r	NS	NS
	Dilution (C)	NS	NS
	S x C	NS	NS
	r x C	NS	NS

[a] Disease incidence (percentage of infected plants in a random samples of 15 plants/pot) was transformed into arc-sine angles before carrying out analysis of variance. Transformed means are shown in parentheses. [b] Mean of three replicates.

Table (3): Effect of *Streptomyces* isolates, kind of diluent and dilution of antagonist and their interactions on severity[a] of powdery mildew on flax cultivar Sakha 2 under greenhouse conditions in 2005.

Kind of Diluent	Dilution of antagonist (%)	***Streptomyces* isolates**											
		Sc-2		**Sc-11**		**Ma-13**		**Qa-44**		**Qa-51**		**Qa-53**	
		%	**Trans-formed**	**%**	**Trans-formed**	**%**	**Trans-formed**	**%**	**Trans-formed**	**%**	**Trans-formed**	**%**	**Trans-formed**
Water	4	5.55	(11.11)[b]	8.19	(16.26)	9.90	(18.31)	18.49	(25.12)	8.67	(17.05)	21.62	(27.48)
	2	15.60	(22.91)	5.07	(12.95)	19.88	(26.21)	21.40	(27.24)	23.82	(28.80)	18.36	(25.17)
	Mean	10.58	(17.01)	6.63	(14.61)	14.89	(22.26)	19.95	(26.18)	16.25	(22.93)	19.99	(26.33)
Media	4	9.77	(17.69)	11.02	(18.95)	13.45	(21.03)	12.42	(20.49)	12.27	(19.96)	19.82	(25.49)
	2	9.77	(18.16)	12.41	(20.32)	14.27	(21.71)	19.68	(26.16)	9.20	(17.55)	34.47	(35.80)
	Mean	9.77	(17.93)	11.72	(19.64)	13.85	(21.37)	16.05	(23.33)	10.74	(18.76)	27.15	(30.65)
Mean overall		10.18	(17.47)	9.18	(17.13)	14.37	(21.82)	18.00	(24.76)	13.50	(20.85)	23.57	(28.49)
Mean of Dilution	4	31.18	(33.21)										
	2	33.81	(34.88)										

Table (3):Cont.

Kind of Diluent	Dilution of antagonist (%)	*Streptomyces* isolates											
		Qa-84		Da-3		Is-10		PS-12		Si-1		Si-4	
		%	Trans-formed	%	Trans-formed	%	Trans-formed	%	Trans-formed	%	Trans-formed	%	Trans-formed
Water	4	8.25	(16.65)	24.61	(29.66)	36.12	(36.90)	49.09	(43.96)	18.80	(25.52)	15.90	(23.22)
	2	14.37	(21.91)	13.63	(21.53)	28.37	(32.09)	61.40	(51.62)	31.53	(33.24)	20.34	(26.68)
	Mean	11.31	(19.28)	19.12	(25.60)	32.25	(34.50)	55.25	(47.79)	25.17	(29.38)	18.12	(24.95)
Media	4	29.61	(32.89)	34.00	(35.60)	64.72	(53.60)	45.74	(42.52)	15.05	(22.64)	22.78	(23.27)
	2	17.44	(24.53)	34.43	(35.84)	53.28	(46.91)	73.04	(58.72)	20.26	(26.38)	23.26	(28.30)
	Mean	23.53	(28.71)	34.22	(35.72)	59.00	(50.26)	59.39	(50.62)	17.66	(24.51)	23.02	(28.29)
Mean overall		17.42	(24.00)	26.67	(30.66)	45.63	(42.38)	37.32	(49.21)	21.42	(26.95)	20.57	(26.62)
Mean of Dilution	4												
	2												

Table (3) Cont.

Kind of Diluent	Dilution of antagonist (%)	***Streptomyces* isolates**											
		Si-6		**Si-8**		**Si-9**		**S16**		**Control**		**Mean**	
		%	**Trans-formed**	**%**	**Trans-formed**	**%**	**Trans-formed**	**%**	**Trans-formed**	**%**	**Trans-formed**	**%**	**Trans-formed**
Water	4	40.86	(39.71)	33.39	(34.00)	47.52	(43.65)	32.94	(34.68)	98.69	(84.72)	28.15	(31.06)
	2	43.73	(41.38)	51.17	(45.89)	62.54	(52.34)	46.31	(42.87)	74.79	(64.73)	32.49	(33.97)
	Mean	42.30	(40.55)	42.28	(39.95)	55.03	(48.00)	39.63	(38.78)	86.74	(74.73)	30.32	(32.52)
Media	4	48.80	(45.87)	49.34	(44.55)	46.09	(42.74)	47.50	(43.58)	98.96	(85.29)	34.20	(35.36)
	2	25.14	(29.79)	43.50	(40.62)	69.62	(54.91)	39.26	(38.48)	98.25	(84.07)	35.13	(35.78)
	Mean	36.97	(37.83)	46.42	(42.59)	57.86	(48.83)	43.38	(41.03)	98.60	(84.68)	34.67	(35.57)
Mean overall		39.67	(39.19)	44.35	(41.27)	56.45	(48.42)	41.50	(39.91)	92.67	(79.71)	32.50	(34.05)
Mean of Dilution	4												
	2												

		($p \leq 0.05$)	($p \leq 0.01$)
LSD (transformed data) for:	Isolates (S)	6.217	8.214
	Diluent (r)	2.133	2.817
	S x r	NS	NS
	Dilution (C)	NS	NS
	S x C	8.793	NS
	r x C	NS	NS
	S x r x C	NS	NS

a Disease severity (percentage of infected leaves/plant in a random sample of 10 plants/pot) was transformed into arc-sine angles before carrying out analysis of variance. Transformed means are shown in parentheses.

[b] Mean of three replicates.

Table (4): Effect of *Streptomyces* isolates, kind of diluent and dilution of antagonist, and their interactions on seed yield[a] of flax cultivar Sakha 2 under greenhouse conditions in 2005.

Kind of Diluent	Dilution of antagonist (%)	*Streptomyces* isolates																	
		Sc-2	Sc-11	Ma-13	Qa-44	Qa-51	Qa-53	Qa-84	Da-3	Is-10	Ps-12	Si-1	Si-4	Si-6	Si-8	Si-9	S16	Control	Mean
Water	4	0.26[b]	0.22	0.34	0.25	0.28	0.27	0.22	0.26	0.21	0.23	0.34	0.24	0.21	0.20	0.18	0.16	0.18	0.24
	2	0.29	0.31	0.23	0.24	0.27	0.24	0.28	0.31	0.31	0.27	0.30	0.19	0.22	0.19	0.19	0.17	0.18	0.25
	Mean	0.28	0.27	0.29	0.25	0.28	0.26	0.25	0.29	0.26	0.25	0.32	0.22	0.22	0.20	0.19	0.17	0.18	0.25
Media	4	0.26	0.29	0.28	0.30	0.28	0.27	0.25	0.30	0.20	0.35	0.25	0.17	0.21	0.14	0.17	0.12	0.15	0.23
	2	0.27	0.28	0.33	0.24	0.24	0.32	0.28	0.29	0.24	0.30	0.23	0.14	0.21	0.20	0.16	0.14	0.23	0.24
	Mean	0.27	0.29	0.31	0.27	0.26	.030	0.27	0.30	0.22	0.33	0.24	0.16	0.21	0.17	0.17	0.13	0.19	0.24
Mean overall		0.28	0.28	0.30	0.26	0.27	0.28	0.026	0.30	0.24	0.29	0.28	0.19	0.22	0.19	0.18	0.15	0.19	0.25
Mean of Dilution	4	0.24																	
	2	0.25																	

		($p \leq 0.005$)	($p \leq 0.001$)
LSD for:	Isolates (S)	0.057	0.075
	Diluent (r)	NS	NS
	S x r	NS	NS
	Dilution (C)	NS	NS
	S x C	NS	NS
	r x C	NS	NS
	S x r x C	NS	NS

[a] Seed yield (g/plant).

[b] Mean of three replicates.

Table (5): Effect of *Streptomyces* isolates, kind of diluent and dilution of antagonist, and their interactions on straw yield[a] of flax cultivar Sakha 2 under greenhouse conditions in 2005.

Kind of Diluent	Dilution of antagonist (%)	*Streptomyces* isolates																
		Sc-2	**Sc-11**	**Ma-13**	**Qa-44**	**Qa-51**	**Qa-53**	**Qa-84**	**Da-3**	**Is-10**	**PS-12**	**Si-1**	**Si-4**	**Si-6**	**Si-8**	**Si-9**	**S16**	**Control**	**Mean**
Water	4	0.81[b]	0.94	1.21	0.88	0.87	0.97	0.81	0.87	0.86	1.00	1.49	1.08	1.02	1.06	1.01	0.84	0.89	0.98
	2	1.01	1.05	0.80	0.91	1.04	0.91	0.86	0.93	1.14	0.97	1.34	1.11	1.26	1.01	1.03	1.00	0.86	1.01
	Mean	0.91	1.00	1.01	0.90	0.96	0.94	0.84	0.90	1.00	0.99	1.42	1.10	1.14	1.04	1.01	0.92	0.88	1.00
Media	4	1.12	0.92	0.96	1.02	1.06	1.12	0.96	1.14	0.90	1.22	1.21	1.16	1.27	0.93	0.84	0.106	0.75	1.04
	2	0.88	0.87	1.11	0.94	0.90	1.12	1.04	1.03	0.96	1.37	1.08	0.92	1.20	1.15	0.79	0.89	1.06	1.02
	Mean	1.00	0.90	1.04	0.98	0.98	1.12	1.00	1.09	0.93	1.30	1.15	1.04	1.24	1.04	0.82	0.98	0.91	1.04
Mean		0.96	0.95	1.03	0.94	0.97	1.03	0.92	1.00	0.97	1.15	1.29	1.07	1.19	1.04	0.92	0.95	0.90	1.02
Mean of Dilution	4	1.01																	
	2	1.02																	

LSD for:		($p \leq 0.005$)	($p \leq 0.001$)
	Isolates (S)	NS	NS
	Diluent (r)	NS	NS
	S x r	NS	NS
	Dilution (C)	NS	NS
	S x C	NS	NS
	r x C	NS	NS
	S x r x C	NS	NS

[a] Straw yield (g/plant).

[b] Mean of three replicates.

Table (6): Analysis of variance of the effect of *Streptomyces* isolate, kind of diluent, dilution of antagonists and their interactions on powdery mildew and yield of flax cultivar Sakha 2 under greenhouse conditions in 2006 based on arc-sine transformed data.

Source of variation	df	Powdery mildew incidence			Powdery mildew severity			Seed yield			Straw yield		
		MS	**F. value**	**P>F**	**MS**	**F. value**	**P>F**	**MS**	**F. value**	**P>F**	**MS**	**F. value**	**P>F**
Replication	2	1690.762	28.4912	0.0000	128.150	2.2633	0.1080	0.116	69.0575	0.0000	0.012	0.9713	--------
Isolates (S)	16	3145.823	53.0106	0.0000	3334.187	58.8852	0.0000	0.009	5.3324	0.0000	0.038	3.2002	0.0001
Diluent (r)	1	838.594	14.1313	0.0003	245.061	4.3280	0.0394	0.005	3.0849	0.0813	0.005	0.3770	--------
S x r	16	362.536	6.1091	0.0000	85.207	1.5048	0.1067	0.001	0.8567	--------	0.010	0.8532	--------
Dilution (C)	1	334.054	5.6292	0.0191	229.702	4.0568	0.0460	0.001	0.5376	--------	0.003	0.2363	--------
S x C	16	188.952	3.1841	0.0001	64.791	1.1443	0.3217	0.002	1.1654	0.3037	0.011	0.9161	--------
r x C	1	6.751	0.1138	--------	59.995	1.0596	0.3052	0.000	0.1050	--------	0.015	1.2102	0.2733
S x r x C	16	89.073	1.5010	0.1081	92.537	1.6343	0.0680	0.002	1.0083	0.4520	0.015	1.2318	0.2521
Error	134	59.343	--------	--------	56.622	--------	--------	0.002	--------	--------	0.012	--------	--------

Table (7): Effect of *Streptomyces* isolates, kind of diluent and dilution of antagonist, and their interactions on incidence[a] of powdery mildew on flax cultivar Sakha 2 under greenhouse conditions in 2006.

Kind of Diluent	Dilution of antagonist (%)	*Streptomyces* isolates											
		Sc-2		Sc-11		Ma-13		Qa-44		Qa-51		Qa-53	
		%	Trans-formed	%	Trans-formed	%	Trans-formed	%	Trans-formed	%	Trans-formed	%	Trans-formed
Water	4	20.00	(26.07)[b]	36.67	(37.14)	40.00	(39.23)	23.33	(28.78)	46.67	(43.08)	40.00	(28.49)
	2	33.33	(35.22)	4.00	(39.15)	40.00	(39.15)	30.00	(33.21)	40.00	(39.23)	30.00	(33.21)
	Mean	26.67	(30.65)	38.34	(38.15)	40.00	(39.19)	26.67	(31.00)	43.34	(41.16)	35.00	(30.85)
Media	4	23.33	(28.79)	40.00	(39.23)	50.00	(45.00)	60.00	(50.83)	43.33	(41.07)	33.33	(35.22)
	2	26.67	(31.00)	33.33	(35.22)	53.33	(47.01)	33.33	(35.22)	46.67	(43.08)	36.67	(36.93)
	Mean	25.00	(29.90)	36.67	(37.23)	51.67	(46.01)	46.67	(43.03)	45.00	(42.08)	35.00	(36.08)
Mean		25.84	(30.28)	37.51	(37.69)	45.84	(42.60)	36.67	(37.02)	44.17	(41.62)	35.00	(33.47)
Mean of Dilution	4	55.30	(50.32)										
	2	51.67	(48.35)										

Table (7): Cont.

Kind of Diluent	Dilution of antagonist (%)	*Streptomyces* isolates											
		Qa-84		Da-3		Is-10		PS-12		Si-1		Si-4	
		%	Trans-formed	%	Trans-formed	%	Trans-formed	%	Trans-formed	%	Trans-formed	%	Trans-formed
Water	4	33.33	(34.93)	56.67	(48.93)	36.67	(40.14)	46.67	(42.08)	53.33	(46.92)	50.00	(45.29)
	2	26.67	(31.00)	53.33	(46.92)	36.67	(57.22)	76.67	(61.22)	30.00	(33.21)	53.33	(46.92)
	Mean	30.00	(32.97)	55.00	(47.93)	36.67	(48.68)	61.67	(51.65)	41.67	(40.07)	51.67	(46.11)
Media	4	66.67	(55.07)	60.00	(50.85)	56.67	(48.93)	56.67	(48.82)	26.67	(31.00)	33.33	(35.22)
	2	43.33	(40.78)	70.00	(57.00)	46.67	(42.99)	43.33	(57.29)	26.67	(31.00)	50.00	(39.06)
	Mean	55.00	(47.93)	65.00	(53.93)	51.67	(45.96)	50.00	(56.98)	26.67	(31.00)	55.00	(37.14)
Mean overall		42.50	(40.45)	60.00	(50.93)	44.17	(47.32)	55.84	(54.32)	34.17	(35.54)	53.34	(41.63)
Mean of Dilution	4												
	2												

Table (7): Cont.

Kind of Diluent	Dilution of antagonist (%)	*Streptomyces* isolates											
		Si-6		Si-8		Si-9		S16		Control		Mean	
		%	Trans-formed	%	Trans-formed	%	Trans-formed	%	Trans-formed	%	Trans-formed	%	Trans-formed
Water	4	53.33	(57.79)	96.67	(83.86)	73.33	(59.71)	90.00	(71.57)	100.00	(90.00)	52.75	(48.47)
	2	36.67	(37.22)	86.67	(68.86)	66.67	(55.78)	70.00	(46.79)	100.00	(90.00)	50.00	(46.72)
	Mean	45.00	(47.51)	91.67	(76.36)	70.00	(57.75)	80.00	(59.18)	100.00	(90.00)	51.38	(47.60)
Media	4	76.67	(66.14)	63.33	(52.86)	96.67	(83.86)	96.67	(83.86)	100.00	(90.00)	57.84	(52.16)
	2	50.00	(45.00)	66.67	(60.00)	90.00	(78.93)	90.00	(78.93)	100.00	(90.00)	53.33	(49.97)
	Mean	63.34	(55.57)	65.00	(56.28)	93.34	(81.40)	93.34	(81.40)	100.00	(90.00)	55.59	(51.07)
Mean overall		54.17	(51.54)	78.34	(66.32)	81.67	(69.58)	86.67	(70.29)	100.00	(90.00)	53.49	(49.37)
Mean of Dilution	4												
	2												

LSD (transformed data) for:		($p \leq 0.05$)	($p \leq 0.01$)
	Isolates (S)	6.220	8.218
	Diluent (r)	2.133	2.819
	S x r	8.797	11.62
	Dilution (C)	2.133	NS
	S x C	8.797	11.62
	r x C	NS	NS
	S x r x C	NS	NS

[a] Disease incidence (percentage of infected plants in a random samples of 15 plants/pot) was transformed into arc-sine angles before carrying out analysis of variance. Transformed means are shown in parentheses. [b] Mean of three replicates.

Table (8): Effect of *Streptomyces* isolates, kind of diluent and dilution of antagonist, and their interactions on severity[a] of powdery mildew on flax cultivar Sakha 2 under greenhouse conditions in 2006.

Kind of Diluent	Dilution of antagonist (%)	*Streptomyces* isolates											
		Sc-2		Sc-11		Ma-13		Qa-44		Qa-51		Qa-53	
		%	Trans-formed	%	Trans-formed	%	Trans-formed	%	Trans-formed	%	Trans-formed	%	Trans-formed
Water	4	13.60	(21.07)[b]	13.93	(21.87)	13.11	(21.13)	6.93	(15.20)	22.18	(27.38)	12.22	(32.75)
	2	17.52	(24.19)	13.96	(21.83)	12.01	(20.24)	7.99	(15.87)	9.91	(18.34)	14.18	(21.65)
	Mean	15.56	(22.63)	13.95	(21.85)	12.56	(20.69)	7.46	(15.54)	16.05	(22.86)	13.20	(27.20)
Media	4	10.53	(18.69)	18.22	(25.26)	22.46	(27.89)	15.24	(22.80)	17.87	(24.99)	16.14	(23.67)
	2	9.24	(17.42)	12.99	(21.01)	15.55	(22.39)	7.69	(15.71)	13.54	(21.30)	21.54	(25.88)
	Mean	9.89	(18.06)	15.61	(23.14)	19.01	(25.14)	11.47	(19.26)	15.71	(23.15)	18.84	(24.78)
Mean overall		12.73	(20.35)	14.78	(22.50)	15.79	(22.92)	9.46	(17.40)	15.88	(23.01)	16.02	(25.99)
Mean of Dilution	4	31.33	(33.94)										
	2	29.14	(31.82)										

Table (8): Cont.

Kind of Diluent	Dilution of antagonist (%)	*Streptomyces* isolates											
		Qa-84		Da-3		Is-10		PS-12		Si-1		Si-4	
		%	Trans-formed	%	Trans-formed	%	Trans-formed	%	Trans-formed	%	Trans-formed	%	Trans-formed
Water	4	9.69	(17.82)	15.88	(22.68)	19.69	(26.32)	23.11	(28.65)	13.96	(21.91)	17.73	(24.51)
	2	19.78	(26.28)	29.21	(32.13)	36.18	(35.60)	27.68	(31.22)	13.96	(21.89)	13.34	(21.30)
	Mean	14.74	(22.05)	22.55	(27.41)	27.94	(30.96)	25.40	(29.94)	13.96	(28.88)	15.54	(22.91)
Media	4	25.69	(30.45)	25.73	(30.29)	29.78	(33.05)	18.09	(25.04)	27.95	(28.71)	19.20	(25.96)
	2	25.94	(29.84)	31.20	(33.83)	21.18	(27.38)	25.42	(30.25)	5.33	(13.32)	18.00	(24.97)
	Mean	25.82	(30.15)	28.45	(32.06)	25.48	(30.22)	21.76	(27.65)	15.14	(21.02)	18.60	(25.47)
Mean overall		20.28	(26.10)	25.50	(29.74)	26.71	(30.59)	23.58	(28.80)	14.55	(24.95)	17.07	(24.19)
Mean of Dilution	4												
	2												

Table (8): Cont.

Kind of Diluent	**Dilution of antagonist (%)**	***Streptomyces* isolates**											
		Si-6		**Si-8**		**Si-9**		**S16**		**Control**		**Mean**	
		%	**Trans-formed**	**%**	**Trans-formed**	**%**	**Trans-formed**	**%**	**Trans-formed**	**%**	**Trans-formed**	**%**	**Trans-formed**
Water	4	32.80	(34.92)	69.23	(59.57)	51.75	(46.00)	45.26	(42.27)	98.95	(84.98)	28.24	(32.30)
	2	20.54	(26.62)	43.43	(41.22)	46.89	(43.12)	51.21	(47.36)	98.29	(82.53)	28.00	(31.26)
	Mean	26.67	(30.77)	56.33	(50.40)	49.32	(44.56)	48.24	(44.82)	98.62	(83.76)	28.12	(31.78)
Media	4	50.47	(45.26)	38.77	(38.29)	70.56	(57.21)	79.61	(63.17)	98.91	(84.01)	34.42	(35.57)
	2	23.69	(28.39)	57.69	(49.55)	60.78	(51.24)	66.42	(54.89)	98.39	(82.89)	30.27	(32.37)
	Mean	37.08	(36.83)	47.73	(43.92)	65.67	(54.23)	73.02	(59.03)	98.65	(83.45)	32.35	(33.97)
Mean overall		31.88	(33.80)	52.03	(47.16)	57.50	(49.40)	60.63	(51.93)	98.64	(83.61)	30.23	(32.88)
Mean of Dilution	4												
	2												

		($p \leq 0.05$)	($p \leq 0.01$)
LSD (transformed data) for:	Isolates (S)	6.076	8.027
	Diluent (r)	2.084	NS
	S x r	NS	NS
	Dilution (C)	2.084	NS
	S x C	NS	NS
	r x C	NS	NS
	S x r x C	NS	NS

[a] Disease severity (percentage of infected leaves/plant in a random sample of 10 plants/pot) was transformed into arc-sine angles before carrying out analysis of variance. Transformed means are shown in parentheses. [b] Mean of three replicates.

Table (9): Effect of *Streptomyces* isolates, kind of diluent and dilution of antagonist, and their interactions on seed yield[a] of flax cultivar Sakha 2 under greenhouse conditions in 2006.

Kind of Diluent	Dilution of antagonist (%)	*Streptomyces* isolates																	
		Sc-2	**Sc-11**	**Ma-13**	**Qa-44**	**Qa-51**	**Qa-53**	**Qa-84**	**Da-3**	**Is-10**	**PS-12**	**Si-1**	**Si-4**	**Si-6**	**Si-8**	**Si-9**	**S16**	**Control**	**Mean**
Water	4	0.21[b]	0.18	0.16	0.15	0.14	0.19	0.15	0.15	0.16	0.17	0.21	0.14	0.13	0.20	0.09	0.17	0.09	0.16
	2	0.21	0.18	0.16	0.19	0.21	0.15	0.19	0.16	0.19	0.17	0.12	0.11	0.11	0.15	0.10	0.10	0.09	0.15
	Mean	0.21	0.18	0.16	0.17	0.18	0.17	0.17	0.16	0.18	0.17	0.17	0.13	0.12	0.18	0.10	0.14	0.09	0.16
Media	4	0.18	0.13	0.18	0.16	0.17	0.17	0.14	0.13	0.17	0.13	0.20	0.12	0.15	0.14	0.14	0.12	0.08	0.15
	2	0.19	0.16	0.17	0.14	0.13	0.16	0.18	0.17	0.16	0.13	0.14	0.10	0.14	0.12	0.12	0.15	0.08	0.14
	Mean	0.19	0.15	0.18	0.15	0.15	0.17	0.16	0.15	0.17	0.13	0.17	0.11	0.15	0.13	0.13	0.14	0.08	0.15
Mean overall		0.20	0.17	0.17	0.16	0.17	0.17	0.17	0.16	0.18	0.15	0.17	0.12	0.14	0.16	0.12	0.14	0.09	0.16
Mean of Dilution	4	0.16																	
	2	0.15																	

LSD for:		($p \leq 0.05$)	($p \leq 0.01$)
	Isolates (S)	0.03611	0.04771
	Diluent (r)	NS	NS
	S x r	NS	NS
	Dilution (C)	NS	NS
	S x C	NS	NS
	r x C	NS	NS
	S x r x C	NS	NS

[a] Seed yield (g/plant).

[b] Mean of three replicates.

Table (10): Effect of *Streptomyces* isolates, kind of diluent and dilution of antagonist, and their interactions on straw yield[a] of flax cultivar Sakha 2 under greenhouse conditions in 2006.

Kind of Diluent	Dilution of antagonist (%)	*Streptomyces* isolates																	
		Sc-2	**Sc-11**	**Ma-13**	**Qa-44**	**Qa-51**	**Qa-53**	**Qa-84**	**Da-3**	**Is-10**	**PS-12**	**Si-1**	**Si-4**	**Si-6**	**Si-8**	**Si-9**	**S16**	**Control**	**Mean**
Water	4	0.34[b]	0.35	0.39	0.30	0.36	0.48	0.37	0.36	0.44	0.44	0.49	0.35	0.42	0.49	0.25	0.42	0.21	0.38
	2	0.24	0.40	0.39	0.47	0.50	0.36	0.42	0.28	0.45	0.32	0.29	0.49	0.26	0.39	0.34	0.27	0.19	0.36
	Mean	0.29	0.38	0.39	0.39	0.43	0.42	0.40	0.32	0.45	0.38	0.39	0.42	0.34	0.44	0.30	0.35	0.20	0.37
Media	4	0.35	0.34	0.39	0.38	0.40	0.40	0.31	0.27	0.37	0.36	0.55	0.32	0.39	0.36	0.37	0.28	0.19	0.35
	2	0.34	0.39	0.40	0.34	0.36	0.48	0.44	0.34	0.40	0.32	0.44	0.28	0.43	0.37	0.33	0.37	0.22	0.37
	Mean	0.35	0.37	0.40	0.36	0.38	0.44	0.38	0.31	0.39	0.34	0.50	0.30	0.41	0.37	0.35	0.33	0.21	0.36
Mean overall		0.32	0.38	0.40	0.38	0.41	0.43	0.39	0.32	0.42	0.36	0.45	0.36	0.38	0.41	0.33	0.34	0.21	0.37
Mean of Dilution	4	0.37																	
	2	0.37																	

LSD for:		($p \leq 0.05$)	($p \leq 0.01$)
	Isolates (S)	0.08845	0.1169
	Diluent (r)	NS	NS
	S x r	NS	NS
	Dilution (C)	NS	NS
	S x C	NS	NS
	r x C	NS	NS
	S x r x C	NS	NS

[a] Straw yield (g/plant). [b] Mean of three replicates.

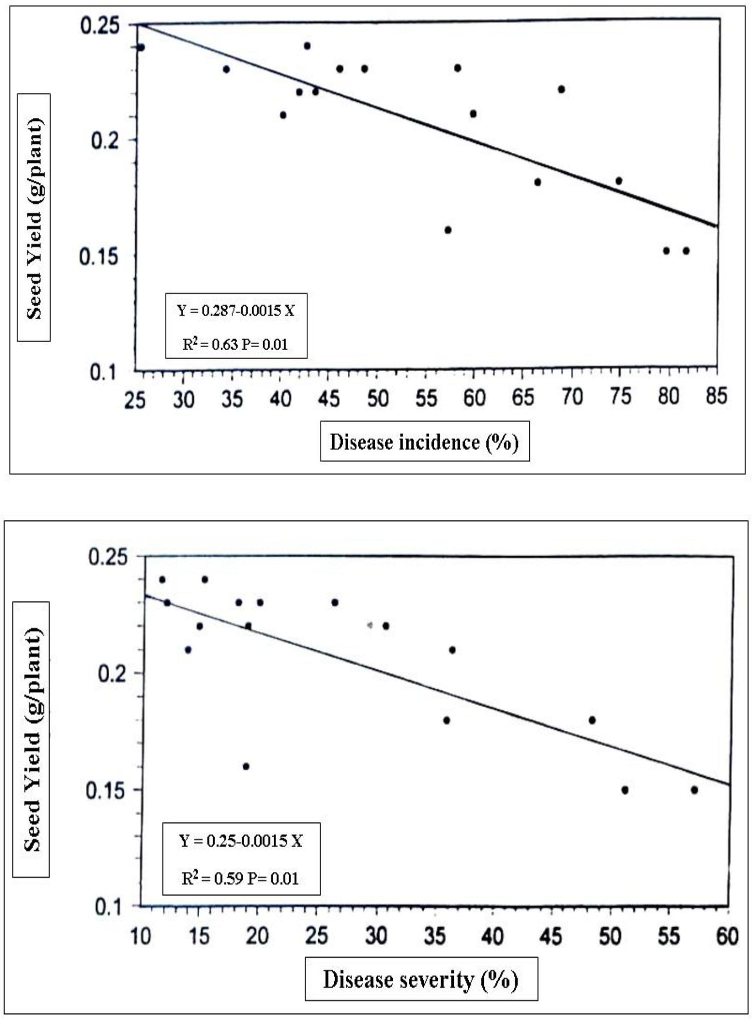

Fig. (2): Relationship between powdery mildew of flax disease incidence, disease severity and seed yield.

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كبح مرض البياض الدقيقى على الكتان
باستعمال بكتريا الإستربتوميسس رشاً على المجموع الخضرى

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إنه لمن المعروف أن أفضل طريقة إقتصادية لمقاومة مرض البياض الدقيقي في الكتان من خلال استخدام أصناف مقاومة. كما إن التبكير لميعاد الزراعة سوف يؤدي الي خفض تأثير المرض علي محصول البذور وذلك لمنع وبائية المرض. ولهذا فإن هذه الدراسة تم تقييم تأثير 16 عزلة من بكتريا الإستربتوميسس علي حدوث مرض البياض الدقيقى (PMI) وشدة المرض (PMS) ومحصول البذرة ومحصول القش لنباتات الكتان صنف سخا 2 تحت ظروف الصوبة خلال موسمى النمو 2005 ، 2006. وبعد تحضين عزلات الأستربتوميسس لمدة 6 أيام في جهاز رج تم تجهيز تخفيفان من مخلوط النمو المكون من الجراثيم والراشح وهما 4% و 2% في كل من الماء وبيئة النمو وهي بيئة نيترات النشا السائلة قبل التطبيق. وفي نهاية موسم النمو 2005 أظهرت نتائج التحليل الأحصائي أن عامل عزلات الأستربتوميسس ذات درجة p=0.01 كانت المصدر الوحيد للتباين المعنوي علي الـ PMI. وفيما يتعلق بالـ PMS فإن عزلات الإستربتوميسس ونوع المادة المستخدمه في التخفيف وتفاعل العزلات X النشاط التضادي للتخفيفات بدرجات p=0.01, p=0.01 , p=0.05 علي التوالي قد تبين أنهم مصادر معنوية للتباين فى شدة المرض. أما بالنسبة لمحصول البذرة فكانت عزلات الإستربتوميسس هى المصدر الوحيد المعنوي للتباين بدرجة P=0.01 . وعند مقارنة المتوسط العام للزيادة في محصول البذرة ظهر أن أكثر العزلات كفاءة هي Da-3 ، Ma-13 ، P2-12 ، Si-1 ، Sc-2 ، Sc-11. وعلي الجانب الآخر فإن كل من العزلات ونوع المادة المستخدمه للتخفيف والتخفيفات وتفاعلاتهم كانوا مصادر غير معنوية للتباين بالنسبة لمحصول القش. فى عام 2006 كانت العزلات (P=0.01) ونوع المادة المستخدمه للتخفيف (P=0.01) والتفاعل بين العزلات والمادة المخففه (P=0.01) والتخفيفات (P=0.05) ونفاعل العزلات × التخفيفات (P=0.01) كلها مصادر معنوية للتباين بالنسبة لـ PMI. ومشابها لتلك النتائج فإن مصدر التباين المعنوي بالنسبة لشدة المرض (PMS) كانت العزلات ونوع المادة المخففه والتخفيفات بدرجات P=0.05 ، P=0.05 ، P=0.01 علي التوالي. أما بالنسبة لمحصول البذرة ومحصول القش فكانت العزلات هى المصدر الوحيد للتباين وخاصة العزلات Qa-53 ، Qa-51 ، Ma-13 حيث أدت لزيادة معنوية فى محصول البذرة والقش. تبرهن نتائج الدراسة الحالية على أن استعمال بكتيريا الإستربتوميسس رشاً على المجموع الخضرى قد يكون بديل ناجح وآمن بيئياً للمبيدات الكيماوية عند مقاومة مرض البياض الدقيقى على الكتان.